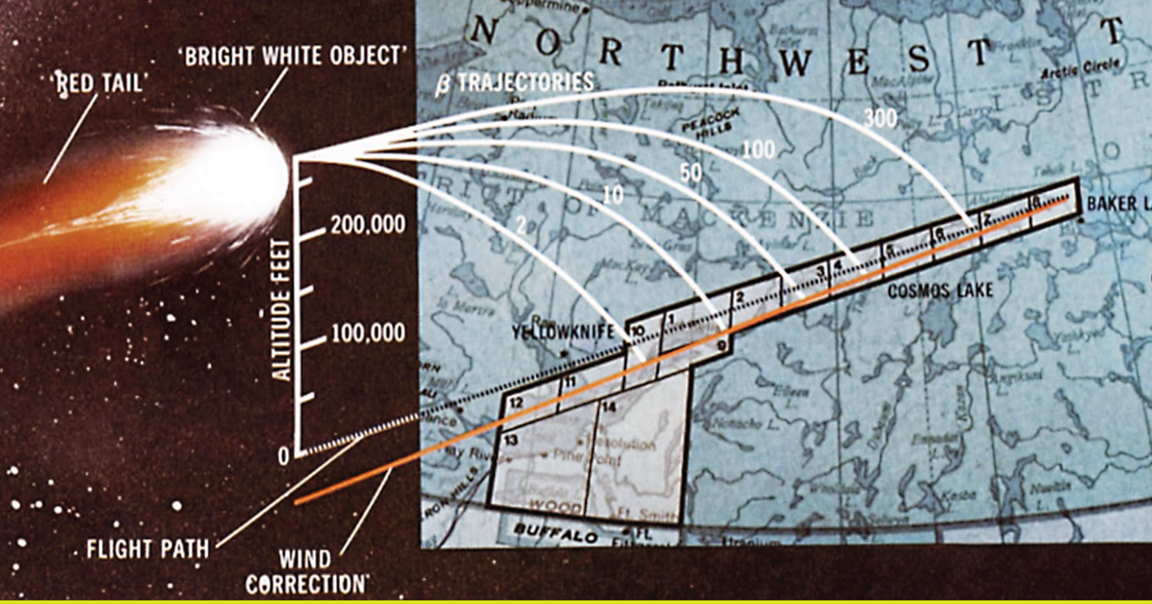
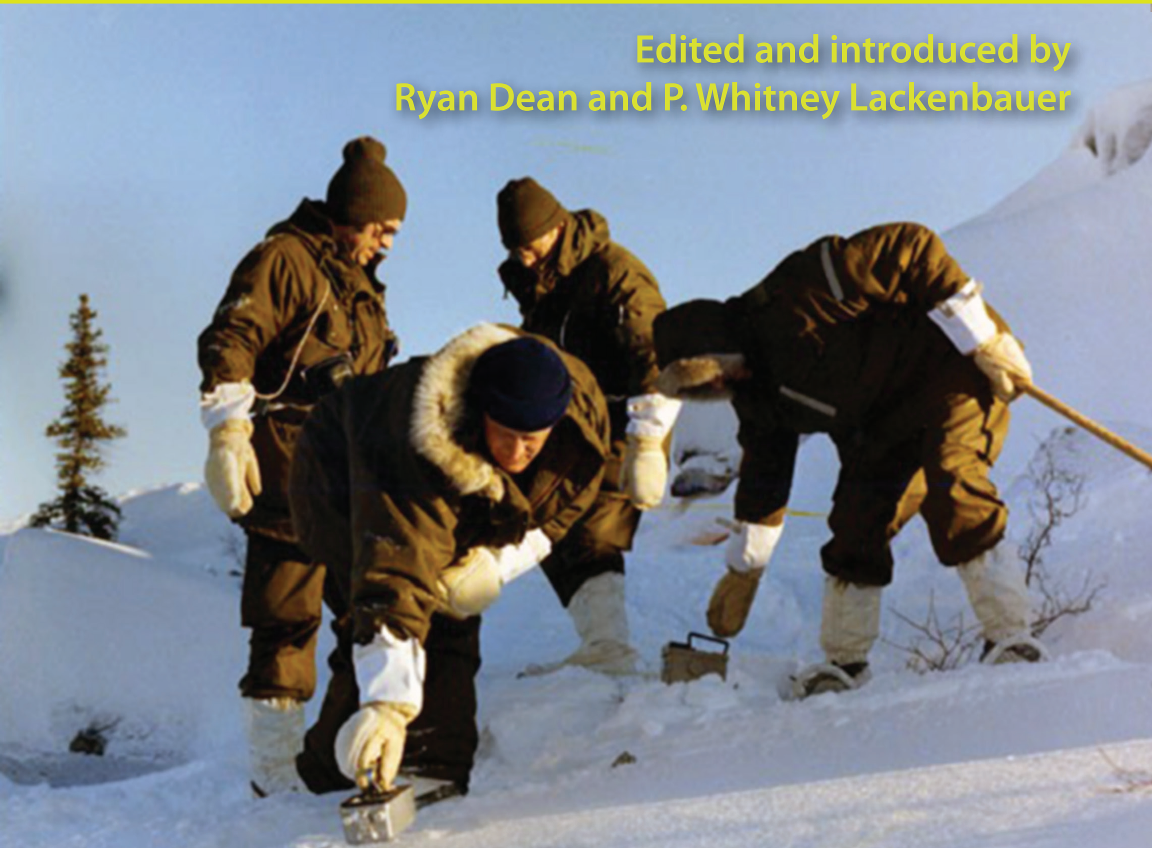


OPERATION MORNING LIGHT

Edited and introduced by
Ryan Dean and P. Whitney Lackenbauer



Operation Morning Light
An Operational History

CFB Edmonton Report

Edited and Introduced by
Ryan Dean and
P. Whitney Lackenbauer

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Operation Morning Light was accomplished through the combined efforts of people from two countries with a multiplicity of expertise. Without the joint free and frank cooperation of all of the people involved, the recovery of the radioactive debris from the Soviet Cosmos 954 would not have been nearly so successful, expeditious or most importantly, so safe. To all of the people involved and their organizations, the Canadian Government is indebted. The long hours of tough work under severe Arctic weather conditions combined with the unfamiliar and unknown circumstances encountered daily challenged every individual involved. Despite these obstacles people made the Operation a success. I am extremely proud to have been in command of such dedicated individuals and it is to their conspicuous credit that the goals of the Operation were achieved without serious accident.

- Colonel D.F. Garland (1978)

The Arctic Operational History Series

The Arctic Operational History Series seeks to provide context and background to Canada's defence operations and responsibilities in the North by resuscitating important, but forgotten, Canadian Armed Forces (CAF) reports, histories, and defence material from previous generations of Arctic operations.

Since the CAF's reengagement with the Arctic in the early 2000s, experience has demonstrated the continuity of many of the challenges and frictions which dominated operations in decades past. While the platforms and technologies used in previous eras of Arctic operations are very different, the underlying challenges – such as logistics, communications, movement, and sustainment – remain largely the same. Unfortunately, few of the lessons learned by previous generations are available to today's operators. To preserve these lessons and strengthen the CAF's ties to its northern history, this series is reproducing key reports and histories with direct relevance to CAF operations today.

Adam Lajeunesse
Series Editor

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INTRODUCTION

"The Satellite that Came into the Cold"[1]

Ryan Dean and P. Whitney Lackenbauer

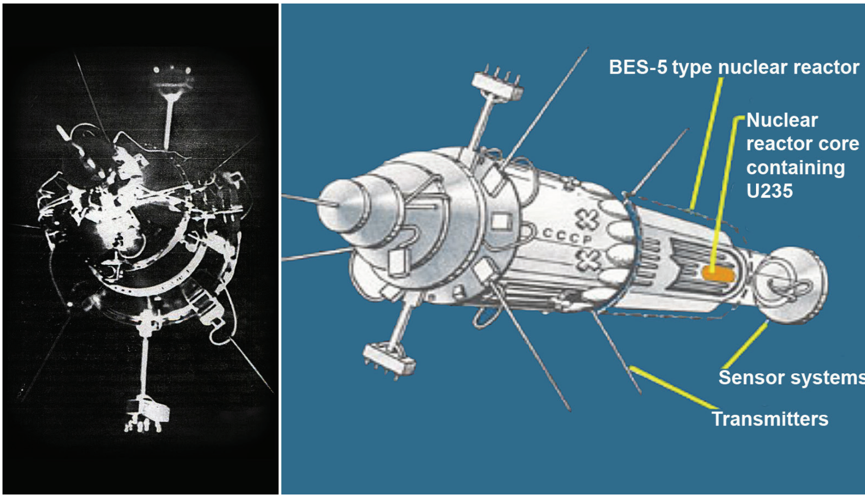
As Cosmos 954, a Soviet Radar Ocean Reconnaissance Satellite (RORSAT), tumbled across the early morning sky over Yellowknife on 24 January, witnesses reported that the object "looked like a jet on fire... with flaming jet stream." Local resident Marie Ruman recounted that the main body of Cosmos was followed by "dozens of little pieces" with smaller but similar flaming tails that glowed a bright red.[2] Cosmos 954's power-plant, a nuclear reactor fuelled with approximately 45.5 kg of enriched uranium-235 to operate the large radar array, had failed to eject from the stricken craft and boost itself into a higher disposal orbit as designed to do. As the satellite broke up plunging through the atmosphere, its reactor compartment failed, spewing out radioactive fuel 55-60 kilometres above the Earth's surface. Scientists were concerned about the uranium-235 as well as other long-lived reactor by-products, such as the isotopes strontium-90 and cesium-137 that could contaminate the area.[3]

During its three-minute burn through the upper atmosphere on 24 January, Cosmos debris scattered from the western edge of Great Slave Lake, tracking east-north-easterly over an 800-km stretch along the Thelon River,

[1] Gus W. Weiss, "The Satellite that Came into the Cold: The Life and Death of Cosmos 954" *CIA Historical Review Program* 22 (1978): 1. Of course, the Canadian North (even in the heart of winter) is significantly warmer than the vacuum of space.

[2] Roland Semjanovs "Satellite looked 'like a jet on fire'; witness" *Yellowknifer, 13* January 1978.

[3] U.S. Department of Energy (DoE), *Operation Morning Light: Canadian Northwest Territories, 1978 -- A Non-Technical Summary of United States Participation* (September 1978), 67, 71; "The unscheduled return of Cosmos 954," *Science News* 113:5 (2 April 1978): 69.



through the barrens, to the region just north of Baker Lake. Authorities were quick to respond. A 22-person Canadian Forces Nuclear Accident Support Team (NAST) had been sent from Canadian Forces Base (CFB) Edmonton to Yellowknife that morning to begin their preliminary assessment of radioactive contamination and recovery of satellite debris.[4] "The normally easy-going citizens of Yellowknife were startled by the sight of yellow-garbed troops walking the streets, reading radiation meters and taking air samples," Major W.R. Aikman observed.[5]

Operation Morning Light, which brought fascination with outer space and the Canadian North together with a dose of concern about nuclear safety and the implications of superpower antagonism for North Americans, unfolded over the next 84 days. The NAST was the lead element of a task force of Canadian soldiers, scientists, and American specialists who combed the projected debris area for radioactive wreckage. This recovery effort

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[4] DoE, *Operation Morning Light*, 8, 11.
[5] Major W.R Aikman, "Operation Morning Light" *Sentinel* 14, no.2 (1978/2): 6. He noted that "tension dropped when negative results were announced." While Yellowknife was spared from contamination, analysts projected that massive radioactive objects could survive re-entry and reach the Earth's surface further down range towards Baker Lake. DoE, *Operation Morning Light*, 12n.

spanned 24,000 square kilometres of sub-arctic wilderness in conditions that dipped below -40°C.[6] Much of this activity took place from the hastily constructed military "tent city" known as Camp Garland (also referred to as Cosmos Lake in the literature) in the Thelon Game Sanctuary where the first large piece of debris was discovered.[7] Specially-equipped CC-130 Hercules aircraft flew search patterns to detect "hits" of radiation, while helicopters carried recovery teams to find and secure the radioactive debris. Encasing the remnants of the fallen satellite in specially constructed lead-lined containers, these materials were then transported to Baker Lake or Yellowknife. From there, Cosmos 954's radioactive remains were flown to CFB Edmonton for preliminary analysis. In this manner, Operation Morning Light successfully recovered 66 kg of wreckage, with all but one 17.7 kg piece proving to be radioactive.[8]

Shortly after the operation concluded, author Leo Heaps and official historian C.A. Morrison produced books examining the failure of Cosmos 954 and the subsequent challenges of Operation Morning Light. The cover of Heap's popular history *Operation Morning Light* boasts the hyperbolic tag line: "it was a science-fiction nightmare come true!"[9] Filled with anecdotes from those involved in the operation, the book preys on popular fears about radioactivity for dramatic effect. Written at least in part as a corrective to Heap's flawed and sensationalist version of events, Morrison's more traditional and technical history *Voyage into the Unknown* emphasizes the

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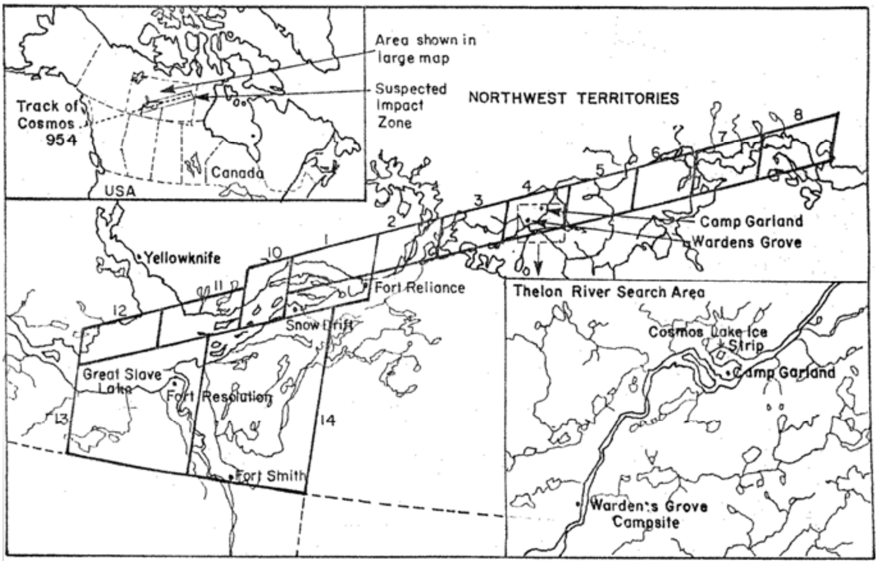
[6] "Canada Wants Cash for Cosmos 954 Cleanup," *Science* 203 (16 February 1979): 632-3; W.K. Gummer, "Summary of Cosmos 954 Search and Recovery Operation" (Ottawa: Atomic Energy Control Board, January 1979), 1.

[7] Nancy Cooper, "Forces end search for Soviet satellite parts," *Globe and Mail,* April 8, 1978; and Major Bill Aikman, "Ice Strip on the Thelon: They Story of Camp Garland," *Sentinel* 14:2 (1978/2): 17-9.

[8] W.K. Gummer, F.R. Campbell, G.B. Knight, and J.L Ricard, *Cosmos 954: The Occurrence and Nature of Recovered Debris* (Ottawa: Minister of Supply and Services Canada, 1980), iii.

[9] Leo Heaps, *Operation Morning Light: The True Story of Canada's Nuclear Nightmare* (Toronto: Random House, 1978).



difficulties that searchers had to overcome in their recovery operations.[10] Morrison treats Operation Morning Light as a prototypical case study in recovery and clean-up when nuclear-powered satellites fail.[11] As the first mission of its kind to locate and remove radioactive debris that had fallen to earth from space, which happened to be scattered across a difficult operating environment, Morrison ultimately considered Morning Light to be a resounding success.[12]

This volume in the Arctic Operational History Series publishes for the first time the previously classified CFB Edmonton Operation Morning Light Final Report. The report is a collation of the final data produced by Canadian federal departments and agencies in the immediate aftermath of the operation. Prepared for internal use within the Department of National

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[10] C.A Morrison, *Voyage into the Unknown: The search and recovery of Cosmos 954* (Stittsville, ON: Canada's Wings, 1983), 120.
[11] Ibid., 4; and Heaps, *Operation Morning Light*, 181. For more on satellite failures in general, see Les Johnson, *Sky Alert! When Satellites Fail* (Chichester, UK: Springer-Praxis Books, 2013).
[12] Morrison, *Voyage into the Unknown*, 120-1.

Defence (DND),[13] this key document is organized around four primary themes: the military's ability to accomplish its mission, bi-national operations, multi-departmental operations, and operational techniques and equipment. By critically evaluating the methods, equipment, and personnel employed during Morning Light, this insightful report explains how the combination of civilian scientific expertise with military capabilities succeeded in overcoming large distances across a frigid, subarctic environment to effectively locate and recover the radioactive remnants of a downed nuclear-powered satellite.

Morning Light: Setting the Context

The Americans had good reason to track the launch and orbit of Cosmos 954 after it was launched on 18 September 1977. Fourteen metres long with a mass of 3500 kilograms, the nuclear-powered RORSAT was built around a powerful X-band radar that could look through thick cloud layers to scan the world's oceans for naval vessels (primarily American aircraft carriers, as Cosmos was able to track smaller warships like destroyers only in clear weather conditions). The small *Romashka* reactor on the spacecraft, which was powered by 90 percent enriched uranium-235 embedded in carbide and surrounded by a graphite moderator, also allowed the satellite to send its observations back to Moscow or directly to Soviet naval units and possibly even Tu-22 "Backfire" bombers.[14]

The U.S. became aware that Cosmos 954 was in trouble on 7 November 1977. North American Aerospace Defense Command (NORAD) noted Cosmos 954's slowly decaying orbit and began updating plots of when and where the satellite would re-enter the atmosphere. Most of these calculations were done at the Lawrence Livermore National Laboratory by engineer Milo

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[13] Foreword to CFB Edmonton, "Operation Morning Light Final Reports: Post-Operation Report" (hereafter "Post Operation Report"), Department of National Defence (DND), Directorate of History and Heritage (DHH) file 79/303, ii.
[14] Jeffrey T. Richelson, *Defusing Armageddon* (New York: W. W. Norton & Company Inc., 2009), 48-50; Weiss, "The Satellite that Came into the Cold," 1.

Bell and mathematician Ira Morrison, supported by engineer Robert Kelley. The trio had access to the highly sophisticated Control Data Corporation 7600 supercomputer, with its C-shaped frame stretching twenty feet and filling an entire room at the laboratory.[15] The simple problem was clear: "what does one *do* about a live nuclear reactor reentering the earth's atmosphere aboard a Soviet surveillance satellite?" Gus Weiss, a special assistant to the Secretary of Defense, explained how "a quick scan of literature showed no textbook answer, nor even a textbook question. It remained for the National Security Council [NSC] Staff to put together a group to cope with the problem."[16]

On 19 December, the NSC formed a working group (the *Ad Hoc* Committee on Space Debris) to prepare contingency plans and prepare to mount a quick search and recovery operation of Cosmos 954 if needed, thus birthing Operation Morning Light. Contributing agencies included the Central Intelligence Agency (CIA), the Department of Defense (DoD), the Department of Energy (DoE), the State Department, the Environmental Protection Agency (EPA), the Federal Preparedness Agency, and the Office of Attorney General. The NSC placed the DoE's nuclear emergency response capabilities on alert "to assist in the protection of public health and safety should radioactive debris from Cosmos 954 come to earth in the United States." This included organizations such as the Accident Response Group (ARG) and the Nuclear Emergency Search Team (NEST), which had the experts and equipment necessary to find and recover radioactive materials. Due to the "uncertainty in determining when or where (in the world) Cosmos 954 would reenter," experts anticipated "that there was no preventative or preparatory action that could be taken by the public." Subsequently, both the American public and the US's allies were kept in the dark until experts could plot a more accurate projection of Cosmo 954's return.[17]

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[15] DoE, *Operation Morning Light*, 66; Richelson, *Defusing Armageddon*, 53.
[16] Weiss, "The Satellite that Came into the Cold," 1.
[17] DoE, *Operation Morning Light*, 2.

In early January, Cosmos 954's orbit suddenly decayed precipitiously. Updated calculations estimated a reentry date of 24 January, but the location where the satellite would crash remained hazy. In an effort to secure some information from the Soviet Union regarding the radioactive hazard that Cosmos 954 posed, American authorities summoned Soviet Ambassador Anatoli Dobrynin. The Soviet response was rather sparse, noting that the power plant on the satellite was "explosive-proof" and was designed to burn up when it entered denser layers of the atmosphere. Nevertheless, the depressurization that had caused the satellite to lose control meant that some destroyed parts of the plant could still reach the earth's surface, and "in that case an insignificant local contamination may occur in the places of impact with earth which would require limited usual measures of cleaning up." One US official remarked that he was not sure what "'usual measures of cleaning up' a reactor crashing in from outer space might be, and there was also some ambiguity in the meaning of 'explosive-proof.'" Nevertheless, the firm knowledge that the nuclear reactor had been designed to burn up during re-entry offered a measure of comfort to American planners.[18]

By this time, computer modelling discerned the ultimate trajectory of Cosmos 954. Australia, Britain, Canada, Japan, and New Zealand were located along the wave-like orbital path of the doomed satellite. Weiss explained the predicament:

> Who should be informed by the United States, if anybody? What were our responsibilities to our allies and to the world for a problem which was not of our making but about which we knew? Skipping pros and cons, lists of countries, and the imponderable factor that the more nations informed, the greater the chance of a leak, the notification problem was surely disturbing. Mortals, with notorious shortcomings, should not have to make these judgments. But it had to be

[18] Weiss, "Satellite that Came into the Cold," 3-4. Heaps noted that Dobrynin, a former aerodynamic engineer, would only inform the US National Security Advisor that "Cosmos 954 was not an atomic bomb." *Operation Morning Light*, 27.

Operation Morning Light - Chronology of Events, COSMOS 934

	1977
September 18	Soviets launched Cosmos 954.
November	Intelligence sources determined Soviets experiencing difficulties.
December 1	Deputy Under Secretary of Defense for Policy (Admiral Murphy) alerted by his staff.
December 19	NSC interagency task force on space debris established (State, Defense, NASA, CIA, Energy and OSTP).
	1978
January 6	Through intelligence sources, determined Soviets had lost control of satellite; reentry date established January 23 or 24, 1978.
January 12	Approached Soviets on the issue.
January 14	Soviets' response confirmed that nuclear power source was on board and that they had lost control of satellite. Projected re-entry on January 24, 1978.
January 17-18	Informed key Congressional leaders (Byrd, O'Neill, Baker, Rhodes, Inouye and Boland) of problem and steps we were taking in event that the satellite landed in the United States.
January 17	Dr. Brzezinski memorandum making [the Department of Energy] responsible for clean-up and other safety considerations relating to possible re-entry in the United States, receiving support from Defense and from other agencies as appropriate. State was made responsible for foreign requests for assistance, calling on Energy and Defense as appropriate.
January 17	Approached Soviets for clarification.
January 18	Informed our allies and other countries with which we have a special relationship, e.g., tracking facilities.
January 19	Soviets responded, indicating the reactor would not go critical and that it was designed to disintegrate during re-entry.
January 20	The Department Energy Task Force went into operation.

January 22	Approached the Soviets and asked if there were any new developments.
January 23	Soviet response indicated that re-entry was projected for January 24, 1978.
Januarv 24	Satellite re-entered atmosphere at 658 a.m. EST over Queen Charlotte Island and impacted last at Great Slave Lake.
January 24	Prime Minister Trudeau was immediately informed that the satellite had landed in Canada. United States offered assistance in locating fallen debris and in cleanup. Trudeau accepted by a return telephone call to the President.
January 24	Dr. Brzezinski informed the Soviets that the satellite had landed in Canada.
January 24	AFTAC/MAC aircraft and Nuclear Energy Search Teams dispatched to Canada.

Source: Gus W. Weiss, "The Satellite that Came into the Cold: The Life and Death of Cosmos 954" *CIA Historical Review Program* 22 (1978): 7.

> done, and we went at it on the general approach of notifying our allies and some other countries with which we share such special relationships as tracking facilities. From those countries notified, State received uniform gratitude, but some governments were intensely upset over the slightest prospect that Cosmos 954 might land on their soil.[19]

While the countries who received information initiated their own preparations to deal with Cosmos 954, the U.S. DoE's field units were ready for deployment by 22 January, with all personnel on a two-hour alert and NEST equipment loaded onto four Air Force C-141 Starlifters at Andrews Air Force Base (AFB) in Washington D.C., Travis AFB in California, and McCarran International Airport in Nevada.[20]

[19] Weiss, "The Satellite that Came into the Cold," 4.
[20] DoE, *Operation Morning Light*, 2-3, 5; Aikman, "Operation Morning Light," 6.

Canada first learned that Cosmos 954 could crash in its territory on 19 January. The following day, DND alerted all regional commanders and its Nuclear Accident Support Team of the impending threat.[21] Air Command Headquarters alerted CFB Edmonton Base Commander Colonel D.F. Garland on 23 January that Cosmos would be entering Edmonton's Search and Rescue Region the following day, and the NAST was informed and placed on two-hour standby.[22] At this time, the Prime Minister's Office (PMO) notified several of the civilian departments of the threat that the satellite posed to the country and their responsibilities in the response effort. This meant that many of the key agencies and actors who became involved had less than twenty-four hours advance notice, and some did not receive notification until after it had crashed.[23]

As soon as American experts confirmed Cosmos 954's reentry over the NWT on the morning of 24 January, President Jimmy Carter contacted Prime Minister Pierre Trudeau and offered American assistance. Trudeau immediately accepted the President's offer. The principal mission for the U.S. NEST teams was to help the Canadian government locate radioactive debris. Accordingly, they enlisted American experts to provide technical assistance in calculating the reentry of the Cosmos and the ballistics properties that various pieces of it would likely exhibit in their fiery plunge back to Earth. This involved sophisticated reentry calculations and computer modelling, establishing the perimeters of the search area, and estimations of where larger pieces of debris would land.[24] NEST also operated aerial measuring equipment and assisted with ground recovery actitivities.[25] At the request of DND, the DoE provided two gamma ray spectrometers and operating personnel, who arrived in Edmonton on 24

[21] Gummer, "Summary of Cosmos 954 Search and Recovery Operation," 2.
[22] CFB Edmonton, "Post Operation Report," 3.
[23] Gummer, "Summary of Cosmos 954 Search and Recovery Operation," 2.
[24] DoE, *Operation Morning Light*, 8, 15-7. Canada's first contribution to this bilateral, collaborative effort was meteorological reports to enhance reentry modelling.
[25] DoE, *Operation Morning Light*, 62.

January to install their equipment on Canadian CC-130 Hercules aircraft. Canada provided the technical assistance to mount the detection equipment onto the aircraft, as well as on-site logistics support such as providing the NEST with military clothing for sub-arctic operations.[26]

Despite having received little to no advance warning, Canadian civilian scientists responded immediately and began arriving in Edmonton on mid-morning of 24 January – at roughly the same time as American NESTs, which had seven weeks of forewarning and preparation. The first of these scientists was Dr. Bob Grasty of the Geological Survey of Canada (GSC), whose expertise in aerial surveying for naturally-occurring uranium was mobilized to detect Cosmo 954's highly enriched uranium-235 core. A GSC gamma ray spectrometer designed for uranium exploration and mapping was quickly shipped, along with Grasty, from Ottawa to Edmonton that would enable the search.[27]

NORAD had provided Operation Morning Light with projections of Cosmo 954's probable debris field between Great Slave and Baker Lakes, delineated as an area 600km long and 50 km wide. The first phase of the operation called for CC-130s, specially equipped with gramma ray spectrometers to detect radiation emitted from the surface, to fly a grid pattern 1000 feet above ground level (AGL) over the suspected satellite crash area.[28] Aircrews quickly fell into a routine, Major Aikman described, and "the rhythm of the search developed. An aircraft would take off and fly for a

[26] Aikman, "Operation Morning Light," 6; DoE, *Operation Morning Light*, 8-9, 14.
[27] Aikman, "Operation Morning Light," 6. The spectrometer has just been built when it was sent to Edmonton for Operation Morning Light. Both the spectrometer and its designer Quinten Bristow, head of nuclear and analytical instrumentations for GSC, were soon aboard a CC-130 Hercules flying search patterns for Cosmos 954's radioactive debris. The machine cost GSC some $250,000 to construct. The agency was rewarded with detecting the first "hits" of radiation near Great Slave Lake. Barb Livingstone, "In Search of Radiation in Barren Land," *Edmonton Journal*, 2 February 1978.
[28] Gummer et al., *Cosmos 954,* 3, 8; Aikman, "Operation Morning Light," 5-6; DoE, *Operation Morning Light*, 25.

12 to 14 hour mission. Upon return it would refuel and take off again with a new crew and team of technicians. Fourteen hours later the cycle would begin again with another crew."[29] By 28 January the whole search area had been overflown at least once by CC-130 aircraft.[30]

The gamma ray spectrometers aboard the CC-130 Hercules proved much more effective in detecting Cosmos debris than specially-equipped U.S aircraft desgined to measure for radioactivity in the atmosphere.[31] While the pilots focused on carefully flying their intended search tracks under difficult conditions, "back in the cargo compartment, the [NEST] scientists took turns watching several needles as they slowly swayed up and down across a piece of graph paper, waiting for the telltale swing that would indicate a hit."[32] NEST members operating these devices quickly began registering "hits" along the search area, which were recorded on data tapes and then fed into NEST computer vans at Yellowknife and Baker Lake for analysis. "Each hour of search flight time for each of the C-130s created four hours of computer analysis time, creating a major assessment backlog," the DoE's official report recounted.[33] "Hits" would then be located on

[29] Aikman, "Operation Morning Light," 7. On NORAD, see Joseph T. Jockel, *No Boundaries Upstairs: Canada, the United States, and the Origins of North American Air Defence, 1945–1958* (Vancouver: UBC Press, 1987) and Jockel, *Canada in NORAD, 1957-2007* (Montreal: McGill-Queen's University Press, 2007).

[30] DoE, *Operation Morning Light*, 39.

[31] A special WC-135 Constant Phoenix aircraft, designed specifically to detect nuclear explosions, searched the atmosphere for radioactivity but failed to detect anything. A Convair 580 also contributed and, along with a Canadian CP-107 Argus, provided electronic, infrared, and photographic coverage of the search area. The Convair flew only one mission, however, before it returned to Las Vegas. In short, this early part of the search operation failed to yield any positive results to guide recovery operations. From 24-25 January, American U-2s flew high-altitude air sampling flights over Alberta, Saskatchewan, Michigan, and northern Ontario. Radioactive detection results from both flights were negative. DoE, *Operation Morning Light*, 14, 42; Richelson, *Defusing Armageddon*, 55-56.

[32] Aikman, "Operation Morning Light," 7.

[33] DoE, *Operation Morning Light*, 22. Data also was sent on to Los Alamos and Livermore for further study. Richelson, *Defusing Armageddon*, 64.

navigation charts[34] and helicopters fitted with detection equipment sent to these sites to precisely locate the radioactive source. One helicopter would drop a bright coloured streamer on the suspect site, and a second helicopter carrying a three-person recovery team would follow to inspect the area on the ground and recover any radioactive materials.[35]

The largest piece of debris, found through aerial search and location on 1 February, became known colloquially as the "stovepipe." Lieutenant Colonel Donald Davidson, the head of the search team that recovered this piece, recounted to excited reporters that it was evident "something [had] really gone through the ice at high speed." He elaborated that a strange looking canister was "all that's left sticking out, or maybe separate pieces. We don't know. We didn't pull it apart." Paul Murda, the leader of a five-man American scientific team that analyzed the object, described it as "sort of like a cylinder that got smashed," with what "looks like structural tubing"

[34] Gummer et al., *Cosmos 954,* 8.
[35] DoE, *Operation Morning Light*, 53-4.

sticking out the ends.[36] Fortunately it was not radioactive, which made its detection from the air a stroke of luck.[37]

On 4 February, another recovery team – wearing their trademark thick yellow coveralls, parkas, and Arctic boots, with radiation detectors hanging their waists[38] – disembarked from helicopters. As they "walk[ed] towards the suspected hit site their personal radiation dosimeters began emitting a high pitched chirping sound," Aikman recounted. "Soon the air was filled by what sounded like a field of crickets."[39] A clutch of beryllium rods and cylinders partially embedded in the snow and ice proved to be some of the most radioactive material found. When the recovery team, led by Atomic Energy Control Board (AECB) members Tom Robertson and Wick J. Courneya, cautiously approached the debris, their "Geiger-counter readings exceeded 100 roentgens per hour."[40] Courneya, a health physicist, put this level of radiation into perspective in a later interview. "If a person held [an object measuring some 200 roentgens] for one hour, he would probably get ill," he explained. "If a person held it for two hours, he probably would

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[36] Canadian Press "Searchers find satellite debris," *Fort McMurray Today*, 30 January 1978.

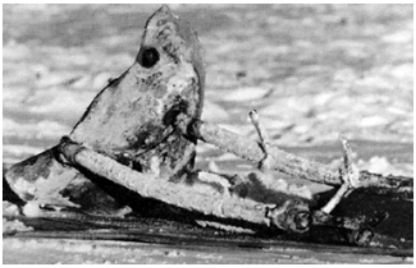
[37] Gummer et al., *Cosmos 954*, 2. Because the stovepipe was not radioactive, Yellowknifers hoped to secure the "stovepipe" for display at the Prince of Wales Northern Heritage Centre as part of its aviation collection. Resident Robert Penny originally hit upon the idea, worrying that "if we don't ask first, the National Museum might grab it." Penny, after consultation with the museum's advisory committee, hoped that the Soviets might even come themselves to officially present the piece. "After having it land without letting us know, they might just feel it would be a good public gesture to do this," Penny ventured. "Piece of satellite for posterity?" *Yellowknifer*, 2 February 1978. The "stovepipe" could be viewed at the Canada Science and Technology Museum in Ottawa according to Gummer et al., *Cosmos 954*, 4.

[38] John Noble Wilford, "Canadians Pick Up 'Hottest' Satellite Fragment Yet," *New York Times*, 6 February 1978.

[39] Aikman, "Operation Morning Light," 10.

[40] Wilford, "Canadians Pick Up 'Hottest' Satellite Fragment Yet."

die."[41] Accordingly, it was standard operating procedure after every mission to check recovery teams and aircrew for radiation, and "any item of clothing which produced a reaction on the meters was immediately removed."[42]



The most famous piece of recovered debris, known as "the antlers," was initially discovered by adventurers in the midst of a fifteen-month trip across northern Canada. Travelling from the Yukon into the Northwest Territories (NWT) along the Mackenzie River, the party was wintering over in the Thelon Game Sanctuary when Cosmos 954 broke-up in the skies above them.[43] At 2:30 in the morning on 26 January, Christopher Norment recorded that "we are awakened by a large, four-engined plane passing low over the cabin; it appears to be flying a grid pattern, as if it is conducting a search."[44] It was one of the CC-130 Hercules from Edmonton's 435 Transport Squadron searching for radioactive debris.[45]

Although the aerial search failed to turn up a "hit" in this area, John Mordhorst and Mike Mobley (both part of Norment's expedition) had undertaken a two-day dog sled from their camp at Warden's Cove to visit cabins erected by the English naturalist John Hornby and his party during their 1926-7 expedition (which Norment's group was retracing).[46] Crossing

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[41] Canadian Press "Satellite fragment is radioactive" *Fort McMurray Today*, 2 February 1978.
[42] Aikman, "Operation Morning Light," 12.
[43] DoE, *Operation Morning Light*, 33. For a complete record of their travels based off of diary entries, see Norment, *In the North of Our Lives*.
[44] Christopher Norment, *In the North of Our Lives* (Renssalaer, N.Y.: Hamilton Printing Co., 1989), 158.
[45] Aikman, "Operation Morning Light," 6.
[46] Edgar Christian, Harold Adlard, and Hornby spent 1926-7 in the Thelon River area, building cabins and hunting game. They missed the caribou migration however, and died of starvation in 1927. See Malcolm Waldron's, *Snow Man: John*

the frozen Thelon River en route back to their camp on 28 January, they came upon "an odd-looking metal object" which they stopped to examine.[47] When the pair returned to Warden's Cove they reported their discovery to Norment. He recalled:

> On the first night out we were sitting around the fire when a huge plane flew right over us. It looked like it was conducting a search and then this afternoon we found a strange object in the river ice just below Grassy Island, not more than a hundred yards from where we'd passed three days ago. There was this crater, six or seven feet across, where something hot had hit and melted into the ice, and several charred metal struts were visible.[48]

By then, news of the satellite's crash had been broadcasted all across Canada and the wider world. Norment had heard about it on his radio and had been visited two days earlier by land use officers interested in any signs of Cosmos. "You guys have found a goddamn (etc., etc.) Russian satellite!" exclaimed Norment.[49] The party radioed in their discovery.

The next day, a military CC-138 Twin Otter arrived with a recovery team to inspect and remove the adventurers and secure the debris. Norment recounted how:

> Two boffins in full protective regalia emerge with radiation detection devices and begin measuring contamination levels; the other passengers remain on board, awaiting word that it is safe to deplane. I can see faces peering out of the plane's windows, and I feel like an animal on display in a drive through wildlife park. The scientists run their instruments over the dogs and sled, and take readings of John and Mike. One of Mike's mitts is found to be very faintly radioactive, and it's confiscated… An hour later, a twin-engined Chinook

Hornby in the Barren Lands (Montreal & Kingston: McGill-Queen's University Press, 1997).

[47] DoE, *Operation Morning Light*, 33.

[48] Norment, *In the North of Our Lives*, 159.

[49] Ibid., 158-9.

> helicopter comes whopping into camp with a Hercules flying support and making large circles overhead. The Chinook disgorges twenty people…scientists, military types, photographers. Everyone is outfitted in what will become familiar attire: white insulated boots, regulation green overpants and parkas, and white-and-tan mitts with synthetic fur backing.[50]

The NAST team led by LCol Davidson pushed through the snow and scrub to the river. They found twisted metal protruding from the river like a pair of antlers. Their Geiger-counters produced readings of 10-1000 milliroentgens per hour, "not the several hundreds of roentgens per hour that the solid core would produce."[51]

Due to time constraints brought on by extreme cold and impending darkness, the recovery teams were flown out to Baker Laker by Chinook helicopters later that day. John, Mike, Christopher, and the rest of their party were loaded onto the Twin Otter and flown to Yellowknife before being sent to a hospital in Edmonton for further radiation testing. In light of growing concerns about members of the news media arriving at the unsecured site, as well as the welfare of the dogsled team that had to be left behind, the military dropped four paratroopers into Warden's Grove on the morning of 31 January to secure the area. The adventurers, meanwhile, were found to have absorbed the equivalent of one or two X-rays of radiation from their experience. After a press conference, the men were released from

[50] Ibid., 160.

[51] Aikman, "Operation Morning Light," 9.

hospital and hired by the military to act as guides in the Thelon Game Sanctuary to assist scientists before returning to their dogs and expedition.[52]

Over the course of Operation Morning Light, scientists used two general methods of data collection to determine if the uranium 235 core (or a part of it) survived re-entry and posed a risk to people and the surrounding environment. The first involved collecting ground samples along the debris field. The second method was aerial survey by helicopter-mounted gamma detectors flying search patterns. Surveyors found that particles were randomly distributed and far apart, and scientists concluded by early March that people living in the affected area had little to be concerned about.[53]

While officials were worried about a hysterical public reaction to the "first live nuclear object (spewing deadly nuclear radiation) tumbling in from the cold depths of outer space,"[54] analysis of regional newspaper coverage suggests that Northerners did not overreact. Jarvis Jason, the manager of a fried chicken outlet in Yellowknife, told a reporter on 26 January that the nuclear fall-out threat "doesn't really bother me at all. We've had these arsenic scares and things like that. After all, we're Yellowknifers."[55] More generally, *The Yellowknifer* newspaper editorialized in February 1978 that:

> It appears that people in the North, and particularly Yellowknife, have done it again. Acted in a peculiar manner. They did not fall apart and get hysterical and start evacuating the city when this newsworthy satellite entered our area. What did they expect the citizens to do? … Please, you Southerners, stop expecting us to react in a predictable manner – by now – at least the media – should know we are different.[56]

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[52] Ibid., 9; DoE, *Operation Morning Light*, 33.
[53] DoE, *Operation Morning Light*, 56, 58; Gummer et al., *Cosmos 954*, iii.
[54] Weiss, "The Satellite that Came into the Cold," 6.
[55] Hubert Johnson, "The Day Yellowknife Became Famous" *Edmonton Journal,* 26 January 1978, 64.
[56] "Yellowknifers didn't contract satellite hysteria," *The Yellowknifer,* 9 February 1978, 37.

"Is there enough left to determine what caused it to malfunction?"

Yellowknifer editor Sig Sigvaldason, already disillusioned with the federal government over its treatment of arsenic contamination in Yellowknife, had little faith in official reports. Rather than alarmist reporting, he lauded the economic boost that the influx of authorities and outside media brought to his community. "The Russians have contributed more to the economy of the Yellowknife area in a few days," he quipped, "than the Federal government does in a year." One of his stories suggested that "the only fallout one could observe so far were the media types who filled every available hotel space."[57] Cartoons in the Northern media also cast Operation Morning Light in a humorous or cynical light, appropriating the situation to poke fun at the influx of scientists and military personnel into the NWT and the environmental threats posed by radioactive debris.

[57] Heaps, *Operation Morning Light*, 53, 84.

While the debris area was large, barren, and sparsely populated, searchers were highly aware that it was also a homeland for humans.[58] "The inhabitants of the Northwest Territories in the path of the Cosmos 954 Satellite were concerned about their safety and it was necessary to undertake search and recovery operations so that the inhabitants could be assured that all debris dangerous to their health had been recovered," an official summary noted. Dan Billing, the Chief of Emergency Services for the Government of the Northwest Territories, explained that:

> There are approximately 10,000 persons who reside in the "hit-zone". The municipal councils of the Towns of Fort Smith, Hay River, Snowdrift, Fort Resolution and Pine Point expressed great concern for their citizens about the danger of the radio-active debris in their respective areas. Citizens['] committees were established in some of these municipalities for the purpose of expressing their concern about their safety. Signs were erected in these municipalities alerting the residents to report any sitings of unusual debris and to warn the citizens that this debris may be dangerous. Persons residing around Great Slave Lake were concerned that the drinking water and fish were unfit for human consumption. Residents were concerned that the caribou might be unsafe for human consumption. Residents restricted their normal use of of the territory for fear of contact with radio-active material. An area north of the Town of Snowdrift was restricted from any unauthorized travel for approximately one month.

Morning Light crews completed foot searches for radioactive material in the municipalities and around hunting and fishing lodges, finding radioactive debris in several of these locations.[59]

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[58] CFB Edmonton, "Post Operation Report," 22.

[59] Witness Dan Billing, Chief of Emergency Services, Government of the Northwest Territories, AECB 15-200-24-12-2 vol.2, ATIP A-2016-00082. On impacts on specific communities, see the reports on AECB file 15-200-24-12-2 vol.2, ATIP A-2016-00082.

In addition to checking towns and settlements, authorities were dispatched across the affected area to contact Northerners who were out on the land. Although distance and sub-arctic operating conditions complicated logistics, authorities were confident they had found all of the civilians in the search area by early 28 January and advised them of the possible hazards.[60] Authorities were particularly anxious about how they would explain the situation to many of the region's Indigenous inhabitants. "There was a common concern and generally not enough known about this strange element … translated from English to Chipewyan [as] 'poisonous,'" reporter Robert Blake explained. "There are no words in Chipewyan to adequately describe radioactivity, gamma ray sweepers and the like."[61] When a NAST team flew to the Chipewyan (Dene) community of Snowdrift (now Łutsel K'e), its inhabitants scattered. Canadian Northern Region Headquarters commander Brigadier General (BGen) Ken Thorneycroft flew to the village the next day to explain what was happening and to reassure local residents that no radiation had been detected near their community.[62]

While the reported results were reassuring, mixed official messaging left some observers skeptical. Reporter Mitchell Beer later recalled how:

> An Interdepartmental statement on March 3 called particles found in the Great Slave Lake region "undesirable nuisances," not serious enough to warrant changes in lifestyle or recreation, and Jack Werry, head of health operations at the Chalk River laboratories of Atomic Energy of Canada Ltd., said on March 1 that the radiation involved was below accepted limits. But at the same time, AECB's Dr. Roger Eaton was warning Fort Resolution residents not to make tea from the top layer of snow, or eat bones of game animals where radioactive elements would concentrate. And AECB-1157, an Interim report on the

[60] DoE, *Operation Morning Light*, 25.
[61] Robert Blake "Snowdrift safer than most places, General tells residents" *Yellowknifer*, 2 February 1978.
[62] Aikman, "Operation Morning Light," 9. See also Heaps's description of the visit (replete with offensive racial stereotypes) in Heaps, *Operation Morning Light*, 117-22.

> cleanup published in January, 1979, said the radioactivity of some particles "has been strong enough to be a potential risk to people if they were accidentally inhaled, ingested, or trapped on clothing."[63]

Although concerns never entirely dissipated, Morning Light's coordinated response offered credible reassurance to Northeners that their safety was of paramount importance, and that the search and recovery operations for debris appropriately addressed the most serious threats to human and environmental health.

"Think there's any chance fragments from the nuclear satellite will have an adverse effect on marine and wildlife around here?"

[63] Mitchell Beer, "Aftermath of Cosmos Crash," *Globe and Mail*, 25 October 1980.

Bi-National Operations

The American contribution reached its zenith two weeks into the operation, when 120 specialists in various fields were participating. Author Leo Heaps, in his dramatic account, observed that:

> When the Americans went into full gear with their immense back-up resources, there was very little in the world that would be able to equal them. The motive of competition, of sensitive pride where the Americans were concerned, was all one-sided. Canadians are traditionally apt to have some acute feelings in these matters. However, this was an emergency and the clear-headed Garland and his team appreciated the assistance. The American scientists and technicians stayed out of sight in spite of the urgings of their public relations man, allowing the Canadian scientists and military to make all the announcements. They would have their turn when they arrived home.[64]

Importantly, the sovereignty concerns that dominated most discussions of American involvement in the Canadian North since the Second World War were not in play.[65]

When the United States eventually published its official "non-technical" summary of the operation detailing its agencies' roles, it highlighted Morning Light as an "example of international cooperation for the

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[64] Heaps, *Operation Morning Light*, 76.

[65] On these concerns, see for example Ken Coates, P. Whitney Lackenbauer, Bill Morrison, and Greg Poelzer, *Arctic Front: Defending Canada in the Far North* (Toronto: Thomas Allen, 2008); Lackenbauer and Peter Kikkert, eds., *The Canadian Forces and Arctic Sovereignty: Debating Roles, Interests, and Requirements, 1968-1974* (Waterloo: Laurier Centre for Military Strategic and Disarmament Studies, 2010); Shelagh Grant, *Polar Imperative: A History of Arctic Sovereignty in North America* (Vancouver: Douglas & McIntyre, 2011); and Adam Lajeunesse, *Lock, Stock, and Icebergs: A History of Canada's Arctic Maritime Sovereignty* (Vancouver: UBC Press, 2016).

protection of the health and safety of the population of North America."[66] The internally-directed CFB Edmonton report published here affirms that the two countries' intimate cooperation during the operation proved seamless and effective. "The American agencies provided excellent technical support… plus the all important scientific expertise for re-entry, health physics and radioactive material recovery advice and support," it notes. From an organizational perspective, this technical support "melded well into an efficiently functioning team that preformed the job safely."[67]

As more Canadians arrived, the Americans drew down their assistance as planned. [68] The first NEST team left on 8 March, and two weeks later the last Americans left for Las Vegas with the remaining US equipment.[69] NEST expertise proved to be tailor-made for the Cosmos 954 search. As the CFB Edmonton report observes, "the much smaller resource base in Canada did force some adjustments on the American time accomplishment expectations. Beyond this… without reservations, this was an excellent, productive exercise in international cooperation."[70] In the end, the Canadians were saddened to see their American counterparts go.[71]

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[66] DoE, *Operation Morning Light*, iv. Although the Americans expected Canada to publish "one or more reports" on this model of binational cooperation, Canada never released one publicly. Excerpt from CFB Edmonton, "Operation Morning Light Post Operation Report."

[67] CFB Edmonton, "Post Operation Report," 11.

[68] Beer, "Aftermath of Cosmos Crash," 2; DoE, *Operation Morning Light*, 62.

[69] Aikman, "Operation Morning Light," 16; DoE, *Operation Morning Light*, 62.

[70] CFB Edmonton, "Operation Morning Light Post Operation Report,"33. American planning regarding Morning Light failed to adequately appreciate the impact that the sub-arctic environment and the distances involved had on operations in the initial designs of their timelines. While Americans planners acknowledged that Canadians logistical support overcame the tyranny of distance, a key lesson was the imperative for "staff to withstand the energy loss to environmental stresses," concluding that whe operating "under severe environmental conditions, two to three times as many people will be required to do the same task as fair-weather planning would anticipate." DoE, *Operation Morning Light*, 74.

[71] Aikman, "Operation Morning Light," 6.

"There was no historical precedent for Operation *Morning Light*," Lieutenant General (retired) William Carr noted afterwards. "From my vantage point as Commander, Air Command during the events recorded here, I was privileged to see the spontaneous cooperation which invariably surfaces when Americans and Canadians, under pressure, work toward a common goal."[72] Supporting this assessment, the CFB Edmonton report explains that:

> Canadian/American individual responsibilities became well defined in the early days of Morning Light. The two national teams of the Task Force worked extremely well together… [in] a common purpose easily and productively with amazingly few problems. The blend of skills each side brought to the task was essential to the other side's requirement and success, which is an exceedingly important factor. Without reservation, this was an excellent, productive exercise in international cooperation.[73]

Accordingly, Prime Minister Trudeau expressed Canada's appreciation for American assistance in a message to President Carter on 22 March.[74]

For their part, the Americans participating in Operation *Morning Light* concluded that "the Canadians were outstanding hosts, both in technical support and personnel consideration. This likely represents the best of international assistance conditions that we could ever expect to encounter; many other situations could be far from ideal."[75] While the Canadians provided the bulk of personnel and logistics, the Americans brought "previous specialized experience of the U.S. team with nuclear radiation search and measurement over large areas was a key Morning Light resource; the operation could not have been completed as expeditiously without it."[76] In addition to helping a close ally, the U.S. was able to glean intelligence

[72] Lieutenant General (ret'd) W.K. Carr, "Foreword," in Morrison, *Voyage into the Unknown*, 1.
[73] CFB Edmonton, "Operation Morning Light Post Operation Report," 33.
[74] Aikman, "Operation Morning Light," 16; DoE, *Operation Morning Light*, 62.
[75] DoE, *Operation Morning Light*, 73.
[76] DoE, *Operation Morning Light*, 22.

about Soviet reactor design from recovered fuel samples.[77] Perhaps the greatest benefit for both the Americans and Canadians was that Operation "Morning Light represented a genuine emergency response, much larger than any simulation that would have been reasonable to fund. To some degree the costs of participation in Morning Light represent an investment for invaluable experience."[78]

Multi-Departmental or "Whole of Government" Operations

The gradual draw down and departure of the Americans necessitated further cooperative measures between the deparments and agencies involved in Morning Light. The AECB, responsible for the recovery, transportation, and storage of debris, expanded the pool of civilian scientist it could draw upon to take over from the departing NESTs. The AECB also provided additional scientific instrumentation to the Department of Energy, Mines, and Resources (EMR), itself responsible for the management of the airborne search for radioactive wreckage. As the American drawdown continued, DND, responsible for overall operations, increased logistical support to the AECB and the EMR to help in the achievement of their objectives.[79]

In terms of generating experiential knowledge, Operation Morning Light demonstrated the adverse effects that cold had on the effectiveness of personnel. The US report emphasises that these cold conditions "require more people, more reserves, to withstand the additional environmental fatigue and to carry out tasks which take longer to accomplish in extreme physical stress." Given that personnel could only work for a few minutes at time in subarctic conditions, meeting a fixed deadline would require two to three times the people necessary to respond to such an event in more temperate climates. This environmental constraint complicates any multi-

[77] Richelson, *Defusing Armageddon*, 70.
[78] DoE, *Operation Morning Light*, 73.
[79] Gummer et al., *Cosmos 954,* 2, 4.

departmental response in the North and the generation of appropriate specialists.[80]

The experiences gleaned from Morning Light caused the CAF to identify the operation as a template for responding to future air disasters in the northern Canada. Yellowknife was recommended as the base for an On-Scene Commander (OSC) in any future Northern operations, and various government departments and agencies were subsequently encouraged to draft their contingency plans so that Yellowknife would serve as a common hub from which to mount multi-departmental responses.

The Canadian response in Morning Light also embodied a nascent Whole of Government (WoG) approach to interdepartmental/agency cooperation. In a northern context this approach means sharing information, assets, facilities, supplies, and even occasionally personnel between agencies and departments – all of which operate in the region with extremely limited resources. WoG operations are essential in the North, not only to leverage capabilities, but to ensure that departmental mandates are

[80] DoE, *Operation Morning Light*, 74.

fulfilled properly. It is in this supporting role that the CAF normally operates in a domestic emergency, providing transport, ships, and human resources that enable other government departments to react to contingencies in a rapid, coordinated manner.[81]

The need for a WoG framework to guide northern defence planning was well established, at least in theory, prior to Morning Light. The Advisory Committee on Northern Development (1948-71) encouraged this approach, and the 1971 Defence White Paper, *Defence in the 70s*, acknowledged the value of an integrated government approach. Despite this policy direction, however, WoG operations were never incorporated into CAF northern training during the 1970s. Nevertheless, the military was uniquely equipped and positioned to provide rapid, coordinated support to other departments and agencies in an emergency or crisis, thus enabling them to fulfill their mandates.[82]

Even today, with a strong awareness that planning, engaging, and cooperating with mission partners in the North is critical to successful domestic operations, WoG collaboration in the North remains notoriously difficult to achieve in practice.[83] Looking within Canada's federal response

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[81] P. Whitney Lackenbauer and Adam Lajeunesse, "The Emerging Arctic Security Environment: Putting the Military in its (Whole of Government) Place," in *Whole of Government through an Arctic Lens,* P. Whitney Lackenbauer and Heather Nicol eds. (Antigonish: Mulroney Institute on Government, 2017), 1-36.

[82] P. Whitney Lackenbauer and Daniel Heidt, eds., *The Advisory Committee on Northern Development: Context and Meeting Minutes, 1948-67*, Documents on Canadian Arctic Sovereignty and Security (DCASS) No. 4 (Calgary and Waterloo: Centre for Military and Strategic Studies/Centre on Foreign Policy and Federalism, 2015); Department of National Defence, *Defence in the 70's* (Ottawa: Queen's Printer, 1971), 11. See also Lackenbauer and Kikkert, eds., *Canadian Forces and Arctic Sovereignty*.

[83] See, for example, Lackenbauer and Lajeunesse, "Emerging Arctic Security Environment"; Lackenbauer, *From Polar Race to Polar Saga: An Integrated Strategy for Canada and the Circumpolar World* (Toronto: Canadian International Council, 2009); Peter Gizewski, "Discovering the Comprehensive Approach," in *Security Operations in the 21st Century: Canadian Perspectives on the Comprehensive Approach,* ed. Michael Rostek and Peter Gizewski (Kingston: Queen's Centre for International

during Operation Morning Light, planners and operators confronted two challenges that hindered (but did not prevent) multi-departmental cooperation. The first problem was the lack of a clear and unified line of authority and communication. Military personnel would report to Air Command Headquarters in Winnipeg while DND civilians would report to National Defence Headquarters in Ottawa (NDHQ). Similarly, AECB, Atomic Energy of Canada Ltd. (AECL), and EMR personnel reported back to their respective National Headquarters in Ottawa as well. Consequently, the Edmonton Report notes "that all military communications had to be reassessed at Air Command while the civilian agencies went directly to their senior headquarters with real time and detailed information." This resulted in communication and decision-making lags between the military (which was in overall command of the operation) and civilian participants.[84]

C.A. Morrison attributed this chronic interdepartmental coordination problem to the virtually last-minute notification some departments had of Morning Light, hampering efforts to marshal the various participating actors and meld them into a cohesive search and recovery effort.[85] The CFB Edmonton report notes that the participation of American personnel helped to compensate for this initial multi-departmental coordination shortcoming.[86]

The CFB Edmonton Report also observes that the second challenge came after the American departed and "field operations were characterized by a shortage of civilian manpower."[87] The 120 Americans that had

Relations, 2011), 13-23; and P. Whitney Lackenbauer and Heather Nicol, eds., *Whole of Government through an Arctic Lens,* (Antigonish: Mulroney Institute on Government, 2017).

[84] CFB Edmonton, "Post Operation Report," 33.

[85] Morrison, *Voyage into the Unknown*, 120.

[86] CFB Edmonton, "Post Operation Report," 3; DoE, *Operation Morning Light*, 22. American participants in Operation Morning Light had had much more advanced notification of Cosmos 954 than their Canadian counterparts. The US Department of Energy (DOE) had been planning to respond to Cosmos 954 since 6 December 1977.

[87] CFB Edmonton, "Post Operation Report," 33.

participated in Morning Light were mostly specialists with their NESTs and had been specifically trained for such an operation. "Canadian personnel were identified to take over search planning, scientific photography, search operation, health physics, computer support, and other functions,"[88] the US report noted, but many of these Canadians did not have the levels of specific expertise that their American counterparts possessed. Instead, they were scientists and technicians with skills amendable to the detection and recovery of radioactive material. This challenge was compounded by a shortage and rapid turnover of AECB scientific personnel (to the point that "rarely did a familiar face return") and the rotation of their departmental leadership out of the field. This required the military's NAST teams to compensate with their own personnel. "Canadian military/civilian agency operations accomplished the task," the CFB Edmonton report concludes, but with less efficiency than had been the case in the early stages when Canada drew upon American technical support.[89]

The CFB Edmonton Report recommended that in future operations "the entire problem of an interdepartmental task force should be planned for in advance" to address the lack of a unified line of communication and authority that complicated efforts during Operation Morning Light. The military's NAST was "vindicated" by the search and recovery operation, but the expansion of this asset was not advanced as a solution to the shortage of scientists. The CFB Edmonton Report focussed on a civilian solution, recommending the generation of "methods of providing sufficient scientific and technical expertise and man power on a call up basis from industry or universities."[90] This gestures towards an awareness of the benefits of a comprehensive approach that would leverage both government and non-government resources and capabilities to mount an effective, collective response in an emergency.

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[88] DoE, *Operation Morning Light*, 62.
[89] CFB Edmonton, "Operation Morning Light Post Operation Report,"12, 33.
[90] Ibid, 33.

Operational Techniques and Equipment

In terms of generating experiential knowledge, Operation Morning Light also represented a prolonged test of techniques and equipment in Northern conditions. Cold temperatures, extremely limited infrastructure (such as roads, airfields, and communications networks), and great distances from main logistical support hubs dramatically increase the resource intensity of northern operations. Moving supplies and personnel into and within the North is often more difficult and requires more time than in southern regions. To respond rapidly and effectively to unpredictable events such as a satellite crash, the military must not only integrate and synchronize efforts with other departments, but also have the right equipment, training, and preparedness to meet the unique circumstances of the North.[91]

While much of the Canadian military and government equipment performed well under demanding conditions, the CFB Edmonton Report makes clear that "equipment which did not do so or failed must be singled out for improvement." Because the operation had depended so heavily on airlift, aircraft were subjected to particular scrutiny. The CC-130 Hercules was praised for its "airlift and endurance capability … versatility and reliability," with this aircraft providing 1,800 hours of operational support. Hercules equipped with gamma ray spectrometers proved particularly critical to the operation and covered about 9100 square kilometres -- nearly 100% of the territory marked out for aerial survey. Furthermore, CC-130s could land on ice strips and deliver the equipment by Low-Altitude Parachute-Extraction System (LAPES). Both methods delievered the personnel and equipment that built Camp Garland and established fuel caches to support other fixed- and rotary-wing assets.[92] The CFB Edmonton Report emphasizes the exceptional flying skills of the pilots and aircrews throughout the operation, allowing them to manage a steep operational tempo, poor weather, and navigational challenges.

Not all equipment and techniques were up to the challenges posed by Operation Morning Light. The reliance on the American-provided microwave ranging system (MRS) underscored the unsuitability for Northern operations of the navigation systems deployed on CAF aircraft (such as the Omega Navigation System) and the flying of precise tracks over

[91] On these themes, see for example the Canadian Forces Employment Support Concept for the North, 23 March 2011, DND file 3060-1 (Northern Strat 1); Canadian Joint Operations Command (CJOC) Plan for the North, 28 January 2014, DND file 3350-1 (J5); Canadian Forces Northern Employment and Support Plan, November 2015.

[92] CFB Edmonton, "Post Operation Report," 28, 31, 33, 34, A/1/A-1, Annex A "LAPES Operation Report," Part 1 B (4).

long distances.[93] These navigational challenges were compounded by the lack of 1:50,000 scale maps east of 108°W longitude in the Northwest Territories and the inability to obtain replacement photos quickly.[94] Furthermore, the CFB Edmonton Report points out that military shelter left much to be desired. Tents were "poorly insulated" and there was a "lack of a safe, reliable method of heating field shelters." CAF shelters also suffered from using "plastic items such as tent pegs or certain tools," which "were either useless of fractured in the cold." Shelters and electrical equipment – most importantly radios – also suffered from the cold draining battery power.[95]

While the specific details of equipment shortcomings during Morning Light might not be relevant in today's context, given changes to CAF equipment, organization, and doctrine over the last forty years, the broad "lessons learned" during the 1978 operation continue to resonate with those gleaned from Northern operations and exercises over the last decade.[96] Most importantly, the extremely cold temperatures in the North strain equipment

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[93] CFB Edmonton, "Post Operation Report," 28. The MRS consisted of directional beacons placed on two high points of land 20 to 50 km apart. A receiver/computer mounted in the CC-130 received the two signals and, using triangulation principles, monitors the exact position of the aircraft and enables the pilot to fly along a specific path, allowing for radiation "hits" to be pinpointed to within 200 meters. The beacons were placed by helicopter and became operational on 3 February, greatly assisting the search of the debris area. Aikman, "Operation Morning Light," 13; Operation Morning Light: Canadian Northwest Territories/1978. A Non-Technical Summary of United States Participation, prepared for the U.S. Department of Energy, September 1978, 46.

[94] Ibid., 27-8.

[95] CFB Edmonton, "Operation Morning Light Post Operation Report,"36, 37.

[96] See, for example, Adam Lajeunesse, The Arctic Response Company Groups: Presence and Mass," and Nathan Fry, "Survivability, Sustainability, and Maneuverability: Implementing DoD Arctic Strategy at the Tactical and Operational Levels," in *Canadian Armed Forces Arctic Operations, 1945-2015: Historical and Contemporary Lessons Learned* (Fredericton: Gregg Centre for the Study of War and Society, 2017), 331-69; and P. Whitney Lackenbauer and Lajeunesse, "The Canadian Armed Forces in the Arctic: Building Appropriate Capabilities," *Journal of Military and Strategic Studies* 16, no.4 (March 2016): 7-66.

that has been designed for temperate climates, leading to decreased mechanical reliability and the need for more maintenance. Additionally, the magnetic pole and general orbits around the equator of telecom satellites hindered CAF communications during Morning Light. The limitations of non-polar orbital satellites remain a planning consideration today, and the necessity of procuring and maintaining Arctic-capable equipment remains equally relevant to ensure that the CAF can "generate sufficient forces at an appropriate level of readiness to meet a wide range of objectives and contingencies that the Government of Canada (GoC) has specified."[97]

Mission Accomplishment

All told, Operation Morning Light successfully met its objective to find, secure, and define the radioactive risk to civilians in the affected area.[98] The military was able to do this with about 250 personnel and thirteen aircraft,

[97] Canadian Army Land Warfare Centre, *Northern Approaches: Army Arctic Concept 2021* (Ottawa: DND, 2013), 19.
[98] CFB Edmonton, "Operation Morning Light Post Operation Report,"4.

along with thirty scientists from AECB, GSC, and EMR.[99] This success also depended on the AECB's lead effort in recovering, storing, and disposing of the radioactive debris.[100]

As the CFB Edmonton Report shows in great detail, the Morning Light mission was accomplished through surveys of the debris area by fixed-wing aircraft, helicopters, and ground teams. Tremendous distances, cold temperatures, and lack of infrastructure were overcome through the prudent development of operational techniques and integration of appropriate equipment. About 65 kg of satellite material was recovered, including 3500 particles that appeared to be the remnants of the enriched uranium fuel used in the satellite's nuclear reactor.[101] Of this, Morning Light crews recovered the following debris of note:

1. a single non-radioactive fragment (the "stovepipe") showing signs of melting and directional flow of molten metal;
2. a partial assembly of control rods (the "antlers") containing residual lithium (largely as hydride when found);
3. a group of beryllium rods and cylinders, some with remarkably fresh appearance;
4. a miscellaneous group of flakes and shards of more or less highly oxidized metal, probably all steel, some very strongly radioactive; and

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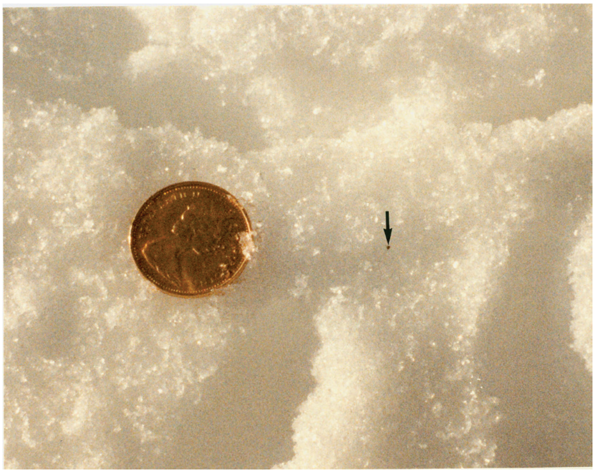
[99] Gummer et al., *Cosmos* 954, 2.

[100] CFB Edmonton, "Operation Morning Light Post Operation Report,"4. Much of the material collected by Operation Morning Light, after being flown to CFB Edmonton and then for further testing and storage at the Whiteshell Nuclear Research Establishment at Pinawa, Manitoba, was later sent to the Chalk River Laboratories at Deep River, Ontario, for disposal. Gummer et al., *Cosmos* 954, iii; CFB Edmonton, "Post Operation Report," 7; and Morrison, *Voyage into the Unknown*.

[101] Taylor, et al., "Cosmos 954: Search for Airborne Radioactivity on Lichens in the Crash Area," 1383-5; Gummer et al., *Cosmos 954*, 4-5. Small particles measured as low as a few thousandths or millions of a roentgen per hour, and steadily decayed to below natural background levels. September measurements found radiation levels to be one-fifth of what they were in January.



5. a multitude of minute spherical particles that occurred in the western section of the trajectory and spread to the south and east, presumably under the influence of wind at the time. Their radioactivity related to fission products.[102]

AECB contracted the Whiteshell Nuclear Research Establishment (WNRE) of AECL to analyze and store recovered debris. By the time the project was completed in the summer of 1978, scientists at Whiteshell had examined hundreds of specimens and conducted more than 4700 analyses.[103] Studies of the radioactive fragments quickly yielded debris of particular interest, including a highly-radioactive steel "hotplate" determined to be part of the reactor container, beryllium "slugs" that were thought to be part of Cosmos 954's reactor core, and a series of small cylinders in pristine condition that may have been part of the reactor control device. WNRE staff quickly determined that the reactor core had broken up and pieces of it were distributed across the search area. By analyzing the recovered fuel, staff determined the approximate size and power of the *Romashka*-type reactor, discerning that the powerplant produced an output of 132 kilowats and would "have left in excess of 13,000 Curies of radioactivity 90 days after re-entry." WNRE concluded that "much of this [radioactivity] may never have reached the ground."[104]

Scientific reports based on investigations of radioactive contamination of people and the environment confirmed that much of Cosmos' reactor core had vaporized in the upper atmosphere, thus limiting irradiation of the terrestrial environment.[105] Most of the uranium-235 fuel remained in the

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[102] Gummer et al., *Cosmos 954*, 2. For a more in-depth breakdown of the recovered materials and the nature of their radioactivity, see pages 10-32.
[103] R.B. Stewart, "Russian Satellite Debris: Examination of COSMOS 954 Fragments at the Whiteshell Nuclear Research Establishment," May 1979, DHH 79/528, acquired through ATIP A-2015-00298.
[104] Ibid., 9.
[105] See, for example, H.W Taylor, E.A. Hutchison, K.L. McInnes, and J. Svoboda, "Cosmos 954: Search for Airborne Radioactivity on Lichens in the Crash Area, Northwest Territories, Canada," *Science* 205:4413 (28 Sept 1979): 1383-5.

atmosphere. The major effort placed into searching the debris area and measuring radiation levels gave scientists the confidence to conclude that dangerous radioactive debris which had fallen to the ground had been cleaned up, with smaller particles deteriorating rapidly and thus posing no serious threat to human health.[106]

Conclusion

> *Morning Light was an unmitigated success when measured against the Operational constraints. In the main these were cold, weather, distance, aircraft shortages, aircraft under-equipped for navigation, trained manpower, the pitting of resources against the cold, and the general lack of deployable equipment to support such an operation. Despite all of these and the dangers inherent in the operational milieu, the Operation was completed as measured above without major aircraft accident, radiation over exposure or serious injury.*
>
> CFB Edmonton, Operation Morning Light Final Report, 32

All told, Morning Light represented a success story in binational and WoG cooperation. After reviewing a draft historical narrative on the operation in 1981, Lieutenant Colonel E.D. Champagne commented that "the problem, as always, is what do you do with it so long after the event? Like a dead atheist, it's all dressed up with no place to go! One could say that the aim should be to learn lessons, but then it'll never happen again. Which simply makes the point that CF people get paid to think on their feet, they did just that and they did very well."[107]

Others disagreed that this was a "one off" scenario. Official historian Colin A. Morrison asserted in 1983 that while Cosmos 954 remained a

[106] Gummer et al., *Cosmos 954*, iii.

[107] LCol. E.D. Champagne, "Minute Sheet: Operation Morning Light – Narrative," 10 February 1981, DHH file 1325-6, acquired through ATIP A-2015-00300.

unique occurance, "there is a good chance that the events of Operation *Morning Light* will be repeated." He insisted that:

> Operation *Morning Light* was, and remains, a prototype for probable future nuclear accidents involving satellites and the recovery of radioactive debris. Those involved in the planning and execution of the search for and recovery of *Cosmos* 954 were venturing into a new field of operations – a voyage into the unknown – a process that entailed much trial-and-error. This lack of experience was made crucial by the concern that there was an immediate potential danger to humans, as well as to the fish and wildlife that form a major part of the diet of the people of these regions.... It was this concern, and the consequent need for speed, that led to crisis-management during the first two to three weeks of Operation *Morning Light.*[108]

Responding to the crash of a nuclear-powered satellite was uncharted terrain for both the United States and Canada. Amidst tremendous uncertainty, officials had to decide how to address a scenario that could pose an acute threat to public safety. The mere potential of human impacts demanded that governments prepare for serious contingencies. This was far from a simple mission, given the vast areas that had to be covered by search and recovery teams. A professional, systematic effort was also essential to securing compensation from the Soviet Union for scattering radioactive satellite debris across Canadian territory.

The diplomacy associated with this first test of anticipatory international law governing space-borne vehicles crashing to Earth is beyond the scope of this introduction but has attracted a modest amount of academic attention. Although Cosmos 954 was the seventh nuclear-powered vehicle to return to Earth, it was the first example of one state's space assets inadvertently crashing onto another state's territory.[109] Subsequently, legal scholarship has assessed how the response to Cosmos 954 fit within international law and

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[108] Morrison, *Voyage into the Unknown*, 4.
[109] Morrison, *Voyage into the Unknown,* 3-4.

how it served as a precedent-setting case,[110] focusing on the issue of liability pursuant to the *1972 Convention of International Liability for Damage Caused by Space Objects* and Soviet compensation to Canada.[111] Despite ambiguity in existing legal instruments and their non-binding nature,[112] Canadian legal experts noted that the convention was important in securing a settlement. After Canada presented a bill of $6.1 million to the Soviet Union in 1979, the countries eventually agreed to a lump sum settlement of $3 million in April 1981.[113]

From an international legal standpoint, this settlement ended the Cosmos 954 affair. For Northern Canadians, however, the sweep of a diplomatic pen did not eradicate all concerns. Although the CFB Edmonton report conceded that "a finite risk that some radioactive debris from Cosmos 954 may remain undetected" because it was impractical to conduct a ground survey of the *entire* debris area, it concluded that the extensive surveys that were completed ensure "a high level of protection of humans and of the natural environment."[114] Modest concerns remained, however, about the residual legacies. *Globe and Mail* journalist Mitchell Beer reported in October 1980 that, "despite soothing official words" about the clean up of the satellite debris, local residents remained apprehensive about the longterm effects of low-level radiation on their health. "Federal officials say they'll

[110] For example, see Edward R. Finch, Jr., and Amanda Lee Moore, "The Cosmos 954 Incident and International Space Law," *American Bar Association Journal* 65 (January 1979): 56-9.

[111] R. I. R. Abeyratne, "Environmental Protection and the Use of Nuclear Power Sources in Outer Space," *Environmental Policy and Law* 26:6 (1996): 255-60.

[112] Joseph A. Burke, "Convention on International Liability for Damage Caused by Space Objects: Definition and Determination of Damages after the Cosmos 954 Incident," *Fordham International Law Journal* 8:255 (1984): 255-85; Andrew Brearley, "Reflections Upon the Notion of Liability: The Instances of *KOSMOS 954* and Space Debris," *Journal of Space Law* 34 (2008): 291-318.

[113] Edward G. Lee and D.W. Sproule, "Liability for Damage Caused by Space Debris: The Cosmos 954 Claim," *Canadian Yearbook of International Law* (1988): 273-80.

[114] CFB Edmonton, "Operation Morning Light Post Operation Report,"11.

never know whether radioactive fragments of a Soviet surveillance satellite that fell over Great Slave Lake in 1978 will affect human health, despite the concerns of a U.S. radiation specialist," he noted.

> One lasting concern is the fate of a number of highly radioactive rods that came down In Keewatin District, about 1,000 kilometres (621 miles) east of Great Slave Lake. The Soviet Union refused to say how many rods the satellite contained, and Dan Billing, NWT emergency measures officer at the time of the incident, said any undetected rods "may well be a bit of a landmine. They're attractive-looking pieces of metal, and this country is constantly covered by people who are looking for metals.
>
> "What worries me is some trapper, who may never have even heard of Cosmos, coming across a big piece of it, and we still don't know if there are any pieces out there. No one should pick those up and put them in their pocket…."

Beer emphasized that "perhaps the most easily quantified and lasting result of the Cosmos 954 incident" was the stress that it had on Northerners who lived in the five towns where the particles landed. Although local media at the time had highlighted Northerners' measured response to the threat of contamination, subsequent news stories suggested deeper-seated worries. "While most residents have gone back to their daily routines and forgotten about Cosmos, Brian Wainwright, a union representative at the Pine Point lead-zinc mine at the time of the incident, says a nagging fear lurks below the surface," Beer reported. "None of us know for sure whether we've been got," Wainwright said, "or if our lifespan as individuals has been shortened. I don't know how much longer I've got to live, or what my kids have got to look forward to - this is the kind of cloud that's left hanging over everybody."[115] In the ensuing decades, some NWT residents have linked ailments to their possible exposure to radiation from the Soviet satellite and others worry about environmental contamination that may persist from

[115] Mitchell Beer, "Aftermath of Cosmos Crash," *Globe and Mail*, 25 October 1980.

undiscovered debris (including rumours that the reactor may sit at the bottom of a lake).[116] For most, however, Cosmos 954 – for all of the light that it threw into the early morning sky on 24 January – has faded into memory.

Today, over sixty years of space launches have catapulted 1,738 operational satellites into orbit, and this number increases every year.[117] This means that Earth's orbits are littered with over 500,000 pieces of man-made space debris the size of a marble or larger. This "space junk" ranges from "nonfunctional spacecraft" to "abandoned launch vehicle stages, mission-related debris and fragmentation debris"[118] – including more than thirty nuclear-reactor-powered satellites, all but one placed there by the Soviet Union.[119] Recent concerns about residual toxic hydrazine (thruster fuel) from Russian rocket stages crashing into Arctic waters have also reignited conversations about Russian space debris, the safety and security of Canadian airspace, and potential environmental concerns.[120] The old adage that "what goes up, must come down" continues to resonate. Launch

[116] See, for example, Gordon Kent, "Cosmos reactor feared in lake; Doctor says radioactivity could spread across N.W.T.," *Edmonton Journal*, 30 January 1993: G12; "Crippled by Cosmos 954? A Brooks man suspects the 1978 spy satellite crash," *Western Report Edmonton* 8/8 (22 March 1993): 27.
[117] See "UCS Satellite Database" *Union of Concerned Scientists*, 7 November 2017, https://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database.
[118] See "Space Debris and Human Spacecraft" *NASA*, 26 September 2013, https://www.nasa.gov/mission_pages/station/news/orbital_debris.html.
[119] Rebecca Harrington, "Dozens of dead nuclear reactors are floating in space, and they'll eventually hit the earth," *Business Insider*, 10 March 2016, http://www.businessinsider.com/nuclear-powered-satellites-space-2016-3. This number does not include satiellites powered by radioisotope systems that convert the heat released from the decay of their radioactive fuel into electricity.
[120] Michael Byers and Cameron Byers, "Toxic Splash: Russian rocket stages dropped in Arctic waters raise health, environmental and legal concerns," *Polar Record* 53:6 (2017): 580-91. See also Bob Weber, "Canada says it didn't get enough warning about a Russian rocket stage that will splash down in Arctic," *National Post*, 3 June 2016.

failures, defunct satellites, and other pieces of space junk currently in orbit make the prospect of uncontrolled returns to Earth an ongoing risk.

The Canadian military continues to prepare to respond to space-borne threats that might crash into our Northern territory. For example, the primary scenario of Excerise NARWHAL 2004 was locating a downed foreign satellite that had crashed the Canadian Arctic. The exercise brought together various CAF units, including the Canadian Forces Experimentation Centre and the Directorate of Space Development, with the Canadian Coast Guard Ship (CCGS) *Henry Larsen*.[121] Canadian Ranger patrols have also practiced locating and reporting satellite debris, making their own mockups of satellites to hide and then encourage patrol members to find.[122] Operation Morning Light continues to serve as an important reminder of how the CAF must be trained, equipped, and prepared to respond to any contingency, working in conjunction with its allies and in support of civilian departments and agencies to protect Canadians and their environment.

Ryan Dean and P. Whitney Lackenbauer
Otterville, Ontario
January 2018

[121] The Excerise NARWHAL series ran from 2002-7 as part of the Canadian Armed Forces strategic collective training plan. The NARHAL series "was designed to exercise Canadian Forces Northern Area, now known as Joint Task Force (North), in the conduct of domestic operations in its area of responsibility, Canada's Arctic." DND, "Exercise NARWHAL Series – Backgrounder," 16 April 2007, http://www.forces.gc.ca/en/news/article.page?doc=exercise-narwhal-series/hnps1tx1.

[122] Based on the authors' conversation with Ranger Sergeant John Mitchell in Whitehorse, Yukon, June 2018. There is no nuclear response component to these Ranger activities.

Editors' Note

The document has been reproduced almost verbatim, with some minor grammatical edits. We have retained the original wording in the report to preserve its integrity as an historical document produced at a specific time (1978) and bearing the biases of the era in which it was written. Accordingly, some of the terms used by the authors are no longer preferred usages for people or places. Various locations described in the text have also been renamed (eg. the settlement of Snowdrift is now Łutsel K'e).

We have incorporated some of the annotations, corrections and comments that Captain C. A. Morrison, the official military historian of the operation, made in ink or pencil on the copy of the CFB Edmonton report held at the DND Directorate of History and Heritage (file 79/303). Please note that we have removed the photographs included in the original report because these were poorly reproduced, but we have retained various charts and maps.

List of Acronyms

AECB	Atomic Energy Control Board
AECL	Atomic Energy of Canada Limited
AFB	Air Force Base
A.G.L.	above ground level
ARG	Accident Response Group (U.S.)
BGen	Brigadier General
CAF	Canadian Armed Forces
CCGS	Canadian Coast Guard Ship
CF	Canadian Forces
CFB	Canadian Forces Base
CFEC	Canadian Forces Experimentation Centre
CIA	Central Intelligence Agency (U.S.)
DND	Department of National Defence
DOD	Department of Defense (U.S.)
DoE	Department of Energy (U.S.)
EMR	Department of Energy, Mines, and Resources
EPA	Environmental Protection Agency (U.S.)
GSC	Geological Survey of Canada
LAPES	Low-Altitude Parachute-Extraction System
LCol	Lieutenant Colonel
MRS	microwave ranging system
NDHQ	National Defence Headquarters
NSC	National Security Council (U.S.)
NM	nautical mile
NORAD	North American Aerospace Defense Command
NAST	Nuclear Accident Support Team (Canada)
NEST	Nuclear Emergency Search Team (U.S.)
OSC	On-Scene Commander
PMO	Prime Minister's Office
RCMP	Royal Canadian Mounted Police
RORSAT	Radar Ocean Reconnaissance Satellite
U.S.	United States
WNRE	Whiteshell Nuclear Research Establishment

Operation Morning Light

An Operational History

CFB Edmonton Report[1]

(1978)

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[1] Marginalia: "ALL NOTES IN RED INK ARE COMMENTS / CORRECTIONS BY CAPT C.A. MORRISON (DHIST), HISTORIAN RESPONSIBLE FOR PRODUCING THE OFFICIAL REPORT ON OPERATION MORNING LIGHT. C.A. MORRISON / CAPT. 19 APRIL, 1979."

Canadian Forces Base Edmonton
Lancaster Park, Alberta
30 November 1978

Foreword

1. Operation Morning Light was accomplished through the combined efforts of people from two countries with a multiplicity of expertise. Without the joint free and frank cooperation of all of the people involved, the recovery of the radioactive debris from the Soviet Cosmos 954 would not have been nearly so successful, expeditious or most importantly, so safe. To all of the people involved and their organizations, the Canadian Government is indebted. The long hours of tough work under severe Arctic weather conditions combined with the unfamiliar and unknown circumstances encountered daily challenged every individual involved. Despite these obstacles people made the Operation a success. I am extremely proud to have been in command of such dedicated individuals and it is to their conspicuous credit that the goals of the Operation were achieved without serious accident.

2. This report amalgamates the final data available from Canadian Government agencies at this time at Base level. The search criteria and the hit status reports are from AECB, however that Board will be producing its own final report once summer re-survey checks of the NWT are fully analyzed. An official US Government report is available reporting the involvement of its agencies in this Operation.

3. The final CFB Edmonton report is prepared for internal use within the Department of National Defence. Any requests for information or use of public release are to be directed to National Defence Headquarters. Official Operation archives will also be held in Ottawa.

4. I reiterate the credit that is owed to all personnel - Canadian or American, military or civilian - in achieving the results of this search and recovery. It was an experience of a lifetime.

[Signed]
D. F. Garland
Colonel
Base Commander

<u>The Commander's "Cross of Thorns"</u>
<u>A Roman General's Opinion of "Military Critics"</u>

> *LUCIUS AEMILIUS PAULIS, a Roman Consul, who had been selected to conduct the war with the Macedonians, B.C 168, went out from the Senate-house into the assembly of the people and addressed them as follows:*

"In every circle, and, truly, at every table, there are people who lead armies into Macedonia; who know where the camp ought to be placed; what posts ought to be occupied by troops; when and through what pass that territory should be entered; where magazines should be formed; how provisions should be conveyed by land and sea; and when it is proper to engage the enemy, when to lie quiet. And they not only determine what is best to be done, but if anything is done in any other manner than what they have pointed out, they arraign the consul, as if he were on trial before them. These are great impediments to those who have the management of affairs; for everyone cannot encounter injurious reports with the same constancy and firmness of mind as Fabius did, who chose to let his own ability be questioned through the folly of the people, rather than mismanage public business with a high reputation. I am not one of those who think that commanders ought at no time to receive advice; on the contrary, I should deam that man more proud than wise, who regulated every proceeding by the standard of his own single judgement. What then is my opinion? That commanders should be counselled, chiefly, by persons of known talent by those who have made the art of war their particular study, and whose knowledge is derived from experience; from those who are present at the scene of action, who see the country, who set the enemy; who see the advantages that occasions offer, and who, like people embarked in the same ship, are sharers of the danger. <u>If therefore, anyone thinks himself qualified to give advice respecting the war which I am to conduct, which may prove advantageous to the public, let him not refuse his assistance to the state, but let him come with me into Macedonia.</u> He shall be furnished with a ship, a horse, a tent, even his travelling charges shall be defrayed. But if he thinks this too much trouble, and prefers the repose of city life to the toils of war, let him not, on land, assume the office of a pilot. The city, in itself, furnishes abundance of topics for conversation; let it confine its passion for talking within its own precincts, and rest assured that we shall pay no attention to any councils but such as shall be framed within our camp"

Livy, ('Titus Livius) History of Rome
Vol. 7 Book XLIV, Chapter 22
Translation by George Baker, A.M.

OPERATION MORNING LIGHT

POST OPERATION REPORT

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INTRODUCTION

1. At approximately 0500 hours, Mountain Standard Time, 24 January 1978, the remains of Soviet satellite Cosmos 954 re-entered the earth's atmosphere over Northern Canada. This debris came to earth along an area of Northwest Territories (NWT) approximately on a path over the south half of Great Slave Lake and extending along a trajectory towards Baker Lake, NWT. Cosmos 954 was powered by a nuclear reactor, therefore to ensure public safety and to clean up as much of the radioactive debris as possible, the Government of Canada was obligated to mount a major search and clean up operation. An activity was begun, known as Operation Morning Light, to undertake this task. A task force marshalled from the Canadian Armed Forces (CF); the Department of Energy, Mines and Resources (EMR), the Atomic Energy Control Board (AECB), plus scientific and nuclear search teams from the United States Government was formed to execute the mission. American teams from the United States Department of Energy (US/DOE), Lawrence Livermore Laboratories (LLL) and support agencies (the major integrated contractor being EG&G), provided a mobile, scientific and technical expertise which made an immediate reaction possible in Canada.

2. Cosmos 954. This oceanic surveillance satellite was launched by the Soviet Union in September 1977 in an orbit inclined 65° to the equator. It was initially thought to be powered by a "Romashka" type reactor. In December 1977 it became evident that the satellite was in a decaying orbit and its path might cause it to fall over North America or US Pacific territories. Normally such nuclear powered satellites are boosted into orbit to decay, but some malfunction prevented the Soviets from accomplishing this safeguard. Accordingly the National Security Council (NSC) of the United States was warned that Cosmos 954 would re-enter the atmosphere in January. The satellite's final track over the Western Hemisphere brought it across the Pacific with re-entry commencing over the Queen Charlotte Islands. During breakup and burn up in re-entry, survivable portions reached the earth in NWT. The reactor core released a significant amount of particulate at high altitudes which spread in the upper winds over and south of Great Slave Lake, probably in a fine distribution into Northern Alberta and Saskatchewan below 60° N latitude. The re-entry itself was witnessed in the Territories by residents of Fort Nelson, Hay River, Pine Point, and Yellowknife in the dark sky of the pre-dawn hours of 24 January.

3. Canadian Preparations. Advance notice of the re-entry of Cosmos 954 on the date of 24 January was available at CFB Edmonton approximately one week before the event. The exact location was not known however. On 23 January the Base Commander was alerted by Air Command Headquarters of the possibility of the impact of Cosmos 954 in the Edmonton Search and Rescue Region. A Team (twenty-two personnel) of the Base Nuclear Accident Support Team (NAST) was alerted and placed on two hour standby. President Carter Contacted President Trudeau as soon as re-entry was confirmed on 24 January and offered the assistance of the resources of the United States Government. American scientific and technical assistance was accepted and CF crews and aircraft were placed on alert for immediate launch. The Base Commander of CFB Edmonton was appointed On-Scene-Commander.

4. American Preparation. The extent of US Government actions prior to 24 January is the subject of the American report. As an overview however, the following detail is provided. The Government of the United States Department of Energy maintains a Nuclear Response Organization under the Director of the Emergency Action Coordinating Team. Elements of this team were placed on full alert to respond to the need to protect the public health safety in case of satellite re-entry over the Continental United States. The Department of State was directed to coordinate Department of Defense tasked to provide any necessary logistic support. DOE began planning 6 December but accelerated their efforts through alerting of field units after 9 January. A complete federal emergency response plan was prepared for and approved by the NSC. By late evening 22 January, the Nuclear Emergency Search Team (NEST) with complete logistic support was loaded on five USAF C141s located at Andrews Air Force Base (AFB), Washington, D. C.; Travis AFB, California and at McCarron International Airport in Las Vegas, Nevada. All personnel were on two hour alert.

5. Cosmos 954 was tracked through its final orbit by various American tracking stations until it re-entered the atmosphere. The immediate offer of American assistance was accepted by the Canadian Government and the first part of the NEST Team arrived at Canadian Forces Base Edmonton at 1645 hours MST, 24 January.

6. First Launches. Initial activity at CFB Edmonton was immediate on 24 January. The Base NAST Team was flown to Yellowknife in the afternoon of that day by CC130. Two Twin Otters from 440 (SAR) Squadron were launched at 1545 hours and 1620 hours local for deployment to Yellowknife. Canadian aircraft and American equipment CF CC130 Hercules was launched on a search mission at 0115 hours, Wednesday 25 January, just over nineteen hours after the spectacular re-entry of the Soviet Satellite. Operation Morning Light had begun.

MISSION

7. The mission of the On-Scene-Commander was to employ available Canadian and American Government resources to search, locate, secure, and define associated nuclear or chemical risk; and through AECB to recover, store and dispose of the radioactive debris remaining from Cosmos 954.

AN OVERVIEW OF METHODS OF ACCOMPLISHING THE MISSION

Search Area

8. The first task was clear. Define the area in which to search. Through evolutionary means based on computations and subsequent discoveries, a full search region was determined. Depicted at Figure 1 is the final series of search sectors defined as the area over which the land and air search would eventually be conducted. This area is bounded by the lines between the coordinates 60°N 116°W to 61° 42'N 116°W to 62° 35'N 112°W to 62°47'N 112°W to 64° 55'N 96°W to 64° 25'N 96°W to 62° 50'N 109°W to 62° 35'N 109°W to 62° 25'N 110°W to 60°N 110°W to point of beginning. In turn this area was divided into search sectors, initially every two degrees of longitude, for reference convenience. Preliminary calculations provided by the Re-entry Group determined that the most likely trajectory of the satellite parts which reach the earth would extend from 111°W to 96°W longitude. This area was divided into search sectors 1-8. During overflight of the hamlet of Snowdrift by a detector equipped helicopter on 11 February[1] unexpected numbers of radioactive particles were found concentrated in the vicinity. This sighting was outside the originally defined search sectors. Coupled with radioactive contacts found along the trajectory path short of Sector One, these two events dictated the establishment of Sectors 9 and 10.[2] Finally by the third week in February a considerable number of radiation contacts had been made by helicopters traversing Great Slave Lake and the area south as far as 60°N. The majority of these contacts was from a fine spread of reactor particles and it was evident that a more extensive search would be necessary in this area. Search sectors 11, 12 and 13 were established. The fine particulate spread was postulated as existing further south of 60° N into N. E. Alberta and N.W. Saskatchewan, but in view of the lack of contacts was believed to be below airborne detectability limits and not a significant hazard.

[1] Marginalia: "10 Feb "

[2] Marginalia: "9 & 10 added 30 Jan 78 due data analysis "

9. The search faced the initial task of covering an area 30 nautical miles (nm) wide and approximately 500 nm long or 15, 000 square miles. The final area, Sectors 1 to 14, encompassed 47, 312 square miles of the NWT.

LOCATING

10. Detection Equipment. Except in two instances all of the remains of the Satellite were located by equipment capable of detecting radioactivity. The detectors were mostly operated airborne carried in CC130s, CH135s and very early on, in CH147s. Hand carried equipment, largely American supplied, was used for close in work on the ground. Sodium iodide crystal detection equipment, American supplied, was placed on all aircraft except for one C130-bourne major piece of detection equipment supplied by EMR/GSC.

11. Navigation. Aircraft equipped with detection gear were faced with the problem of transiting to the search area and then flying assigned tracks and areas very accurately. The factors of featureless barren lands, large lake surface and whiteout over Great Slave Lake, the lack of maps of 1: 50,000 scale over much of the search area, and the inability of aircraft navigation systems to locate exactly where the aircraft had been with sufficient accuracy, all pointed to a serious requirement for a better method of navigation. The eventual solution was to adopt the Microwave Ranging System (MRS) normally used by the NEST team to survey small areas. The MRS system was very accurate but required a difficult logistics support for repositioning and rebatterying the ground stations. MRS searches began in Sector 1 and eventually covered the centre of the trajectory line from Sector 12 to 5 with expanded areas into Sector 9 and 10. To replace the one set of American supplied equipment, DND leased a set for Canadian use.

12. A complete description of locating equipment, techniques and navigation methods is reported upon following and in the Annexes to this report.

13. Hit Analysis. When the airborne detection equipment sensed a suspected radioactive -source during the search, a “hit” was recorded. Gamma spectrometry was also recorded on detection tapes. The background radioactivity from geological sources is high in much of the region, consequently many hits were recorded, only a percentage being satellite debris. Upon return to Edmonton the detection tapes were analyzed daily and the data reduced. Hit data were passed to a Hit Analysis section and hit coordinates were recorded on a large 1:250,000 map of the search area. Coordinates were passed to the forward bases at Yellowknife and Cosmos Lake with taskings and priorities for the next phase of the task.

Figure 1: Search Areas and Sectors

14. Helicopter Locating. CH135 helicopters from the two forward bases proceeded to the hit coordinates one, two, or sometimes more days later. The hit would be relocated using on board detection equipment, and the helicopter would land, a Team proceed to the site to mark the location and determine the risk.

SECURE AND DEFINE RISK

15. Securing the hit was considered necessary only in two cases. A major find was located on the Thelon River by members of a NWT Expedition about eight miles from a cabin site called Warden's Grove. Located at Warden's Grove on the River was both the Expedition's winter camp and a short airstrip. This was used for aircraft to fly out the expedition's members for health monitoring. After the six members of the Expedition were evacuated, four troopers were parachuted into Warden's Grove on 31 January[3] to keep curiosity seekers out. Two RCMP constables were brought in to replace them right at the debris site at Cosmos Lake. RCMP and military police were also given security tasks near Fort Reliance and Snowdrift. Otherwise the hit sites were too remote to be generally accessible.

16. Risk. After landing by helicopter, a Team approached the hit site and took readings as close as safety permitted. Measurements, both radioactive and physical, were taken as were photographs. The site was marked and all data returned to the CFB Edmonton Command Post (CP) for analysis. Definition of the dimensions and protection level of a transportation cask was also done at this time.

RECOVERY

17. Recovery actions were conducted under the control of AECB. A second helicopter with a recovery team would relocate the hit by its mark and recover the object or objects. Each was loaded into a safe container by NAST and AECB personnel and flown back to either Yellowknife or Cosmos Lake. From here the container was flown to CFB Edmonton and transported to a bunker in an old ammunition depot converted to a laboratory. The objects underwent preliminary analysis, were repackaged and flown to Winnipeg for onward transport to Pinawa, Manitoba to the Whiteshell Nuclear Research Establishment. Here final analysis of the objects was performed and the satellite remains were stored. Thus the full mission from location of the debris to present storage was executed.

[3] Marginalia: "0700 hrs 30 Jan "

SEARCH AND RECOVERY CRITERIA

Objectives

18. The cleanup of the radioactive portions of the satellite debris had to meet specific criteria established by AECB in their document 15-200-24-0 28 March 1978. Mission accomplishments are measured in part by success in attaining these criteria as quoted below through paragraph 24:

a. The basic objective of these criteria is to ensure that any exposure of humans to ionizing radiation from the radioactive debris of Cosmos 954 is minimized in accordance with the principles of radiation protection generally and, in particular, the "as low as is reasonably achievable" recommendation of the International Commission on Radiological Protection.

b. Although the basic objectives of these criteria is to minimize human exposure, a second objective is to minimize exposure of other species. and, equally, to protect against ecological damage generally.

General Considerations

19. In developing these criteria, a number of pertinent factors have been taken into consideration. These include, inter alia:

a. the requirement for very stringent standards to be applied in areas of human habitation and somewhat less stringent standards in other areas for reasons of practicality while still ensuring a high level of protection (i.e. exposure probabilities and exposure time intervals);

b. exposure pathways (direct external exposure of the whole body ·and internal exposure via ingestion or inhalation);

c. the detection capabilities of aerial and ground survey instruments;

d. the allocation of appropriate resources on a practical, realistic basis;

e. recognition of the fact that naturally-occurring uranium and thorium mineralization exists in the region of the satellite's re-entry trajectory. Some uranium and thorium-bearing rock outcroppings have been found to have radiation fields of the order of 1 milliroentgen per hour at one metre which is more than one hundred times higher than the minimum detection capability specified below for ground surveys conducted in inhabited areas; and

f. assuming that the reactor on board Cosmos 954 may have operated at 40 kilowatts (thermal) for a period of 3,075 hours (i.e. from time of launch on 18 September 1977 to its re-entry on 24 January 1978) the total inventory of radioactive fission products in the core on 24 January 1978 would be about 180,000 curies. By 21 February 1978 these fission products would have decayed to about 9,000 curies and by 18 April 1978 to about 4,500 curies. Thereafter there will be a gradual reduction in the activity levels such that by 24 January 1979 the activity remaining would be about 250 times lower than upon re-entry or about 720 curies. Thus, the radiological significance of any fission products which survived re-entry, recognizing that some may have remained in the upper atmosphere, will reduce with the passage of time. Nevertheless, the quantity of fission products involved warrants the careful and systematic completion of planned surveys.

Survey Specifications

20. Aerial Surveys - Fixed Wing Aircraft. Aerial surveys using C130 Hercules aircraft conducted at an altitude of 750’ to 1,000’ on a grid spacing of 1,500’ covering an area broadly defined by the re-entry trajectory of the satellite modified to take into account the physical distribution of the debris (see figure one). The detection threshold for these surveys is such that sources with a gamma radiation field of about 10 to 50 roentgens per hour in close proximity to the source or about 10 to 50 milli-roentgens per hour at one metre can be detected.

21. Aerial Surveys - Helicopter Aircraft. Aerial surveys using helicopters flying at an altitude of 50’ to 100’ conducted in a three-fold approach:

a. to locate precisely radioactive debris identified by the C130 surveys and by visual observation;

b. to survey the environs of communities situated within the search area. As a general rule, an area three miles by three miles centered on the communities is considered as the “environs” of such communities; and

c. to survey roads and railways where these may be affected by the debris from the satellite.

The detection threshold for these surveys is such that sources with a gamma radiation field of about 100 to 200 milli-roentgens per hour in close proximity to the source or about 0.1 to 0.2 milli- roentgens per hour at one metre can be detected.

22. Ground Surveys. Ground Surveys conducted in all inhabited areas including camping areas using portable survey instruments capable of detecting radiation fields of about one to three micro- roentgens per hour above the natural background. This range is approximately equal to the average annual variation in naturally occurring radiation levels.

23. Recovery of Radioactive Debris. All radioactive debris of radiological significance detected as a result of the surveys referred to in paragraphs 20, 21, 22 is recovered and transferred to CFB Edmonton.

Net Effect of the Program

24. The application of the above surveys ensures a high level of protection of humans and of the natural environment. Notwithstanding the stringency of the surveys specified above, a post search and recovery environmental monitoring program is planned for the summer of 1978 under the direction of the Atomic Energy Control Board in consultation with Rational Health and Welfare Canada and Environment Canada. This program is intended to provide further assurance that all reasonable measures have been taken to protect human health and the natural environment. It is recognized that for reasons of practicality it will not be possible to conduct ground surveys in areas other than those in which human habitation exists. Thus, there is a finite risk that some radioactive debris from Cosmos 954 may remain undetected. The combined effect of extensive aerial surveys by fixed wing and helicopter aircraft provides a high level of assurance that any undetected fragments will pose minimal risk to human health and to the environment.

TASK FORCE ORGANIZATION

25. As the search and recovery of the Satellite ground footprint brought in more resources and more agencies, the Task Force structure to perform the mission evolved from an ad hoc response to an organized relationship. The response organization was created to serve two major phases, the first one occurring at the outset with the American NEST providing the majority of the scientific and technical expertise, and the second as operations became virtually all Canadian manned.

26. Canadian/American Organization. By 3 February the organization to execute Morning Light operations had settled as illustrated in Annex H Part 1 A. Responsibilities are as stated in the Annex. The significant points to note are the task of the On- Scene-Commander for the Canadian Forces, AECB and the roles conducted by US Government Forces. The basic functions were maintained; Canadian organizations provided the command and control, flight and ground operations and recovery activities. The American agencies provided excellent technical support (equipment and equipment employment) plus the all important scientific expertise for re-entry, health physics and radioactive material recovery advice and support. This organization melded into an efficiently functioning team that performed the job safely. It lasted until the final departure of American equipment on 23 March.

27. From that date until 18 April, a small American advisory group remained at CFB Edmonton. It consisted of a senior US Government representative, a scientist and a secretary. Information flowed easily through these advisors to DOE Nevada Operations Officer (NVOO) and to LLL so that American scientific support remained vital, ready and useful.

28. Canadian Organization. American withdrawal from forward bases began with a complete departure from Cosmos Lake on 7 March 1978. Most US personnel left Yellowknife about 20 March with the withdrawal of the helicopter-borne detection gear supplied by EG&G. Through this March transition period a CF/AECB/EMR Team grew in behind the American departure. Annex H Part 1 B illustrates the initial Canadian organization which worked de facto. Roles and functions had been well established by earlier experience therefore little further was done to prepare terms of reference. This new organization was characterized by a chronic shortage of sufficient scientists and technicians from AECB and the need to backfill radioactive debris recovery operations with personnel from the CF NAST Team. The chief difficulty occurred however in the manning of this organization from the Canadian Scientific side at Edmonton. Senior personnel were rotated frequently in as little time as one week and rarely did a familiar face return. Naturally this produced a lack of continuity at Edmonton where real time decisions were required on the scientific approach to the radioactive material search, recovery and dispersion sampling procedures. This constant turn over of senior directing staff remained an operational constraint.

29. Mission Planning Group. The steering group for the Operation was a dominant and critical component of the organization. It was manned by the senior executive of the response group and the finest scientific minds available. Early on in the operation, sub-groups such as re-entry analysis scientists met first to derive

methods of tackling the search and recovery problem. The Mission Planning Group met at least once daily throughout the entire Operation analysing all available data and progress to date and mapping out future operations. Until operations stabilized, future missions were virtually the next day's work. Long term planning objectives changed with the fluid nature of discoveries, weather and equipment problems.
Ultimately this Group's work produced the steady flow of missions to the field. The proceedings of each day's meetings were recorded verbatim except for one or two omissions during the transfer of scientific responsibility from to Canadian personnel and are available on record. Following the meeting taskings were dispatched to Yellowknife and Cosmos Lake both for areas to search and for hit recovery action.

30. The Canadian counterpart of this Group continued to operate after the departure of the main body of the US and it was through the Group that the remaining US advisors exercised their consultative role.

31. A group functioned in each of the field detachments to digest and plan the direction of their operations. However, in Yellowknife initially there was some reluctance to establish a senior scientific advisor because of insufficient people, but once he was appointed recovery and control of data was much more satisfactory.

32. <u>Operation Command Post (CP).</u> On 24 January, at approximately 0930 hours, the CFB Edmonton CP was opened. From then until 17 April it functioned almost continuously. As with the other Morning Light organizations, the CP went through several transformations to meet the need. Initially a senior searchmaster from 440 Squadron was brought in to conduct search operations. This proved an excellent decision and accomplished the gross search activities in a manner analogous to a normal search and rescue squadron activity. The CP's structure finally settled into the organization shown at Annex H Part 1 C. To reach this position it suffered a number of growing pains, the chief ones being the interface between the CP and the normal Base Operations Centre for CC130 tasking, rationalizing both the operations and technical staffing, the lack of qualified officers to man both CP and field positions, and the missing link between logistics and the Air Movement Unit. All were covered, the latter being resolved by placing a CP air movements officer on the job. This position is essential to any operation whereby most logistics are conducted solely by aircraft. Operationally, role-qualified operations officers are essential to CP manning. The CP served as the link to all Base and Air Command personnel and logistics support. These functions are amplified in the appropriate Annexes.

33. The Base CP was underequipped for this kind of Operation. Improved communications were brought in early "which provided a great assist, especially CSN lines and communications by satellite terminal to Cosmos Lake.

34. Detachments. The organizational structure of each field generally paralleled that of the Base. Northern Region Headquarters (NRHQ) perhaps differed more because Operation activities were superimposed upon regular NRHQ functions. The greatest problem in Yellowknife, however was insufficient personnel to support logistics. A full traffic officer role complete with sufficient MAMS personnel is essential for aircraft loading/unloading and the control of supplies through a transition point. An adequate organization is necessary or the same results will be repeated; lost equipment, confused and disorganized flow of essential material through an intermediate terminal. The organizations at Yellowknife, Cosmos Lake, Baker Lake are explained in the appropriate detachment reports in Annex D.

OPERATION METHODS AND DETAILS

Search Tasking and the Search

35. Search Tasking. Conducting the search was an ever changing process, immediately responsive to new data and new derived conclusions. The story of the results of daily aircraft searching and findings unfolded on the master "hit" map each evening and the following morning. As the search area definition grew beyond the original sectors 1 to 8, searches shifted in emphasis as to area and kind. Drawing from the hit analysis, the Mission Planning Group synthesized the results with new information or assessment from the determinations of the Re-Entry Group at LLL. Priorities were determined and following the daily meeting, operations staff tasked the next day's flights from Edmonton and the field detachments. As the Operation stabilized, taskings were set out two or more days ahead making a much better managed operation. At Edmonton up to four CC130s, one Argus and one Convair 580 were despatched to accomplish the gross search as quickly as possible. Upon return to Edmonton the data returns from the CC130 were taken off the aircraft to the Data Vans where the information was reduced in order to plot the coordinates of the area covered, any hits made and an analysis of the spectral data for evidence of fission or activation products. This information was completed in times from four to twelve hours, delivered to Hit Control, plotted and available for analysis by the Planning Group. Hit summaries were sent by message to Yellowknife and Cosmos Lake. Thus the cycle was complete. The search missions were launched on subsequent days armed with new taskings and the detachments had specific targets to find. The detachments, it is worthy of note, were seldom ordered to perform a given task on a given day, but rather were given a list of hits with priorities and they in turn planned their own activities to execute the mission.

36. Gross Search. The search of Sectors 1 to 14 was done in two distinct phases: a gross search and a fine search. Early in the Operation, the task was clear. Scan the entire probable area (Sectors 1 to 8 at this time) with detection equipment to determine if any significant pieces of the reactor lay on the ground particularly in areas close to habitation. The area consisted of the length of the from 111° W to 96° W and 15 NM either side of track (total 30 mile width), an area of 14,000 square miles. This gross search was conducted by 3 x CC130s with American equipment on board and 1 x CC130 with EMR equipment all flying at altitudes of 1,000 feet above ground on one mile track spacings. Use of an Argus was attempted for one day then discontinued because its navigation equipment proved no more accurate than that of the CC130 plus the Argus suffered a high unserviceability rate in the cold temperatures. In five days, between 25 to 29 January inclusive the gross search of Sectors 1 to 8 was virtually complete, a superb accomplishment under the circumstances. Overlapping this period until 8 February the DOE Convair 580 flew a number of Infra Red (IR) Scan and photo trips to provide another kind of detector search. Some excellent IR data was obtained but the system discovered no new hits. Equipment unserviceabilities plagued this activity also.

37. Fine Search. From the early analyses of the gross search data, a painful tale began to emerge. The CC130 Omega Navigation System was producing uncertain results because its accuracy was not sufficient for the search in hand. Overlapping of survey lines, missed areas or inconclusive coordinates of hits meant that the search criteria were not being met. Because the radiation from the debris was attenuated by snow on all sides but the top, its energy was highly collimated necessitating almost direct overflight by detector equipped aircraft. To meet this challenge an American Microwave Ranging System (MRS) was supplied by DOE and installed in the CC130. With this system the aircraft flying at 750 feet above ground and on 1,500 foot track spacings could locate itself and hits accurately within ± 20 feet.[4] In view of this fine search capability and the uncertainties left by the initial area coverage the entire search area problem now had to be re-examined.

38. The gross search had found no extremely hazardous radioactive objects. The daily area (200 square miles at best) covered by a MRS CC130 meant an unacceptable of missions would be necessary to complete all Sectors. The pattern of satellite debris discovered to date indicated that it was scattered along a fairly definite line probably no more than ten miles either side of the trajectory line. Therefore the width of the area to search was reduced to 16 miles total and the fine search was not to be extended beyond Sector 5 unless further evidence of debris turned up in that area. The first MRS mission was conducted 5 February. A second MRS system was leased by DND

[4] Marginalia: "Figures vary ± 100' ± 6' "

and this Canadian supplied system went into service 1 A steady MRS search from Sector 12 to 5 was completed by 2 x CC130 over the area displayed in Figure 2. MRS searches terminated 8 April with all of the essential areas covered as per the established criteria.

39. Mapping Mission. The search was difficult to conduct without sufficient maps. The featureless winter barren lands made the problem even more difficult. Maps of 1:50,000 scale useful for precise reading did not exist beyond Artillery Lake, about halfway along the search area (108° W). To resolve this problem and to provide current photography of the area, two solutions were attempted. First, a camera equipped Argus flew photo missions over some of the Sectors. The photography from these missions and the DOE Convair produced general pictures, but only those taken of Cosmos Lake area were put to good use. The second solution was an attempt to have NDHQ/D Cart 0 produce the required maps quickly from photo archives, but this attempt proved fruitless and for a long period the request was not acknowledged.

NAST Employment

40. The CF Nuclear Accident Support Team (NAST) provided the backbone of this Operation for radiation monitoring and physical labour in debris recovery operations. The Team also provided the trained manpower to conduct habitation searches and radiation surveys throughout the region. The CFB Edmonton NAST was the first deployed resource into the field at the outset of Morning Light. Its personnel were augmented by Air Command resources to assist and provide training for other bases but essentially the Team was deployed for the full 84 days of the Operation.

41. NAST were deployed at Edmonton and at all field components. Their duties in the field were to monitor for radioactivity at debris pick up locations, assist with its handling and packaging, escort the material during transport, store it and perform decontamination checks and procedures on personnel, aircraft and equipment. At Edmonton, the Team controlled field manning, performed radiation monitoring on all personnel departing and returning on flights (controlled DT-60 readings and film badge recording) and performed transport and storage bunker duties at Edmonton. They flew in every kind of CF aircraft, worked laboriously long hours, lived in tents, suffered the cold, were away from home weeks at a time and worked anonymously in the shadow of the scientific corps. In short the personnel performed a first-class job and earned every credit both those acknowledged and those not acknowledged.

42. Matters of radiation safety were always overseen by a health physicist and the Rad2ons worked under his guidance. During the American period, health physics

was under excellent control and the Team members well briefed and checked. The chronic shortage of manpower of AECB personnel after the Americans departed at times left the Radmons to their own devices, but by this time they knew their own job and were current on safety measures. Future teams of this nature must be well manned with more than enough health physicists and radiation technicians, all in good physical condition for arduous work.

43. Specifics of equipment and procedures are reported in Annex B.

Aerial Search Activities and Techniques

44. Gross Search. This flying was conducted fairly conventionally using Omega, Doppler and the Along-and-Cross Track computer on the CC130. Visual map reading was used as a check but was seriously limited by flat, snow covered terrain and maps which lacked detail. At 1,000 feet the search could be safely conducted at night or under instrument flight conditions. The aircraft was equipped in the cargo compartment with gamma detector pods, a multi-channel recording system to provide a chart read out of radiation hits and spectral data. Detector equipment had to be kept warm which became an aircraft parking restraint overnight or during stopovers. The aircraft flew lines one mile apart to be best of the crew's ability, data was recorded and returned to Edmonton for analysis. Missions lasted almost six hours on-station plus transit time. Details on the detection equipment are available. in Annexes D and E. The detector had a greater capacity than the American equipment and interestingly the first hit[5] of the search was recorded on this equipment. EMR also leased a small computer for data reduction and erected it in a dedicated room at CFB Edmonton. This was the beginning of a complete Canadian data recovery system.

45. MRS Search. MRS missions were flown at 750 feet and on parallel 1,500 foot track spacings. The addition of a computer keyboard on the aircraft provided data for directing the crew's flight. Two ground transponders transmitted a signal when interrogated and provided ·a track read out in the aircraft. A steering pointer placed on the instrument cowl in front of the pilot displayed this data and provided him with a steady track guidance. Detectors and recorders operated in the back of the aircraft along with the MRS system to provide a complete navigation/recording system. Further data on the installation and acquisition problems of MRS for the CC130 are amplified in Annex E. MRS operating procedures for aircraft are available in Operation archives.

[5] Marginalia: "First recognized hit – US DoE had a valid hit 25 Jan but did not realize it till around 29-30 Jan "

Figure 2: MRS "Fine" Search Coverage

46. The MRS system ground stations required a significant logistics support. Line of sight signals coupled low aircraft operating altitudes meant that in two days flying on the average by the CC130, it covered all the area within beacon range. Secondly, in the very cold temperatures, the NICAD batteries which powered the transponders had to be replaced every two days. Rebatterying and beacon moving was done by CH135s. For Yellowknife based helicopters the range to Sectors 1 and 2 necessitated enroute refuelling. Thus the number of activities associated with these logistics requirements and the fact that the transponders were often hard to locate caused many coordination problems. Missed contacts, delayed helicopter departures, misaligned beacons all led to an inevitable wastage of CC130 hours, sometimes a whole day's mission. Part of this was a learning function and operations improved with practice.

47. As the Canadian based MRS system came on line, the question of who would operate it had to be answered. After considering a number of alternatives, the Base asked for and was provided with experienced maritime air navigators. These officers picked up the operation quickly and performed many hours of dedicated work. Fitting into the 11 to 12 hour CC130 missions was analogous to long maritime patrols. All training on all aspects of MRS operations and interfacing of software was done wit the impressive cooperation of EG&G.[6]

48. After 1 March until about 20 Mar when the American equipment was withdrawn, two MRS equipped aircraft covered a large territory. One aircraft worked in the vicinity of Cosmos Lake, the second over Great Slave Lake in Sectors 12 to 1. This division prevented any mutual interference.

49. MRS did all it was expected to do. Flying was long in time but easy to perform accurately. The fine search was completed with confidence that the designated area had indeed been accurately flown to the radiation search program specified by AECB.

50. <u>Detection Equipment Technicians</u>. Through the long hours of both searches the radiation detection equipment and recorders were manned by EG&G or EMR technicians. These individuals probably flew more hours than any other crewmen during Morning Light and are among the unsung heroes of the hardworking, uncomplaining many who performed this search.

[6] Marginalia: "Also Quentin Bristow EMR "

51. Helicopter Search and Recovery. An overview of helicopter procedures for recovering satellite debris has been given in paragraphs 14 to 17. The helicopter team which was eventually developed consisted of a detector equipped aircraft and a recovery aircraft. Two were needed because one, the detection equipment and operator filled the payload of one helicopter and, two, at no time could radioactive material be placed on the detector aircraft for fear of contaminating the equipment. Locate, mark and recovery activities were conducted often by a helicopter team and debris returned to Base relatively quickly. Prior to the team activity however, the time from the first hit signal to pick up for any piece of debris could be a week. Navigation was doubly hard for helicopters working at low level therefore the second often flew higher to help locate the team's position.

52. Helicopter searches were carried out 50 to 100 feet above ground. Habitation checks, road checks and radiation surveys were done by helicopter, the greatest effort in these tasks being over Great Slave Lake and the communities along the south shore. The helicopter equipment could detect significant hits over ice or water only because the background radiation over the land was too high. Therefore helicopter searches were largely done over lakes and along rivers. Little useful data could be obtained otherwise. Progressively the southern extremity of the contaminated area was defined by this method. Helicopter discovered hits over the Great Slave Lake plus MRS hits in turn revealed that debris had landed further west than originally thought. Sectors 11 and 12[7] were defined as a result and the Search area now extended to its western limit of 116° H. Hits occurred to about 115° W.

53. Helicopters at Yellowknife and Baker Lake were originally equipped with American detection equipment and manned by their technicians. As the outlook for search activity appeared to face extension to the summer months, Canadian equipment had to be acquired. A program was set up to procure, install and operate three sets of Canadian supplied equipment. In less than three weeks, an amazing program was completed and the CH135s were on task in the Arctic with detection and recording equipment leased and manned by EMR. Much credit is due to the supplier, McPhar Geophysics and the installer, 1 AFMS.

54. Sectors 13 and 14. It did not become apparent until well into February that the satellite breakup held a surprise in store. Although the search area communities had been checked for radioactivity and found relatively free of any contamination, transits of the south shore of Great Slave Lake water courses about 22 February began to reveal low order hits. When able, detector helicopters were assigned to the area and began slowly to define the limits of detectable radiation. Fort Providence proved clear

[7] Marginalia: "There's a definite problem i.e: when 11, 12, 13, 14 added "

of the fall out area. Hay River was just on the edge, Pine Point, Fort Resolution and Snowdrift required some clean up and Fort Smith also revealed some particles. Associated with lake and river checks a pattern of spread of particles from the reactor core became apparent. This entire area was included in two new search sectors 13 and 14.

55. Airborne Radiation Surveys. The fine and widespread nature of the reactor particles made pick up recovery virtually impossible. The risk was assessed as low to people and the ecological effect negligible, especially after the spring run off. However, to try to attain acceptable radiation safety levels, AECB required checks of all habitation plus data on the ecological impact of the radiation. Ground surveys were performed as are amplified below. In addition data was required on the nature, strength, type, density and spread of the radioactive particles in order to reconstruct a model of the possible hazard and effects. From this model an evaluation of the ultimate effects of the radiation could be determined by computer analysis and extrapolation.

56. Between 27 February and 1 March an initial radiation survey was conducted along the south shore of Great Slave Lake with emphasis on inhabited areas. This survey covered the area from Hay River to Fort Resolution and covered from the road and railroad to approximately five miles out in the Lake. The survey was conducted at 50 feet above ground by detector helicopter at one mile intervals near towns and three mile intervals away from towns. This survey determined that there was no major contamination in the area, but smaller sources were encountered sporadically. Scientifically the results were inconclusive and no useful picture emerged.

57. By late a second major approach to the determination of the spread of radioactive material was taken. A series of thirteen straight lines were flown by detector helicopters over the water (ice) portions of Great Slave Lake. Data were recorded and the spread of the radioactive particles was now told in terms of activity, distribution and fission products. The conclusion of this survey, known as the "Grasty Plan" is recorded in the EMR Report. The survey area is shown in Figures 3 and 4. The preliminary scientific analysis of these data corroborated the estimate that the health hazard was low and that no further useful widespread recovery activity was practical. These data were instrumental in concluding the search in Sectors 13 and 14 and, indeed, ultimately the Operation. Final conclusions will be provided by AECB.

58. An additional airborne survey was conducted on 6-7 April to validate the CC130 MRS searches.[8] In order to obtain a sample over an area of any debris missed by MRS and detector equipped Hercules, helicopter flights were conducted. The area between Artillery Lake and Douglas Lake was chosen as representative and detector flew the satellite trajectory line and the area up to five miles south at 250 feet above ground at one mile intervals. No hits were located, therefore a good approximate indication was gained that the higher and faster CC130 search had indeed been valid over this area.

Ground Search Activities and Techniques

59. Satellite Debris. Owing to the wide geographical dispersion of the satellite ground searches per se, were impossible. Following a hit by a CC130, however, a helicopter would be dispatched to the coordinates, relocate the hit, land nearby and send out a ground search team. The team would locate the hit with hand held detectors, measure its radioactivity and begin recovery activities. This was the extent of this kind of ground search. However, checks were specifically conducted on:

a. all known human habitation including towns, cabins and camps;

b. transportation routes of all kinds; and

c. the radiation density dispersion to analyze its spread and ecological impact.

60. Human Habitation. The first goal of the Operation was human safety therefore habitation checks were carried out as soon as a problem was identified. Initially these were by NAST members alone led by a CF Radiation Officer. Yellowknife, Fort Reliance and Baker Lake were done in the first two days by NAST using Staplex air samplers and hand-held detectors. Snowdrift, Fort Resolution, Fort Smith, Hay River, Pine Point and Rocher River were all covered later by joint teams of US Health physicists, AECB and NAST members as it became clear that these communities may have been in the contaminated area. Finally transportation routes such as roads, winter roads and railways were also covered. Water resources camps, fishing camps and endless numbers of cabins were all checked on the ground by helicopter transported teams.

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[8] Marginalia: “”Campbell Plan” 6 Apr definite. No evidence of a second flight 7 Apr ”

Figure 3: The Grasty Survey

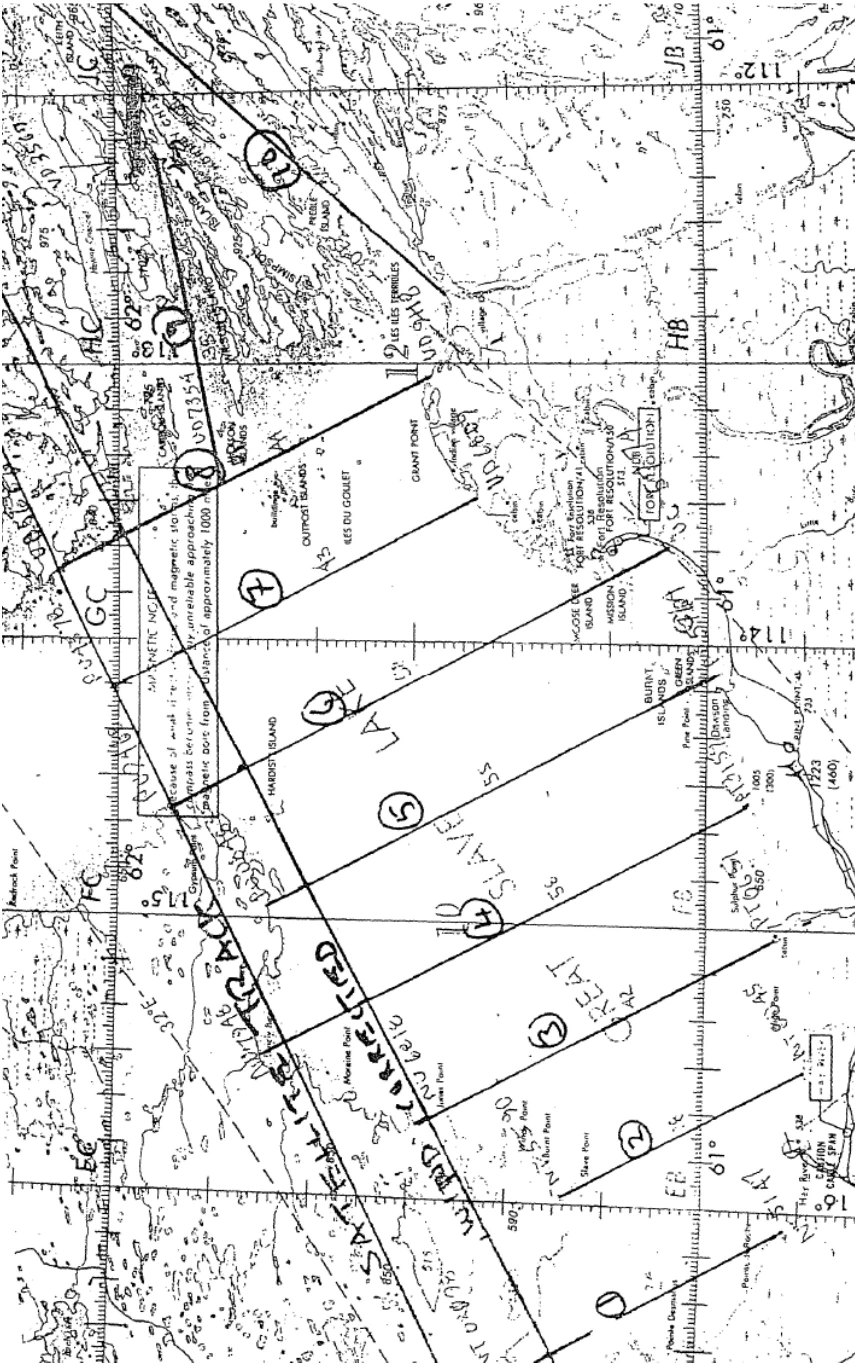
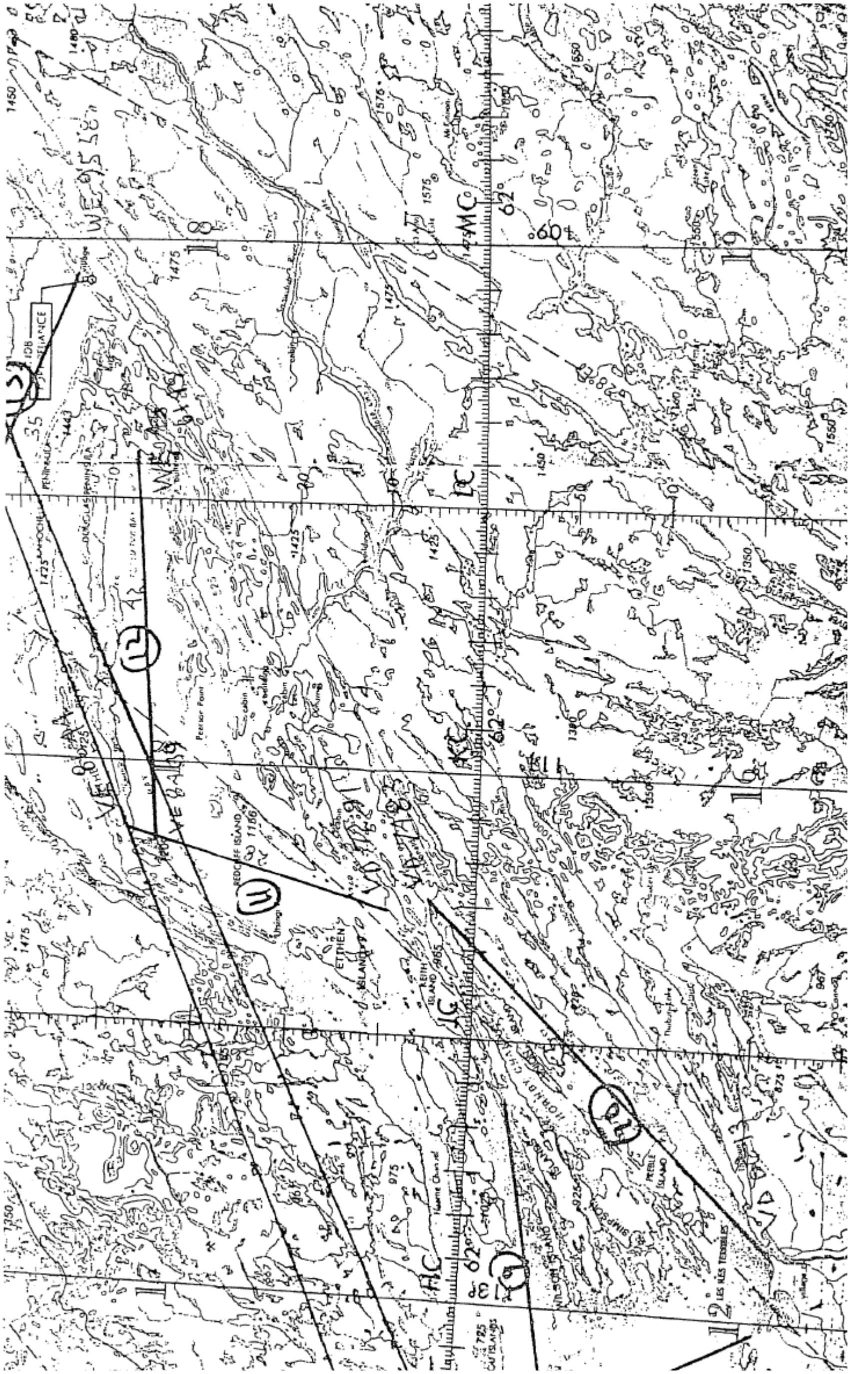


Figure 4: The Grasty Survey



61. The most prominent of these ground checks consisted of the surveys of Fort Resolution, Pine Point and Hay River between 26 February and 10 March. As the southward spread of radiation was defined by 22 February, AECB declared that these communities must be ground surveyed. A NAST Team was flown to each area sequentially. The Team, guided by an AECB physicist, lived in the town and progressively surveyed the roads and houses with hand-held instruments. Any particles were removed and that area checked more closely. This activity served to clean up the area in time for the Arctic Games over which considerable concern was expressed. The AECB is evaluating the necessity to return to these towns for a confirmatory check in the summer months.

62. Radiation Sampling Survey. An additional ground survey was conducted to determine the radiation density and distribution on and south of Great Slave Lake. Its purpose was to obtain a measure of the radiation density in one square kilometer samples at ten specific points, seven on Great Slave Lake and the others on Buffalo Lake, Copp Lake and Tsu Lake. Later, more lakes were added, Pilot Lake, Thekulthili Lake and Rutledge Lake. At least twenty particles were to be picked up at each point, the dispersion spread density noted and the particles sent to Whiteshell for analysis. Performing this survey, known as the "Tinney Plan" turned out to be hard, exhausting work in the snow and cold. The greatest concern was expressed by experienced northerners over the one point in the centre of Great Slave Lake. Flying visibility and ice surface conditions are dangerous. The Yellowknife NAST team performed this pick up, known as the "Ice Capades", grandly and safely roped together after arriving gingerly by helicopter. Samples were taken from all the points required. Results of this radiation density survey will be included in an AECB report.

Yellowknife Detachment

63. The longest lasting field detachment was Yellowknife which operated the entire 84 days of Morning Light. Superimposed upon NRHQ's regular duties, the Operation-taxed the staff fully. The interface NRHQ provided with the government of the NWT sources of information such as through NORRIS, and acting as the local spokesman were all invaluable services to the success of the Operation Details of operations are recorded in Annexes D Part 1 A and D Part 1 B.

Cosmos Lake Detachment

64. The successful construction of an ice strip and the operation of an austere base on the Thelon River ranked as a major accomplishment in the history of the CF and its predecessor services. Resources and experience were brought together from many operational, engineering and support services to operate Cosmos Lake for nine

weeks. CC130 ice strip operations, helicopter arctic flying, field camp deployments, logistics, engineering to provide electrical power, heat, water and communications challenged everyone's ingenuity in the severe Arctic conditions. On top of this unplanned deployment, the need to operate an international team in radiation contamination recovery operations imposed an entirely new set of problems. The fascinating tale of the birth, growth, maturity and death of Cosmos Lake unfolds in Annexes D Part 1 D, Part 1 E and Part 1 F.

Cape Dorset Detachment

65. In retrospect, the Cape Dorset operation was simply an interesting sidelight to the search for Cosmos 954. This nine day operation in March was investigation of an unusual ice impact area, in line with the satellite trajectory, far east beyond the predicted impact footprint. Nonetheless, once reported it was investigated by a joint Canadian-American team from Edmonton with the addition of an ice scientist from the National Research Council and an AECB representative from Ottawa. The disrupted ice area turned out to be a natural phenomenon. Annex D Part 1 G provides the details of the Cape Dorset expedition.

Recovery and Transportation

66. The satellite debris was recovered to WRNE in three phases; field pick up and transportation to Yellowknife or Cosmos Lake; storage and transport to Edmonton; and storage and transport to Pinawa for WRNE.

67. Transportation, where possible, was handled using standard containers for radioactive materials. Special lead lined casks or pigs were custom made for odd size pieces or very radioactive sources. Stocks of containers were often short, thus the shortage frequently threatened to become a critical path item. AECB let special contracts for extra containers but it was soon reported that stocks of lead were nearly exhausted in Western Canada. Flying pick up operations, always well behind the hits, were almost halted several times for lack of containers to take to a site.

68. Field pick up of radioactive debris was done using accepted practices, everything made much more difficult by deep snow and intense cold. The heavy lead containers were difficult to lift and carry to a helicopter. The sturdy NAST members were invaluable again. Taken to the forward bases, the casks were unloaded, rechecked for adequate seals and stored apart or under guard awaiting airlift by CC130 to Edmonton. Helicopters were contaminated several times by loose snow from casks or clothing melting onto the floor areas. NAST personnel cleaned these up and a final check was done at Edmonton at termination of operations to declare the aircraft clean.

All transport after this point was done with an AECB or NAST escort. The escort (which was equipped with detection gear) monitored radioactive levels and ensured that the aircraft was clean at trip's end. The loads were kept at least twenty feet from any passengers and only Operation duty passengers were carried.

69. At Edmonton, the hot loads were immediately taken to a bunker in the Explosives Depot at Namao. This bunker had been converted to a minimally equipped laboratory. Items were examined, photographed and repackaged. Finally, the loads were shipped to Winnipeg by available transport aircraft; then taken from there to Pinawa by AECL vehicles equipped to transport radioactive material. CFB Winnipeg provided good service here. Often loads were shipped by available flights which arrived during silent hours. AECL did not usually work outside normal hours therefore loads sometimes waited, under guard by Winnipeg personnel, for an entire weekend. A steady return of containers from Winnipeg was executed on available CF aircraft.

Data Analysis

70. The airborne multipath recorders produced an immense amount of data which required analyses before they were usable at hit control. The American came to Edmonton equipped with two data vans including computers which could be linked to LLL computers for further capacity and information passage. The two vans were placed inside No. 5 Hangar at Namao where they were relatively warm and in constant use. The methods and results of data van will be amplified in the American report.

71. Shortly after their arrival in Edmonton, EMR/GSC also required a capability to reduce data recorded on their equipment. A small computer was brought to the hangar and set up in a classroom. The EMR equipment lacked the capability to handle certain types of data analysis and a contingency backup was arranged with the University of Alberta. Once the Canadian MRS system was functioning, coordinates of areas covered and hits were supplied to hit control about eighteen hours after the CC130 landed with fresh data.

72. Full cycle was completed at this point. The coordinates of hits were plotted on the master map, sent to the field and to the mission planning group. Priorities, taskings and missions were assigned as the impact of new data was evaluated.

Operation Equipment Shortfalls

73. Each Annex in this report reviews special areas of operation during Morning Light. The main body of the report talks of the Operation itself. Much of the CF and Canadian Government equipment performed well, was well designed for its job and stood up to the low temperatures. However the equipment which did not do so or failed must be singled out for improvement. The significant operational equipment shortfalls were:

a. the severe lack of suitable navigation equipment for the CC138, the CH135, CH136 and CH147 for Arctic flying;

b. the inability of CC130 on board navigation equipment to fly sufficiently accurate tracks or determine positions for this type of meticulous search;

c. the vulnerability of the CH147 “Chinook” and the CP107 “Argus” to cold temperatures;

d. the lack of 1:50,000 scale maps east of 108° 1-J longitude in the NWT and equally important the lack of a method of obtaining the necessary replacement photo coverage quickly;

e. the underequipped photo section at CFB Edmonton to support operational field deployments requiring photographic evidence;

f. the reliance upon HF communications for voice or secure transmission in an area so vulnerable to HF blackouts;

g. the lack of a portable satellite ground terminal in the CF;

h. insufficient, not sensitive enough and ancient portable radiation detection equipment in Base NBC inventories;

j. lack of batteries to provide long reliable power sources at temperatures -40° to -60° C range;

k. insufficient winter surface transport capability needing a small over-the- snow vehicle to carry two people and tow one thousand pounds;

m. no all-terrain forklift or other air- craft loading vehicle suitable for an austere base;

n. the lack of an air deployable forward base of specific size for Arctic operations;

p. the poorly insulated tents;

q. the lack of air transportable, collapsible hardwall trailers for winter camp accommodation and ablution;

r. the lack of a safe, reliable method of heating field shelters;

s. no designated, prepared electrical power grid source ready engineered to provide service to a field camp;

t. the lack of deployable communications kit with telephone, radio, walkie-talkie and pager capability;

u. the lack of a reliable field hangar for helicopter servicing; and

v. the lack of a trained, equipped, deployable Canadian Government team to respond to a nuclear accident.

<u>Specialized Activities</u>

74. Operation Morning Light highlighted a number of special activities. These are reported upon in the various Annexes and the details are fully amplified in the Annexes or fine detail may be obtained from the Operation Archives or the agency possessing the appropriate expertise. The major specialized activities were:

a. LAPES;
b. radiation detection from the air;
c. MRS;
d. ice strip construction and fixed-wing air operations;
e. long-range rotary-wing wilderness operations;
f. photo reconnaissance response capability
g. IR surveys
h. POL logistics
j. satellite communications
k. austere airbase and logistics operations;
m. international group operations;

n. Canadian government inter-departmental task force;
p. public and community relations;
q. and radiation safety operations.

ACCOMPLISHMENTS

General

75. Operation Morning Light lasted 84 days from 24 January to 17 April 1978. An International, interdepartmental team had the task of searching for and recovering the radioactive remains of Cosmos 954. The teams operated under the difficult conditions of new relationships, an problem, a search area of impressive magnitude and overriding all of the above problems, the winter conditions of the Canadian north. The challenge was to search approximately 47,000 square miles of territory and recover as much of the satellite as possible that had returned to earth.
It is estimated that approximately one percent of the satellite by weight was recovered and a significant percent of the reactor accounted for, the majority of it finely spread over Sector 9 through 14 and possibly south again of those. The majority of the search and recovery was by air and about 5,050 flying hours were expended by Canadian Forces aircraft. The total expenditure of mandays and financial and logistics resources is detailed in Annex C Part 4. The total cost of this effort plus that of other agencies is being accumulated in Ottawa and Washington. The expenditure of these resources accomplished Operation Morning Light against its objectives within practical limits.

Summary of Results

76. The final tally of results is as follows as of 17 Apr when the Operation light was turned out. Some adjustment to this result will be in order when all the information is reassessed.

a. Hits:
(1) Total number of radiation sources recorded 204
(2) Number deleted for reasons such as natural radiation, nothing found, etc. 110
(3) Total hits recovered (satellite pieces or reactor particles) 94
b. particles recovered (ground surveys) 565

77. Human habitation checks for public safety:
a. number of communities checked - 15;
b. number requiring clean-up - 9;
c. miles of roads and railroads covered - all that existed;

d. commercial and fishing camps checked - 20;
e. number of cabins checked - 51;
f. sites not located or not landed at - 33;
g. number of cabins requiring radioactive material removed- 11; and
h. other sites checked - 3.

78. Radiation Surveys: The following were completed:
a. Tinney Plan - Particle spread and density - 12 sites;
b. Grasty Plan- Radiation dispersion and strength- 13 lines on G.S.L., 14 lines on small lakes;
c. Campbell Plan - Double check sample on CC130 coverage - 25 square miles; and
d. The results of these surveys are subject to further analysis as a record of the spread of the reactor particles.

<u>Success Measured Against Criteria</u>

79. The criteria for the search and recovery program, were established after the gross search was complete. The coverage of Sectors 1 to 8 (about 14,000 square miles) was performed by the gross method in five days. It defined the general footprint of the debris and enabled a saving of resources in the fine search by providing sufficient information to negate further searching of Sectors 6, 7 and 8.

80. <u>Aerial Surveys - Fixed Wing Aircraft</u>. This search was conducted by MRS equipped aircraft. 5,667 square miles of territory were covered close to the trajectory line and farther away when finds so indicated. The selection of MRS area was judgemental, deduced from specific data as hits were analyzed. The search was and all plots double checked by EMR, EG&G and LLL depending upon whose MRS/Detection equipment was recording the data. Therefore, there were undoubtedly sufficient data at the conclusion of MRS searches to conclude that the criteria for the fixed wing aircraft search was met almost one hundred percent.

81. <u>Aerial Surveys – Rotary Wing Aircraft</u>. Detector equipped helicopters were most capable of finding weak hits over water, but generally had inconclusive results over land. The radioactivity of the satellite debris was of sufficient strength that it could be readily detected, although if the CC130 had originally located a "hit" which was in fact a group of "hits.", the helicopter could not resolve which was the original hit nor if it had located them all. Therefore in terms of the criteria:

a. In the majority of instances the radioactive hit discovered by the fixed wing survey was relocated by the helicopter and its source determined.

Better than ninety- five percent of the hits were relocated and the reason for the radiation source determined.

b. The community searches were inconclusive when done by detector equipped helicopters. Background noise on the detectors over land obscured any useful results. Therefore the three nautical mile town environs were not covered. Ground surveys were substituted. Results of these surveys and clean-up met AECB criteria at the time before each search was terminated.

c. Roads, railways and camps were covered but the detector problem over land still existed. Hits were reported except for the occasional road camp site where ground surveys were done.

82. Ground Surveys. As recorded in paragraph 81 b. the ground surveys in communities met the AECB criteria supervised to the extent possible under the prevailing weather and snow conditions. Further judgement as to the completeness of these surveys may rest in the results of follow on summer conformation surveys. AECB is the authority in this regard.

83. Recovery of Radioactive Debris. All debris and particles of any size in or near habitation recovered. This material was all shipped to WRNE, Pinawa, Manitoba. The fine spread of particulate otherwise was impossible to recover.

Success Measured Against Operation Constraints

84. Morning Light was an unmitigated success when measured against the Operational constraints. In the main these were cold, weather, distance, aircraft shortages, aircraft under-equipped for navigation, trained manpower, the pitting of resources against the cold, and the general lack of deployable equipment to support such a field operation. Despite all of these and the dangers inherent in the operational milieu, the Operation was completed as measured above without major aircraft accident, radiation over exposure or serious injury. Two fires at Cosmos Lake constituted the only significant loss due to misadventure. The overall result is a tribute to the training, ingenuity, application of existing operational techniques and safety awareness of Canadian and American personnel.

CONCLUSIONS:

CF Mission Accomplishment

85. The CF assigned mission as stated in paragraph 7 was accomplished in Operation Morning Light.

Bi-National Operations

86. Canadian/American individual responsibilities became well defined in the early days of Morning Light. The two national teams of the Task Force worked extremely well together. The much smaller resource base in Canada did force some adjustments on the American time accomplishment expectations. Beyond this, however, the two national groups worked together to a common purpose easily and productively with amazingly few problems. The blend of skills each side brought to the task was essential to the other side's requirement and success, which is an exceedingly important factor. Without reservation, this was an excellent, productive exercise in international cooperation.

Multi-Departmental Operations

87. The Canadian team was made up of representatives of five separate government agencies. Several worked on different lines of authority and communication, i.e. CF to Air Command Headquarters, DND civilians to NDHQ, AECB/AECL and EMR to Ottawa National Headquarters. The results of this meant that all military communications had to be reassessed at Air Command while the civilian agencies went directly to their senior headquarters with real time and detailed information. The significance of these observations is better assessed from the report of each Headquarters.[9]

88. Field operations were characterized by a shortage of civilian manpower after the US contingent departed. Once this was sorted out, Canadian military/civilian agency operations accomplished the task, but with less facility than the Operation began with. The entire problem of an interdepartmental task, force should be planned for in advance with methods of providing sufficient scientific and technical expertise and manpower on a call up basis from industry or universities.

[9] Marginalia: "NDHQ has a report. Have not heard of NRHQ or Air Com. HQ reports "

Operational Techniques and Equipment

89. CF operational techniques and equipment were tested thoroughly in this undertaking. Throughout this report and its Annexes these techniques are described and amplified.

90. Techniques which were important to the Operation and in which CF training and equipment were vindicated were:

a. Arctic flying skills for fixed and rotary wing aircraft;
b. LAPES;
c. ice strip operations as per ATCP 1401;
d. field deployment training of Pioneer and helicopter squadron personnel;
e. ATCCT training and field deployment capability;
f. the CC130 airlift and endurance capability;
g. the versatility and reliability of the CC130;
h. the CH147 heavy lift load and sling lift capability;
j. the versatility of the CH135 and CH136;
k. flight feeding capability and IRPs;[10]
m. CF Arctic clothing;
n. MAMS Teams;
p. rotary wing maintenance adaptability to triple the CH135 maintenance rate;
q. logistic support systems for aircraft and Base;
r. bladder fuel system;
s. Base support capabilities;
t. NAST Teams; and
u. survival equipment.

RECOMMENDATIONS

95. As a result of the experiences of Operation Morning Light a large number of recommendations can be made. Listed below are those of a broad nature. Within each Annex there are a series of recommendations which should be reviewed by those offices concerned within that particular field. Overall, it is recommended that:

a. an air portable, collapsible hardwall trailer camp capable of sustained Arctic operations as an austere base be designed and held in CF inventory for contingencies complete with:

[10] Editors' note: There is no "l" in the original document.

(1) an electrical supply, emergency power supply and building block grid capability,

(2) efficient and low POL consumptive field heating system free of carbon monoxide and fire hazard. If Herman Nelsons are used they must be electrically operated,

(3) a cold weather water and sewage system, and

(4) a garbage disposal system.

b. an operational replacement for HF communications, both voice and secure message, be obtained as an immediate requirement;

c. a satellite ground terminal be provided automatically for a major northern deployment;

d. adequate long range navigation equipment be standard equipment in any CH147 or CH135 helicopter tasked for operation in the NWT;

e. a reliable and portable field hangar be available for helicopter field deployments in the Arctic;

f. measures be taken to improve the cold weather serviceability of the CH147 for operations away from heated hangars;

g. tent structure be researched to redesign entrances to be more functional and tents better insulated Arctic use consistent with the state of the art;

h. 1:50,000 maps be published for all of Canada;

j. updated radiation detection equipment be obtained for Base Nuclear Defence Sections such as a Canadian version of the E140 Eberline gamma survey meter and the AEC3 Swipe Reader probe, plus suitable check sources for calibration and practice;

k. a reliable battery or fuel cell source be provided as a regular CF supply item to power all portable electric equipment operating in the -40° to -60° C temperature range;[11]

m. the CF inventory of transportation equipment include:
  (1) an over-the-snow vehicle capable of carrying two people and tow up to one thousand pounds. A vehicle similar to the Bombardier Bombi would be useful;
  (2) an all-terrain forklift or other aircraft loading vehicle with a 10,000 pound lift capacity for austere, snow capable base support. A diesel "Bobcat" should be evaluated.

n. a deployable communication centre be obtained for a contingency reserve capable of telephone, radio, walkie-talkie, pager and vehicle radio communications;

p. engineering references CFP 302(2) and operations reference ATCP 1401 for ice strip parameters be made mutually consistent;

q. the CF LAPES capability be firmly established with:
  (1) defined goals and capabilities such as numbers of sufficient L23 loading support and reduced light or darkness delivery requirements evaluated,
  (2) a fully supported training program,
  (3) a better design of tow plates,
  (4) sufficient personnel support, i.e. qualified MAMS Teams,
  (5) updated procedures;

r. the bladder fuel systems for fuel caches and bulk transport of fuel be fully developed into a deployment system complete with large reserves of equipment;

s. a larger number of adequate fuel pumps be obtained for CH147 and smaller helicopters to support forward base and fuel cache operations;

[11] Editors' note: There is no "l" in the original typescript of the report.

t. two Operations such as Morning Light and a major contribution to Arctic Express not be tasked to a single base in terms of aircraft servicing personnel requirements;

u. CF inventory of field deployable camera kits be upgraded and on ready standby with equipment capable of operating in all climatic extremes

v. all Base Photo Sections be upgraded to include automatic colour film pro- cessing and modernize CF photographic services to widespread use of colour;

w. field camp fire protection routines be re-emphasized in all field training and checked by a fire marshal early in any operation;

x. all vehicles acquired for Arctic use be diesel powered for cold weather dependability and fuel economy;

y. generally Base administration, medical and food services, supply and comptroller services be brought into and on site at a major operation much sooner in order to both set up their response and to support field operations closely;

z. all field deployable equipment be thoroughly tested for Arctic use prior to installation in kits i.e. plastic items such as tent pegs or certain tools were either useless or fractured in the cold;

aa. a full contingency plan be prepared for use of Yellowknife as a main logistics and operations base for any operation or major air disaster response in the Arctic with full definition of augmentation personnel and material resources required;

bb. a complete public relations plan be prepared to deal with the media based on use of a single Operation spokesman, sufficient numbers of information officers and to keep media representatives from interfering with the progress of the Operation by their demands upon Operation senior personnel;

cc. the system be evaluated for possible use in the CP140 Aurora program for check out of the TAC NAC System;

dd. the lack of a readily deployable team to respond to nuclear accident or terrorism in Canada be seriously examined and as a result, an interdepartmental nuclear emergency response team be created and trained.

POSTSCRIPT

91. Two return visits by CFB Edmonton personnel were made to Cosmos Lake in the summer of 1978.

92. On 22 and 23 August, a group from the Base flew in by CH147 to build a memorial cairn, reorganize the fuel cache and clean up any remaining garbage. The first two tasks were completed but the third proved of greater magnitude than first assumed. The visit was purposefully left until late in the season, but to no avail in avoiding insects. A non-existent harassment in the winter, the black flies made working conditions very difficult at this time of year.

93. More man and machine power was needed. Between 11 and 14 September a team of seventeen people from the CFB Edmonton NAST were flown in by 450 Sqn CH147 to clean up the remaining garbage. The ground was too soft for machinery and the black flies were still a swarming nuisance. More than thirty bags of garbage were picked up by hand and removed from the Cosmos Lake site.

94. A commemorative plaque was attached to the cairn to record the participation of the majority of the organizations in Operation Morning Light. Its wording is recorded in Annex D Appendix 3.

ACKNOWLEDGEMENTS

95. The Operation Commander recognizes and acknowledges the services of the following organizations or people without which the Operation would not have succeeded:

a. the United States Government and the US/NEST Team Members;

b. Mr. Mahlon Gates, Commander of the US Team;

c. the Department of Energy, Mines and Resources, the Earth Physics Branch, the Geological Survey of Canada and the Centre for Remote Sensing;

d. the Atomic Energy Control Board;

e. Atomic Energy of Canada Limited;

f. the support of Air Command Headquarters, Bases and Units;

g. Canadian Forces Military and civilian support;

h. Northern Region Headquarters, Yellowknife;

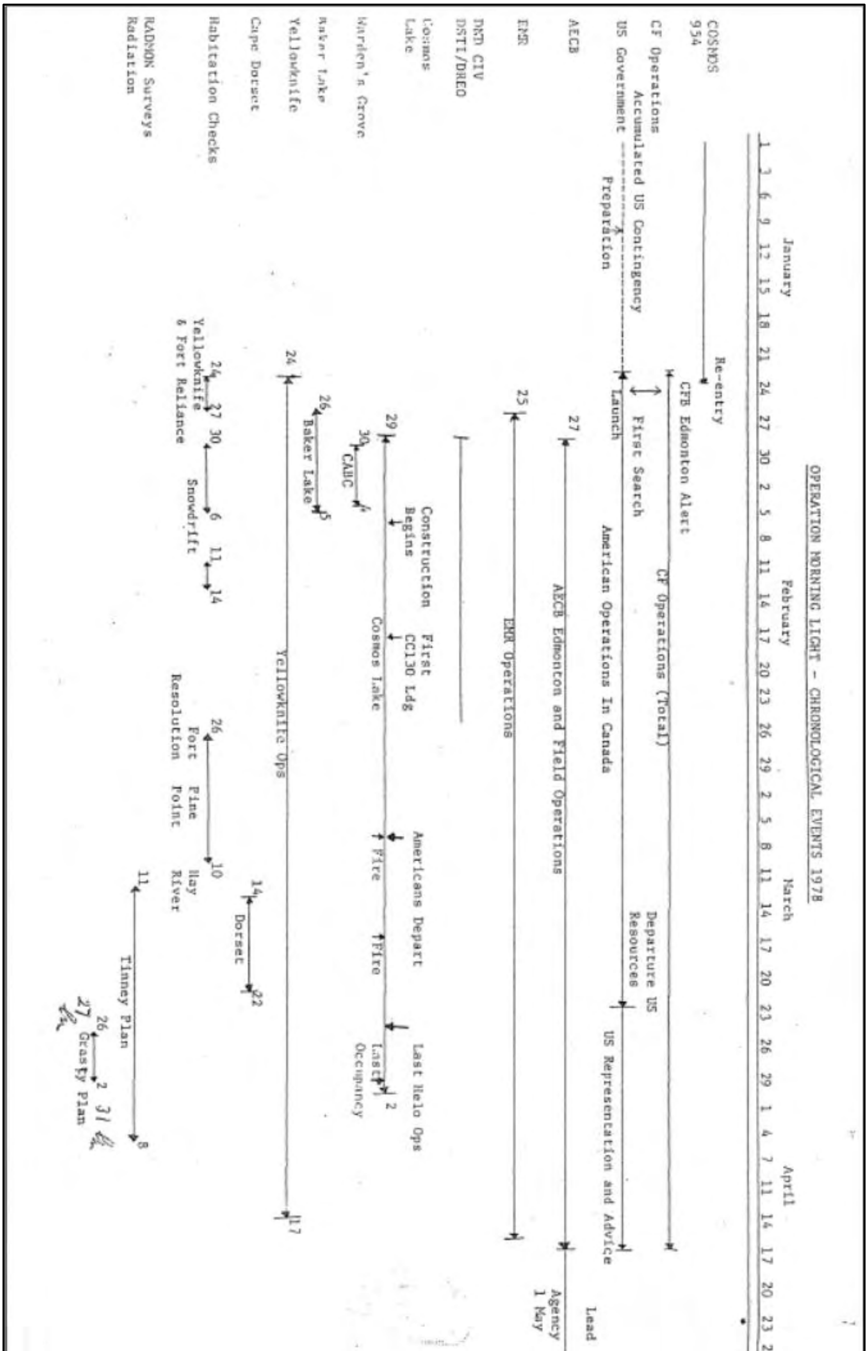
j. the people of Baker Lake,

k. the Government and communities of the NWT;

m. the RCMP “G” Division; and

n. the loyalty, hardwork and dedication of the personnel of CFB Edmonton.

Figure: Operation Morning Light – Chronological Events 1978



CHRONOLOGY

SIGNIFICANT EVENTS IN CHRONOLOGICAL ORDER

1.	18 Sep 77	- Cosmos 954 launched by Soviet Union.
2.	6 Dec 77	- US/DOE notified[12] that nuclear powered Satellite will probably return to earth and to prepare federal emergency response efforts.
3.	9 Jan 78	- NSC Working Group informed of probable January re-entry date of Satellite.
4.	22 Jan 78	- NEST Team placed on two hour alert at Andrews AFB, Washington, D.C.; Travis AFB Sacramento, California and McCarra Field, Las Vegas, Nevada.
5.	23 Jan 78	- CFB Edmonton NAST and NRHQ Teams placed on alert for possible re-entry of Cosmos 954 over the NWT.
6.	24 Jan 78	- Cosmos 954 re-entered the atmosphere and impacted, scattered across the NWT about 0500 hours MST.
		- CFB Edmonton designated the response base and search aircraft readied.
		- CFB Edmonton NAST/RADMON Team departed. for Yellowknife by CC130 at 1400 hours MST.
		- 2 x CC130[13] departed Edmonton for Yellowknife at 1545 and 1620 hours MST.
		- First American C141 arrived at CFB Edmonton at 1645[14] hours MST.
		- Second USAF C141 arrived at 1725[15] hours MST.

[12] Marginalia: "put on full alert" instead of "notified"
[13] Marginalia: "138" instead of "130"
[14] Marginalia: "707" instead of "1645"
[15] Marginalia: "1737" instead of "1725"

		- Air Sampling for radiation completed by NAST in Yellowknife.
		- First CF CC130 launched on search mission at 1:15 hours past midnight with American detection equipment on board.
7.	25 Jan 78	- 3x CC130 with American detection equipment launched on searches western sectors (1 and 2)2 x CC138 launched to conduct visual search on Great Slave Lake.[16]
		- CF NAST/RADMON Team to Fort Reliance for ground surveys.[17]
		- Search/Recovery Teams formed at Edmonton.
		- One additional CC130 launched with detection equipment on board supplied by EMR/GSC First "hit" at 2000 hours MST.
8.[18]	26 Jan 78	- 4 x CC130 on search.
		- Canadian/American search/recovery team deployed to Baker Lake.
9.	27 Jan 78	- Canadian/American search/recovery team deployed to Yellowknife.
		- Eleven missions flown – several possible hits and sixty percent of search area covered.
		- All civilians notified of possible radiation hazard by now through NWT Government.

[16] Marginalia: "One was our sampling at FL "

[17] Marginalia: "No – CC138 had which – did air sampling "

[18] Marginalia: "0725hrs 26 Jan First EMR trip with Bristow, next trip was with Bob Gronski, on 26 Jan at 2215 C130 313. "hit" was early hours of 27 Jan. "

		- Resources now up to 4 x CC130, 4 x CC138, 2 x CH147 and DOE Convair 580. - AECB Personnel arrive at Edmonton.[19]
10.	28 Jan 78	- Satellite debris found in Thelon River by members of NWT Expedition wintering at Warden's Grove. -Hot debris located near Sector 1.[20]
11.	29 Jan 78	- Baker Lake Team deployed to Thelon River site and confirmed debris was from Satellite and mildly radioactive. - 6 expedition members evacuated to Edmonton and Yellowknife for examination. - Sectors 1 to 8 completely surveyed by gross research.
12.	30 Jan 78	- New Sectors 9 and 10 established.[21] - Snowdrift survey by RADMON. - First Argus photo mission. - Four paratroopers from CABC jumped into Warden's Grove[22]
13.	31 Jan 78	- Second trip from Baker Lake to debris site, guards left on scene. - Commander NRHQ visits Snowdrift. -Retrieval of radioactive debris begun by Yellowknife Team. - Detector equipped Argus mission Sector 10.

[19] Marginalia: "AECB arrived in Ed at 1455 MST on Falcon 502 on 26 Jan. "
[20] Marginalia: "ML1(1) confirmed. ML5(1) bonus (DOE) "
[21] Marginalia: "see contradiction p. 3 "
[22] Marginalia: "see contradiction p. 6 "

14.	1 Feb 78	- Visual discovery of "stovepipe" piece.[23]
		- 200 R source located.[24]
		-3 CC130 formation sweep Sector 1 to 4.
		- System of "Hit" designation promulgated.
		- First satellite piece arrived in Edmonton MLI(1).
		- First cabin checks.
		- Decision to construct forward base at Cosmos Lake.
15.	2 Feb 78	- First LAPES Drop Fort Reliance.
16.	3 Feb 78	- Survival night for seventeen persons of Baker Lake Team on Thelon River.
17.	5 Feb 78	- MND, COMD AIRCOM, Base Commander visit Yellowknife and Baker Lake.[25]
		- LAPES fuel to Cosmos Lake.
		- Cosmos Lake build up began.
		- First MRS Search Sector 1 complete with US equipment.
18.	6 Feb 78	-Two LAPES missions.
		- Baker Lake evacuated – All CH147s to Yellowknife.
19.	7 Feb 78	- Water barrel drop – seismic experiment on Great Slave Lake. Inconclusive results.

[23] Marginalia: "31 Jan (initial)"

[24] Marginalia: "Found a.m. 27 Jan. Relocated 28 Jan. Pinpointed 1 Feb (initial)"

[25] Marginalia: "4 Feb (initial)"

		-Debris discovered by helicopter with American H500 detector pods. First Satellite pieces arrive at WRNE Pinawa.
		- First Satellite pieces arrive at WRNE Pinawa.[26]
20.	8 Feb 78	- LAPES POL Cosmos Lake.
		- DOE Convair 580 returned to Las Vegas.
		- MRS Search Sector 1, 2 and 10 locates several hits.
21.	9 Feb 78	- CABC paratroopers withdraw from Warden's Grove.[27]
		- Many new Hits Sector 2.
		- LAPES Fort Reliance (POL) and Cosmos Lake (D-4) Bulldozer.
22.	10 Feb 78	- LAPES Cosmos Lake (POL).
23.	11 Feb 78	- LAPES Fort Reliance (POL).
		- New series of hits found at Snowdrift.[28]
24.	12 Feb 78	- LAPES Cosmos Lake (POL).
25.	13 Feb 78	- LAPES Cosmos Lake (POL).
26.	14 Feb 78	- LAPES Cosmos Lake (Modular Tents).
		- Photo reconnaissance flight by 4 x CF5 supported by aerial refueling CC137.
		-AECB and RADMON final cleanup at Snowdrift.
27.	15 Feb 78	- Ice Strip at Cosmos Lake completed to 4900 feet. First

[26] Marginalia: "6 Feb (initial)"

[27] Marginalia: "6 Feb (initial)"

[28] Marginalia: "10 Feb (initial)"

		Buffalo landing (115462 from 424 Sqn).
		- Scientific team build up began at Cosmos Lake.
28.	16 Feb 78	- First CC130 landing at Cosmos lake – payload 20000 lbs.
		- Helicopter Operation begun Cosmos Lake.[29]
29.	17 Feb 78	- LAPES at Cosmos Lake (POL).
30.	21 Feb 78	- CRATTZ functional at Cosmos Lake.
		- Check of three prospectors at Fort Smith by AECB.
31.	22 Feb 78	- Helicopter surveys begin to define particulate spread south of Slave Lake. Entire new radiation survey problem turned up. Led to establishment of Sectors 13 and 14.
32.	23 Feb 78	- ATCO ablution trailers flown to Cosmos Lake.
		- Nast individual team to both Fort Resolution and Fort Smith.
33.	26 Feb 78	- Survey and clean up Fort Resolution by Team.
		- Particle density survey south shore Great Slave Lake.
34.	27 Feb 78	- AECB Community briefing at Pine Point.
35.	28 Feb 78	- LAPES Artillery Lake (POL).
36.	1 Mar 78	- First mission with Canadian supplied MRS.
		- LAPES Artillery Lake (POL).
		- Fort Resolution clean up complete.
37.	2 Mar 78	- LAPES Hanbury Lake (POL).

[29] Marginalia: "17 Feb CH135 (initial)"

		- NAST/AECB clean up Pine Point begun.
38.	3 Mar 78	- Takeover of photo services represents first event in replacing American personnel and equipment with Canadian supplied resources.
39.	5 Mar 78	- Pine Point clean up complete.
40.	6 Mar 78	- NAST/AECB clean up Hay River begun.
		- Satellite Ground terminal operational - telephone communications now normal.
		- Buffalo departs Operation.
41.	7 Mar 78	- Fire in Mess and Supply tent Cosmos Lake.
		- All Americans depart Cosmos Lake.
42.	8 Mar 78	- Argus returned to Summerside. Remaining photo requirements cancelled.
		- Canadian supplied detector equipment operational at Cosmos Lake.
43.	10 Mar 78	- Hay River clean up complete.
		- Report of large hole in ice near Cape Dorset.
44.	11 Mar 78	- "Tinney Plan" particle recovery survey begun.
		- Canadian supplied detector equipment operational at Yellowknife.
		- Cape Dorset investigative resources launched from Edmonton.
45.	14 Mar 78	-Artist, Mr. Evans, flew to various locations. in preparation for paintings of Operation.
46.	16 Mar 78	- American MRS missions terminated.

47.	17 Mar 78	- Fire in equipment tent at Cosmos Lake.
48.	21 Mar 78	- Cosmos Lake withdrawal begun.
49.	22 Mar 78	- Cape Dorset operations terminated, false alarm.
		- CRATTZ Operation terminated at Cosmos Lake.
50.	23 Mar 78	- Lieutenant-General Carr, Colonel Garland visit Cosmos Lake.
		- Helicopters depart Cosmos Lake.
51.	26 Mar 78	- Radiation survey "Grasty Plan": begun on Great Slave Lake.[30]
		- Satellite Ground Terminal shut down.
52.	29 Mar 78	-All personnel evacuate Cosmos Lake, personnel commute with aircraft thereafter.
53.	2 Apr 78	- Cosmos Lake last flight out - Operation closed. - Grasty survey completed.[31]
54.	6 Apr 78	- "Campbell Plan" debris survey begun.
55.	7 Apr 78	- "Campbell Plan" survey complete.
56.	8 Apr 78	- "Tinney Plan" survey complete with "Ice Capades".
57.	10 Apr 78	- Whooping Crane nesting areas surveyed in Wood Buffalo National Park.
58.	15 Apr 78	- Surveys of transportation routes and cabins complete.
59.	17 Apr 78	- Helicopters and Yellowknife detachment return to Edmonton.

[30] Marginalia: "27 Mar (initial)"

[31] Marginalia: "31 March (initial)"

		- Operation Command Post closed.
		- Operation Light terminated.
60.	18 Apr 78	- Last representative departs Edmonton.
		- Hit control terminated.
61.	19 Apr 78	- Last radioactive debris shipped to Pinawa. AECB personnel depart Edmonton.
62.	22 Aug 78	- Party from CFB Edmonton stays two days at Cosmos Lake, builds cairn and cleans up some garbage.
63.	11 Sep 78	- Seventeen person NAST team from CFB Edmonton flown to Cosmos Lake by CH147 for three day to clean up last of garbage. Ecology contribution complete.

ANNEX A
Part 1 A

FLIGHT OPERATIONS FIXED WING AIRCRAFT OVERVIEW

1. The following parts of Annex A detail the operations of fixed wing aircraft in Morning Light. The aircraft were employed and their roles are:

a. CC130 Hercules
(1) logistics,
(2) LAPES,
(3) large area search, and
(4) Microwave Ranging System (NRS) search.

b. CC138 Twin Otter
(1) logistics,
(2) communications, and
(3) NAST Team deployment.

c. CC115 Buffalo
(1) logistics.

d. CP107 Argus
(1) photographic mission.

e. CC137 Boeing
(1) air mission for CFS - one day.

f. CC129 Dakota
(1) logistics (hot cargo Edmonton to Winnipeg)

g. Convair 580 (DOE)
(1) Infra Red search.

h. CF5
(1) air reconnaissance - one day - photography not successful (due to weather).

2. The backbone of the fixed wing operation was the CC130 which flew approximately 1,800 hours. This aircraft was based at CFB Edmonton for the entire Operation because of the lack of hangar space or storage for detection equipment at Yellowknife. Approximately one third of the hours of each search or MRS mission

went to transit time, however the lack of facilities at Yellowknife and the technical interface at Edmonton precluded any other choice.

3. The CC138 Twin Otter proved itself again a reliable and adaptable airplane for Northern work. Where servicing teams and significant amounts of equipment were necessary to support some of the more highly-bred helicopters, the CC138 started, flew, landed on snow, moved people and small amounts of equipment without fail and with only crew members in support. It proved its worth and the value of the CF owning an aircraft which will operate easily away from facilities in the extreme cold. Other short-range aircraft should be adapted to perform as faithfully as the Twin Otter. It did, however, lack suitable long range navigation equipment. Installation of equipment such as Omega would prove a great asset to CC138 Northern operations.

4. The reports which follow detail the experiences of those of the above aircraft which had a major involvement with Operation Light.

ANNEX A
Part 1 B (1)

CC130 OPERATIONS
435 (T) SQUADRON

LOGISTICS

1. Operation Morning Light began, for 435 Squadron, with the requirement to provide a standby crew on two hours notice for a classified mission for an indefinite period commencing approximately 1700 hours MST, 23 Jan 78. In view of the security aspects of the mission that crew was identified as the SAR Standby Crew who were already on two hour notice and therefore would not require special alerting or notification of the classified circumstances. The SAR Back-Up Crew was brought to two hours notice and an additional SAR crew was identified but not placed on alert status. The first mission, manned by the original SAR Standby Crew, was launched 241400 HST January to deploy the NAST to Yellowknife. Thereafter aircraft were launched/recovered on a continuous basis until the final flight returned from the transport of radioactive material between Yellowknife and Winnipeg on 17 Apr 78.

2. There was never a conflict of understanding as to tasking priorities on Base Edmonton, and Morning Light was always the primary mission, however there was a lengthy period of conflicting priorities for tasking between Base Operations/435 Squadron and ATOC. That situation was a factor until ATGHQ and ACHQ resolved their priorities between themselves. Overall the Squadron was able to meet all demands of the revised taskings satisfactorily and the pinch was not really felt until Arctic Express came about. Considerable juggling of was required to attempt to ensure that no-one overflew their monthly/quarterly allowable hours during the period. Although this was not completely successful and several crew members overflew the monthly maximum time (120 hours), it was not a problem and did induce an added feeling of achievement and satisfaction. This situation would have been more significant except that one 436 Squadron crew was borrowed from Trenton for a 13 day period.

3. Numerous QAP missions were ultimately cancelled or otherwise juggled by ATOC to the disadvantage of the Squadron's normal training. In particular the loss of Trans-Atlantic flights created additional problems of attaining Navigator "leg" currency, however the overall emolument as one of significant new additional operational training and experience for all the crews.

4. Initially Squadron operations operated on a continuous basis but were shortly able to revert to a relatively routine status after the first ten days. The acquisition of pocket pagers (8) on 20 Feb significantly eased the burden for

Commanding Officer and Operations staff of having to constantly remain in telephone contact. Daily mission tasking was accepted directly from the ML Command Post throughout and until approximately end February crews were alerted for their missions by Base Operations as and when aircraft/loads were known to be available. Thereafter, crews showed automatically at published times.

5. All aircraft were crewed by 435 Squadron except:

a. one 436 Squadron crew was seconded to 435 Squadron for 13 days inclusive, (3 MRS/3 transport missions, Total 60.6 hours);

b. one 426 Squadron freight mission to Trenton/Ottawa/Cosmos Lake to deploy the satellite communications terminal, the time estimated at six hours;

c. one 429 Squadron communications mission for Commander Air Command (time estimated at six hours);

d. 429 Squadron missions to transport hot cargo from Edmonton to Winnipeg; and

e. 436 Squadron crew and aircraft to recover CH135 from Cape Dorset Operations at Frobisher.

ADDITIONAL GENERAL COMMENTS

6. The total crew effort required of 435 Squadron, exclusive of paragraph 5 above follows:

Aircraft	Request	Cancelled	Flown	Remarks
CC130	215	8	207	Cancellations were due to last minute unserviceable aircraft and/or poor weather.
US Convair	12	7	5	1 Pilot (AC) and 1 Navigator per aircraft. Cancellations due to unserviceable aircraft or MRS equipment.
Argus	1	0	1	

7. 90 landings were conducted at the Cosmos Lake ice strip – first landing 16 Feb 78, last landing 2 Apr 78.

ANNEX A
Part 1 B (2)

CC130 SEARCH TECHNIQUES

INITIAL

1. It quickly became clear that the navigation accuracy required during the search for radioactive material was not possible with doppler, omega or even visual pinpoints. The first two methods are accurate only within .5 to 1.5 miles of the required location and while visual pinpointing may be closer in well mapped areas that technique can have at least those same errors, in addition to becoming almost impossible in areas of little geo graphic detail such as existed over much of the area of probability, particularly in the winter months.

2. An attempt was made to guarantee specific coverage through a three aircraft 1500' spacing formation mission conducted 1 Feb. However, presuming that formation integrity could be assured, and that in itself was almost an impossible task, track accuracy was still predicated on the ability of the lead aircraft to know exactly where he was; this aspect coupled with the fact that it took three aircraft to do the work of one quickly ruled that technique out as uneconomical in the extreme. A method that would guarantee accuracy within a few feet was required.

MRS SEARCH TECHNIQUES

3. The MRS was the answer. MRS search was not without a considerable cost however since it often took many hours of coordinated effort between the CC130 and the helicopter to properly place and check out the MRS transmitters. This requirement was seriously hampered on several occasions by MRS or sensing equipment unserviceability, poor weather in the operating areas or at the helicopter bases, the transit time involved by all aircraft, and the fuel penalty paid by the helicopters resulting in reduced loiter time. Time was also wasted when the CC130 had to wait for the helicopters to land and refuel. The MRS did however provide the accuracy required for guaranteed coverage once the pilot adapted to its use. The pilot's readout while simple enough, was very sensitive and accuracy was therefore subject to his requirement for attention to other flight problems and to the degree of fatigue he was experiencing at the end of a lengthy day (MRS missions averaged 10 to 11 hours each).

ANNEX A
Part 1 B (3)

COSMOS LAKE OPERATIONS

1. When the option of creating an ice strip suitable for the CC130 operations was first considered, 435 Squadron undertook to determine the feasibility of the idea. It is interesting to note that this event was a precedent in Canadian Forces history - on no earlier occasion had the RCAF/CF ever operated the CC130 off a fresh water ice runway, constructed by military personnel alone. (Although it had been done with Cl19s in the early 1960s) Although ice strips have been used by the CC130 before (Pond Inlet for example) there was little current freshwater ice strip experience to be had anywhere within the existing system. Reference material was very dated and as will be seen, contradictory in nature. This entire aspect of Morning Light was in itself a unique and significant event.

2. The basic document consulted consisted of ATCP 1409 - "Ice Strip Requirements for the Hercules, Buffalo and Twin Otter Operation Dec 71 11". The data therein evolved from two essential sources:

a. "Snow Ice and Permafrost Research Establishment Reports" (SIPRE) Oct 56; and

b. "Considerations for Landing Aircraft on Floating Ice.", by TG Dunkin 24 Oct 71.

The ATCP 1409 data was supported by CFP 320 (2) "Interim Edition of Engineer Field Manuals Vol II", (Art 624). However, a comparison of the charts therein quickly established that this publication was a direct repeat of ATCP 1409. An additional document - CFP 302 (2) Part 2 - "Specific Operations Vol 2, Arctic and Subarctic Operations, Part 2" unfortunately contradicts the other documents, in that the minimum freshwater ice thickness required for a CC130 at 130,000 pounds appeared to be three inches in excess of that of the other documents for restricted (three aircraft/day) operations.

3. Additional data was acquired through discussions with knowledgeable personnel of Pacific Western Airlines regarding their ice operating criteria. It was easily established that their requirements were almost exactly identical to the data provided by ATCP 1409, although they did not operate off ice thickness less than 54 inches. This thickness represents the ATCP 1409 criteria required for unrestricted and continuous operations of unlimited numbers of aircraft per day. Morning Light

requirements were established as a maximum of three missions per day to allow the same AUW on 36 inches of ice.

4. The first Cosmos Lake ice strip landings by the CC130 were conducted on 16 Feb, Mission No. 6359,[32] aircraft No. 130331. A total of 90 landings conducted between 16 Feb and 2 Apr 78. A copy of the Squadron Operations "Aircraft's Mission Guide Notes regarding Ice Operations" is included at Appendix 1.

5. The ice acted as predicted although it did appear to thicken at a somewhat slower rate than expected once the snow blanket had been removed. A rather significant crack appeared shortly after the runway was cleared which was startling. It ran zig-zag fashion the full length of the 4900' runway more or less in the centre and was up to two inches wide and three feet deep (on 48" ± of ice). This crack was caused by the thickening ice floating higher than the surrounding snowcovered and unaffected lake ice; this created a "bowed up" effect of "crowning" of the runway which finally split due to the lifting force. The crack was flooded and refrozen and presumably resulted in an even stronger supporting surface. No further cracks. of this nature developed.

6. Through the auspices of the ATCCT, a TACAN and an ADF were set up which gave an IFR capability at Cosmos Lake of 580' AGL and two miles visibility on the lowest weather runway. While this capability was well worth the effort of installation for enroute and orientation purposes it was little help when the prevailing ice crystal fog was present. Fortunately communications were reasonable in this period and arrivals could be adjusted to the best time of day. Only one aircraft did not "get in" and diverted, however several were required to make more than one approach. The CC130 radar picture derived from the lake itself and the barrels along the runway did much to aid in this regard. Copies of the let plates prepared by 435 Squadron are at Appendix 2.

7. On several occasions CC130 crews were instrumental in assisting helicopter; Buffalo and CC138 missions by providing enroute navigation and ice strip location assistance.

[32] Marginalia: "6859 (initial)"

APPENDIX 1
To Annex A
Part 1 B (3)

COSMOS LAKE ICE STRIP
435 (T) SQUADRON
CC130 OPERATING CRITERIA

(Criteria established and approved by Commanding Officer 435 Squadron and CFB Edmonton Engineering Officer, through the Morning Light Command Post - 16 Feb 78.)

Reference:
A. ATCP 1409 Ice Strip Operations - CC130, Dec 71 Vol I
B. GPH 204/205 - JBI/RCR data and equivalents
C. Cosmos Lake Tacan/NDB/DME Let Down Charts

1. Strip Particulars

a. 6349N 10414.5W.

b. 4900' X 130'.

c. Runway Heading 176° M/356° M.

d. Variation 24° E.

e. Mean surface W/V 306° M/12K.

f. Ice thickness varies 38-42" (Minimum acceptable 36 ").

g. Tacan CH69 (8W).

h. NDB 278 kcs (8P)(Ident on CH only – every 4 minutes).

2. Principles of Operation

a. All let downs approved for operational use 13 Mar 78.

b. After dark take-offs are approved on those exceptional occasions that they are required. Night landings will be approved by exception only.

c. Normal maximum landing weight of 130M is authorized for load requirements only (Command Post) or where extra fuel is essential (AC).

d. Maximum three landings/day on 36” ice (ice thickness/5 2 Mar 78 - 46” minimum.

e. Minimum 54” ice required before operations unlimited.

f. Unless specifically authorized, no more than one aircraft on the strip at a time (regardless of aircraft type). Authorization normally by Command Post only. Where authorization is forthcoming maximum taxi speed “dead slow”, minimum distance between aircraft 500’.

g. All operations will be suspended if ice sagging or other deterioration becomes apparent.

h. Most important - watch the surface temperatures - if a sharp decrease (more than 10° F/5.5° C) other than normal daytime highs and lows, the ice strengths will be drastically reduced and in all probability all ice operations may be suspended for three to five days until after the temperature has stabilized (if in doubt on this one - ask). S Ops 0 will monitor continuously.

3. <u>Operation Limitations</u>

a. <u>Landing</u>

(1) touchdown at least 500’ from the thresholds,
(2) touchdown as smoothly as possible,
(3) assume an RCR of not more than 5 (see Reference B),
(4) maximum crosswind with that RCR must be watched closely,
(5) stopping requires a guaranteed reverse and anti-skid braking capability under conditions of low RCR and high crosswind, therefore get on the ice early and check that props have gone into ground range early on the roll.

b. <u>Taxiing</u>

(1) maximum taxi speed at any time 5 mph,
(2) maximum speed in threshold areas – dead slow
(3) avoid unnecessary maneuvers on threshold areas,
(4) cross significant cracks at 90° wherever possible.

c. Parking

(1) maximum in one spot – one hour at 36” ice,
(2) minimum ice for one to six hours - 45”
(3) minimum ice for six to 24 hours - 54” (move aircraft daily).

NOTE: On all occasions ice must be watched closely for settling/cracking and the aircraft moved soonest regardless of time should it be necessary.

(4) avoid parking near significant cracks,
(5) do not park closer to other aircraft than 1,000’ in the event two aircraft are authorized on the ice at one time,
(6) use alternate parking locations, least 500’ distant from each other, on subsequent missions, (this arrangement will be coordinated by Cosmos Lake).

d. Onload/Offload

(1) shut down No. 2 and No. 3 engines if possible. Keep No. 1 and No. 4 operating in low speed to ensure ability to move \ and aircraft quickly and reduce the possibility of GTC/electrical snags developing,
(2) have a crew member on the headset outside, monitoring the ice for sagging/cracking and the general area for pedestrians/vehicles operating around 1 and 4 props during ground operations. Brief the LM that in the event it becomes necessary to move the aircraft, you will ring the crash bell. He will then be required to secure what he can of the load/warn people/raise the ramp as time will permit. Move the aircraft gently away at least a distance of 500’.

4. Frequencies/Call Signs

a. Satellite One - 11233/5400 USB.

b. Oscar (Station Commander) - 282.8 UHF.

c. Area Interplane - 282.8/123.45/122.2.

d. Cosmos Lake - 282.8/134.1.

5. Notes and Observations

a. Be wary of optical illusions created by downhill approaches from either end (tendency to feel high on the glide slope).

b. Fly a maximum effort profile (using speeds and procedures) to reduce landing roll, but touchdown gently.

c. Level 2 and 3 First Officers may do Cosmos Lake landings at the Aircraft Commander's discretion provided the aircraft Commander is either an Instructor Pilot or a Senior Supervisor.

d. The ice strip is easy to see - good radar returns from the lake and the fuel barrels along the side.

e. Prevailing terrain is the hills south of the river (1000 ± MSL).

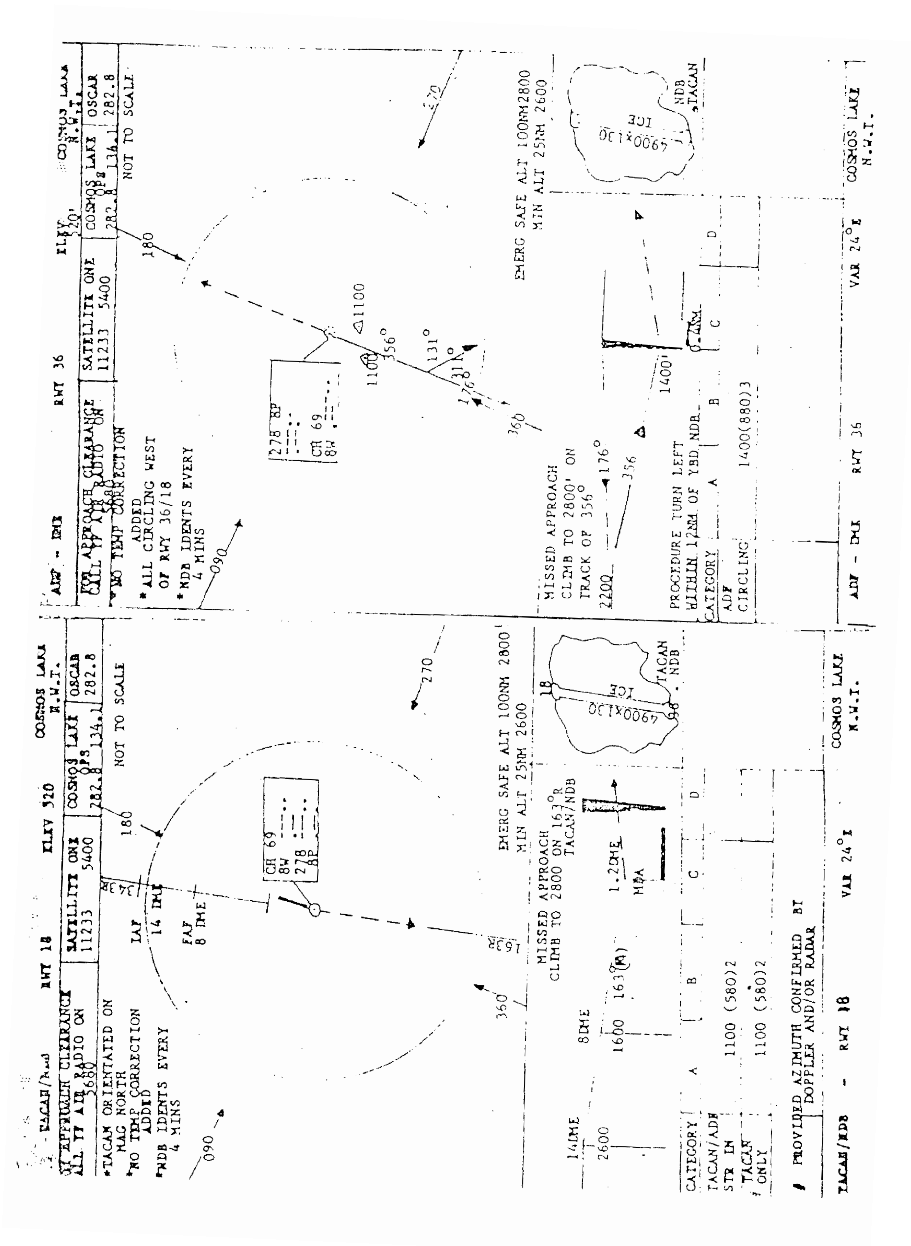
f. Personnel on the ground wander rather aimlessly without apparent concern for props etc.

g. CC130 crews should be prepared to provide homing/navigation assistance to Choppers/C115/CC138s in the area, particularly in poor weather.

h. Don't forget to close/open your IFR Flight plans on arriving/departing Cosmos Lake - suggest through Cosmos Lake Operations on their Satellite GP phone line.

j. DT 60 checks are no longer required, however all crewmembers will acquire and carry a film badge and pencil (MR) dosimeters for the Morning Light Operations, and return same to the RADMON desk after completion of the Mission. Film badges shall be exchanged on a weekly basis.

APPENDIX 2
To Annex A
Part 1(B)(3)



ANNEX A
Part 1 B (4)

OPERATION MORNING LIGHT
LAPES OPERATION REPORT

Reference: A. D/COMD 376 ATGHQ Trenton 162045Z Feb 78

PART I - GENERAL

INTRODUCTION

1. Operation Morning Light, the search for satellite Cosmos 954 provided a realistic operational proving ground for the LAPES technique of serial delivery. During the initial stages of the search, Helicopter and Twin Otter operations being conducted out of Yellowknife NWT were extended to the limits of their operating range. In order to extend operating time of these aircraft in the search areas, it was decided to provide fuel caches at selected locations in the search area, (Annex B). The most expeditious and economical method to insert these fuel caches was determined to be LAPES because of qualified crew and equipment availability at CFB Edmonton, and the relative simplicity of delivery of large quantities of fuel with minimum rigging and parachute equipment requirements.

2. Subsequent to the decision to provide fuel caches, the discovery of a large piece of space debris in the Warden's Grove area warranted the up of a base camp in the vicinity of the find. This particular location was beyond the useful operating range of helicopters from Yellowknife or Baker Lake, and again, LAPES was determined to be the most practical method of delivering fuel and supplies as well as the construction equipment required to construct an ice runway and Base Camp which would be used to support air landed operations.

3. On 30 Jan, 435 Squadron Tactical Airlift School (TALS) was directed to prepare platforms of fuel for LAPES delivery to the Fort Reliance area to provide a fuel cache for helicopter and Twin Otter operations. The first load of fuel was delivered on 2 Feb and LAPES operations continued until the last LAPES delivery was completed on 02 Mar.

PART II - DISCUSSION

4. Manpower Resources. 435 Squadron instructor loadmasters plus augmentees from 1 were pressed into service to build the initial platforms and loads.

Their reaction to this requirement was exceptional in that they voluntarily cancelled earned days off and worked well into the nights to have the loads ready on time. They were later replaced by 1 AMU MAMS personnel on completion of Exercise Rapier Thrust who also put forth a first class effort to keep the operation going. 435 Squadron loadmasters were responsible throughout the operation for loading and rigging the aircraft.

5. MAMS manpower was organized on the basis of 3 x 4 man teams. One team was employed on platform construction, the second on platform build up and the third on day off.
Tasks and teams rotated daily. The two duty teams also required to load and rig the LAPES aircraft. This manpower figure does not include the officer supervisor. It is considered that this organization was sufficient to sustain the airdrop of one 20' + 16' tandem load daily on an indefinite basis. It also provided the flexibility to afford a second drop per day on an occasional basis. On the basis of our experience during Operation Morning Light a planning figure of eight man days per 20'+ 16' tandem LAPES load appears reasonable. This includes all aspects from platform construction to final aircraft rigging. It is preferred to express this labour requirement in man-days rather than man-hours as the two are not strictly interchangeable. The basic organizational unit of the four man team should be retained.

6. At the outset of the operation, only one current LAPES crew was immediately available. Other qualified crew members re-gained currency as the operation progressed, after completing at least one operational mission with a current crewmember prior to dropping.

7. Equipment Resources. Sufficient LAPES equipment for building the platforms was available from TALS training stocks for the initial stages of the operation, however, as the operation progressed, a shortage of articulating links and bolts, attitude control bars, plywood and extraction slings was experienced. Rapid procurement of all required items was made by the Morning Light Command Post. (The shortage of these items became a limiting factor in the continued conduct of LAPES operations until some of the equipment was able to be recovered).

8. Weather Conditions. Reduced ceilings and/or high winds and continuous sub-zero temperatures prevailed for the majority of the drops. In-hindsight, these conditions would have precluded the option of using a heavy equipment drop. All LAPES missions were able to be completed on schedule, with remarkable accuracy, and exceptional load survivability despite adverse snow drift conditions on some of the extraction zones.

9. Extraction Zones. The present system of marking an extraction zone is excellent, provided the personnel tasked to set up the zone are available and are completely cognizant of the requirements. But, as personnel were not available at most locations, a formal extraction zone could not be set up. A procedure was therefore devised whereby smoke cannisters were dropped at 2 second intervals to simulate the normal position of the release and impact panels and to provide depth perception over the ice and snow as well as to assist in marking the desired load location. This procedure, proved effective and was successfully employed at Fort Reliance, Artillery Lake, Hanbury Lake, and at Cosmos Lake prior to the arrival of the Base Camp personnel. The value of this procedure was most noticeable at Cosmos Lake, where it was difficult, if not impossible, for the personnel on the ground to set up the extraction zone due to sub-zero temperatures and adverse weather conditions. In addition, each drop required a new extraction zone because the previous platforms could not be readily moved and a new zone set up prior to the next delivery of fuel/equipment.

10. Tow Plate. All drops were made utilizing a modified tow plate. (This tow plate was modified to increase the reliability of the system by eliminating the possibilities of a premature extraction.) The tow plate used throughout the exercise is the only tow plate so modified. These modifications were completed at unit level over a period of several years, with locally manufactured parts. During the operation, some internal part failures occurred and replacement parts were also manufactured locally, as all parts are unique. The present tow plate system does not have spares or parts available through any supply system.

11. Loading Equipment. The 435 Squadron TALS L23 loader at Namao is the only L23 in the air transport system modified to accept LAPES platforms. Unmodified L23s will not accept the platforms because metric LAPES platforms have skids attached to the bottom for directional slide control. Dependancy on the single modified L23 imposes an unnecessary restriction on the present LAPES capability, particularly since the serviceability record of L23s is not very good. All the fuel barrels were "man handled" on to the platforms, due to a lack of barrel loading equipment and ice conditions at the loading area which prevented the use of a forklift. This procedure proved to be costly in man hours and somewhat of a hazard to personnel working in extreme weather conditions. The lack of a suitable CF crane for lifting loaded platforms onto the L23 required the rental of a commercial crane.

12. Adequate work facilities exist at the Nose Dock for sustained LAPES operations. Work was organized on an assembly line basis. Stored LAPES platforms were located to the rear of the facility. Platform construction was carried out on saw horses forward of the storage area. To the front of this two platform build-up areas

with heavy duty warehouse rollers were used. A third build-up site, also rollerized, was created for the storage of assembled platforms when the rate of assembly exceeded the rate of build up. This entire area was serviced by an overhead warehouse light capacity block and tackle. Loaded LAPES platforms were pushed on rollers outside the building for storage awaiting aircraft loading.

13. Equipment Dropped. Appendix 1 and 2 outline the type and weight of each drop. Items not listed are three skidoos, and miscellaneous items and small pieces which were strapped to the top of loads to Cosmos Lake. The only damage to equipment dropped was to a windshield on one of the skidoos which occurred during an unusually high extraction.

14. Aircraft Ground Contacts. Two aircraft/ground contacts were made. At Fort Reliance, an electrical malfunction prevented the normal extraction sequence from taking place, causing the pilot to compensate for a C of C change which did not take place. As a result the aircraft wheels touched the snow but no damage occurred to the aircraft. At Cosmos Lake, the aircraft touched down during the extraction sequence, the pilot had misjudged his flare and the aircraft contacted the hard packed snow resulting in minor skin damage which was repaired at unit level. Appendix 3 and 4 show the wheel marks left at Fort Reliance and the aircraft skin damage which occurred at Cosmos Lake.

15. Loading Facilities. The Nose Dock, (Building 300 Namao) provided an adequate area for an assembly line manner of building the platforms and loads. Storage facilities for attractive items and platform parts is also adequate. However, other units who also share this facility have to curtail their activities during operations of the magnitude of Morning Light.

16. Equipment Recovery. To facilitate the movement and recovery of the platforms from the various drop locations, the initial loads contained helicopter slings and wrenches to disconnect the platforms to allow slinging. The platforms and empty barrels were recovered from Cosmos Lake by C130 after the ice strip was completed. The platforms and barrels from the other sites were slung and carried by Chinook Helicopter to Yellowknife. In both instances, this created a considerable effort by personnel and additional expenditure of aircraft resources to recover the equipment, in particular, the empty barrels.

17. LAPES Equipment Damaged or Not Returned. The following equipment cost was experienced during the Operation:

a. 7 - sixteen foot platforms (bent);

b. 4- twenty foot platforms (bent);

c. 6 - attitude control bars (bent);

d. 200 rolls of type 10 nylon;

e. 400 sheets 4 x 8 x 2[33] plywood;

f. 100 sheets of Horse Hair (packing) used;

g. 40 nuts and bolts for articulating links;

h. 20 plates for articulating links;

j. 2- 60 foot extraction slings; and

k. numerous cinch binders and quick fits.

<u>PART III - CONCLUDING MATERIAL</u>

18. The LAPES capability and utilization proved to be an extremely valuable asset in the effort to recover Cosmos 954. It provided both ground and aircrews with concentrated heavyweight drop experience, much of it under severe weather conditions and to unfamiliar, unmarked drop zones.

19. The Operation further proved to be a realistic test of our ability to react to a demanding situation utilizing present manpower and resources. In light of the experience gained during this Operation the following recommendations are made:

a. <u>When a LAPES operation is conducted, 1 AMU should be augmented as required on a priority basis</u>. It is recommended that 1 AMU continue to be the only unit tasked to support LAPES operations. However, when 1 AMU LAPES qualified personnel are required to perform this function it is imperative that they be augmented immediately in order that their normal day to day tasks can still be carried out. The practicability of training additional AMUs in LAPES operations has been reviewed but, in view of the currency and continuation training requirements, and the limited application of the LAPES capability, it is considered to be unmanageable if the available training were to be spread amongst the various AMUs. What

33 (Illegible correction PDF pg. 76 possibly a "2" or a "7")

must be avoided, however, is the need to draw on 435 Squadron and in particular 435 TALS loadmasters to provide the MAMS function as well as to fly the LAPES missions. In order to prevent this from occurring, it should be established policy that 1 AMU be augmented on a priority basis in order to not jeopardize either the LAPES capability or the daily function of 1 AMU.

b. CFB Edmonton be tasked to ensure a credible LAPES continuation training program. Prior to Operation Morning Light, 435 Squadron attempted to maintain the currency of LAPES qualified crews. Attempts to conduct LAPES currency training were often thwarted because of conflicting commitments of the supporting agencies or lack of aircraft. AMU support was often difficult to obtain because of their own commitments and a sizeable portion of the required support had to be provided from within 435 Squadron resources. This proved difficult and often impossible to obtain and/or coordinate because of conflicting operational commitments. Subsequent to the Morning Light Operation, discussions were held with NDHQ, ATG and Squadron personnel which resulted in direction by ATG for Base Edmonton to provide the capability of having a minimum of two crews and ten MAMS personnel current in LAPES operations at all times. This direction (Reference B) should assist in alleviating many of the previous difficulties provided aircraft are also available.

c. The degree of LAPES capability required, in terms of equipment should be determined and promulgated. While it is difficult to forecast the amount of equipment required to support a hypothetical operation, it is necessary that some basic degree of involvement be determined from which to base equipment requirements. This Operation proved that, with current TALS training equipment only we could support the Morning Light Operation and perhaps one slightly larger before our equipment resources were exhausted. 435 Squadron is attempting to replace all equipment lost or destroyed, but a quantitative assessment of equipment entitlements is really required. A capability somewhere between twenty and thirty tandem sixteen and twenty foot platforms plus platforms and equipment required for miscellaneous loads and training purposes seems realistic. When an assessment of proposed capabilities made known, 435 Squadron can proceed with the paperwork required to obtain any additional equipment.

d. The status of CF ground loading equipment be evaluated with consideration to LAPES loading capability. The single L23 modified to accept LAPES platforms is considered inadequate to provide a continuing

LAPES capability. Specifications of future ground loading equipment should ensure a LAPES platform capability and at least some of the existing L23 equipment should be modified in the meantime. If modification to the remainder of existing L23s is not warranted due to the projected service life of the equipment, at the minimum, conversion kits should be fabricated to raise the existing rollers to accept the platforms and chains can be used to provide fore, aft and side restraint. This should be considered an interim measure only until such time that existing equipment is modified or new compatible equipment purchased.

e. <u>CFB Edmonton obtain fuel bladders and associated pumps to replace barrel containers</u>. The delivery of fuel in barrels has proven to be a cumbersome and costly procedure. The loading and rigging of these barrels proved to be archaic and at times dangerous because of the lack of suitable loading equipment and the icy conditions. The requirement to recover the barrels is expensive in terms of airlift and manpower, plus the lack of suitable purging facilities makes their airlift a less than ideal flight safety situation. Airlift of fuel in bladders is a proven procedure which offers sizeable advantages: The bladders are compact; more fuel per lift can be carried, and the recovery is simplified as when empty and collapsed, they can be easily recovered with minimal airlift. While some bladders are already available at CFB Edmonton, it is understood that their condition has deteriorated through use and it is not known whether or not they would be able to withstand the deceleration forces exerted during an airdrop operation. Rigging and airdrop procedures are already established and future fuel airlift/airdrop operations should be conducted in this manner.

f. <u>Procedures for dropping on un-marked extraction zones be refined</u>. The smoke canister method of marking extraction zones as described proved to be invaluable however, there were drawbacks to this method. The smoke cannisters used were three minute cannisters and it was found that a longer burning smoke was required due to the time required between smoke deployment and actual drop time. 435 Squadron TALS should be tasked to investigate the use of longer smoke, reflective markers, or other paraphernalia to mark extraction zones and load locations and to provide better visual depth perception over snow conditions.

g. <u>Procedures be developed for reduced light darkness LAPES deliveries</u>. In the past, night trials of LAPES were conducted during a test of the Visual Approach Monitor (VAM) system. During these trials, it was found that the aircraft external lighting provided some promise in judging aircraft height in darkness, however, the VAM, the prime reason for conducting the trial was unacceptable in its existing installation. As the equipment was inadequate, further trials were discontinued and a night LAPES capability was not pursued. Notwithstanding, when it is considered that during the winter months, daylight in the arctic and subarctic is severely limited or non-existent, it is evident that if LAPES is to be used in support of a MAD Rescue that our LAPES capability should include dropping in severely restricted light conditions if not total darkness. Reflective markers used as emergency runway guidance lights at Cosmos Lake proved very adequate and the use of these or similar markers, or dropping under flares released from an accompanying aircraft could provide the added visual guidance required to develop a LAPES capability in darkness. Accordingly, it is recommended that 435 Squadron TALS be tasked to investigate the feasibility of conducting night LAPES operations.

h. <u>Existing tow plates be modified to provide an improved capability until such time that better equipment is developed</u>. Subsequent to Operation Morning Light and prior to the completion of this report, approval has been obtained to modify existing tow plates to the same status as the tow plate used on Morning Light Operations (Reference C). In addition, the USAF Airlift Centre has demonstrated a new "state of the art" tow plate known as the "Oxford Tow Plate". This tow plate and its associated equipment radically simplifies LAPES equipment installation and operation. It is a solenoid-operated release mechanism activated by the aircraft drop signal light controls. The system is lightweight, compact and offers a more reliable manual backup function which eliminates the present system of cables and pulleys. Unfortunately, the system is still in the prototype stage and production details have not yet been finalized. The success during prototype trials has proven overwhelmingly promising and production copies are expected to be made available at a cost of less than one sixteen-foot platform (a cost which would make it one of the least expensive items of the system). It is strongly suggested that the CF either purchase this equipment at the same time as the USAF or manufacture our own equipment as soon as design specifications can be obtained.

APPENDIX 1
To Annex A
Part 1 (B) 4

PHASE ONE 01-17 FEB 78

	CHALK SUMMARY	PLATFORM SUMMARY	WEIGHT SUMMARY
a. Platform loads Constructed, built up, loaded and rigged by 435 Squadron TALS (Augmented by 1 AMU)	3	3 x 20' + 16' tandum loads	91000
b. Platform loads Constructed and built up by 1 AMU; Loaded and Rigged by 435 Squadron TALS	10	8 x 20' + 16'	269323
c. Platfrom loads Constructed, built up, loaded and rigged by 1 AMU	1	1 x 20' + 16' tandem load	31840
TOTALS	14	12 x 20' + 16' Tandem loads 1 x 20' single 1 x 16' single	392163

NOTE: In addition to the above 1 x 20' + 16' tandem load of JP4 was constructed and built up and remained at the Nose Dock as a standby LAPES load. One 12' platform was constructed by not used.

PHASE TWO 28 FEB - 02 MAR. 78

	CHALK SUMMARY	PLATFORM SUMMARY	WEIGHT SUMMARY
Platform loads Constucted, Built up, loaded and rigged by 1 AMU	3	3 x 20' + 16' Tandem loads JP4	104770

NOTES:

a. The initial chalk of this phase consisted of a 20 1 + 16 1 tandem load of JP4 which was the standby load previously constructed during Phase One.

b. In addition to the above a 20'+16' tandem load of JP4 was constructed and remained at the Nose Dock as a standby LAPES load. This load will be LAPSED in the ALERT NWT area during early May in support of a CFCC exercise.

MAMS Team Number 435 SQN TALS/1 AMU

MAMS TRAFFIC HANDLING REPORT

STATS CF(G) 241A

Detachment Location EDMONTON

Page 1 of 1 Page

Name of Operation MORNING LIGHT

Baggage computed at ______ lbs per passenger

ARRIVALS							DEPARTURES								
Date	Flight or Chalk Number	A/C Number	Arriving From (Place)	Time (Local)	Pax	Freight	Date	Flight or Chalk Number	A/C Number	Going To (Place)	Time (Local)	Pax	Freight	Remarks
01 FEB	6791	329	ED	2100			01 FEB	6791	329	LOCAL	2027			DROGUE PULLS
02 FEB	6791	329	FT RELIANCE	1425			02 FEB	6791	329	FT RELIANCE	0812		30200	FUEL 20' + 16'
04 FEB	6825	329	COSMOS LAKE	2030			04 FEB	6825	329	COSMOS LAKE	0819		32000	FUEL 20' + 16'
05 FEB	6827	329	"	1539			05 FEB	6827	329	"	1023		28800	FUEL 20' + 16'
06 FEB	6832	329	"	1126			06 FEB	6832	329	"	0600		35000	DOZER+FUEL 20' + 16'
06 FEB	6833	329	"	1915			06 FEB	6833	329	"	1358		29000	FUEL 20' + 16'
08 FEB	6837	329	"	1535			08 FEB	6837	329	"	1022		29000	JP4 20' + 16'
09 FEB	6840	329	FT RELIANCE	1247			09 FEB	6840	329	FT RELIANCE	0717		18000	JP4 20'
09 FEB	6843	329	COSMOS LAKE	1925			09 FEB	6843	329	COSMOS LAKE	1440		35000	DOZER + FUEL 20' +16'
10 FEB	6845	329	"	1612			10 FEB	6845	329	"	1105		15000	FUEL + SKID BD 16'
11 FEB	6848	329	FT RELIANCE	1440			11 FEB	6848	329	FT RELIANCE	0840		32000	20' + 16'
12 FEB	6850	329	COSMOS LAKE	1535			12 FEB	6850	329	COSMOS LAKE	1033		29000	JP4 + DIESEL 20'+16'
13 FEB	6853	329	"	1813			13 FEB	6853	329	"	1310		29000	20' + 16'
14 FEB	6855	329	"	1700			14 FEB	6855	329	"	1148		18323	TENTAGE + SKID BD 20' + 16'
16 FEB	6861	316	ED	1430			16 FEB	6861	316	ED	1346			DROGUE PULLS 20'+16'
17 FEB	6862	316	COSMOS LAKE	1458			17 FEB	6862	316	COSMOS LAKE	1047		31840	JP4(52) + ME GAS(12)
													392163	

Part 1 (B) 4

A/1/B(4)-2-1

MAMS Team Number 1 AMU LAPES

MAMS TRAFFIC HANDLING REPORT

STATS CF(G) 2414

Detachment Location EDMONTON

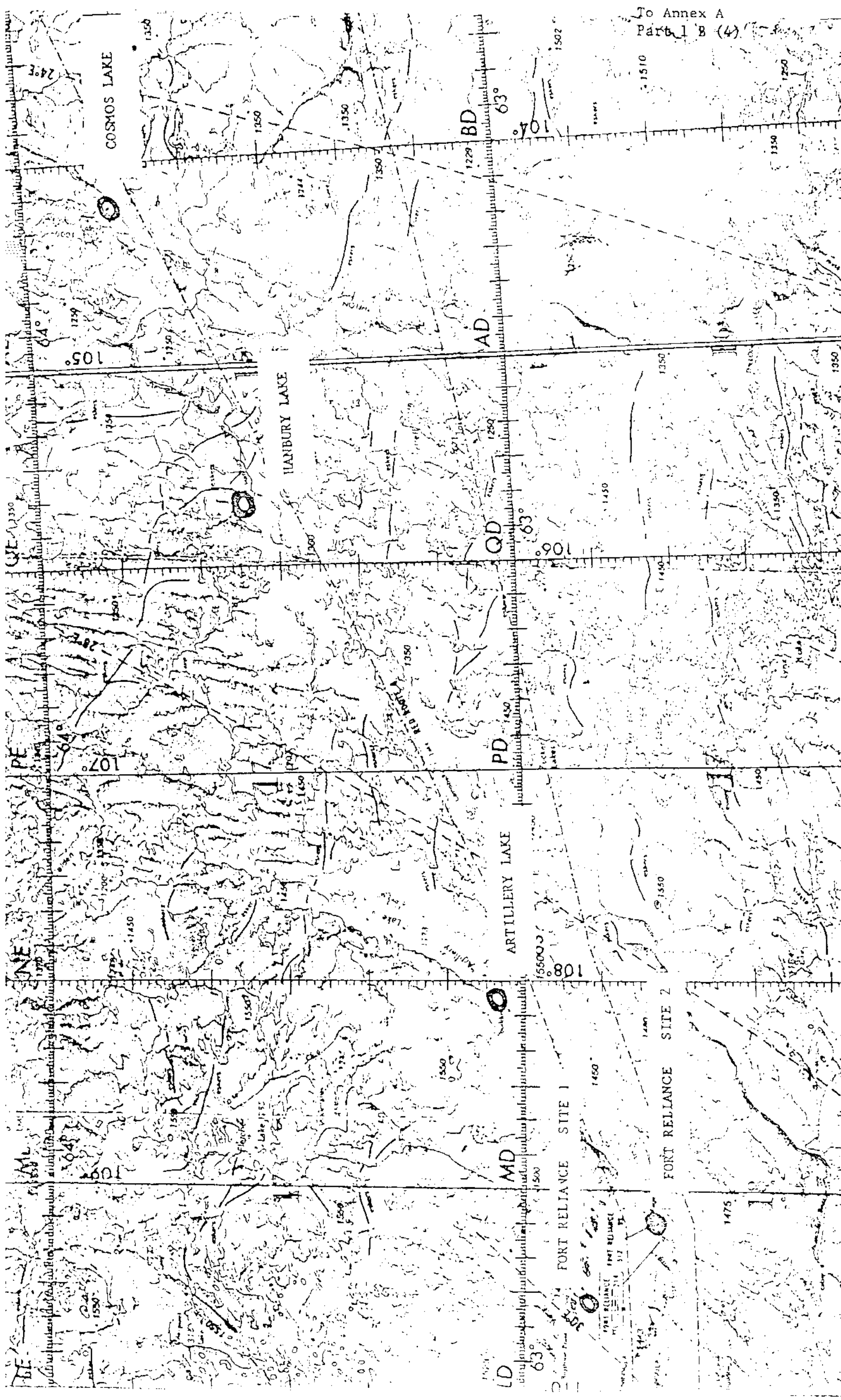
Page 1 of 1 Page

Name of Operation MORNING LIGHT (PHASE II)

Baggage computed at ______ lbs per passenger

ARRIVALS							DEPARTURES							
Date	Flight or Chalk Number	A/C Number	Arriving From (Place)	Time (Local)	Pax	Freight	Date	Flight or Chalk Number	A/C Number	Going To (Place)	Time (Local)	Pax	Freight	Remarks
28 FEB	6891	329	ARTILLERY LAKE	1433			28 FEB	6891	329	ARTILLERY LAKE	1202		31,490	1X20' + 16' TANDEM JP4
01 MAR	6895	329	"	1415			01 MAR	6895	329	"	0949		31,480	1X20' +16' TANDEMJP4
02 MAR	6801	329	HANBURY LAKE	1533			02 MAR	6801	329	HANBURY LAKE	1017		31,800	1X20' +16' TANDEMJP4
													104,770	

A/1/B(4)-2-2


To Annex A
Part 1 B (4)
COSMOS LAKE
HANBURY LAKE
ARTILLERY LAKE
FORT RELIANCE SITE 1
FORT RELIANCE SITE 2
A/1/B(4)-3-1

ANNEX A
Part 1 C

CF 107 ARGUS OPERATIONS

1. Task

Two Argus were tasked to the Operation with the assigned roles of:

a. search; and

b. photography.

2. Argus 10729 from Summerside was tasked to search an area on the east end of Great Slave Lake with radiation sensing equipment 31 Jan 78. A search was on track spacing of 0.2 NM using for navigation the LTN-51 INS, the CMA 719 ONS and visual cues. A total of 3.3 hours were flown on task.

3. Results

These were similar to the Omega navigation on the CC130 for track accuracy. Operationally the Argus was difficult to keep running in the extreme cold and aircraft unserviceabilities commonly delayed departures.

4. Task

A second Argus from 415 Squadron Summerside operated from Edmonton from 30 Jan to 6 Feb and 15 Feb[34] to 8 Mar. Its task was to conduct air photo surveys largely because of the lack of 1:50,000 or larger scale maps east of Artillery Lake.

5. Method

Argus aircraft equipped with RC-8 photo-mapping camera flew straight line tracks with spacing ranging from 1 to 1.5 NM altitude 3,000 to 8,000 feet. Area covered was 5,596 square miles.

6. Results

The Omega navigation system did not provide sufficient precision, due to only one or two station reception. With 1 ¼ NM track spacing, any navigation error is critical. Photos taken under favorable weather conditions of the Thelon River area were of very good to excellent quality but otherwise weather conditions were unacceptable most of the time.

[34] Marginalia: "16 Feb"

ANNEX A
Part 2 A

FLIGHT ROTARY WING
CH147 OPERATIONS

1. 450 Squadron Detachment, while on Exercise Snow Ramble in the Chilcotin Training area of British Columbia, was tasked to provide one CH147 Chinook on 24 Jan 78 in support of what was to become Operation Morning Light.

2. This aircraft, 147007, departed the exercise area at 0010Z 24 Jan, and because of weather was forced to RON Prince George, arriving in Yellowknife at 2400Z 25 Jan.

3. The aircraft captain reported to the On-Scene-Commander and was told not to expect any tasking before 1600Z on 26 Jan 78. A report of flying time and aircraft status was made to the Search Master at CFB Edmonton by telephone. At 0800Z 26 Jan 78, the aircraft captain was informed by telephone from Edmonton Operations that he should be prepared to depart for Baker Lake at 1200Z, but due to a number of delays 147007 departed IFR for Baker Lake at 1600Z. The weather was forecast to be excellent and since the aircraft would be in the area of compass unreliability the compass was set up on Direct Gyro. Approximately 70NM east of Fort Reliance at 7000 feet MSL, enroute beacon coverage was lost. The aircraft was VMC and flight was continued MDR. The distance left to go was approximately 300 miles and drift had been accurately assessed up to that point. When the aircraft instruments did not pick up either the VOR or the ADF in Baker Lake at the calculated time, contact was made with a C130 known to be operating in the area and through use of VHF DF and TACAN air to air a reasonably accurate position was plotted. That plus another plot twenty minutes later put the aircraft 100 NM south of track. Since the aircraft had been flying constant heading and altitude there must have been a strong windshift coupled with some gyro precession. Although the weather was VMC, the ground was snow covered and with conditions of blowing snow VFR navigation was impossible. The aircraft landed at Baker Lake at 2300Z 26 Jan 78.

4. The aircraft captain reported to the On-Scene-Commander and informed him that since VFR navigation was impossible, a navigational system such as Omega or a Hercules (mother ship) were a must if the CH147 was to operate safely out over the tundra (Barren Lands). This was agreed to in principle.

5. The next two days were spent flying in the Baker Lake area establishing drills for use with the American scientists and their detection equipment. As forecast, pin point navigation was impossible however a system of returning to a "hit" was established. The aircraft was carrying ten passengers plus the crew and some means of inter communication for all was partially resolved through the use of "Y" cords. In fact "Y" cords were plugged into "Y" cords to put everybody on the intercom system.

6. Baker Lake NWT has very limited aerodrome facilities and as such the aircraft remained outside for the duration. Since little has been published on the preheating of CH147 aircraft at extremely low temperatures, -50° C with winds of 25-30 knots, it was decided that all transmissions and engines would be pre-heated to well above the 0° C mark. This involved approximately three hours with Herman Nelsons before engine start. The Reddy Heater was completely inadequate for aircraft pre-heating, however it was found very useful for pre-heating the Herman Nelsons which otherwise would not start. As long as the CH147 was properly pre-heated, no problems were encountered with starting.

7. A second Chinook, 147008, departed Edmonton for Yellowknife on 28 Jan 78. Initial tasking for 147008 was carrying press[35], and recovery of some radioactive material.

8. On 29 Jan 78, 147007 flew from Baker Lake to Warden's Grove to investigate a civilian sighting of some metal on the ice. The C130 "mother ship" concept worked well and the round trip of 460NM went smoothly.

9. 147004 arrived at Baker Lake from Ottawa on 30 Jan 78 and on 31 Jan another trip was made to Warden's Grove.

10.[36] 147007 flew to Warden's Grove and it went unserviceable with an engine starting problem and spent two nights on the ice. The aircraft had been a "major air disaster kit" and the crew and passengers survived quite comfortably. As well, a Rescue Specialist was part of the crew to ensure proper survival techniques were followed if required.

11. 147007 was recovered to Yellowknife on 4 Feb[37] 78, 147004 following on 6 Feb 78. A fourth Chinook, 147006, had deployed from Edmonton to Yellowknife on 3 Feb.

[35] Marginalia: "No - this was 006"
[36] Marginalia: "3 Feb"
[37] Marginalia: "5 Feb"

12. From 6 Feb 78 until the end of Operation Morning Light, the CH14 7s worked out of the Wardair Hangar in Yellowknife doing in the main, fuel cache re-supply, recovery of empty barrels to Yellowknife and NAST transport. Some radioactive material was carried, and slung loads were transported including ATCO trailers and LAPES platforms. A CH147 aided in the recovery of a 22,000 pound[38] bulldozer which had partially gone through the ice at Cosmos Lake, and one 200 pound "PIG" containing radioactive material was hoisted out of a deep ravine using the rescue hoist.

13. The majority of tasked missions were at heavy all up weights in the area of 46,000 to 48,000 pounds. Included were 11 sorties to Cosmos Lake in the initial establishment of that camp prior to the opening of the C130 ice strip.

14. When Camp Garland opened in Cosmos Lake 450 Squadron Detachment provided the majority of required tentage, and three cooks to set up the operation. Our Cooks were subsequently rotated with 408 Squadron cooks, with each doing two or three ten day tours.

15. Loading Personnel. For approximately the first 30 days of the operation there were no TAMS/MAMS personnel in Yellowknife or Baker Lake. This meant that the CH147 crews had to load/unload their own aircraft which added many extra hours of work to a five to seven hour flying day and caused most return trips from Cosmos to Yellowknife to be done during darkness. The lack of TAMS/MAMS also resulted in a lack of control and priority in the movement of stores. C130 loads were often double handled and occasionally ended up going to the wrong place. Eventually TAMS personnel arrived in Yellowknife and the job became somewhat easier.

16. CH147 Capability. The heavy lift capability of the CH147 was utilized greatly during Operation Morning Light. As previously mentioned, takeoffs with gross weights in the 46,000 to 48,000 pound range were the norm. The inherent stability and IFR capability of the CH147 enabled it to operate safely in conditions of white out and at night in the arctic where the majority of transit was clear of cloud but under IMC conditions due to blowing snow and darkness.

17. The use of up to three internal fuel bladders gave the CH147 up to 6.5 hours of endurance enabling it to operate with minimum refuelling from Yellowknife and Baker Lake to Warden's Grove and return.

[38] Marginalia: "20,500 lbs"

18. The Omega sets, once installed near the end of the operation, worked very well and with advertised accuracy. For future operations in the winter above the tree line, a navigational system such as Omega is an absolute necessity for safe operation.

19. Cold Weather Ground Operations. During extended periods of temperatures below -25 C, no shelter available, the serviceability rate of the CH147 drops drastically. A considerable amount of preheating is required and even then many different problems occur in the hydraulic, electrical and fuel systems. Once the aircraft were moved to Yellowknife where hangar space was available for most aircraft, Chinook serviceability was in excess of 90 percent.

20. Flying hours for the operation are as follows:

a. Logistics	342.4 hours	Cargo carried: 608,050
b. Search/Recovery	27.3 hours	Pax carried: 450
c. Transit	129.1 hours	
Total	498.8 hours	

21. The command structure for CH147 operations was as follows:

a. When Operation Morning Light commenced 1 x CH147 was put under operational command of the Base Commander CFB Edmonton who was named Operational Commander Operation Morning Light. Tasking of CH147 resources was through the On-Scene-Commanders at Yellowknife and Baker Lake. Once the CH147 operation was based completely out of Yellowknife, 450 Squadron Detachment, as a unit was placed under operational command of Base Commander CFB Edmonton. A 450 Squadron Detachment Commander Yellowknife was appointed and was tasked directly by the OSC.

b. Initially, since all tasking was passed via telephone from the Morning Light Command Post in Edmonton the On-Scene-Commander's missions were received either very late at night or on the morning of the day for which they were planned. As a result take off times were often delayed and in view of the short hours of daylight available this was not a very efficient method of tasking. Eventually the

Command Post started planning a day in advance and system worked reasonably well.

22. Recommendations. The following are made based on the experience during Operation Morning Light:

a. All Chinooks tasked to operate in the Arctic be equipped with Omega navigation systems.
b. A high volume, electrically driven fuel transfer pump be made available for refuelling from fuel caches.
c. A portable button-on shelter be purchased immediately for CH147 maintenance when hangars are not available.
d. MAMS/TAMS support is required during any extended Chinook operation and must be tasked when the aircraft are deployed.

ANNEX A
Part 2 B

CH135/CR136 OPERATIONS
408 TACTICAL HELICOPTER SQUADRON

OVERVIEW

1. On 16 Jan 78, 408 Squadron deployed to CFB Shilo to take part in exercise Rapier Thrust. On 24 Jan, the Squadron was tasked to provide support to Operation Morning Light. Two CH135 helicopters were deployed to Yellowknife and were utilized in primarily transport tasks.[39]

2. As the operation developed and with the advent of the opening of Cosmos Lake operations, more aircraft were deployed to Yellowknife. Two CH135s arrived at Cosmos Lake on 18 Feb 78.[40] On 20 Feb, the estimated requirement for CH135 resources four in Yellowknife and two in Cosmos Lake continuously for a three month period commencing 1 Mar 78. To support these numbers, an additional two back-up aircraft were placed in Yellowknife for a total of eight deployed CH135s.

3. CH136s were introduced to the operation primarily as safety aircraft at Cosmos Lake. However, they were found to be useful for other tasks and were so utilized. A total of four CH136s were utilized continuously (two at Yellowknife, two at Cosmos Lake).

4. CH135 crews were assigned a variety of tasks: movement of MRS beacons, changing MRS beacon batteries, personnel and utility transport, search, detection, recovery, etc. CH136 crews were assigned fewer tasks: safety aircraft at Cosmos Lake, personnel and utility transport, limited search and recovery, support of CH135 operations and changing of MRS beacon batteries.

5. An additional CH135 and crew was deployed to Cape Dorset on 15 Mar 78.[41] This aircraft was utilized exclusively for personnel and equipment transport.

6. Helicopter operations at Cosmos Lake ceased on 21 Mar 78.[42] At this time, the detachment at Yellowknife was increased to eight CH135s and two CR136s. This operation was incrementally reduced and operations ceased 17 Apr 78.

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[39] Marginalia: "25 Jan "

[40] Marginalia: "CH135 107 on 17 Feb. CH135 133 on 18 Feb "

[41] Marginalia: "13 March "

[42] Marginalia: "23 Mar "

7. Operation Morning Light offered the opportunity for a number of accomplishments, experiences, lessons and deficiencies which are discussed in the sections following.

NORTHERN WINTER OPERATIONS

8. 408 Squadron operations were generally divided between Yellowknife and Cosmos Lake. The Cosmos Lake area was designed as the area east of the western side of Artillery Lake. This area was characterized by extremely difficult navigation, unpredictable weather, no navaids and ideal white-out conditions.

9. Crews of both types of aircraft experienced certain difficulties flying in the north in winter conditions. CH136 crews obviously had more difficulty because of the aircraft's spartan IFR and instrument capability, lack of TACAN and HF, and single pilot configuration.

10. Navigational map coverage (1:250,000) provided adequate details although the absence of features made navigation difficult. Many large areas were difficult to navigate because snow cover obscured and blended all features together.

11. The introduction of the portable TACAN at Cosmos Lake proved invaluable. On numerous occasions, such as deteriorating weather, CH135 crews had to resort to this navaid. The ADF beacon at Cosmos Lake was virtually useless because of shortrange. This was particularly frustrating because the CH136 has only an ADF capability. In the barrens of the north in winter, adequate navaids are an absolute necessity for safe flying operations.

12. Weather was fairly unpredictable in the barrens. Although a weather observer was on-site at Cosmos Lake, pilots had to be extremely careful because of quickly changing weather and weather changes over short distances. In winds in excess of 10 knots, blowing snow created visibility problems. In no wind conditions, ice crystals and ice fog impeded visibility. On cloudy days, white-out conditions existed. There is no easy solution to winter weather problems in the barrens. Pilots must be ever alert to the weather. CH136 pilots must particularly avoid white-out conditions.

13. Adequate arctic clothing, survival gear and IRPs were carried by all aircraft. This equipment included coleman stoves.

14. The extreme cold temperatures (-35° to --45°) had an indirect effort on both aircrew and groundcrew. Prior to the installation of adequate heating in the sleeping accommodation proper sleep was difficult. The situation was one of survival rather

than one of operations which reduced operational efficiency. During the period when the hangar was not useable, it was necessary to pre-heat the aircraft each day. This meant that the working day started between 0500 and 0600, adding to an already arduous situation. Although most personnel were from the Tactical Helicopter environment and acclimatized quickly, they gradually became more and more tired because of the arduous conditions.
For safe flying operations in the north in winter, reasonably comfortable shelters are a necessity. The aircraft maintenance (Harrier) hangar at Cosmos Lake was excellent when it was serviceable. The temperature inside was maintained at 7-10° C. The hangar was used to store two CH135s, two CH136s, one 5/4 conditions were particularly ideal for the temperature sensitive sensor equipment installed in one CH135. The hangar was eventually abandoned because it was impossible, for a number of reasons, to maintain the tent inflated. However, the concept is sound and for extended operations in the north in winter, an adequate shelter is necessary.

15. HF Communications. All aircraft were not fitted with HF. For extended range operations in the north, this equipment is necessary.

16. OMEGA. The absence of navaids in the north makes navigation from A to B difficult and tedious. At times, low level precise navigation is impossible. One solution to precise position determination is the use of equipment which provides flexibility and accuracy such as OMEGA. Since crews were not familiar with the equipment practice was necessary. However, once a crew became proficient and confident in the equipment it became invaluable aid. “Hits” located near the centre of large lakes or well out in the barrens could be located with ease and accuracy. The equipment is recommended for northern operations particularly winter, and would be useful for all operations in isolated areas.

17. CH136. CH136 helicopters were deployed to Cosmos Lake as safety aircraft to support CH135 operations. Once deployed, other tasks were found. In fact, CH136 crews carried out many tasks which otherwise would have had to be done by CH135 resources, thereby saving these resources. However, the CH136 has certain limitations when operating in the barrens of the north in winter. These include inadequate navigation equipment, no HF, and a single pilot configuration which is not ideal for inadvertent actual IFR and white-out conditions. They should not be operated singly.

18. Fuel. As the operation progressed, fuel caches were established at various locations between Yellowknife and Cosmos Lake. These caches consisted of 45 gallon drums. The requirement for small portable fuel pumps (with filter) once again came to the fore. Suitable pumps are an absolute necessity for any isolated operation. Since no pumps were available from 408 Squadron resources, other squadrons and

establishments were requested to provide them. Fuelling at Cosmos Lake involved both 45 gallon drums and 250/500 gallon fuel bladders. The bladder system proved far superior in all respects. Fuelling from bladders is quicker, easier and safer. Bladders can be slung or towed and can easily be airlifted by C130 and CH147. Backloading is also easier and more efficient. The overriding advantage is that all aspects of bladder operations requires less manual labour which is a critically important consideration in winter operations.

19. Flying Restrictions. For the record, the following flying restrictions were imposed:

a. Daily crew maximum flying time limitations were set at seven hours for Yellowknife operations and seven hours[43] for Cosmos Lake operations. When any aircrew member reached 80 hours in any consecutive four week period, he was obliged to inform the Commanding Officer, 408 Squadron.

b. Night flying was not carried out except for transitting aircraft.

c. CH136 aircraft were not operated singly in the Cosmos Lake area of operation (outside of 10 miles from Cosmos Lake). When the situation arose that only one serviceable helicopter was in location at Cosmos Lake, for purposes of safety this aircraft was not to be operated beyond ten miles from Cosmos Lake.

COSMOS LAKE OPERATIONS

20. Discussion of the overall Cosmos Lake operations are found at Annex D.

21. Helicopters at Cosmos Lake operated from the heliport-hangar complex. As has already been mentioned, extreme cold weather and difficult navigation were the major difficulties encountered.

22. The helicopter operation did not actually develop to the extent that was initially anticipated. The aircraft were involved in search, detection, recovery, MRS beacon support, personnel and equipment transport in Sectors 3, 4 and 5. Many of the hits investigated proved to be natural rock outcroppings.

YELLOWKNIFE OPERATIONS

[43] Marginalia: “Crews often exceeded 7hrs.”

23. Discussion of the overall Yellowknife operations are found at Annex D.

24. The major CH135/CH136 effort was conducted in the Yellowknife area. All aspects of the operation were encountered including search, detection, MRS beacon support, recovery, utility transport, etc. As well, aircraft maintenance and logistic support was provided to the Cosmos Lake operation.

25. The WARDAIR hangar at Yellowknife was utilized for maintenance and stowage of sensor-equipped aircraft.

CAPE DORSET OPERATIONS

26. Discussion of the overall Cape Dorset operations are found at Annex D.

27. On 13 Mar 78, CH135120 departed Edmonton by C130 for Frobisher Bay NWT. After a night in Sondrestrom, Greenland due weather, the aircraft arrived in Frobisher for

28. CH135120 arrived at Cape Dorset during the afternoon of 15 Mar 78. The flight to Cape Dorset from Frobisher was accomplished without difficulty although navigation was difficult at times. An OMEGA equipped aircraft would have been an advantage.

29. After arrival in Cape Dorset, a short reconnaissance flight was made to the site. The site was not immediately found because the original position was in error. After this initial flight no major navigational difficulties were encountered.

30. Between 15-22 Mar 78, the CH135 was used exclusively to transport personnel and equipment to and from the site. The operation would have been impossible if a helicopter had not been available, unless a base camp had been established at the site, since the site was approximately four hours travel from Cape Dorset by skidoo. At the site itself, a ten man Arctic tent was erected and stocked with survival equipment and IRPs in case the helicopter became inoperable.

31. The weather at Cape Dorset was very unpredictable and quick-changing. It was necessary for the aircraft captain to be ever aware of the weather.

32. Helicopter operations at Cape Dorset were smooth with no problems hampering the operation. The flexibility of the C130 delivered CH135 has again been shown. It should be noted that certain difficulties were encountered in both the re-assembly and dismantling of the CH135 because of missing or unserviceable

equipment. The flexibility and usefulness of this operation has been proven. More attention must be paid to ensuring the complete package of tools, equipment supplies etc is available.

33. One other area which should be noted is that of fuelling. The CH135 fuelled from 45 gallon drums. However, two 500 gallon bladders were delivered to Cape Dorset without pump, hoses, attachments, etc. These were requested and delivered but one part was still missing making the 1,000 gallons of fuel still unuseable. The bladders were eventually backloaded from Cape Dorset full. This situation in no way stopped the overall operation but a lesson has been learned.

SENSOR SEARCH RECOVERY

34. Technical discussion of the three CH135 radiation sensor equipment is not included in this section. The equipment was installed in the forward end of the main cabin area in lieu of the seats. The weights varied up to almost 1,000 pounds. When loaded with sensor equipment, crew, sensor operations, survival equipment and auxillary fuel tanks, the CH135 was operated at maximum or high all-up weights demanding a constant attention by pilots to handling characteristics and movement of the centre of gravity. One significant feature of the American equipment was the temperature-sensitivity (crystal) characteristics requiring continuous heat. At Cosmos Lake when the hangar was unuseable, it was necessary to maintain continuous heat in the aircraft with Herman-Nelsons. The effort expended to this end was somewhat staggering.

35. The search for radioactive material was based on a computer generated plot of "hot spots" or "hits" The information was gathered by C130 sensor-equipped aircraft flying a fine line survey using microwave relay system (MRS). The location of suspected satellite debris was passed on to helicopter crews in the form of latitude and longitude positions or UTM grid coordinates.

36. Upon being assigned an area or particular hits to locate, a sensor-equipped CH135 would proceed to the location using the most accurate maps available. Generally, transit was carried out on a 1:500;000 and pinpointing was accomplished using 1: 250,000 or 1: 50,000, if available. After arrival at the reported "hit" location, the CH135 crew set up a search pattern to locate and pinpoint the "hit". Patterns were flown between 100 to 200 feet at 60 to 80 knots and 300 feet lateral spacing. When the sensor operator located a "hit", the aircraft was brought to a high hover and manoeuvered on directions from the operator to a point directly over the radioactive source. The spot was then marked using a red streamer tied to a weight or

by securing large red panels near the source. The pilot concurrently pinpointed the location on his sap to facilitate its location by a pickup aircraft.

37. Limited search operations were carried out with the CH136 which carried hand-held radiation detection equipment.

38. The recovery of radioactive material was normally accomplished by a team of three to five persons (AECB, AECL, NAST, DOE). All three types of helicopter (CH135, CH136, CH147) were utilized in recovery operations although the prime vehicle was the CH135. CH136s were utilized in sections or in support of other aircraft. CH147s were involved in both direct recovery and "second-line" transport of hot material.

PERSONNEL

39. At the peak of the operation, 408 Squadron maintained the following deployed personnel:

a. Yellowknife
Detachment Commander (responsible to OSC)
4 CH135 crews
2 CH136 crews
8 Maintenance personnel
1 supply technician

b. Cosmos Lake
On-Scene-Commander
Camp Senior NCO
2 CH135 crews
2 CH136 crews
Operations/Duty Officer
1 Vehicle Technician
1 Supply Technician
Cooks (in conjunction with CFB Edmonton)[44]
1 Radio Operator
4 personnel
1 Medical Assistant (in conjunction with Second Battalion PPCLI)
1 Administration Clerk

[44] Marginalia: "450 Sqn Det "

c. Cape Dorset
On-Scene-Commander
1 CH135 crew
2 Maintenance personnel

40. The planned rotation of aircrew was on a seven day basis. Groundcrew rotated through Cosmos Lake and Yellowknife (seven days each location). Other personnel spent anywhere from seven to 21 days ·in location.

41. In order to accomplish the contents of the above paragraphs, it was necessary to augment 408 Squadron. 10 TAG arranged continuous augmentation from all other group helicopter units.

MAINTENANCE AND CH135 RESOURCES

42. From 24 Jan to 20 Feb 78, 408 Squadron provided support to Operation Morning Light from within Squadron resources. From 29 Feb,[45] the Squadron was tasked for six CH135s to fly a daily rate of seven hours each. The initial tasking was to continue until 1 Jul 78 (3,864 hours). In order to accomplish this rate, a total of twelve aircraft was required. Included in this number was a planned four aircraft in 1 at any time undergoing periodic inspections. A total of five CH135s were provided to bring the total to thirteen. Aircraft were drawn from other Tactical Helicopter Squadrons. As it turned out, the seven hours per day for six aircraft was not maintained thereby providing a buffer.

43. Few major maintenance problems were encountered. The supply system was geared up for the operation and as a result the acquisition of parts was accomplished more quickly than normal.

44. A three-man MRP (Mobile Repair Party) was on constant standby from 1 AFMS which ensured that major repairs were completed in the shortest possible time.

45. The requirement for non-destructive testing of CH135 crosstubes occasionally interrupted operations especially when aircraft had to be ferried from Cosmos Lake to Yellowknife for this purpose.

46. The combination of 10 TAG provision of additional CH135 resources quick acquisition of parts, availability of MRPs from 1 AFHS and the efficient

[45] Marginalia: "Presume 28 "

support of 1 AFMS resulted in there not being a single case of a major lack of support during the entire operation.

47. The largest single problem was caused by lack of heating equipment. Herman-Nelson heaters were useful for pre-heating as long as there was a method of pre-heating the Herman-Nelson to get it started. The Herman-Nelson serviceability problem at Cosmos Lake caused primarily by the unavoidable lack of maintenance to the machine because of the necessity for continuous operation to heat working and living tents.

RECOMMENDATIONS

48. For Arctic winter operations, certain navigation equipment or combinations of equipment is absolutely essential for helicopter operations. The equipment includes:

a. OMEGA;
b. portable TACAN; and
c. portable non-directional beacon with a range capability of at least 25 miles at 500' AGL.

49. For continuous operations under winter Arctic conditions, aircrew and groundcrew require reasonably heated accommodation. Unheated modular tenting is adequate for very short periods only (for trained personnel).

50. Adequate helicopter maintenance shelter is a necessity for winter Arctic operations. A serviceable Harrier hangar is ideal.

51. Helicopters must be fitted with HF radios for all northern or isolated operations.

52. Because of their limitations, CH136 helicopters must be operated very carefully in the barrens of the Arctic. They should not be operated singly.

53. Provision of a small standard portable electric fuel pump (with filter) to Tactical Helicopter Squadrons would greatly increase operational efficiency.

54. Whenever possible, refuelling of tactical helicopters in isolated locations should be accomplished using bladders instead of 45 gallon drums.

55. Prior to any winter Arctic operation, helicopter pilots must be well briefed on the arduous flying conditions which may be encountered. Particular emphasis

must be placed on navigation, weather, communications, white-out conditions and survival. Special rules, regulations, limits, and restrictions may have to be imposed.

ANNEX A
Part 3 A

SUMMARY OF CC130 FLYING HOURS

1. It has not been possible to accurately isolate transit time from search time and/or logistics time. Numerous missions were combinations of all three. Any adjustment of the following times to try to provide such a breakdown would be speculative. The following data is considered to be the most reasonable breakdown of the effort.

2. 435 Squadron:

Type of Mission	No. of Missions	Flying Hours	Remarks
Detection/MRS	96	934.3	Includes one three aircraft prior to use of MRS.
Transport/Frieght/ Logistics	81	604.1	
Combined MRS/	13	148.9	
LAPES	17	97.0	Fort Reliance – 3 Artillery Lake – 2 Hanbury Lake – 1 Cosmos Lake – 11
Totals 435 Squadron	207	1784.9	

3. Totals 436 Squadron 85.9

4. CC130 Total 1870.8 hours[46]

SUMMARY OF FLYING HOURS – ROTARY WING

	CH135	CH136	CH147
Total	1554.9	501.9	498.8

[46] Marginalia: “429 Sqn missing both C130 and Dakota (initial)”

SUMMARY OF HOURS FLOWN BY OTHER AIRCRAFT

CH115 Buffalo	135.9
CP107 Argus	157.8
CC138 Twin Otter	294.6
CC137 Boeing	3.7
CF5 Freedom Fighter	13.6
T33 Silver Star	4.2
CC109 Cosmopolitan	13.2
Total other aircraft	623.0[47]
Military aircraft	5049.4 hours
US/DOE Convair	39.9
Total Aircraft	5089.3 hours

[47] Marginalia: "Helos missing "

ANNEX A
Part 4 A

BASE MAINTENANCE
FIXED WING AIRCRAFT

PART 1 - GENERAL

INTRODUCTION

1. Operation Morning Light provided an excellent, if unplanned, opportunity to assess CFB Edmonton's ability to support an increased flying rate that is assumed would be available for operations during an emergency. It also provided an opportunity to assess the bases' ability to respond to unusual taskings, including on-site equipment installations without prepared engineering drawings for guidance. These opportunities served to demonstrate some problem areas in aircraft maintenance, personnel, maintenance scheduling and support resources.

AIM

2. The aim of this part of the report will be to review the effects/problems created by the Morning Light fixed wing aircraft support tasking and make recommendations for methods by which we could improve our response to future taskings of this sort.

PART 2 - DISCUSSION

BACKGROUND

3. Present CF aircraft maintenance policy is to squeeze as much productivity out of the CF resources as possible. This is achieved in part by periodic reviews of aircraft maintenance establishments based on the "typical" workload situation and by adjustments of the establishment based on gain or loss of significant workload such as changes in aircraft strength of MFR. The base underwent such a in 75/76 after which it was recommended a number of positions be removed from the base aircraft maintenance organization and the concept of a Mobile Support Team be disbanded in favour of Withdrawing personnel from sub-sections as required to support away from base operations. Although the results of that review have not as yet been officially implemented by ECP action, the organizational changes have already been made and attrition has resulted in section strength being generally lower than that recommended. Therefore this operation provided a realistic assessment of our ability to meet unusual commitments with the OSMER recommended establishment.

PERSONNEL

4. Generally personnel resources were adequate for the aircraft maintenance function. Some juggling was necessary between crews to "beef up" midnight shift and make some trades available when normally they would have been "on call". However crews were heavily tasked; we could not have afforded to supply full BDF and NAST commitments at this time.

5. The time when personnel resources were not adequate was during Exercise Arctic Express. Present commitments to the AMF(L) and AMF(A) airlift preclude continuing second line maintenance (PSI) and continuing an air operation such as Morning Light. We had considerable difficulty meeting Morning Light requirements during Arctic Express, even with PSI and shop support personnel available for back-up to Morning Light. We were operating two Hercules with sufficient manpower for only one.

SCHEDULING

6. Fixed Wing aircraft scheduling problems occurred with both day to day first line operations and with the longer range second line maintenance.

7. Initially, first line operations encountered many problems which improved somewhat after a few weeks but were never completely sorted out. Although normal tasking and communications continued from Base Operations for other than Morning Light taskings, the separation of Morning Light from Base Operations resulted in incomplete information, incorrect fuel loads, frequent changes of tasking resulting in frequent configuration changes, incorrect or changing departure and arrival times and no single source of instruction/confirmation. The ASO and BAMEO found it frequently necessary to personally check with the Command Post to verify information/taskings. Also, since ASO was receiving direction from two different sources, there was frequent conflict of activity. It was not uncommon to have four or five heavy transport departures or arrivals within one hour. ASO does not have sufficient personnel to debrief and desnag aircraft when this many arrive close together, consequently a great deal of "thrashing around" occurred getting things sorted out and recovering the aircraft. Aircraft tasking should have continued through Base Operations with specific instructions that normally one and certainly no more than two, arrivals or departures occur per hour.

8. There were instances also when flights were delayed due to unserviceabilities and then not rescheduled when serviceable because Command Post were not aware they were serviceable. When sensor equipment went unserviceable, Servicing were not

always advised when repairs were complete, Command Post were not aware of rectifications and so on. Although it would have been possible to assign a BAME representative to the Command Post, that would have tied up manpower that was not readily available, both in the Command Post and at the Servicing end, and would have required space in the Command Post that was not available. A better solution would be TV monitors in the Command Post to display the Servicing aircraft status and location boards. These are kept current by the NCOs and have the most up-to-date information available.

9. Maintenance scheduling also provided its share of headaches. Frequent revisions were made to the maintenance schedule to revise the sequence of inspections as one aircraft outflew another. Major changes had to be made to the schedule when one aircraft ran out of flying time and was sent to Trenton for inspection. This work tied up one Senior NCO who normally has other duties to handle in addition to scheduling, resulting in substantial overtime in the AMCRO section. Even now it is necessary for AMCRO and Base Operations to monitor aircraft hours closely and ensure that flying stays within MFR to avoid the need to ground aircraft prematurely.

RESOURCES

10. The most outstanding resource deficiency identified at this base during Operation Morning Light was hangarage for fixed wing aircraft. Normally there is not enough heavy transport hangarage during the winter months for our own aircraft. The addition of a civilian sensor aircraft which required frequent maintenance and Argus aircraft which will not start in very low temperatures unless hangared or pre-heated aggravated the problem. Transient aircraft continued to appear throughout the exercise and expected to be hangared. In attempting to accommodate some of them we spent a considerable amount of time towing aircraft about and damaged the rudder on a Dakota.

11. Light Transport was not much better off. Although normally they have sufficient (albeit crowded) hangarage and had fewer aircraft present at this base than normal since some were deployed to Yellowknife, the use of No. 4 Hangar as an assembly point for material going north made it very difficult to control the temperature inside the hangar and keep it warm enough to work inside. The lesson here is that we need to reserve hangars for aircraft and keep transient to an absolute minimum, with no overnight storage.

12. Other base resources were generally adequate for the task. Workshops and avionics laboratories were able to handle everything that came their way. He obtained adequate support equipment after the delayed departure of Arctic Express aircraft underlined the need for a new de-icer truck. Some problems were experienced keeping

sufficient heating units serviceable but this was an unusual demand situation, with heaters detached for Arctic Express and also required for each sensor equipped aircraft that was left outside. Even with the demand for AMSE we were able to provide one heater and two generators for deployment north.

EQUIPMENT INSTALLATIONS

13. Special equipment installations aboard the Hercules did not provide much difficulty despite the almost total lack of engineering drawings and installation instructions. Generally the personnel who came with the equipment were quite knowledgeable on it and were able to work with CF technicians to interface with aircraft power supplies. Since we did not seek headquarters engineering assistance or approval, the US MRS installation was accomplished quickly. The Canadian MRS installation required more time due to computer program and antenna problems. Had we followed normal approval routine, many weeks would have been required to complete these installations instead of the few days actually used. It is worth noting that the installations could not have been attempted from a deployed situation. He required the resources available on base to complete these installations and get the equipment functioning successfully. Greater detail on the modification carried out is available in Annex E to this report.

OTHER PROBLEMS

14. A recurring problem throughout the Operation was determining who was responsible for each particular piece of equipment, both for and unserviceability rectifications. With equipment belonging to both US and Canadian agencies, sometimes installed in the same aircraft, it was a constant problem to determine who was going to do what to what and when. This was further aggravated by configuration changes often requested on short notice to change aircraft from sensor to airlift roles and back again. At times it was not possible to determine what aircraft would be flying which mission until late on the preceding day.

15. A problem which resulted from an attempt on our part to eliminate a potential problem area was the CF shortage of Nicad batteries. By replacing the US lead-acid batteries in the MRS ground beacons, we were attempting to avoid problems which might result from poor battery performance at the low temperatures being experienced in the search area. The required number of Nicads to provide a pool of spares batteries seriously depleted CF resources. This was further aggravated when a number of batteries were destroyed along with some of the very expensive Nicad battery chargers in a fire. Fortunately we had sufficient batteries to complete the operation.

16. The use of SAR MAD kits on Morning Light had both good and bad effects. The good effect was a realistic evaluation of the kit contents, especially when the Chinook helicopter experienced problems and the occupants had to await rescue the following day. The bad effect was the consumption of all spare kits beyond those carried aboard the SAR Hercules. It has taken a considerable time to replace those kits. In fact, three are still incomplete awaiting stoves which are on IOR as of 15 May 78.

PART 3 - CONCLUDING MATERIAL

CONCLUSIONS

17. Operation Morning Light provided an opportunity to test our reaction to an unusually heavy fixed wing aircraft tasking situation and the introduction of unusual equipment into service in a very brief period of time. Overall we were able to cope, albeit with problems in the area of personnel availability when other exercise tasking occurred, with hangarage for fixed wing aircraft at this base and with the command and control aspects of the aircraft tasking and maintenance during the Operation.

RECOMMENDATIONS

18. If the CF ever has another Operation such as Morning Light overlap a major exercise like Arctic Express again, recommend that participation in one or the other be cancelled or at least reduced to a lower level than was done on this Operation. Our manpower resources for Morning Light were overextended during Arctic Express.

19. Recommend that another operation of this size not be attempted from this base without restricting transient traffic and keeping all but essential aircraft off the base. If other aircraft such as the Argus are required, they should operate from another base which has hangarage available and Edmonton Hercules not used in the operation should be detached to another Hercules base whenever possible. This base does not have sufficient hangarage during the winter for the present number of heavy aircraft stationed here.

20. Recommend that aircraft tasking be continued through Base Operations even when aircraft are assigned to a special use so that someone can be charged with responsibility for ensuring that not more than two arrivals/departures occur per hour. This also gives Servicing NCOs a single contact point for fuel loads, configurations, etc. In addition, the Command Post should have a TV monitor system so that they can keep up to date on the status of their resources. As well, specific areas of

responsibility must be identified so that everyone knows who is responsible for what equipment whenever we have a situation such as this with two or three other agencies having equipment installed in our aircraft.

ANNEX A
Part 4 B

BASE MAINTENANCE
ROTARY WING AIRCRAFT

Reference: A. 10 TAG Air Op Order 06/78 7 Mar 78

TASKING

1. 1 AFHS was tasked under Operation Morning Light with the following support of CH135, CH136 and CH147 operations:

a. Provision of second line maintenance and Mobile Repair Parties;
b. Provision and coordination of helicopter spares;
c. Assembly and dis-assembly of CH135/136 aircraft as required for C130 consignment;
d. In conjunction with 408 Squadron, 450 Squadron Detachment and 10 TAG coordination of aircraft stagger programme; and
e. Upon operation completion to ensure that augmentation aircraft are returned to their parent unit in a status as directed by Headquarters 10 TAG based on known operational requirements.

2. In addition to the above tasking via Reference A, additional tasking of the operation included:

a. in the CH135 and CH147 helicopters, proto-typing, installing and ground and flight testing and OMEGA Navigation System;
b. proto-typing, installing and coordination of flight testing of the McPhar Engineering and Scintrex Corporation Radiac monitoring equipment in the CH135; and
c. provision of technical advice to Operation Morning Light staffs.

PROPOSED CH135 FLYING AND MAITENANCE SCHEDULE

3. Although all three helicopter types were to be in operation to support Morning Light activities, the CH135 flying schedule was the only one to be far in excess of existing MFRs. To support search activities, the CH135 schedule called for six CH135 to be operational for a total of 42 flying hours per day. This was to be sustained for seven days a week for a period of three months (March, April and May).

4. To support this flying rate, a total of 12 CH135s were required: eight on site, to ensure six operational at any one time; and a maximum of four on Periodic Inspection to ensure replacement as inspections became due. A flying/maintenance

schedule was drawn up which called for 1½ inspections per week or three every two weeks. The established AFMS workload is two inspections every five weeks. This represents a workload increase of a factor of about 3.75.

PREPARATION

5. In order to meet the schedule, further preparation was required:

a. four augmentation CH135s were required, chosen by tail number so that the time remaining on them would facilitate their entry to the stagger program;
b. because up to four inspections would be underway at any given time, two more full periodic inspection crews were required;
c. in order to preclude inspection back-ups caused by shortage of spares/components, supply holdings had to be increased commensurate with the increased work volume;
d. one additional Supply Technician was required;
e. AFMS responsibility for accepting CH135 from DLIR at Bristol was suspended;
f. delays of some postings and courses for the Operation duration;
g. one Mobile Repair Party (three technicians) was required to preclude inspection delays due to sending maintenance personnel on MRPs;
h. working hours were extended one hour per day; and
j. an overriding factor was the requirement for 408 Squadron Operations to maintain the stagger to ensure one CH135 into periodic each five days.

6. The augmentation CH135s were provided by 10 TAG Squadrons, with the requested tail numbers. They were transported to Yellowknife via Hercules and assembled by AFMS to be on site by the required date.

7. Periodic inspection crews were provided as follows:

a. 2 AFMS Ottawa provided one fully qualified inspection crew consisting of one Sergeant, one AF Master Corporal, three AF Corporals, two AE Corporals, one IE Corporal and one CS Corporal. This crew arrived 02 Mar 78 and commenced work 03 Mar.
b. Bristol Aerospace in Winnipeg was contracted to provide one inspection crew. This crew consisted of one civilian supervisor and six civilian technicians. (all trade mix with the exception of the AE trade functions, which were handled by 1 AFMS AE Technicians).

8. Mobile Repair Parties were provided by 427 Tactical Helicopter Squadron Petawawa, each consisting of one Master Corporal and two Corporals; of the AE, AF and I and E Technician trades. Initially one MRP was provided and dispatched to Yellowknife and a second party also from 427 replaced them.

9. Supply preparations included updated push maximum/minimum level list, on a total of approximately 350 items. The 1977 IOR file was reviewed and 750 demands submitted to double quantities in pre-expended areas. All TX lists for the operation CH135 aircraft were reviewed for the upcoming two periodics and Code I demands submitted for these items. The Supply Section was supplemented by one Supply Technician from 2 AFMS.

CONDUCT AND RESULTS

10. With most of the preparations complete and inspections underway within a week of the tasking, maintenance operations ran very smoothly. Determined efforts by all personnel involved ensured schedules were met. Although the operation did not fly the 294 hours per week proposed, and the operation terminated mid-April, the increased effort could easily have been sustained.

11. Some of the CH135 Morning Light statistics are:

a. total flying hours: approximately 1314[48]
b. Periodic Inspections, completed: 7 (plus 2 in progress at termination);
c. average periodic completion time: 9 .6 working days;
d. IORs submitted; 142; and
e. average IOR delivery time: 2.1 days.

12. In addition to the CH135, statistics on other helicopters include:

a. CH136 hours flown: 2pproximately 396;[49]
b. CH136 Periodic Inspections completed: 4;
c. CH147 hours flown: 499 - includes two aircraft from 450 Squadron, Ottawa; and
d. CH147 Periodic Inspection completed: 2 (plus 1 in progress)[50]

[48] Marginalia: “1554.9”

[49] Marginalia: “501.9"

[50] Marginalia: “1710”

A list of all inspections completed is contained in Appendix 1, including the period to end 1978.

OTHER TASKINGS

RADIATION MONITORING EQUIPMENT

13. In addition to the increased inspection workload, 1 AFMS was tasked with providing assistance to McPhar Engineering and Scintrex Corporation in the fitting of radiation detection and monitoring equipment in the CH135. Power sources were required in addition to a definition in location of the major components of the detection system. The system weighed about 700 pounds and therefore weight and CG considerations were critical. The installation is illustrated in the accompanying photograph (Figure 1). For the Scintrex installation an aircraft maintenance CWO from 1 AFMS provided liaison at Toronto for the fit. The equipment was then test flown at 1 AFMS before being flown to Yellowknife and Cosmos Lake.

OMEGA NAVIGATION EQUIPMENT

14. Since navigation in the search area was very difficult with just basic navigation gear, a requirement existed to provide aircrews with a better navigation system. Six OMEGA sets were borrowed from another CF programme, and, with the assistance of the Marconi Field Service Representative, Mr. Gagnon, they were installed in CH135 and CH147 aircraft. Although very short notice was given of the requirement, the installation including antenna, computer and controller was completed and flight tested in a very short time and provided the necessary navigational assistance to the search crews. It should be noted that this was the first installation of the OMEGA Navigation System in the CH135 and CH147 and therefore presented quite a challenge to the technicians. Flight testing to verify electromagnectic compatability with other electronic systems was conducted and proto-type installation instructions and drawings were forwarded to NDHQ. Briefings on operating procedures were given by Mr. Gagnon[51] to the aircrews.

POST OPERATION ACTIVITIES

15. Although the Operation was officially terminated mid-April, some 1 AFMS activities related to the Operation continued. The Bristol Aerospace periodic inspection crew remained on site until mid-May, to ensure aircraft from the Eastern squadrons were returned with sufficient time remaining to periodic. A total of six

[51] Marginalia: "Frank "

CH135 periodics over and above the regular workload were completed following Operation termination.

APPENDIX 1
To Annex A
Part 4 B

PERIODIC INSPECTIONS CARRIED OUT
IN SUPPORT OF OPERATION MORNING LIGHT

1. Following are periodic inspections completed by 1 AFMS support of Operation Morning Light during the period 27 Feb to 30 May 78:

a. CH135
139
132
133
145
123
128
110
142
107
150
119
106
131

b. CH147
006
008

c. CH136
255
242
268
241

ANNEX B
Part 1

RADIATION MONITORING RECOVERY OPERATIONS
NUCLEAR ACCIDENT SUPPORT TEAM (NAST)
CFB EDMONTON

OPERATIONS

1. General. The NAST Team from CFB Edmonton, extensively augmented by personnel from other Air Command NAST Teams, bore the brunt of ground radioactive material recovery operations. Primarily trained to work around nuclear accident sites, these personnel (male and female) were thrown into the breach to provide radiation monitoring services, hit site monitoring, personnel and equipment decontamination, recovery of satellite debris, escort duties and general bull work associated with the movement of radioactive containers. They first worked under the guidance and direction of radiation health physicists using both American and Canadian civilian - supplied detection equipment. Much later in the Operation they functioned in association with AECB personnel, heavily augmenting the sparse numbers of these technicians in the handling and transportation of satellite pieces. The NAST members were a central pillar to the success of this Operation.

2. Chronology (Times HST)

23 Jan 78 - CFB Edmonton NAST placed on standby alert by Air Command order.

24 Jan 78 - 0800 hours - NAST placed on full alert
1400 hours - Team departed for Yellowknife
1800 hours[52] - Hand held and air sampling radiation two day survey of Yellowknife begun. No radiation detected.

26 Jan 78 - Six member NAST sub-team conducted two day radiation monitoring survey of Fort Reliance. OC NAST and two radiation monitors (RADMONS) deployed to Baker Lake.

27 Jan 78 - Centre set up in DND hangar at Yellowknife.

29 Jan 78 - One deployed with group to investigate sighting on Thelon River.

[52] Marginalia: “Cpl Thompson in interview said 2000 hrs.”

- One deployed to Warden's Grove to assist in monitoring cabin site.

30 Jan-2 Feb 78 - Radiation monitoring of Snowdrift conducted.

31 Jan 78 - OC NAST and one RADMON deployed for recheck of Thelon River site.

11 Feb-20 Feb 78 - Air sampling and radiation surveys of various sites on Great Slave Lake.

3 Feb 78 - Two RADMONs overnight at survival camp Thelon River.

6 Feb 78 - OC NAST and one RADMON deployed to Cosmos Lake.
- Set up of Camp Garland and radiation monitoring duties of site and personnel for ten days.

7 Feb 78 - Decontamination/transit centre established at CFB Edmonton.

22 Feb 78 - Team of two RADMONs dispatched to Fort Smith and two to Fort Resolution to provide public radiation monitoring services for people returning from wilderness camps.

26 Feb 78 - Team at Fort Resolution withdrawn.
- Two man team sent to Fort Reliance.

27 Feb 78 - Twelve man team sent to Fort Resolution to clean up newly discovered fine particle contamination.
- 136 "hot spots" removed.[53]

2 Mar-5 Mar 78 - Team moved from Fort Resolution to Pine Point.
- 181 "hot spots" removed.[54]

6[55] Mar-10 Mar 78 - Team moved to Hay River - 28[56] "hot spots" removed.

10 Mar 78 - Team returned to Yellowknife.

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[53] Marginalia: "110 – hit rep "

[54] Marginalia: "176 – hit rep "

[55] Marginalia: "5 Mar "

[56] Marginalia: "48 hot spots"

4 Mar-15 Apr 78 - Extensive daily participation in "Grasty" and "Tinney" plan radiation surveys.[57]

15 Apr 78 - NAST returned to Edmonton from Yellowknife.

3. CFB Edmonton Operations. A RADMON cell was set up in the hallway of No.5 Hangar as part of the Base Command Post. This cell provided an interface with the Command Post to support NAST field operations although its location left it somewhat out-of-touch with Command decisions. Its immediate routine function was to provide Canadian personnel with radiation monitoring. This was done by issuing pocket dosimeters and film badges to all personnel (including aircrew flying sorties returned to Edmonton each day), collecting and reading these monitors upon the return of personnel, tabulating readings for medical records and forwarding film badges for reading to National Health and Welfare
in Ottawa. Monitoring personnel in and out for flights meant manning the desk 16 to 18 hours daily.

4. Decontamination Centres. CFB Edmonton became the trans-shipment point for all radioactive material. A material decontamination centre was set up in Bunker 259 in a 48 hour period with the considerable support of Base Construction Engineering. Satellite material and contaminated and clothing were flown in from the forward sites, picked up at the aircraft, driven to the Bunker, subjected to initial analysis and repackaging under the guidance of AECB personnel, then reshipped to Winnipeg. NAST members supported this entire process.

5. At both Yellowknife and Cosmos Lake, personnel decontamination centres were established. At Yellowknife, personnel were surveyed in a "dirty area" upon return from field missions and contaminated clothing removed. Aircraft were monitored at the end of each mission. On several occasions helicopters had to be decontaminated from radioactive material brought in with snow on clothes or boots. At Cosmos Lake a tent was set aside for monitoring purposes and decontamination of all people as they returned from daily operations.

6. Storage sites were established for satellite debris at Yellowknife and Cosmos Lake. Yellowknife constantly faced the problem of being in a populated area with no secure storage. A locked "Paul Bunyan" held the small containers while larger articles were kept moving to Edmonton through immediate air shipment. The Cosmos Lake personnel established a tent in a remote location from the main camp to store radioactive material.

[57] Marginalia: "Tinney on 11 March & Grasty on 26 Mar "

PERSONNEL

7. A total of 45 personnel of all ranks from CFB Edmonton comprised the Base NAST. Twenty-eight augmentees from other Air Command bases were-assigned throughout the operation. All Team members had the opportunity to work in the field. A number of female members worked at Edmonton, Yellowknife and Baker Lake. None was sent to Cosmos Lake after the camp building begun because of the communal living in tents, although one female served well in the lead party to the Thelon River. Team members generally all pulled more than their weight, although one male augmentee was returned to his unit for lack of effort, two female personnel from CFB Edmonton were constrained to the Base after they found helicopter flying circumstances beyond their tolerance, and female members generally faced a difficult time with the heavy manual labour required to haul and lift containers through the snow at debris pickup sites when operating from Yellowknife.

8. The level of training of NAST personnel in the handling of radiation detection equipment was generally satisfactory. Immediate on-job-training was necessary to familiarize them with American and AECB equipment, but this was done quickly. American health physicists provided the initial guidance in personnel safety and the techniques in handling radioactive material were backed up by AECB technicians. The Operation overall proved significant asset and impetus to the training and motivation of Air Command NAST members.

9. Equipment. The following types of RADIAC. Instruments were used by NAST members during the operation:

a. IM 5016/PD	Gamma Survey meter (low range);
b. PDR 60	Low range Alpha and Gamma;
c. IH 5006/PD	Personal dosimeter (self reading);
d. DT 60 A/PD	Personal dosimeter;
e. CP 95 A/PD	Personal dosimeter reader;
f. LUD 19	Micro reader;
g. PIC 6A	Eberline Gamma survey meter;
h. E 140	Eberline Pancake Gamma meter;
j. AECB HP 210	SWIPE Reader;
k. AECB JH-4	SWIPE Holder;
m. PRH 7	Eberline micrometer; and
n. STAPLEX	Air Sampler.

10. Canadian military RADIAC equipment (9 a. and b.) proved inadequate to the task once it was determined that much of the radioactive debris registered in the micro R range. The PDR 60 also failed quickly in cold temperatures. Detectors 9 f. to m. were used in the main and were, as indicated, either US or AECB supplied. These are battery powered and were also susceptible to cold temperatures although not as much as the PDR 60. The personal dosimeters (9 c.) were excellent and film badge monitoring provided a valuable back-up. (Data took several weeks to be obtained however because the badges were read in Ottawa and the results returned to Edmonton by mail).

11. The DT60As were inappropriate to this Operation. An occasional malfunction resulted in some aircrew being medically grounded until the indicated results were double checked by film badge readings. Faithfully checked early in the Operation, the DT60As recorded no useful data and reading of these dosimeters was discontinued.

12. NAST members were equipped with the standard issue one-piece winter suit produced by Wholesale Distributors, Queensville, Ontario. Cold drafts leaked through the unprotected zipper and the nylon cover cracked in the extreme cold. Other clothing items were standard CF Arctic issue clothing which is generally very good for purpose.

RECOMMENDATIONS

13. As a result of Operation Morning Light it is recommended that:

a. the NAST command and control structure be carefully arranged with the OC remaining at the Operation Command Post as part of the Command Post decision-making team;

b. clear terms of reference and authority be established for each component of a joint military/civilian nuclear accident response team;

c. greater continuity of at least one month be established for the senior civilian scientists overseeing radioactive material recovery operations;

d. civilian and military field team members be physically fit to face the rigors of Arctic outdoor work;

e. a fixed contamination level acceptable for aircraft and equipment be established by competent technical authority at the outset of an operation;

f. more sensitive detection equipment be mandatory issue for each CF Base NAST team including:

(1) Gamma survey meters (6) equivalent to the Eberline E140 for personnel and vehicle decontamination,

(2) Swipe Reader Probes (2) similar to the AECB HP210, and

(3) Swipe Holder (2) similar to the AECB JH-4; and

g. all battery equipped detection meters be powered to operate in -40° to -60° C temperature through the use of lithium cells.

ANNEX C
Part 1 A

LOGISTIC SUPPORT
BASE LOGISTICS

1. The Operation was very beneficial to Supply. It provided a critical situation for which quick and accurate response by the Supply staff and CFSS was mandatory and could be engaged.

2. Initially and in some cases throughout the Operation, the importance and magnitude of the Operation was not appreciated by staff not directly involved. It was at least a week before
the seriousness of the requirements being processed was appreciated by the NDHQ Item Manager receiving the referrals from the system. Once personnel realized the Operation was so important, response was fast, efficient and exceptional.

3. The HF communications difficulties experienced from Base to the isolated field deployments were a definite drawback, especially at the outset of the Operation. It was almost impossible for Command Post Supply Officers to question a requirement or get additional information. Demands from Cosmos Lake were a prime example. Therefore, some confusion, delay and duplication of effort was experienced and unavoidable.

4. Close-out of accounts has been a real problem. As is the case in Exercises and Operations, returns have been difficult. The identification of material and ownership has taken many manhours. Write-offs for losses have not been as large as anticipated considering the size of the area, weather conditions and inherent difficulty to control stores.

COMMAND POST

5. Initially Supply was grouped with the Technical Desk. It was impossible to determine the magnitude and duration of the Operation, therefore the requirement was impossible to define.
The Technical Desk was tasked with responsibility to demand, direct and coordinate Transport and Administrative requirements and Supply demands. The burden of these duties caused innumerable problems and miscalculations. Consequently, double tasking and wasted time and effort resulted. However, once the scope of the Operation was realized, Command Post was re-organized to function more efficiently.

6. Not all requirements were processed through Supply at the Command Post. Units and Sections were submitting requirements direct to Base Supply Groups, other units and NDHQ causing double tasking and delays.

7. The major problem encountered was control of material. Before it was realized just how big the Operation would become, several accounts had been opened and stores were scattered all over Northern Canada from Great Slave Lake through to Cape Dorset in support of these Operations. Control was cumbersome in view of this diversity.

8. With the establishment of the base camp at Cosmos Lake, the decision was made to use only one camp account- 3F0127. A degree of control was then possible; however, it was hindered and complicated by other factors. Various units and sections were still demanding and receiving items without going through the Command Post or Base Supply Edmonton, i.e., Squadrons from their stores, electricians from Construction Engineers, cooks from mess hall, equipment rentals and purchases etc. In addition, Supply Technician NCOs at Cosmos Lake could not control and secure stores adequately because the urgency and diversified nature of demands. Lock-up facilities were unavailable and consequently attractive items would disappear during silent hours. This was a persistent problem throughout the Operation. However, Supply procedures through the Command Post maintained an adequate line of accounts for control purposes.

9. Base Supply Edmonton responded to every demand and many manhours were required. Requests came at all hours of the day and night and the staff responded in a professional and dedicated manner. Augmentees were received for Base Supply, NAST and Cosmos Lake supply operations and proved themselves invaluable.

<u>IORs</u>

10. Increased flying commitments caused an influx of IORs on the system. In order to monitor the effect of these increased demands on the overall performance of the CFSS and to ensure top priority action, a special IOR team was formed in conjunction with Air Command and NDHQ, DCOS LOG. Despite the fact that the IOR desk was sometimes circumvented by IOR demands going through the Supply Groups instead of the IOR team, their overall effectiveness in satisfying IORs remained at a high level.

CLOTHING STORES

11. Involvement and activity with Operation Morning Light was heavy in all groups at Base Supply with perhaps the hardest hit group being Clothing Stores. From the very outset of the Operation large stocks of arctic gear were required and the demand remained high throughout. 110 0X and 80 Code I demands on depots, nearby bases and stations and militia and BDF stores were submitted in order to meet the requirement. All together, throughout the operation, Clothing Stores staff received 61 phone calls after normal working hours (i.e., requests from Command Post for clothing) which resulted in approximately 152 hours overtime.

PURCHASING GROUP

12. Because of the urgency for certain items and equipment, (i.e.' lead lined drums, ice augers, etc) it was not always feasible or possible to draw on stocks from the system. Our Purchasing Group spent many hours liaising with the Command Post, American scientists and technologists and commercial outlets in order to procure exact requirements as quickly as possible. Response from all sectors was excellent, as each realized the importance of items purchased for human safety. A total of $243,879.13 was spent on B, C and D class items bought directly through the group in support of the Operation.

POL

13. To meet increased operational requirements, POL contracts were extended and at the outset a 24 hour shift was established at the POL Group. This was later reduced to a 16 hour shift, with a duty Supply Technician on call 2400 to 0800 daily. Supply Technicians were constantly busy satisfying demands for JP4, ME gas and various lubricants (i.e., hydraulic fluid, turbo oil, grease, varsol, etc).

14. The critical need for fuel in Cosmos Lake necessitated the stockpiling of a reserve there. Consequently at the close of the Operation a number of POL items were returned. The following are figures of the cost of these items:

Issues

a.	Turbo, JP4, Drummed	43,360 gallons	$40,988.34
b.	Turno, JP4, Bulk	1,213,849 gallons	506,175.03
			$547,234.47

Returns

a.	Turbo, JP4, Drummed	540 gallons	$ 406.62
		NET TOTAL ISSUED	$546.827.85

Issues

a.	Various POL products		$ 20,530.08
		NET TOTAL ISSUED	$ 21,640.83

WAREHOUSE GROUPS

15. Tasking rose significantly in our warehouse groups (Technical Stores, Aircraft Supply, CE Supply, Supply and General Stores). Because of the unique requirements, there were times when demands were placed with the wrong Supply Group. It was then that the expertise and devotion in researching items proved invaluable. Many manhours were spent filling demands and researching sources of supply. It is impossible to calculate exactly how much time was spent meeting operational needs, however, during the first weeks there were times when personnel were unable to do any of their regular duties during the day because of operational requirements.

INTRANSIT AREA

16. Items destined for our Operations in the North were sent from the Supply Groups to Intransit Area for packaging and crating prior to shipping. Daily reports were given to the Command Post as to what these stores were. Despite occasional circumvention, the system worked well and a degree of control was maintained.

CLOSURE OF ACCOUNTS
RETURNS AND WRITE-OFFS

17. As mentioned earlier, the closure of accounts has been a real problem. Many items listed on the Material-in-use printouts were destroyed in the two fires that occurred at Cosmos Lake. Exact details, i.e., quantities, descriptions and NATO stock numbers, were unavailable as the Supply records were also lost in the first. Of the

stores that were returned, identification of material and ownership has proven to be a difficult task. This is due to the condition of the returned stores, lack of documentation when shipped back and to the lack of control at various stages of the Operation during which time issued items were not properly recorded. Examples of fire damage and returned stores are shown on photographs included in this report.

18. Through many manhours and the dedication of Supply personnel, Base Supply the write-off requirements. The cost of write-offs are listed below. These figures as accurate as possible, however, a few revisions may occur:

a.	Account AA0127	$10,000.00
b.	Clothing	10,436.20
c.	Account 3F0127	135,336.01
d.	Fire No. 1	200,000.00
e.	Fire No. 2	24,415.86
f.	Account AC1568 (Yellowknife)	1,594.12

CONCLUSIONS

19. The overall consensus of all personnel involved is that Operation Morning Light was a valuable experience. Being the "real thing" and not merely a paper exercise, Supply personnel experienced a sense of purpose and excitement. An enthusiastic response united all sections in a common bond and morale remained high despite long hours and heavy taskings.

20. Such an unique operation was not its drawbacks and many original problems were encountered. Mistakes inevitably arose, however, for the most part Supply expertise enabled supply operations to run smoothly.

RECOMMENDATIONS

21. Upon reviewing Operation Morning Light, it is now possible to make suggestions. To promote order and avoid confusion in the event of a similar incident, it is recommended that:

a. initial control of items be introduced by the establishment of ONE camp account to which all operational requirements are issued;

b. all units, sections, personnel involved be instructed to deal directly with the Command Post, Log Desk for demands;

c. an IOR Team be established immediately and all personnel be instructed to use it;

d. a Supply Officer accompany the base camp staff. Senior NCOs at Cosmos Lake were outranked and unheard with regard to Supply and administration of stores; and

e. Supply Technicians be dispatched to base camps with the advance parties to establish and maintain supply control.

ANNEX C
Part 1 B

LOGISTICS SUPPORT
AIR MOVEMENTS

OPERATIONS

1. 1 AMU was tasked at various times throughout subject operation to provide personnel support in Edmonton, Yellowknife and Cosmos Lake.

2. The total number of operational chalks in support of Morning Light cannot be determined by this unit. However, approximately 223 cargo chalks were utilized in the airlift between Edmonton, Yellowknife and Cosmos Lake. In addition approximately 700 passengers were carried to and from these points.

3. The transshipment point at Yellowknife was short-manned for the first month of the operation and considerable confusion in shipment resulted. An experienced air movements officer was sent to trouble-shoot the problems and to arrange for adequate manning.

4. Several late departures occurred during the operation due to; personnel shortages, material handling equipment failures and insufficient loading time.

MANNING

5. All 1 AMU personnel involved in Operation Morning Light at one time or other in the following areas: LAPES build up, Command Post duties, cargo handling, augmentation for
Yellowknife and Cosmos Lake.

6. An air movements officer proved essential in the Command Post to resolve the interface problems between supply, transportation and aircraft loading.

7. Regular AMU commitments carried on throughout Operation Morning Light creating serious manning problems with the additional workload. Most personnel not already deployed worked shifts of 24 on and 24 off for the duration of the operation, while others worked 12 to 16 hours daily. This schedule did not have any effect on the timely completion of the operation, but did however indirectly contribute to two minor personnel injuries and one major ground incident involving aircraft damage.

8. It is suggested that any future operations similar to Morning Light with such national and international consequences should take precedence over all other operations/exercises in terms of personnel and material resources.

<u>INCIDENTS</u>

9. Three incidents of cargo fuel leakage were reported during the operation. The major causes being improper preparation for shipment and improper inspection prior to airlift.

10. One serious vehicle/aircraft accident occurred in which a forklift struck an aircraft[58] causing serious damage to the aircraft tail section.

11. Initially several dangerous cargo violations occurred which necessitated the issuance by ATGHQ of blanket authority for Operation Morning Light cargo movement. However, out of necessity several improperly packaged items were shipped. The shipment of overfilled propane cylinders caused the most significant incidents including the jettison of one leaking cylinder. A major review of the procedures involved which caused the overfill corrected the problem.

12. Unpurged fuel bladders and drums were shipped out of Cosmos Lake in great numbers by necessity. No hazardous incidents occurred.[59]

<u>OTHER FACTORS</u>

13. The following factors summarize some of the problems faced by 1 AMU in the efficient completion of duties in support of Morning Light:

a. last minute receipt of items for shipment;
b. numerous changes in shipping priorities, which resulted in several instances of loading, unloading and reloading airplanes;
c. lack of documentation on items such as packed and sealed tri-walls with no indication of the nature of contents;
d. material received by AMU with incorrect shipping addresses, resulting in unnecessary trans-shipment and delay in receipt at final destination;
e. civilians and at other military-personnel telling traffic technicians how to do jobs;

[58] Marginalia: "Dakota"
[59] Marginalia: "See my recollections ref. Capt. Fisher"

f. several items of sophisticated and costly equipment handed over for shipment with insufficient packaging protection; and

g. lack of sufficient aircraft pallets and cargo tie down straps.

CONCLUSION

14. Operation Morning Light was an excellent test of the flexibility of air movements operations both static and deployed. Valuable experience was gained by this operation.

15. Reports on AMU involvement in LAPES build-up and the redeployment of Cosmos Lake have been submitted under separate cover.

ANNEX C
Part 2 A

TECHNICAL SUPPORT
PHOTOGRAPHIC SERVICES

INTRODUCTION

1. From 25 Jan to 07 78 the photographic support for Operation Morning Light was provided by the US Department of Energy (DOE), through their sub-contractors E.G. & G. of Las Vegas. The processing of film and printing was arrange by an Atomic Energy Control Board (AECB) contract with Northwest Colour Laboratories of Edmonton.

2. E.G. & G. supplied the photographers and support staff to administer and classify photos. It was not until 07 Mar 78 that DND photographers took over the photo support operation. The phase-over to self-sufficient DND resources was primarily due to the US withdrawal to permit the Canadians to take over the whole Operation. Prior to this time CFB Edmonton Photo Section gave limited assistance to E.G. & G., however, for all intent and purposes, this segment of the Operation Morning Light was kept separate to enable the Base Photo Section to continue with its regular Base commitments.

COMMENCEMENT OF CF PHOTO SUPPORT

3. The first team of CF Photo Technicians from other Bases and Units arrived 2 to 5 Mar 78 at CFB Edmonton. Their initial task was to work with E.G. & G. photographers and to familiarize themselves with all aspects of photo support operations.

4. One of the first problems was to equip the Photo Technicians with appropriate camera kits. By asking questions of E.G.&G. photographers it was learned that the extreme cold tended to freeze their cameras. After much discussion, it was decided to procure the 35 mm Nikkormat. Photo kits were purchased locally, one for each photographer in the field. Each kit contained a backup camera and lens. This was necessary in case the main camera or its lens froze or became unserviceable. The backup equipment was considered necessary to ensure mission success. The selection of the equipment was under the advice of NDHQ DAES 5 and CF Photographic Unit representatives.

5. When the equipment was assembled and the Photo Technicians became familiar with the different exposures that would be necessary in filming in bright snow conditions, two Photo Technicians were deployed to Cosmos Lake and one to Yellowknife to relieve the E.G. & G. photographers of their duties. One photographer was kept at CFB Edmonton to photograph any material that might be sent back from the field and also in the event a photographer was needed in another area. In addition to the field photographers, a Photo Technician augmentee was employed at CFB Edmonton as a "Photo Librarian" whose duties included that of cataloging and filing of all negatives and prints.

AUTOMATIC COLOUR PROCESSOR AND PRINTER EQUIPMENT

6. As the cost of developing and printing film through Northwest Colour in Edmonton was very expensive, NDHQ DAES 5 were asked by CFB Edmonton to investigate if colour processing and printing equipment could be installed in the Base Photo Section to provide an in-house facility. Again, DAES 5 and CF Photographic Unit representatives assisted the Base in selecting the most appropriate equipment. The procurement was handled through NDHQ DAES 5 and DSS Ottawa. The following equipment was procured and installed in the Base Photo Section:

a. Kreonite Table Top Processor;
b. Printer Pako BC-24; and
c. Kreonite PM-10 Mixer.

7. This equipment arrived on the Base approximately 15 78 and was installed shortly thereafter. Base CE Section personnel completed the necessary electrical and plumbing work to install the equipment. The equipment was fully operational by 28 Mar 78.

CONTINUING OPERATIONS

8. A second Photo Technician relief crew reported for duty on 21 Mar 78. The Photo Librarian from the first crew was extended by Air Command authorization for an indefinite period of time for the duration of the Operation. The retention of this Photo Technician Librarian proved to be most valuable towards the overall success of the photo operation. She became a link between E.G. & G., AECB and the Base Photo Section as she held a wealth of information at her finger tips.

9. In was during this time period of the second Crew at CFB Edmonton that saw the final installation and eventual commencement of use of the Kreonite (Kermatic) colour processor and Pako printer at the Base Photo Section. The processor was originally assembled and installed under the supervision of a Senior

NCO from CFB Photo Unit CFB Ottawa (North). With the installation complete, he returned to his Unit 22 Mar 78 following the arrival of a replacement from CFPU.

10. The replacement's assignment was to train Base personnel on the correct procedure on the use of the lab colour equipment. Following four days instruction and testing of chemistry, etc. the processor and printer went into operation on 28 Mar 78. Northwest Colour Lab printing of negatives was terminated however, some processing of negatives and slides was necessary later.

11. From that date until OS Apr 78 under the guidance of the CFPU Photo Technician, Base personnel produced colour corrected prints to support the Operation. However, following the departure of the CFPU Photo Technician, the colour printing operation encountered some difficulties apparently due to the lack of sufficient time allowed for formal training. As the backlog of desired printing continued to build up it was decided to return to the proven facilities of NWC. After recalling one of the Photo Technicians from the Yellowknife Detachment, he was able to rectify the production problems and by 10 Apr 78, the processor was again working properly, even though it was not fully geared for production.

12. During the final week of Operation the Photo Technicians carefully scrutinized every negative in their possession. Using their judgement, a representative collection of negatives were retained for eventual filing with the Central Negative Library (CNL) while others were permanently destroyed. To prepare the negatives for CNL purposes all were annotated with a proper Edmonton prefix (ENC) and an OPML block of numbers beginning at ENC 78-3000. All negatives were listed on a CNL disposal log (CF286) and a contract print prepared for filing with each negative. A duplicate log sheet was retained at the CFB Edmonton Photo Section.

13. The OPML Photo Support Unit finally closed its doors on 28 Apr 78. All pertinent negatives had been sent to CNL and the original proofs were retained at the Base Photo Section at CFB Edmonton for possible future reference. This also included the proof prints that were left behind by E.G. & G.

<u>WORK ACCOMPLISHED</u>

14. Both E.G. & G. photographers and CF Photo Technicians amassed a phenomenal total of some 10,000 frames of 70 and 35 mm negatives and positives. An estimated quantity of 25,000 prints and slides were produced by both E.G. & G. and CF resources throughout the whole Operation Morning Light.

15. The CF Photo Support phase developed some 4,000 frames and produced approximately 10,000 prints (proofs included). Seventy-five percent of the CF photos were processed in-house with the colour processor and printer.

FINANCIAL ARRANGEMENTS

16. For the most part, AECB contracted with Northwest Colour Labs of Edmonton for the processing of all film and printing work.

17. That work which was undertaken for AECB within the Base Photo Section, recovery action through NDHQ D Fin S was initiated at the termination of the Operation. A total amount of $8,000 was claimed.

CONCLUSIONS

18. The Canadian Forces were ill prepared to accept photographic support for this Operation. The first problem was that there were no suitable camera kits available in the CF inventory for the deployed operations at Cosmos Lake and at Yellowknife. The camera equipment that was eventually procured locally was found to be suitable for the cold temperatures encountered.

19. Another deficiency highlighted during Operation Morning Light in the Photo Support side was the lack of colour processing capability in the Base Photo Section. Even the black and white equipment in the Section was in the Section was inadequate to handle the large production requirements of the Operation. Operation Morning Light proved beyond a doubt that the Base Photo facility was inadequate, antiquated, and urgently required upgrading.

20. Through experience of this Operation it was found that colour photographs added a considerable dimension to record technical characteristics of the Cosmos 954 debris. It was found that even fire reports, when accompanied by colour photographs, were much more explicit and from a technical point of view, colour prints enabled the portrayal of effects of corrosion, burning, wear and tear much more explicitly than black and white photos.

21. Another conclusion reached through the Operation Morning Light is that not all 35 mm cameras work satisfactorily in cold temperatures. The CF should make careful selection of 35 mm cameras to ensure that they will operate satisfactorily in such extreme temperatures as encountered in Operation Morning Light. The 35 mm Nikkormat was found to be suitable.

22. Although the Base Photo Section was at first unable to provide adequate support for this Operation, the method of providing augmentation personnel from other units and bases worked well. With dedicated Crews, the regular Base Photo Section was able to carry on with its normal commitments.

RECOMMENDATIONS

23. The following recommendations apply vis-a-vis the above conclusions:

a. A more concerted effort be made by DAES 5 to upgrade the CF inventory of field deployable camera kits to be prepositioned at particular Bases or in Supply depots.

b. All Base Photo Sections be upgraded to include automatic processing capability of colour film.

c. The current practise of using Black and White photographs for technical report purposes be replaced by colour throughout the Forces. This will modernize the CF Photo services and bring it up to the current state-of-the-art.

d. 35 mm cameras being procured for national inventory must be capable of satisfactory operation in extreme climatic temperatures. The 35 mm Nikkormat is one type found to be satisfactory.

e. In future operations such as Operation Morning Light, provision should be made to transfer augmentee Photo Technicians to provide dedicated support for the operation.

ANNEX C
Part 2 B

TECHNICAL SUPPORT
BASE MAINTENANCE LAND

PARTICIPATION OF PERSONNEL

1. Thirty-one Base Maintenance Land (BML) personnel were directly involved or contributed significantly to Operation Morning Light. These people contributed directly through regular and overtime work, i.e., beyond 1700 hours and on weekends, NAST activities or employment at Cosmos Lake or in the Base Command Post. It must be pointed out that all personnel of BML did in fact contribute to Operation Morning Light, albeit through their normal day to day taskings.

RESOURCE EXPENDITURE

2. Attached at Appendix 1 is a list of tasks, cost of material and manhours expended in support of the operation from BML at CFB Edmonton.

3. The personnel hired under the FLIP programme enabled Base Maintenance Land to cope the additional heavy workload generated by support to the operation and at the same time continued to provide normal day to day services to CFB Edmonton, lodger units and to the Militia.

COSMOS LAKE
MAINTENANCE TECHNICIANS

4. The maintenance duties were shared between two Sergeants and four Privates on a rotational basis, with a Senior NCO and a Private on the ground at the same time. On one occasion, a member of the NAST team at Cosmos Lake was a Vehicle Technician 411 and when he was not busy with NAST duties he was employed on maintenance activities.

MAINTENANCE FACILITIES

6. The tools available to the technicians were adequate for all the maintenance tasks they performed. During the initial period 6 to 23 Feb 78, a proper maintenance shelter was not available however, and a set-up using a table at one end of a sleeping tent utilized. Once a maintenance shelter was erected, working conditions became much more favourable.

7. The following variety of equipment was maintained by the technicians:

D4 Dozers	Snowblower
TD8 Dozers	Flex-trac
Skidoos	1 ½ ton vehicle
Generators	Bobcats and Bambi
Water and fuel transfer pumps	Herman Nelson Heaters

8. Approximately 90% of the technician's time [was] spent keeping the Herman Nelson heaters running. They were vital equipment and were constantly in need of repair. A good percentage of the daily maintenance on the heavy equipment, i.e., D4s and TD8s was done by the operators themselves.

LOGISTICS - SPARE PARTS

9. During the first two weeks of Cosmos Lake, some difficulties were encountered with the ordering of spare parts in that some orders were duplicated while on occasion others were never passed to the Command Post at CFB Edmonton. It wasn't until the Supply Technician was established at Cosmos Lake that the problem was for the most part overcome.

10. Labelling of spare parts shipped into Cosmos Lake was also a problem. On numerous occasions parts arrived in boxes simply labelled "Cosmos Lake" (probably only to keep it out of Yellowknife) with no identification as to who ordered the parts or what equipment it was for.

COMMAND POST
ORGANIZATION

11. The set up of the logistical functions of the Edmonton Command Post into separate Administration, Supply and Transport desks worked well.

ACTIONING OF REQUESTS

12. The majority of requests from Yellowknife and Cosmos Lake for spares/supply items or maintenance assistance were passed to the Command Post via telephone. On occasion however requests were brought back by crew members of returning aircraft and were passed direct to the appropriate agency/unit/sub-section for action, by-passing the Command Post when the Command Post was queried on the status of certain requests, little assistance could be provided as there was no record of the having been received and invariably the originator had been rotated back to

Edmonton. The end result was that valuable time was wasted while the request/demand was re-submitted. Use of a standard format would reduce problems of this type but more importantly it should be emphasized that all demands/requests must be coordinated through the Command Post regardless of the method of submission.

NAST

13. Land provided four personnel (1 x Corporal, 3 x Private) to NAST on a permanent basis. Discussions with the EML NCO i/c indicated that the accommodation and messing was good. The radiac equipment they had to with not adequate and was considered to be obsolete. This problem, however, is the subject of a separate report on problems faced by NAST.

GENERAL

14. From the viewpoint of a "maintainer" doing duty officer shifts in the Command Post, a few words of praise must be directed to the personnel of CMTT, to the MAMS teams, to the Base Transport despatchers and to the duty Supply Technicians. Their dedication and devotion to their respective duties, their professional attitudes and the long hours they put in were very instrumental in ensuring that all requests for support were met as quickly as possible and went a long way in making Operation Morning Light the success it was.

RECOMMENDATIONS

15. It is recommended that Supply Representatives be established with the advance parties at such camps as Camp Garland in future operations to control the logistics activity from the start of operations.

16. It is recommended that in future operations a spare parts order format be used, whether the order is placed by phone, by radio or hand carried. Such a format must include among other pertinent information, a control/demand number, the equipment for which the part is required and the name of the originator.

17. It is recommended that electrically (4520-00-341-8383) rather than gas, operated Herman Nelson heaters be utilized in future cold weather operations where sustained usage is required. The gas-type heater is designed for intermittent use only and constitutes a definite fire and health hazard during refuelling.

APPENDIX 1
To Annex C

To Part 2 B

RESOURCE EXPENDITURES
OPERATION MORNING LIGHT

1. Shown below is a list of jobs, cost of material and manhours expended in support of the operation:

Job	Cost of Material	Manhours	
		Straight	Overtime
Inspect and repair D4 7117402		37.0 MCpl	
Inspect and reparir D4 7117402		12.0 MCpl	
Inspect and repair Snow		39.0 MCpl	
Removal Unit 6405301			
		2.0 VHE-9	
Repair Generator			
		3.0 MCpl	
Repair Yukon Heaters		6.0 VHE-9	
Off loading 3 containers from Aircraft to Truck and from Truck to Bunker		1.0 WO 3.0 Pte	
Load Material from X-Depot to Truck and off-load at Nose Dock		6.5 MCpl 6.5 Pte	
Repair L23			
		3.0 Cpl	
Repair wiring on Snowblower 6405301		3.0 Pte	

Inspect and modify 2 – 22 KVA Diesel Generator Sets		1.5 Cpl	
		2.0 Cpl	
Repair oil cooler, install 1 rim, 2 tires, 2 tubes on Flextrac 7625450			
		8.0 CWO	
Replace power steering hose 7320183		8.0 Sgt 8.0 Mcpl	
Repair and release L23 6569325	$277.07		3.0 VHE-9
Repair starter and carb by Exch 6767786			
Replace Alternator 7624869		1.0 Pte	
Inspect and repair 2 Skidoos 7520613, 7520615, 7520621			1.0 VHE
Assemble and repair 24 fuel bladders	$ 80.47	1.5 VHE -10	
Flying Kitchen	$47.35	1.0 MCpl	
Grapple Hooks		12.0 VHE -9	
Lead Coffin			
		22.0 Sgt 128.0 Pte 15.0 VHE	
Ice Auger		-9	
		11.0 MWO	

		11.0 Sgt	
		11.0Pte	
Jerry Can Modification			
		3.0 GL	
		-5	
1 ½ Ton Water Tank			
		1.0 GL	
Herman Nelson		-3	
Modification		1.0 GL	
		-3	
Lead Lined Barrel			
		4.0 Maj	
		4.0 MWO	
Drip Trays		4.0 GL	
		-3	
		2.0 Pte	
Barrels Waste Burning		3.0 GL	
		-3	
Tow Cables			
		1.5 GL	
		-3	
Lead Cutting		3.0 GL	
		-3	
		3.0 GL	
		-3	
Herman Nelson Mod and			
Prep		5.0 GL	
		-3	
		12.0 Pte	
Bob Sleds			
		17.5 Pte	
		5.5 GL	
		-3	
Tractor Cab		10.0 Pte	
		2.0 Sgt	

Lead Covers		1.0 Pte	
		2.0 GL	
		-3	
Oil Lines from Furnaces			
		3.0 MWO	2.0 GL-3
		2.0 Sgt	2.0 GL-5
		8.0 GL	
		8.0 GL	
		-5	
		12.0 GL	
		-3	
		5.0 Pte	
		51.0 Pte	12.0GL-3
			7.0 GL-5
		14.0 GL	
		-3	
		3.0 Sgt	

ANNEX C
Part 2 C

TECHNICAL SUPPORT
FIRE PROTECTION

BACKGROUND

1. As the result of two major fires at Camp Garland, Cosmos Lake during Operation Morning Light, a special part in this report is devoted to this subject to outline briefly the lessons learned and what could be done to prevent similar fires in future operations.

2. One should recognize from the outset that all Camp Garland facilities were of a temporary construction, working conditions very severe and personnel diverted by sheer survival requirements not able to adhere to safety precautions as rigidly as they would under· normal conditions.

LESSONS LEARNED

3. Investigation into the two fires revealed that:

a. the tents involved were constructed dangerously close to each other (the first modular tents erected were set up in available cleared space constrained by the need to utilize the available bulldozers on runway clearing and ecological concerns);

b. the Herman Nelson heater was the contributing cause of Fire No. 1;

c. inexperienced tradesmen were assigned to re-fuel the Herman Nelson heater;

d. re-enforcement of the briefing given to these tradesmen on the dangers associated with refuelling a Herman Nelson was not conducted;

e. some camp personnel were not familiar with the operation of First Aid Fire·Extinguishers;

f. improper storage of flammable liquids may have been the contributing cause of Fire No. 2; and

g. once a fire has passed the incipient stage, destruction to a tent shelter "is swift and complete.

<u>RECOMMENDATIONS</u>

4. Recommendations for operations are:

a. a trained Fire Fighter (651) be attached to the camp;

b. the Fire Fighter will be responsible to the Commanding Officer for the organization of fire patrols, extinguisher training and enforcement of fire and safety regulations;

c. a minimum distance of 20 meters be maintained between all tents;

d. POL compounds, vehicle repair and aircraft servicing tents be located downwind from the remainder of the camp;

e. a new portable heater be acquired to replace the Herman Nelson heater model No. BT-400;

f. smoking regulations, storage and handling precautions of flammable liquids and electrical/heating maintenance must receive top priority in camp operating instructions; and

g. a proper sounding device to raise a general alarm in case of fire is a necessary piece of equipment.

ANNEX C
Part 2 D

TECHNICAL SUPPORT
TRANSPORTATION

GENERAL

1. As with many of the other sections on the Base, the Transportation Section found it very difficult to continue "normal" Base support operations and handle the problems of the Operation. It was fortunate to have had the FLIP and Air Command augmentation personnel, or the section would have had to dramatically adjust routine Base support. While equipment was rented at relatively short notice, personnel were much harder to come by.

PERSONNEL

2. At the height of the operation, there were 18 other ranks (Master Corporal, Corporal, Private) fully committed to Operation Morning Light. This represented 26 percent of Base established personnel in these ranks. In addition, the Base Transport Officer and later the MSEO and Section Administration Officer were involved for considerable periods of time for Command Post duties. The most heavily hit group on per capita basis was the Traffic sub-section which at the time had the officer, one senior NCO and two other ranks unavailable because of Courses, attached posting and sickness. This represented 44 percent of military strength in that sub-section.

3. The shortage of personnel was relieved when augmentees were finally obtained. The quick work of the Personnel Staff at Air Command Headquarters was appreciated.

EQUIPMENT

4. The operation proved once again the requirement for air portable equipment. With the trend to larger and larger pieces of equipment, we (the Canadian Forces) are in danger of losing our ability to conduct such operations. The equipment still in the system is old and not fully equipped for Arctic operations. The dozers for example could not be fitted with protection from the elements because such is designed to fit on the roll cage and these were too heavy to lift into place on the machines. (Helicopters were available but the wind chill factor in the downwash precluded their use).

5. At the height of the operation, the following were deployed:

a. 1 x Flextrack OSV;
b. 2 x D4 Dozers;
c. 1 x Snowblower;
d. 1 x Bombadier Bombi (Light Tracked OSV);
e. 2 x Bobcats (1 small, 1 large);
f. 5 x light vehicles of various types; and
g. up to 4 LOSVs (Skidoos).

In addition, up to ten U-drive vehicles were in use at one time.

6. The majority of the equipments suffered from breakdowns at one time or another. In particular the Skidoos were a problem as was the Flextrack, one dozer and the small Bobcat. The skidoos and Bobcat were in reality tasked beyond their capabilities and were at times operated by unqualified personnel. This showed in the maintenance problems. The principal problem with the Flextrack and later the Bambi were wheels. These vehicles are really designed for muskeg and generally flat terrain. The terrain they were used on was quite rocky and the rocks inevitably damaged the wheels.

7. Towards the latter part of the Operation a larger Bobcat with Diesel engine was leased locally and flown to Cosmos Lake. This Bobcat was able to handle the larger loads and proved to be much more reliable.

8. It should be explained here that one of the main problems at Cosmos Lake was the lack of a forklift vehicle. The normal hangar line forklift, Hyster, was not suitable as it would not have been able to negotiate the rough terrain. The Terrex Forklift was considered to be too unreliable and complex. Furthermore, there were no qualified drivers available.

9. A search locally found a commercial version of the Bobcat Forklift which is widely used in civilian industry. The Bobcat's front end loader was small enough to fit under the tail of the C130 while its four wheel drive gave it sufficient traction to drive through deep snow.

10. The first Bobcat sent to Cosmos Lake was too small for the loads to be lifted. It soon became unserviceable. A second larger Bobcat with 6, 000 pounds lift capacity was obtained. It completed its service at Cosmos Lake with flying colours.

Cost

11. The total operating cost of DND vehicles was $53,100. The sum of $37,494 was expended on rental equipment, mainly because the Canadian Forces did not possess sufficient quantities, the right type of vehicles or it was more practical to rent locally.

RECOMMENDATIONS

12. It is recommended that the Canadian Forces acquire tracked snow vehicles larger than a snowmobile (Skidoo) and smaller than a Nodwell/ Flextrack. The Bombadier Bombi would be suitable.

13. It is recommended that the Canadian Forces acquire forklift vehicles suitable for relatively rough terrain and snow. The larger diesel Bobcat was found to be entirely suitable. The Terrex is not suitable.

14. Diesel powered vehicles were found to be much more reliable than gasoline engines in the cold temperatures. Furthermore the fuel consumption was much lower with diesel. This is especially important when it is realized that all POL had to be flown in. It is therefore recommended that wherever possible the trend should be towards deployment of diesel vehicles for remote Arctic use.

ANNEX C
Part 2 E

TECHNICAL SUPPORT
BASE CONSTRUCTION ENGINEERING
INTRODUCTION

1. The Base Construction Engineering Section CFB Edmonton was tasked with engineer support to Operation Morning Light on 25 Jan 78. This support was to be in the way of an Engineer Advisor and engineer stores, equipment, material and labour. This report deals with the problems encountered on the operation which are not normal to a Construction Engineering Section.

CRATER COSMOS LAKE

2. On 28 Jan 78 notification was received that two large pieces of metal from the satellite had been discovered in a crater in a river west of the settlement of Baker Lake. A recce party was to be despatched from Baker Lake to obtain information on the following:

a. thickness of ice;

b. depth of water;

b. current velocity;

d. amount of radio-activity;

e. diameter and depth of the crater; and

f. the possibility of other debris in a close proximity.

Due to the lack of stores and equipment, also a method of transporting the recce party in the extreme cold weather, it was ascertained that it would probably be two or three days before the information was obtained. In the meantime, plans were made; stores, material and equipment were located to isolate the crater by the use of a coffer dam.

3. Three days later the recce report came in stating that there were only six inches of water below the ice, and upon removal of the two large pieces of metal there was no radio-activity in the crater. This information negated the requirement for the engineer support to the operation for clean up and damming of the crater site.

ICE AIRFIELD

4. It was decided that a camp was to be built in the proximity of the crater. In order to provide a means of supply to the personnel living in the camp an airfield capable of handling Hercules aircraft was to be constructed.

5. The site for the airfield was located, and the runway was sited. Two D4 dozers were delivered by LAPES to begin removing the two to three feet of wind-packed snow. On 16 Feb 78 the first Hercules landed on the ice airfield on what is now called Cosmos Lake.

6. Needless to say there were many problems in the construction, and later the operation of the airfield. These problems will be the subject of a separate report.

CAMP GARLAND

7. A section of infantry pioneers from 1 Brigade Group was tasked with assisting in setting up a temporary camp under the direction of the on-site commander. It was ascertained that Camp Garland was going to become the centre of the clean-up operation and as such as going to have to be improved. 1 CEU was tasked with studying the feasibility of using trailers at the camp.

8. It was decided that due to the cost, the amount of air transportation necessary and the short time to spring breakup that a modular tented camp with a wash-up trailer would be the best answer.

9. 1 CEU was tasked with the design, procurement and set up of the wash-up trailer. The wash-up trailer was operational on 4 Mar 78.

10. Water. Initially some concern was expressed for the safety of the water supply from Cosmos Lake or the Thelon River. Water samples were checked to confirm that no contamination existed. The advance teams who built the camp used melted snow as a water supply. Once the runway was complete water was flown in in water trailers which were recycled to Edmonton. Finally, once the ablution trailer was functional, water was piped directly from Cosmos Lake and tapped for cooking, drinking and ablution.

11. Garbage. Garbage accumulated quickly and Camp cleanliness was a constant problem. All wet garbage was collected in plastic bags and set aside for freezing. Incinerators were set up and fired using contaminated fuel the final debris remaining was flown out in commercial large steel garbage containers. These were recycled in

Edmonton from Base supplies and emptied through the normal Base contracted disposal system. An abortive attempt was made to shorten the disposal time by flying the full container to Yellowknife, but non standard containers and trucks at Yellowknife thwarted this solution.

12. Sewage. Portable toilets were used at Camp for solid human wastes and urine pits for liquid. Plastic bags from the toilets were allowed to freeze and double bagged separate from other garbage. Once very hot incinerator fires were established, these bags were burned and the fire-cleansed remains flown out in the large garbage containers.

13. Heating. A great number of serious problems were experienced in attempting to heat the modular tents. Initially, Herman Nelsons were used, but personnel were subjected to an excessive amount of carbon monoxide; plus these heaters were baulky and a fire hazard when being refuelled. Coleman space heaters were tried but they were unable to sufficiently raise the temperature. The final solution was to use 125,000 BTU diesel oil-fired furnaces with Herman Nelson tubes suspended from the roof as duct work.

14. Electrical. Initially the power was supplied by a number of portable generators. Upon arrival of the wash-up trailer which had two 50 KW generators, a distribution panel and field lighting kits were installed. This worked very well but required an EGS Technician and an electrician to be in camp at all times.

CAPE DORSET

15. The next major problem was the discovery of what appeared to be a large crater on a small lake approximately 30 miles from Cape Dorset. The discovery was reported on 12 Mar 78. On 13 Mar 78 a Hercules was despatched complete with a Twin Huey and crew. On 14 Mar another Hercules with stores, equipment and a recce party was despatched. The recce party consisted of an On-site Commander, two Military Engineers, American and Canadian scientists.

16. The Twin Huey had to be re-assembled in Frobisher Bay where hangar facilities were available. Due to bad weather conditions, it did not arrive in Cape Dorset until 1500 hours on 15 Mar 78. The actual operation started on 16 Mar, and was completed on 21 Mar 78.

17. The following is a list of activities that took place from 16 Mar to 19 Mar 78:

a. a survival tent and emergency supplies were moved to the site in case of personnel being stranded due to bad weather;

b. two to three feet of snow was removed from the suspected crater area (approximately 150 m x 200 m) ;

c. a grid was laid out and holes were augered through the six feet of lake ice;

d. the area was gridded with survey lines at 10 m intervals to check the variation in ice level; and

e. the complete area was tested for radioactivity as well as the ice shavings from each hole, and the water beneath the ice.

18. It became quite apparent as a result of the above task that it had been some type of natural phenomenon. In order to ensure this was a correct assumption, and to try to explain it, the following additional personnel were brought in to Cape Dorset:

a. an ice expert from National Research Council Canada;

b. a metal detector expert from R.M. Hardy and Associates; and

c. a team of naval divers with underwater cameras (this team and their equipment were never used) .

19. The following is a list of the tasks that were carried out by the above personnel in conjunction with the initial recce party:

a. a visual recce of the surrounding area both by air and foot was carried out to determine the difference in elevation of surrounding lakes and creeks;

b. ice cores were taken of the blocks and lake ice in the immediate area and of undisturbed areas; and

c. the area was again gridded and magnetically surveyed to locate any possible metal debris:

20. It was concluded as a result of all the tests, surveys and studies that what had appeared to be a crater was a result of the following:

a. an underground stream which had caused an ice heave on the shoreline approximately 100 feet long and five feet high and approximately 15 feet across at the base; and

b. the eruption of the ice heave scattered blocks of ice out onto the lake ice, probably caused by the water pressure from below, and the extreme cold temperatures.

SUMMARY

21. In summation, it should be noted that this section of the report has not included the total administrative and logistical support that was required to make all the tasks successful. In addition to those tasks outlined in the preceding paragraphs, the normal support, i.e., the arranging of contracts, procurement of stores, construction of all types of temporary buildings, platforms, boxes, etc. was carried out. These points may appear insignificant and probably would be, except that CFB Edmonton Base Construction Engineering Section received no augmentation, and was still expected to, and did carry out its normal role. This was only possible because of the high degree of professionalism and dedication to duty displayed by not only the military personnel but also the civilians.

RECOMMENDATIONS

22. From the lessons derived in establishing the ice runway at Cosmos Lake, Canadian Forces data documentation is recommended to be updated and revised to preclude some of the uncertainty encountered in Operation Morning Light.

23. It is recommended that more efficient heat retaining shelters be obtained by the Canadian Forces for Northern Canada deployment.

24. Large modular tents are not recommended for Arctic Operations as they are too difficult to heat. Small tents should be considered.

25. Portable and sufficiently powerful (5OKW) diesel electrical generators are recommended to be made available for Arctic deployment. The provision of 115 volts 60HZ power is considered essential to any temporarily established Arctic camp.

ANNEX C
Part 3 A

ADMINISTRATIVE SUPPORT
PERSONNEL ADMINISTRATION

INTRODUCTION

1. With the dawning of "Operation Morning Light", Jan 78, the Personnel Administration section, including Base Security and Base Accommodation Centre, at CFB Edmonton were tasked to provide manning at the command post, on/off base accommodation arrangements and security. Initially, the attitude of most personnel in the section was lackadaisical but once the scope of the operation unfolded, a quick and professional response became evident.

2. At the outset, much confusion and a lack of communication between sections appeared to be the rule. Consequently, much wasted time and effort resulted. Needless to say, several of the problems experienced were unavoidable. However, these problems were soon overcome and conquered solely due to the concentrated effort and flexibility of personnel involved.

3. The aim of this report is to discuss the effects/problems created by Operation Morning Light on the Personnel Administration section while also providing suggestions/recommendations for their resolution prior to future operations of this magnitude.

PERSONNEL ADMINISTRATION

4. Primarily, the role of the Personnel Administration section in support of Operation Morning Light was augmentation/ manning orientated. At some point during the operation every individual in the Section became actively involved either by filling a Command Post position, employment with NAST or as augmentation staff.

5. The following is a breakdown of the Personnel Administration Section's associated duties and manpower contribution to Operation Morning Light:

a. Command Post Administration Clerk - 882 man hours averaging 11 man hours per day throughout the operation. The greatest expenditure of man hours occurred during the early stages carrying over until the first week of March. The bulk of the workload provided included typing messages, claims, nominal rolls, etc., for staff officers at the Command Post.

b. Command Post Administration Officer – Approximately 680 man hours averaging nine man hours per day throughout the operation. The bulk of man hours were utilized during early stages carrying over until late March The tasks and problems encountered by this position will be discussed in a later paragraph.

c. NAST - two clerks for Radiation monitoring duties at Yellowknife, Cosmos Lake and Command Post throughout the operation.

a. Augmentation Cosmos Lake - one clerk 3 Mar to 16 Mar 78-orderly room duties.

6. Relatively few problems, if any, were encountered by the Command Post Administrative Clerk and the Clerk dispatched to Cosmos Lake for augmentation.

7. More than 1200 military personnel were directly involved with the operation, of which approximately 275 came from outside Base resources. At some point during the operation the greater portion of these personnel came in contact with Command Post Administration Officer·, for transportation arrangements, travel advances and claims, arranging accommodation and briefing prior airlifts to Yellowknife.

8. The frequent and continuous change of personnel, incomplete briefings on shift hand-over and the fact that many of the personnel filling the Command Post Administrative position were lacking good knowledge of administrative procedures resulted in many hours of research in locating personnel, delays in rotation and making alternate transportation/accommodation arrangements. At first this problem was very pronounced but as the operation progressed incidents of this nature greatly decreased. One result of the inconsistent approach to the personnel record keeping is the error rate in lists of Operation participants (this may run as high as three percent).

9. As previously mentioned, the Personnel Administration sections main contribution to the Operation was manning. This factor left a minimal staff to handle the day to day functions of base support. This challenge was met due in a large part to the assistance from the FLIP program, and by the dedication of the personnel in the Section.

BASE SECURITY

10. On commencement of the Operation, 16 military police personnel were placed on immediate recall status and issued arctic gear should requirement exist to deploy to the operational sites. This status remained in effect throughout the operation.

11. Although minimal operational support was required from Military Police resources during the ·Operation, the main contribution being access control, many man hours were utilized to fulfill this function. A total of 818 man hours were logged on Command Post access control. Personnel employed in this duty were detailed from normal on-duty shifts.

12. The "Security Operation Desk" in the Command Post was manned commencing at 0800 hours, 24 Jan 78. From 25 Jan 78 to the operation's conclusion, security and police activity was controlled from Hilitary Police Headquarters in Griesbach. This was appropriate in view of the minimal operational support required from Military Police resources.

13. Throughout the Operation, on-duty Military Police personnel were frequently requested to assist in controlling members of the press, transporting personnel and periodically required to locate individuals for the Command Post staff. From a security point of view, media personnel control was a definite area of concern.

14. During the first several days, members of the press had virtually total freedom of movement once access had been gained to the Base. This created a particular problem in the hangar line area. On numerous occasions, military police were required to escort press personnel from the ramp area.

BASE ACCOMMODATION CENTRE

15. The Base Accommodation Centre was alerted 24 Jan 78 and instructed to obtain accommodation for up to 250 Americans (military/civilians) who were expected to arrive within hours. The military staff of the office was put on standby duty and contact maintained with Command Post regarding number at ETA of personnel arriving. Immediate preparation instituted- to either accommodate these personnel on Base or at hotels/motels in Edmonton area.

16. For the remainder of the operation 15 rooms in the officers' quarters and 16 beds in the other ranks' quarters were reserved for personnel from outside Base in

support of the operation. Approximately 1200 personnel were quartered and no significant problems arose. Daily contact was maintained with the Command Post Administration Officer to establish accommodation requirements.

RECOMMENDATIONS

17. No problems of a significant nature were noted although, several minor areas of concern were highlighted and should be rectified. The following recommendations are provided to assist in the planning of future similar operations:

a) a set of SOP's be developed for the Command Post Administration Officer position to ensure proper maintenance of logs, records, nominal rolls, etc;

b) definite terms of reference be formulated for each branch/section involved at Command Post;

c) multi-line telephones be installed at the Command Post; and

d) designate the hangar line as a restricted area and control access to the area at the gatehouse on Central avenue. Through this, the press could congregate at a designated location outside the restricted area and be allowed access only under escort of RIO personnel.

CONCLUSION

18. Operation Morning Light presented a unique opportunity for the Personnel Administration section to pull together as a team. Regardless of the problems encountered or the situation experienced, all were met and overcome. The Operation proved a valuable learning experience for all concerned and the Section is proud of the contribution that its staff made to bring about the success of the Operation.

ANNEX C
Part 3 B

ADMINISTRATIVE SUPPORT FOOD SERVICES OPERATION

INTRODUCTION

1. On the 24 Jan 78 Base Foods received notification of a disaster in the north resulting from the landing of a Russian satellite. We were to activate the disaster response plans and prepare to provide feeding facilities in the north.

2. We approached the only Squadron (450) holding field equipment in accordance with the Operations plan and discovered that their field kitchen was unserviceable. In order to provide some equipment, a cook along with Base Maintenance Land personnel worked all night to restore serviceability to some key pieces of equipment.

3. At the same time the main Combined Mess kitchen was placed on 24 hours service and personnel worked late into the night to put up the rations as requested by the Command Post (Command Post).

4. Food Service responded quickly to this challenge and were ready to go north within 24 hours of notification. This however was premature as the standby cooks waited for two days and we ended up having to make up a new ration order as no one picked up the original order and portions were spoiled.

5. The first few days of the Operation were very mixed up with many personnel requesting all sorts of food and equipment from Base Foods. This was often either not used, misused or lost. Many sections ordered directly as was their normal practice rather than to through the Command Post which produced conflicting orders.

6. Eventually a detachment was set up at Cosmos Lake and Base Foods personnel with the aid of personnel and equipment from both 450 Squadron and 408 Squadron established a reasonable operation. Four cooks were rotated up north at regular intervals of ten days duration. Rations were sent up twice weekly based on orders placed by the senior cook on location at the time. One cook and supplementary fresh rations were sent to Baker Lake to augment the lone hotel cook while the Canadian Forces detachment was present.

7. Things were operating very smoothly with feeding at Cosmos Lake until the

fire on the 7 Mar 78 The food service staff was notified that the entire kitchen complex had burnt down. Within hours food was prepared and flown up to feed personnel on location and fresh rations were made up to replace lost food.

8. Replacement of equipment was a major problem. 408 Squadron's kitchen truck was lost in the fire and all equipment destroyed. 450 Squadron's field kitchen was still unserviceable so we had to look to other field units for the loan of field equipment as this Base as such has no holdings. A less capable field kitchen was provided by CFB Calgary but the cooks made do with it and had resumed regular feeding within a few days.

9. Withdrawal from Cosmos Lake was done smoothly.

10. The base kitchens, especially the Combined Mess, provided· excellent support during this period to the Command Post and to rear party personnel. The base fed approximately 125 extra personnel a day plus fifty meals to the Command Post. During peak periods this kitchen was operating 24 hours and until Mar provided a night meal until 0100 hours. This kitchen supplied all food for Cosmos Lake plus the dispatch of about 80 meals three times a day to personnel being fed at their workplace.

RATION CONTROL

11. Ration control proved to be a major concern and problem area to the Base Foods section. Rations of food are accountable items and are drawn in accordance with an entitlement. Names are required of all personnel consuming rations.

12. At first, there was a problem, of obtaining accurate nominal rolls of personnel requiring food. In many cases we provided food to personnel not entitled and did not receive replacement ration issue for them. Early on Command Post personnel were over zealous in ordering meals to sustain the Operation.

13. Owing to confusion in the ordering and transportation of food or rations some food was lost because of mishandling.

FOOD COSTS

14. A rough estimate of food costs for the operation is $52,393.00. This cost included ration costs for rear party personnel and Command Post, northern detachments and flight feeding costs.

PERSONNEL

15. All Base Foods personnel were involved in supporting this operation although some were more directly involved than others. Seventeen cooks were involved in the northern rotation to support operations there. Personnel working in the Combined Mess Lancaster Park were required to operate for extended hours. The extra workload resulted in increased overtime for civilians. Overtime costs were $671.26 for 107½ hours of overtime for the duration of the operation. Military personnel worked all night long at times and often worked 10 to 14 hour shifts when required.

16. Base Food service staff all worked hard and long hours during the operation and are to be commended for their concern that everyone be fed despite many difficulties.

<u>SUPPLY</u>

17. No difficulty was encountered in increasing food demands from local suppliers. There were however communication problems encountered with the Command Post in ordering food and non-food items. Anything remotely connected with eating was ordered through Base Foods rather than Supply. Making Base Foods the middle-man only delayed delivery.

<u>EQUIPMENT</u>

18. The procurement of field equipment was a very real problem. This Base does not hold any field cooking equipment and all contingency plans call for the use of equipment belonging to either 408 or 450 Squadrons. However when the Operation began neither squadron's had equipment available. 408 Squadron's equipment was eventually dispatched upon its return from exercise, but its loss by fire caused further problems.

19. The job was handled well despite equipment shortages due to the skill of a few of the Squadron and Base cooks. This however does not take away from the very real need for field cooking equipment to be held by the Base Foods Section in reserve for this type of contingency.

20. Generally, Food Services responded well to this operation. All personnel involved were well fed and despite all of the apparent early confusion, the Base ration issue ended up less than its entitlement for the period.

<u>RECOMMENDATIONS</u>

21. As a result of this operation we have two recommendations to make for future operations of this sort:

a. that Base Foods be given authority to hold field cooking equipment in order to meet operational demands and contingencies placed on this base;

b. that in future operations either the Base Foods Officer or the Deputy Base Foods Officer be given the task of coordinating all feeding requirements from the Command Post.

ANNEX C
Part 3 C

ADMINISTRATIVE SUPPORT
MEDICAL SERVICES

INTRODUCTION

1. The dawning of "Operation Morning Light" in Jan 78 introduced some new and interesting medical support challenges to the medical personnel at CFB Edmonton. These challenges proved frustrating at times due to the lack of accurate information but all requests for assistance were met.

2. The aim of this report is to discuss the types of support provided, make note of any problem areas and also provide recommendations/ suggestions for their resolution prior to involvement in a similar future operation.

MEDICAL SERVICES

3. The initial medical support for this operation was provided by a Medical Assistant who was part of the Pioneer Platoon supplied by 1 CBG, Calgary. He was replaced by the medical assistant from 408 Squadron which was tasked to operate the Base Camp at Cosmos Lake after it was established. He was replaced by a Medical Assistant from the Base Hospital from 6 to 23 Mar 78 inclusive.

4. Medical support was also provided to a limited extent by the Medical Assistant at NRHQ and a Medical Assistant with 1 CEU.

5. Medical support and advice in respect to the nuclear safety medical aspects of this Operation were provided by Dr. Cavender, an American nuclear medicine specialist. He assisted in the evacuation and assessment of Mr. John Mordhorst and Mr. Michael Mobley who were brought to the W.W. Cross Cancer Institute in Edmonton, Alberta, on 29 Jan 78 following possible exposure to radiation from satellite debris.

6. The Medical Assistant from NRHQ assisted in the evacuation of two personnel from Cosmos Lake to Yellowknife suspected of having food poisoning following consumption of quarantined IRPs.

7. A medical officer from CFB Edmonton was sent to Cosmos Lake on 26 Feb 78 to conduct a hygiene inspection of the Camp following reports of high carbon monoxide levles in the sleeping quarters. The Medical Officer did a complete

investigation of all areas and found things generally in good order. CO levels were monitored and no further problems encountered.

8. At 0530 hours 7 Mar 78 the Base Hospital was called to provide a medical response team to treat possible casualties following a major fire at Cosmos Lake. Two doctors, one nurse and five medical assistants were dispatched by aircraft to provide medical support. Fortunately nobody was injured in the fire and the team returned to Edmonton that afternoon.

9. Throughout Operation Morning Light the Base Hospital provided medical re-supply to the medical Assistant at Cosmos Lake. Items supplied included large quantities of cough and cold remedies, water purification tablets, throat lozenges, antihistamines, etc. No major re-supply problems were encountered.

10. Personnel from BNBCO, AECB and the Base Hospital worked together in monitoring and controlling radiation dosage exposure levels.

11. The Base Hospital also provided other support to Operation Morning Light including:

a. provision and repair of glasses, as required;

b. liaison with the Alberta Provincial Laboratory regarding analysis of raw water samples; and

c. flight surgeon advice when requested.

PROBLEMS ENCOUNTERED

12.

a. Lack of proper medical plan - the Base Surgeon was not asked for any input into the planning for this Operation. Many problems encountered during the Operation could have been averted had an adequate medical plan been formulated.

b. Lack of familiarity with Operations in the North - medical problems such as frostbite, disorientation, burns, etc. were minimized through survival briefings for all civilian personnel at CFB Edmonton as they departed for the North. These were given by the Survival School staff. Upon arrival at Cosmos Lake further briefings were provided on sanitation and personal hygiene by the Camp staff. Medical personnel were not directly involved except for the Medical Assistants at Camp Garland.

c. Inadequacy of spectacles - issue frames for prescription glasses break easily in cold weather. Metal frames tend to adhere to skin surfaces in extreme cold weather.

d. Difficulty in measuring radiation dosage exposure – although some minor problems were encountered initially due to the lack of film badges this problem was soon corrected and proved satisfactory in the end.

RECOMMENDATIONS

13.

a. The initial planning for any type of operation should include medical input to ensure the most effective use of available medical resources.

b. Personnel participating in any type of operation of this nature should continue to be given a briefing on the medical aspects of the operation, i.e. personal hygiene, effects of heat and cold, etc.

c. Investigation should be undertaken regarding the supply and use of proper eyeglasses and eye protection in the North (this can be coordinated by Base Surgeon if required).

d. The value of the DT60 as a low dosage radiation detection device should be investigated. It's value is suspect. Film badges are by far the best detection method.

PART III – CONCLUSION

14. The types of problems encountered by the Base Hospital staff during Operation Morning Light proved to be a valuable learning experience for all concerned. Certain procedures will be adjusted internally to ensure effective and efficient medical support for future operations of this type.

ANNEX C
Part 4 A

FINANCIAL SUPPORT
BASE COMPTROLLER BRANCH
PUBLIC FUND ACCOUNTING

GENERAL

1. The main areas of support for Operation Morning Light included:

   a. Financial Management (coding and reporting costs);

   b. Finances and Accounting (advances, invoices and claims); and

   c. Non-Public Fund Accounting (NPF purchases and canteen).

FINANCIAL MANAGEMENT

2. CFB Edmonton was tasked to abide by the reporting requirements of DNDP55 Chapter 11 (Provision of Services to Non-Public Agencies) and CFAO 231-1. This tasking included the reporting of all Air Command units involved in any way with the operation. Other Commands were to report their involvement to Air Command Headquarters who were to submit a consolidated report to NDHQ.

3. Following is a summary of sequential events dealing with direction received on the reporting system to be implemented:

   a. 24 Jan 78 - In the beginning all costs were to be accounted for through the Financial Information System (FIS) using the FIS coding per Air Command message OPS 022 242032Z Jan 78. Costs incurred in direct support of Operation Morning Light were to be coded (or journalized) to 0054AV 155F075 Fl304 and applicable sub-allotment and resource codes.

   b. 2 Feb 78 – NDHQ DFINS 370 022145Z Feb 78 issued instructions whereby a report of resource allocation in support of Operation Morning Light was to “be submitted in the format outlined in DNDP55, Chapter 11, Annex B. This report was to be forwarded within 30 days of completion o: the operation. It was pointed out that direct expenditures should be recorded through the Financial Information System. All direct expenditures would be costed by the Directorate of Costing Services at NDHQ.

c. 6 Feb 78 - Air Command FIN 4058 061710Z Feb 78 restated the requirements of NDHQ DFINS 370 and directed that all costs coded per Air Command OPS 22 be reported be resource codes within one week of cessation of the operation. All Air Command units were to report direct costs through their base/station comptroller to the Base Comptroller, CFB Edmonton. Base Comptroller, Edmonton was to send a consolidated report to Air Command Headquarters.

d. 10 Feb 78 - Air Command FIN 4069 101400Z Feb 78 stated a new costing requirement. Base Comptroller, Edmonton was to forward to Air Command Headquarters a report of all Air Command costs for the period 24 Jan 78 to 15 Feb 78 using the DNDP55 (provisional) form. Subsequent cost reports were to be forwarded· in the same manner for each 30 days.

<u>NOTE</u>: It became quite evident at this point that the Financial Information System was unable to provide the Operation Morning Light costing information in a timely and detailed manner. Difficulty was also being experienced in determining the regular force manday usage from infrequent and incomplete operation nominal rolls. Contacts were established in each base squadron/ unit section involved with the operation to provide the necessary reporting information. In order to comply with the requirements of Serial 10 of the DXDPSS report, an attachment for the Squadron Commander's Report was devised to record all Operation Morning Light flying activity in a summary format:

e. 7 Mar 78 - Air Command FIN 409 7 071400Z Mar 78 added a new reporting requirement. Base Comptroller, CFB Edmonton was to report weekly by message showing cumulative manday totals to 2400 hours of each Wednesday for Air Command regular force and civilian personnel involved in Operation Morning Light.

f. 26 Apr 78 - Air Command FIN 4163 261710Z Apr 78 informed that Operation Morning Light was terminated as of 20 Apr 78 and that photostat copies of <u>all</u> documentation supporting costs reported in support of Operation Morning Light were required by NDHQ. CFB Edmonton was to report to Air Command Headquarters the final total of Air Command supporting costs by 4 Mar 78. Supporting photostat copies of documentation were to be at Air Command Headquarters by 24 May 78. In addition, CFB Edmonton was to report the total expenditure charged against Air Command Headquarters FE by resource code by 4 May 78.

4. While Operation Morning Light's task of locating, identifying and recovering Cosmos 954 moved rapidly and successfully through the period 24 Jan 78 to 20 Apr 78, the Financial Information reporting of Operation Morning Light lurched on with ever changing formats and time frames. The requirement to have photostated documentation support for the total Air Command involvement presented communication difficulties. The time frame was short and the documentation requirements were immense.

5. A summary of the report submitted to Air Command Headquarters on 24 May 78 is attached as Appendix 1. As had been requested, this report is annotated "final report"; however, it was observed that many Serials were not finalized. It was not possible to complete the required data by the target dates given. As a matter of fact, it will be some time yet before final data is available. Serials such as for temporary duty, material consumed, write-offs, and fire losses are under continuing update and follow-up investigation. Other interim reports were submitted by message format as directed.

<u>NOTE</u>: The request to provide photostated documentation to Air Command Headquarters by 24 May 78 was met by rush production. Because of such priority, accurate checking and audit of all documentation could not be accomplished. Although the NDHQ initial target date had been extended to satisfy a reporting delay by other commands, this Base had not been made aware of such extension and consequently, the additional time allowed could not be used for our report.

<u>FINANCES AND ACCOUNTING</u>

6. The areas of weakness that were observed during the operation are categorized under the subject heading:

a. Pay. The time frame for dispatching personnel from the Base to duty locations precluded them from making arrangements for their normal pay particularly if they did not have their pay deposited to their bank account. A finance clerk was sent on two occasions to pay personnel at sites without any knowledge of who he would be paying or if he would cause an overpayment to be made to the individuals.

b. Allowances. A site (Cosmos Lake) was designated as a Field Operation location thereby creating an entitlement for personnel to draw Field Operations Allowance in lieu of incidental expenses for the period on duty at that location. The administrative task of originating paperwork for the field operations allowance entitlement was eventually coordinated by the Base Operations Office Orderly Room. The coordination was essential to prevent duplication and to ensure that only personnel entitled to the allowance received it.

c. Claims. The initial dispatch of some personnel to the operations sites was covered by a bulk claim to cover travel expenses. The use of bulk claim does eliminate paperwork but creates a multitude of problems when personnel depart for other locations or new personnel are added at different dates. The concept of a bulk claim is that all personnel tasked would be travelling at the same time and would return together. When it was realized that the operation was continuing and that there was a constant turnover of personnel, advice was tendered to cease using the bulk claim and revert to individual claims. The turnover personnel caused confusion in preparing the claim and submitting it for settlement particularly since the holder of the claim was actively involved in the operation and did not have time available to clear it.

d. Advances on Claims. Many problems arose in allocating funds for travel expense purposes. The problems included over-advancing funds, processing advances back to accounts and advance forms failing to show where member was from.

e. Hotel Bills. Some advances were made against claims to personnel on the understanding that they would in fact have to pay for their own hotel bill in cash and claim for them. As it turned out NRHQ started paying for some hotel bills and the hotel at Baker Lake was asked to submit the bill direct to the Base. The confusion caused over-advances on some claims and caused concern of duplicating payment to the hotels. Payment of the hotel bills was eventually resolved by the Base paying some, NRHQ paying some, and individuals paying for some and claiming for them.

f. Sundry Expenditures. Expenditures were made to purchase minor items which were needed. The method used was expedient in that the necessities were obtained but it was difficult to determine what items were bought. In some cases, the retail source could not provide a listing of goods purchased.

g. Purchases. Several emergency purchases were made without proper follow-up to authorize the purchase. Although emergency situations arise that necessitate circumventing the normal purchasing procedures follow up action should be taken to obtain proper approval.

NON-PUBLIC FUND ACCOUNTING

7. In order to record and account for purchases made through NPF facilities, an Accounts Receivable was set up and all NPF transactions were maintained in this account.

8. Although no major problems were encountered, the clearing of the account will require decision by Base Fund in respect of the extent of NPF base support. It also requires extensive reconciliation to determine the financial responsibility of the parties involved. To this end, a report from NPFAO is attached. Appendix 2 provides a brief summary of NPF transactions.

9. Insurance claims are being processed as a result of the fire which occurred at Cosmos Lake.

REMARKS

10. At the beginning of an operation, it may be difficult to appreciate the need for a strong administrative and financial input. However; in view of some of the problems that arose during this operation, an over reaction may be preferable to under reaction. The time spent by the concerned staff after the operation could have been more than offset by greater input at the start of the operation.

11. A need exists for greater communication concerning areas of:

a. other governments involvement and financial responsibility;

b. other Federal departments involvement and their financial responsibility;

c. personnel involvement from other bases and units; and

d. NRHQ involvement and the extent of their obligation when an operation takes place in the North.

12. While the operation itself was a success, it is considered that in future such events should include a greater degree of on site administrative and financial support. The extent of such direct support would, of course, depend on the size of the operation.

13. Other areas of concern, from a Base Comptroller Branch point of view, include the following:

a. availability of accurate daily nominal rolls of personnel involved – for purposes of reporting and verification;

b. usefulness of bulk claim usage versus individual claims;

c. awareness of members on cash handling procedures;

d. requirement to seek approval from higher authorities for certain expenditures not otherwise provided for but necessary for the operation.

<u>RECOMMENDATIONS</u>

14. Based on the experience gained in this operation and subject to consideration of the size and purpose of an operation, it is recommended that:

a. reporting and recording procedures be amplified by NDHQ to provide specific direction as to timings and requirements for this type of operation where multi-organizations are involved;

b. on site representation from Base Comptroller staff be provided when, in the opinion of the Operations Staff, such manning is operationally warranted and desirable;

c. a financial package be prepared (by Base Comptroller) which would contain brief instructions on handling a cash imprest account for daily fund emergency use;

d. the Commander of an operation be empowered to authorize all expenditures necessary for the conduct of the operation; and

e. internal procedures be developed to provide a step-by-step list of events or action contemplated in an operation where several units/ sections of the Base are involved.

APPENDIX 1
To Annex C
Part 4 A

SUMMARY OF DND PUBLIC FUNDS EXPENSES FOR SERVICES PROVIDED TO OPERATION MORNING LIGHT

Air Command Units 24 Jan - 20 Apr 78

	Cost
Regular Force Personnel	$640,000.00
Rations and Quarters	44,000.00
Individual Temporary Duty Expenses	341,166.00
Civilian Personnel (DND)	9,000.00
Charges paid to non-DND agencies	952.00
Aircraft costs	
- aircrew	351,000.00
- aircraft	4,577,998. 00
Material consumed, lost, destroyed	416,569.00
CF Vehicles	67,000.00
Hangar Rental Fees - Yellowknife	20,303.00
Other items - MSE Rental, Equipment rental etc.	109,870.00
TOTAL	6,577,858.00

NOTE: Detailed lists of expenditures and nominal rolls of personnel are retained at CFB Edmonton and in Operation archives.

ANNEX C
Part 4 B

FINANCIAL SUPPORT
NON-PUBLIC FUND ACCOUNTING

ACCOUNTS RECEIVABLE – OPERATION MORNING LIGHT

1. During Operation Morning Light, a number of Non-Public Funds items were purchased for personnel serving at Cosmos Lake. Some of these items were for resale through the canteen operated by 408 Squadron and other items were provided for the general wellbeing of the troops. All items were paid for through Base Fund, and held as Accounts Receivable in account number 1197-110.

2. The total purchases actioned through account 1197-110 was $13,646.89 and the total revenue deposited to that account was $7,984.43. In addition merchandise valued at $1,264.37 was returned and credited to the account. The outstanding balance as of 29 May 78 was $4,398.09. A complete list of revenue and expenses plus transactions is on record at CFB Edmonton. Appendix 1 provides a statement of NPF accounts.

3. Of the items which remain outstanding, pop valued at $218.40 and sunglasses valued at $12.22 will be paid through Base Supply by Local Purchase Order. This reduces the amount outstanding to $4,167.47.

4. As a result of the fire which occurred on 07 Mar 78, an insurance claim has been prepared in the amount of $3,755.75 less $500.00 deductible for a net claim of $3,755.75 less $500.00 deductible for a net claim of $3,255.75 which reduces the outstanding to $796.53.

6. Included in the outstanding accounts receivable is $471.25 for films and film delivery. A decision should be made as to who will pay the cost of these films. Once this decision is made, the outstanding balance will be $325.28 which should either be recovered from 408 Squadron, who operated the canteen, or written off by Base Fund.

7. In addition to the Accounts Receivable outstanding in Base Fund, films valued at approximately $5,000.00 were destroyed in the fire and appropriate action has been taken to have the Canadian Forces Movie Guild settle directly with Bellevue Films.

APPENDIX 1
To Annex C
Part 4 B

OPERATION MORNING LIGHT
STATEMENT OF REVENUE/ EXPENSE
AS AT 26 MAY 78

DESCRIPTION	Revenue	Expense	Balance
Beer and Liquor		$8,306.51	
Tobacco		1,647.64	
Films		4 71.25	
Sundries		213.10	
Sony AM/PM Receiver		115.19	
Sun Glasses		12.22	
Newspapers		47.40	
Stamps		12.00	
Soft Drinks		2,298.00	
Chocolate Bars		340.20	
Plastic Cups		20.87	
Puzzles and Games		82.53	
Matches		27.60	
Peanuts		52.38	
Cash Receipts	$7,984.43		
Returned Items	1,264.37		
TOTAL	$9,248.80	$13,646.89	$4,398.09

ANNEX C
Part 4 C

FINANCIAL SUPPORT
SUPPLY COSTING

1. This Operation proved highly consumptive of supply items, particularly those items supportive of arctic operations. The wide ranging operation coupled with a high turn over of personnel meant that much equipment was on loan. The compressed time allowed little opportunity for normal inventory control measures. Arctic survival circumstances usually require large amounts of equipment and the gear is frequently consumed. Two fires proved costly in the amount of equipment destroyed and also suffered the destruction of clothing loan records. Some clothing items were contaminated by radioactive material and were shipped to Pinawa, Manitoba for disposal without any listing as to the specific items.

2. The final supply costs are subject to some modification by board of inquiry results. The cost figures as of this date are:

a. Account AA0127	$ 2,230.55
b. Clothing	10,436.20
c. Account 3F0127	27,046.68
d. Fire No. 1	143,042.82
e. Fire No. 2	23,948.87
f. Account AC1568 (Yellowknife)	1,594.33
g. Direct and Indirect Lists (LPO and DPO etc)	256,033.61
h. Account 3G0127 (Cape Dorset)	1,799.92
Total	$466,132.98

3. Investigative boards of inquiry were completed at CFB Edmonton in December 1978. Many of the above figures will face a revision. These cost data are being accumulated at Air Command and NDHQ, therefore the above figures are to be regarded as informative only.

ANNEX C
Part 5 A

COMMUNICATIONS SUPPORT
GENERAL REVIEW

GENERAL

1. Communications Support for Operation Morning Light was supplied by a variety of agencies, namely:

a. Air Transport Group - Air Transport Command Communication Team (ATCCT), Trenton;

b. 742 Communications Squadron, Edmonton; and

c. CFB Edmonton Base Telecommunications Section.

ATCCT

2. As the Operation unfolded in the first few days the ATCCT from Trenton were dispatched to Edmonton, Yellowknife and Baker Lake with High Frequency Single Side Band (HF SSB) equipment. The ATCCT consisted of personnel and equipment configured for Northern deployment. This included tents, and Auxiliary Power Units (APUs). Later, the HF SSB ground station at Baker Lake was transferred to Cosmos Lake to provide the initial Camp Garland long range communications.

3. Problems. Operation Morning Light proved again that HF communications in Northern Canada were very unreliable in that they were susceptible to atmospheric conditions. This problem was highlighted at Cosmos Lake when reliable contact could only be maintained for less than twenty percent of the total time. Often the adverse conditions prevailed for many days thus curtailing the vital communications link. This problem was also experienced at Yellowknife and Baker Lake. Another problem encountered with the HF SSB was that Military Aeronautical Communications System (MACS) frequencies were utilized. By using the Edmonton MACS a base station was thus available. However, this arrangement was in competition with other MACS commitments. The MACS operators complained that their frequencies were being monopolized by Operation Morning Light transmissions.

742 COMMUNICATION SQUADRON

4. As it became apparent that the ATCCT HF SSB was not adequate for the Cosmos Lake operation, it was decided to press 742 Communication Squadron Communication Radio and Teletype (Secure) (CRATTZ) System into use. This mobile facility installed in a 1¼ ton truck and accompanied by auxiliary vehicles-provided secure HF teletype and dedicated HF SSB voice frequencies. The teletype system was established through CFB Penhold and Gateway where the messages were received from and transmitted to Cosmos Lake. From Penhold the message traffic was routed through the normal CFCC message network.

5. Problems. Although the teletype transmissions provided somewhat better communications between Cosmos Lake and Edmonton, the HF system was still affected by atmospheric conditions. Reliable teletype communications could only be established for an approximate 25 percent of the time. At times adverse conditions would exist for 36 hours during which time no communications could be established. One incident revealed that it took approximately 36 hours to send an Operational immediate message from Cosmos Lake to Edmonton. It was faster to relay messages by visiting aircraft than by the HF system. It was clearly unsatisfactory for this Operation because quick and continuous communications were vital to the success of all missions.

SATELLITE COMMUNICATIONS

6. As a result of the unsatisfactory HF SSR. Communications experienced in the first three weeks of the Operation it was decided to request that a Satellite Communications Terminal be established at Cosmos Lake.

7. While it is understood that a Satellite Terminal was on standby since the early days of the Operation Morning Light, no official attempt to get it was made until 21 Feb. Prior to that date the following factors contributed to the delay of decision to install the terminal:

a. Anticipation that morning Light would not last long once the reactor was found.

b. Move of operations from Baker Lake to Cosmos Lake.

c. Establishment of ATCCT HF with the hope that it would suffice.

d. High cost of rental (approx $15,000 per month).

e. Establishment of ATCCT HF the hope that alternate voice HF and teletype circuits would augment the ATCCT HF and therefore help to alleviate problem.

f. Eventual experience with HF that it was not reliable due to atmospheric conditions.

g. Continued disbelief by AIRCOM/ NDHQ/ CFCC that HF was unsatisfactory.

h. Normal lead time delays in decisions and acquisition.

8. Early constraints imposed on Cosmos Lake operation was to keep the people and equipment to a minimum. Therefore no serious thought to installing the Terminal was pursued until it became painfully obvious that HF was not the answer.

9. The following chronological sequence of events may help to show what actually happened:

a. 07 Feb - ATCCT Operational at Cosmos.

b. Approximately 14 Feb - CFB Edmonton queried Air Command Headquarters as to possibility of Sat/Term installation. Pointed out that ATCCT HF not satisfactory and that HA.CS complaining that their frequencies were monopolized. Air Command Headquarters suggested CRATTZ facility be installed to:

1) provide teletype (unclas and secure).

2) dedicated HF.

c. 15 Feb - CFB Edmonton requested CRATTZ.

d. 16 Feb - CTCC tasked 742 Comm Sqn to install CRATTZ at Cosmos.

e. 18 Feb - CRATTZ delivered to Cosmos Lake.

f. 22 Feb - CRATTZ operational.

g. 21 Feb - CFB Edmonton officially requested Satellite Terminal.

h. 24 Feb - Air Command Headquarters concurred with requirement and asked NDHQ that action be taken.

j. 27 Feb- NDHQ and CFCC still in doubt as to validity of requirement. CFCC CRATTZ statistics misleadingly showed that most message traffic was successful. The CFCC statistics only counted success once reliable contact was established. NO statistics were kept nor promulgated to show where contact was not successful. Once it was proven that contact was successful less than 25 percent, the case for Satellite Communications was substantiated.

k. 28 Feb - NDHQ/CFCC made---final arrangements to rent Satellite Terminal.

m. 04 Mar - Terminal delivered to Cosmos· Lake.

n. 06 Mar - Terminal operational through CSN/GP access.

p. 29 Mar- Terminal removed from Cosmos Lake.

10. In summary, it may appear, on the surface, that undue delay and procrastination occurred in acquiring the Sat/Term. However, it should be recognized that much reliance was placed. on HF to do the work. As soon as it became obvious that ATCCT and CRATTZ would not do the job, CFB Edmonton decided to ask for the terminal.

11. The Satellite Terminal provided excellent and reliable communications. With the priority pre-empting system quick contact was established between Cosmos Lake and Edmonton. The advantage of this was demonstrated on the morning of 07 Mar when a major fire broke out at Cosmos Lake. With the Edmonton Command Post immediately notified, arrangements were quickly made to launch aircraft with medical and other staff plus replacement food to assist in the aftermath of the fire. By using the telephone, the OSC was able to advise the Command Post of his losses for which replacement equipment was immediately acquired. By the end of the day

Camp Garland was more or less back to normal due to the help of the Satellite Terminal telephone. Had we had to rely on HF SSB it would have taken much more time to bring the situation back to normal - not to mention the ensuing confusion that would have existed because of poor communications.

CFB EDMONTON COMMUNICATIONS SUPPORT

13. Appendix 1 is a listing of equipments installed, issued, shipped, repaired, modified, tested, etc., throughout the period of the operation.

14. Telephone Requirements:

a. Alberta Government Telephones (AGT) and to a lesser extent CN/CP telecommunications were extremely helpful in satisfying requests. AGT staff reacted with alacrity to our requests, worked extra hours including meal times (many of which were not billed). Indeed, some commercial customers apparently indicated some slight annoyance at this military pre-emption. For example, the 10 lines installed at the CFB Edmonton Command Post 25 Jan 78, were requested at 0830 hours 25-Jan and installed to foreign equipment (in· this case USA/DOE) by 1230 hours, same date, without the normal "paper work" delay. The telephone companies at Yellowknife and Baker Lake responded in an equal manner. Similarly long hours were expended by the Satcom engineers/technicians at Camp Garland where with military assistance a 12 foot dish was assembled, erected and made Operational in approximately 7½ finger tingling hours.

b. Some telephones were, contrary to regulations, installed by military technicians because the "system" did not permit quick civilian weekend reaction. On 27 Jan, approximately 1400L a request was received to install an extension in an office. In that the need was identified "in most expeditious manner" and AGT indicated Tuesday 31 Jan as an earliest date, Base Telephone personnel effected the installation. Another request at 1900 hours on 27 Jan identified a requirement for two extensions off existing locals· to the "press briefing" room by 281000 hours. Again Base personnel met the deadline.

c. A total of 41 hours of overtime (Appendix 1) was necessary at the switchboard. At other times the work load was extremely busy causing extensive delays. In addition to the increased use by DNDOI, many "press" and USA/DOE calls were handled; a large volume of which were credit card calls.

15. Radios:

a. On 29 Jan a Mocom 70 (VHF/FM) base station complete with microphone and RT cable was requested for shipment north. Two Base Telephone personnel returned to work, crated and delivered it to AMU for its "non specified" destination. This radio never did arrive but was eventually located by ATCCT at Trenton following the Operation conclusion.

a. An additional Mocom 70 (Appendix 1 Item 15 Feb 78) was issued from supply stock to Base Telephone to crystalize and crate for shipment to camp Garland. Since no crystals were available, a superseded RG56 base station complete with items identified at Annex B item 01 Mar 78 were shipped.

b. Six PRC 512s (Handheld radios) which, fortuitously were on their way back to supply depot from Exercise Nanook Lark were intercepted and diverted to Camp Garland. They were immediately returned in that the installed crystals were not compatible with CFB Edmonton's base station. They could not be modified and were returned and employed on a separate net.

17. Nav Aids - Beacons:

a. On 18 Feb a GT20 Omni directional beacon (LF) was crated and shipped to Camp Garland; two Base Telephone Radio Technicians accompanied. After overcoming many problems including lack of: antenna, deadman for guy wires, centre pole for tent shelter, equipment serviceability, power cord and with three code changes, the beacon was operational on 211230 hours Feb. Subsequently a return trip connected a ground plane to improve the effective power out, however, the beacon could not be properly peaked and never did enjoy pilot popularity.

b. On 27 Feb, two TRN 30 transportable Omni beacons were received in Edmonton. Both were unserviceable on receipt and gave problems in effecting repairs, principally because technical pubs/drawings were not shipped. These were subsequently received on 2 Mar and the fault, two "hung-up" relays, located. In the meantime two insulated shelters large enough to contain two parallel connected NICAD batteries along with the TRN30 were manufactured by Base Construction Engineers. Two Radio Technicians returned to Camp Garland and installed one set remotely on "Tel Star Hill" on 15 Mar. It was subsequently declared reliable to 20, marginal to 25 miles at 500 feet. This beacon was still operational on 17 Mar on original batteries although the battery power meter indicated below the green level. The temperature range was between -24 and -37° C. The second set was never deployed due to the fire that destroyed all the available NICAD batteries.

17. <u>TACAN</u>

a. On 7 Feb a Base Telephone technician was dispatched to Camp Garland to deploy 408 Squadron's TRN 26 TACAN Ground Station which was non-serviceable on arrival and a second TACAN was shipped from Trenton and successfully erected several days later. Two Base Telephone (one 408 Squadron and one ATCCT) Radar Technicians subsequently rotated duty at Camp Garland until it was abandoned.

18. <u>PAGERS</u>:

a. As Operation Morning Light continued it became evident that Pagers would be required for Key personnel. The US DOE staff had their own equipment (voice pagers) which demonstrated not only their utility but their advantage for locating key individuals for urgent reasons.

b. Some 18 pagers were rented from AGT and distributed as follows: Base Commander, Base Operations Officer, Base Technical Services Officer, Air Movements Officer, NAST/RADMON team, AECB team leader, and a number of other individuals who were deemed likely to be urgently required for operational reasons.

RECOMMENDATIONS

19. Satellite Communications. Whenever a major operation such as this takes place, top priority be given to state-of-the-art communications with the emphasis on secure voice communications such as are available through the satellite. It is highly recommended that the Canadian Forces acquire Satellite Communications terminal equipment for routine use for operations and exercises. Contingency plans should be formulated and promulgated to all Operational Commanders that this type of facility is or can be made available. This would dispel much of resistance such as that encountered at the outset of Operation Morning Light.

20. Long Range Radio Communications. This Operation reemphasized that HF/SSB is very unreliable for Northern Canada. It is recommended that this constraint be well publicized to preclude dependence upon this type of unsatisfactory radio communications for future exercises and operations.

21. Short Range Radio Communications. This Operation showed that there were significantly insufficient hand held radios (PRC 512s etc.) for all uses. It is therefore recommended that additional units be procured nationally and distributed to units and bases to augment current holdings.

22. Pagers. It is strongly recommended that Pagers be considered as vital equipment for most Operations and that the CF allocate pagers not only to all senior officers but to all key Base personnel. Current distribution of CF pagers should be re-examined in the light of lessons learned from Operation Morning Light.

23. Frequency Allocation. As USA/DOE required a frequency to be cleared for their own paging system, a frequency was obtained in close proximity to a commercial user of one Khz. The inevitable interference resulted producing complaints. As a national military spectrum is reserved to the US military it is recommended a similar band be obtained in Canada.

24. Nav Aids - Beacons. As too much time was lost in deploying the TRN 30 Beacons; it is recommended that transportable sets be ready for immediate

deployment complete with technical manuals and accessories. All system's component items are recommended to be periodically checked for serviceability and completeness.

25. Tacan. While the second ATCCT TACAN was rapidly made operational and was thoroughly reliable to the end of the operation, it was fortunate that Base Edmonton and ATCCT had three TRN 26 qualified technicians to augment 408 Squadron's technician. The number of ATCCT TRN 26 qualified technicians should be augmented to ensure adequate maintenance support. The augmentation could be derived on an as required basis from other units when the need arises.

APPENDIX 1
To Annex C
Part 5 A

OPERATION MORNING LIGHT COMMUNICATIONS EQUIPMENT LIST

24 Jan 78	- Quantity nine walkie talkie (PRC 512), 18 Nicad batteries P/N NLN-8002, and one battery charger P/N PP-5263 loaned to BNDO (Telecom spares).
25 Jan 78	- 10 subscriber lines installed by AGT in Hangar 5 for US/DOE communications console interconnect.
26 Jan 78	- Quantity six PRC 512s deployed with OSC to Baker Lake.
27 Jan 78	- 10 pocket pagers leased for US/DOE team. BFSO phone installed, local 435.
28 Jan 78	- Two telephone extensions installed in temporary press room, Hangar 5.
29 Jan 78	- Quantity one HOCOM 70 base station complete with microphone and RF cable supplied by Base Telecommunications for shipment North.
	- Quantity four PRC 512s utilized by forward recce teams on initial forays to Thelon River in support of Radiation Survey Teams.
31 Jan 78	- Two IBL telephones installed at Baker Lake by Bell Canada.
01 Feb 78	- Direct line installed from CFB Edmonton Command Post to Yellowknife.
	- 4 x 4 touchtone phone (CSN/GP) extension installed, Base Operations to Command Post.
04 Feb 78	- Telephone local installed in Command Post, Hangar 5 by AGT. Overtime involved.

06 Feb 78	-Wall cord extension installed on No. 2 1A1 Key system in Command Post by AGT. - Quantity six PRC 512s deployed Baker Lake to Cosmos Lake.
7-10 Feb 78	- One Radar Technician TD to Camp 'Garland to install TRN 26 TACAN
09 Feb 78	- Direct line installed from Atomic Energy Commission Office Hangar 5 to Yellowknife.
10 Feb 78	- Six walkie talkie (PR 512) received from Camp Garland for frequency change. NIL xtals available for frequency required. Returned equipment to Camp Garland for use on separate frequency net.
15 Feb 78	- One telephone local installed in Hangar 5 by AGT for use by Department of Energy Hines and Resources. - CF-C70 to retain extension of CSN 2GP- 48-374-202 to Command Post from Base Operations.
18-22 Feb 78	- Two Radar Technicians TD to Camp Garland to install GT20 Beacon.
20-27 Feb 78	- One Radar Technician TD to Camp Garland to maintain TRN 26 TACAN.
21 Feb 78	- Additional quantity eight pocket pagers leased from AGT.
27 Feb 78	- Quantity two TRN 30 beacons, two CPP2 power supplies and four APUs received from CFB Trenton. - Mocom 70 received from Camp Garland for xtal installation.
01 Mar 78	- Quantity one RG 56 radio one CPP2 power supply, two AS-5003/U antenna, one microphone, one loudspeaker and one cable assembly supplied by Base Telecommunications for installation at Camp Garland, (in lieu of Mocom 70 above).
03 Mar 78	- One telephone local installed in Hangar 5 by AGT for use by Dr. Eaton, Hit Control.

4-6 Mar 78	- Base Telephone Officer and two Radar Technicians TD to Camp Garland to check on communication facilities.
8-11 Mar 78	- One Radar Technician TD to Cosmos Lake to maintain TRN 26 TACAN.
14-17 Mar 78	- Two Radar Technicians TD to Camp Garland to install TRN 30s.
15 Mar 78	- Quantity one CPP2 power supply shipped to Camp Garland.
17 Mar 78	- Seven of ten subscriber lines installed 25 Jan for US/EG&G communications console interconnect removed. Remaining three lines moved to other location.

EQUIPMENT WRITE OFF

1. The following equipment has not been returned and is listed as missing:

58-0-21-871-0139 Radio Set AN/PRC 512 Quantity One,
Cost $1,442.00. Write off action is being initiated.

5985-21-803-8697 Antenna, AS-5003, Quantity Two,
Cost·$146.77 ea (D Class)

6140-21-869-9863 Battery storage P/N NLN 8002A,
Quantity One, Cost $56.00

ANNEX C
Part 5 B

COMMUNICATIONS SUPPORT
ATCCT OPERATIONS

INTRODUCTION

1. The Air Transportable Communications and Control Team (ATCCT) was tasked with providing communications and technical support to the Operations Command posts at CFB Edmonton, Alberta, NRHQ Yellowknife, N.W.T. and Camp Garland, Cosmos Lake, N.W.T. HF Communications Centers were set up at NRHQ Yellowknife, Baker Lake, N.W.T. and Camp Garland, Cosmos Lake, N.W.T.

2. The ATCCT was tasked by Air Command with installing, operating and maintaining the following from 25 Jan to 09 Apr 78 inclusive:

a. NRHQ Yellowknife –
   1) HF/SSB (AN/GRC - 106) point to point and Air Ground Air communications complete with SELCAL and phone patch facilities; and
   2) Low Band FM (RT -524, on loan from 408 Squadron, Edmonton) Air Ground Air communications for rotary winged aircraft.

b. Baker Lake-
   1) HF/SSB (AN/GRC - 106) point to point and Air Ground Air communications - 26 Jan - 06 Feb 78; and
   2) VHF/FM fixed and portables.

c. Camp Garland, Cosmos Lake –
   1) HF/SSB (AN/GRC - 106) point to point and Air Ground Air communications;
   2) VHF/FM fixed and portables (PRC 512s) for communications ground net and personnel control;
   3) VHF/UHF Operations Kit for Air Ground Air communications from Command Post Cosmos Lake;
   4) TACAN (AN/TRN -26)

a) 408 Squadron TACAN - 08-19 Feb 78; and
b) ATCCT TACAN - 19 Feb - 28 Mar 78.

5) Non-directional Beacon
a) AF/UTG 121- 19 Feb - 16 Mar 78; and
b) AN /TRN 30 - 16-23 Mar 78.

6) Auxiliary Power Units
a) Two Onan 17.5 KW Diesels 120/240 VAC; and
b) one CHRYCO 3 KW 120 VAC gas.

3. CFCC was tasked to augment the ATCCT communications facilities at Camp Garland, Cosmos Lake, N.W.T. with the following equipment:

a. Mobile Radio detachment (CRATTZ) HF/SSB point to point.

b. Satellite Ground Terminal to provide a single voice channel into the Canadian Switch Network through leased facilities.

AIM

4. The aim of this report is to discuss the participation of the ATCCT in Operation Morning Light.

COMMUNICATIONS OPERATIONS

6. HF propagation during the operation ranged from very poor to excellent, dependent on sun spot and solar flair activity. Operators used their judgment to determine the best working frequencies and utilized the MACS frequencies to a large degree. Each station used one HF set to monitor and work the MACS frequencies and one HF set to monitor and work the ATCCT operational frequencies. This provided good flexibility and a wider, more integrated HF communications in all areas.

7. The ATCCT HF station at NRHQ Yellowknife was set up and antennae oriented in an east/west direction to provide point to point and Air Ground Air Communications along the corridor of the satellite track. Baker Lake and Cosmos Lake HF stations were set up and antennae oriented in the same manner.

8. The CRATTZ was installed to provide point to point communications and

secure teletype via gateway Penhold to CFB Edmonton. The passing of the daily on-site commander and scientific SITREPS via teletype provided:

a. reliable secure communications with available hard copy;
b. reduced the tice required to pass the sane information, which at times took up to four hours using the ATCCT HF facility; and
c. allowed the ATCCT HF station to concentrate on its assigned role, ·in addition to the added airfield air traffic control function, inherited when the airstrip opened on Cosmos Lake.

9. The Satellite Ground Terminal (SGT) provided an immediate voice communication via leased facilities to the Canadian Switch Network and was 100% reliable throughout its deployed period. The use of an SGT in future operations should be seriously considered, and if a teletype channel was provided, in addition to a voice channel, only one HF facility would be required to provide HF point to point and Air Ground Air Communications. This would provide a decided savings in manpower, money and hardship to static organizations tasked to provide augmentees.

<u>EQUIPMENT</u>

10. Equipment unserviceabilities were minor and repairable on site with the following exceptions:

a. One AN/GRC - 106 HF/SSB RX/TX was replaced. A spare AN/GRC - 106 was borrowed from the CRATTZ until the replacement arrived from CFB Trenton;

b. Auxiliary Power Units
   1) Onan No. 260 APU- alternator unserviceable, head gasket blown and gauges burned out. This unit was not repairable on site and was shipped to CFB Trenton – replaced with two D4400 Catapillar 20 KH units from 7 SD, CFB Edmonton.

   2) Both D4400 Cats were unserviceable within four hours of arrival in Cosmos Lake. An ATCCT D311 Cat on loan to CFB Wainwright, was shipped to Cosmos Lake for use until the end of the operation; and

   3) A 3 KW Chryco seized and was returned to

ATCCT, CFB Trenton for replacement action.

c. The RT - 524 low band FH RX/TX failed; the RX/TX was replaced by 408 Squadron, CFB Edmonton; and

d. The non-directional beacon AF/UTG 121 initially installed was only marginally acceptable. Its very short range at the working altitude of the Kiowa (250 feet) made it next to useless. Several attempts to improve its performance with ground planes, and antennae changes were unsuccessful. It was finally replaced with an AN/TRN - 30, which gave good range at the Kiowa working altitude. The TRN 30s light weight, portability, and simple, easy erection make it a necessary facility in operations/ exercises where visual navigation is difficult.

PERSONNEL

11. A total of 30 personnel, excluding the CRATTZ and SGT, were employed by the ATCCT during this operation. 24 were augmentees provided from Air Command and CFCC and included Radio Operators, Radio Technicians, Radar Technicians and EGS Technicians. All were highly professional and dedicated individuals who worked many extra hours under extremely difficult winter survival conditions. However, very few had any experience in the Arctic or living in Arctic field conditions. All adapted rapidly and, in addition to their regular duties spent many manhours on house keeping and camp duties.

12. Wherever possible, the total number of personnel at Cosmos Lake was reduced, i.e. one Radio Technician to service all communications equipment at Cosmos Lake including CRATTZ. A further reduction in personnel would have been possible had the SGT been used as recommended in paragraph 8 of this report.

ADMINISTRATION

13. The administration support supplied by the CFB Edmonton and NRHQ Yellowknife Command Posts was excellent. All requests were actioned with a minimum of delay.

14. Accommodations at both CFB Edmonton and Yellowknife, N.W.T. were adequate.

CONCLUSIONS

15. Operation Morning Light was carried out in conjunction with Exercise Arctic Express. These two deployments used the whole of the team's resources. Without the assistance of other bases in supplying augmentees the operating and maintaining of communications facilities would not have been possible. The ATCCT completed both missions as tasked.

16. Technical support received from CFCC (CRATTZ) proved beneficial and outlined the need for the ATCCT to acquire a secure teletype capability.

17. The Satellite Ground terminal was an excellent facility but arrived somewhat late at Cosmos Lake. Had the unit deployed in early February as requested, the CRATTZ would not have been required.

18. Problems with the NDB could have been avoided if the communications problem had clearly been defined. An inner-marker beacon was employed as a NDB, therefore the range was hopelessly inadequate for its intended purpose. The ATCCT will be purchasing TRN 30s.

19. The HF/SSB worked well and was fully appreciated by participating aircrews.

ANNEX C
Part 5 C

COMMUNICATIONS SUPPORT
742 COMMUNICATION SQUADRON OPERATIONS

INTRODUCTION

1. The aim of this brief is to describe the part played by 742 Communication Squadron and other Communication Units and elements in providing communications for Operation Morning Light.

PRELIMINARY EVENTS

2. 742 Communication Squadron's involvement in Operation Morning Light began on 24 Jan 78 with Communication Detachment Yellowknife going on a 24/7 basis, high precedence traffic at Communication Facility Namao began to increase significantly and phone patch traffic at MACS Edmonton to the search aircraft began to mount. The Commanding Officer attended briefings given the Base Commander and also by the Searchmaster at the Base Command Post. The Searchmaster was briefed on possible resources available from 742 Communication Squadron.

3. Preparations were made to conduct the search mission from Yellowknife. On 25 Jan Communication Group Vancouver instructed the Squadron to prepare their remaining AN/GRC 142B for a possible air deployment to Yellowknife. (The other AN/GRC 142B was at Nanaimo, British Columbia, along with 1 x radio operator and 1 x radar technician in response to a group contingency plan made necessary by the British Columbia Telephone strike.) By the end of the month standby requirements were relaxed somewhat. Communication Facility Namao and MACS Edmonton continued to be very busy. Communication Detachment Yellowknife went back to 16/5 at 28 Jan 78.

4. During the last week of Jan and the first part of Feb the ATCCT moved one half team into Baker Lake to work A/G/A and Yellowknife. Both Baker Lake (GIPSY) and Yellowknife (CARAVAN) worked MAGS Edmonton occasionally. Special frequencies were cleared by Air Command via CFCCHQ in an attempt to unplug the MACS frequencies. These were used mostly on the Cosmos Lake - Yellowknife circuit using 10562.5 khz.

5. Work on the airstrip at Cosmos Lake began 6 Feb. ATCCT (Satellite One) was in contact with MACS Edmonton 071815Z Feb 78. By 7 Feb 78 the Searchmaster informed the Commanding Officer that he was going to ask for the

CRATTZ Detachment for Cosmos Lake and they discussed possible options. Four possibilities were examined:

a. Baker Lake to Cosmos Lake;

b. Cosmos Lake to Yellowknife;

c. Cosmos Lake to Edmonton; and

d. Cosmos Lake to Gateway Penhold.

The necessary Units within the Group were warned and put on standby. This tasking did not materialize. Communications Facility Namao had gone to a four shift system on 041500Z Feb 78. Some MACS operators were rotated out of Cosmos Lake to take part in Exercise Arctic Express approximately 9 to 10 Feb 78.

6. As the camp at Cosmos Lake began to build up the overtasked MACS frequencies resulted in the danger that the primary mission of MACS could become degraded. The civilian scientists were used to duplex circuits of at least telephone quality and were not accustomed to phone patch operation. Apart from this the type of information that they had to send lent itself more to the printed page. The Command Post warned us that the CRATTZ would definitely be required. The other 142B was back to the Unit by this time and available for spares.

7. The CRATTZ Detachment departed Namao on 18 February and was packed with as much spare equipment as could be found by virtually gutting the second 142B. Two AL60P 18.28m (60 feet) masts were included in the Detachment as well as 2 x 5 kw GENRs which were mounted in a ¾ ton trailer. The Detachment was self contained with the exception of POL, rations and water which were supplied by Camp Garland. 743 Communication Squadron's Gateway was standing by awaiting the first calls and they had prepositioned an AN/GRC 142B outside the bunker as back-up. A Communications Electronics Instruction (CEI) was issued and the necessary liaison was set-up between MACS Edmonton and Gateway Penhold so that they would be able to check set-up progress via Satellite One. Through the DOC computer frequency prediction data was obtained.

8. The modifying of the AL60Ps to 24.38 (80. feet) was ruled out as impracticable in the environment present at Cosmos Lake because the building and erection of these masts in their normal configuration would be difficult enough as it was. The frequency prediction data was based on a TERMINATED SLOPING VEE (TSV) with an apex height of 18.28m and predictions indicated that the required

circuit time of 12 to 14 hours daylight could be achieved. It was anticipated that the Cosmos Lake Detachment would also be able to erect a VERTICAL HALF RHOMBIC (VHR) and a DROOPY DIPOLE (DD) on the same AL60P and erect the second AL60P later for duplex working. The circuit was expected to be operational 48 hours after touchdown. The experience gained on Exercise Nanook Lark was beginning to pay off.

ON SITE OPERATION

9. Upon arrival at Cosmos Lake the CRATTZ Detachment proceeded to erect shelter for men and machines. Generators were started and power was fed slowly to the pod heating and then to the CRATTZ equipment. This took up the remaining hours of the 18th and all of the 19th. The next day (20th) the OSC, upon finding that his AL60Ps had not arrived, decided to use one of the CRATTZ AL60Ps to support a TACAN (Chan 69) antenna. The lighting kits (red, clearance) also helped the aircraft at time of bad visibility. After the TACAN and A/G/A antennas were completed, work was started on the mast for the TSV. The TSV was built and raised on the 21st and contact was made with Gateway Penhold on 21 Feb after the crew had worked very hard in extremely cold and windy weather up to 16 to 18 hours a day.

10. The circuit settled down now to steady daily working and the phone patch traffic via MACS Edmonton declined abruptly. The Detachment was unable to erect the VHR antenna due to restrictions on space. Lack of a second mast and/or antenna and subsequent events prevented any attempt in establishing a duplex circuit. As expected, the TSV outperformed any other antennas used out of Cosmos, no doubt in part due to the approximate 10 db gain over a reference dipole at 12 MHz.

FURTHER DEVELOPMENTS

11. By 28 Feb 78 Air Command had indicated that the phone patch facility provided CRATTZ - Gateway was not adequate and as the circuit was not available during the silent hours there was no contact with the outside world should an emergency occur. It was therefore decided that an ANIK Satellite Ground Terminal (SGT) would be put into Cosmos Lake to provide 24/7 phone interface to the GPCSN. As a secondary aim a secure teletype channel would be attempted with interface at Communication Squadron Borden. Only one channel was rented and the channel would carry phone or teletype alternately. The SGT phone circuit was operational 7 Mar 78. The teletype circuit was not hooked up as more equipment was required. The SGT took its power from one of the 5 KH generators of the CRATTZ Detachment. A line voltage regulator was later flown into Cosmos Lake to ensure that there were no power surges to the SGT, although the 5 KWs ran smoothly in any

event. Despite the subsequent delivery of extra equipment, the teletype circuit into the "'DDN via Borden was not achieved. There was a slight mix-up on protection of traffic after the SGT was put in. A service message to Communication Squadron Borden and CCOC straightened this out and the CRATTZ continued to operate up to 14 hours a day to protect hard copy traffic.

12. Two fires occurred but communication equipment was not damaged and the 24/7 phone link was justified. There were no significant events after the second fire. The circuits continued to operate well, personnel rotations were carried out, things settled down to a routine as the search for the radio-active debris went on.

WITHDRAWAL PHASE

13. The CRATTZ ceased operation on 22 Mar 78 and the SGT ceased shortly after that. The CRATTZ was air lifted out on 24 Mar 78 and the SGT on 27 Mar 78. A team returned from CFCCHQ to dismantle the SGT and two people from the CRATTZ Detachment remained behind to assist them. All persons were decontaminated and the equipment went into quarantine to be released as it was declared "clean". The only communications out of Cosmos between 22 to 28 Mar was via ATCCT at Cosmos to Yellowknife and/or MACS Edmonton/Trenton.

14. Aircraft continuing the search were now based on Yellowknife and the ATCCT continued to operate out of there on A/G/A until 9 Apr. The ATCCT team ceased operation 9 Apr and departed Yellowknife 16/17 Apr 78.

OPERATIONAL SUMMARY

15. Equipment problems were minor. Only one TT98 had to be brought out to Edmonton. Other faults both at Cosmos and Penhold were solved easily on the spot. The generators worked well due to oil, plugs and filters being changed regularly. They were run alternately until the arrival of the ANIK Satellite Ground Terminal (SGT) and then both were run continuously. The problem of noncontact by teletype via ANIK SGT remains a mystery especially after the success enjoyed at Resolute Bay by the LRCT on Exercise Nanook Lark IV.

16. The SGT at Cosmos Lake was operational into· the GPCSN network from 070100Z Mar 78, phone only, until close down 22100Z Mar 78. The secondary aim of c. secure teletype via the path was never achieved. Various means were tried and extra equipment was flown in but to no avail.

17. A general circuit analysis is provided as Appendix 1 to this part. Detailed

data are on Squadron files.

CONCLUSIONS

18. The attendance by the Commanding Officer 742 Communication Squadron at briefings held at the Command Post allowed us to keep a close watch on events and ensured that the Squadron's services were at all times pertinent.

19. Absence of a mini-Gateway at Yellowknife prevented proper tie-in to the impact area during the initial stages and later when CRATTZ was deployed.

20. Training received on Exercises Nanook Lark paid off in preparing for this deployment. Group and Squadron SOPS were adequate but need refining. Cooperation between the ATCCT teams, MACS Edmonton, Base Operations and Command Post Edmonton, communication Detachment/NRHQ and 743 Communication Squadron was good.

21. The constant stand-to-stand-down atmosphere for CRATTZ deployment was debilitating on the troops but the preparedness gained was adequately repaid.

22. The spares situation for a deployment such as this is not adequate especially for generators.

23. The AL60P masts, while adequate this time, are not ideal for deployments.

24. The Manpower resources of 742 Squadron were not sufficient to run the deployment. Use of the Gateway helped as we then had to man one end of the circuit only.

25. The terminated SLOPING VEE (TSV) antenna performed well as its gain is good at the higher frequencies. The new receivers at Gateway contributed greatly to contact times.

26. The crew sent (3) is not sufficient for speedy erection of a CRATTZ Detachment under these weather conditions. 72 hours sufficed for this operation but that would not be acceptable in some other cases.

27. The aim, daylight operation only, was achieved. Close to 90% contact time was achieved but the service was inadequate for phone patch discussions at essential times particularly in the evenings when analysis and forward planning were critical. Also Cosmos Lake was not covered 24/7 incase of emergencies.

28. Deployment of the ANIK SGT was entirely successful as regards phone link for scientists and emergencies, but proved disappointing along teletype line.

29. Apart from a few minor problems· the equipment stood up well. Sufficient components were taken along to go to duplex operation but this did not come to fruition.

30. Comsec measures and publications taken proved to be adequate.

31. It should be noted that 742 Communication Squadron would not have been able to deploy its second CRATTZ as it had been gutted to supply spares for Cosmos and neither was the manpower available.

RECOMMENDATIONS

32 It is recommended that:

a. close liaison at the local level be continued;

b. studies on the possibilities of mini Gateway stations (Yellowknife, Frobisher, Resolute and Churchill) be set up in the near future;

c. until a mini-Gateway station becomes a reality Gateway Penhold be used for circuits, to the 142B, up to 1500 Km;

d. Radio Exercises such as Nanook Lark continue to be given full Command support for their training value;

e. Squadron, Group and Command SOPs be implemented to bring about standardization in methods of deployment and operation;

f. all CRATTZ Detachments be brought to Duplex configuration with two UK 18.24m masts and two 5kw generators plus adequate spares. A trials team should also be formed;

g. Detachments always be deployed with adequate manpower to enable quick set-up times;

h. in the light of daylight operation only'· supplemented by satellite communications, that the viability of the CRATTZs be examined and reasonable goals and aims be set for them;

i. CRATTZ always be deployed with radio technicians and telephone technicians;

j. the publication list, keylist and Comsec holdings be standardized and adequate safe storage be provided; and

k. a reliable quick start package be developed to interface secure teletype plus voice through the ANIK SGT.

APPENDIX 1
To Annex C
Part 5 C

CIRCUIT ANALYSIS

CRATTZ

1. A brief synopsis of circuit analyses follows:

a.

	TRAFFIC	Z	O	P	R	TOTAL
1)	Penhold Received	Nil	32	125	33	190
2)	Cosmos Lake Received	Nil	48	213	94	355
3)	Totals	Nil	80	338	127	545

4) Traffic Increase - Communication Facility Namao

	Outgoing						Incoming	
Week	0	% Increase	P	% Increase	R	% Increase	All Prec	% Increase
16-22 Jan	41		257		212		860	NORM
23-29 Jan	78	90	271	5.4	196	-7.5 -8.16	1024	19
30 Jan-5 Feb	99	141	285	10.8	237	11.79	1072	24
6-12 Feb	58	41	250	-2.7	265	2.5	1041	21
13-19 Feb	79	92	287	11.6	223	5.1	1053	22
20-26 Feb	59	44	307	19.4	239	12.7	1028	19
21 Feb-5 Mar	99	141	319	24	277	30	1181	37
6-12 Mar	72	75	295	14.7	273	28	1129	31
13-19 Mar	76	85	284	10.5	286	34	1151	33
20-26 Mar	70	70	236	-8.8	220	3.7	1008	17
27Mar-2 Apr	71	73	195	-31.7	215	1.4	855	-0.58
3-9 Apr	85	107	264	2.7	282	33	1219	41
10-16 Apr	65	58	287	11.6	320	50.9	1110	29

b. PHONE PATCHES:

1) From Penhold - Requested 48 - Completed 45
2) From Cosmso Lake - Requested 65 - Completed 60
3) Total - 105 - or 20 hours 20 minutes circuit time (Buried in secure or non-secure time)
4) Traffic Breakdown Operation Morning Light

MACS Edmonton 24 Jan - 8 Apr 78

	24-31 JAN	1-28 FEB	1-31 MAR	1-8 APR	TOT AL	TOTAL% INCREASE
PP IN FM A/C	33	120	93	9	255	75
PP OUT FM GRND	16	52	36	1	105	56
MSG IN FM A/C (NOT FORMAL TFC)	281	260	527	24	1092	-9
MSG IN/OUT PT-PT	14	291	192	5	502	70
FORMAL MSG FM A/C	1	1	0	0	2	-243
FORMAL MSG PT-PT	0	16	0	0	16	No comparative figures available
MSG OUT TO A/C (NOT FORMAL TFC)	39	44	116	8	207	73

NOTE: This survey includes only traffic relating to Operation Morning Light as a percentage increase over normal operations at MACS Edmonton.

c. Circuit TIMES	HRS: MIN	DECIMALIZED	PERCENTAGE
Secure	193:22	193.366	49.961
Non-Secure	156:47	156.783	40.478
ZGN	32:48	32.800	8.474
Down For Maint	4:05	4.083	1.054
Circuit Open	387:02	387.032	99.967 %

NOTE: QSY Time buried in ZGN time.

ANNEX C
Part 6 A

PUBLIC INFORMATION REPORT

INTRODUCTION

1. The aim of this report is to outline the public information activities in support of the search for the downed Soviet satellite Cosmos 954. On Jan 24, 1978 the DND Information Office, Edmonton was alerted that a satellite had fallen in the Northwest Territories by a CBC reporter asking for details. Later the Directorate of Information Services, Ottawa called to supply background information as an aid in replying to news media queries. Throughout the day about 350 calls were received from world media. It was evident the media were treating this event as a major news story.

POLICY

2. Within hours of the re-entry of Cosmos 954, the Director General Information in the lead federal department, Department of National Defence, with the concurrence of the Minister of National Defence and the Chief of the Defence Staff, established two public information policy guidelines that would be the basis of the information program. These guidelines were:

a. Operation Morning Light was a totally Canadian-controlled operation and every opportunity would be exploited to emphasize this fact; and

b. in the interest of both the Canadian public and the international community, the public information program would be very active, with maximum disclosure of information with with a minimum of delay.

NEWS MEDIA REPRESENTATION

3. Because Cosmos 954 was powered with a uranium reactor it had the potential to cause harm to people and wildlife and damage the environment. This was important news to the world, thus international, national, regional and local news media descended upon Canadian Forces Base Edmonton Jan 24-25 in search of story material. Following is a list of news media in attendance:

a. International media
ABC-TV news Chicago 4

CBS-TV news Los Angeles 4
NBC-TV news San Francisco 4
Japan TV news Tokyo 2
United Press International
Mutual Radio 1
London Telegraph 1
Japan newspaper Tokyo 1
Reader's Digest 1
Agence Française 1
Los Angeles Times 1
New York Times 1
Washington Post 1
Newsweek 1
Time 1
London Times 1
London Observer 1
Esquire magazine 2
Bantam Books 1

b. National media
CBC-TV 2
CTV -TV 2
Canadian Press 2
Toronto Star 2
Toronto Globe and Mail 1

c. Regional and Local media
Calgary Herald
CFCN-TV Calgary 2
CBX-TV Edmonton 2
CFRN-TV Edmonton 2
CBC Radio 2
CJCA Radio 1
CHED Radio 1
CHFA Radio 1
Edmonton Journal 2
Edmonton Report 2
CITV-TV Edmonton 2
CBC-TV (French) 2
CFRN Radio 1
CHQT Radio 1
CKUA Radio 1

CKO Radio 1

d. <u>News media daily callers not in attendance</u>
Reuters
UPI New York
San Francisco Chronicle
Las Vegas Sun
Mutual Radio New York
ABC Radio Chicago
St Paul Minn. Radio
Winnipeg Free Press

Note: In addition to local media about 12 international and national media were assigned to cover the story from Yellowknife.

The international media were extremely aggressive and demanding. Some wanted exclusive stories, others wanted special Canadian Forces aircraft flights to take them to Yellowknife, Fort Reliance, Warden's Grove and Baker Lake. Of course all media had their own specific needs; television teams wanted action footage and lots of visuals; radio reporters required taped interviews with scientists, pilots, nuclear accident support team members; photographers wanted the unusual and dramatic photo while magazine writers needed in-depth interviews with scientific and military operation leaders. This was the scenario confronting the Canadian Forces information team.

<u>PUBLIC INTEREST</u>

4. One of the basic government concerns in the search for Cosmos 954 was public safety. It was imperative to assure members of northern communities, Indian Brotherhood, N.W.T. Territorial Council, Baker Lake Innuit community, northern trappers, that no danger existed to them or to the water /food chain as a result of radioactive particles descending upon the land.

5. In addition, other publics identified were the scientific community, aviation interests, house organs for federal government agencies and the internal audience of the Canadian Forces. There was also, of course, world-wide general interest, international political interest (Soviet Union) as well as the general U.S. and Canadian publics.

<u>PUBLIC INFORMATION PROGRAM OBJECTIVES</u>

6. The primary objective was to demonstrate to international, national and special publics that the Canadian Forces had the capability to search for, locate and recover Cosmos 954 pieces and radioactive materials in concert with Canadian and U.S. scientific agencies under adverse conditions. An additional objective was to assure Northwest Territories citizens that they were not in danger and that all efforts were being made to recover as many radioactive particles as possible.

PUBLIC INFORMATION PROGRAM

7. The demands for information from the media were insatiable. A steady barrage of calls were received throughout the day. Night editors, eastern and overseas media would call during early morning hours. It was obvious a 24-hour-a-day seven-day-a-week media desk operation was required. It was also obvious that it would be impossible to set up a media desk in the Operation Command Post since media calls were interfering with operational activity. So a media centre was set up in the Air Movements Section. This area was selected for its easy media access, roominess, abundance of outside telephone lines and non-interference with operations. Tables, maps, boards, podium, typewriters were installed for media use. Upwards of sixty media were in attendance daily from the period Jan 25 to Feb 8. Numbers dwindled after that date.

8. News releases and summary of activity were issued daily throughout the operation. It was normal procedure to hold a morning meeting attended by scientific, operational and information staff. The previous day's activities were discussed along with the latest scientific information. A joint news release would then be composed, drafted and agreed upon by all participants prior to release. For major-breaking news items the above format was also followed. However, the resultant release was then forwarded to National Defence Headquarters via telecopier, for comments and concurrence prior to release. This method ensured management and the Defence Minister were apprised of and concurred in all public announcements before they were published.

9. In addition to news releases there was a requirement to expose scientific and operational commanders to the media on a daily basis to field media questions. News conferences were arranged at 10 a.m. to satisfy as many deadlines as possible. Until Canadian scientists arrived, the conferences featured a report by the operational commander and comments by daily conferences took on an all-Canadian flavour in accordance with stated policy. Additionally, during telephone briefings and interviews information staff would make a special point of emphasizing that this was a Canadian operation assisted by U.S. scientific personnel.

10. The news conferences satisfied a partial requirement of the media but not all. Numerous interviews were arranged; members of the nuclear accident support team posed in their yellow, Martian-like suits for photographers and on-site photographs taken by Forces' photographers were provided to the media. In addition, Forces photographers assigned to Yellowknife shot 16 m.m. colour footage of the search and recovery operation which was airlifted daily to Edmonton for processing arid given to all television networks on a pool basis.

11. To ensure news media received all of the information that they required, and to emphasize the DND policy that there would be maximum disclosure; media flights were arranged to fly media representatives to the scene(s) of operation. Four such flights were arranged. On one flight, the media were present when scientists made the first radioactive contact on their instruments over the Eastern end of Great Slave Lake. In this instance, the media themselves were part of the news. Other flights were made to Fort Reliance when the media accompanied Defence minister Danson and to the completed "tent city" on Cosmos Lake. Also some media were taken on local flights from Yellowknife over the Great Slave Lake region.

12. Throughout the operation it was emphasized that the Canadian Forces assisted by scientific agencies were breaking new ground. No country in the world had ever been tasked to locate radioactive pieces from a downed satellite before. In effect the Canadian Forces were embarking on a virgin project. It was indicated to the media that there would be some failures and some mistakes made. The enormity of the problem was also emphasized, i.e. "How does one go about finding small, minute pieces and radioactive particles in an area the size of Switzerland which has nil navigation aids, compasses are uncertain and the chill factor is in the 40-85 below zero celsius range?" The media were, by and large, understanding and reported in that manner.

13. To assure northern communities they were not in danger of the radioactive particles, a public relations/education program was put into effect. Canadian Forces members based at Edmonton and Yellowknife toured local schools, addressed the Indian Brotherhood and Territorial Council, spoke to senior Indian leaders, toured small communities accompanied by an Indian interpreter and generally outlined the problem and what Canadian government authorities intended to do about it. In addition, CBG northern network broadcast in Chippewa and Dogrib language all pertinent facts concerning environment hazard, possible water contamination and the food/chain problems. Also northern local and native press were fed information for dissemination. All of the above emphasized that because of the small amount of radioactive particles there was no cause to worry. However, all residents were warned not to pick up suspicious looking metal pieces.

14. A steady stream of articles and photographs were sent to 65 Canadian Forces newspapers to satisfy the requirements of the internal audience. In addition, staff from the Canadian Forces house organ, the Sentinel, arrived to gather material for a special edition on the Operation. Also, an active hometown news/photo release program commenced for community newspaper consumption. Special interest groups like the US Department of Energy, Atomic Energy Control Board, Ministry of Transport, Territorial Government Information Service, Aviation Week, Wings, Air Force and other magazines were supplied information and photographs for their special publics. And 16 m.m. movie footage shot (about 4,000 feet) is now being made into a 15-20 minute film for use in the Canadian Forces speaker's bureau program, staff and training schools, cable television and other uses. For other speaking engagements to service clubs and others a slide series was developed.

PUBLIC INFORMATION PERSONNEL

15. At the operation outset there was only one Canadian Forces Information Officer located at Edmonton. He was assisted initially by a U.S. Department of Energy Information Officer. However, as the need became evident to effect a 24-hours a day operation this manpower resource was inadequate. A call went out for additional information officers. Responding first was a member of the Reserves who dropped his full-time job to help out. This temporary relief was short-lived· when he was dispatched to Yellowknife. An information officer was required at Yellowknife since the media were playing both the Edmonton and Yellowknife ends of the story. It was vital the information officer at Yellowknife gave out exactly the same information as the Edmonton staff. A further call went out to the Directorate of Information Services, Ottawa. Three officers arrived from Ottawa at various time intervals along with one information officer from Air Command, Winnipeg. Some were dispatched to relieve the information officer at Yellowknife while the others helped man the media query desk in Edmonton on eight-hour shifts.

16. Information liaison and coordination links were established with other Canadian Forces information offices at Yellowknife, National Defence Headquarters, Winnipeg, North American Air Defence Command, Colorado Springs, and the Atomic Energy Control Board, Ottawa.

17. Assigned to the operation initially was one NCO photographer. He was directed to shoot black and white, colour stills plus 16 m.m. movie footage. He was on-site at Yellowknife, Fort Reliance, Hay River, Pine Point, Warden's Grove and other areas. Despite equipment problems (shutters freezing) in extreme cold temperatures, throughout the operation he shot about 200 black and white, 350 colour and approximately 2,000 feet of movie footage. He was assisted by a Canadian

Forces photographer from Esquimalt during part of the operation.

PUBLIC INFORMATION PROBLEMS

18. The information staff faced quite a few problems, mostly military, in trying to meet media requirements. The biggest single problem was arranging media flights. The chain of command from NDOC/Air Command/CFB Edmonton proved extremely cumbersome, at times puzzling, exasperating and time consuming. Problems were experienced by information staff at Yellowknife by overzealous operational personnel who made dealing with the media difficult and at times impossible. Throughout the exercise there appeared to be a lack of appreciation by a good many operational members who did not or could not understand that the public information function was as important as the operation function. On one occasion the information staff was informed by the Command Post that they would not be provided with information on the latest radioactive "hits" for 24 hours so staff at NDOC could place these locations on their NDOC maps. This decision was objected to on the grounds that it was DND policy to inform the public of danger areas immediately they were known. Another problem that surfaced early in the exercise was the multiplicy of spokesmen for Operation Morning Light. Senior management and others at NDHQ plus those at CFB Edmonton were bound to run into media difficulties under such an arrangement. Personnel problems were apparent early. It was humanly impossible to conduct the public information function of this Operation with only one information officer. In addition, there was a decided lack of public information personnel support from other federal agencies involved in Morning Light. It was difficult for military information officers to field scientific questions from the media. As on NDHQ decision and inter-departmental Ottawa agreement, DND handled all information releases with support from scientific personnel in Edmonton. This proved inadequate. Finally, it was extremely difficult for the photographer assigned to the information staff to accomplish all his tasks i.e. still and cine photography without support.

NEWS MEDIA ANALYSIS

19. The international media covering the operation were first-rate, hard-nosed professionals. Their reporting covering military operation, political, economic scientific and human issues was excellent. Time and Newsweek magazines, unfortunately sent second-string personnel; their reporting was factually inaccurate which was brought to their attention for correction. Also included in the good-to-excellent category were the national, regional and local media. Information staff constantly monitored their reporting on television, radio and in print daily and tactfully suggested corrections to errors or misunderstandings the following day.

Some radio reports indicated inaccurate reporting (CBC northern network aired on one broadcast that the uranium reactor· core had been located; this was corrected immediately). Overall, the general assessment of news media coverage was excellent with few exceptions.

EFFECTIVENESS OF PUBLIC INFORMATION PROGRAM

20. The effectiveness of the public information program for Operation Morning Light can only be described as excellent. The information staff accomplished its stated public information objectives while satisfying almost all of the international, national, regional and local media requests and requirements. The resultant multitudinous news clips, magazine articles, 240 minutes of aired news television time on Canadian and U.S. networks plus a like number of aired radio minutes all testify to that.

SUMMARY

21. Operation Morning Light was a severe test for Canadian Forces public information officers because of the uniqueness of the Operation, the sheer numbers of international and national media involved and the duration of their interest. However, by adopting sound public relations principles, the information staff was able to deal effectively with all of the problems posed and see the operation come to a successful conclusion.

RECOMMENDATIONS

22. It is recommended that:

a. a procedure be put into effect for major operations to facilitate the provision of Canadian Forces aircraft for media flights;
b. all personnel involved in a major operation be advised prior to the operation of the importance of the DND public information program in support of that operation;
c. for major operations there will be only one spokesman, namely the commander of the operation or those he delegates;
d. there be an "instant response" public information team, available at a moment's notice to assist the information staff in that region
e. in joint inter-departmental federal government operations with DND that the other departments provide information personnel to support the operation; and
f. the Canadian Forces Photo Unit Rockcliffe be tasked

immediately to support the motion picture/cine requirements for any major operation.

PRESS RELEASES

23. Daily or even more frequent press releases were issued from CFB Edmonton. Copies of these are available in Operation records at CFB Edmonton or archives at the Directorate of History, NDHQ.

ANNEX D
Part 1 A

YELLOWKNIFE DETACHMENT 28 JAN - 8 FEB 78
ON-SCENE COMMANDER (OSC) REPORT - LIEUTENANT-COLONEL A.A. BIALOSH

INTRODUCTION

1. The advance party of the Yellowknife Detachment was established 24 Jan 78 by the CFB Edmonton Nuclear Accident Support Team (NAST). The team initially consisted of one Captain and 22 other ranks. During the next few days the Yellowknife NAST was reduced in size as a number of members were required to proceed to Baker Lake. The group that remained at Yellowknife consisted of one Senior NCO, Sgt Fergusson, and 20 other ranks. This was essentially the strength of the Yellowknife NAST for most of the Operation.

2. The Yellowknife NAST began its radiation monitoring activities on 25 Jan[60] 78 with the checking of Yellowknife and Fort Reliance communities. (For more complete information on NAST activities, refer to Annex B.)

3. Also deployed to Yellowknife from CFB Trenton on 25 Jan 78 was the Air Transport Command Communications Team (ATCCT) consisting of Single Side Band Radio (SSB) equipment, and several Other Ranks. The equipment was installed and operated in the Northern Region Headquarters (NRHQ) Operations Room.

ESTABLISHMENT OF OSC AT YELLOWKNIFE

4. As it became apparent from the C130 overflight on 27 Jan 78 that a number of strong man-made radioactive hits were detected in McLeod Bay in the Fort Reliance area, it was decided to establish an On-Scene Commander (OSC) at Yellowknife. Lieutenant-Colonel A.A. Bialosh, BTSO CFB Edmonton was appointed and dispatched to Yellowknife on 28 Jan 78, along with some ten US DOE, E.G. & G., and LLL personnel. Also accompanying the group were two scientists· from AECB, and two DNDOI representatives. The lead DOE member was Mr. Joe Tinney and the lead AECB member was Mr. Jeffery Knight. Lieutenant-Colonel Bialosh was instructed to act as the senior team leader within terms of reference as stipulated by the CFB Edmonton Command Post (CP) for day-to-day operations.

[60] Marginalia: “24”

5. The team and its equipment (portable detector, a minicomputer and a number of spectrum analyzers) were transported to Yellowknife by C130 during the evening of 28 Jan 78. At Yellowknife the NRHQ Duty Officer, Major Elrick, assisted the team to establish itself in the NRHQ Conference room where the OSC was able to use the communications facilities already installed. This Operations Room was normally manned by an NRHQ Duty Officer on a 24/7 basis. As it turned out later, the NRHQ Duty Officer was of valuable assistance to the OSC. Also installed in the Operations Room was the direct telephone link to the CFB Edmonton Command Post.

6. Initial NAST Activities. Prior to 28 Jan 78 the Yellowknife NAST had been monitoring most communities in the Yellowknife area for radioactivity using basic CF NAST detection instruments. They did not detect any radioactivity with these instruments at that time. Had they utilized more sensitive instruments capable of detecting micro-roentgens (mR) perhaps the whole picture would have evolved differently from the beginning. The team checked communities with these relatively insensitive instruments and declared them clean. Later, the same communities were re-checked with more sensitive American instruments and radioactive particles were then detected, e.g. Snowdrift.

AIRCRAFT RESOURCES

7. To assist the OSC in his assigned task, two CH135s, one CH147 and two CC138s were allocated for use along with crews from 408 Tactical Helicopter Squadron, 450 Detachment (West) Squadron, and 440 (T&R) Squadron. Aircraft operations were conducted from the DND/RCMP and Wardair hangars. The helicopters used the Wardair hangar, while the CC138s utilized the DND/RCMP hangar.

SEARCH AND RECOVERY OPERATIONS

8. One of the first tasks assigned to the OSC on 29 Jan 78 was the dispatching of a CC138 to Warden's Grove on the Thelen River on a medical evacuation mission to recover six civilians who were reported to have come into contact with suspected Cosmos 954 debris. The CC138 was dispatched to Warden's Grove with Dr. Cavander, a medical specialist in radiation medicine on contract service to the US/DOE on board. The remainder of the team was tasked to search the Fort Reliance area where several hits were known to have been detected by C130 sensor equipped aircraft.

9. The first sortie by the team was attempted in a CH147 because of the

number of the scientific team members that were tasked for mission. The DOE, E.G. & G. and LLL members equipped themselves with a myriad of sensors (IR, etc.). However, it became obvious that some of the sophisticated equipment could not be used to its fullest extent.

10. After several grid search passes in the area now identified as ML-1 (5),[61] detection was made by several on-board sensors. The helicopter landed and- the precise area was identified by a ground party. Measurements were taken on the surface of the snow directly over the source to determine the approximate strength of the radioactivity. The debris, when recovered, was measured to be 20 R/hour at near contact. The hit area was then marked with one meter long ice pegs driven into the ice around the radioactive source. Red ribbon tape was used to cordon the area. The team then returned to Yellowknife.

RECOVERY PROBLEMS

11. The AECB team members recovered the radioactive source and contamination at hit ML-5 (1) by 01 Feb 78. Problems experienced in preparation of this first recovery were lack of suitable equipment, tools and materials. While a satisfactory lead shielded container was available, the AECB crew needed to be equipped with tongs, shovels, garbage bags, and tape. Most of this material was locally procured at Yellowknife from a hardware store. Initial experience with the common household plastic garbage bags and masking tape showed that the cold temperatures caused the plastic and tape to become extremely brittle. Attempts to use these bags and tape were futile and proved to be most unsatisfactory. Subsequent plastic bags used were of the "freezer" variety which could withstand cold temperatures. The most suitable tape used was the ducting tape (tuck) or gun tape. An initial attempt was also made to use plastic garbage cans, especially for the recovery of contaminated snow. Unfortunately, this type of can was also very unsatisfactory as they tended to break quite readily. Metal garbage cans were used thereafter.

ML-1 (1) RECOVERY

12. The strongest hit from a radioactive point of view was ML-1 (1), which was determined to have a reading of 200 R/hour at near contact. As this hit was considered to be an extremely powerful one, special precautions were taken to properly isolate it and mark the danger and safety zones. The hit location was isolated by a search helicopter. Again, as per hit ML-5 (1), similar techniques in driving steel pegs into the ice around the radioactive source were used. As the hit was very strong, it took several days before the debris could be picked up. The main problem was that a

[61] Marginalia: "-5 (1)"

sufficiently shielded lead container was not immediately available at Edmonton. A specially manufactured "pig" had to be made and transported to the site where the radioactive source was placed inside the shielded container.

13. The actual recovery operation was conducted 04 Feb 78. It was witnessed by the Minister of National Defence, Mr. Barney Danson, the Commander of Air Command, Lieutenant-General Carr, and the Commander NRHQ Brigadier-General Thorncroft. Also witnessing from a respectfully safe distance, were some 35[62] Press members who were transported to the site by CH147 Chinook helicopter. This was the first opportunity by the Press to view recovery operations of radioactive debris from Cosmos 954. During the recovery, the MND discussed at length with the media various facets of the Operation.

STOVE PIPE RECOVERY

14. On 31 Jan 78, while the Yellowknife search team was proceeding to the Fort Reliance area by one CC138 Twin Otter and two CH135 Twin Huey helicopters, an object was sighted on the ice on McLeod Bay. The original sighting was made by the CC138 crew who radioed its relative position to the CH135s that were following behind. After a brief search, the helicopters found the object and landed to investigate.

15. Upon examination, the team determined that the object was not radioactive. Its shape resembled that of a stove pipe some 50 centimeters long and 20 centimeters diameter and 1.85 kilograms in weight. The surface of the object appeared to be charred (as if. by burning). Some debris was scattered through out an area of 20 meters in diameter as a result of the impact of the object with the ice.

16. The "stove pipe" object was carefully removed, packaged in plastic bags, and packed into a metal garbage container. All surrounding debris was also picked up.

17. Prior to departure, the helicopter crews took note of the position of the site which was determined to be approximately 2VWE678715 (UTM). The position was determined by triangulation of recognized shoreline features.

18. During the recovery of the "stove pipe", the DNDOI photographer recorded the event on movie film. Upon return to Yellowknife, when authority was received from the Edmonton CP, this movie sequence was released to the media. It was later shown on national and international news on TV to an estimated audience of some 80 million viewers (DNDOI estimate).

[62] Marginalia: "29-30"

19. The celebrated "stove pipe", classified as ML-10 (1), was later determined to be made from a steel alloy. Its function on the Cosmos 954 satellite is thought to be part of the electronics package.

DEVELOPMENT OF SEARCH AND RECOVERY TECHNIQUE

20. With the experience gained in searching and recovering ML-5 (1) and ML-1 (1), it was decided to refine the operations to· minimize helicopter flight time and speed up operations. As the Microwave Ranging System (MRS) equipped C130 Hercules aircraft were beginning to locate many more hits, it became evident that a more efficient operation had to be devised.

21. Several methods were tried until it was decided to utilize two helicopters, one for search and one for recovery. The search helicopters were equipped with sensitive Gamma Detectors and marking devices. Once a hit was isolated and marked, the second helicopter, with a recovery team, would land and investigate the hit debris. If the radioactivity level was sufficiently low for the shielded containers brought by the helicopter, the objects would be put into the containers and transported back to Yellowknife. If the radioactivity level was too high for the containers, the objects would be left at the site and recovered at a later date when a proper container was available.

RECOVERY SUMMARY

22. During the period 29 Jan to 07 Feb 78, the Yellowknife team recovered the following debris:

a. one stove pipe object - non-radioactive;[63]
b. one metal plate- 200 R/hour;[64]
c. one Berylium rod - 20 R/hour;[65]
d. one metal flake- 0.6 R/hour; and[66]
e. one Berylium rod[67]- 30 R/hour[68]
f. scrapings from "antlers"[69]

[63] Marginalia: "ML 10(1)"
[64] Marginalia: "ML 1(1)"
[65] Marginalia: "ML 5(1)"
[66] Marginalia: "Mesled by ML 5(1)"
[67] Marginalia: "sheathing"
[68] Marginalia: "ML 12(1)"
[69] Marginalia: "ML 2(4)"

23. Also located, marked, examined, but not picked up, were two other hit debris. Both were Berylium rods, one 5O R/hour and the other 20 R/hour. These were recovered after 07 Feb 78 and are the subject of a separate report.

MICROWAVE RANGING SYSTEM (MRS) BEACON RELOCATIONS

24. As well as searching and recovering satellite debris. The Yellowknife Detachment also had the task of relocating two MRS ground stations to new positions specified by the CFB Edmonton Command Post and changing batteries in each station every two days.

25. The first ground positioning was attempted by a CH147 Chinook helicopter, but because of its size it was not practicable to use it. Trees endangered most helicopters using landing sites around Great Slave Lake and cleared areas were small. The CH135 Twin Huey helicopters were much more suited for this work. Their smaller size enabled them to land safely in most areas where some clearance was available from trees and terrain obstacles.

26. This extra MRS commitment meant that the two CH135s (one for each station) could not be used for search and recovery missions. During the period in question the daylight hours of six hours limited the helicopters to single missions. The first MRS beacon positions were east of Fort Reliance, some 175 miles east of Yellowknife. The transit (four hours), refueling (two hours), and mission (30 minutes) left no time for other tasks.

27. The MRS batteries were of the standard 34 ampere hour 19 cell aircraft variety. After two days of service they needed to be recharged at Yellowknife. This required a total inventory of eight batteries (two per station). As the 440 Squadron Detachment at Yellowknife did not have sufficient quantity of batteries, more were demanded and obtained from Edmonton. To assist the Detachment in recharging the batteries, an Instrument and Electrical technician and an additional Charger Analyser from Edmonton were obtained. Once the technician, batteries, and charger were in position at Yellowknife, the MRS operations were carried out smoothly.

LAPES AND REFUELING OPERATIONS

28. LAPES. As Sector One in the Fort Reliance area was some 150 miles east of Yellowknife, it was necessary to establish a fuel cache. Initially, the Northern Region fuel cache consisting of approximately 15 barrels at Fort Reliance, was used. However, after three days this fuel was quickly consumed. A fuel LAPES drop was therefore

requested by the OSC for the area near hit ML-5 (1), where it would be more central to most of the hit locations.

29. The first LAPES drop of 64 barrels was made on 2 Feb 78 by C130 flight 6791. It was an excellent drop. It was precisely positioned and no damage to any of the barrels occurred.

30. Refueling. One of the first problems that became evident during the refueling of the CH135s was the excessive time used to hand pump the JP4 into the aircraft. Typically, it took two hours per aircraft. With the extreme cold and the limited. Daylight hours, this was clearly unsatisfactory. An electrical pump was requested and obtained. It, too, was slow. A second and more rapid pump was finally obtained which refueled each aircraft within 20 minutes.

31. Another problem was the transportation of the fuel pump. At first the pumps were carried in the aircraft until it was arranged to leave the pump with the fuel cache. By carrying the bulky fuel pumps in the aircraft, the payload (passengers and equipment) was reduced.

YELLOWKNIFE LOGISTICS

32. Air Movements. Until the Cosmos Lake runway was established, Yellowknife was used as an air head to transport supplies by Twin Otter and CH147. This, combined with supplies for Yellowknife itself and with some activity at Baker Lake, caused much confusion at the DND/RCMP hangar. Equipment and supplies were arriving in massive quantities; with no augmented Air Movements personnel to assist harried personnel at Yellowknife, the situation became desperate at times. Through sheer determination and luck were most supplies forwarded to the right destination. Had an Air Movements Team (MAMS etc.) been pre-positioned at Yellowknife at the very beginning, the Operation would have not encountered as many delays and lost equipment.

33. Supply. After several days of operation, it also became evident that the NRHQ Supply Section would need augmentation to assist them in the myriad of activities that took place: issuing, procurement, inventory control, etc. A Sergeant Supply Technician was obtained from Edmonton and the problem was alleviated somewhat. The Sergeant dedicated his efforts to monitoring Air Movements shipments and all equipment and supplies dedicated for Operation Morning Light. His efforts paid off as he was able to implement an orderly system that provided more responsive Logistics.

34. Transportation. To augment the Yellowknife MSE operations several

vehicles and drivers were dispatched from Edmonton. Initially the drivers were under the direct control of the OSC. However, it was determined that more effective use would be made of the drivers if they were integrated with the NRHQ MSE Operations. As with every new Operation, teething difficulties were encountered. NRHQ MSE Operations attempted to conduct their operations as with normal requirements from a Central Dispatcher. However, as the drivers did not have radios in their vehicles, frequent delays were experienced in acquiring transportation for the urgent requirements. Finally the drivers developed a system of pre-positioning themselves in areas of anticipated activity. This was more or less satisfactory. The best solution would have been radio control and/or pocket pagers.

35. Communications. The NRHQ Operations Room was equipped with:

a. direct telephone link to the Edmonton CP;

b. ATCCT HF SSB system;

c. XEROX 4000 Telecopier; and

d. normal telephones.

36. Because of the distance between the hangar line and NRHQ Operations Room, it was difficult at times to locate and/or contact individuals. A system of pocket pagers was proposed for key persons in the detachment, however, some NRHQ staff were reluctant to concur with this requirement. Their questioning of the requirement merely reflected their normal attitude towards economy of resources during times of less urgent situations. The OSC did not have sufficient time to pursue acquisition of the pagers prior to his departure from Yellowknife and handover to Lieutenant Colonel Butchard on 8 Feb 78. The pager acquisition was recommended, but it is not known if it was implemented. There is no doubt that-the pagers would have aided immeasurably in the Yellowknife operations.

37. The direct telephone link to the Edmonton CP was invaluable. Needless to say it was in constant use for operational, administrative, logistical or scientific reasons.

38. The XEROX 4000 Telecopier was used primarily to send SITREPs or diagrams to the Edmonton CP. It, too, was invaluable in sending data and information rapidly.

39. The ATCCT HF SSB was useful only when suitable atmospheric conditions prevailed. It is estimated that the HF was only useful less than 20% of the time. For northern communications, HF is not an effective primary means of communicating. Some communications were transmitted between Baker Lake, Cosmos Lake and aircraft. However, since the percentage of success was so low, the usefulness of HF is

questionable.

PRESS COVERAGE

40. One of the main difficulties encountered during the first days of the Yellowknife operations was confrontation by the numerous visiting press. An estimate of their numbers was approximately 75 to 100.

41. While the DNDOI assigned to the team was to keep the Press informed, the media nevertheless applied considerable pressure to "out scoop" each other.

42. To further complicate the problem, the local NRHQ Public Relations Officer was also dealing with· the Press. This tended to duplicate efforts by the DNDOI and also introduce different versions to different reporters. When this apparent duplication of effort was discovered, the OSC asked the NRHQ PRO to refer all media enquiries to the DNDOI.

43. Upon return of the search team to Yellowknife on the first day, they were met at the airport by a large number of Press (NBC, ABC, CBS, CBC, etc.). Upon disembarking from the aircraft, the OSC was mobbed and questioned by the media about the day's activity. The only reply the OSC had decided to give that time (which was televised nationally) was that some data was acquired and it needed to be analysed before any conclusions could be reached. Even though the OSC and the scientific team members were certain that they had isolated a strong man-made radioactive source, it was decided that no information would be released without first consulting with the Edmonton CP. A second question on the progress of the Med-Evac CC138 dispatched to Thelon River was posed. A truthful answer of, "I don't know." was given. Later that evening when the Twin Otter returned with four of its six intended evacuees, the DNDOI and Press entourage were surprised to learn that two members were missing. What had happened in reality was that the two civilians who had actually touched the satellite debris were transferred to a waiting C130 at Baker Lake and transported immediately to Edmonton without the knowledge of the media. The remaining four civilians were taken to Yellowknife by CC138 for observation. With the Yellowknife Press expecting all six, the Baker Lake Press contingent was unaware of the "end around play" until it was too late. In the meantime the Yellowknife Press corps was somewhat annoyed for being out maneuvered. Interestingly this incident was not planned. However, it not only caught the Press off-guard, but also the Yellowknife DNDOI.

44. Insofar as the Press and media at Yellowknife [were] concerned, they tended to hinder the Operation to a certain extent. In their eagerness and high competitive spirit that prevailed, frequent attempts in extracting information from the OSC were

made. The OSC, upon direction from the CP, minimized contact with the Press in order to have as much time available for duty. Press conferences for the most part were conducted by the DNDOI once he was briefed by the OSC. While this freed the OSC to carry on with his work, it also placed a burden on the DNDOI on telling the Press what was happening. In several instances the DNDOI second guessed what he thought was happening. Occasionally he was incorrect. There were several times when subsequent corrections had to be issued. The prime cause for this was the tremendous pressure applied by the various members of the Press to get the facts. With so many anxious news persons continually demanding information, the DNDOI and OSC had their hands full. Later when the Press interest dwindled and most of their numbers left town, the Operation itself became easier and smoother.

GUARDING DEBRIS

45. With the discovery of the crater and debris at Cosmos Lake and the decision of the CFB Edmonton CP to deploy guards to protect that debris, it was also decided that a similar measure would be taken to protect hit ML-5 (1) in the Fort Reliance area. Upon direction from the CP, the matter of providing guards was left to NRHQ and Yellowknife RCMP "G" Division. With the help of the Commander NRHQ, Brigadier-General Thorneycroft, the OSC briefed the RCMP with the requirement. The Commander NRHQ decided that two Canadian Forces members from NRHQ Detachment would accompany the two RCMP constables to the site where they would guard the hit area.

46. The four guards were flown to the hit area on 30 Jan 78 with a CH147[70] helicopter. Necessary survival gear, equipment and food were transported along with the guards. The guards made their base camp on shore in a sheltered area several hundred meters from the hit, but within easy sight distance. ·It would have been impossible to set up their tent on the ice due to the wind chill factor.

47. The requirement for the RCMP guard at that time appeared to be justified. At that early stage of the Operation there existed a certain degree of mystery that surrounded the radioactive debris. Little was known about the nature of the contamination of the immediate area. Along with the persistent and curious interest of the media, it was felt that it would be prudent to guard the hit area until such a time that it could be cleaned up. The guard spent five consecutive days in guarding the first hit area and later moved to a nearby location for a second hit. The four guard members were put through a severe survival test with the average night temperature being below -40° C and wind chill factor frequently reaching below 100. The four

[70] Marginalia: "CH147008 went U/S. Trip done by CH13513."

individuals involved deserve to be commended for their endurance of the extreme cold for such a long period of time.

THE SNOWDRIFT AFFAIR

48. As the community officials of Snowdrift, located some 100 miles east of Yellowknife, or 50 miles west of Fort Reliance, expressed concern about the possibility of being contaminated by radioactive fallout, it was decided to dispatch a NAST crew by twin Otter to Snowdrift on 30 Jan 78. The crew was instructed by the OSC to contact the local RCMP and request assistance throughout the radioactive monitoring procedure. The crew checked streets, houses and vehicles with negative results. Upon completion of the task several hours later, they returned immediately to Yellowknife.

49. The Snowdrift Town Council voiced an immediate objection that they were not informed of the survey results and that none of the inhabitants were checked.

50. To allay their fears, commander NRHQ, Brigadier-General Thorneycroft, decided to personally visit the community on 31 Jan 78 to explain the results of the NAST sweep. He was accompanied by a NAST member who was equipped with RADM0N equipment to demonstrate it to the community members. Also accompanying the Commander NRHQ were members of the Press and the commissioner of the NWT.

51. Upon his return to Yellowknife, Brigadier-General Thornycroft reported that his mission was successful. He had briefed the Town Council officials and many members of the community. Many questions were asked to which the General had given reassuring replies that no radioactivity was detected by the NAST equipment.

THE DRYBONES AFFAIR

52. One of the concerns expressed by the Town Council was that a trapper (Eddie Drybones) and his family were currently in the Fort Reliance area on a trap line. As fears for their safety were expressed, Brigadier-General Thornycroft made a commitment that an attempt would be made to locate the family and warn them of the potential hazard. On 1 Feb 78 the OSC and a NAST member visited the trap line region by Twin Otter to search for the family. On board the aircraft were also members of the Press from NBC TV, Japanese TV, and Paddington Press, London. After an extensive search, a camp was located which appeared to be occupied! Upon landing, an inspection of the camp revealed that it was currently in use, (tracks were only several hours old and supplies and equipment were still at the site. Because the Twin Otter was reaching a critically low fuel state, members of the Press were asked

to remain with the aircraft. The OSC and the NAST member quickly visited the site and checked for radioactive contamination. None was found. The OSC left a brief note inside the camp tent warning of the potential hazards and risk of coming into contact with the radioactive debris. The note also asked that any strange objects discovered along the trap line be immediately reported to the authorities. This incident was subsequently shown on National TV news.

53. While only one family was thus notified, it became apparent in subsequent searches that other trappers were present in the area many snowshoe and snowmobile tracks were evident throughout the whole area of Sector One. Attempts to get information from the NWT government were unsuccessful as it was understood that no accurate records were kept on the exact location of each trap line.

54. As other priority tasks intervened, further investigation of the number of trappers in the trajectory path was not pursued during the period 29 Jan to 8 Feb 78.

HANDOVER

55. Lieutenant-Colonel Bialosh handed over OSC duties to Lieutenant-Colonel W. Butchard of NRHQ at 1000 hours 8 Feb 78. The handover was required to permit NRHQ to assume a greater role in the Operation than was otherwise possible. Additionally, Lieutenant-Colonel Bialosh was required to return to the Edmonton Command Post to perform the duties of Senior Technical Officer.

CONCLUSION

56. The following conclusions are offered by the Yellowknife OSC for the period 29 Jan to 7 Feb 78 inclusive:

a. The Detachment's operations were reasonably successful inspite of the fact that many facets were not clearly defined, pre-planned, previously organized, nor anticipated.

b. Many lessons were learned that apply not only to an operation of this type, but to any major air disaster in Northern Canada.

c. The Command and Control of the Detachment under a Lieutenant-Colonel OSC was effective as it permitted local supervision of all operations.

d. The assignment of the OSC duties to a Lieutenant-Colonel from CFB Edmonton permitted more rapid establishment of operations at Yellowknife than would have been otherwise possible. NRHQ would not have been aware of the resources that were available to draw upon. There might have been the tendency for NRHQ to be self sufficient with the result that the operations would not have been as effective.

e. The handover of OSC duties to NRHQ served its purpose to transfer the responsibility to local command and control and to increase NRHQ involvement and participation in Operation Morning Light.

f. The use of Yellowknife as a primary air head revealed the requirement for Air movements, Supply, Transportation, and other support personnel. NRHQ staff is not sufficiently large to undertake the scope of the administrative and logistics workload.

g. Most augmentation personnel arrived too late to avert problem areas. Their arrival, however, assisted to resolve the difficulties.

h. The NRHQ Operations Room was well suited for Yellowknife Command Post.

i. NAST detection instruments were not sensitive enough to detect the radioactivity levels from Cosmos 954 debris. This is deemed to be a major deficiency.

j. Search and recovery operations proceeded well even though in the early stages of the Operation much uncertainty existed as to the best plan of attack. The availability of CH135 Twin Hueys, CH147 Chinooks, and CC138 Twin Otters greatly assisted in the conduct of operations.

k. Plastic items used in the recovery operations tend to be extremely fragile when exposed to low temperatures (-40 C).

l. AECB was not adequately equipped for the recovery of the radioactive debris. Much of the material and tools had to be procured locally or obtained from Canadian Forces resources.

m. Insufficient lead containers existed within AECB' s inventory.

n. The LAPES delivery of fuel to remote locations to establish fuel caches were very successful. This increased the effectiveness and range of aircraft such as CH135s and CC138s.

o. The hand fuel pumps used to refuel CH135s Twin Hueys were too slow for the purpose.

p. Local communications equipment for vehicle and personnel control was non-existent. This led to many delays in local coordination where quick re-direction was required. Vehicle FM radios and personnel pocket pagers would have assisted the Detachment's operations.

q. The direct telephone link from NRHQ to the CFB Edmonton Command Post was well utilized.

r. The ATCCT HF SSB system at Yellowknife was of questionable utility.

s. The XEROX 4000 Telecopier added considerably to the communications between Yellowknife and Edmonton.

t. Due to the high interest of the Press in this Operation, their activities tended to interfere with the day-to-day tasks of the Detachment.

u. Because of the fast moving events, the DNDOI did not obtain up-to-date SITREPs from the OSC.

v. The four guard members assigned to guard ML-5

(1) and ML-1 (1) were exposed to a veritable survival environment under adverse conditions. Commendation should be considered.

w. In politically volatile situations such as Snowdrift, it was inappropriate for NAST members to liaise with the public ·to explain the situation. However, the subsequent action undertaken by Commander NRHQ, Brigadier-General Thornycroft, was most appropriate. His position at Yellowknife along with his ability to understand the local political pressures, were key factors in defusing what could have been an explosive situation.

x. While only one trapper and his family were warned of the radioactive debris, other trappers were likely in the area of the satellite trajectory path.

RECOMMENDATIONS

57. The following recommendations are applicable to each conclusion above. It is recommended that:

a. Contingency plans for major air disaster operations in northern Canada be written to define, plan, and organize likely Yellowknife Detachment operations.

b. The lessons learned from Operation Morning Light be applied to major air disaster plans for northern Canada.

c. An On-Scene Commander (OSC) be established at Yellowknife at the rank level of Lieutenant-Colonel as a Standard Operating Procedure for any major air disaster in northern Canada.

d. The initial assignment of OSC duties should be to a Lieutenant- Colonel from CFB Edmonton to permit more rapid establishment of operations at Yellowknife.

e. Subsequent handover of OSC duties to NRHQ be considered in the event the operation lasts for a considerable period of time.

f. Air Movements, Supply, Transportation and other support personnel form part of the advance party.

g. Augmentation personnel be transferred to Yellowknife Command Post.

h. NRHQ Operations Room normally be used as a Yellowknife Command Post.

i. More sensitive NAST detection instruments be procured for use in the Canadian Forces.

j. CH135 Twin Huey, CF147 Chinooks, and CC138 Twin Otters continue to be used extensively for any major air disaster operation as was the case in Operation Morning Light.

k. Any major air disaster plans take into consideration that plastic components and items are extremely fragile when exposed to low temperatures and that their use should not be considered.

l. AECB improve their inventory of material and tools for radioactive disasters.

m. AECB increase their inventory of lead shielded containers.

n. LAPES operations continue to receive a relative degree of importance within the Canadian Forces Tactical Airlift requirements.

o. The hand fuel pumps used to refuel CH135 Tlvin Hueys be discontinued and that they be replaced by more rapid electrical pumps.

p. Additional vehicle FM radio communications be procured to provide a capability at deployed locations such as Yellowknife. (It is also recommended that deployable pocket pagers with voice similar to the US DOE equipment be procured for major air disaster operations.)

q. The direct dial telephone link from NRHQ Yellowknife to CFB Edmonton be again established whenever a requirement occurs.

r. The utility of the ATCCT HF SSB system be re-examined and that other more effective means of communication, such as satellite communications, be considered.

s. Command Post implementation plans should specify the establishment of XEROX 4000 telecopiers for communications between Command Posts.

t. The responsible authority within DNDOI issue specific direction and guidance with regard to the control of Press activities within an Operation such as Morning Light in order to prevent their inadvertent interference with priority day-to-day operational tasks.

u. DNDOI offices maintain close contact with OSCs and operational commanders to ascertain up-to-date SITREPs in order to accurately inform the Press media.

v. Commendation should be considered for the four guard members assigned to guard ML-5 (1) and ML-1 (1) for their duties in the Fort Reliance area 30 Jan to 3 Feb 78.

w. NAST members not be required to liaise directly with the public to explain the results of their work and that such explanations be undertaken by sufficiently senior staff who can analyse properly local political situations and offer reasonable briefings.

ANNEX D
Part 1 B

YELLOWKNIFE DETACHMENT 8 FEB - 17 APR 78
ON-SCENE CONTROLLER REPORT - LIEUTENANT-COLONEL H. BUTCHART

BACKGROUND

1. During the morning of 23 Jan 78 NRHQ was advised by NDHQ that USSR Satellite, Cosmos, 954 was decaying in orbit and could possibly re-enter the earth's atmosphere over Northern Canada early on the morning of 24 Jan. Later that day a further message from NDHQ indicated that the re-entry would probably not occur over the North American continent and that no Canadian military activity associated with the re-entry was contemplated. On the strength of this latter information NRHQ contingency preparations were ceased.

2. At approximately 0510 local, 24 Jan, the Chief of Staff NRHQ was informed by NDOC that Cosmos 954 had in fact re-entered over Northern Canada and debris had possibly impacted in the Great Slave Lake area. Additionally, NRRQ was not to take any immediate action but to stand by for further direction. Subsequently, NRHQ was informed that the Commander, Air Command had been assigned responsibility for the search and recovery operation; designated Operation Morning Light, and that Base Commander, CFB Edmonton had been appointed Operation Commander. NRHQ was requested to assist the CFB Edmonton Based Command Post to the extent of NRHQ's limited resources.

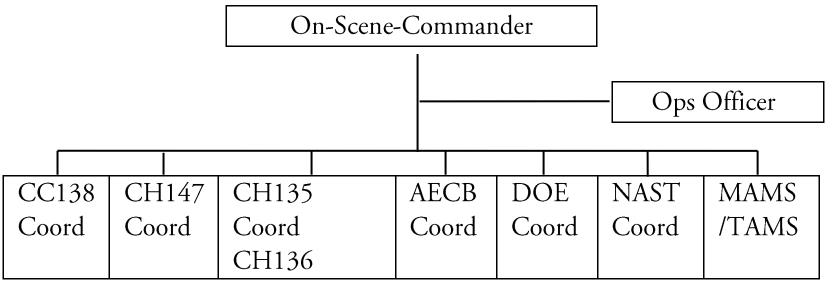
3. A Yellowknife Detachment was established with an On-Scene- Commander appointed by the Operation Commander. The Detachment operated from limited accommodation in the NRHQ Operations room and a task force of approximately 70 personnel and several aircraft were soon assembled, reacting to direction from the Edmonton Command Post.

NRHQ YELLOWKNIFE INVOLVEMENT

4. Although NRHQ provided desk officers for the Operation Centre and assisted the Task Force in arranging accommodations, transport, etc., direct responsibility for On-Scene-Command was not assigned to NRHQ until the COS NRHQ was designated On-Scene Commander 8 Feb 78 and subsequently for the duration of the operation.

ORGANIZATION

5. In order to avoid unnecessary traffic and the ensuing confusion in the confined areas of the Operations Centre, the Yellowknife Task Force was organized as follows:



6. Daily sitrep and planning briefings were held[71] with the coordinators of all sub-elements of the Task Force who in turn briefed the members of their respective teams and assigned individual taskings.

OPERATIONAL CONCEPT AND TACTICS

7. Two normal northern winter conditions immediately placed severe constraints on the employment of both men and equipment in the search and recovery operations. These were the severe (-40° C) sustained cold temperatures and the limited daylight available during the months of January, February and March.

8. With only five to seven hours of useable daylight for most of the operation and recognizing the fact that even utilizing heated aircraft hangarage a minimum of one hour was lost in preflight activities each morning, it was concluded on 8 Feb that the program for the next day's activities must be briefed on tasking details, transportation arranged, etc. Otherwise confusion reigned supreme and valuable daylight hours were lost each morning trying to get the day's program underway. With approximately 1:30 hours required for transit to the prime search and recovery areas, it was essential that aircraft be launched not later than ½ hour after first light. Otherwise, only about two to three hours of productive search/recovery activity could be achieved each day. Hence the need for an established program 12 to 15 hours in advance and all personnel well briefed on their next day taskings.

9. It also became rapidly apparent that a team concept must be followed in the search/recovery phase in order to achieve optimum results. CH135 search helicopters and CH135 recovery helicopters operating as a two aircraft element rather than

[71] Marginalia: "1900 hrs"

attempting independent search/recovery operations proved much more efficient and virtually eliminated the need to re-mark hits for recovery.

10. A further lesson relearned during Operation Morning Light was that helicopter operations, and to a certain extent fixed wing aircraft operations, conducted on a sustained basis, must have the support of a heated hangar facility. Otherwise serviceability is reduced drastically and operational effectiveness becomes a myth. Operation Morning Light activities, especially those involving helicopters with electronic sensor equipment installed, would have been impossible on the scale required or severely curtailed without the availability of the DND/RCMP and Wardair hangars in Yellowknife.

FALL-OUT OPERATIONS

11. When the presence of radio active particulate was detected in the Snowdrift area 11 Feb 78[72] and the possibility of wide spread contamination, including settlements, was realized, the operational tactics were changed somewhat. Firstly, the degree of contamination in populated areas had to be determined and in such a manner as to avoid unduly alarming the local inhabitants. Secondly, the area of contamination had to be roughly delineated as quickly as possible.

12. In response to the first requirement ground survey parties composed of AECB and NAST rnernbe.rs conducted thorough surveys of each settlement determining that there was no immediate health hazard. Later, all recreational fishing lodges in the area were also surveyed.

13. Secondly, sensor equipped helicopters were tasked to probe and define the borders of the fall-out area. When this completed, further surveys were conducted to determine density and fall-out patterns within the area.

14. Perhaps most important in this phase of the operation was the need to liaise closely with community leaders and keep the public well informed of survey team activities in order to preclude severe apprehension arising from sensationalized media reporting or the spread of unfounded "scarce" rumors. To this end the task force was extremely successful.

LOGISTICS CONSIDERATIONS

15. As NRHQ does not possess either accommodation or messing facilities, all

[72] Marginalia: "10 Feb"

Morning Light personnel on temporary duty were quartered and fed in local hotels. This reality lessened the strain on the small Logistics staff of NRHQ but the MSE facilities, Supply facilities, Administration and finance staffs were taxed to the limit, even with augmentation. The fact that the Operation was conducted on a 24/7 basis began to create a visible strain on personnel after the initial month of activity.

16. With respect to air logistics, the greatest challenge proved to be the provision of fuel caches to sustain helicopter operation in the Fort Reliance/Snowdrift/Artillery Lake areas of prime search activity. Initially, drummed fuel was delivered to remote area caches by the C130 LAPES system. Hmvever, this method required that LAPES platforms and empty drums be recovered by CH147 helicopter to Yellowknife and subsequently returned to Edmonton. As the CH147's were required to shuttle to the operational areas in any case it was concluded that fuel should simply be delivered to the caches by helicopter and drums returned for refill at Yellowknife, thus creating a closed circuit delivery system and freeing valuable C130 hours.

17. It was found that one CH147 round trip to Fort Reliance area daily could sustain Yellowknife based helicopter operations and provide enroute fuel for Cosmos Lake based helicopters as well.

RADIOACTIVE MATERIAL STORAGE AND TRANSPORT

18. One of the most potentially hazardous aspects of the operation arose from the lack of any suitable storage facility in the Yellowknife area for radioactive debris or particulate material. As daily availability of CC130 log flights was not always possible, it was necessary to store recovered hits in a locked "Paul Bunyan" container adjacent to the DND/RCMP hangar (unguarded, due to lack of personnel) for up to several days at a time.

19. Fortunately, no regrettable incidents occurred as a result of this enforced practice, but future plans for such contingency activities should envisage the construction of an air transportable "hot" material, secure storage facility to obviate the possibility of exposure resulting from accidental or unauthorized access.

MRS BEACON POSITIONING

20. Among the varied CH135 taskings was the placement and battery replacement for the MRS beacons. Although attempts were made to mark the beacons with high visibility colors there were many problems in attempting to relocate the beacons once positioned, especially under conditions of semi "white-out" or featureless terrain such as lake surfaces. In future if the MRS system is utilized a small, short range low frequency radio beacon should be co-located in order to preclude

expensive hours of fruitless visual searching.

SAFETY CONSIDERATIONS

21. Throughout Operation Morning Light, safety considerations were paramount at all times. Fortunately, in the Yellowknife/Fort Reliance area no aircraft or helicopters were forced to remain on the Tundra overnight for weather or serviceability reasons. The achieved safety record not withstanding, it should be noted that almost without exception the civilian members of Operation Morning Light were totally inexperienced in winter survival techniques and in many cases had to be equipped with even basic cold weather clothing items after arrival in Yellowknife. Needless to say, all civilians were accompanied in the field by Canadian Armed Forces personnel who had some degree of survival training.

PUBLIC INFORMATION

22. As might be expected, a unique event such as Operation Morning Light evoked wide spread sensationalized and emotional media coverage and the Operation was hampered somewhat be a deluge of media representatives. In this situation an experienced Public Information Officer was of paramount importance.

23. It was first envisaged that all media released, etc. would be processed through the Edmonton Command Post, but the army of press, TV and periodical representatives which descended on Yellowknife made this PI system unworkable in the Yellowknife area.

24. PIOs were provided and performed extremely competently, relieving the OSC of time consuming interviews and enabling him to get on with the primary duties of planning and directing the Task Force. The only criticism is that the PIOs were rotated so frequently that little continuity existed giving both local and out of town media the impression
of a somewhat disorganized operation.

GENERAL COMMENT

25. NRHQ's involvement in Operation Morning Light presented a welcome challenge to conduct an emergency operation in the North under the most difficult conditions the sub-arctic area has to offer. Support and cooperation from all elements of the Task Force was beyond question "superb". In almost three months of non-stop activity, until the operation terminated 17 Apr 78, personnel normally worked up to 16 hours a day, seven days a week and without a word of complaint. The Operation

was a singular success which greatly embellished the reputation of the emergency Task Force's ability to react to a disaster situation under the most adverse circumstances. This success was due in large part to the decision of the Operation commander to permit the OSC almost total freedom in the use of his judgment in the planning and direction of local operations.

RECOMMENDATIONS

26. It is recommended that:

a. upon formation of a Task Force, the OSC should establish an executive organization to effect both short and long term planning and supervise as well as participate in day-to-day taskings;

b. a personnel and accommodation roster must be established in order that personnel can be located quickly either day or night and the rotation of personnel can be controlled effectively;

c. in sub-arctic winter conditions, planning and notification to participants of the next day's activity plan should be completed at least 15 hours in advance of launch time.

d. any Task Force formed for Northern Operations should, if possible, include only essential personnel trained to operate under arctic climate and terrain conditions and should be self-contained, i.e. not requiring support of a virtually non-existent NRHQ infrastructure.

ANNEX D
Part 1 C

BAKER LAKE DETACHMENT - 26 JAN - 6 FEB 78
ON-SCENE-CONTROLLER REPORT –
LIEUTENANT -COLONEL D.A. DAVIDSON

SITUATION

1. As the probable ground impact path of the debris from Cosmos 954 became apparent, the defined search area extended from Yellowknife to the vicinity of Baker Lake, NWT. Owing to the distances involved and the lack of any airport closer to the search scene, the Response Commander elected to deploy an operational search team to Baker Lake. The team comprised a mix of Canadian Forces personnel tasked to conduct searches, organize base support and conduct aircraft operations, plus a team of American scientists experienced in and equipped for radiation surveys and safeguarding personnel from radiation hazards. Baker Lake operations began 26 Jan and terminated 6 Feb, lasting a total of twelve days.

2. Baker Lake is a community of approximately 1,000, 80% of whom are Innuit people. Approximately two miles from the hamlet is a gravel airstrip 4,200 feet long with very limited aircraft support facilities.

TASK

3. The task of the Baker Lake detachment was to search for, find and define the nature of any debris of Cosmos 954 for the purpose of recovery of radioactive material and protecting human health and the environment within the defined search sectors.

RESOURCES

4. The human and material resources provided to perform this task were:
   a. Canadian Forces detachment personnel – 6 (later increased to 15);
   b. American personnel - 8 (reduced to 5 on 28 Jan);
   c. Canadian Forces helicopter crews and technicians - 13;
   d. ATCCT - 3 (two operators, one technician);
   e. 2 x CH147;
   f. 1 x carryall van (not usable in snow conditions);
   g. 1 x Flextrac;
   h. 3 x MAD kits;

i. 100 IRPs;
j. radiation detection equipment (largely American); and
k. other supplies as usage occurred and operations expanded.

5. Local resources utilized at Baker Lake were:
a. accommodations;
b. transport (initial) - 1 x Bombadier and driver (contracted);
c. RCMP advice and assistance;
d. hotel manager assistance;
e. advice and assistance from local federal water resources technician;
f. game authorities; and
g. supply purchases.

AIR OPERATIONS

6. The search team's responsibilities were to perform searches for radioactive material using American portable detection equipment on CH147 helicopters. Preliminary missions proved that this was quite feasible and detailed crew operations and helicopter procedures were worked out. The helicopter was equipped with headsets for each position and a task commander in the back coordinated the actions of each individual. By using the portable sodium iodide crystal detectors significant hits would be identified on track while transiting at 500 feet at 70 kts. A 270° turn one way would pinpoint the hit in a second dimension; a 270° turn the opposite would confirm it and the helicopter could then go into a hover to land cautiously within a safe distance from any radioactive source.

7. Two trips worked up these procedures and simultaneously covered two search areas. The high geological outcropping radiation count became a significant factor in determining that many hits would have to be investigated to find the pieces of the satellite. At the same time the helicopter could dismiss a hit quickly by landing and investigating it immediately. No actual satellite pieces were found by this method of Chinook operations because none existed in the area initially investigated. Long searches by helicopter (six hours) proved very tiring for personnel and reduced their efficiency fairly quickly. Localized find, recovery and transport roles became the better employment of the helicopter.

8. Operating conditions were severe. There was only a Transport Canada heavy equipment garage at the Baker Lake strip, therefore, all aircraft had to remain outside. Ambient temperatures in the short days and long nights reached -40° to -50° Celsius

and cold soaked aircraft required at least three hours and usually more to be ready to start. Technicians worked hard under conditions of extreme difficulty. The need for portable heated shelter was very apparent. Only the hard work and determination of 450 Squadron technicians and flight engineers kept the helicopters operating. Herman Nelsons provided the ground heat but they were temperamental and prone to frequent failure.

9. The impressive lifting capability of the CH147 (28,000 pounds)[73] was a great asset. Later in the operation its ability to fly a range of 250 miles[74] and still carry 10,000 to 12,000 pounds of cargo was a cornerstone of the supply line to an austere base. It lacked adequate navigation equipment such as Omega or INS, hence both accurate locating and route flying were strictly dependent upon visual navigation. In the featureless terrain of the tundra between Baker Lake and the Thelon River, visual navigation was very difficult and large scale maps nonexistent. Cases of helicopters going astray over one hundred miles off track occurred several times. Transit flights with a CC130 mother ship to navigate became essential from the second flight to Cosmos Lake onward. This safety practice proved effective but expensive in CC130 hours. There is no doubt that the CH147 must be equipped with sufficient navigation equipment to operate safely in northern Canada.

10. The CH147 proved very vulnerable to the cold. Ultimately these machines were moved to Yellowknife and warm hangarage which solved the majority of problems stemming from cold soaking.

11. Survival was an important aspect of every trip. To ensure that the capability was always ready and sufficient, a rescue specialist, a Major Air Disaster (MAD) ten man kit and extra survival rations were carried on board each trip. This proved a most valuable precaution when seventeen team members had to spend overnight on the Thelon River in conditions well below -40° C and in a surface blizzard.

SCIENTIFIC/JOINT OPERATIONS

12. To perform the main radiation search task, the international team of Canadian and Americans worked together very well. The search and radiation safety would have been impossible without the knowledge of the American scientist and their equipment. Canadian supplied winter clothing was excellent. All personnel operated on the basis that the operational problems were solved from Canadian Forces resources and knowledge, but when radioactive materials were found, the American

[73] Marginalia: "12,750 kgs"
[74] Marginalia: "300nm"

health physicist directed procedures. Personal safety was always under good control except where primitive facilities and extreme cold drove people to perform minimum monitoring for contamination upon return to the aircraft.

13. All of the radiation detection equipment was battery operated. Outlets in the MOT garage were used to recharge it as were hotel room power sources. Cold temperatures quickly reduced the effectiveness of the batteries and hence the equipment, therefore it had to be protected constantly. The helicopter was thoroughly warmed inside before detection equipment was brought on board. Small portable detectors were kept under outer clothing but there always existed the uncertainty that the detector that one was depending upon to warn of radiation may well have failed.

14. Joint operations were carried out according to a plan evolved at daily working group meetings after discussing tasks with the Command Post. These brought all the expertise available to the subject, but were very time consuming after a long day's operations. Notwithstanding, morale was high, everyone worked well together and mutual respect existed for the expertise each person had to get on with the search.

BASE SUPPORT

15. Accommodation. The Detachment was roomed at the Iglu Inn, a limited hotel run by the Community Cooperative, at $63.00 per day for room and board. Up to five people shared a room and the Detachment Commander's room also became an operations room. Conditions were acceptable under the circumstances. The Inn manager, W. Davidson, became an unofficial administrative officer and provided very valuable liaison with the community.

16. Rations. These were provided by the hotel as a one dish menu for each meal. The limited service and operating hours proved too much of a constraint therefore a Canadian Forces cook and fresh rations were flown in from Edmonton.

17. Transport. The route from the airport to the hamlet was across the lake and only navigable by tracked vehicles in the winter. A local Bombadier taxi service was used until the extra demands upon the aged vehicle caused it to break down. A Canadian Forces Flextrac was flown in by CC130. This tracked vehicle proved a slow, but very capable transport. The Transport Canada airport manager also was very accommodating and provided extra transport with his Bombadier when necessary.

18. Supplies. Specialized supplies were required for field operations. A daily supply mission from CFB Edmonton provided superb response. High priority basic items '"ere purchased locally in the Hudson's Bay store.

COMMUNICATIONS

19. Circumstances changed daily as the search unfolded. Command, control and operations were dependant upon rapid contact between Baker Lake, the Command Post and Yellowknife. Baker Lake had a satellite telephone link with five lines to southern Canada. This proved invaluable and rapid. To attain privacy two telephones were installed in hotel rooms otherwise all calls had to be made from the lobby which denied any privacy.

20. Hand portable radios from CFB Edmonton stocks proved invaluable. There existed no communication link between the garage and the hamlet, therefore these radios supported the necessary contacts between servicing crews, helicopter crews and operations staffs.

21. An HF base station with operators was deployed by the ATG ATCCT. This provided contact with enroute aircraft, Yellowknife and if necessary Edmonton or Trenton. As usual the ATCCT deployed fully capable of performing its task and was a necessary asset to the operation. The HF rear link was intermittent but there was no dependence upon it because of the availability of telephones. However, it proved most useful in A/G/A communications to Operation aircraft.

FINANCIAL ASPECTS

22. The fast breaking events did not always allow time for orthodox procedures. Hotel bills were paid for in part by the detachment administrative officer from cash advances and partly by billing DND. Supplies were obtained by local purchase billed to the Hotel and ultimately to Base. The mix of American, Canadian government civilians and Canadian Forces provided a number of problems. The detachment was chronically short of administrative/financial staff.

PUBLIC INFORMATION

23. The entire Operation was well covered by the media because of wide ranging international interest. At Baker Lake, the media were represented by a TV reporter and Cameraman from CBC Winnipeg, and a reporter from the Canadian Press. Staying at the same hotel as the search staff, these people were constantly taking part in the developing story. Their presence made privacy difficult therefore to provide a regular update a daily evening press conference was held. These representatives behaved very responsibly so that relations were good and stories accurate.

24. Telephone interviews with Canadian and American reporters from all over North America were also common and much time was spent describing the search and daily operations. All media relations were handled by the Detachment Commander which kept the releases consistent.

COMMUNITY RELATIONS

25. Upon arrival at Baker Lake, the Detachment discovered that, the Inuit were both curious and fearful of military operations, satellites and radiation dangers. Therefore a program was conducted which included visits to the schools, a town meeting and frequent briefings with the Inuit Taparisit Hamlet Secretary- Manager to explain to the community just what was happening. This proved successful and community relations were excellent.

26. Other people in town provided essential background information or invaluable operations support. These included Corporal Klass Lok and Constable R. Grinstead, RCMP Detachment; Scott McDonald of DFE/Water Resources/Hydrology (who travelled to Cosmos Lake to assist in taking ice thicknesses and water samples); S. Denby Transport Canada Airport Manager (who refueled aircraft at any time of day or night, provided support transport and most importantly provided working space in the large Transport Canada garage); Mr. W. Davidson, Iglu Inn (general assistance in every way); G. Smith (Bombadier taxi service); David Simailak, the Hamlet Secretary- Manager; and D. Stewart, Territorial Fish and Wildlife Service.

RECOMMENDATIONS

27. Based upon the operations and experience of the Baker Lake Detachment it is recommended that:

a. navigation equipment suitable for Canada's north be installed in CH147 helicopters when operating in the NWT;

b. portable, heated maintenance shelters be devised for CH147 field deployment;

c. reliable, safe heaters be developed to replace the Herman Nelson;

d. 1: 50,000 scale maps be prepared for all of Canada;

e. batteries capable of reliable operation in extreme cold be provided for all Canadian Forces portable and field use equipment;

f. an adequate pool of hand portable radios be provided at CFB Edmonton for deployed operations. Numbers to be defined by Base; and

g. detachments always be provided with sufficient administrative staff and financial support advice to the operation.

APPENDIX 1
To Annex D
To Part 1 C

BAKER LAKE DETACHMENT
CHRONOLOGY OF EVENTS – 1978

25 Jan
- Base Commander decision to deploy forward scientific and search team at Baker Lake.

26 Jan
- Initial Team departs via C130 consisting of six Canadian Forces, eight US DOE/LLL personnel and equipment.
- Lieutenant-Colonel Davidson as Team Leader.
- Troy Wade/DOE US Team Leader.
- Dr. Richard Wagner/LLL US Senior Scientist.
- Set up operations.
- 450 Squadron Detachment CH147007 arrives from Williams Lake via Yellowknife.

27 Jan
- First helicopter shake down trip. Flew out of Baker Lake in area north of Schultz Lake to develop radiation search procedures, crew coordination and learn natural background count level.

28 Jan
- Second helicopter trip to further refine procedures. Systematic search for six hours in area west of Baker Lake.
- Received tasking from Command Post for trip to Thelon River to investigate possible debris find.

29 Jan
- Flew from Baker Lake to Thelon River via CH147007.
- Landed Harden's Grove to consult with members of NWT Expedition wintering there who discovered probable satellite debris.
- Arrived within hour of CC138 from Yellowknife with RADMON Team and US radiation safety experienced medical doctor.
- Proceeded approximately eight nautical miles downstream by CH147 with Mike Mobley and John Mordhorst of NWT Expedition to crater site in river ice at 63° 48' N104° 14' W. Dr. Cavender accompanied
- Landed on a nearby rock outcropping, 1,000 meters from ice crater, snowshoed to site with two radiation monitoring teams and a photographer at approximately 1630 hours local. Light failing. Team One consisted of Tom Crites, Health Phsicist/ LLL and Lieutenant-Colonel

Davidson/CF. Team Two consisted of Paul Mudra/ DOE and Pte Wilson, CF/RADMON. Photographer Rex Windon/ ECG.

- Crater and satellite debris identified. Area and metal defined as mildly radioactive.
- Initial site survey conducted, area photographed and marked. Objects called "antlers" (Hit ML2 (4)). Radioactivity measured as 15R/HR on contact. Beta and gamma radiation detected.
- CC138 at Warden's Grove notified us that it could stay no longer and evacuated all RADM0N and four expedition personnel to Yellowknife.
- CH147 departed site after dark for Baker lake with Mobley, Mordhorst, Cavender and detachment team on board.
- Mobley, Mordhorst and Cavender transferred to CC130 at Baker Lake for flight to Edmonton, waiting media members eluded.

30 Jan
- No trip to site owing to helicopter unserviceabilities, weather and long day previously.
- Second CH147 from CFB Ottawa arrived.

31 Jan
- Second trip to Thelon River site (now called "Satellite One").
- Further analysis of site and river area although time on station limited to about one and one-half hours.
- Investigated two other "hits" in area. Determined to be aminal yards trampled in the snow.
- Departed site leaving one RCMP constable and one Canadian Forces Rescue Specialist on scene to guard site. Constable R. Grinstead, RCMP and Master Corporal P. Collaghan.
- CABC jumped into Warden's Grove with four jumpers in early hours of morning. Made radio contact with jumpers while flying by on route to Satellite One.[75]

02 Feb
- Food drop to Satellite One guards by C13O
- CC138 trip Baker Lake to Satellite One with ski landing on

[75] Marginalia: "0700 30 Jan"

river and nearby lake. CC138 provided more time on task. It returned to Yellowknife.[76]

03 Feb

- Third helicopter trip to Satellite One.
- Fuel LAPES delivery on lake (called Cosmos Lake)[77]
- Second RCMP constable taken from Warden's Grove to Satellite One to relieve Rescue Specialist.
- Ice thickness and bottom depth data taken to survey Cosmos Lake for possible ice runway construction. Mr. Scott McDonald of Department of Environment/Water Resources brought along from Baker Lake. His equipment used to take ice thicknesses. Power auger ailed in cold, holes drilled by hand using ice chippers.
- Helicopter engine failed to start during after dark departure. Survival camp set up for seventeen people using MAD kit on board. Master Corporal P. Callaghan, Rescue Specialist invaluable in overseeing survival aspects of camp.
- First AECB scientist - Geoff Knight on task.

04 Feb

- All personnel survived night in good order.
- Nine[78] flown to Baker Lake by CC138.
- Remaining eight (helicopter crew, Rescue Specialist and RCMP[79]) awaited MRP for CH147 and recovered next day to Yellowknife.
- Decision to establish airstrip and operational camp at Cosmos Lake.
- Briefing at Baker Lake on situation to visiting team of MND, Mr. Danson; Commander Air Command, General Carr; Response Commander, Colonel Garland, American Senior Manager, Mahlon Gates and several media representatives.

05 Feb

- Begin Cosmos Lake buildup. One heavy equipment operator, one vehicle technician and eight pioneers from 1 CBG flown in via Yellowknife to begin set up of camp.
- Second LAPES drop of fuel.

[76] Marginalia: "On 3 Feb"
[77] Marginalia: "4 Feb"
[78] Marginalia: "Ten"
[79] Marginalia: "plus INAST"

- All American personnel departed Baker Lake for Edmonton.

06 Feb

- All but one Canadian Forces personnel depart Baker Lake for Cosmos Lake or Yellowknife.[80]
- Camp Commander, RADMON, Rescue Specialist supply technician and second heavy equipment operator arrive Cosmos Lake at dusk.
- Bulldozer LAPES delivery and site clearing began.
- Canadian Forces "Flextrac" and driver left in Baker Lake until both could be ferried to Cosmos Lake and airlanded.

[80] Marginalia: "Flextrac drive"

ANNEX D
Part 1 D

COSMOS LAKE DETACHMENT - 29 JAN - 16 FEB 78
ICE STRIP AND CAMP PREPARATION
ON-SCENE COMMANDER REPORT - LIEUTENANT- COLONEL D.A. DAVIDSON

SITUATION

1. The initial search area for the distribution of Cosmos 954 debris extended from near Yellowknife to the vicinity of Baker Lake, NWT. An important portion of the debris was located on the Thelon River approximately midway between the two locations noted and it appeared that this debris could be part of a larger portion of the reactor. Because of the distances involved from the· search bases and the possibility of a major engineering project to recover all radioactive contamination, the Response Commander decided to construct a forward operations base in the vicinity of the Thelon River, near 63° 48' N 104° 14' W. An advance party was deployed to the area to prepare a forward base from 5 to 15 Feb 7 8.

MISSION

2. The task of the advance party to Cosmos Lake was to construct an ice strip and support base capable of sustaining CC130 and helicopter operations for the search, find and recovery of satellite debris.

DEPLOYMENT

3. The chronology of deployment is recorded at Appendix 1. This chronology must also be read in conjunction with the Baker Lake report and chronology in Annex D Part 1 C to understand the interface of the two operations. The Canadian Forces Detachment· Commander and support personnel were dispatched from Baker Lake. Pioneer Infantrymen to set up the initial Base Camp and to supply a workforce were tasked from 1 CBG Calgary. Heavy equipment operators came from CFB Chilliwack and CFB Edmonton. Communicators were deployed from ATCCT field teams and CFB Edmonton, backed up by Air Command resources, became the main source of manpower. 1 CEU and Base military engineers provided engineering support Rescue specialists came from 440 Squadron in Namao.

4. A number of advance trips by the Baker Lake Detachment reconnoitered the area and selected camp sites and the ice strip location. First teams were deployed to the site by CH147 from Baker Lake and Yellowknife. Major logistics support for

POL and delivery of bulldozers was accomplished by CC130s from Edmonton using the Low Altitude Parachute Extraction System (LAPES) method of delivery.

5. As the forward base grew it became necessary to provide designations to the various areas. The initial call sign assigned to the site and the ATCCT A/G/A radio was "Satellite One" to distinguish it from Warden's Grove, eight miles up river. The lake (essentially a backwater of the Thelon River) upon which the ice strip was constructed was named "Cosmos Lake" after the Soviet Satellite series and the main base entitled "Camp Garland". The rocky height of ground which served as a location for ATCCT communicators and the TACAN site was christened "Telestar Hill".

ICE STRIP CONSTRUCTION

6. The ice strip was laid out and built according to data derived from ATCP 1409, "Ice Strip Requirements for Hercules, Buffalo and Twin Otter Operations", SIPRE Reports and the Engineering Manual CFP 302(2). The inconsistencies between these references are noted under CC130 ice strip operations in Annex A, Part 1 B.

7. Initially the strip was planned in a 070/250° True direction in order to take advantage of the long dimension of the Lake for a 7,000 foot runway. However, the direction was later changed to 360/180° Magnetic for a shorter length to align the strip closer to the apparent direction of the prevailing wind prior to commencing clearing operations.

8. Ice depths were obtained at first by chipping holes with ice chisels. Power driven ice augers failed routinely in the extreme cold. Eventually, when power augers could be warmed in heated tents they became more reliable and proved basic to any regular ice drilling program. The Lake ice was 36 inches deep minimum at the time of first tests on 3 Feb and eventually thickened to an average over 50 inches in late March at the time of evacuation of Cosmos Lake. A bottom profile under the strip and the ice data is available in 1 CEU engineering records. Equipment and assistance to drill the original holes was provided by the DFE Hater Resources technician from Baker Lake.

9. Clearing operations were conducted by one and eventually two D-4 bulldozers. Three operators spelled one another off so that the machines ran continuously during available daylight hours. An operator (in an open driver's cockpit) worked in thirty minute or better increments, warming up after changeover in a heated five-man Arctic tent which was kept nearby the work area. No cabs were used because those delivered by LAPES were too heavy to lift into place on the D04

and of the safety factor of the operator being able to free himself quickly if the bulldozer broke through the ice. Installing a cab slung under a helicopter was too cold with the chill factor of the downwash. The diesel powered D-4s proved steady, reliable machines and gave little trouble. Larger dozers would have been preferred to speed up operations; but the limitations of what can be fitted into the CC130 are appreciated.

10. The snow which had to be cleared back to prepare the runway was characterized as very hard, crusted granular snow 15 to 25 inches thick. Snow banks were feathered well back to keep these banks from building up higher than 36 inches and subsequently to 24 inches to spread weight over the ice as required by the references. A diesel powered snow blower would have been of great assistance to spread the snow well back. "Diesel" is emphasized because a gasoline engine would have cold soaked too easily over night. Snow removal operations consisted of direct repetitive back and forth sweeps clearing from centre line to bank. Arctic experienced operators proved essential. Their work was magnificent, they stopped for nothing and worked tirelessly despite the cold and long hours.

11. It took nine days to clear a runway 4,900 feet long by 130 feet wide. One D-4 worked nine days, the second six days, or a total of 15 dozer days. The total area cleared was runway plus turnaround dumbbells at each end approximately 600,000 square feet. In these circumstances a D-4 bulldozer cleared an average of 40,000 square feet per day or in basic terms for a one hundred foot wide runway 400 feet of length daily.

12. The ice characteristics were of interest. Host of the ice was black ice without significant depths of snow ice. Its strength was readily determined based upon reference data. After the ice surface was cleared and banks built up on both sides of the runway, two phenomena became apparent. Thermal cracking of the ice surface (the temperature gradient was approximately one degree Celsius per inch of ice between water and surface) was frequent and the ice surface became laced with cracks. Secondly as the banks built up, the ice in the centre "crowned" and ultimately a large crack appeared meandering along the centre portions of the runway to relieve this stress. Some cracks split right to water, which welled up in the cracks, refroze quickly and mended the surface. However, edges of cracks were easily broken out by the cleats on bulldozers creating a "pothole" which had to be mended with a mixture of snow and water (slush).

13. Marking of the strip presented a challenge. The low visual contrast of runway from lake snow made some kind of marking essential. Clumps of small trees were used each side of the Runway every 200 feet, barrels every 1,000 feet plus touchdown point and lead in marking barrels. A marking dye was supplied early but

the spreading equipment froze up. Surface markings and trees were covered with hoar frost each morning thus lost much of their value until the frost was knocked off. The barrels were the most visible items but could not be located too close to the runway. Retroreflective markers were also installed to provide an emergency night takeoff or landing capability. These were excellent.

CAMP SUPPORT

14. Accommodation. After living initially in five and ten-man Arctic tents, personnel were accommodated in modular tents supplied from CFB Edmonton unit resources. These tents were reasonable except for their inability to retain heat. Doors were not well designed and did not successfully accomplish the dual purpose of permitting easy passage and keeping drafts out. The insulation of the tents was poor. As the heat went off (which happened regularly), one's breath was quickly visible and the tent lost heat very quickly. Floors were cold. Heat· transfer was rapid when the winds blew. Some method of good, light insulation of tents is an essential need. A collapsible, air transportable, insulated, hardwall trailer type structure would be far superior than any tent.

15. Heat. The problem of supplying sufficient heat to free personnel to get on with the job proved unending. Herman Nelsons were unreliable and failed frequently. Refuelling them was a fire hazard and they produced carbon monoxide. Reserve machines became cold soaked (being fuel filled they could not be kept inside) and baulked at starting. Frequently, as the Herman Nelson's died, Coleman stoves and lanterns proved the only heat source. These, of course, are a severe fire hazard and consumed many man hours to fill and provide a safety watch. Through all of this, the ATCCT were snug and warm because of their electrical heat supplied by generator load racks. An attempt was made to have Base engineering staff duplicate an electrical heating system for the entire camp, but it was dismissed as requiring too much electrical power. This experience proved that an efficient, safe heat source is essential to effective field operations and free personnel for more time on the assigned job. Both a main source and an emergency back up source of heat are necessary. Combined with a well insulated tent or hardwall building, heat must be supplied safely and requiring minimal amounts of fuel.

16. Rations. Meals initially came from stocks of Individual Ration Packs (IRPs). These were excellent for a short time, particularly with the Arctic supplement. Once the fresh rations began to arrive food was plentiful and well served by 408 Squadron[81] cooks. This was an important base to good morale and work production to cope with

[81] Marginalia: "(and 450)"

the severe cold.

17. Water and Ablution. At this stage of the camp all water came from melted snow. Hot water for cooking and washing was supplied from this source. After two weeks of operation, water trailers became necessary. There were no other washing facilities until ablution trailers were flown in. Outdoor toilets (two only) quickly became a morale problem and improvement to proper facilities was necessary.

18. Electrical Power. Initially, only the ATCCT was supplied with generators (two at 17 KWH[82]). The main camp had none. A power grid to supply light and electricity became necessary and should have been designed as a unit from the outset.

19. Transport. During the period up to the first CC130 landing, the only transport consisted of two D-4 bulldozers and eventually four military snowmobiles. To build the airstrip in as short a time as possible, the D-4s had to be dedicated for runway work and heavy towing. The snowmobiles were used to haul drums of fuel and soon became overworked and broke down. Tracked vehicles were necessary because of the sugarlike consistency of the snow on the roads. CH147 helicopters were off loaded manually by manpower. Loads were arriving in triwalls and in forklift sized loads, too heavy to manhandle. Each vehicle required warm storage unless it was diesel powered and could be left running continuously. For future operations of this nature, tracked vehicles are important, and equipment such as bulldozers (as large as possible), snowmobiles with trailers capable of towing one thousand pounds and an all-terrain off-loading vehicle with approximately a five-ton capability. Without this support, limited manpower is soon overwhelmed by the amount of supplies being delivered.

20. Personal Clothing. All personnel were equipped with Canadian Forces Arctic gear. This proved very adequate to the climate with the addition of peaked balaclavas purchased LPO. The survival parka would be improved with "Velcro" fasteners on pockets instead of buttons and a frost repelling fur lining on the hood. Anything worn over the mouth and nose became icy and wet, a source of frost bite. DCIEM clothing technology should try to resolve this problem and also evaluate the worth of a down filled vest.

COMMUNICATIONS

21. During the build up, communications were provided by the ATCCT. For A/G/A (voice and CW) and rear link to Yellowknife and Edmonton, HF 106 sets

[82] Marginalia: "20 KW."

were used. The ATCCT was well equipped and trained for field deployments and its personnel dedicated to the job. HF blackouts were frequent however and for periods of up to three days at a time, Cosmos Lake had no contact. Messages were passed via transient aircraft, but this means lacked any discussion capability. Surprises were common for arrivals of equipment and personnel. A means of overcoming the deficiencies of HF in the Arctic is a vital need. The subsequent installation of a satellite terminal was invaluable in providing immediate, direct telephone communications.

22. A base station and five hand portable radios provided excellent local communications during runway clearing operations. Personnel were spread over two miles with insufficient transport. These radios were worth their weight in gold in providing quick communications and reducing the need for liaison type travel.

PERSONNEL

23. The build up of personnel is always a balance between enough to do the job and too many which creates an administrative and logistics burden. Generally the numbers provided by CFB Edmonton were correct. The mix of skills sometimes did not equate to the equipment deployed. For example, snowmobiles and Herman Nelsons gave trouble, but there was no trained technician.to service the faults. A shortage of electricians or EGS technicians created circumstances where equipment could not always be maintained.

24. The basic camp structure of a commander, NBC/Administration Officer, one rescue specialist, two RADMONs, Supply Technician, three cooks, three heavy equipment operators, and a pioneer group which included a Medical Assistant was adequate. The ATCCT group of three operators, two technicians and an EGS Technician was efficient. The rescue specialist was important to assisting in survival circumstances early on. The arrival of the camp RSM was most beneficial in getting the housekeeping, camp erection and discipline chores in hand.

RECOMMENDATIONS

25. The experiences at Cosmos Lake tested Canadian Forces deployable resources for Arctic Operations. As a result it is recommended that:

a. Air Command develop a CC130 air transportable forward base with:

1) collapsible, insulated trailers for operations, accommodation and ablution,
2) better tent insulation,
3) efficient and fuel conserving heaters, preferably electrical,

4) a predesigned electrical power grid, and
5) a cold weather water supply system and sewage disposal method.

b. inconsistencies in reference manuals ATCP 1409 and CFP 302(2) for ice data be resolved for the building of CC130 ice strips;
c. a method of LAPES delivery of a diesel powered snowblower be developed;
d. retroreflective runway markers be added to the ATCCT inventory;
e. better methods of marking ice runways for visibility be developed;
f. Herman Nelsons be replaced by a modern, reliable, fire-safe heat source;
g. military snowmobiles with a towing capability of up to 1,000 pounds be acquired;
h. a tracked or all-terrain forklift of five ton capacity be developed to support austere strip aircraft loading/off loading;
j. modifications to Canadian Forces arctic gear be evaluated such as use of Velcro fasteners and efficient face protection; and
k. satellite ground terminals be provided immediately for any significant field deployment.

APPENDIX 1
To Annex D
Part 1 C

CHRONOLOGY OF BUILD UP ACTIVITIES –
COSMOS LAKE 1978

28 Jan	-	Report of discovery of satellite pieces on Thelon River by members of NWT Expedition wintering at Warden's Grove.
29 Jan	-	First visit to site by Team from Baker Lake flying in by CH147 helicopter.
31 Jan	-	Second visit to site by Team from Baker Lake. RCMP constable and Canadian Forces rescue specialist left on scene as guards. River site named "Satellite One". Continuously occupied from this date.
03 Feb	-	Third visit to site by CH147 from Baker Lake. Helicopter unserviceability forced overnight survival stay of Team. First LAPES drop of fuel on lake to north which was entitled "Cosmos Lake".[83]
04 Feb	-	Team returned to Baker Lake. Helicopter crew and RCMP remained at site.
05 Feb	-	"Pioneer" group from 1 CBG and one heavy equipment operator in place by CH147 to commence Camp set up. Sixteen personnel on site.
06 Feb	-	Camp commander and limited staff plus ATCCT arrive from Baker Lake and Yellowknife. Bulldozer (D-4) delivered by LAPES. Accommodation in five and ten man Arctic tents. 24 personnel on site.
07 Feb	-	Ice strip clearing begun.[84] Cleared to 200 feet long by 100 feet wide. Persistent surface wind of 30 Kts plus makes

[83] Marginalia: "4 Feb"
[84] Marginalia: "16 Feb"

outdoor work slow and night rest broken.

08 Feb - Ice strip clearing continues to 600 feet. Main Camp site established at "Camp Garland" and modular tent erected.

09 Feb - Clearing of snow difficult. Continues to 1,000 feet. Second bulldozer (D-4) delivered by LAPES Camp RSM arrives. Clean up of LAPES platform and rigging laborious and time consuming in cold.

10 Feb - Ice strip cleared to 1,500 feet. Reorganization of Camp begun to new site. All personnel moved to Camp Garland except Pioneer Group. One tent unit used as kitchen recreation and sleeping quarters. First fresh rations supplied by CH147.

11 Feb - Strip cleared to 2,500 feet and dumbbell cleared at Button Runway 36. No aircraft arrivals owing to ice fog and poor visibility.

13 Feb - Strip cleared to 3,900 feet. Replacement Camp Commander arrived. NRHQ CG138 landed uninvited.[85] LAPES drop of JP4.

14 Feb - Strip cleared to 4,800 feet. Continued problems of sufficient heat. Majority of modular tent groups delivered by LAPES drop. "Husky 06" - Tanker CC137 plus 4 x CF5 overhead. Ice fog precluded any photographs.

15 Feb - Strip cleared to 4,900 feet. Dumbbell cleared at Button Runway 18. NRHQ CC138 arrived unannounced. First landing of Operation[86] fixed wing aircraft - CC115 Buffalo from Edmonton with first of US and AECB scientific party on board. Second party of personnel arrive via CH147. Runway opening ceremony.[87] First Camp Commander departs.

16 Feb - First CC130 landing on ice strip with 20,000 pounds of

[85] Marginalia: "Took in flags & ceremonial cake "

[86] Marginalia: "This is very tactless "

[87] Marginalia: "See flags/cake above "

		freight and passengers.
17 Feb	-	Build up continues with more equipment. 408 Squadron CH135 arrives.
18 Feb	-	First CH135 survey mission from Cosmos Lake. Inflatable hangar erected. Operation Commander Colonel Garland and Mahlon Gates US/DOE visit. Camp operational. Continued build up and activities reported in following reports by 408 Squadron.

ANNEX D
Part 1 D

COSMOS LAKE OPERATIONS 15 FEB - 29 MAR 78
ON-SCENE CONTROLLER REPORT – LIEUTENANT- COLONEL S. MCGOWAN

1. ESTABLISHMENT OF BASE CAMP

a. Preplanning

1) Preplanning of requirements for the establishment of the Base Camp was carried out primarily in Edmonton, by 408 Sqn and AMU personnel. The decision was made to base the camp on standard modular tenting because of its immediate availability, ease of erection and flexibility. Re-usable ATCO trailers were considered but they were not apparently readily available, costly, and thought to be difficult to recover. As it turns out, re-usable trailers could well have been the answer for a camp which had at one point, almost one hundred (100)[88] personnel. They would have been easier to heat, easier to light, safer and more comfortable. They can also be readily moved slung under a CH147.

2) Planned equipment, vehicles and POL totaled 9 C130 Chalks (3-4 Chalks POL). The order of delivery was planned that scientific and helicopter operations could commence the day after the arrival of the third chalk. With the delay in completion of the ice runway because of difficult snow removal conditions, tenting and initial equipment was delivered by LAPES in order to get the operation underway earlier.

3) A list of major equipment in location at Cosmos is at Appendix 1 to Part 1 F of Annex D.

b. Camp Buildup

1) Modular tenting was delivered by LAPES on 14 Feb 78. The next several days were spent erecting basic tenting. The camp was laid out along one main line based on the original kitchen complex. When the kitchen vehicle arrived it was incorporated into this complex which

[88] Marginalia: "Max recorded (SITREPS) was 82 "

was enlarged. The operations/scientific centre provided facilities for scientific and NAST personnel for working. It also included the 408 Squadron Command Post, space for duty officer, met tech, administration, etc and generally was the operations centre for the whole complex. A smaller tent was also provided for scientific equipment storage. Similarly, a smaller tent was erected at a very central location for decontamination.

2) Other small tent complexes included the supply tents, CRATTZ (including vehicle, tenting, generator, etc) and a maintenance tent.
3) Two arctic tents were maintained along the ice runway to provide periodic shelter to personnel working in that area. A further arctic tent was placed in the vicinity of the north end of the runway for the storage of hot material.
4) At the original crater site ML- 4 (2),[89] two sections of modular tenting were erected over the crater to keep it from filling with snow.
5) The ATCCT site, which was located on the high ground between Cosmos Lake and the Thelon River, included a portable TACAN and an NDB.
6) Two roads were constructed to connect the camp and the runway. On one of these roads a POL burning site was built. All empty 45 gallon drums were transported to this area and the remaining fuel drained and burned. The drums were then readied for backloading by C130 to Edmonton.
7) All POL for general use was concentrated in one area. JP4 was concentrated at heliport.
8) On 15 Feb 78 the ice rummy was formally opened following the arrival of the first Buffalo aircraft.

c. Camp Opening

1) On 15 Feb 78 the ice runway was formally opened and named Davidson Field. The opening followed the arrival of the first Buffalo (with 17 scientists on board).
2) The camp itself was named Camp Garland.
3) The first C130 landing was completed on 16 Feb 78.

1. Tenting

a. The basic accommodation tents each consisted of six sections of modular

[89] Marginalia: "2 (4)"

tenting. Flooring consisted of various combinations of tarpaulin, coconut matting plywood, and horsehair matting. The kitchen tent was larger ten (10) sections and contained the 408 Sqn flying-kitchen truck. The Operations scientific tent of seven sections contained a 408 Sqn Command Post vehicle. Other tents were smaller as required.

b. Heating for all spaces was initially provided primarily by Herman Nelson heaters. These proved.to be cumbersome, difficult to maintain and a lot of work (maintenance and fuelling). They also, on two specific occasions, were a source of carbon monoxide danger in the sleeping tents.

c. This led to the imposing of restrictions during the silent hours. With temperatures inside the tents reaching minus 25-30° C at night, the situation became unacceptable. Several solutions were investigated. That decided upon was the installation of commercial diesel powered forced fan furnaces. These solved the problem completely although they are not particularly rugged. Technical data and installation of these furnaces is discussed elsewhere in this report.

d. Electric power for the camp was initially provided from 5 KW generators. This was adequate. However, on 28 Feb 78, 1 CEU completed the installation of two ATCO ablution trailers including two 50 KW generators. One (1) CEU redesigned the electrical distribution. The large generators provided all power necessary including the heating furnaces.

e. Modular tenting without adequate heating is not feasible in the Arctic environment except for trained troops. ATCO type trailers are an alternate solution.

3. Food Services

a. Once the camp was established, food services were based on a 2½ ton kitchen vehicle complex. Fresh rations were always available backed up by a supply of IRPs for emergency purposes. Meals were excellent and virtually no problems were encountered.
b. Following the major fire of 7 Mar 78, a replacement kitchen truck was obtained from 1 Service Battalion. It was transported by C130 and was in full operation within twenty-four (24) hours.
c. The 2½ ton kitchen vehicle demonstrated a good capability for providing food services for a large number of people in an Arctic environment.

4. Vehicles

a. The extreme cold temperatures required that vehicles be kept running continuously with the attendant requirement for POL.
b. Vehicles utilized at Camp Garland are included in the list at Appendix 1.
c. Various vehicles were required for a variety of uses. A forklift with at least a 2000 pound lift capability was an absolute necessity. 5/4 ton trucks were vital for general transportation OSC use, MAMS supply, moving of helicopters, etc. Bulldozers were required for snow clearance in the main camp as well as the runway. They were not adequate for clearance of the daily snowfall, for which a snow blower was utilized. Bulldozers were also used for towing LAPES and other platforms. The Flex Track was used extensively to move personnel and cargo to and from the runway. It does not have a good cross country capability in deep snow.

5. Communications

a. A number of communications facilities including aircraft navigation equipment were in use throughout the operation. The prime antennae site was a piece of high ground located midway between Camp Garland and the Thelon River called "Telestar Hill".
b. ATCCT This provided ground-to-air HF communications with C130 aircraft and proved invaluable. ATCCT also provided HF voice communications with Edmonton and Yellowknife which was the only outside communications until the commencement of CRATTZ operations.
c. CRATTZ This facility was located in close proximity to the operations Centre and provided HF and HF teletype, secure, and phone patch capabilities.
d. SGT Telephone capability utilizing satellite facilities proved to be the answer. In any future operation of this type, satellite communications should be considered from the beginning.
e. GROUND-SETS Hand held walkie-talkie sets (PRC 512s) were excellent and were an absolute· requirement due to the dispersion of camp facilities. More sets were required i.e. 12 vice 6.
f. GROUND-AIR The 408 Sqn Command Post provided standard VHF, UHF and VHF-FH communications for· control of helicopter operations and fixed-wing transient operations. Few problems were encountered.
g. NDB BEACON A NDB beacon was installed at the ATCCT site. Since it was a short range beacon (3-5 miles), it was useless. The requirement was a

beacon with a range' of 20-30 miles at 500' AGL.

h. TACAN A TACAN installation was also located at the ATCCT site. Availability of the TACAN was critical. when the equipment was unserviceable due to lOR parts, several aircraft had difficulties locating Cosmos Lake. On two occasions, helicopters turned back to Fort Reliance. On two other occasions, C130 aircraft were held on the ice runway in order to operate air-to-air TACAN to assist inbound helicopters. In the northern environment where navigation is extremely difficult, TACAN or the equivalent is a necessity.

6. POL

a. The main types of fuel utilized at Cosmos were JP4, ME Gas, diesel, kerosene and propane. With the exception of propane, fuel was delivered in 45 gallon drums and bladders. The drums were delivered by LAPES, or as air landed loads on pallets holding 4-6 drums, or as individual drums were man-handled individually. This was a tremendous constant workload, particularly considering the cold temperatures.
b. Fuel Bladder operation was most successful. Both 500 gallon and 250 gallon sizes were used. Both JP4 and ME gas were delivered in bladders. The bladders can be slung or towed. Fuelling is quicker, easier and safer for helicopters, vehicles, and jerry cans. Backloading of empty bladders is much easier and more efficient.
c. Fuelling from 45 gallon drums is acceptable, particularly in long term storage situations. For active operations, fuel bladders are far superior. In fact, now that this system has been developed and is available, it is the most sensible way to operate.

7. Logistic Support

a. Generally, the logistic support for Cosmos Lake was excellent. There were a considerable number of cases of duplication, delay and wrong item delivery. However, this number was very small compared to the overall quick-reaction support of CFB Edmonton. Generally, critical items were sent to the next aircraft or on the first aircraft the next day.
b. As the camp grew in size it became evident that better control of supply items, both on site and incoming, must be developed. This was done, with success. Unfortunately, the supply complex was destroyed in the fire of 7 Mar 78.

8. Personnel

a. At one point, the number of personnel at Camp Garland had almost reached one hundred (100). Personnel were drawn from virtually dozens of different units. This, coupled with constant daily rotation of a number of personnel, created certain command, control and continuity problems.

b. Numerous classifications and trades were represented at Camp Garland. Manning was generally adequate when additional trades personnel were required they were generally provided immediately. The one position which was vacant throughout the entire operation was that of "Camp Commandant" - a field experienced officer of captain rank.

9. Scientific Team

Almost without exception, civilian personnel at Cosmos performed enthusiastically and well. Initially, living conditions were arduous. Operations were occasionally frustrated by unserviceable vehicles or weather. Cooperation was evident at all times.

10. Accidents, Safety, Fires

a. There were no serious accidents throughout the entire operation. A number of safety regulations and procedures were developed concerning helicopters, vehicles, runway, fire piquets, POL, etc.
b. Two fires occurred on 7 and 16 Mar 78. Losses during the first fire included the kitchen complex (11 sections modular tenting, 408 Sqn Kitchen vehicle, 450 Sqn Kitchen equipment, canteen, other contents) and the entire supply complex. The second fire destroyed the maintenance tent (GSE, battery shop, heaters, tools, etc).
c. A separate fire investigation inquiry has been conducted.
d. The first major fire confirmed the validity of a number of standard practices, such as refueling procedures, fire piquet procedures and the spacing of tenting. The latter point was most important since had the tents been any closer together, there was an extremely good chance that the whole camp would have been lost. This situation coupled with bad weather could have been disastrous.

11. Helicopter Operations

Covered under "Flight Operations Rotary Wing"

12. Ice Runway Maintenance

a. Once the ice runway was operational for C130 aircraft, maintenance and improvements were continued. Prior to the first landing each day, the length of the runway was 'walked' to check for new cracks. Large cracks which did not self-heal and holes caused by bulldozer blade damage were repaired. After each snowfall, the runway was cleaned by the bulldozers. This was a very lengthy process and pulled the bulldozers off continued runway improvements. The arrival of a snow-blower solved this problem. The ice-thickness was checked ·every few days as the thickness increased from approximately 36 inches to over 50.

b. The major effort in runway improvement was continued bulldozer work. The durnbells at each end of the runway were enlarged to double the size and the edges feathered. Two parking areas were constructed and feathered. The parking areas were located on opposite sides of the runway at 1000 and 4000 foot marks. Other improvements included threshold markers, landing point markers, centerline, thousand foot marking and runway edge marking.

13. Chronology of Events

15 Feb	Ice Runway (Davidson Field opened, Scientific Team arrived)
16 Feb	First CC130 landing
17 Feb	Commander NRHQ visited First CH135 arrived.
18 Feb	Colonel Garland and Mr Gates visited. Helicopter Operations commenced.
25 Feb	First CH136 arrived.[90]
27 Feb	Media visit.
7 Mar	Kitchen complex destroyed by fire
23 Mar	Lieutenant-General Carr (Commander Air Command visited).
29 Mar	Camp Garland closed.
2 Apr	Final CC130 Chalk.

14. Conclusions and Recommendations

a. Modular tenting is adequate for the Arctic environment only if properly heated.
b. For the establishment of a major camp in the north in winter in the future, re-usuable ATCO-type trailers should be seriously considered.
c. Herman-Nelson heaters are useful in extreme cold temperatures for pre-

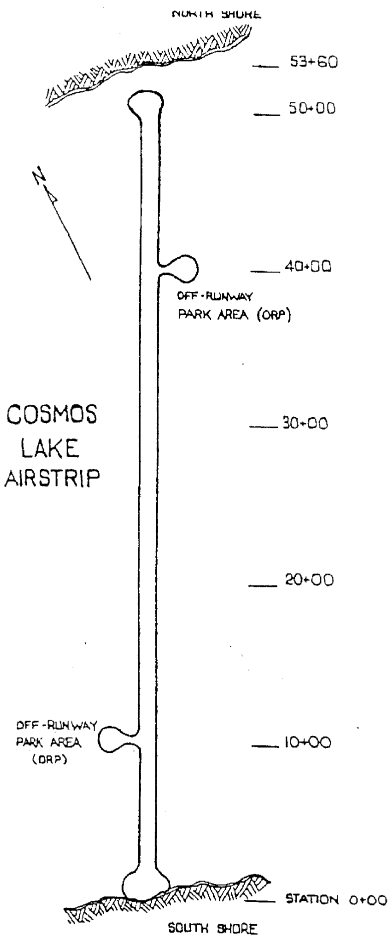
[90] Marginalia: "24 Feb. CH136 255 and 268"

heating aircraft (their purpose) but are not adequate for long-tern continuous heating of living spaces.

d. Feeding of large numbers of personnel in extreme cold temperature conditions can be accomplished very efficiently in a tent complex based on a 2½ ton kitchen vehicle.
e. Vehicles in extreme cold temperatures must be kept running and are therefore costly in POL resources.
f. The most effective and most reliable mode of communication from Cosmos Lake to the outside was the satellite ground terminal for telephone contact.
g. Portable non-directional beacons for use in the north must have a range capability of 20-30 miles at 500' AGL.
h. Fuel bladders (250 gallon and 500 gallon) are far more practical for major isolated operations than 45 gallon drums. They are easier to move, less manual labour, faster to fuel from, safer, take less space, and easier to back-load. This recommendation does not necessarily apply to long-term storage situation. It does, however, apply to all types of fuel which are used in large quantities.
j. Personnel manning of a large complex base camp should include a field-experienced camp commandant.

APPENDIX 1
To Annex D
Part 1 F

ADDITIONAL DATA FOR COSMOS LAKE



STATION FROM SOUTH SHORE	11 FEB 78		19 MAR 78	
	ICE DEPTH	WATER DEPTH	ICE DEPTH	WATER DEPTH
0+20	29 IN	2.9 FT.	55 IN.	1.5 FT.
3+00	33	3.4		
10+00	40.5	5.7	52	4.7
20+00	39.5	22.5	50	20.7
30+00	39	14.8	47	13.5
40+00	41.5	5.8	47	4.3
50+00	38.5	3.3	47	2.0
ORPs:				
NORTH			50	3.8
SOUTH			50	5.8

NOTES:

1. SKETCH IS NOT TO SCALE.
2. DEPTH READINGS OBTAINED FROM DIFFERENT LOCATIONS EACH TIME AND RESULTS THEREFORE CANNOT BE COMPARED DIRECTLY.
3. WATER DEPTHS REFER TO DEPTH BELOW LOWER SURFACE OF THE ICE

APPENDIX 2
To Annex D
Part 1 F

COSMOS LAKE
LIST OF MAJOR EQUIPMENT

2 x D-4 Bulldozers
1 x Snowblower
1 x Flextrack
1 x Front-end loader (forks and bucket) (Bambi)
1 x Front-end loader (Bobcat)
1 x 5/4 ton Command Post and trailer
1 x 5/4 ton CRATTZ vehicle and trailer
1 x 5/4 ton vehicle with Comstock
1 x 5/4 ton vehicle with jet starter
1 x 5/4 ton utility vehicle
1 x 2 1/3 ton kitchen vehicle and trailer (destroyed vehicle replaced)

5 x Skidoo (Bombadier Olympic)
Modular tenting (60 plus sections)
2 x ATCO 16 foot trailers (ablution facility)
2 x 50 KW generators
1 x Satellite ground terminal
1 x Harrier hanger
1 x Portable TACAN
ATCCT complex including HF radio equipment and generators
non-directional beacon
Diesel powered forced-air furnaces - use both JP5 and ME Gas

APPENDIX 3
To Annex D
To Part 1 F

ADDITIONAL COSMOS LAKE INFORMATION
REDEPLOYMENT

INTRODUCTION

1. Except for one brief contingency plan by Commander Air Command to examine the engineering possibilities of constructing a permanent gravel strip in the vicinity of Cosmos Lake, there always existed among the senior Operation staff the inevitability that the site would be only temporary. Once the backlog of essential supplies, especially POL and rations, had reached a ten day safety reserve, planners consistently prepared for withdrawal from the wilderness site. Loads of empty fuel drums and other no longer needed items were being backloaded regularly. Two contingency plans were prepared to withdraw quickly, one by CC130 and one by CH147 should the operation extend past the time of ice strip break up.

2. By mid- March it became evident that no satellite pieces were being detected east of Cosmos Lake. The majority of the operations were west towards Sector 3, and as these pickups were completed and the MRS support done, Cosmos Lake operations were shutdown.

3. The purpose of the redeployment was to centralize resources in Edmonton and Yellowknife, reduce the costly maintenance of Cosmos Lake and to leave the site as restored to the natural state as possible.

Operations

4. Withdrawal operation commenced 21 Mar and the last trip left the site on 2 Apr. An average of three CC130 trips per day served to clear the area over the thirteen days. Helicopter operations concluded on 23 Mar and all personnel left the site on 29 Mar.[91] For the last four days MAMS personnel were flown in each day from Edmonton on the first trip and returned on the last aircraft out. The ice thickness still averaged about fifty inches on the second of April.

5. A total of 791,941 pounds of cargo and 135 passengers were airlifted during the redeployment in 37 flights.

[91] Marginalia: "CH135 107 "

6. Camp Garland was dismantled by the army Pioneers and the items moved to a load buildup area near the ice strip. Here the MAMS Team build up the loads on pallets and weighed them in preparation for airlift.

7. Ice operating constraints still existed for the aircraft. Differing parking spots were used and often loads had to be handled some distances to the aircraft with the limited machinery available. Turn around times were kept to one hour where possible.

8. Communications became more difficult as the Camp was dismantled. After the CRATTZ, ATCCT and SGT were gone, only UHF existed. Aircraft could not be contacted until very close in with this limited means. At the end, the MAMS Team did not have UHF and the Operation was reduced to strictly visual circumstances.

Equipment

9. The Clark Bobcat utilized at Cosmos Lake proved to be the key to the successful and timely completion of the redeployment. It was used by MAMS for; build up, weighing, towing and loading aircraft. Although the maximum lift capacity was 3,800 pounds, very few loading problems were experienced. The Bobcat performed functions that usually require an L-23 Cargo Loader and a 10,000 pound capacity forklift. The all- terrain capability of the unit was frequently tested as the camp was being disassembled and transported to the build up area. The dual function of the Bobcat was probably the most time and labour saving attribute of the machine. As well as functioning as a forklift, with a minor modification it was converted to a front end loader which was instrumental in the removal of the many containers of garbage that were recovered to Edmonton and Yellowknife.

10. The D-4 bulldozer employed in the operation was also extensively by MAMS for several functions; as a tow vehicle for built up loads, a prime mover for loading unserviceable equipment, and an aid in stacking, transporting and loading empty LAPES platforms.

11. The L-23 Cargo Loader was brought in specifically to assist in loading 2 ATCO trailers. Although the L-23 would have been useful for the entire redeployment, it is unable to function for extended periods in the cold of the Arctic environment and therefore could not be utilized.

12. The major problems encountered during build up and loading were caused by the lack of serviceable pallets and straps available. Several unsuccessful attempts were made through Edmonton Command Post to obtain these items. These shortages did not affect the completion of the operation but did make it more difficult to

complete aircraft loading.

Specific Loads

13. Two ATCO trailers used at Cosmos Lake as ablution units were airlifted to Edmonton utilizing two operational chalks. One was used to transport the loading aids required (L-23, pry bars, skatewheels, shoring) and one to transport the trailers. The first trailer was placed on the L-23 with the assistance of the Chinook helicopter.[92] It was then lifted (one side at a time) and inverted skatewheels were positioned under it. The trailer was then maneuvered into the aircraft using pry bars, the bobcat and manpower. The second trailer was loaded in a similar fashion except that the Chninook was not used. As it took some time for the Chinook to correctly position the first trailer on the L-23, the second one was winched from a make-shift snow ramp onto the L-23. The entire operation took approximately ninety minutes. When loaded, the trailers filled the main cargo floor with clearance margins of three inches on the sides and top.

Incidents

14. A number of items shipped from Cosmos Lake were received by CFB Edmonton in damaged condition. There were several reasons for this:

a. no proper packing and crating facilities were available from the supply detachment in Cosmos Lake;
b. many items, i.e. furnaces were damaged during initial installation;
c. much damage was sustained when the camp was dismantled and transported to the load build up area; and
d. limited time from the receipt of items until loads were completed for the arriving aircraft.

15. Due to runway conditions the MAMS Team was given one hour to offload and reload all chalks. Considering the equipment available and the small number of take-off delays encountered, the damage that occurred was minimal for the circumstances.

Conclusion

16. Wind-down operations are usually forgotten in the excitement of the other Operation accomplishments. This redeployment was executed expeditiously and safely. Cosmos Lake was cleared out as the result of a major airlift in itself, without

[92] Marginalia: "Flight records do no support this "

accident, while attention was focused elsewhere on Morning Light developments. It is a tribute to the personnel involved that they performed so much with limited equipment and in the Arctic winter environment.

17. A final site inspection and clean up was programmed for completion after the snow was gone. This was done in August and September of 1978. Also a cairn was constructed to commemorate the historical existence of Cosmos Lake.

18. The cairn was constructed 23 August 1978. Its inscription reads:

> *This cairn is placed to commemorate the use of this site by the Thelon River as a forward air Operation Base and ice airfield during the search and recovery of the downed soviet satellite "Cosmos 954" in Operation Morning Light*
>
> *A joint task force of Canadian and American groups worked together in true international cooperation to recover the radioactive satellite debris. Members of the Canadian Armed Forces, the Atomic Energy Control Board of Canada, the geological Survey of Canada, the United States Department of Energy, the Lawrence Livermore Laboratories and the United States Contactor EG & G met the challenge and successfully surmounted the difficulties of working in circumstances of extreme cold and featureless navigation.*
>
> *The lake to the north and this site were collectively names Cosmos Lake. The inhabited area was known as Camp Garland.*
>
> *Operation Morning Light took place from 24 January 1978 to 14 April 1978. This site was first visited on 29 January and was occupied continuously from 5 February until 29 March 1978.*

APPENDIX 4
To Annex D
Part 1 F

COSMOS LAKE, NWT
WEATHER OBSERVING AND CLIMATOLOGICAL INFORMATION

1. The site of Cosmos Lake on the Thelon River was located far from any weather observing site. Members of the Expedition wintering at Warden's Grove nearby had been providing twice daily observations to AES through Yellowknife but these were not aviation oriented nor provided by trained observers. Therefore, DND meteorological technicians were placed on site from 15 February to 28 March 1978. Observations began on 18 February.

OPERATIONS

2. The Met Tech's primary role was to provide weather observations while the Air Strip was operational. The first observation was scheduled at 0500 MST to support incoming aircraft and hourly and special observations were then taken until 1600 MST or until helicopter search operations ceased for the day. This occasionally meant a 14 hour working day with a 12 hour observation program being the norm. The weather reports were passed to CAFB Edmonton Forecast Centre via the radio net of Cosmos Lake, Yellowknife and MACS Radio Edmonton.

3. Temperature forecasts and a terminal forecast for Cosmos Lake was received twice daily from the Forecast Centre. These forecasts were posted on the Status Board in the Operations tent and passed to aircrew as required. The "on- scene-commander" was kept informed of the latest aviation forecasts and was also given a general weather briefing for the day with emphasis on maximum and minimum temperatures. The temperature trends were considered critical in ice landing strip operations.

METEOROLOGICAL EQUIPMENT

4. The TMQ-22 Meteorological Measuring Kit was the primary instrument used. It is a mobile, battery powered (D-cell) instrument designed for field operations and is capable of measuring barometric pressure (which can be converted to altimeter setting) wind speed and direction, temperature and dew point. Attachments are also available for measuring snow depth and rainfall.

5. As a back up for the TMQ-22, a hand held anemometer, sling psychrometer (Temp and dew point instrument) and an aneroid barometer were available. The

appropriate forms and manuals completed the kit.

FORECAST PROGRAM

6. The forecast program to support operations consisted of a 12 hour terminal forecast issued at 1330Z daily and passed to the Command Post, the Mobile Radar Detachment at Cosmos Lake and MACS Radio, Edmonton. Also, a 24 hour forecast of clouds and weather, the overnight low temperature expected and the forecast high temperature for the following day. This forecast was issued for the Cosmos Lake/search area and were issued at OlOOZ and passed to the Command Post for planning purposes. Five day outlooks of general weather and temperature trends were issued as required and passed to the Command Post.

7. The routine forecast program continued from 21 February to 27 March 1978 inclusive.

PROBLEM AREAS

8. Observing:

a. The visibility was difficult to assess due to lack of markers or objects on the horizon. Visibility was particularly difficult to assess at night when virtually no horizon or markers were visible. During the extremely cold weather, visibility was frequently reduced to near zero in ice fog. The location of the landing strip and observing site were considered to contribute to the low visibilities observed.

b. The cloud base was also difficult to determine during darkness as no means of measuring the height was available. The same problem occurred with low ceilings during the daylight hours. Pilot reports proved extremely valuable during the operation.

c. The dew point was difficult to determine during extremely cold weather and was frequently not reported.

9. Equipment: The wind speed detector of the TMQ-22 was mounted on a mast five feet above the maximum height of the nearest tent or vehicle. During a period of wind gusts in excess of 35 knots and temperatures in the -20° C to -30° G range, the propeller and holding clamp worked loose and blew away. The propeller shaft was loose and wobbly and apparently separated from the generator. The wind speed was then determined by the hand held anemometer until the defective

equipment was replaced. While mounting the replacement detector on the mast, the plastic housing on the compass was broken. The extreme cold contributed to the brittleness of the plastic.

RECOMMENDATIONS

10. To improve the quality of field observations, some form of portable cloud measuring equipment should be devised.

11. During extended periods of extreme cold, dew point readings could not be determined. Modifications in current equipment should be investigated to overcome this problem.

12. The wind speed detector should be modified to withstand extreme cold and strong winds, perhaps a metal propeller is required with a stronger clamp to remedy the problem.

ATTACHMENTS

13. The following data attachments are provided:
   a. a summary of Cosmos Lake aviation weather 18 February to 27 MARCH 1978;
   b. a graphical depiction of surface air temperatures used to monitor ice strip conditions.

WEATHER RECORDS

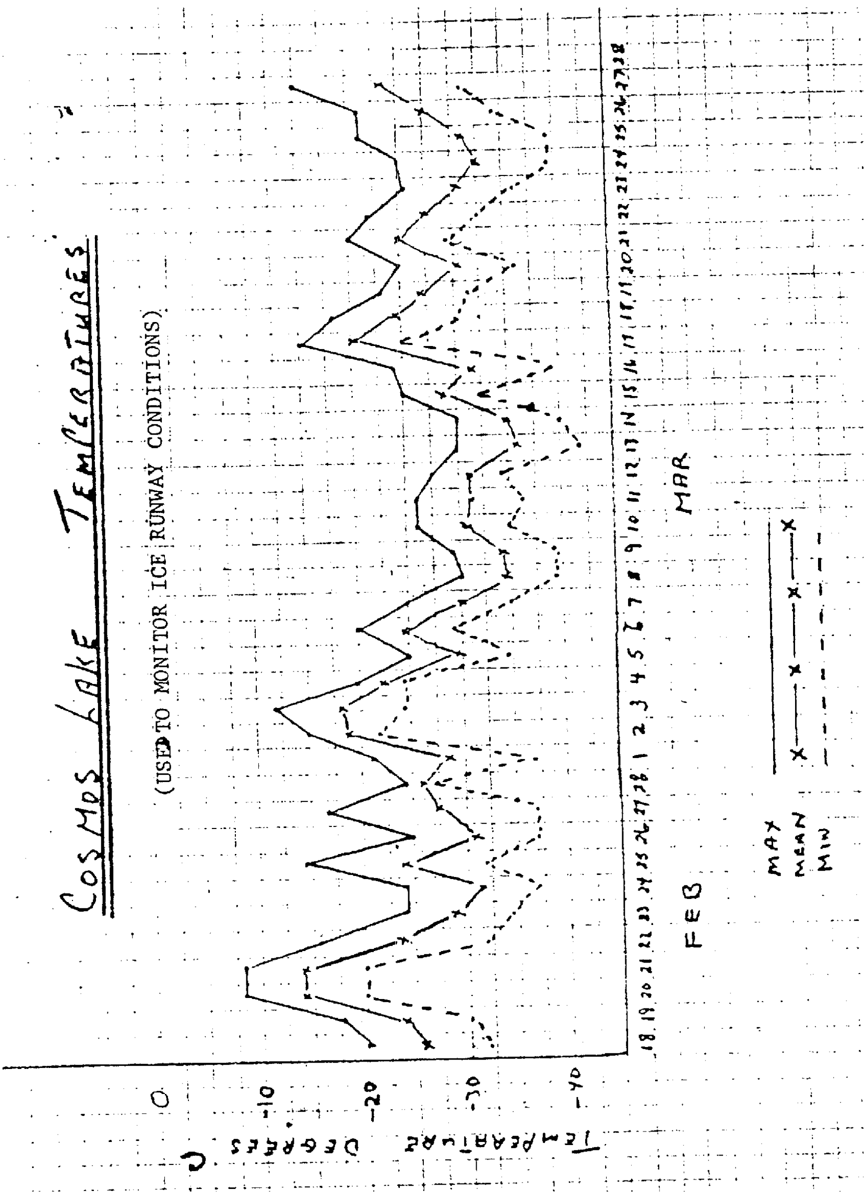
14. A record of weather observations taken at Cosmos Lake and those received from Warden's Grove are retained in the Canadian Forces Forecast Centre (CFFC), CFB Edmonton. This will be held for five years.

15. The observations for Warden's Grove were generally taken every six hours, OOOOZ, 0600Z, 1200Z and 1800Z. Not all observations were received at CFFC Edmonton owing to communication transmission problems.

COSMOS LAKE AVIATION WEATHER
BASED ON 12 HOUR DAY

63-221!

	FEBRUARY 1978						MARCH 1978					
	VFR	IFR	CLOSED	MAX	MIN	WIND	VFR	IFR	CLOSED	MAX	MIN	WIND
	1000 3 MI or more	Less 800 & 3	Less 600 & 2	Temp	Temp	Dir.+ Kts	1000 3 MI or more	Less 800 & 3	Less 600 & 2	Temp	Temp	Dir.+ Kts
1							11	—	1	-22	-36	3408
2							12	—	—	-15	-22	2415g25
3							12	—	—	-12	-22	2705
4							10	2	—	-19	-24	3512
5							11	1	—	-25	-35	Calm
6							12	—	—	-19	-28	L/V
7							12	—	—	-26	-35	L/V
8							10	2	—	-30	-39	0510
9							12	—	—	-29	-39	2205
10							2	9	1	-27	-35	3515g20
11							7	3	2	-26	-32	3210
12							12	—	—	-28	-34	1708
13							7	1	4	-31	-43	L/V
14							12	—	—	-30	-41	2006
15							12	—	—	-25	-33	1809
16							12	—	—	-24	-39	2108
17							12	—	—	-15	-24	2305
18	4	—	—	-20		3305	10	1	1	-18	-29	3315g25
19	8	4	—	-18	-31	2205	12	—	—	-23	-32	1808
20	6	1	5	-8	-30	2208	12	—	—	-24	-36	2505
21	11	1	—	-8	-20	3315g25	6	4	2	-20	-29	3408
22	12	—	—	-17	-31	3413	12	—	—	-22	-31	2707
23	10	2	—	-24	-34	3408	12	—	—	-26	-33	3208
24	12	—	—	-24	-37	1706	12	—	—	-25	-39	2208
25	11	1	—	-14	-31	1906	12	—	—	-22	-39	2207
26	12	—	—	-25	-37	3506	12	—	—	-22	-34	L/V
27	6	—	6	-17	-36	2110	11	1	—	-16	-31	0107
28	12	—	—	-24	-27	3412						
29										MEAN MAX	MEAN MIN	MEAN TEMP
30										-21.6	-32.7	-27.2
31												


COSMOS LAKE TEMPERATURES
(USED TO MONITOR ICE RUNWAY CONDITIONS)
TEMPERATURE DEGREES C
0
-10
-20
-30
-40
FEB
MAR
MAX
MEAN
MIN

APPENDIX 5
To Annex D
Part 1 F

A SHORT EVALUATION OF TENTS USED AT COSMOS LAKE

RESOURCES

1. The variety of tents used for accommodation Camp Garland were:
   a. five man Arctic;
   b. 10 man Arctic; and
   c. modular tents from 408 and 450 Sqn deployment stocks.

2. Other points:
   a. all tents had liners;
   b. flooring consisted of layered plastic, horsehair and plywood; and
   c. personnel slept in Arctic sleeping bags on air mattresses on floor.

3. Camp Garland was not a mobility situation but rather a short term fixed base camp.

OBSERVATIONS

4. Arctic tents probably served their purpose reasonably well as a mobile tent and were used as first accommodation until main camp was setup. Their limitations were:

   a. tent pegs useless in frozen Arctic tundra or in strong winds on snow. 15 inch steel nails were substituted;
   b. zippers failed frequently through repeated use on entrances;
   c. shape caused all heat to collect in peak leaving floor area always close to ambient outside temperatures. Tents such as the standard rounded top Polish tent used by UN Forces in the Middle East appear to be a more sensible design;
   d. insulation is very poor. Heat loss in strong winds extremely high; and
   e. method of heating by Coleman stove or heater in -40° C or colder is very poor - both a fire hazard, a carbon monoxide hazard and inefficient. The only efficient heat sources that existed were in tents belonging to the ATCCT who used electric load racks as heaters.

5. Modular tents had similar problems. These were roomy but peaked roof kept heat high and floors very cold. Heating methods went through many expensive experiments from Herman Nelsons to Coleman heaters to forced air furnaces, none of which proved entirely satisfactory and all of which left the sleeping areas on floors cold. Entrance doors to modular units were poor in that they could not be used both for access and to contain heat. Cold drafts at doors were legion.

6. To meet Canadian Arctic temperature and weather conditions, it was the unanimous conclusion of all who lived at Camp Garland that the CF are not well equipped to live satisfactorily in their own country under these circumstances. The basic problems were two:

a. tents were insufficiently insulated; and
b. efficient heat sources did not exist.

7. Insulation. In an area of fossil fuel energy conservation the waste of fuel caused by virtually no insulation was phenomenal. Early on, Herman Nelsons failed the colder it got with predictable regularity. When the last one would quit it took 30 seconds until one's breath was visible and the tent reached ambient outside temperatures within five minutes or less. The more enterprising entrepreneurs placed money on the most accurate time. An efficiently designed insulation that would reduce heat loss by a factor of say ten would have:

a. kept the tent warmer;
b. reduced the size of heater necessary;
c. reduced the amount of fuel used;
d. reduced the number of CC130 flights necessary to provide POL Log support; and
e. probably have reduced the fire hazard.

There is no doubt that a better insulated tent must be developed without delay.

8. Heat. The final solution to the heat problem was a system of two oil fired forced air furnaces in each tent at a cost of $18,000.00. These were not totally satisfactory, took one complete C130 load to fly in and were not sufficiently substantial for transport without extensive crating. The state of the art in heating technology should be vigorously pursued to provide the CF with adequate tent heating.

9. The value of warm accommodation is often denigrated as a lack of hardiness of the personnel in a field deployment. This is a wrong assessment of the problem. The job always gets done, but the time spent in survival, keeping warm and tending to poor equipment subtracts heavily from the tine available to get the prime mission

done. Scientists, helicopter crews and camp support people were badly hampered by the time and morale problems stemming from sleeping or getting up cold.

10. Therefore the shortcomings listed in paragraph 6 were the major tent faults at a fixed base camp. If an air portable camp of this nature is to be a CF capability, then the problems listed above must be addressed and a CF standard of Arctic equipment and employment be created second to none.

ANNEX D
Part 1 G

CAPE DORSET DETACHMENT - 11 - 22 MARCH 78
ON-SCENE CONTROLLER REPORT –
LIEUTENANT- COLONEL S. MCGOWAN

OVERVIEW

1. On 10 March 1978, two Inuit hunters from Cape Dorset discovered some unusual ice formations on a lake approximately twenty miles northwest of the town. This discovery was reported to the RCMP detachment at Cape Dorset and the information was brought to the attention of Operation Morning Light authorities. Since the discovery site was on the extension of the satellite fallout centerline, further investigation was considered warranted. Two civilian scientific personnel were sent to Cape Dorset to research the formations. The initial investigation was conducted by a ground party consisting of the two scientists, two RCMP members and the two Inuits. The initial team could not explain the phenomenon so further examination was ordered.

2. On 14 March 1978, a military/scientific team arrived in Cape Dorset by CC130. Commanding Officer 408 Squadron headed the team. One CH135 helicopter was transported by CC130 to Frobisher Bay for re-assembly. The helicopter arrived in Cape Dorset during the afternoon of 15 March 1978. A quick recce of the site was completed by the team the same afternoon. Initial radiation checks were made with negative results.

ESTABLISHMENT OF THE DETACHMENT

3. The Detachment consisted of thirteen[93] military and four civilian personnel. All personnel were fed and accommodated in the Kingnuit Hotel of Cape Dorset. A rented van provided transportation. The town provided a school classroom for use as an office/ workspace, etc. The RCMP Detachment provided all manner of continuous support.

4. The CH135 was parked on the ramp of the airport beside the fuel cache which had been delivered by CC130. The airport manager provided all necessary assistance including filing of flight plans, storage, front-end loader service, etc.

5. An Arctic tent was erected at the ice site and was equipped with necessary

[93] Marginalia: "11 originally + 3 from Fleet Diving School makes 14"

survival supplies should the helicopter become nonoperational for any reason.

6. The team consisted of an OSC, CH135 crew and maintenance crew, four civilian scientist (AECB[94], DOE[95], NRC[96]), two military engineers,[97] photographers,[98] an information officer,[99] one geological technician,[100] and three clearance divers.[101]

SUMMARY OF OPERATIONS

7. On the initial recce flight, the site was difficult to locate since the reported position was one mile south of the actual location. For the first four or five days, the team was flown to the site to conduct general investigation.

8. Captain Barr, CFB Edmonton supervised the engineering aspects including the drilling of holes, gridding the area, overall survey and engineering advice.

9. Dr. Paul Kennedy of AECB and Dr. Joe Tinney of DOE/LLL carried out extensive radiation surveys, took water samples and provided scientific advice. They concluded that there was no radiation hazard.

10. A diving team from CFB Shearwater joined the team with underwater camera equipment. Their services were not utilized primarily because of the difficulty of cutting a large number of three foot diameter holes in the ice which varied up to six to seven feet in depth.

11. A technician from R.M. Eardy and Associates Limited of Calgary made a magnetic survey of the area searching for metal debris. Results were negative although the equipment was not designed to detect an object under one cubic meter in size.

12. Dr. R Frederking of NRC arrived late in the operation. He took ice core samples and cut cross-sectional samples. These samples were viewed under polarized light. From inspection of the area and the samples, Dr. Frederking postulated that

[94] Marginalia: "Paul Kennedy"
[95] Marginalia: "Joe Tinney / 'Rick' or Don Rickard"
[96] Marginalia: "Dr. R. Frederking"
[97] Marginalia: "Capt Garry Barr / CWO Jack Ritchie"
[98] Marginalia: "WO Jack Lasey"
[99] Marginalia: "Capt Dave Preikshot"
[100] Marginalia: "Colin MacDonald"
[101] Marginalia: "Lt Bill Lang or Laing / MWO Bill Malott / Sgt Joe Laflamme"

the formations were a natural phenomenon.

13. CH135120 flew 21.6 hours in support of this operation with few minor problems. Helicopter operations are discussed under 'Flight Operations Rotary Wing'.

14. Towards the end of the operation, a village elder from Cape Dorset was flown to the site. After observing the phenomenon, he recalled that he had observed similar ice formations many years before.

CONCLUSION

15. It was generally concluded fairly early in the operation that the ice formations were not satellite-associated. However, a single plausible explanation was not readily apparent. Subsequently, further technical and scientific consultation was sought.

16. It is concluded that the Cape Dorset ice formations investigated were a natural phenoenon most likely caused by a mid-winter pressure-oriented break up of ice in a canyon, overlooking and leading into, the lake at the investigation site in conjunction with an "underground" type water flow at the edge of the lake.

REDEPLOYMENT

17. The majority of the team and supplies redeployed to Edmonton by CC130 on 20 March 1978. The remaining scientists departed Cape Dorset by commercial air on 22 March 1978.

18. CH135120 flew to Frobisher Bay on 22 March 1978 for dismantling and return by CC130.

ANNEX E
Part 1 A

SPECIALIZED EQUIPMENT
MICRO WAVE RANGING SYSTEM

Reference: A. UCR D0127/8082 dated 21 April 1978

GENERAL

1. When it became apparent that the initial over flights by CC130 sensor equipped aircraft may not have covered all of the sectors due to navigation constraints, it was decided by US DOE to use a Micro Wave Ranging System (MRS). The MRS consisted of two ground stations transmitting positional data to an airborne unit where a calculator and processor computed the precise location of the aircraft.

US MRS

2. The first MRS used in Operation Morning Light was installed by US DOE personnel in CF C130 sensor equipped aircraft. The system was used extensively until such a time when a Canadian MRS was leased, installed and made operational in another CC130 aircraft.

3. During the US MRS operations, DND support was provided in assisting DOE personnel to install the equipment in the aircraft and to prepare the ground stations for remote unattended 48 hour operation. Specially insulated boxes were locally constructed to house the equipment. Each station was equipped with two Nickel Cadium aircraft batteries to enhance and prolong cold temperature operation.

4. The first US MRS missions were flown in Sector One. The Yellowknife Detachment was responsible to position the two ground stations as specified by the Edmonton Command Post and to replace the batteries every two days with new fully charged units. Refer to Annex D for the Yellowknife OSC report on this part of the MRS operation.

CANADIAN MRS

5. To enable the Canadian takeover of the MRS operations to free the US MRS for other domestic commitments, the following items were obtained on a rental basis from Marinav Corporation Ottawa:

a. two remote transmitter/receivers;
b. master transmitter/receiver;

c. distance measuring unit;
d. HP9825A calculator and "214" processor; and
e. attaching cables.

The following items were purchased from Marinav by DND:

a. left/right indicator (navigator) ;
b. power supply;
c. data output cable; and
d. cassettes.

6. The Micro Wave Ranging system was interfaced with Energy Mines and Resources recorder/computer. Complete documentation on manufacture of accessories and installation as applicable to Hercules aircraft is contained in a "Special Information Leaflet" forwarded to NDHQ under cover of Reference A.

7. <u>Technical Description of MRS Operation</u>: The remote trisponders (ground stations) were placed in pre-determined locations approximately 25 kilometers apart and were triggered from signals from the aircraft master trisponder on command from the Distance Mileage Unit. Distance was obtained by measuring the round-trip travel time of RF signals transmitted between master and remote. The best accuracy obtained was +6 meters, however some degradation of accuracy was inevitable due to the large separation of the two ground stations. (The manufacturer recommended 15 kilometers separation, however this was not feasible for Morning Light and some loss of accuracy was deemed acceptable in order to cover a large area more effectively. The best range obtained was 83 kilometers on a trial with one station). Each distance measurement requires about 1 ms and the indicated average is updated once per second and displayed in digital form on two displays on the DMU. This electronic positioning system provided accurate distance information from the airborne master to the two known ground locations, and were utilized,as in the case of "Morning Light", to determine the exact location of radioactive material as the aircraft flew on a pre-determined survey line and passed overhead. The distance off pre-determined track was computed and indicated on L/R indicators to assist pilots in correcting flight pattern and flying a true track. The calculator fed signal data to the EMR recorder which provided a graphic print-out of "hits". This was subsequently overlaid on aerial survey maps for pin pointing debris.

8. <u>Operation of the Airborne MRS</u>. While the US MRS team were self sufficient and provided their own operators; the Canadian version required a crew to operate the calculator/processor on each mission. It was decided therefore to use Aircrew Navigators to man this position on the basis that some knowledge of navigation was definitely required to ensure that each mission would be successful.

Maritime Command was tasked to provide Navigator personnel.

9. The first Navigator to arrive on the scene at CFB Edmonton was Maj Frieson from 415 Squadron Summerside. He was given the task of overseeing the test and trial of the installed equipment and to develop (with MARINAV) operating instructions to be used on each mission. After many long hours of work for several consecutive days and evenings the system finally was declared operationally ready 02 MARCH 1978. Subsequently until the termination of MRS operations 07 April,[102] Maritime Command provided a total of nine navigators. These personnel rotated throughout the whole period.

<u>NICAD BATTERY CHARGING</u>

10. To power the remote "Trisponders" a DC power supply (23-32 volts) was required. Due to the extreme temperatures (minus 40 and below), NICAD batteries were selected. Four ground stations, each containing two remote trisponders and two batteries were utilized in pairs. Batteries were removed after two days operation for recharging. To negate the requirement to ship or fly to home base for batteries temporary NICAD charging facilities were established at Yellowknife and Cosmos Lake in support of operation.

11. The Yellowknife facility commenced operations 04 February and ceased 18 February. It was re-opened 02 March and finally terminated 16 April. The Cosmos Lake facility operated from 19 February until 22 March.

12. <u>Manpower Utilized</u>. At Yellowknife a total of 91 mandays were spent to support this task while at Cosmos Lake, some 57 mandays were required.

<u>TECHNICIAN MANPOWER</u>

13. In support of the Canadian MRS the following technical manpower was spent:

a. CFB Edmonton (in support of initial aircraft configuration and testing); approximately 400 man hours;
b. Yellowknife (in support of Battery recharging); 91 man days; and
c. Cosmos Lake (battery recharging); 57 man days.

14. At the onset and during "Operation Morning Light" CFB Edmonton was

[102] Marginalia: "8 April"

engaged in "Exercise Arctic Express" and "Boxtop" which had depleted unit strength considerably. On request Air Command allotted to Base on Temporary Duty four additional technicians for the direct support of MRS operations.

SUPPORT EQUIPMENT

15. In support of the operation and the NICAD Charging facilities a total of six chargers, 45 NICAD batteries, four digital voltmeters and miscellaneous tools, spare cells and charging equipment were utilized in the system. A tent which was completely destroyed by fire at Cosmos Lake housed the NICAD Battery Shop. Losses were:

NSN	ITEM	QTY/COST	TOTAL
6140-21-867-6802	MAS NICAD Battery	8/$1,002.25	$8,018.00
6625-21-874-1317	Digital Voltmeter	1/ 275.00	275.00
6130-00-616-8863	Christie Charger	1/ 3,000.00	3,000.00
6130-21-847-1783	Sonotone Charger	2/ 1,320.00	2,640.00
6625-21-805-7868	Multimeter	1/ 335.00	335.00
Sub Total			$14,268.00
Miscellaneous Tools (B and C Class)			115.46
Six Cells and Charging Equipment			150.00
Total Loss			$14,533.46

Write-off action has been implemented.

TERMINATION OF MRS OPERATIONS

16. The Canadian MRS was removed on completion of exercise from aircraft on 8/9 April 1978. The rental equipment as returned to Marinav Ottawa on 16 April 1978.

17. As directed by NDHQ, the equipment purchased by DND, has been dispatched to CFB Ottawa for storage.

PROBLEMS ENCOUNTERED

18. One of the first problems encountered with the Canadian MRS was that the software program erroneously assumed that the geographical location of each trisponder (ground station) would be precisely surveyed. As this was not practical in the remote regions of Great Slave and Cosmos Lakes, the US MRS used a series of calibrating flights to fix each ground station location. Consequently a software modification to the Canadian MRS was required.

19. A second problem was that some of the equipment was unserviceable when received at CFB Edmonton and installed in the aircraft. Repairs by the Company

Technician Representative were required.

20. A third problem was that the aircraft antenna supplied by Marinav was not suitable for airborne use. The overall length of the antenna was too short. This caused poor range. The problem was temporarily resolved by installing a three-inch waveguide extension. It was learned that an antenna suitable for airborne use had been developed by Del Norte, Texas. NDHQ was requested to procure it. In the meantime the "bucksheed" antenna lasted only one week. It broke off in mid-air. Renewed efforts to hasten the new antenna from Texas was finally successful 16 March. A test trial showed the new antenna performance to exceed the manufacturer's specifications.

21. A fourth problem was that the software tapes provided by MARINAV did not have one sub-routine included in the program. This caused some confusion and several aborted missions until it was determined what actually was wrong. The problem was resolved by manual inputs until new corrected tapes were received from MANINAV

22. A fifth and final problem was that one of the interface cables became intermittently unserviceable during the last ten days of MRS operations. This caused considerable delay while the fault was investigated and finally isolated. This type of fault was particularly difficult to troubleshoot as its symptoms were misleading. A systematic check of all MRS components finally isolated the troublesome cable.

CONCLUSIONS

23. The Canadian MRS operations, in spite of the equipment and software problems, proved to be successful. Approximately 60 percent of the Sectors were covered by the Canadian MRS.

24. The MRS provided accurate navigation for an area approximately 80 kilometers long. Beyond this range, the MRS ground stations become limited by line of sight at low altitude. Some increase in range is possible at higher altitudes.

25. The typical grid lines flown were 1500 feet apart at an altitude of 700 feet. Approximately 2,500 square miles were flown by Canadian MRS.

RECOMMENDATIONS

26. Application of the MRS might be possible for check out of the Command Post 140 Aurora TAC NAC system. It is recommended that this possible use be

investigated by NDHQ.

27. Software problems experienced in this Operation support the requirement to test the program under actual operational conditions to ensure to false parameters were included and to ensure all elements of the mission are catered to. For future software projects, provisions must be made for final check out and modification.

28. An MRS Operating Procedures Guide is available on Morning Light files at CFB Edmonton.

ANNEX E
Part 1 B

SPECIALIZED OPERATIONS
1 CONSTRUCTION ENGINEERING UNIT

INTRODUCTION

1. Under authority of 1 CEU Project Instruction 77-CEU-39 1 CEU was to provide one officer as part of long range recovery program planning staff AECB/DOE Edmonton. On 1 February 1978 Lieutenant- Colonel Downs, CO 1 CEU, and Lieutenant Bolohan, the designated officer, arrived at CFB Edmonton to learn of further details. In a warning order drafted by the Commanding Officer 1 CEU the probable tasks indicated were cutting ice, installation of sheet pile coffer dam and assistance on ice runway preparations, though these tasks never materialized others did.

2. Three Recces were carried out by 1 CEU personnel and they were:
   a. to describe the condition of a used drilling camp and its suitability for use as a temporary camp for Operation Morning Light;
   b. to select a site for a used camp in the Cosmos Lake area; and
   c. to determine the feasibility of constructing a summer use airstrip near Cosmos Lake.

3. Under authority of 1 CEU Project Instruction 77-CEU-44 1 CEU provided ablution facilities in support of the tented base camp at Cosmos Lake.

4. Under authority of 1 CEU Project Instruction 77-CEU-44 1 CEU carried out an engineering study on the ice strip prepared on the surface of Cosmos Lake.

TASKINGS

5. Advisory Stage. 1 CEU was not involved in the siting of the base camp at Cosmos Lake or in the selection and siting of facilities incorporated in the camp design. Under authority of 1 CEU Project Instruction 77-CEU-39 personnel from 1 CEU did go to Cosmos Lake but only to complete a Reece for the location of a Hercules transportable camp which was examined by other 1 CEU personnel simultaneously However, once at Cosmos Lake 1 CEU's Project Officer was requested to measure the ice thickness and report on the ice strip conditions daily. As part of the recce for an air transportable camp water samples were obtained and returned to Edmonton for testing.

6. Semi-Permanent Camp - Hercules Transportable. On 6 February 1 CEU was tasked to determine the availability of a Hercules transportable camp which could provide rapid available accommodation for an indefinite period for approximately 40 to 60 Morning Light personnel at Cosmos Lake. A camp was located. A camp in use by Bawden Drilling Company south of Grande Prairie Alberta was investigated. This camp included a kitchen unit, a washcar, a superintendent's office, a cook's quarters, a recreation unit and three sleepers. Power was provided by two caterpillar 250 KVA diesel generators. The recce report concluded the camp was suitable for use as a temporary camp at Cosmos Lake. It was possible to deliver the camp to Edmonton by 14 February 1978 if the decision was received to go this route. A detailed report was hand delivered to the Base Commander CFB Edmonton on the 22 February 1977 for consideration if ever the operation became extended and a more permanent facility were required.

7. Summer Operation Airfield Cosmos Lake. On the 24 February 1 CEU was requested to carry out a cursory recce to determine the feasibility of constructing a gravel airstrip near Cosmos Lake for use by Buffalo or Hercules aircraft during the summer. A recce report was to include determining the equipment requirements and time to construct. A recce was completed by helicopter within a 10 mile radius of the camp at Cosmos Lake. Assuming approximately 200,000 cubic yards to be moved, to complete an airstrip in two months, April and May, a crew of 100 men with 36 pieces of heavy construction equipment would be required material to construct a gravel airstrip near Cosmos Lake would have to be drilled and blasted from a rock quarry. The recce report concluded the construction of a summer airfield at Cosmos Lake would be an extremely difficult and costly undertaking. Approximate cost for construction including equipment purchase and explosives is 7.5 million dollars (did not include transportation).

8. Ablution Facilities - Cosmos Lake. On the 13 February 1978 1 CEU was tasked to provide ablution facilities in support of the base camp at Cosmos Lake. The facilities consisted of a Hercules transportable wash unit consisting of two helicopter portable units which had been in storage at ATCO Structures Limited Calgary, Alberta. Water was supplied to the unit by means of a heat traced plastic pipeline. Two (2) 50 kilowatt diesel generators produced the necessary electrical power for the unit. The installation was completed within a period of 15 days. The project report concluded that the facilities installed were a viable solution to the engineering problem of providing ablution facilities at Cosmos Lake. The report also recommended the facilities and construction materials used to complete the project less the diesel generators be located in Winnipeg under 1 CEU's care for future use by DND.

9. Engineering Study of Ice Airstrip - Cosmos Lake. In early March, 1 CEU was tasked to provide an engineer to monitor the performance of the runway and to offer advice on the structural safety of the ice to the Camp Commander who was responsible· for the control of the aircraft using the strip. 1 CEU proposed that, instead of judging the ice's capabilities by only visual inspections and ice thickness measurements, the ice strip advisor could take readings of various ice properties as well. The monitoring of these properties could indicate such things as impending strength loss or gradual fatigue of the ice. It could provide data for research purposes. On site, the project commander supervised the patching of the worst cracks and the measuring of ice thickness while awaiting the arrival of his equipment. However, it was announced that the camp would be closed out by 01 April 1978, and the plan to conduct a number of continuing tests of the ice was abandoned. Generally the icestrip was operated and maintained in accordance with the guidelines presented in ATCP 1409. The project report concluded ATCP 1409 was successfully used as a guide to operate the ice strip although conditions were never really hazardous enough to test the validity of the limits imposed by it. The project report also recommended ATCP 1409 be updated and adopted as an official publication and distributed appropriately.

OBSERVATIONS

10. After a few days of Operation Morning Light had elapsed, it became evident that engineering problems were going to be numerous and varied. BCEO CFB Edmonton appointed an Engineer Captain to be full-time engineering staff officer to the Command Post, to act as the Commander's advisor and focal point for resolution of engineering problems.

11. The tented camp was suitable for initially getting personnel on the ground, however, a more permanent camp could have been established for personnel comfort and safety and to reduce the necessary airlift and personnel support required to maintain a tented camp. The ATCO Hercules transportable camps are too bulky and wasteful of aircraft time for their purpose, and time factors in finding them, producing reports, etc precluded their use, and there does not exist within DND a semi-permanent camp complete with a heat water, sewer and power package for accommodating personnel in an Arctic environment. The tented camp provided reasonable shelter and the operation continued but at necessary discomfort to personnel.

RECOMMENDATIONS

12. It is recommended:

a. that engineer staff continue to be provided in Command Posts for their professional knowledge when planning for and participating in a field operator.;
b. that DND develop a semi-permanent camp (a prefab, knockdown, manually constructed unit) complete with a heat, water, sewer, and power package to operate in an Arctic environment;
c. that the helicopter transportable ablution units be returned to 1 CEU CFB Winnipeg Inventory and NDHQ/DMER control their use for similar operations; and
d. that an engineering agency in DND be tasked to update ATCP 1409 and acquire ice airstrip construction expertise.

ANNEX F
Part 1 A

CANADIAN SCIENTIFIC ACTIVITIES
ATOMIC ENERGY CONTROL BOARD (AECB) SUMMARY REPORT

1. The Atomic Energy Control Board was first advised of the possible impact of Cosmos 954 in Canada, and of the AECB's responsibility for recovery, storage and disposal of radioactive debris at a meeting convened by the Privy Council Office on the afternoon of January 23, 1978. Following the reports of the re-entry of the satellite on January 24, AECB staff were alerted for possible aerial and ground search and recovery operations, and representatives of the Department of Energy, Mines and Resources were briefed by AECB on possible requirements for EMR or civilian contractor assistance in the aerial search.

2. Immediately following receipt of the first report of a radioactive contact by EMR on January 26, a five man team from AECB left for Edmonton by DND special air flight to open an AECE office to provide Canadian health physics, nuclear criticality, radiation monitoring, nuclear transportation and scientific coordination capabilities at the search headquarters. For the duration of Operation Morning Light the size and composition of the AECB staff varied to suit the on-site requirements for those capabilities, in Edmonton, Yellowknife and Cosmos Lake. Additional staff were loaned to AECB by Atomic Energy of Canada Limited to supplement AECB resources in the radiation monitoring and transportation areas and by DND/DREO for scientific coordination.

3. The AECB immediately assumed responsibility for the supervision of the recovery of all satellite debris and for its recording and transportation in accordance with the rules of legal evidence, to Edmonton and on to a storage site at the Atomic Energy of Canada Limited Whiteshell Nuclear Research Establishment (WNRE) at Pinawa, Manitoba.

4. The AECB arranged with Atomic Energy of Canada Limited for WNRE to conduct any necessary analyses on the satellite debris, to provide timely information for the protection of the health and safety of personnel involved in the search and recovery operations, and to provide data to assist in the rapid location and recovery of other debris which might be hazardous to persons or to the environment. Requests for analysis were passed to WNRE the AECB Scientific Coordinator in Edmonton following consultation with the US scientific component in Edmonton, and results of the analyses were sent to Edmonton, and to AECB Ottawa, for assessment and use in the ongoing search and recovery operations.

5. The AECB developed radiation protection criteria to determine the lower limit of radioactivity allowable for the conduct and eventual completion of the search and recovery operation, to ensure the health and safety of the public and the protection of the environment.

6. The AECB provided scientific advice and assistance to the Department of External Affairs in connection with the Cosmos 954 incident and the Canadian initiative in the United Nations concerning the use of nuclear power sources in satellites. The AECB prepared lists of questions for External Affairs to pass to the Soviet Government, to obtain information on the reactor which would assist in planning and conducting the search and recovery operations, and assessed the replies received. A senior officer of the AECB attended the 16th Session of the Science and Technology Sub-Committee of the UN Committee on the Peaceful Uses of Outer Space, to provide technical advice to the Canadian Delegation in connection with its posture and declaration to the Sub-Committee.

7. A more detailed report of the Atomic Energy Control Board's activities in connection with Cosmos 954 will be published by the AECB on completion of the proposed search and recovery operation to be conducted by the AECB during the summer of 1978.

ANNEX F
Part 1 B

CANADIAN SCIENTIFIC ACTIVITIES

DND SCIENTIFIC ACTIVITIES

1. The Director General of Intelligence and Security and the Defence Research Establishment Ottawa (DREO), became involved in Operation Morning Light at the invitation of AECB. AECB personnel in Edmonton were relying heavily on United States scientific expertise in the conduct of day to day search and recovery operations. It was realized by AECB that should a US nuclear emergency occur, the US scientific team would have to be withdrawn to respond to the emergency. As lead agency, AECB requested DND assistance to augment their scientific team in Edmonton. Initially, a team consisting of two scientists, (Dr. E.G. Leger and Mr. G.L. Dufresne) of the Directorate of Scientific and Technical Intelligence (DSTI) and a Warrant Officer (J.W. Webster) from the Directorate of Defence Intelligence, was sent to Edmonton to aid in the scientific coordination and prepare for the orderly transition from US-Canadian personnel to all Canadian personnel. This team was on duty from 13 February to 28 February inclusively. They were replaced by officers from DSTI and DREO (Mr. D.G. Thacker and Dr. R. Herning) who were on duty from 28 February to 14 March. Finally, from 14 March to 28 March, Dr. B. Farnworth of DREO was the only DND scientist involved at Edmonton. At that time, the search and recovery efforts were winding down.[103]

2. The primary task of DND scientists in Edmonton was in support of AECB's overall concern for health safety. Prior to the arrival of DND scientific personnel, the Scientific Coordination Office had been organized by the US team and was responsible for maintaining records of the scientific activities in support of the search and recovery activities. The records first consisting of only a few items, rapidly evolved to a large number of items in response to the increasing number of detected and recovered debris. Beside the main task of coordinating the scientific information, one of the first actions taken was to establish a daily report on the scientific developments. This report, which was issued by the Base Commander, was complementary to the situation report (SITREP) and consisted of the following: a summary, a list of new hits detected, a list of hits recovered with a few words describing the debris, a list of hits detected usually due to natural radioactive sources, and a box score showing total hits deleted, removed, deleted and outstanding. It was distributed to all Morning Light agencies in Edmonton, to the Whiteshell Nuclear Research Establishment

[103] Marginalia: "Farnworth was replaced by Dr. 'Jack' Purdie (DREO) who stayed till the end. Telecon DHist Purdie, 11 Oct 79; DHist 79/377, F3"

(WNRE) in Winnipeg, and to the National Defence Headquarters (NDHQ), the Defence Research Establishment Ottawa (DREO), and the Atomic Energy Control Board (AECB) all located in Ottawa. Although these reports were insufficient to permit scientific evaluation by themselves they were however valuable to the personnel directly involved- in the conduct of the search and recovery of satellite debris. A point worth noting· is that all hits were reported in grid coordinates, as used in the field by the search and recovery personnel, and not in latitudes and longitudes as done previously. The conversion from grid to geographic and vice-versa had led to inaccuracies and necessitated a considerable amount of time. Other actions were also taken such as the use of additional visual aids in displaying data on wall maps, tables and a scoreboard so that those directly involved would know at a glance the status of the search.

3. The Scientific Coordination Office provided data and responded to tasking by the Base Commander. Specifically, the office produced hit assessment data necessary for the optimum tasking of aircrafts and ancillary equipment essential to the detection and recovery operations. At the request of the Command Centre, the office also provided technical planning data for the tasking of the Canadian MRS coverage, and issued priority assessments for the investigation and recovery of detected hits. These duties were carried out by all DND scientists assigned to the Scientific Coordination Office in Edmonton.

4. The WO, part of the initial DND team, was assigned to the US photographic team and was given the responsibility of managing the AECB contract for the processing of all photographic material used in conjunction with Operation Morning Light. At that time, all photographs were being taken by US technical photographers. The WO was also given the task of providing the Base Commander with a list of DND service personnel and the necessary photographic equipment required to take over all photographic activities after the departure of the US team. Photo taking and processing equipment was purchased to make the Canadian Armed Forces completely self sufficient. Subsequently, after having successfully planned the transition, the WO was replaced by service personnel from Air Command. The WO's plan was successfully implemented.

5. Meanwhile, in Ottawa, DSTI set up a centre to collate and record all technical data relevant to the satellite. DSTI is continuing to coordinate the collection and reporting of the technical details of the satellite derived from analysis of the recovered material.

6. As recovered material began to arrive at Whiteshell Nuclear Research Establishment (WNRE) for analysis and storage, the AECB asked for an officer from DREO to coordinate the flow of analytical information which could assist in the

search. Secure communications were established with Ottawa and Edmonton, using the facilities of CFS Beausejour. The DREO officer was active in deciding the order of priority for analysis to be given to the fragments arriving at WNRE. Assistance was given in writing summary reports of the analytical results and in particular, comprehensive reports were drafted on the sets of specimens known as the “Antlers” and on the numerous pieces of beryllium.

ANNEX G

RESULTS

The following parts to Annex G are provided by AECB as a result of the “hit” control activities of DSTI/DREO personnel and the field recording activities of AECB personnel. These are updated to 19 October 1978 as per AECB Document 15-200-24-0.

ANNEX G
Part 1

OPERATION MORNING LIGHT
"HITS" REPORT

HIT NO.	POSITION	MEANS FOR DISCOVERY	DESCRIP-TION OF FRAGMENT	DISPOSITION	REMARKS
ML-1 (1)	WE 764 679	Cdn. high altitude search 26/1/78	Charred metal piece approx. 22 cm x 7.5 cm x 2.5 cm.	Recovered 4/2/78 Shipped to WNRE 6/2/78	
ML-2 (1)	WE 948 803	US MRS 5/2/78 and 7/2/78	Charred metal rod approx. 10 cm long x 2.5 cm diam.	Recovered 15/2/78 Shipped to WNRE 17/2/78	
ML-3 (1)	WE 468 672	US MRS 25/1/70			Deleted – Geological Occurrence
ML-4 (1)	WE 990 758	Cdn. MRS 30/1/78			Deleted - results of MRS flights 5/2/78 and 7/2/78 indicate. Probable confusion with ML-12 (1)
ML-5 (1)	WE 746 717	Ground search 29/1/78	Rod similar to ML-2 (1)	Recovered 31/1/78 Shipped to WNRE 6/2/78	Found while searching for ML-1 (1)
ML-6 (1)	WE 959 809	Cdn. MRS 30/l/78	Rod similar to ML-2 (1)	Recovered 10/2/78 shipped to WNRE before or on 17/2/78	
ML-7 (1)	WE 764 673	Cdn. MRS 30/1/78			Deleted- Considered name item as ML-1 (1)
ML-8 (1)	XE 007 798	Cdn. MRS 30/1/78			Deleted - suspect it is ML-12 (1) from MRS flight results 5/2/78 and 7/2/78
ML-9 (1)	WE 879 812	Cdn. MRS 30/1/78			Deleted - not confirmed by MRS flights

					5/2/78 and 7/2/78- possible confusion with ML-20 (1)
ML-10 (1)	WE 678 715	Visual from air 31/1/78	Hollow cylinder approx. 50 cm long x 25 cm diameter and 12 fragments various sizes	Recovered 31/1/78 one fragment shipped to RCMP lab around 1/2/78 Reminder shipped to WNRE	Not Radioactive
ML-11 (1)	WE 946 818	Ground search 1/2/78	Rod similar to ML-2 (1)	Recovered 2/2/78 Shipped to WNRE around 1st week of Feb./1978	Found while searching for ML-2 (1)
ML-12 (1)	XE 006 765	Visual & hand instruments from helicopter 2/2/78	Piece of ribbed sheathing, approx. 6 cm long and 4 cm wide	Recovered 3/2/78 Shipped to WNRE around 1st week of Feb./1978	
ML-13 (1)	WE 016 740	MRS 5/2/78	Rod similar to ML-2 (1)	Recovered 20/2/78 Shipped to WNRE 2/3/78	
ML-14 (l)	WE 880 760	MRS 5/2/78			Deleted - false hit
ML-15 (1)	WE 603 667	MRS 8/2/78	Rod similar to ML-2 (1)	Recovered 4/3/78 Shipped to WNRE 7/3/78	
ML-16 (1)	WE 745 710	MRS 7/2/78	3 small flakes in snow	Recovered 20/2/78 Shipped to WNRE 2/3/78	
ML-17 (1)	WE 820 749	MRS 7/2/78			Deleted- geological occurrence
ML-18 (1)	WE 039 743	MRS 0/2/78			Deleted- geological occurrence
ML-19 (1)	WE 074 766	MRS 5/2/78 & 7/2/70	Rod similar to ML-2 (1)	Recovered 26/2/78 Shipped to WNRE 2/3/78	
ML-20 (1)	WE 001 770	MRS 5/2/78 & 7/2/78	Rod similar to ML-2 (1)	Recovered 26/2/78 Shipped to WNRE 2/3/78	
ML-21 (1)	WE 977 847	MRS 7/2/78			Deleted- geological

					occurrence
ML-22 (1)	WE 503 539	MRS 16/2/78	Flake; black, size of a potato chip	Recovered 10/2/78 Shipped to WNRE 19/2/78	
ML-23 (1)	WE 250 488	MRS 16/2/78	Rod similar to ML-2 (1)	Recovered 2/3/78 Shipped to WNRE 5/3/78	
ML-24 (1)	WE 183 424	MRS 16/2/78	Part of rod similar to ML-2 (1) 5 cm long	Recovered 18/2/78 Shipped to WNRE 20/2/78	
ML-25 (1)	WE 942 110	Confidential origin 2/3/78			Deleted- geological occurrence
ML-26 (1)	WE 142 666	MRS 17/3/78			Deleted- MRS error
ML-27 (1)	WE 435 750	MRS 17/3/78			Deleted- MRS error
ML-28 (1)	WE 319 545	MRS 17/3/78			Deleted- MRS error
ML-29 (1)	WE 444 620	MRS 17/3/78			Deleted- high natural background
ML-30 (1)	WE 211 686	MRS 17/3/78			Deleted- nothing found by helicopter check flight
ML-31 (1)	WE 134 406	MRS 17/3/78			Deleted- nothing found by helicopter check flight
ML- 32 (1)	WE 033 849	Helicopter 21/3/78	Rod similar to ML-2 (1)	Recovered 5/4/78 Shipped to WNRE	
ML-33 (1)	WE 495 585	Helicopter 23/3/78	Metal fragment approx. 7.5 cm x 2.5 cm x 0.3 cm	Recovered 24/3/78 Shipped to WNRE	
ML- 34 (1)	WE 925 807	MRS 7/4/78			Deleted- nothing found by helicopter check flight
ML-1 (2)	XE 249 969	US high altitude search 25/1/78			Deleted- increase in natural background

ML-2 (2)	XE 154 906	MRS 5/2/78	Rod similar to ML-2 (1)	Recovered 28/2/78 Shipped to WNRE 5/3/78	
ML-3 (2)	XE 116 880	Formation Flight US equipment 1/2/78			Deleted- not confirmed by MRS flights 7/2/78 and 8/2/78
ML-4 (2)	XE 189 912	Formation flight US equipment 1/2/78			Deleted- not confirmed by MRS flights 7/2/78 and 8/2/78
ML-5 (2)	XF 430 009	Formation flight US equipment 1/2/78			Deleted- not confirmed by MRS flights 7/2/78 and 8/2/78
ML-6 (2)	XE 074 866	MRS 5/2/78	Rod similar to ML-2 (1)	Recovered 13/2/78 Shipped to WNRE 14/2/78	
ML-6 (2) 11	XE 074 066	Helicopter 5/4/78	Rod similar to ML-2 (1)	Recovered 5/4/78 Shipped to WNRE	
ML-7 (2)	XE 049 861	MRS 5/2/78	Rod similar to ML-2 (1)	Recovered 13/2/78 Shipped to WNRE 14/2/78	
ML-8 (2)	XE 090 881	MRS 5/2/78	Rod similar to ML-2 (1)	Recovered 13/2/78 Shipped to WNRE 14/2/78	
ML-9 (2)	XE 020 845	MRS 5/2/78 & 7/2/78	Rod similar to ML-2 (1)	Recovered 2/3/78 Shipped to WNRE 5/3/78	
ML-10 (2)	XE 251 946	MRS 7/2/78	Rod similar to ML-2 (1)	Recovered 3/3/78 Shipped to WNRE 5/3/78	
ML-11 (2)	XE 300 975	MRS 7/2/78 Helicopter 5/4/78	Rod similar to ML-2 (1) small flakes	Recovered 3/3/78 Recovered 6/4/78 Shipped to WNRE	
ML-12 (2)	XE 100 085	MRS 7/2/78 Helicopter 5/4/78	Rod similar to ML-2 (1) second rod similar to ML-2 (1)	Recovered 6/3/78 Recovered 6/4/78 Shipped to WNRE	
ML-13 (2)	XE 125 879	MRS 8/2/78	Rod similar to ML-2 (1)	Recovered 3/3/78 Shipped to WNRE 5/3/78	

ML-14 (2)	XE 131 884	MRS 8/2/78	Rod similar to ML-2 (1)	Recovered 4/3/78 Shipped to WNRE 7/3/78	
ML-15 (2)	XE 159 903	MRS 7/2/78	Rod similar to ML-2 (1)	Recovered 26/2/78 Shipped to WNRE 7/3/78	
ML-16 (2)	XE 206 936	MRS 7/2/78	Rod similar to ML-2 (1)	Recovered 28/2/78 Shipped to WNRE 5/3/78	
ML-17 (2)	XE 220 932	MRS 8/2/78	Rod similar to ML-2 (1)	Recovered 3/3/78 Shipped to WNRE 5/3/78	
ML-18 (2)	XE 219 912	MRS 8/2/78	Rod similar to ML-2 (1)	Recovered 5/3/78 Shipped to WNRE 7/3/78	
ML-19 (2)	XE 230 913	MRS 8/2/78	Rod similar to ML-2 (1)	Recovered 5/3/78 Shipped to WNRE 7/3/78	
ML-20 (2)	XE 318 961	MRS 8/2/78	Rod similar to ML-2 (1)	Recovered 5/3/78 Shipped to WNRE 7/3/78	
ML-21 (2)	XE 325 968	MRS 8/2/78	Rod similar to ML-2 (1)	Recovered 5/3/78 Shipped to WNRE 7/3/78	
ML-22 (2)	XE 338 959	MRS 10/2/78			Deleted- MRS reference error- probably ML-20 (2)
ML-23 (2)	XE 354 974	MRS 10/2/78	Rod similar to ML-2 (1)	Recovered 5/3/78 Shipped to WNRE 7/3/78	
ML-24 (2)	XE 344 965	MRS 10/2/78			Deleted- MRS reference error- probably ML-21 (2)
ML-25 (2)	CA 537 066	MRS 10/2/78	Flaky slice of cinder like material	Recovered 6/3/78 Shipped to WNRE 9/3/78	
ML-26 (2)	XF 493 115	MRS 10/2/78	Metal cylinder 25 cm long x 10 cm diameter	Recovered 12/3/78 Shipped to WNRE 14/3/78	
ML-27 (2)	CA 039 185	MRS 10/2/78	Horseshow shaped metal piece 15 cm	Recovered 5/3/78 Shipped to WNRE 20/3/78	

			across, 5 cm thick		
ML-28 (2)	CA 911 261	MRS 10/2/78	Cylinder similar to ML-26 (2)	Recovered 17/3/78 Shipped to WNRE 20/3/78	
ML-29 (2)	CA 919 256	MRS 10/2/78	Cylinder similar to ML-26 (2)	Recovered 2/3/78 Shipped to WNRE 5/3/78	
ML-30 (2)	XE 333 960	Helicopter 26/2/78	Particle	Recovered 2/3/78 Shipped to WNRE 14/3/78	
ML-31 (2)	XE 131 884	Ground Search 4/3/78			Deleted- this was apparently ML-14 (2)
ML-32 (2)	XE 335 965	MRS 6/3/78	Silver about 1 cm by 1 cm	Recovered 6/3/78 Shipped to WNRE 9 of 10/3/78	
ML-33 (2)	CA 854 238	Helicopter 20/3/78	Cylinder similar to ML-26 (2)	Recovered 23/3/78 Shipped to WNRE	
ML-34 (2)	CA 865 245	Helicopter 22/3/78	Cylinder similar to ML-26 (2)	Recovered 23/3/78 Shipped to WNRE	
ML-1 (3)	DA 054 304	MRS 10/2/78	Cylinder similar to ML-26 (2)	Recovered 5/3/78 Shipped to WNRE 9 or 10/3/78	
ML-2 (3)	DA 945 600	MRS 23/2/78			Deleted-geological occurrence
ML-3 (3)	DA 995 665	MRS 25/2/78			Deleted-geological occurrence
ML-4 (3)	DA 974 634	MRS 25/2/78			Deleted-geological occurrence
ML-5 (3)	DA 931 627	MRS 25/2/78			Deleted-geological occurrence
ML-6 (3)	DA 966 617	MRS 25/2/78			Deleted-geological occurrence
ML-7 (3)	DA 972 630	MRS 25/2/78			Deleted-geological occurrence
ML-8 (3)	DA 460 379	MRS 12/3/78			Deleted-geological

					occurrence
ML-9 (3)	DA 366 336	MRS 12/3/78			Deleted-spectrum data
ML-10 (3)	DA 460 364	MRS 12/3/78			Deleted-geological occurrence
ML-11 (3)	DA 504 410	MRS 12/3/78			Deleted-geological occurrence
ML-12 (3)	DA 464 470	MRS 12/3/78			Deleted-spectrum data
ML-13 (3)	DA 453 498	MRS 12/3/78			Deleted-spectrum data
ML-14 (3)	DA 476 506	MRS 12/3/78			Deleted-spectrum data
ML-15 (3)	DA 517 525	MRS 12/3/78			Deleted-spectrum data
ML-16 (3)	DA 521 528	MRS 12/3/78			Deleted-spectrum data
ML-17 (3)	DA 597 529	MRS 12/3/78			Deleted-spectrum data
ML-18 (3)	DA 617 530	MRS 12/3/78			Deleted-spectrum data
ML-19 (3)	DA 654 545	MRS 12/3/78			Deleted-spectrum data
ML-20 (3)	DA 659 541	MRS 12/3/78			Deleted-spectrum data
ML-21 (3)	DA 659 554	MRS 12/3/78			Deleted-spectrum data
ML-22 (3)	DA 657 560	MRS 12/3/78			Deleted-spectrum data
ML-23 (3)	DA 679 541	MRS 12/3/78			Deleted-spectrum data
ML-24 (3)	DA 796 542	MRS 12/3/78			Deleted-spectrum data
ML-1 (4)	EA 312 875	MRS 25/1/78			Deleted-geological occurrence
ML-2 (4)	EA 390 744	Visual 20/1/78	Complex shaped object; concave thin plate of cracked cylinder and with tubular	Removal 21/2/78 Shipped to WNRE	

			(double) braces and related parts (located at Cosmos Lake)		
ML-3 (4)	EA 305 784	High altitude search 20/1/78			Deleted-geological occurrence
ML-4 (4)	EA 409 791	US MRS 29/1/78			Deleted-geological occurrence
ML-5 (4)	EA 691 845	Visual from air 29/1/78			Deleted-geological occurrence (crater)
ML-6 (4)	EA 170 793	Cdn. MRS 30/1/78			Deleted-geological occurrence
ML-7 (4)	EA 181 850	Cdn. MRS 30/1/78			Deleted-geological occurrence
ML-8 (4)	EA 363 772	Cdn. MRS 30/1/78			Deleted-geological occurrence
ML-9 (4)	EA 379 773	Cdn. MRS 30/1/78			Deleted-geological occurrence
ML-10 (4)	EA 017 670	MRS 25/2/78			Deleted-geological occurrence
ML-11 (4)	EA 125 671	MRS 25/2/78			Deleted-geological occurrence
ML-12 (4)	EA 128 644	MRS 25/2/78			Deleted-geological occurrence
ML-13 (4)	EA 012 658	MRS 25/2/78			Deleted-geological occurrence
ML-14 (4)	EA 350 700	MRS 25/2/78			Deleted-geological occurrence
ML-15 (4)	EA 640569	MRS 25/2/78			Deleted- believed to be geological occurrence
ML-16 (4)	EA 943 068	MRS 25/2/78			Deleted- nothing

					found
ML-17 (4)	EA 607 872	MRS 26/2/78			Deleted- believed to be geological occurrence
ML-18 (4)	EA 626 879	MRS 26/2/78			Deleted- geological occurrence
ML-19 (4)	EA 646 896	MRS 26/2/78			Deleted- believed to be geological occurrence
ML-20 (4)	EA 746 904	MRS 26/2/78			Deleted- geological occurrence
ML-21 (4)	EA 940 017	MRS 26/2/78			Deleted- nothing found
ML-22 (4)	EA 743 844	MRS 26/2/78			Deleted- geological occurrence
ML-23 (4)	EA 737 842	MRS 26/2/78			Deleted- geological occurrence
ML-1 (5)	FA 140 883	US MRS 25/1/78			Deleted- nothing detected by MRS flight 1/3/78
ML-2 (5)	LG 988 265	Visual from air 30/1/78			Deleted- not confirmed- natural crater
ML-3 (5)	FB 071 008	MRS 25/2/78			Deleted- believed to be geological occurrence
ML-4 (5)	FB 059 009	MRS 25/2/78			Deleted- believed to be geological occurrence
ML-5 (5)	FB 189 016	MRS 26/2/78			Deleted- believed to be geological occurrence
ML-6 (5)	FB 192 028	MRS 26/2/78			Deleted- believed to be geological occurrence
ML-7 (5)	FA 412 962	Confidential source 3/3/78			Deleted- nothing found
ML-8 (5)	FB 156 053	MRS 3/3/78			Deleted- spectrum data
ML-9 (5)	FB 194 012	MRS 3/3/78			Deleted- believed to be geological

					occurrence
ML-10 (5)	FB 349 061	MRS 3/3/78			Deleted- spectrum data
ML-11 (5)	FB 414 105	MRS 3/3/78			Deleted- spectrum data
ML-12 (5)	FB 442 176	MRS 3/3/78			Deleted- spectrum data
ML-13 (5)	LG 560 139	MRS 3/3/78			Deleted- spectrum data
ML-14 (5)	LG 635 210	MRS 3/3/78			Deleted- spectrum data
ML-1 (6)	MG 250 097	US high altitude search 26/1/78			Deleted- increase in background not significant
ML- 2(6)	MG 380 370	US high altitude search 26/1/78			Deleted- geological occurrence
ML-3 (6)	MG 916 370	US high altitude search 27/1/78			Deleted- geological occurrence
ML-1 (7)	NG 403 805	US high altitude search 27/1/78			Deleted- not confirmed by later check
ML-1 (8)	PG 186 882	US high altitude search 26/1/78			Deleted- no data on tape
ML-2 (8)	PG 163 725	US high altitude search 26/1/78			Deleted- no data on tape
ML-3 (8)	PG 131 653	US high altitude search 26/1/78			Deleted- no data on tape
ML-1 (9)	WE 030 110	Helicopter and ground search	6 particles	Recovered 22/2/78	Murky Lake
	WE 123 193	Helicopter 10/2/78 and ground search	97 particles	Recovered between 14/2/78 and 21/2/78 shipped to WNRE about 2/3/78	Snowdrift community area
ML-2 (9)	WE 205 220	Helicopter 12/2/78	Confirmed as a flake but lost on 7/3/78		Blown away by helicopter down-wash and unable to locate again
ML-3 (9)	WE 430 275	Helicopter 12/2/78			Deleted- nothing found by later

					searched
ML-4 (9)	WE 480 315	Helicopter 12/2/78			Deleted- nothing found by later searched
ML-5 (9)	WE 403 340	Helicopter 13/2/78			Deleted- nothing found by later searched
ML-6 (9)	WE 395 250	Helicopter 13/3/78			Deleted- geological occurrence
ML-7 (9)	WE 355 240	Helicopter 13/2/78			Deleted-known (GSC) uranium deposit
ML-8 (9)	WE 160 205	Helicopter 13/2/78			Deleted- nothing found by later searched
ML-9 (9)	WE 040 215	Helicopter 9/3/78			Deleted- nothing found by later searched
ML-1 (10)	VE 605 160	Visual from air 7/2/78			Deleted- natural crater, no radiation
ML-2 (10)	VE 825 575	Ground crew in helicopter 9/2/78			Deleted- geological occurrence, high natural background
ML-3 (10)	VE 675 155	MRS 20/2/78	Chunk of slag about 2.5 cm x 1.5 cm x 1 cm	Recovered 23/3/78 Shipped to WNRE 27/2/78	
ML-4 (10)	VE 993 803	MRS 19/2/78			Deleted- wrong position reference- reference to ML-1 (9)
ML-5 (10)	VE 762 261	Cdn. MRS	ROD similar to ML-2 (1) second rod similar to ML-2 (1) & silver of material	Recovered 5/3/78 Shipped to WNRE 7/3/78	
	VE 762 265	1/3/78			
ML-6 (10)	VE 716 218	Cdn. MRS 2/3/78	End of rod approx. 2 cm long	Recovered 9/3/78 Shipped to WNRE 10/3/78	

ML-7 (10)	VE 845 225	Cdn. MRS 2/3/78	Black chunk of material 2.5 cm dia.	Recovered 9/3/78 Shipped to WNRE 10/3/78	
ML-8 (10)	VE 937 249	Cdn. MRS 2/3/78	Silver about 8 cm long x 3 mm wide + small particles 3 mm in diameter	Recovered 9/3/78 Shipped to WNRE 10/3/78	
ML-9 (10)	VE 945 165	Cdn. MRS 2/3/78			Deleted- geological occurrence
ML-10 (10)	VE 735 140	MRS 10/3/78	Irregular flake approx. 2 cm x 1.5 cm + 6 particles	Recovered 11/3/78 Shipped to WNRE 14/3/78	
ML-11 (10)	VE 650 137	MRS 10/3/78	Particles	Recovered 11/3/78 Shipped to WNRE 14/3/78	
ML-12 (10)	VE 650 126	MRS 10/3/78			Deleted- nothing found on ground
ML-13 (10)	VE 660 135	MRS 10/3/78			Deleted- nothing found by later searches
ML-14 (10)	VD 505 970	MRS 11/3/78	Small Particle	Recovered 19/3/78 Shipped to WNRE 21/3/78	
ML-15 (10)	VD 532 903	MRS 11/3/78	Particle	Recovered 19/3/78 Shipped to WNRE 21/3/78	
ML-16 (10)	VE 520 045	MRS 11/3/78			Deleted- nothing found by later searches
ML-17 (10)	VE 725 132	MRS 11/3/78	Small fragment approx. 1 cm x 1 cm x 0.5 cm	Recovered 21/3/78 Shipped to WNRE	
ML-18 (10)	VE 643 130	Helicopter 11/3/78	Specks in snow	Recovered 11/3/78 Shipped to WNRE 14/3/78	
ML-19 (10)	VE 651 121	Helicopter 11/3/78	Specks in snow	Recovered 11/3/78 Shipped to WNRE 14/3/78	
ML-20 (10)	VE 665 103	Helicopter 11/3/78	Silver	Recovered 19/3/78 Shipped to WNRE 20 or 21/3/78	
ML-21 (10)	VE 524 943	MRS 12/3/78	Long silver	Recovered 16/3/78	

				Shipped to WNRE 20/3/78	
ML-22 (10)	VE 700 090	MRS 12/3/78	Particle	Recovered 19/3/78 Shipped to WNRE	
			Particle	Recovered 24/3/78 Shipped to WNRE	
ML-23 (10)	VE 754 067	MRS 12/3/78			Deleted- nothing found
ML-24 (10)	VE 836 103	MRS 12/3/78	Flake approx. 1.5 cm square	Recovered 27/3/78	Held for use in calibrating helicopter borne detectors
ML-25 (10)	VE 657 105	Helicopter 14/3/78	Triangular shaped particle	Recovered 19/3/78 Shipped to WNRE 21/3/78	
ML-26 (10)	VE 795 130	Ground search			Particle survey- nothing found
ML-27 (10)	VE 685 110	Helicopter 17/3/78	Particle	Recovered 24/3/78 Shipped to WNRE	
ML-28 (10)	VE 555 990	Helicopter 17/3/78	Small flake	Recovered 21/3/78 Shipped to WNRE	
ML-29 (10)	VE 925 625	MRS 17/3/78			Deleted-high natural radiation
ML-30 (10)	VE 980 482	MRS 17/3/78			Deleted- MRS error
ML-31 (10)	VE 925 592	MRS 17/3/78			Deleted-nothing found by later search
ML-1 (11)	VD 270 997	MRS 7/3/78	5 cm dia. x 0.3 cm thick, black plate, not flaky	Recovered 0/3/78 Shipped to WNRE 9/3/78	MRS location given VE 270 003
ML-2 (11)	VE 483 042	MRS 10/3/78	Small speck in snow		Deleted- nothing found by later search
ML-3 (11)	VD 396 953	MRS 12/3/78		Recovered 16/3/78 Shipped to WNRE 20 or 21/3/78	
ML-4 (11)	UD 460 630	Helicopter MRS 12/3/78	Flat oval plate 14 cm x 9 cm x 3.5 cm	Recovered 16/3/78 Shipped to WNRE 20 or 21/3/78	
ML-5P (11)	UD 610 590	Ground search 14/3/78	19 particles	Recovered 21/3/78 Shipped to WNRE	
ML-6 (11)	VD 349 827	MRS 14/3/78	Chip approx. 0.3 cm square	Recovered 16/3/78 Shipped to WNRE	

				20 or 21/3/78	
ML-6 (11) B	VD 349 827	Helicopter 8/4/78	Speck in snow	Recovered 0/4/78 Shipped to WNRE	
ML-7 (11)	VD 411 805	MRS 14/3/78	Chip approx. 1 cm long	Recovered 16/3/78 Shipped to WNRE 20 or 21/3/78	
ML-7 (11) B	VD 411 805	Helicopter 8/4/78	Speck in snow	Recovered 8/4/78 Shipped to WNRE	
ML-8 (11)	UD 637 531	MRS 26/3/78	1 particles	Recovered 29/3/78 Shipped to WNRE	
ML-8 (11) B	UD 637 531	Helicopter 8/4/78	Speck in snow	Recovered 8/4/78 Shipped to WNRE	
ML-9 (11)	UD 505 539	MRS 26/3/78	2 particles	Recovered 29/3/78 Shipped to WNRE	
ML-10P (11)	VD 280 670	Ground search 30/3/78	8 particles	Recovered 30/3/78 Shipped to WNRE	Particle survey-Simpson Island
ML-1 (12)	PU 125 170	MRS 31/3/78	Sheet metal approx. 22 cm x 8 cm x 0.3 cm + 1 small particle	Recovered 6/4/78 Shipped to WNRE	
ML-1P (13)	NT 760 453	Ground search 26/2/78	2 particles	Recovered 27/2/78 Shipped to WNRE	Particle survey-Tinney plan Southshore-Great Slave Lake
ML-2P (13)	UD 670 165	Ground search 13/3/78	19 particles	Recovered 13/3/78 Shipped to WNRE	Particle survey-Tinney plan Fort Resolution area-Great Slave Lake
ML-3P (13)	NS 950 815	Ground search 19/3/78 & 22/3/78	19 particles	Recovered 19/3/78 and 22/3/78 Shipped to WNRE	Particle survey-Tinney plan Buffalo Lake
ML-4P (13)	NT 605 700 area	Ground search Feb.-Mar. 78	48 particles	Recovery completed 9/3/78 Shipped to WNRE	Survey and clean -up Hay River
ML-5P (13)	PT 380 465 area	Ground search Feb.-Mar. 78	176 particles	Recovery completed 5/3/78 Shipped to WNRE	Survey and clean -up Pine Point
ML-6P (13)	UC 565 857	Ground search Feb. Mar. 78	110 particles	Recovery completed 1/3/78 Shipped to WNRE	Survey and clean-up Fort Resolution
ML-7P (13)	NS 715 330	Ground search 6/4/78	Speck in snow	Recovered 6/4/78 Shipped to WNRE	Particle Survey-Tinney Plan

ML-8P (13)	PU 100 000	Ground search 7/4/78	6 particles	Recovered 7/4/78 Shipped to WNRE	Particle Survey-Tinney Plan Centre Great Slave Lake
ML-1P (14)	VC 540 250	Ground search 23/3/78	Contaminated snow No particles found		Particle survey-Tinney Plan Tsu Lake
ML-2P (14)	WB 000 830	Ground search 2/4/78	36 Small particles	Recovered 2/4/78 Shipped to WNRE	Particle survey-Tinney Plan Pilot Lake
ML-3P (14)	WD 110 335	Ground search 5/4/78	7 Small particles	Recovered 5/4/78 Shipped to WNRE	Particle survey-Tinney Plan Ruthledge Lake
ML-4P (14)	VD 070 070	Ground search 2/4/78	2 Small particles	Recovered 2/4/78 Shipped to WNRE	Particle survey-Tinney Plan Rocher River

ANNEX G
Part B

SURVEY OF COMMUNITIES, CAMPS AND CABINS

COMMUNITIES

1. Following the discovery of small radioactive particles in the Snowdrift area, all communities in the apparent area of particle dispersion were checked by ground survey parties, and all radioactive particles located by the survey were removed.

2. Particles were found in the following communities, with the highest concentration being found in the Pine Point – Fort Resolution area and very few particles as far South as Fort Smith:

Hay River	Salt River Indian Reservation
Fort Resolution	Pine Point
Rocher River	Snowdrift
Fort Smith	Bell Rock
Indian Village - Grant Point	

3. The following communities were checked, and no particles found:

Fort Reliance — Rat River
Indian villages and camps on Slave and Taltson Rivers

COMMERCIAL CAMPS AND LODGES

4. The following commercial tourist and fishing camps and lodges located by lists provided by the NWT Travel Association and the Department of Indian and Northern Affairs, were checked by ground survey parties.

NAME	LOCATION
Arctic Star	62° 57' N - 110° 12' W
Beaulieu River (Murphy)	62° 30' N - 112° 58' W
Bricker	62° 25' N - 110° 42' W
Campbell Lake	62° 20' N - 112° 52' W
Carter	62° 20' N - 113° 05' W
Duncan Lake	62° 50' N - 113° 53' W
Finlayson	62° 43' N - 109° 11' W
Gordon Lake	63° 08' N - 113° 06' W
Hanging Ice	60° 48' N - 112° 09' W

Laviolette	60° 43' N - 112° 16' W
Namushka	62° 25' N - 113° 21' W
Nonacho	61° 45' N - 109° 37' W
Pilot Lake	60° 17' N - 110° 57' W
Plummer	62° 36' N - 111° 31' W
Prelude	62° 34' N - 113° 58' W
Ruttledge	61° 35' N - 111° 45' W
Schaefer Lakes	60° 04' N - 111° 21' W
Spencer	62° 56' N - 110° 41' W
Tiaga	62° 10' N - 112° 41' W
Watta	62° 17' N - 113° 07' W

5. One particle was located end removed from Pilot Lake and one from Schaefer Lakes. Some snow contamination was detected and removed from Laviolette.

6. Commercial camps and lodges outside of the areas in which satellite fragments were found, or outside of the area in which the wind-borne particles were estimated to have fallen, were not checked.

CABINS

7. A list of cabins and lodges in the area South of Great Slave Lake was provided by the Department of Indian Affairs. This list, attached as Appendix 1, gave map coordinates and brief descriptions of these cabins and small camps. Based on their locations and descriptions they were divided into four categories - high, medium and low priorities for survey, and those which were apparently uninhabitable and were not to be checked. Survey activities were conducted as detailed below. Numbers given are the Cabin numbers on the attached list.

8. The following cabins were not surveyed, based on descriptions on the list, and some confirmatory helicopter overflights: No. 6, 8, 13, 14, 16, 19, 24, 25, 30, 31, 36, 37, 42, 58, 59, 60, 61, 63, 65,66, 67, 69, 70.

9. The following cabins were checked and no particles found: No. 1, 4, 5, 7, 9,10, 12, 15,17, 18, 21, 22, 23, 26, 27, 28 (and 3 new cabins nearby), 29, 33, 35, 38, 40, 41, 43, 44, 45, 46, 47, 48, 49, 55, 57, 71, 72, 73, 74, 79, 80, 81, 84, 85.

10. The following cabins were checked, and radioactive particles found and removed:

No. 2	- Schaefer Lakes Lodge, one particle
No. PL	- Pilot Lake Lodge, one particle
No. 32	- One particle 100 feet from cabin
No. 34	- Bell Rock, four particles among buildings
No. 39	- Rocher River, one particle
No. 51,52,53,54	- Salt River Reservation, one particle
No. 76	- One particle
No. 78	- Bison Fish Camp (Laviolette?), contaminated snow

11. The following cabins were checked by helicopter at low level, as it was not possible to land in the immediate area. No radiation above normal background was detected: No. 3, 11.

12. The following cabins were not checked, either because they could not be located or because from the air they were found to be broken down and abandoned: No. 20, 50, 56,62,64, 68,77,82.

13. The following locations not included in the list were checked and no contamination detected.

Power House and residence - Elsie Falls VB 780 980
Hook Lake Base Camp - VC 020 340
Cabin - VC 960 420

ROADS

14. The roads between Hay River, Fort Resolution and Fort Smith were checked using hand held detectors from low-flying helicopters and from vehicles. No radiation above normal background was detected on these surveys. Results were inconclusive because of the conditions of the search.

WILDLIFE AREAS

15. Whooping crane nesting areas in Wood Buffalo Park were checked by a combination of ground and helicopter survey, in the company of personnel from Canadian Wildlife Service. The Sass, Klewi and two Nyarling sites were found clean of radioactive contamination.

CABINS AND LODGES SOUTH OF GREAT SLAVE LAKE

(Provided by Department of Indian Affairs and Northern Development)

Cabin 1 — This cabin is on the south portion of Shaefer Lake at approximately 12VVBS08576. The location is an active trappers camp comprised of one log house, several tents, several boats and a dock. The camp is located on a point inside heavy bush.

Cabin 2 — Shaefer Lake Lodge is located on the south end of Shaefer Lake; 12VVB86582. This facility is an active Fishing Lodge comprised of nine frame or log structures, three docks, numerous boats and some tent facilities. The position is bounded on two sides by water and by heavy bush on the other two sides. Some open ground exists between camp and the bush.

Cabin 3 — Trappers cabin located above falls at the North end of Shaefer Lake. Single frame structure, and a couple of boats. Located on high open rock, vegetation open. Rock area surrounded by heavy bush. This facility appears to be active. 12VVB43664.

Cabin 4 — Trappers cabin located due North of Shaefer Lake; 12VVB781681. Single log cabin facility which is presently in active use. Surrounded on three sides beavy poplar bush. Cabin is in a clearing.

Cabin 5 — Trappers camp located on the Tethul River near Little Bent Tree Lake; 12VVB69738. Single log structure, a couple of boats, a dock and assorted machinery. Cabin has been set in heavy Spruce bordered on one side by the river. Cabin is presently in active use.

Cabin 6 — Trappers cabin on Tethyl River near junction with Kenneth Creek; 12VVB691759. This facility has been abandoned and does not appear to be in use.

Cabin 7 — Trappers cabin on Jackfish Lake; east shore; 12VVB873781. Single log structure, several dog kennels and a couple of boats. This facility has been placed in heavy, but open Spruce. Some poplar is also present. Appears active.

Cabin 8 — Trappers cabin on Nautawa Lake on the central point; 12VVB882738. Single log structure and old dog kennels. Facility appears abandoned and unused. Located in middle of overgrown clearing.

Cabin 9 — Trappers line cabin near Piers Lake; 12VVB905860. Single log structure and one canoe. Facility is located in heavy Spruce and appears active.

Cabin 10	Trappers cabin southwest of Pilot Lake; 12VVB970778. Single log structure set in heavy bush in a clearing surrounded by heavy Spruce. This site does not show much activity, but could be active.
Cabin 11	Game Branch Cabin on west shore of Hanging Ice Lake, 12VWB049762. Single log structure and one boat. Facility is set in heavy Spruce/Poplar. Site is active at the present time.
Cabin 12	Trappers camp on the end of the point in Pilot Lake 12VWB027844. Several log structures, dog kennels. This facility is set in open Spruce-Poplar. Site is presently active.
Cabin P.L.	Pilot Lake Lodge - centre of point in Pilot Lake; 12VWB026849. Multiple unit camp, several aluminum boats and a dock. This facility is set in open, Spruce/Poplar and is an active Fishing.
Cabin 13	Trappers cabins on the Taltson River; 12VWC058023. Two log structures, completely broken down and abandoned. The facilities are set in open Jack Pine.
Cabin 14	Trappers cabin on the Taltson River near Othikettle Falls; 12VWB138994. Single log structure, completely broken down and abandoned.
Cabin 15	Trappers cabin on Tourangeau Lake, north end; 12VWB269932. Single log structure set in open Spruce/Birch. Cabin empty but might be in use.
Cabin 16	Trappers cabin near North Falls. This facility was never located.
Cabin 17	Trappers cabin due south of Natla Rapids on Taltson River; 12VVC646051. Single log structure apparently active. On point in lake, set in heavy Spruce.
Cabin 18	Trappers camp on Mistigi Lake, 12VVB559990. Single log structure and one tent. Facility is set in open clearing near the lake shore. Poplar growth surrounds the clearing. License No. 45721.
Cabin 19	Trappers cabin on Mabel Lake; 12VVB701868. Single log structure set back in heavy Spruce. No apparent activity, not active.
Cabin 20	Trappers camp, west of Mabel Lake; 12VVB638855. No cabin facilities only tent camp remains. Open Jack Pine on rock face.
Cabin 21	Trappers cabin, 2nd Lake west of Mabel Lake, 12VVB598461. Single frame structure set in open poplar on rock slope. Site is very messy, probably active.
Cabin 22	Trappers camp, Tethul River; 12VVB455877. Multiple unit, log structure camp spread. over large area. Approximately three log units and assorted frames. All are situated in open to heavy Spruce. Active hunting and trapping camp.

Cabin 23	Trapper cabin due North of Nagler Lake; 12VV0728212. Single log structure bordering on lake shore. Situated in open poplar/Spruce. Possibly active.
Cabin 24	Trappers near partheast of Three Bears Portage; 12VVC922118. Single decaying log structure, mostly fallen in. This facility is situated in open Jack Pine with no water in the immediate area.
Cabin 25	Trappers cabin located on Champagne Lakes; 12VVC902229. Single log structure, one canoe, no apparent activity. Facility is located in a small opening in heavy Poplar/ Spruce.
Cabin 26	Trappers cabin, located on an island; 12VWC150206. Active log structure placed in open area on rocky island. Poplar and Spruce.
Cabin 27	Trappers cabin located in Thekulthili River; 12VWC359365. Single log structure placed in moderate to heavy Spruce and Poplar. One canoe apparent. Active.
Cabin 28	Trappers camp located on Lady Grey Lake; 12VWC225374. One log structure, one log frame, dog kennels, one dock and fuel storage. Facility is set on a gravel beach, backed by open spruce and Poplar.
Cabin 29	Trappers cabin located on Tarsque Lake, east shore, 12VWC170572. Single log structure, some traps still in building. Facility is set on rock in open Poplar.
Cabin 30	Trappers cabin; 12VVC763588. Single log structure, old and abandoned. Set in heavy Poplar.
Cabin 31	Trappers cabin; 12VVC766430. Single log structure, old and abandoned. Set in open to heavy Spruce on rock.
Cabin 32	Trappers camp, located on Oatlon Lake; 12VVC808366. Single log structure, several boats, dog kennels. Facility is set in open area surrounded by open Spruce and Poplar. Active.
Cabin 33	Northwest Lands & Forests Tower Cabin at Tsu Lake; 12VVC531249. Single log structure, fully equipped presently active. The one on the left in the second photo is Heather - the one with the right paw held up.
Cabin 34	N.T.C.L. boat yards at Bell Rock, Slave River; 12VVB390544. Multiple facilities, living quarter,
	watehouses, workshops, boats, large fuel storage tanks. Facility is now non-operational but is maintained. Placed in opening surrounded by heavy scrub bush.
Cabin 35	Cunningham Landing (Old Hudson's Bay Post). Slave River; 12VVB371550. Inactive Hudson's Bay site, falling into disarray.

	One house is occupied. Heavy Poplar growth surrounding site.
Cabin 36	Trappers cabin; 12VVC495553. One log structure, abandoned and fallen into disrepair. Not active.
Cabin 37	Trapping - Fish camp, Great Slave Lake at the mouth of Taltson River; 12VVD081131. Four frame structures, one log structure. Surrounded by heavy Poplar-Willow bush. Site is inactive.
Cabin 38	Trappers cabin, Great Slave Lake 12VVC150186. Single frame structure on rocky point of lake. Presently active. Surrounded by grasses and willows.
Cabin 39	Rocher River base of delta of Taltson River; 12VVC069062. Seasonal trapping settlement. Located in grass meadows next to Taltson River. This area is surrounded by scrub poplar and Spruce woods. Some portions of settlement are on an island.
Cabin 40	Trappers cabin Taltson River; 12VVC112902. Three structures on site. One cabin and two support buildings. Located in Willow, Grassland at the base of a large, bald rock. Possibly active.
Cabin 41	Trappers cabin, Taltson River; 12VVC134837. Two structures on site. One cabin and one support building. No apparent activity. Situated in a grassy clearing surrounded by Willow, Spruce and Poplar bush.
Cabin 42	Trappers cabin, Taltson River; 12VVC142812. Broken down and abandoned facility set in grassy opening in heavy Spruce and Poplar. Not active.
Cabin 43	Trappers cabin, Taltson River; 12VVC139777. Single structure showing very little sing of activity. Set in grassy opening surrounded by open poplar.
Cabin 44	Trappers cabin, Rat River Settlement on Taltson River; 12VVC129767. Two cabin facilities set on river bank in grassy field. Little apparent activity.
Cabin 45	Trappers cabin, Rat River Settlement on Taltson River; 12VVC137765. Single cabin set on the river bank in a grassy field. Heavy Spruce and willow all around on shore side. Little apparent activity.
Cabin 46	Trappers cabins, Rat River Settlement on Taltson River; 12VVC137764. Multiple unit camp, three cabin structures. Set on river edge in grassy opening edged on one side by rock and heavy Spruce/Poplar. Little apparent activity.
Cabin 47	Trappers cabin, Rat River Settlement on Taltson River; 12VVC137763. Single cabin unit and one boat. Set on rocky shore

	on a grassy opening surrounded by intermittent Spruce/Poplar bush. Some activity apparent.
Cabin 48	Trappers cabin, Rat River Settlement on Taltson River; 12VVC137763. Single cabin facility and one log frame. Set on rocky shore in heavy Spruce. Activity possible.
Cabin 49	Trappers camp, Taltson River; 12VVC166696. Multiple units set on bald rock on point in River. Some willow possible active.
Cabin 50	Recreational fishing, hunting cabin Gauthier. Immediately down Slave River from Bell Rock; 12VVB360584. Single frame crate cabin and several boats. Near edge of Slave River surrounded by heavy Spruce and Poplar.
Cabin 51	Indian Homestead, Salt River Reserve; 12VVB312635. Single structure on grassy opening by river bank. Surrounded by heavy willow and poplar.
Cabin 52	Indian Homestead, Salt River Reserve, 12VVB312635. Single frame structure on grassy opening near the River bank. Surrounded by heavy willow and poplar.
Cabin 53	Indian Homestead, Salt River Reserve; 12VVB312635. Single structure set on a grassy opening surrounded by heavy willow and poplar.
Cabin 54	Indian Homestead, Salt River Reserve; 12VVB312635. Two cabin units set on a grassy opening surrounded by heavy Jack Pine and Poplar.
Cabin 55	Old Mission Hill Site in Grand Detour, near the Slave River; 12VVB188874. Site is composed of the remains, mostly broken down, of an old sawmill. There are extensive deposits of sawdust and slabs. Presently used only as a seasonal logging unit.
Cabin 56	Trappers camp, Grand Detour Area; 12VVB131877. Two log structures one trailer. Near slough, open White Spruce. Presently active.
Cabin 57	Game cabin at Grand Detour; 12VVB060922. Two log structures and one frame structure, on River bank, backed by heavy Spruce. Periodically active.
Cabin 58	North Shore of Slave river, North bank, Grand Detour; 12VVB111943. Old broken down trappers cabin, not active.
Cabin 59	Trappers cabin on sand bank in Slave River above Brule Point; 12VVC155064. Old broken down log structure, not presently active.
Cabin 60	Trappers cabin, Wynn Island just below Brule Point;

	12VVC121116. Old broken down log structure not presently active.
Cabin 61	Old logging mill, Wynn Island, N; 12VVC112149. Remains of old logging camp, several structures and waste material piles. Not presently active.
Cabin 62	Trappers cabin, Slave River opposite Brule Point; 12VVX202116. Single structure set in bush and Willow. Possibly active.
Cabin 63	Old lodging mill below Wynn Island area on Slave River. Eleven frame structures located in young Poplar growth; 12VVC060132. Structures abandoned, no activity.
Cabin 64	Wood Bison Sightseeing camp, on the Slave River just south of Work Lake 12VOC990236. Recently used hunting camp. Three log structures situated in a small opening in heavy Willow and Poplar. Structures are empty.
Cabin 65	Trappers cabin or old logging building on Slave River near the mouth of Landry Creek; 12VUC971354. Old frame structure, no present activity, empty. Situated in open with growth.
Cabin 66	Trappers cabin, south shore of Point Ennuyeuse on Slave River; 12VU0940414. Two log structures and possible remains of a third frame structure. All are broken down and abandoned. All are situated in heavy Willow, Poplar and Spruce growth.
Cabin 67	Old logging camp located near Ring Island, Slave River 12VOC912884. Old milling debris and couple of broken down structures. All are situated in heavy Poplar and Spruce growth. No present activity.
Cabin 68	Old logging mill located near McConnell Island on the Slave River; 12VUC842724. Several old frame structures log carriage and equipment present. Located in heavy to open Willow and Poplar. No present activity.
Cabin 69	Old logging mill on the Slave River; 12VUC74586. One old frame structure and a sawdust pile. Located in heavy Willow and Poplar. Abandoned.
Cabin 70	Old trappers cabin on the Slave River; 12VUC769536. One log structure, broken down, abandoned.
Cabin 71	Trappers cabin, Slave River Delta; 12VUC615967. One frame structure set in heavy Poplar along river bank. Presently active.
Cabin 72	Trappers cabin, Slave River Delta, Resdelta Channel; 12VUC609995. Single log structure located near the river bank in a small grassy clearing surrounded by heavy Willow. Possibly active.
Cabin 73	Trappers cabins near the mouth of the Jean River 12VUD654068.

	Single main log structure and two small support buildings. Located in a small grassy clearing backed by heavy Poplar and Willow. Appears active.
Cabin 74	Trappers cabin, Great Slave Lake to the east of Stony Island, 12VUD726140. Single frame structure located in a grassy clearing surrounded by heavy Willow and Poplar. Two sides of clearing are open to lake winds. Apparently active.
Cabin 75	Fishing cabin- Lease No. 2915, at junction of Taltson River and Tethul River; 12VVC338167. Single frame structure located on a rock peninsula in space Jack Pine. Site is presently active.
Cabin 76	Trappers cabin, Deskenatlate Lake, east shore; 12VVC448585. Small single log structure located on a rock shore surrounded by heavy Poplar growth. Possibly active seasonally.
Cabin 77	Game cabin, Deskanatlate Lake, east shore, 12VVC450551. Single structure located off a sand beach and surrounded by heavy Poplar. Active.
Cabin 78	Bison Sightseeing Fish Camp, Taltson River - Lease No. 2617. 12VVC312322. One frame structure and five tent frames located on the River's edge and backed by heavy Poplar forest. Site is operational.
Cabin 79	Trappers cabins Taltson River; 12VVC216593. Two log structures and one small support building. Located in a grassy clearing on a rocky shore. Bordered on one side by heavy Poplar. Possible active seasonally.
Cabin 80	Trappers cabin, Taltson River; 12VVC231509. Single log structure located on rocky knoll surrounded by Poplar. Area virtually isolated from main land by creeks and sloughs. Possibly active.
Cabin 81	Trappers cabin on Tsu Lake across from Fire Tower; 12VVC524251. Single structure and a frame rack. Located on grassy shore above a gravel beach. Backed by area of heavy Poplar and Spruce. No apparent activity.
Cabin 82	Trappers cabin on Tsu Lake, south end 17VVC550131. One log structure on rocky situation, surrounded by heavy Spruce. No signs of present activity.
Cabin 83	N.W.L. & F.S. Fire Tower Site at Long Island. Single structure; twin· propane tanks, one repeater building and steel tower legs. Site is now used only seasonally.
Cabin 84	Thuban Lake Lodge, east shore of Thuban Lake; 12VVC591206. Two frame structures, tents, support shacks and several boats.

	Located in open Poplar and Spruce. Seasonally active.
Cabin 85	Fishing cabin- Lease No. 2789; south end of Deskenatlata Lake; 12VVC379423. Single structure, located at the base of a rock knoll in heavy Poplar. Presently active.

ANNEX G
Part C

AECB EVALUATION OF RESULTS VS SEARCH CRITERIA

CRITERIA

1. A statement of the "Criteria Governing Search and Recovery Program, Operation Morning Light" is included in pages 7 to 10, paragraphs 18 to 24 of the beginning section of this Report.

RESULTS

2. The search by fixed wing aircraft and helicopters was complicated by a number of factors, including weather, navigational accuracy, aircraft range and serviceability, minimum safe flying altitude, detector sensitivity and discriminating ability, naturally occurring radioactive sources and crew fatigue. The ground search, on foot and by vehicle, involved factors such as weather, mobility in snow-covered terrain, instrument sensitivity and service ability in streme cold conditions, shielding effects of snow, vegetation and buildings, and masking of low level particles by the natural radiation background. Within the limitations imposed by these factors, the evaluation of the search results is as follows:

a. Aerial Surveys - Fixed Wing Aircraft (Criteria Page 9, paragraph 20) -The search area along the satellite trajectory, in which radioactive debris other than small wind-blown particles was found, was well covered using sophisticated navigation aids. While the possibility that some radioactive fragments were missed can not be ruled out, it is considered that the search criteria were adequately met.

b. Aerial Surveys -Helicopter Aircraft (Criteria Page 9, paragraph 21) - The precise location of debris identified by the fixed wing aircraft search (Criteria paragraph 21 a.) was satisfactory, and the criteria were met. The results of the surveys of the environs of communities and of the roads and railway (Criteria paragraph 21 b. and paragraph 21 c.) were inconclusive. The helicopter-mounted detection equipment was unable to identify individual particles against the natural background on land, and hand-held instruments were not sufficiently sensitive to identify particles from a helicopter. No particles were located and recovered by helicopter search in the communities, roads or railway. Confirmation as to whether the search criteria were, or were not met will not be possible until the AECB Summer search program is carried out.

c. Ground Surveys (Criteria Page 10, paragraph 22)- Ground surveys of communities, camps and cabins resulted in the locating and recovery of a number of particles. The distribution of these particles on the ground was generally in agreement with the distribution expected, based on particle size and meteorological conditions at the time of the satellite re-entry and burn-up. The criteria appear to have been met in those areas which could be covered by the ground search. However, the actual degree to which they were met can not be determined until the AECB Summer search of the communities is completed.

ANNEX G
Part D

AECB FUTURE PLANS

1. The following activities are planned by the Atomic Energy Control Board to complete the search for and recovery of Cosmos 954 debris during the Spring and Summer of 1978.

PUBLIC INFORMATION

2. Discussions are to be held with representatives of the Provinces of Alberta and Saskatchewan on the need for further surveys to determine whether radioactive particles have fallen in those provinces, and to plan for any clean-up operations which may be found necessary in Northern Alberta and Saskatchewan.

3. Representatives of the Atomic Energy Control Board, and of National Health and Welfare are to visit communities South of Great Slave Lake in the NWT, and in Alberta and Saskatchewan if required, to describe the proposed Summer search program and to answer questions on the health and environmental impacts of the debris from Cosmos 954.

4. Prospectors, trappers and travellers in the affected areas are to be informed of the possible hazards and advised to inform AECB of any suspicious objects found.

SEARCH AND RECOVERY

5. A contract is to be arranged with a private firm to carry out aerial and ground search and recovery operations as follows:

a. Aerial search by fixed wing aircraft and helicopters along the satellite trajectory in search sectors 1, 2, 3, 4, 9, 10, 11, and 12 to confirm the adequacy of the winter search, or to locate and recover any radioactive fragments missed during the winter.
b. Ground surveys of the communities of Hay River, Pine Point, Fort Resolution, Snowdrift, Fort Reliance and Fort Smith to confirm the results of the winter search, and to locate and recover particles in the environs of those communities which could not be checked during the winter.
c. Ground surveys of Fort Providence, and of any communities in Northern Alberta and Saskatchewan found to be within the area of radioactive particle distribution, and recovery of particles from those communities and

their environs.

d. Ground surveys of commercial and private lodges camps and cabins checked during the winter, and of any other similar installations identified in the particle distribution area, and recovery of any particles located.
e. Ground survey of roads and railways in the Hay River, Fort Resolution, Fort Smith and Wood Buffalo Park areas using vehicle-mounted detection equipment and recovery of any particles located.
f. Ground surveys of frequently used trails, portages, recreation and camping sites in the area, using hand-held detectors, and recovery of any particles located.

6. An Atomic Energy Control Board temporary office is to be established at the location selected by the contractor for his base of operations, to coordinate the search and recovery operations, to take charge of any radioactive material recovered, and to provide liaison between the contractor and municipal, territorial, provincial and federal authorities, and AECB Ottawa.

7. The Atomic Energy Control Board will arrange for any further analytical work considered necessary on radioactive debris recovered during the summer operation, and for the transportation of debris recovered to the storage site at Pinawa, Manitoba.

REPORTS

8. The Atomic Energy Control Board will issue one final report covering both the winter Morning Light operation and the summer contract activity. This report will include both operational information and scientific and technical information on the results of the analyses carried out on satellite fragments.

ANNEX G
Part E

RESULTS
EXPLANATION FOR ICE FORMATION OBSERVED
ON A LAKE NEAR CAPE DORSET, N .W. T.

1. The following report is stated as a result of the investigations of the representative of the National Research Council sent to Cape Dorset.

2. An ice formation comprising ice blocks ranging from football sizes to 2' cubes to 4' x 12' x 2' slabs was observed on the surface of a frozen lake in mid-March 1978. The ice blocks were spread over an oval area 200' x 300' extending out from the shore. Since the site was on the trajectory of Cosmos 954 an explanation for the ice formation was required. The site was examined and judged to be the result of a combination of natural phenomena, having no relation to the impact of any sort of an object with the ice cover.

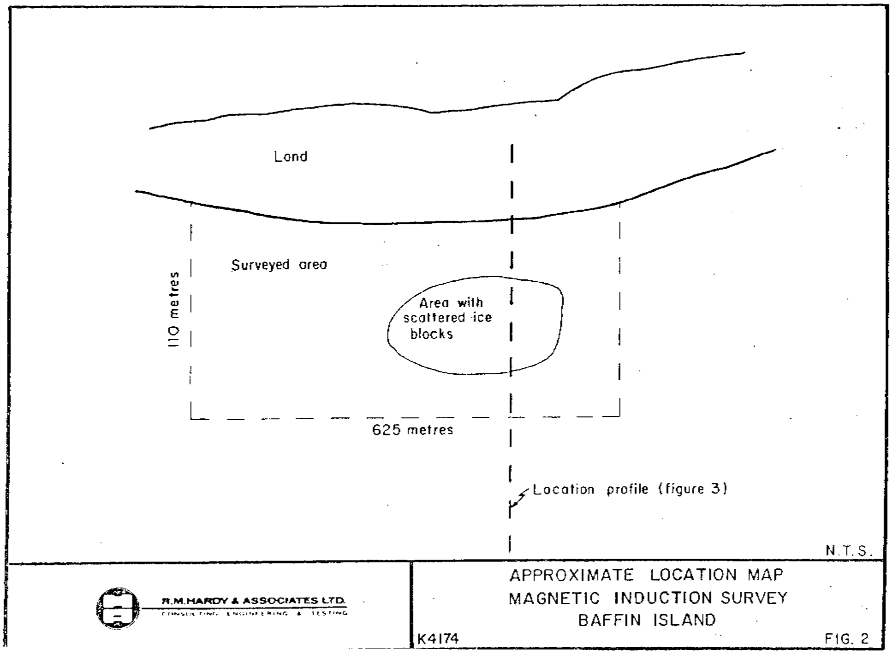
3. A survey of the site revealed a convex ice feature running about 50 yards along the shore and 5 yards back from it. The top of this ice feature was approximately 6' above the level of the lake ice. The ice in the feature was about 4' thick and was underlain by about 1½ feet of water.

4. The following model was proposed for the development of the on-shore ice feature and subsequent explanation of the ice formation on the lake. The site is characterized by groundwater seepage at the surface near the shore. In early winter this area is covered with snow. The ground water seeps up through the snow and eventually freezes. This results in the formation of a granular snow ice shell which effectively caps the area of groundwater seepage. Ice growth under the cap continues at a slow rate which would result in the formation of clear columnar-grained ice. Between the continuing flow, of groundwater, and freezing, pressure could be built up under the ice. At some point this pressure, combined perhaps with a sharp drop in air temperature, would be sufficient to fracture the ice cap. The fracture of the cap would result in a sudden release of water which would wash the ice fragments out on to the surface of the lake. The coefficient of friction for ice on ice when lubricated with water is extremely low; so the ice fragments or blocks could be carried some distance.

5. The model presented in the previous paragraph is supported by the following on-site observations:

a. almost all the ice blocks on the lake were upright, i.e., granular snow ice overlaying clear columnar-grained ice;
b. the elongated oval area of block distribution combined with the graduation of block size (piece size decreasing with increasing distance from shore) suggests ice movement away from the shore;
c. an ice core taken through an ice block 40 yards from shore showed it to have a similar grain structure profile to that of a core through an exposed piece of ice on the shore i.e., both exhibited 12 inches of granular ice overlaying 12 inches of large grained columnar ice;
d. the core through the ice block showed 24 inches of superimposed ice (granular snow ice) under the block before the fine grained columnar structure typical of lake ice was reached. Typical lake ice grain structure was confirmed with a core taken over 150 yards from shore;
e. similar convex domed ice features were observed in the general area. The Inuit call these ice features "KARNIQ"; and
f. about ½ mile away and about 200 feet higher there was a lake which could be the source for groundwater seepage.

6. The following diagrams are derived from a report prepared upon the Electromagnetic Survey to detect occurrence of metal objects under lake ice on Baffin Island. This report was prepared for the. Canadian Armed Forces, CFB Edmonton, Alberta by R.M. Hardy and Associates Limited, Calgary, Alberta.



ANNEX H
Part 1 A

GROUPS	RESPONSIBLE OFFICIAL

1. On- Scene Commander (OSC) — Colonel David Garland
Responsible for overall operations, to include activities and forces of the Canadian and U.S. Governments.

2. Mission Planning Group — On-Scene-Commander
Responsible for integrating all scientific, technical, logistical and administrative data into flight mission plans; and search, identification, and recovery operations. Responsible also for future planning to identify short and long-term needs for continuing U.S. support.
Membership - Colonel Garland, CF
R. Eaton, AECB
M. Gates, DOE
T. Wade, DOE
R. Wagner, LLL
IV. Nelson, LLL
J. Doyle, EGG
K. Shultz, AECB

3. Canadian Government Forces — On-Scene-Commander
The OSC is responsible for integrating the total efforts of the Canadian Government Forces. The OSC has primary responsibility for search, identification, isolation, security, and protection. The Atomic Energy Control Board (AECB) has primary responsibility for recovery and disposal.

4. Canadian Forces Operations — Colonel Garland
Responsible for provision of aircraft, crews, flight schedules and operations duties.

5. Department of Energy, Mines & Resources — Keith Richardson
(Geological Survey & Centre for Remote Sensing) Quenton Bristow
Responsible for operation of radiation detection equipment, originally designed for use in uranium exploration.

6. Atomic Energy Control Board — Geoffrey Knight
Roger Eaton
Ken Shultz

Responsible for recovery of debris and for its storage, transportation and disposal.

7. U.S. Government Forces — Senior U.S. Government Representative

The senior U.S. Government representative is responsible for all U.S. support to the On-Scene-Commander and is in charge of all U.S. personnel.

Senior U.S. Government Rep (SUSGR)	M. Gates, DOE
Deputy SUSGR	T. Wade, DOE

(Medical Advisor- Dr. S. Cavender; REECo)

Major U.S. support is divided into three elements, i.e. Operational, Technical, and Scientific.

8. Operational Plans — Troy Wade, DOE
Bob Peterson, DOE

Responsible for the U.S. participation in overall planning and execution. Includes responsibility for operation of the DOE Command Post, liaison with NV and with the DOE HQ Emergency Operations Centre.

9. Technical Support — J.F. Doyle, EGG

Responsible for all U.S. Nuclear Emergency Search Team (NEST) equipment and NV contractor support. Technical support is divided into five primary areas, ie. Command Post Operations, Flight Operations, Data Analysis, Scientific Photography and Logistics.

Command Post Operations — Marty Parelman

Responsible for manning the EG&G Command Post on a 24 hour basis. Maintains status information, provides U.S. team locator service, responds to service requests. Also provides and maintains the U.S. communication system.

Flight Operations — L.G. Sasso

Responsible for scheduling technical crews for flight systems. Assuring maintenance of systems, and detailed interface with CF on operational matters.

Data Analysis — Thane Hendricks

Responsible for computer analysis of all search data based on requirements from the Hit Assessment Group.

Scientific Photography — Bob Heibaum

Responsible for photographic documentation of search and identification operations. Provides Public Affairs support on the basis of non-interference with technical operations.

<u>Logistics</u> <u>Hal English</u>
Responsible for care and feeding of U.S. contingent. Acquires local materials and services as required.

10. <u>Scientific Support</u> <u>R. Wagner/ W. Nelson, LLL</u>
U.S. Scientific support can generally be divided into four primary areas i.e., forward Area Support, Tracking and Re-Entry, Hit Assessment and recovery decontamination.

<u>Forward Area Support</u> <u>N. Baily</u>
? Callaghan
T. Cri[illegible]
D. Feus[illegible]

Performing broad, integrated forward area support for forward area operations where [illegible] is required to perform several functions because of limited personnel. These functions included detection, data analysis, preliminary assessment, and planning details of forward area mission.

<u>Tracking/Re-Entry</u> <u>Anders Ljungwe, aerospace</u>
K. Stansberry, Aerosp2ce
Ira Morrison, LLL
Fred Jessen, LLL

Responsible for liaison with U.S. agencies providing tracking data, and for evaluation of re-entry track structural dynamics, breakup, burnup, and distribution studies of satellite piece-parts.

<u>Hit Assessment</u> <u>K. Shultz, AECB</u>
T. Dahlstrom, EGG
c. Gatrousis, LLL
A. Darnley, CGS
K. Richardson, CGS
R. Trolan, LLL
R. Wilson, LLL
T. Hain, LLL
H. Hick, LLL

Responsible for evaluation and integration of all analytical data including gamma spectroscopy, IR and photography- and consulting with and advising.

Recovery/ Decontamination — J. Tinney, LLL

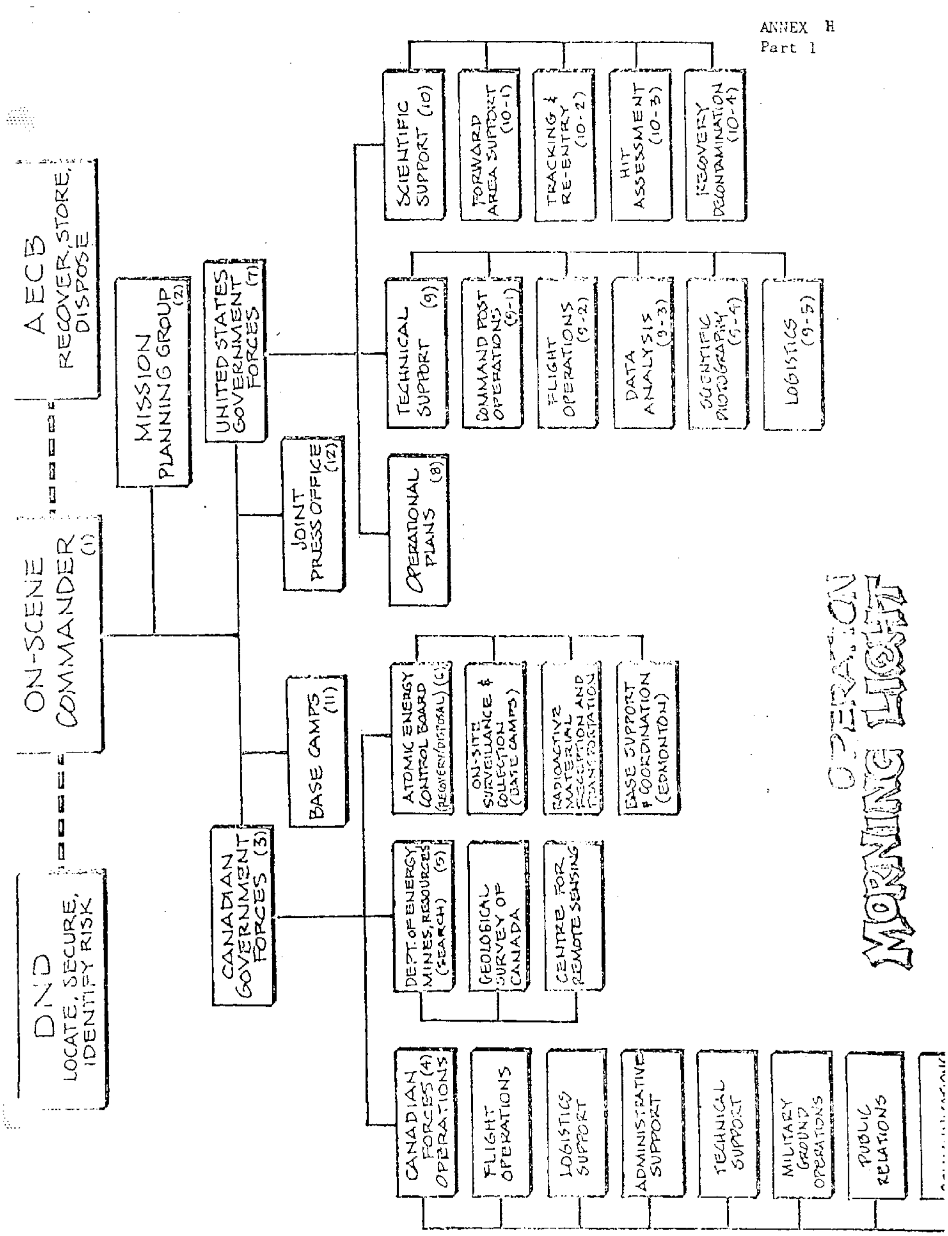
Responsible for advising Canadian authorities relative to health physics, criticality, recovery and clean-up.

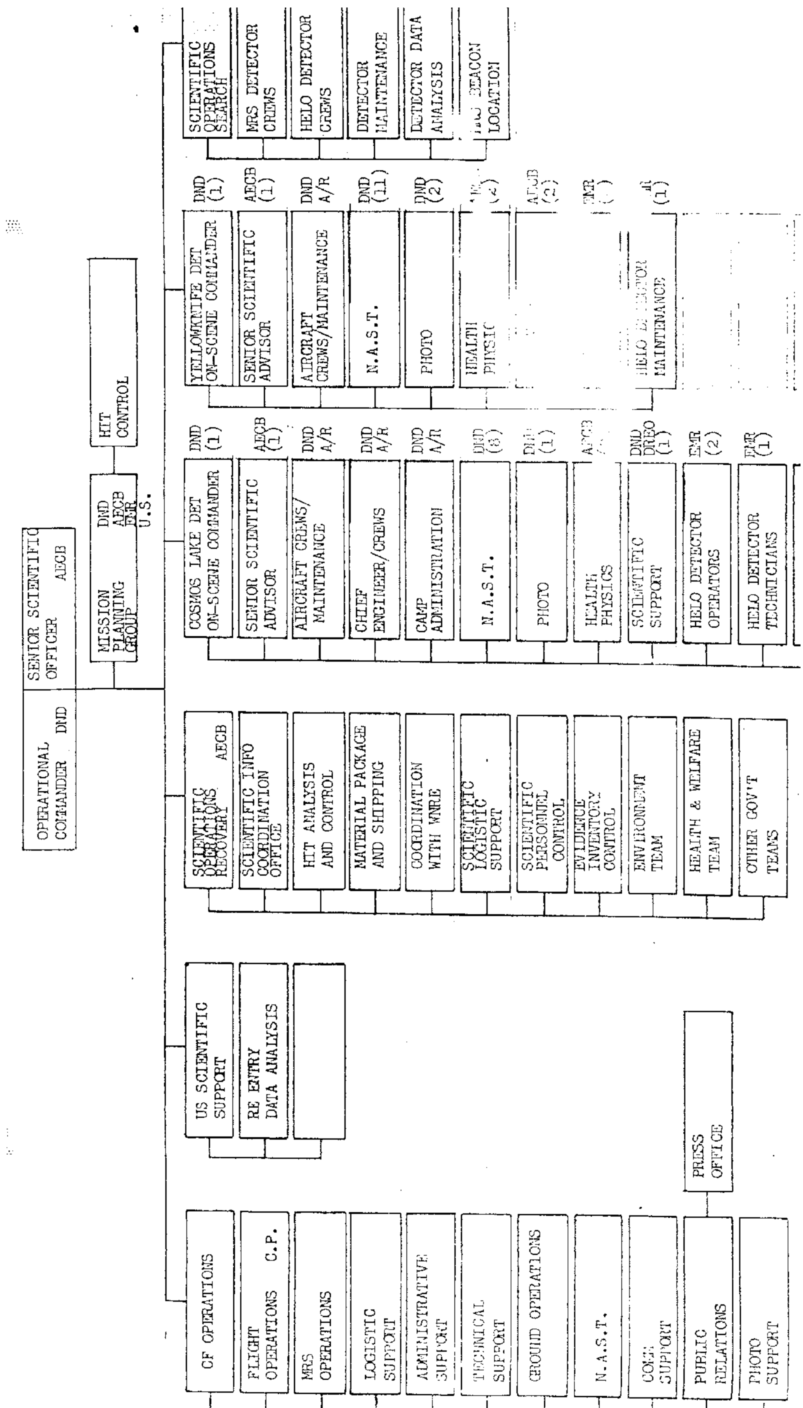
11. Base Camps — As Designated bv OSC

Base Camps (or forward Command Posts) are established as recommended by the mission Planning Group and approved by the OSC. At the present time (2/1/78), there are two base camps as follows: (Planning is now underway to disestablish the camp at Baker Lake and establish a new base camp at Warden's Grove).

Yellowknife	Lieutenant-Colonel Bialosh, CF
	J. Stewart, DOE
	A. Bicker, REECo
	K. Knighen, EGG
	D. Lynn, EGG
	D. Feuss. LLL
	J. Carlos,LLL
	J. Tinney, LLL
Baker Lake	Lieutenant-Colonel Davidson, CF
	P. Mudra, DOE
	C. Henry, LASL
	N. Bailey, LLL
	T. Crites, LLL
	R. Windom, EGG
12. Joint Press Office	Lieutenant-Colonel Totman, CF
	Major Keating, CF
	Major West, CF
	Captain Hogan, CF
	Lieutenant Cyr, CF
	D. Jackson, DOE
	D. Miller, DOE

Reporting to the media locally is the responsibility of the OSC and is executed by the above members of the Joint Press Office. All releases must be approved by National Defence Headquarters, Director of Information Services (NDHQ/ DIS).


ANNEX H
Part 1
DND
LOCATE, SECURE, IDENTIFY RISK
ON-SCENE COMMANDER (1)
AECB
RECOVER, STORE, DISPOSE
MISSION PLANNING GROUP (2)
UNITED STATES GOVERNMENT FORCES (7)
CANADIAN GOVERNMENT FORCES (3)
BASE CAMPS (11)
JOINT PRESS OFFICE (12)
OPERATIONAL PLANS (8)
TECHNICAL SUPPORT (9)
COMMAND POST OPERATIONS (9-1)
FLIGHT OPERATIONS (9-2)
DATA ANALYSIS (9-3)
SCIENTIFIC PHOTOGRAPHY (9-4)
LOGISTICS (9-5)
SCIENTIFIC SUPPORT (10)
FORWARD AREA SUPPORT (10-1)
TRACKING & RE-ENTRY (10-2)
HIT ASSESSMENT (10-3)
RECOVERY DECONTAMINATION (10-4)
DEPT. OF ENERGY, MINES, RESOURCES (5) (SEARCH)
GEOLOGICAL SURVEY OF CANADA
CENTRE FOR REMOTE SENSING
ATOMIC ENERGY CONTROL BOARD (6) (RECOVERY/DISPOSAL)
ON-SITE SURVEILLANCE & COLLECTION (BASE CAMPS)
RADIOACTIVE MATERIAL RECEPTION AND TRANSPORTATION
BASE SUPPORT & COORDINATION (EDMONTON)
CANADIAN FORCES (4) OPERATIONS
FLIGHT OPERATIONS
LOGISTICS SUPPORT
ADMINISTRATIVE SUPPORT
TECHNICAL SUPPORT
MILITARY GROUND OPERATIONS
PUBLIC RELATIONS
OPERATION MORNING LIGHT


OPERATIONAL COMMANDER DND
SENIOR SCIENTIFIC OFFICER AECB
MISSION PLANNING GROUP
DND AECB EMR U.S.
HIT CONTROL
CF OPERATIONS
FLIGHT OPERATIONS C.P.
MRS OPERATIONS
LOGISTIC SUPPORT
ADMINISTRATIVE SUPPORT
TECHNICAL SUPPORT
GROUND OPERATIONS
N.A.S.T.
COMM SUPPORT
PUBLIC RELATIONS
PRESS OFFICE
PHOTO SUPPORT
US SCIENTIFIC SUPPORT
RE ENTRY DATA ANALYSIS
SCIENTIFIC OPERATIONS RECOVERY AECB
SCIENTIFIC INFO COORDINATION OFFICE
HIT ANALYSIS AND CONTROL
MATERIAL PACKAGE AND SHIPPING
COORDINATION WITH WNRE
SCIENTIFIC LOGISTIC SUPPORT
SCIENTIFIC PERSONNEL CONTROL
EVIDENCE INVENTORY CONTROL
ENVIRONMENT TEAM
HEALTH & WELFARE TEAM
OTHER GOV'T TEAMS
COSMOS LAKE DET ON-SCENE COMMANDER
DND (1)
SENIOR SCIENTIFIC ADVISOR
AECB (1)
AIRCRAFT CREWS/ MAINTENANCE
DND A/R
CHIEF ENGINEER/CREWS
DND A/R
CAMP ADMINISTRATION
DND A/R
N.A.S.T.
DND (8)
PHOTO
HEALTH PHYSICS
SCIENTIFIC SUPPORT
DND DREO (1)
HELO DETECTOR OPERATORS
EMR (2)
HELO DETECTOR TECHNICIANS
EMR (1)
YELLOWKNIFE DET ON-SCENE COMMANDER
DND (1)
SENIOR SCIENTIFIC ADVISOR
AECB (1)
AIRCRAFT CREWS/MAINTENANCE
DND A/R
N.A.S.T.
DND (11)
PHOTO
DND (2)
HEALTH PHYSIC
HELO DETECTOR MAINTENANCE
(1)
SCIENTIFIC OPERATIONS SEARCH
MRS DETECTOR CREWS
HELO DETECTOR CREWS
DETECTOR MAINTENANCE
DETECTOR DATA ANALYSIS
LOCATION

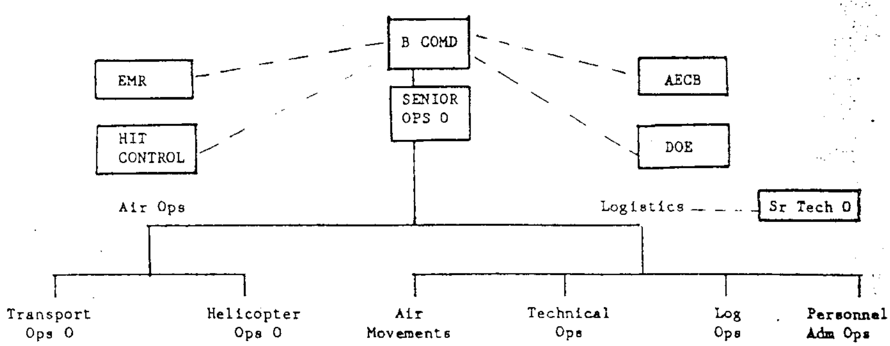
ANNEX H
Part 1 C

OPERATION MORNING LIGHT

2 Mar 78

ORGANIZATION COMMAND POST

CFB EDMONTON



Hours

Sr Ops O	- 0800-2200 (Home Standby)
Transport Ops	- 0700-1900, 1900-0700
Helicopter Ops	- 0700-1900
Tech Ops	- 0500-1500, 1500-2400 (Home Standby)
Log Ops	- 0500-1500, 1500-2400 (Home Standby)
Pers Adm Ops	- 0500-1500, 1500-2400 (Home Standby)
Air Movements	- 0500-1500, 1500-2400 (Home Standby)

Further Readings

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Operation Morning Light

An Operational History

Canadian Forces Base Edmonton final reports

Edited and introduced by Ryan Dean and P. Whitney Lackenbauer

Cosmos 954, a Soviet nuclear-powered satellite launched in Kazakhstan in September 1977, re-entered the earth's atmosphere in the early morning hours of 24 January 1978. The United States, which had mobilized its nuclear emergency response team (NEST) in early January, and Canada, which activated its Nuclear Accident Support Team (NAST) on 20 January, responded. Their search activities, under the designation "Operation Morning Light," determined that radioactive satellite debris had survived re-entry and reached the ground. Their subsequent clean-up operations sought to safeguard the welfare of Northern Canadians living in the affected area. By critically evaluating the methods, equipment, and personnel employed during Morning Light, this recently declassified military report – published for the first time – explains how the combination of civilian scientific expertise with military capabilities succeeded in overcoming large distances across a frigid, subarctic environment to effectively locate and recover the radioactive remnants of Cosmos 954.

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