Report No. CG-D-25-95

EVALUATION OF CANADIAN AND NATIONAL ICE CENTER MANAGEMENT AND SURVEILLANCE PROPOSALS

Annex F of Cost and Operational Effectiveness Analysis for Selected International Ice Patrol Mission Alternatives

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FINAL REPORT

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16. Abstract

This report is Interim Report Volume 6 for the Cost and Operational Effectiveness Analysis for Ice Patrol Mission Analysis Study. This report evaluates invited proposals by the Ice Services Branch, Environment Canada and the National Ice Center proposals to provide management and surveillance services for the International Ice Patrol (IIP) to determine their responsiveness and the feasibility and suitability of transferring or contracting certain elements of the IIP mission to other agencies.

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METRIC CONVERSION FACTORS

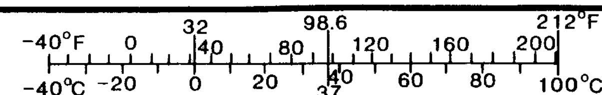
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (WEIGHT)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (EXACT)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly).

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (WEIGHT)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (EXACT)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



Acknowledgments

The United States Coast Guard would like to thank Anne O'Toole of Environment Canada and Captain Larry Warrenfeltz of the National Ice Center for providing proposals for this study. The Coast Guard solicited proposals from both organizations to perform management and surveillance functions for the International Ice Patrol. These proposals took a considerable amount of time, thought and resources to produce. They were very responsive and reflect well upon the professionalism of their respective organizations.

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EVALUATION OF CANADIAN AND NATIONAL ICE CENTER MANAGEMENT AND SURVEILLANCE PROPOSALS

ABSTRACT

In response to an Inquiry of Interest prepared by the study, the Ice Services Branch, Environment Canada and the National Ice Center have submitted proposals to provide management and surveillance services for the International Ice Patrol (IIP). This report evaluates those proposals to determine their responsiveness and the feasibility and suitability of transferring or contracting certain elements of the IIP mission to other agencies. The Ice Services Branch surveillance proposal includes a "locate and identify" search procedure that is not fully described, precluding a determination as to whether the proposed surveillance satisfies the performance requirement. Otherwise, the ISB proposal is complete and comprehensive. The total surveillance cost (adjusted for the length of the 1992 season) is $1,945,000. The National Ice Center recommended a surveillance option to contract to Canada yielding a total surveillance cost of $900,000. Given the costs provided in the Canadian proposal, it is not clear that these costs can be realized. The other NIC option that calls for the U.S. Coast Guard to provide surveillance yields a cost ranging from $2,208,500 to $3,139,000, depending on what cost elements are included. The NIC proposal is weak on implementation details of contracted surveillance. The Canadian management proposal fully utilizes the ISB infrastructure and demonstrates a good knowledge of IIP operations. The estimated annual cost is $859,000. The NIC management proposal transfers ten to fourteen (depending on the surveillance option) Coast Guard personnel to NIC and integrates IIP as a department in the NIC structure.

INTRODUCTION

Objective.

The purpose of this report is to review the proposals by the Ice Services Branch, Environment Canada and the National Ice Center to provide management and surveillance services for the International Ice Patrol (IIP) and to evaluate the contents of the proposals. The results of this evaluation will be used to evaluate the feasibility and suitability of transferring or contracting certain elements of the IIP mission to other agencies.

Background.

Several management and surveillance alternatives were selected by the Coast Guard for a Cost and Operational Effectiveness Analysis (Armacost, 1994). The management alternatives represent options that will take full responsibility for the conduct of the IIP mission. Two of the management alternatives (Canadian management and National Ice Center management) are addressed in this report. In addition, Contracted Canadian surveillance and National Ice Center coordinated surveillance are also addressed and evaluated.

A potential alternative that was considered initially is to have the Canadian government assume the role of Managing Government under SOLAS 74. This option would necessarily require an amendment to the treaty. The existing infrastructure in the AES Ice Services is fully capable of taking on the mission of the IIP. However, all Canadian governmental units are under strong pressures to reduce budgets. Absent any political motivation, it is unlikely that Canada would be willing to take on the full responsibility for the IIP without a strong guarantee of full reimbursement of the operating costs. Therefore, a viable alternative is for the U.S. (perhaps through the Coast Guard) to contract with Canada to manage the entire IIP mission. This alternative is addressed in this report.

In the past, the National Ice Center has been very interested in having the IIP responsibility shifted to its control. It is believed that the assumption was that the Coast Guard resources (e.g., personnel, aircraft support) would be included in such a shift. A change in responsibility to the NIC would require a change in the USC, but would not require an amendment to SOLAS because the U.S. would remain as the Managing Government. A potentially viable alternative is for the NIC to assume full responsibility for conducting the IIP including the funding of all operations, including management and provision of the necessary surveillance. This second alternative is addressed in this report.

Related to the Canadian management of the IIP is assigning the responsibility for Canada to provide the surveillance necessary to generate the ice information. Canadian ice surveillance could be used in conjunction with continued U.S. management of IIP (presumably the Coast Guard). This surveillance alternative is addressed in this report. The NIC management alternative also includes provision of surveillance services.

Inquiry of Interest.

In order to obtain meaningful input for evaluation of the alternatives, it was necessary to seek direct inputs from the Ice Services Branch, Environment Canada (ISB) and from the National Ice Center (NIC). Because of the international and inter-agency dimensions of this data collection effort, requests for information were made using a structure termed an "Inquiry of Interest." It was emphasized that the inquiry and any response to it were not contractual and were made to develop information for planning purposes only. Separate requests were made to both ISB and NIC.

The ISB Inquiry of Interest contained two distinct elements: a request for a proposed surveillance scheme to provide a level of performance equivalent to that currently provided by Coast Guard surveillance, and a proposed management structure to effect the day-to-day management of the entire IIP operations under the direction of a Coast Guard COTR. The complete Inquiry of Interest is included in Appendix I.

The NIC Inquiry of Interest focused on the National Ice Center providing complete management of the IIP, including provision for surveillance. It recognized that NIC does not have in house surveillance resources and that arrangements for continuing Coast Guard surveillance or contracting for surveillance would be required. The complete Inquiry of Interest is included in Appendix II.

Both ISB and NIC provided timely and responsive proposals to the respective Inquiry of Interest. The ISB response is included in Appendix III and the NIC response is included in Appendix IV. The ISB and NIC responses are evaluated in the following sections. The surveillance responses are analyzed first, followed by analysis of the management proposals.

EVALUATION OF SURVEILLANCE PROPOSALS

Ice Services Branch, Environment Canada.

Surveillance.

ISB delivered a comprehensive proposal that demonstrated an excellent knowledge of IIP operations and mission requirements. Their surveillance is based on using the DeHavilland Dash 7 aircraft outfitted with both SLAR and FLAR radars combined with visual reconnaissance employing a "locate and identify" surveillance strategy. The aircraft will be based in Newfoundland providing reduced cost due to the elimination of unnecessary transit times and affording the opportunity to take advantage of favorable weather conditions. The ISB has provided for backup aircraft through the Department of Fisheries and Oceans and the Department of National Defence. The proposal provides for deployment of the AXBT probes by the Dash 7 and deployment of the WOCE buoys by arrangement with the Department of Fisheries and Oceans. Using 1992 surveillance requirements as a base year, the total estimated cost for providing surveillance services is $1,865,000 (1995 $US). The complete proposal is included in Appendix III.

The essential performance requirements specified minimum probabilities of detection, coverage requirements, surveillance frequency, unidentified detections, and iceberg classification. Specifically, the surveillance performance requirements for the response to this inquiry are summarized as follows.

- Provide surveillance with the following probability of detection and identification.

Iceberg Type	*PODI*
Large iceberg (126-213 m)	0.98
Medium iceberg (61-125 m)	0.96
Small iceberg (15-60 m)	0.95
Growlers (< 15 m)	0.85

- Provide surveillance coverage over a 125 nm swath of the Limits of All Known Ice.
- Provide surveillance at least bi-weekly.
- Provide surveillance so that the average percentage of unidentified radar targets within 60 nm inside of the LAKI is less than 10% and zero outside of the LAKI.
- Provide the capability to deploy AXBTs and WOCE buoys.

To meet the POD requirements, ISB proposes to use a "locate and identify" search mode with the CAL-200 SLAR and a new (unspecified) FLAR radars. The proposal asserts that this approach is "more efficient" than the 200% SLAR coverage employed by the U.S. Coast Guard. This conclusion is apparently based on the experienced judgement of the Canadian ice observers. The proposal does not provide any supporting material to justify the approach or attempt to quantify the POD for various sizes of icebergs. Based on the information in the proposal, it is not possible to determine if the proposed approach meets the current level of performance for detecting icebergs.

The effective endurance of the Dash 7 is 1400 nm. (For planning purposes, the USCG uses 1700 nm for the HC-130.) ISB has examined the ability of the Dash 7 to provide coverage of the LAKI (15 June 1992 was the extreme limits during the 1992 ice season extending to 039.5°W) and has provided reasonable justification for the Dash 7 using the locate and identify search strategy. If another search strategy is used, coverage will have to be verified.

ISB estimates that an average of five sorties requiring a total of 35 flight hours will be required to cover the LAKI at the mid-season location. Using six months as a basis with twice monthly patrols, a total of 420 flight hours would be required. ISB asserts that this would be sufficient to cover the entire 1992 season (USCG flights included 19 ICERECDET deployments over eight months.) ISB has also proposed patrols in the interior for the LAKI to support the iceberg sighting data base and to identify bergs crossing 48°N. This would require an additional 360 hours of flight time to cover the area from 52°N twice a month (for six months).

ISB asserts that the locate and identify search strategy will maintain the requirement that there are no unidentified targets outside of the LAKI and less than 10% within 60 nm inside the LAKI. By definition, the search strategy employs a positive identification of identified targets and, consequently, the search strategy should be effective at meeting this requirement. The unanswered question is what happens to the overall POD when this strategy is employed? This strategy with the reliance on visual classification should result in classification at least as good as the existing classification performance standard. If detection does not meet the POD performance standard, then overall classification may not be satisfactory.

Related to surveillance is the ability to deploy the WOCE buoys and AXBT probes. The Dash 7 is capable of deploying the AXBTs and ISB will arrange with DFO to deploy the WOCE buoys. The ISB proposal assumes that the U.S. Coast Guard will continue to procure the WOCE buoys and finance the Service ARGOS data processing.

ISB will employ personnel to provide three ice observers on all surveillance flights. They will use experienced personnel in these positions. The Dash 7 flight crew includes two pilots, one engineer, and one electronics technician in addition to the three ice observers.

The ISB proposal demonstrates that ISB is capable of meeting all performance requirements except for achieving comparable probabilities of detection. The lack of information regarding the locate and identify strategy precludes a determination regarding the adequacy of the POD.

Costs.

Surveillance costs were generated in $CN and converted to $US using an exchange rate of 1.41. This rate is a recent 18 month high. For planning purposes, an average rate should be used. ISB assumed a six month season which affects the aircraft basing costs. It is not clear from the ISB cost estimates (page 29 in the proposal) whether salaries , hangarage, and depreciation are six month amounts or annual amounts. At some point, it will be appropriate to compare the ISB costs for the 1992 season with the U.S. Coast Guard costs actually incurred. Note that the 1992 season extended for eight months. In Table 1 below, we assume that the ice observer salaries and the depreciation costs are given as annual amounts and do not need to be adjusted for an eight month season. Aircraft depreciation is assumed to be an annual amount over the expected life of the aircraft. Equipment depreciation is assumed to cover the new FLAR amortized over five years. The interest charge is assumed to be an annual amount. The hangarage charge is assumed to be six months and will be adjusted.

For the assumed 420 flight hour level, the adjusted 1992 cost corresponds to a flight hour cost of $4,630 per flight hour. The comparable cost calculation for U.S. Coast Guard surveillance does not include the ice observer cost. It is not clear from the proposal what travel is included in the direct operating costs and whose travel is covered. The travel cost will be retained for comparison with U.S. Coast Guard costs. After eliminating the ice observer cost, the total adjusted surveillance cost is $1,758,000 resulting in a per hour cost of $4,186 per surveillance hour.

Table 1. Adjusted ISB Surveillance Costs, 1992 Surveillance Levels (1995 $US).

Account	$ US -- Reported	$ US -- Adjusted
Ice Observer Labor	187	187
Aircraft Costs		
Basing charge (52.9/mo)	225	300
Flying charge (845/hr)	252	252
Maintenance	103	103
Hangarage	14	19
Contingencies	71	71
Equipment Costs	92	92
Direct Operating Costs	115	115
Indirect Costs	71	71
Capital Costs	735	735
Total	1865	1945

National Ice Center.

Surveillance.

The National Ice Center proposal includes two options for surveillance: Option A includes contracted surveillance by the Canadian government and military aircraft; Option B retains the status quo with U.S. Coast Guard HC-130 aircraft conducting iceberg surveillance. NIC has recommended that Option A be pursued (in conjunction with NIC assuming management responsibility for the IIP as discussed below).

In developing its proposal, NIC referred to the different levels of sightings from different sources. NIC noted that their reference did not include the regions in which the sightings occurred and indicated that such locations were an important concern in evaluating sighting input levels. The NIC analysis is driven by costs provided by Atlantic Airways and by the Canadian AES. Specifically, AES can utilize the Atlantic Airways contract with DFO to have the King Air aircraft available at $1100 per hour (assumed to be $US). AES has quoted a price of $1500 per hour for the Dash 7. (This is a very different cost than the $4,186 per hour computed above based on the ISB proposal.) It is expected that both AES and Atlantic Airways would look for longer term contracts that would include basing costs. For computing total surveillance costs, NIC estimates the required patrol hours at 613, the average total aircraft hours provided by the U.S. Coast Guard in 1992-1994.

The NIC proposal states that "differences between performance characteristics for the HC-130 SLAR/FLAR, Atlantic Airways and DND FLAR, and Dash 7 SLAR have not been clearly identified." The proposal notes that these differences may result in more hours being required or lead to a reconfiguration of Canadian radar systems. The NIC proposal does not explicitly discuss POD, frequency of patrol, and unidentified detections and unclassified detections. NIC notes that the Dash 7 is capable of deploying AXBTs but that alternative means would be required for deploying the WOCE buoys.

NIC identifies the access to National Technical Means data as a potential benefit to NIC's involvement in IIP. This may provide supplemental iceberg detection/identification data. It may prove useful if enhanced RADARSAT imagery becomes available. However, this would not be a committed resource and may be preempted by higher priority assignments. This aspect is identical in Options A and B.

A recurring discussion associated with Option A is the need that NIC has for the U.S. Coast Guard SLAR capability to support other ice reconnaissance missions (e.g., USCG icebreakers in polar regions). The NIC proposal suggests on the one hand that contracting the IIP surveillance to Canada would free additional time for other ice reconnaissance missions. On the other hand, the NIC proposal suggests that failure to retain the IIP surveillance mission may lead to canceling the SLAR digital upgrade and ultimately losing the SLAR capability. NIC emphatically states that it is crucial that the HC-130 SLAR capability be maintained.

Costs.

The NIC proposal is not clear as to whether the contract price for surveillance aircraft in Option A includes ice observers. The ISB proposal above includes separate salaries for ice observers. The NIC cost proposal includes travel/lodging expenses approximately equal to what would be required if ice observers were deployed from IIP. It is not clear if ice observers were overlooked in preparing the personnel allowance or if ice observers are being provided from other NIC assets. Even if provided by non-Coast Guard personnel, the use of other staff represents an expense that should be charged to IIP.

For Option A, the total estimated surveillance cost is $900,000 and includes $800,000 for 613 contract flight hours (at $1,300 per hour) and $100,000 for travel/lodging. This compares with $4,186 per hour based on Canada's proposal for providing coverage amounting to 420 flight hours.

For Option B, the total estimated surveillance cost is $2,208,500 using estimated element costs that are reasonable. Not included in that cost estimate is air crew travel, aircraft depreciation and the administrative expense charged (30% of operational expense). These costs will raise the total surveillance cost by approximately $930,500 and the new total surveillance cost will be $3,139,000.

EVALUATION OF MANAGEMENT PROPOSALS

Ice Services Branch, Environment Canada.

Management.

The Ice Services Branch proposes to use a total of nine full time equivalent personnel to manage the IIP program. Primary iceberg forecasting and analysis will be accomplished by a two person analyst/forecaster team during the ice season. One computer scientist will be assigned systems maintenance responsibilities. Computer operators will provide continuous data monitoring. An iceberg scientist will be responsible for monitoring program development. The ISB proposal assumes that CCGDONE (actually CG COMSTA BOSTON/NMF as part of Coast Guard Atlantic Area Communications System) will continue to provide broadcasts and that FNMOC would continue to provide environmental data. The proposed staff will assist in scheduling iceberg reconnaissance flights. The proposed structure will permit effective delivery of required IIP products using existing capabilities. ISB proposes to continue the same quality assurance functions and to maintain the current database. In addition, ISB notes the BAPS (DMPS) capability to automatically identify sightings outside of the LAKI (called an ALERT). ISB notes that these could be automatically distributed to agencies responsible for safety broadcast. IIP experience suggests that some operator evaluation and review be conducted before ALERTS are released to guard against misreported positions, data entry errors, and other elements that could yield a "false positive."

Although not requested in the Inquiry of Interest, ISB included a well structured section on Iceberg Research and Development and included an iceberg scientist in the staffing to head this effort. This individual would have responsibility for operation and development of iceberg models, model verification schemes, implementation of new techniques, and model upgrades. ISB intends to employ advanced technology to improve the quality of information provided to the mariner.

The existing ISB infrastructure provides significant flexibility with regard to personnel and with regard to system maintenance and contingency planning.

Costs.

The cost proposal assumes that IIP and ISB services are integrated. The cost proposal only shows the IIP share of the costs. The following costs are in $US. There are three major elements: Direct labor (salary) of $277,000; Informatics and Operations costs of $299,000 (this includes $121,000 of capital depreciation); and Corporate Support and Program Development costs of $283,000. The total management cost for the program is $859,000.

National Ice Center.

Management.

The National Ice Center has proposed that the U.S. Coast Guard maintain funding responsibility for the IIP and that the IIP operate within the management structure of the NIC. Specifically, this requires relocating IIP personnel to the NIC. The number of personnel involved depends on the surveillance option selected.

Under Option A, a total of ten persons are required. The existing Commanding Officer and Executive Officer billets and the Aerial Ice Observer billets are eliminated. Watchstanding requirements are unchanged from current IIP procedures. Data collection and processing and information distribution continue as currently performed. NIC proposes that DMPS and DMPS2 be installed on new a HP workstation as currently planned by IIP. Existing products and distribution channels will be continued.

Under Option B, a total of fourteen persons are required, adding one DWO and three watchstanders to the Option A allowance. These personnel will allow personnel to serve as Aerial Ice Observers on the Coast Guard HC-130 surveillance flights.

Both options under the NIC proposal continue current IIP procedures using Coast Guard personnel. The proposed personnel allowance for both options provide slight savings by reducing the CO and XO positions. Under the option involving Canadian contracted surveillance, it is not clear where the ice observers are staffed.

Costs.

Under NIC Option A, the total management costs are $747,000. Using the 1995 standard personnel costs, the 1995 USCG personnel costs for the proposed allowance of ten persons is summarized in Table 2. The total cost of $530,871 exceeds the estimated $487,000 used in the NIC proposal.

Table 2. IIP Personnel Baseline Costs, 1995--NIC Option A.

		1995 Standard Costs					
IIP Allowance	**No.**	**Salary**	**PCS**	**O&M**	**Training**	**Medical**	
LCDR (O-4)	1	65,346	1,858	3,257	1,431	2,917	$74,809
LT (O-3)	1	59,031	1,858	3,257	1,431	2,917	$68,494
MSTC (E-7)	1	40,514	1,416	2,999	672	2,917	$48,518
MST1 (E-6)	1	34,609	1,416	2,999	672	2,917	$42,613
YN1 (E-6)	1	34,609	1,416	2,999	672	2,917	$42,613
MST2 (E-5)	2	29,249	1,416	2,999	672	2,917	$74,506
MST3 (E-4)	1	24,008	1,416	2,999	672	2,917	$32,012
GS-14	1	86,300	503	2,506	244		$89,553
GS-11	1	54,500	503	2,506	244		$57,753
Total personnel cost							$530,871

Under NIC Option B, the management costs total $942,000, which includes $682,00 for personnel expenses. Again, using 1995 standard personnel costs, the adjusted personnel cost is $674,761 as shown in Table 3, and the resulting total management cost is $934,761.

Table 3. IIP Personnel Baseline Costs, 1995--NIC Option B.

		1995 Standard Costs					
IIP Allowance	No.	Salary	PCS	O&M	Training	Medical	
LCDR (O-4)	1	65,346	1,858	3,257	1,431	2,917	$74,809
LT (O-3)	1	59,031	1,858	3,257	1,431	2,917	$68,494
MSTC (E-7)	1	40,514	1,416	2,999	672	2,917	$48,518
MST1 (E-6)	2	34,609	1,416	2,999	672	2,917	$85,226
YN1 (E-6)	1	34,609	1,416	2,999	672	2,917	$42,613
MST2 (E-5)	3	29,249	1,416	2,999	672	2,917	$111,759
MST3 (E-4)	3	24,008	1,416	2,999	672	2,917	$96,036
GS-14	1	86,300	503	2,506	244		$89,553
GS-11	1	54,500	503	2,506	244		$57,753
Total personnel cost							$674,761

The management costs in the NIC proposal do not include the significant administrative (overhead) expense included in the baseline costs for IIP operations. This difference needs to be recognized when making comparisons among the alternatives. In addition, it is not clear where the routine administrative and management tasks currently performed at IIP will be performed and how they will be costed.

SUMMARY

Surveillance.

Ice Services Branch has submitted a comprehensive proposal with the only deficiency being a weak description of the locate and identify search procedure. This lack of information precludes a determination as to whether the proposed surveillance satisfies the POD performance requirement. The total surveillance cost (adjusted for the length of the 1992 season) is $1,945,000. The National Ice Center recommended Option A to contract to Canada yields a total surveillance cost of $900,000. The NIC Option B which calls for the U.S. Coast Guard to provide surveillance yields a cost ranging from $2,208,500 to $3,139,000, depending on what cost elements are included. The NIC proposal is weak on implementation details of contracted surveillance. The primary focus was on cost rather than operational effectiveness. The NIC proposal assumed that the system would yield comparable effectiveness or adjustments would be made (in flight hours or equipment) to ensure that performance would be comparable. This is a reasonable assumption given the limited time frame for preparing the proposal.

Management.

Both the ISB and NIC management proposals address the operation of the IIP effectively and provide structures that appear to be capable of continuing the mission consistent with the current operating procedures. The ISB proposal identifies a need for nine persons to accomplish the task while the NIC proposal requires ten persons. The ISB appears to have a stronger infrastructure for integrating the IIP mission. The estimated ISB management cost is $859,000 and the corresponding NIC estimated cost is $790,900.

REFERENCES

Armacost, R. L., Jacob, R. F., Kollmeyer, R. C., and Super, A. D., *Interim Report on the Analysis of Current Operations of the International Ice Patrol*, EER Systems Corporation, September, 1994

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Appendix I. Inquiry of Interest--Canada.

This Appendix includes the request titled "Inquiry of Interest: Canadian Provision of Surveillance and Management of the International Ice Patrol."

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COST AND OPERATIONAL EFFECTIVENESS ANALYSIS
FOR
ICE PATROL MISSION ANALYSIS

Contract No. DTCG39-94-C-E00085 / IIP Mission Analysis

INQUIRY OF INTEREST:
CANADIAN PROVISION OF SURVEILLANCE AND MANAGEMENT FOR THE INTERNATIONAL ICE PATROL

February, 1995

EER Systems Corporation
50 Enterprise Center
Middletown, RI 02840
(401) 846-6222

Security Classification: UNCLASSIFIED

This inquiry is <u>not</u> a formal request from the United States government to the Canadian government for the provision of services, but only a request for information for the International Ice Patrol Mission Analysis study.

INQUIRY OF INTEREST:
CANADIAN PROVISION OF SURVEILLANCE AND MANAGEMENT FOR THE INTERNATIONAL ICE PATROL

Summary

This inquiry solicits a response which reflects the potential interest by the government of Canada for providing surveillance services to the International Ice Patrol and for providing overall management of the International Ice Patrol. Note that this inquiry is not a formal request from the United States government to the Canadian government for the provision of services, but only a request for information for the International Ice Patrol Mission Analysis study. The following sections provide the background for the inquiry and detail performance specifications. A response to the inquiry is requested by March 27, 1995.

1.0 Background

The USCG Research and Development Center has sponsored a contract on behalf of the Commandant (G-NIO), United States Coast Guard and the Commander, International Ice Patrol to examine alternative methods of accomplishing the International Ice Patrol mission. EER Systems Corporation of Vienna, Virginia was awarded the contract to conduct this mission analysis of the IIP. Dr. Robert L. Armacost of the University of Central Florida is the Principal Analyst and Team Leader for this project.

To date, EER has completed an analysis of the current IIP operations which was used as a baseline for identifying alternative methods of conducting the IIP mission. A number of Management, Modeling, Data Acquisition/Processing, and Surveillance/ Detection/Classification alternatives were developed and evaluated by the Coast Guard as candidates for further detailed study based on how they affect the IIP mission of determining and disseminating the Limits of All Known Ice (LAKI). Criteria of technical feasibility, likelihood of accomplishing the mission element, and reasonable cost were used as discriminators, along with the imperative to select three alternatives.

A decomposition approach was used that identified a larger set of elements. The selected alternatives for detailed analysis include:

Management:

- U.S. management with Coast Guard having primary responsibility.
- Canadian management (technically U.S. with Canada subcontracted).
- U.S. management with National Ice Center having primary responsibility.

Modeling:

- Sensitivity analysis and risk structure for system of models.

Data acquisition and processing:

Implementation of CG version of ADAM system/tactical workstation/data management system.

Comparison of upgrading INTERGRAPH system with shifting to ISIS.

Surveillance/detection/classification:

Brief examination of RADARSAT and Ground Wave Radar.

USCG surveillance with SLAR/FLAR/SAR.

Surveillance contracted to Canada.

Surveillance contracted to commercial firm.

At the same time that these alternatives are examined from a cost and effectiveness perspective, a similar analysis will be conducted for the current system. The results of this cost and operational effectiveness analysis will provide the Program Manager and other Coast Guard decision makers with relevant information for decision making.

The purpose of this inquiry is to examine the potential role of the Canadian government in accomplishing the IIP mission beyond its current level of participation. The *Interim Report on the Analysis of Current Operations of the International Ice Patrol* (Armacost, Jacob, Kollmeyer, and Super, 1994) describes the important role that the Canadian government plays in the surveillance and data processing areas of the IIP. In a visit to Ice Centre Environment Canada by Dr. Armacost, it was apparent that there is a larger role that Canada may play. Two of the specific alternatives which continue to be investigated involve (1) contracting surveillance to Canada, and (2) having Canada assume management responsibility for the IIP operation. The present inquiry seeks to further define those alternatives and provide a basis for evaluating their feasibility.

2.0 Response to the Inquiry

This inquiry, and a response to it, are to be considered a preliminary planning exercise that will determine to what degree further inquiries should be made. The Coast Guard is clearly interested in identifying alternatives that will provide an acceptable level of performance and reduce the costs of operation of the IIP. In responding to this inquiry, it is requested that realistic estimates of cost and operational performance be provided. Any information provided in response to this inquiry has no legal standing and is not binding on any one. The mission analysis is targeted to have preliminary findings by the end of March, 1995, with a draft report completed by the end of April, 1995. In order to be useful in the mission analysis, your response should be received by March 27, 1995.

Because two separate alternatives are posed which involve Canada, it is requested that your response address those alternatives separately. In particular, one section should deal exclusively with providing surveillance, and the other section should address the total management of the program. Specific issues are presented in the following sections.

3.0 Surveillance Performance Requirements

The IIP relies on U.S. Coast Guard surveillance of the IIP operations area along with surveillance information supplied by Canadian sources and ships operating in the area to provide input into the drift and deterioration models which generate predicted positions of icebergs. These predicted position are used to determine the Limits of All Known Ice (LAKI). In order to verify those limits, the IIP conducts surveillance in the vicinity of the LAKI on a periodic basis. Generally speaking, Canadian resources are not currently operating in the vicinity of the LAKI on a regular basis, particularly as the LAKI changes and expands southward during the ice season. Because of the importance of being able to identify icebergs in this region and the reduced opportunities to obtain visual identification, the Coast Guard has adopted the practice of using 200% SLAR coverage of the area to enable the operator to classify radar targets as icebergs based on no movement between the first and second sightings. This practice leads to a high level of probability of detecting radar targets as well as providing for their identification as icebergs. The 200% coverage is illustrated with the simple two track search in Figure 1. Note that the coverage on the outside of the track legs is at 100% and is 200% inside of the track legs of the search pattern. On a search with more legs, the area inside of the outer legs will have 200% coverage.

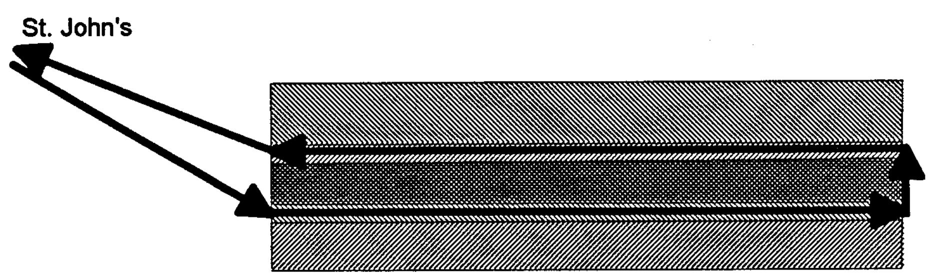

Figure 1. 200% Search coverage.

The combined effect of reported sightings, Coast Guard surveillance, and the use of the drift and deterioration models has resulted in an acceptable level of performance with regard to providing meaningful and timely information regarding the LAKI to the mariners. Therefore, the current operation provides a performance standard for the present inquiry.

3.1 Probability of Detection and Identification.

Several studies have been conducted which have established estimates of the system probability of detection of icebergs using the AN/APS-135 SLAR. The system probability of detection is the inherent capability of the radar as determined by a post-flight laboratory analysis of the film images. Another study has provided estimates of the operator actually detecting radar targets and correctly identifying them as icebergs. These probabilities are assumed to be uniform across the 27 nm range and can be used to estimate the search effectiveness. A typical surveillance patrol is illustrated in Figure 2. Under current practices, the IIP flies a parallel search pattern with a 25 nm track spacing.

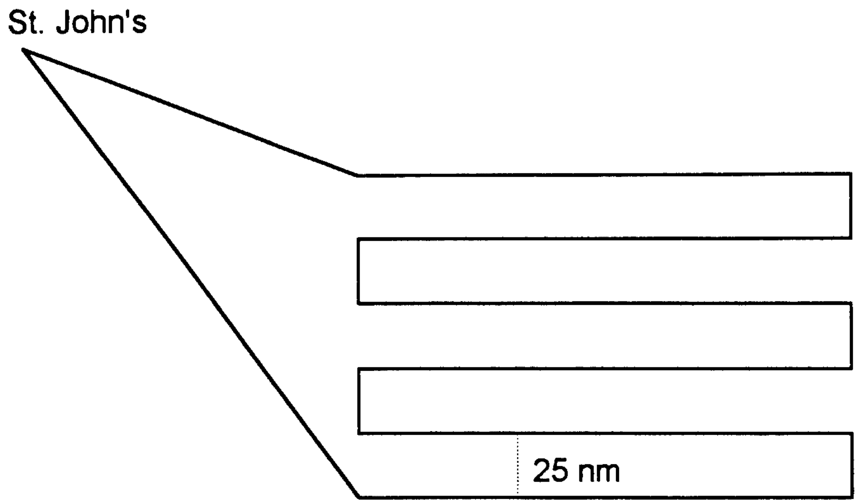

Figure 2. Typical search coverage.

Applying the experimentally estimated probabilities of detection for the six leg search of Figure 2 provides the surveillance performance requirements shown in Table 1.

Table 1. Surveillance Performance Requirements.

TARGET TYPE	Required Probability of Detection and Identification
Large iceberg (126-213 m)	0.98
Medium iceberg (61-125 m)	0.96
Small iceberg (15-60 m)	0.95
Growlers (< 15 m)	0.85

The response to this inquiry should attain the performance levels indicated in Table 1. There is no requirement that patrols be conducted in the same manner as currently conducted by the Coast Guard. The requirement is that whatever method is used should achieve the same performance level as in Table 1. The response to the inquiry should provide supporting information to indicate how the performance level will be attained.

3.2 Coverage

The IIP typically covers a 125 nm swath at 200% coverage using the six leg patrol. Other search patterns may be used to take advantage of environmental conditions and the characteristics of the portion of the LAKI to be searched. When different types of patrols are conducted, coverage still is in the vicinity of a 125 nm swath. In responding to the inquiry, the response should be based on covering a 125 nm swath starting outside of the LAKI and extending inward. Clearly, the level of effort varies from year to year.

However, during the past few years, the IIP surveillance effort has been relatively constant. For planning purposes, Attachment 1 contains semi-monthly depictions of the LAKI for 1992. In addition, Attachment 2 provides copies of the available records for actual surveillance flights by the IIP in 1992. The response should identify the level of effort needed to accomplish equivalent coverage.

3.3 Frequency of Surveillance Information

Given the current quality of information regarding icebergs drifting toward the LAKI, the existing sources and quality of environmental data, and the refinement of the drift and deterioration models, IIP has determined that a LAKI surveillance frequency of one surveillance patrol of the entire LAKI every two weeks is adequate. In practice, the Coast Guard covers a portion of the LAKI on a single patrol sortie. Typically, four such sorties are required to cover the entire LAKI. The response to the inquiry should identify resource requirements necessary to accomplish surveillance of the LAKI at least bi-weekly unless more frequent coverage is required to meet the equivalent of the performance requirements in Table 1.

3.4 Unidentified Detections

Surveillance should be conducted in a way that results in no more than an average of 10% of the radar targets detected in those portions of the patrols within 60 nm inside the LAKI be unidentified targets and no radar targets outside of the LAKI be unidentified. Targets unidentified as icebergs or ships will be reported as radar targets.

3.5 Unclassified Detections

Wherever possible, icebergs should be classified as to size (growler/small/medium/large) and type (pinnacle/tabular). In recent years, approximately 22% of all Coast Guard detections have been visual sightings and have provided detailed iceberg size and type information. The response to the inquiry should produce at least an equivalent performance level.

3.6 Temperature and Current Data Acquisition Requirements

During selected surveillance flights, the IIP also deploys AXBT probes (supplied by the Canadian Forces Meteorology and Oceanography Command) and WOCE ocean drifter current buoys at various times throughout the season. The WOCE buoys play an important role in providing real time current estimates and modifying the historical data on the Labrador Current. Resources provided in response to this inquiry should have the capability to deploy this instrumentation. Note that it is not required that the WOCE buoys and XBTs be deployed from surveillance aircraft. Normally six to ten WOCE buoys will be deployed. The number of AXBTs deployed varies from 40 to 120. The response to the inquiry should indicate how the deployment capability will be provided.

3.7 Cost Format

For purposes of this inquiry, the response should represent costs as both a total cost for the expected level of effort and an equivalent per hour cost represented in U.S. dollars.

3.8 Surveillance Performance Requirements Summary

The surveillance performance requirements for the response to this inquiry are summarized as follows.

- Provide surveillance with the following probability of detection and identification.

Iceberg Type	*PODI*
Large iceberg (126-213 m)	0.98
Medium iceberg (61-125 m)	0.96
Small iceberg (15-60 m)	0.95
Growlers (< 15 m)	0.85

- Provide surveillance coverage over a 125 nm swath of the Limits of All Known Ice.
- Provide surveillance at least bi-weekly.
- Provide surveillance so that the average percentage of unidentified radar targets within 60 nm inside of the LAKI is less than 10% and zero outside of the LAKI.
- Provide the capability to deploy AXBTs and WOCE buoys.

4.0 Management Performance Requirements

As currently structured, the United States government (delegated to the U.S. Coast Guard) is the Managing Government of the International Ice Patrol under the provisions of SOLAS 74. In meeting that responsibility, it is possible for the Coast Guard to contract with another entity to actively manage the IIP function with the Coast Guard providing the reimbursement necessary to do so. Under this arrangement, the Coast Guard would likely negotiate a fixed price contract for the total management of the IIP. A contracting officer's technical representative (COTR) would be the official Coast Guard liaison with the managing entity.

Because Canada has a strong infrastructure within Ice Centre Environment Canada (ICEC) to provide management of the IIP, this inquiry seeks to identify if there is a potential Canadian interest in taking on such a management role, and, if so, to estimate the reimbursement costs required.

4.1 Operating Conditions

IIP operations involve the collection of iceberg surveillance data and environmental data, processing that data using the iceberg drift and deterioration models, and producing twice daily ice bulletins and a daily ice chart. In addition to this information processing function, the IIP conducts surveillance flights as indicated in section 3 above. The IIP also deploys AXBT probes (supplied by the Canadian Forces Meteorology and Oceanography Command) and WOCE ocean drifter current buoys at various times throughout the season. The current operations of the IIP are generally described in the *Interim Report on the Analysis of Current Operations of the International Ice Patrol* (Armacost, Jacobs, Kollmeyer, and Super, 1994), a copy of which is enclosed as Attachment 3. The specific operating procedures used by the IIP are included in the *Standing Orders for IIP Operations Center Duty Personnel* (CIIPINST M3120B) which is enclosed as Attachment 4. This inquiry assumes that Canada will conduct or arrange for all surveillance that is required to support the IIP and will provide or arrange for necessary communications facilities.

4.2 Product Requirements

Several products are required for external distribution when the International Ice Patrol is in operation:

- 0000Z and 1200Z descriptions of the Limits of All Known Ice distributed as safety broadcasts.
- 0000Z and 1200Z Ice Bulletins that include descriptions of the Limits of All Known Ice, an area identified as the "Area of Many Bergs," and the locations of the icebergs and unidentified radar targets in the area between the LAKI and the Area of Many Bergs. Unidentified radar targets beyond the LAKI are also included.
- 1200Z Ice Chart that includes the 1200Z Ice Bulletin data. The 1200Z Ice Chart is to be distributed by facsimile at 1600Z and 1810Z.
- Immediate safety broadcasts will be made whenever an iceberg is sighted outside of the LAKI provided a new ice bulletin is not scheduled to be issued within one hour.

Criteria for retaining icebergs on the active plot are included in the *Standing Orders for IIP Operations Center Duty Personnel* (CIIPINST M3120B) which shall serve as a specification for the determination of the LAKI.

Several products are required for internal use and distribution when the International Ice Patrol is in operation:

- Quality assurance of incoming environmental data and preparation of data files for use in the iceberg Data Management and Prediction System

(DMPS) [identified as the iceBerg Analysis and Prediction System (BAPS) at ICEC.]
- Quality assurance of incoming iceberg and radar target sighting data and preparation of data for entry into DMPS.
- Collection of WOCE data and identification of local currents for input into DMPS.

At the conclusion of the International Ice Patrol season, the following products are required:

- An annual "Report of the International Ice Patrol in the North Atlantic" following the format of the existing reports.
- A report of the actual cost of operating the International Ice Patrol identifying management costs, surveillance costs, and other relevant costs.
- A report to the U.S., Coast Guard identifying potential areas for improvement in the operation of the IIP and recommended policy and procedure changes.
- An update of the iceberg sighting file using the sightings reported during the season.
- A periodic update of the Labrador current file using the WOCE data acquired during the season.

4.3 Operational Procedures

The International Ice Patrol season will officially begin when icebergs begin to enter the IIP operations area and pose a potential threat to trans-Atlantic shipping. Pre-season surveillance shall be conducted to facilitate this evaluation. The determination will be made with the concurrence of the U.S. Coast Guard COTR. Similarly, when icebergs no longer pose a threat to trans-Atlantic shipping, the International Ice Patrol season will be terminated, again with the concurrence of the USCG COTR.

When the International Ice Patrol is in operation, the policies and procedures detailed in Commander. International Ice Patrol Instruction M3120B, *Standing Orders for IIP Operations Center Duty Personnel*, dated 18 December 1992 shall be used to guide the operation and use of DMPS and be the fundamental guidance for retaining icebergs in the system to determine the LAKI. [Note that the resight procedure specified requires individual resights and does not use the concept of "fence resights" currently used for BAPS.] The individual resight procedure results in a better estimate of the actual number of icebergs. Alternative resight procedures may be included in the response to this inquiry.

4.4 Cost Format

A fundamental assumption is that Canadian management responsibility includes the responsibility for conducting or providing for all necessary surveillance. The response to section 3 should provide most of the surveillance costs. The response to the management portion in section 4 should concentrate on actual management and operating costs, exclusive of surveillance provided for in section 3. Costs should be presented in U.S. dollars at the current exchange rate.

5.0 Response Preparation and Submission

The response to this inquiry should strike a balance between being a very brief summary of costs and expected activity levels and being a very detailed analysis of all aspects of the operations. The driving principle is that the response should be detailed enough so that it is evident that the full scope of the work is appreciated and that the required resources have been properly identified.

In preparing your response, your primary contact for clarification of any point is:

Dr. Robert L. Armacost
University of Central Florida
Phone: (407) 823-2619
Fax: (407) 823-3413
E-mail: armacost@pegasus.cc.ucf.edu

Dr. Armacost is available to assist you in the preparation of your response. You may also feel free to contact either of the following persons for clarification of any issues regarding actual operations:

CAPT Alan Summy
Commandant (G-NIO), USCG
Phone: (202) 267-1450
Fax: (202) 267-1457
E-mail: A.Summy/G-NIO@cgsmtp.comdt.uscg.mil

CDR Ross Tuxhorn
Commander, International Ice Patrol
Phone: (203) 441-2631
Fax: (203) 441-2773
E-mail: R.Tuxhorn/IIP@cgsmtp.comdt.uscg.mil

Please submit your response to this inquiry by March 27, 1995 to:

Dr. Robert L. Armacost
Department of Industrial Engineering and Management Systems
University of Central Florida
P.O. Box 162450
Orlando, FL 32816-2450 U.S.A.

6.0 Attachments

Attachment 1 Semi-monthly depictions of the Limits of All Known Ice for 1992. [Extracted from the *Report of the International Ice Patrol in the North Atlantic, 1992 Season*, Bulletin No. 78, CG-188-47.]

Attachment 2: Klarmann, R. V., *International Ice Patrol 1992 SLAR/Ocean Features Atlas*, 1992.

Attachment 3: Armacost, R. L., Jacob, R. F., Kollmeyer, R. C., and Super, A. D., *Interim Report on the Analysis of Current Operations of the International Ice Patrol*, EER Systems Corporation, September, 1994.

Attachment 4: Commander, International Ice Patrol Instruction M3120B, *Standing Orders for IIP Operations Center Duty Personnel*, 18 December 1992.

Appendix II. Inquiry of Interest–National Ice Center.

This Appendix includes the request titled "Inquiry of Interest: National Ice Center Management of the International Ice Patrol."

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COST AND OPERATIONAL EFFECTIVENESS ANALYSIS
FOR
ICE PATROL MISSION ANALYSIS

Contract No. DTCG39-94-C-E00085 / IIP Mission Analysis

INQUIRY OF INTEREST:
NATIONAL ICE CENTER MANAGEMENT OF THE INTERNATIONAL ICE PATROL

February, 1995

EER Systems Corporation
50 Enterprise Center
Middletown, RI 02840
(401) 846-6222

Security Classification: UNCLASSIFIED

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INQUIRY OF INTEREST:
NATIONAL ICE CENTER MANAGEMENT
OF THE INTERNATIONAL ICE PATROL

Summary

This inquiry solicits a response which reflects the potential interest by the National Ice Center for providing overall management of the International Ice Patrol. The following sections provide the background for the inquiry and detail performance specifications. A response to the inquiry is requested by March 27, 1995.

1.0 Background

The USCG Research and Development Center has sponsored a contract on behalf of the Commandant (G-NIO), United States Coast Guard and the Commander, International Ice Patrol, to examine alternative methods of accomplishing the International Ice Patrol mission. EER Systems Corporation of Vienna, Virginia was awarded the contract to conduct this mission analysis of the IIP. Dr. Robert L. Armacost of the University of Central Florida is the Principal Analyst and Team Leader for this project.

To date, EER has completed an analysis of the current IIP operations which was used as a baseline for identifying alternative methods of conducting the IIP mission. A number of Management, Modeling, Data Acquisition/Processing, and Surveillance/ Detection/Classification alternatives were developed and evaluated by the Coast Guard as candidates for further detailed study based on how they affect the IIP mission of determining and disseminating the Limits of All Known Ice (LAKI). Criteria of technical feasibility, likelihood of accomplishing the mission element, and reasonable cost were used as discriminators, along with the imperative to select three alternatives.

A decomposition approach was used that identified a larger set of elements. The selected alternatives for detailed analysis include:

Management:

- U.S. management with Coast Guard having primary responsibility.
- Canadian management (technically U.S. with Canada subcontracted).
- U.S. management with National Ice Center having primary responsibility.

Modeling:

- Sensitivity analysis and risk structure for system of models.

Data acquisition and processing:

- Implementation of CG version of ADAM system/tactical workstation/data management system.

Comparison of upgrading INTERGRAPH system with shifting to ISIS.

Surveillance/detection/classification:

Brief examination of RADARSAT and Ground Wave Radar.
USCG surveillance with SLAR/FLAR/SAR.
Surveillance contracted to Canada.
Surveillance contracted to commercial firm.

At the same time that these alternatives are examined from a cost and effectiveness perspective, a similar analysis will be conducted for the current system. The results of this cost and operational effectiveness analysis will provide the Program Manager and other Coast Guard decision makers with relevant information for decision making.

The purpose of this inquiry is to examine the potential role of the National Ice Center in managing the International Ice Patrol mission. The *Interim Report on the Analysis of Current Operations of the International Ice Patrol* (Armacost, Jacob, Kollmeyer, and Super, 1994) describes the important aspects of the current operation and identified a number of alternatives that could be examined, one of which involved alternative management structures. The present inquiry seeks to further define potential management structures involving the National Ice Center and provide a basis for evaluating their feasibility.

2.0 Response to the Inquiry

This inquiry and a response to it is to be considered a preliminary planning exercise that will determine to what degree further inquiries should be made. The Coast Guard is clearly interested in identifying alternatives that will provide an acceptable level of performance and reduce the costs of operation of the IIP. In responding to this inquiry, it is requested that realistic estimates of cost and operational performance be provided. Any information provided in response to this inquiry has no legal standing and is not binding on any one. The mission analysis is targeted to have preliminary findings by the end of March, 1995, with a draft report completed by the end of April, 1995. In order to be useful in the mission analysis, your response should be received by March 27, 1995.

3.0 Management Performance Requirements

As currently structured, the United States government is the Managing Government of the International Ice Patrol under the provisions of SOLAS 74. That responsibility has been delegated to the U.S. Coast Guard when the U.S. Navy declined participation after the first year of patrol duty. Because of the U.S. Navy's active involvement in the operation of the Naval Ice Center and the National Ice Center, it is very natural to consider the potential for the NIC to assume responsibility for the IIP.

3.1 Operating Conditions

IIP operations involve the collection of iceberg surveillance data and environmental data, processing that data using the iceberg drift and deterioration models, and producing twice daily ice bulletins and a daily ice chart. In addition to this information processing function, the IIP conducts surveillance flights to collect iceberg sighting/detection data along the southwestern, southern, and southeastern borders of the region in the North Atlantic ocean containing many icebergs.. During these patrols, the IIP also deploys AXBT probes (supplied by the Canadian Forces Meteorology and Oceanography Command) and WOCE ocean drifter current buoys at various times throughout the season. The current operations of the IIP are generally described in the *Interim Report on the Analysis of Current Operations of the International Ice Patrol* (Armacost, Jacobs, Kollmeyer, and Super, 1994), a copy of which is enclosed as Attachment 1. The specific operating procedures used by the IIP are included in the *Standing Orders for IIP Operations Center Duty Personnel* (CIIPINST M3120B) which is enclosed as Attachment 2. The Standing Orders are used here as a guide for assessing the responses to the inquiry. It is realized that if the NIC assumed full responsibility for the IIP, the NIC would determine what procedures would be followed in evaluating the iceberg locations and providing information to the mariner. This inquiry initially assumes that the NIC will conduct or arrange for all surveillance and communications that are required to support the IIP as well as perform the management functions that are described below.

3.2 Product Requirements

Several products are required for external distribution when the International Ice Patrol is in operation:

- 0000Z and 1200Z descriptions of the Limits of All Known Ice distributed as safety broadcasts.
- 0000Z and 1200Z Ice Bulletins that include descriptions of the Limits of All Known Ice, an area identified as the "Area of Many Bergs," and the locations of the icebergs and unidentified radar targets in the area between the LAKI and the Area of Many Bergs. Unidentified radar targets beyond the LAKI are also included.
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- Immediate safety broadcasts will be made whenever an iceberg is sighted outside of the LAKI provided a new ice bulletin is not scheduled to be issued within one hour.

Criteria for retaining icebergs on the active plot are included in the *Standing Orders for IIP Operations Center Duty Personnel* (CIIPINST M3120B) which shall serve as a specification for the determination of the LAKI.

Several products are required for internal use and distribution when the International Ice Patrol is in operation:

- Quality assurance of incoming environmental data and preparation of data files for use in the iceberg Data Management and Prediction System (DMPS).
- Quality assurance of incoming iceberg and radar target sighting data and preparation of data for entry into DMPS.
- Collection of WOCE data and identification of local currents for input into DMPS.

At the conclusion of the International Ice Patrol season, the following products are required:

- An annual "Report of the International Ice Patrol in the North Atlantic" following the format of the existing reports.
- A report of the actual cost of operating the International Ice Patrol identifying management costs, surveillance costs, and other relevant costs.
- An update of the iceberg sighting file using the sightings reported during the season.
- A periodic update of the Labrador current file using the WOCE data acquired during the season.

3.3 Operational Procedures

The International Ice Patrol season will officially begin when icebergs begin to enter the IIP operations area and pose a potential threat to shipping. Pre-season surveillance shall be conducted to facilitate this evaluation. When icebergs no longer pose a threat to trans-Atlantic shipping, the International Ice Patrol season will be terminated.

When the International Ice Patrol is in operation, the policies and procedures detailed in Commander. International Ice Patrol Instruction M3120B, *Standing Orders for IIP Operations Center Duty Personnel*, dated 18 December 1992 shall be used to guide the operation and use of DMPS and be the fundamental guidance for retaining icebergs in the system to determine the LAKI.

3.4 Cost Format

A fundamental assumption is that NIC management responsibility includes the responsibility for conducting or providing for all necessary surveillance as well as communications. Surveillance requirements are detailed in section 4. The response to this inquiry should identify the surveillance costs as well as actual management and operating costs. It is expected that a transfer of responsibility for the management and operation of the IIP from the U.S. Coast Guard to the National Ice Center would be accompanied by a funds transfer.

4.0 Surveillance Performance Requirements

The IIP relies on U.S. Coast Guard surveillance of the IIP operations area along with surveillance information supplied by Canadian sources and ships operating in the area to provide input into the drift and deterioration models which generate predicted positions of icebergs. These predicted position are used to determine the Limits of All Known Ice (LAKI). In order to verify those limits, the IIP conducts surveillance in the vicinity of the LAKI on a periodic basis. Because of the importance of being able to identify icebergs in this region and the reduced opportunities to obtain visual identification, the Coast Guard has adopted the practice of using 200% SLAR coverage of the area to enable the operator to classify radar targets as icebergs based on no movement between the first and second sightings. This practice leads to a high level of probability of detecting radar targets as well as providing for their identification as icebergs. The 200% coverage is illustrated with the simple two track search in Figure 1. Note that the coverage on the outside of the track legs is at 100% and is 200% inside of the track legs of the search pattern. On a search with more legs, the area inside of the outer legs will have 200% coverage.

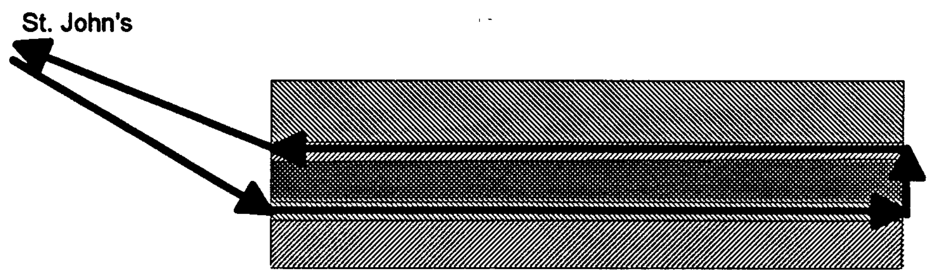

Figure 1. 200% Search coverage.

The combined effect of reported sightings, Coast Guard surveillance, and the use of the drift and deterioration models has resulted in an acceptable level of performance with regard to providing meaningful and timely information regarding the LAKI to the mariners. Therefore, the current operation provides a performance standard for the present inquiry.

4.1 Probability of Detection and Identification.

Several studies have been conducted which have established estimates of the system probability of detection of icebergs using the AN/APS-135 SLAR. The system probability of detection is the inherent capability of the radar as determined by a post-flight laboratory analysis of the film images. Another study has provided estimates of the operator actually detecting radar targets and correctly identifying them as icebergs. These probabilities are assumed to be uniform across the 27 nm range and can be used to estimate the search effectiveness. A typical surveillance patrol is illustrated in Figure 2. Under current practices, the IIP flies a parallel search pattern with a 25 nm track spacing.

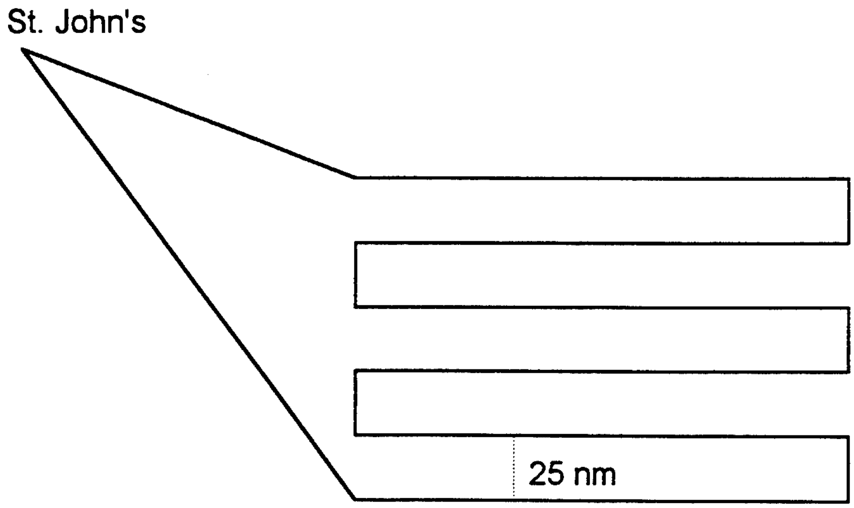

Figure 2. Typical search coverage.

Applying the experimentally estimated probabilities of detection for the six leg search of Figure 2 provides the surveillance performance requirements shown in Table 1.

Table 1. Surveillance Performance Requirements.

TARGET TYPE	Required Probability of Detection and Identification
Large iceberg (126-213 m)	0.98
Medium iceberg (61-125 m)	0.96
Small iceberg (15-60 m)	0.95
Growlers (< 15 m)	0.85

The response to this inquiry should attain the performance levels indicated in Table 1. There is no requirement that patrols be conducted in the same manner as currently conducted by the Coast Guard. The requirement is that whatever method is used should achieve the same performance level as in Table 1. The response should provide supporting information to indicate how the performance level will be attained.

4.2 Coverage

The IIP typically covers a 125 nm swath using the six leg patrol. Other search patterns may be used to take advantage of environmental conditions and the characteristics of the portion of the LAKI to be searched. When different types of patrols are conducted, coverage still is in the vicinity of a 125 nm swath. In responding to the inquiry, the response should be based on covering a 125 nm swath starting outside of the LAKI and extending inward. Clearly, the level of effort varies from year to year. However, during the past few years, the IIP surveillance effort has been relatively constant. For planning purposes, Attachment 3 contains semi-monthly depictions of the LAKI for 1992. In addition, Attachment 4 provides copies of the available records for actual surveillance flights by the IIP in 1992. The response should identify the level of effort needed to accomplish equivalent coverage.

4.3 Frequency of Surveillance Information

Given the current quality of information regarding icebergs drifting toward the LAKI, the existing sources and quality of environmental data, and the refinement of the drift and deterioration models, IIP has determined that a LAKI surveillance frequency of one surveillance patrol every two weeks is adequate. In practice, the Coast Guard covers a portion of the LAKI on a single patrol sortie. Typically, four such sorties are required to cover the entire LAKI. The response to the inquiry should identify resource requirements necessary to accomplish surveillance of the LAKI at least bi-weekly unless more frequent coverage is required to meet the equivalent of the performance requirements in Table 1.

4.4 Unidentified Detections

Surveillance should be conducted in a way that results in no more than an average of 10% of the radar targets detected in those portions of the patrols within 60 nm inside the LAKI be unidentified targets and no radar targets outside of the LAKI be unidentified. Targets unidentified as icebergs or ships will be reported as radar targets.

4.5 Unclassified Detections

Wherever possible, icebergs should be classified as to size (growler/small/medium/large) and type (pinnacle/tabular). In recent years, approximately 22% of all Coast Guard detections have been visual sightings and have provided detailed iceberg size and type information. The response to the inquiry should produce at least an equivalent performance level.

4.6 Temperature and Current Data Acquisition Requirements

During selected surveillance flights, the IIP also deploys AXBT probes (supplied by the Canadian Forces Meteorology and Oceanography Command) and WOCE ocean drifter current buoys at various times throughout the season. The WOCE buoys play an important role in providing real time current estimates and modifying the historical data on the Labrador Current.Resources provided in response to this inquiry should have the capability to deploy this instrumentation. Note that it is not required that the WOCE buoys and XBTs be deployed from surveillance aircraft. Normally six to ten WOCE buoys will be deployed. The number of AXBTs deployed varies from 40 to 120. The response to the inquiry should indicate how the deployment capability will be provided.

4.7 Surveillance Performance Requirements Summary

The surveillance performance requirements for the response to this inquiry are summarized as follows.

- Provide surveillance with the following probability of detection and identification.

Iceberg Type	*PODI*
Large iceberg (126-213 m)	0.98
Medium iceberg (61-125 m)	0.96
Small iceberg (15-60 m)	0.95
Growlers (< 15 m)	0.85

- Provide surveillance coverage over a 125 nm swath of the Limits of All Known Ice.
- Provide surveillance at least bi-weekly.
- Provide surveillance so that the average percentage of unidentified radar targets within 60 nm inside of the LAKI is less than 10% and zero outside of the LAKI.
- Provide the capability to deploy AXBTs and WOCE buoys.

5.0 Alternative Management Structures

It is recognized that the U.S. Navy currently has no SLAR capability for conducting iceberg surveillance patrols, and that the NIC relies on Coast Guard SLAR equipped aircraft to conduct ice surveillance in the Arctic and on the Great Lakes. This limitation may preclude a full response to this inquiry as specified in sections 3 and 4. Nonetheless, there may be an opportunity for decreasing the total cost of conducting the IIP by transferring management responsibility for the IIP to the NIC. It is appropriate to include one or more such alternatives in the response to this inquiry.

6.0 Response Preparation and Submission

The response to this inquiry should strike a balance between being a very brief summary of costs and expected activity levels and being a very detailed analysis of all aspects of the operations. The driving principle is that the response should be detailed enough so that it is evident that the full scope of the work is appreciated and that the required resources have been properly identified.

In preparing your response, your primary contact for clarification of any point is:

Dr. Robert L. Armacost
University of Central Florida
Phone: (407) 823-2619
Fax: (407) 823-3413
E-mail: armacost@pegasus.cc.ucf.edu

Dr. Armacost is available to assist you in the preparation of your response. You may also feel free to contact either of the following persons for clarification of any issues regarding actual operations:

CAPT Alan Summy
Commandant (G-NIO), USCG
Phone: (202) 267-1450
Fax: (202) 267-1457
E-mail: A.Summy/G-NIO@cgsmtp.comdt.uscg.mil

CDR Ross Tuxhorn
Commander, International Ice Patrol
Phone: (203) 441-2631
Fax: (203) 441-2773
E-mail: R.Tuxhorn/IIP@cgsmtp.comdt.uscg.mil

Please submit your response to this inquiry by March 27, 1995 to:

Dr. Robert L. Armacost
Department of Industrial Engineering and Management Systems
University of Central Florida
P.O. Box 162450
Orlando, FL 32816-2450 U.S.A.

7.0 Attachments

Attachment 1: Armacost, R. L., Jacob, R. F., Kollmeyer, R. C., and Super, A. D., *Interim Report on the Analysis of Current Operations of the International Ice Patrol*, EER Systems Corporation, September, 1994.

Attachment 2: Commander, International Ice Patrol Instruction M3120B, *Standing Orders for IIP Operations Center Duty Personnel*, 18 December 1992.

Attachment 3 Semi-monthly depictions of the Limits of All Known Ice for 1992. [Extracted from the *Report of the International Ice Patrol in the North Atlantic, 1992 Season*, Bulletin No. 78, CG-188-47.]

Attachment 4: Klarmann, R. V., *International Ice Patrol 1992 SLAR/Ocean Features Atlas*, 1992.

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Appendix III. Proposal to the U.S. Coast Guard for the International Ice Patrol.

This Appendix includes the Canadian response to the Inquiry of Interest. The proposal is entitled "Proposal to the U.S. Coast Guard for the International Ice Patrol."

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Environment Canada | Environnement Canada

Atmospheric Environment Service | Service de l'environnement atmosphérique

March 24, 1995

Your file Votre reference

Our File Notre reference

Dr. Robert L. Armacost,
Assistant Professor,
Department of Industrial Engineering
and Management Systems,
University of Central Florida,
P.O. Box 16250,
Orlando, FL 32816-2450,
U.S.A.

Dear Robert:

Subject: Proposal from Ice Services Branch to U.S. Coast Guard

The enclosed proposal is in response to your inquiry of interest and request for proposal, dated February 16th, 1995.

The Ice Services Branch, Environment Canada is delighted to have the opportunity to be able to provide you with alternate solutions in implementing the IIP mission.

The IIP services proposed are complementary to the existing work performed by Ice Services Branch. We are proposing solutions that leverage our capabilities and existing infrastructure to provide a cost-effective solution that meets the performance requirements.

While your request stated that separate solutions are required for Surveillance and Management services, we would like to indicate our preference to provide one integrated solution. The management service is felt to provide us the most benefit in leveraging our knowledge core competency.

While realizing that this exercise is for planning purposes only, we trust that this proposal will lead to a mutually beneficial outcome.

If you have any questions concerning the proposal, please do not hesitate to call me at (613) 996-5088.

Sincerely,

ICE SERVICES BRANCH,
ENVIRONMENT CANADA

Anne O'Toole
Director

Encl.

Canada

ENVIRONMENT CANADA

Proposal to the
U.S. Coast Guard
for the
International Ice Patrol

Environment Canada
Atmospheric Environment Service

Environnement Canada
Service de l'environnement atmosphérique

ENVIRONMENT CANADA

Proposal to the U.S. Coast Guard for the International Ice Patrol

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ANNEXES:

A - History of Ice Services in Canada

B - Flight Plans

C - Terminologies/Acronyms

Executive Summary

Ice Services Branch, Environment Canada is pleased to provide two independent service offerings to the U.S. Coast Guard, in response to the Inquiry of Interest, dated February 1995. The following represents the highlights and benefits of the two service offerings.

Surveillance Service

- The primary surveillance role will be fulfilled utilizing the Ice Services owned DeHavilland Dash 7 aircraft. This aircraft would be outfitted with both SLAR and FLAR radar's and complemented with a data management sub-system.
- The Dash 7 aircraft, crew and spare parts complement would be located in Newfoundland to facilitate taking the best advantage of favourable weather conditions surrounding the Grand Banks.
- The use of radar combined with visual reconnaissance provided by a skilled crew, ensures that the performance requirements will be met.
- As a contingency plan, arrangements will be made through the Department of Fisheries and Oceans and the Department of National Defence, for use of secondary aircraft for back-up of the Dash 7 aircraft.
- An additional service could be provided to cover the entire IIP area of responsibility, from 52N to the Limit of All Known Ice (LAKI). This would require an additional 360 flying hours.
- AXBT probes would be deployed from the Dash 7 aircraft.
- The WOCE buoys would be deployed through a partnership agreement with the Department of Fisheries and Oceans.
- The Ice Services Branch is confident that the performance requirements summary is both realistic and achievable with the service solution provided.
- A staff contingent of three people is required to provide the Surveillance service.

- The cost estimates provided are realistic and provide significant cost savings over the current costs.

Management of the IIP Mission Service

- The mission of Ice Services Branch and the IIP mission are very similar. The management service proposed will be provided by leveraging existing capabilities and infrastructure.
- The Canadian Iceberg Analysis System (BAPS), is identical to the system currently used by the U.S. Coast Guard for the IIP.
- Full scheduling of surveillance will be provided by using a flight planning system and weather information available at Ice Services Branch.
- Full utilization of Canadian AES research and development assets will be made in delivering this service.
- The standard and specialized reports specified in the Inquiry of Interest will be delivered by this service.
- Existing and modified QA procedures will assure the highest quality of data is maintained.
- Ice Services Branch will assume responsibility for procuring WOCE buoys and incorporating their data into the BAPS system.
- Standing Orders for the IIP operations will be used to guide Ice Services Branch operations in the delivery of this service.
- Specialized annual reports and data management will be prepared in the off-season.
- Plans exist to upgrade Ice Services Branch capabilities. A new computer system (ISIS) and a data distribution system (ISECS) will be on-line by April 1996.
- As technological advances become feasible, they will be evaluated for inclusion into providing this service. Specifically, these technologies may include satellite imagery and the use of Ground Wave Over-The-Horizon radar.

- The staff complement to deliver the management service is determined to be a staff equivalence of nine persons.

As the financial summaries illustrate, both services can be provided at significant cost savings over the current operational costs of the IIP Program.

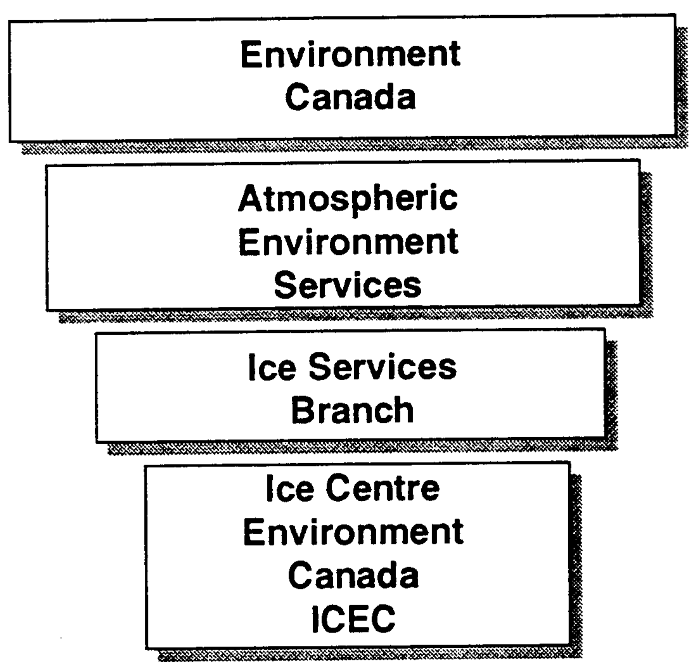
I. Profile of Ice Services, Environment Canada

Ice Services Environment Canada, has had a long and distinguished history in providing mariners ice information and has developed an excellent, collaborative working relationship with the International Ice Patrol (IIP) through the years. In addition, there are close similarities in mandates, infrastructure and capabilities that lend themselves to providing an integrated set of services.

This proposal builds on our existing relationship, infrastructure and services to enable us to provide improved service levels while yielding significant cost savings through integration of similar activities.

The following diagram illustrates how Ice Services fits organizationally within Environment Canada.

Organizational View



Overview of Ice Services, Environment Canada

Ice information services have been available in Canada since 1940, in various forms and provided by various departments. This service was initiated to provide increased ship safety in ice as well as to validate the requirements for vessel insurance for ship hulls.

As the requirements for ice information grew, the Canadian Ice Services programs were consolidated in 1972 under the jurisdiction of the Atmospheric Environment Service within the Department of the Environment. Ice reconnaissance during this period was provided by sensor equipped aircraft as well as satellite imagery from Landsat and TIROS satellites.

Over the years, the Ice Services Branch (ISB) has benefited from its relationship with ice research groups within the department, improvements in technologies such as side looking airborne radars (SLAR) and the use of sophisticated computer systems.

The current mandate of the ISB was updated in 1988 and reads as follows:

> ***"To provide Ice and Iceberg information (analyses, prognoses and warnings) for the safety of Canadians involved in Fishing, marine transportation and offshore petroleum exploration, and for the protection of life and property such as ships and drilling platforms; and to protect the quality of the marine environment by supporting the prevention of environmental disasters."***

There are numerous similarities between the International Ice Patrol mission and the mission of the ISB at Environment Canada. There are also similarities in the infrastructure and capabilities required to execute such missions.

We believe that ISB is uniquely qualified to undertake support of both IIP's surveillance and management roles.

II. Understanding of Requirements

Our understanding of the mission of the International Ice Patrol is that it is to determine the Limits of All Known Ice along the southeastern, southern, and southwestern edge of the ice region and delivering that information to mariners in a timely fashion.

This mission involves data and information acquisition, processing and distribution, finding out where the ice danger exists for transAtlantic shipping and advising the mariner so as to provide knowledge to prevent ship-iceberg collisions.

The International Ice Patrol was formed following the sinking of the *Titanic* in 1912. The IIP operates under the provisions of the International Convention for the Safety of Life at Sea(SOLAS).

The Ice Services Environment Canada fully recognizes the critical nature of the IIP mission and the consequences to transAtlantic shipping of not having reliable, accurate and timely information on iceberg positions and movements.

The purpose of the proposal is for ISB to express its potential interest in assuming in, part or in total responsibility for the management of the International Ice Patrol.

ISB is to propose methods of accomplishing the IIP mission while achieving the following critical success factors:

- Convey confidence to the U.S. Coast Guard of the likeliness of accomplishing the mission element.
- Provide technical feasibility of the solutions proposed.
- Provide cost effective solutions.
- Provide realistic estimates of costs and operational performance.

The ISB fully understands that this is a preliminary planning exercise and that there are no binding obligations as to the outcome of this proposal, on the Canadian Government.

The ISB wishes to express its genuine interest in pursuing these options at the discretion of the U.S. Coast Guard.

III. Service Solutions

The following sections describe the two proposed services which are presented here as independent services. Based on our past performance, we propose a Surveillance service with a high degree of confidence in meeting the IIP performance requirements. Various levels of contingency plans are discussed to ensure availability of the service at all times and in the event of aircraft malfunctions.

Diagrams are used extensively, and are included to illustrate different aircraft ranges and performance in achieving monitoring of the LAKI during the course of the season. As requested, the 1992 season was used as the baseline upon which to build the service. The service would be appropriately adjusted to meet the demands that future ice seasons may present.

The Management Service, builds upon the existing capabilities and infrastructure within the ISB, affording a cost effective solution through integration of similar activities. The mission of the IIP and the AES, Ice Services Branch are very similar and lend themselves well to an integrated approach.

Although the surveillance and management services are presented as independent, it would be Ice Services desire to provide both services concurrently. The management of the IIP would allow a greater reconnaissance flexibility and would result in a better service to the international community.

A. Surveillance Service

> ***" to determine the Limits of All Known Ice along the south-eastern, southern, and southwestern edges of the ice region"***

This proposal to contract for the International Ice Patrol reconnaissance of the Limit of All Known Ice (LAKI) assumes that over-all direction and control, and mission control, remains with an United States Government Agency. A Canadian Ice Services Branch mission manager located at St. John's, Newfoundland would be able to adjust aircraft deployment and specified areas of coverage to maximize weather opportunities.

We have examined various solutions including a 200% SLAR coverage of the LAKI and contracting through a partnership with the Canadian Department of Fisheries (DFO). The forward looking search and identify technique is considered a proven technique which is more efficient than a 200% SLAR coverage. We therefore propose to conduct the reconnaissance using the Transport Canada owned Dash-7 aircraft (currently used for ice reconnaissance), equipped with a CAL-200 SLAR, and upgraded with a forward looking search radar (FLAR) and a Data Management System (DMS). Primary back-up capability and flexibility will be through a partnership Memorandum of Understanding (MOU) with DFO contracted King-Air aircraft. Secondary back-up for extreme ice limits will be through a partnership (MOU) with the Department of National Defence (DND) owned Aurora aircraft.

	AIRCRAFT TYPE	**RANGE**	**EQUIPMENT**	**ROLE**
Transport Canada	De Havilland Dash-7R	1400 nm	SLAR FLAR DMS GPS	Primary
DFO	King-Air	1200 nm	FLAR DMS GPS	Back up
DND	Aurora (P3-C)	4000 nm	FLAR FLIR	Extreme Ice Contingency

This configuration maximizes the flexibility and integrity of the proposed service. Total reliance on any one platform would open the program to increased risk if that platform failed for any reason.

1. Probability of Detection and Identification

To satisfy the requirements for the reconnaissance of the LAKI the search mode will be "locate and identify". Contracts for iceberg reconnaissance during the past several years have demonstrated the efficiency and capability of this method to identify even small targets. The staff on the Dash-7 and King-Air aircraft are currently very experienced in iceberg identification, including sizes and shapes. The "locate and identify" mode will meet the identified/target ratio specified in the statement of requirements. Aerial resources and the mission manager will be based at St. John's and will be available to take environmental window opportunities for low sea state, location and visual identification of all targets.

2. Coverage

Figure 1, shows the start, end and mid-season positions of the 1992 IIP iceberg season and therefore the area of coverage required.

In most cases the mission profiles will be similar, high level to the search area, locating potential targets enroute, and then visually identifying targets. GCFR has an effective endurance of 1400 nautical miles and the King-Air aircraft has an endurance of about 1200 nautical miles.

Figures 2 and 3 show the number of hours available for productive target identification for GCFR and King-Air aircraft respectively. At the outer circle, maximum range, there is no time available for identification. Each circle inward represents one more hour available for identifying targets. It can be seen that coverage can extend southward to 37N and eastward to 35W. An examination of the ranges will indicate that the solution meets the specified coverage.

Optional Coverage

The response to the inquiry is for coverage of the extreme icebergs for the IIP mandate to establish the limits of all known ice. In addition to the mandate, the IIP produces other related products such as Bergs Crossing 48N and an iceberg sighting data base. Figure 4 shows that for an additional 360 hours of

Figure 1

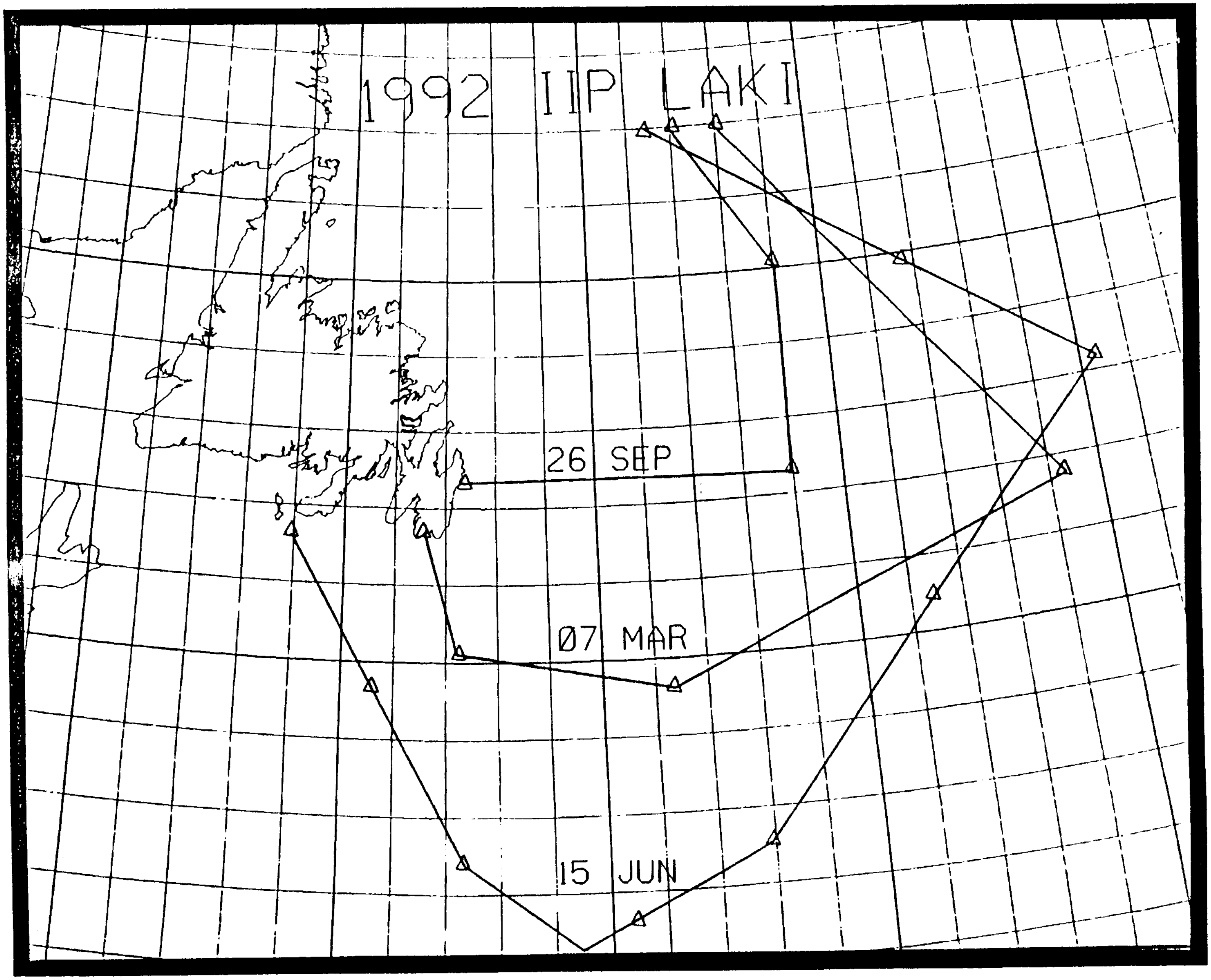


Figure 2

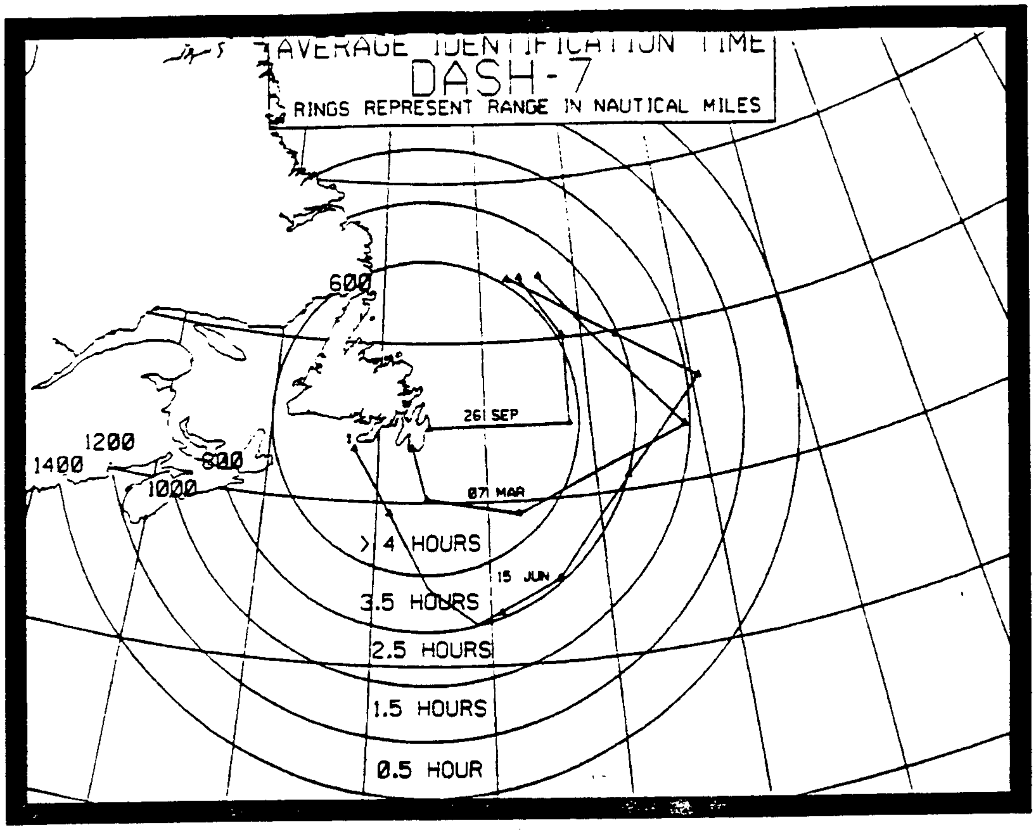
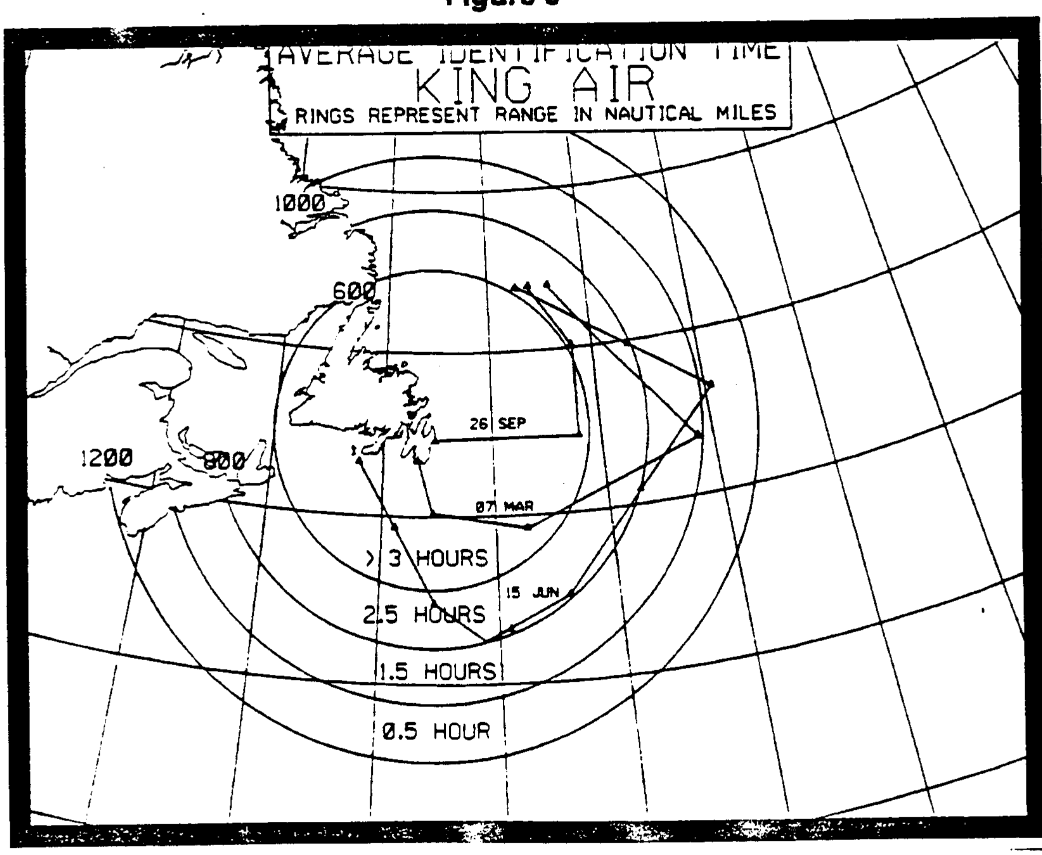


Figure 3



flying time the entire IIP area of responsibility, from 52N to the LAKI, could be covered on a twice monthly basis. Additional surveillance charts are included in Annex B.

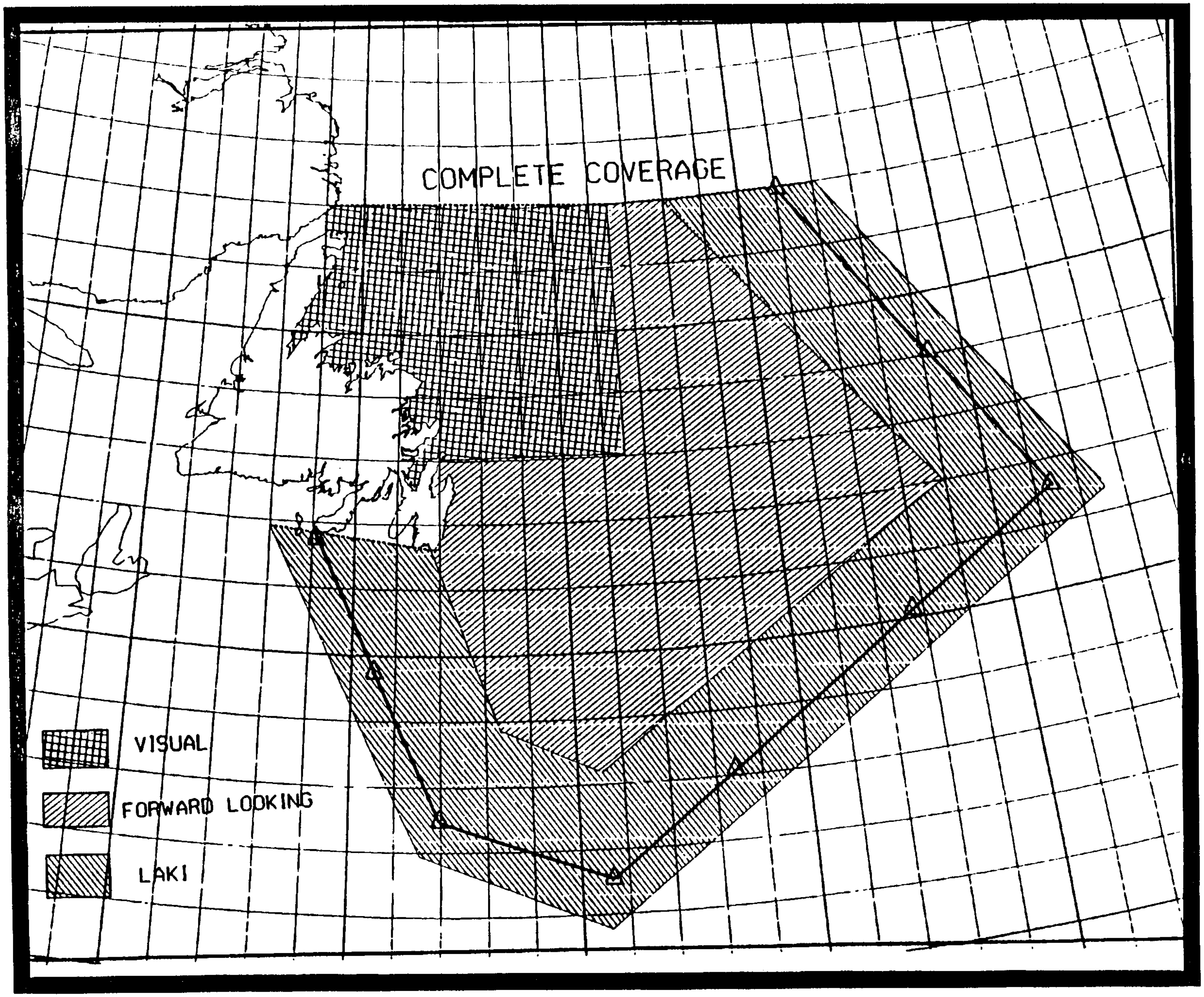
The area of sea ice would be covered on a visual priority and the remaining area using the forward looking radar search and identify technique. Iceberg reports would continue to be supplemented by visual observations from ISB sea ice flights and from fisheries patrols through the partnership with DFO. The extended coverage would enhance greatly the resight capability of the IIP, better describe the Area of Many Bergs, and provide for more optimum direction of patrols along the LAKI through fewer surprises. Arrangements will be negotiated with DFO to provide improved iceberg detection and identification on fisheries patrols.

3. Frequency of Survey

In Figure 4, the hatched area along the LAKI begins 30 nm outside of the LAKI and extends 120 nm inside which includes both the 200 percent and 100 percent IIP coverage as stated in the Inquiry of Interest. In determining the number of missions, it was assumed that within the hatched area and along 160 nm of the southern and western LAKI there would be on average 10 targets. Along the eastern LAKI there would be an average of two to five targets to identify. Flying a zigzag pattern at reduced air speeds to visually identify targets, results in 100 and 120 nm coverage along the LAKI, respectively, per hour of time available. Targets along the LAKI would have first priority for identification. Using these calculations, five missions are required for a total of 35 hours for each complete coverage of the LAKI. Twice per month for six months requires 420 hours.

The calculation of hours is based on six months of LAKIs at or near mid-season positions and therefore these numbers may be a little high. Time for identification, however, may be on the low side during certain periods of the year and in certain locations due to the presence of fishing vessels. Also the knowledge of the LAKI based on model results may indicate that the complete LAKI need not be covered each and every time. Approximately 420 total hours using a combination of resources would have satisfied the surveillance requirements during the 1992 season.

Figure 4



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It may be possible to reduce the number of hours required by completing a Memorandum of Understanding with the Department of Fisheries to share fisheries and iceberg patrols to minimize transit times and maximize information return.

Although not in the statement of requirements, an additional 35 hours would provide for the annual pre-season surveillance to 60N. This would be based on a combination of GCFR visual coverage of sea ice covered waters and forward looking radar coverage from the ice edge to the iceberg limit.

4. Unidentified Targets

The proposed "locate and identify" mode of operation combined with an aircraft that is always available and able to maximize favorable weather conditions will be capable of maintaining the requirement of NO unidentified targets outside the LAKI and achieve much less than the 10% of unidentified targets within 60nm inside the LAKI.

5. Unclassified Detections

It is our intent to maximize the visual identification and classification of all targets as to size and shape. During previous years the IIP was successful in identifying and classifying 22% of all targets. This was done with the aircraft being in the area less than 50% of the time. The on-site aircraft and the flexibility to use more favourable weather will increase that percentage.

6. Temperature and Current Data Acquisition Requirements

It is assumed that a US government agency will continue to purchase the WOCE buoys and continue to cover the cost of their Service Argos positioning. These will be deployed as required through a partnership arrangement with the DFO for deployment anywhere on the Grand Banks during the course of normal surface fishing patrols. For the most part, surface patrol vessels operate out of St. John's, Newfoundland.

The GCFR platform has been used extensively to deploy airborne expendable bathythermographs (AXBT) in the Gulf of St. Lawrence and off the Labrador Coast to obtain oceanographic water profiles which are subsequently used as data source for the Ice Services Freeze-up models. AXBTs can be deployed during the course of iceberg missions. In the case of undercast conditions a combination of SLAR/FLAR can determine the absence of surface vessel activity.

7. Performance Summary

In addition to the flight crew, the Dash-7 aircraft would be crewed by three ISB personnel, of whom two would be Ice Service Specialists (ISS) trained in iceberg surveillance, and led by an onboard mission manager (MM). The current ice reconnaissance MMs have an average 25 years experience in ice surveillance and were instrumental in developing the current iceberg guidelines used by the ISB. The ISSs have an average of 15 years experience with a minimum of three years. The MM would use his experience to provide decision support for flight scheduling and coverage, as well as to provide mission management, quality assurance, and participating in visual observing and radar analysis. As the expertise to identify and classify icebergs with current equipment requires experience that comes with repeated observations and time, these personnel are well equipped.

GCFR Crew Members

POSITION	NUMBER	COMPANY	DUTIES
MM	1	AES	Mission management Quality assurance Radar/Visual
ISS	2	AES	Radar/Visual
Pilot	2	Contract	Flight Control
Engineer	1	Contract	Aircraft Maintenance
Electronics Tech.	1	Contract	Equip. Maintenance

Maximum operational availability would be maintained by having all electronics maintenance performed on-site. An electronics technician(1) and full spares kit would remain with the aircraft at all times. Also, by keeping an aircraft engineer equipped with spares in the field, we can maintain aircraft reliability.

Currently, the IIP aircraft is shared among other tasks. Therefore, the aircraft must be scheduled long in advance. This procedure does not allow much flexibility and results in flights having to be flown in less than desirable weather conditions. Since our aircraft will be continually based in Newfoundland, we can take full advantage of all good weather days to maximize the identification and classification of icebergs. In the event that the back-up king air aircraft is used, the MM would take part and assume responsibility for coordination of the mission. Alternatively if, through partnership arrangement, two or more flights were scheduled for the same day, an ISS would assume control of the second or third flight. We have included in our pricing, funding which not only continues the availability of data from external sources, but also allows us coverage of the LAKI during extreme years.

B. Management of the International Ice Patrol Mission Service

The Safety of Life at Sea mission of the IIP is described in the Standing Orders for the IIP Operations Centre. The prime mission objective is to identify the southeastern, southern, and southwestern limits of the iceberg region in the vicinity of the Grand Banks of Newfoundland and to ensure mariners are informed of the extent of the danger area based on all known iceberg and sea ice information.

The mission described is similar to the one conducted by AES, Ice Services Branch of Environment Canada for icebergs in Canadian waters off east Newfoundland and Labrador. A prime objective of the AES iceberg program is to define the iceberg limit. In addition, a focus is placed on defining the iceberg population within the limit. The iceberg component of the ISB program has been developed with close coordination and assistance of IIP. The Canadian iceBerg Analysis and Prediction System (BAPS) can be considered as identical in capability to the IIP Data Management and Prediction System (DMPS). The development of BAPS was closely linked to the missions of both IIP and ISB. Operating procedures and methodologies at IIP are well understood through frequent contacts between personnel. ISB has incorporated the IIP models for iceberg drift, deterioration, and water current update into BAPS. Iceberg information products in narrative and chart form are prepared and distributed daily throughout the year by the ISB program. During the IIP operational season the position of the iceberg limit is coordinated closely.

The prime responsibilities of the ISB's program are to provide warnings of ice hazards to mariners and to support the icebreaking operations of the Canadian Coast Guard. To fulfill this mandate, an infrastructure has been established including communications facilities, data processing systems and highly trained staff.

As part of AES, the ISB is connected to the AES communication system. This enables real-time access to meteorological, ice and other environmental and satellite data. This information is configured for direct input to the ice and iceberg programs. The communication systems are connected to the marine radio and broadcast facilities for distributing and acquiring information from mariners. Communication and processing systems are operated and maintained throughout the year and regular upgrades are planned to take advantage of new technology.

ISB staff involved in the analysis and production of ice and iceberg information products have a background of meteorological training and experience in weather offices. The ice analysts have been trained in ice and iceberg observing and analysis. The ice forecasters are professional meteorologists and are trained in ice and iceberg analysis and forecasting. Computer scientists maintain the computer facilities and computer operators monitor system operations 24 hours a day. ISB manages directly and also influences research and development for ice and iceberg programs. ISB operational personnel have an average of eight years of ice experience.

The close linkages between IIP and ISB in missions and operating procedures together with the Canadian ice program infrastructure and experience, positions the ISB well to undertake the management of the IIP mission.

Program Management Requirements

To fulfill the responsibilities of the SOLAS mission and the requirements for management of the iceberg program as outlined in the Inquiry of Interest document will require ISB to augment its staff and resources. The IIP mission includes:

- the operation of the iceberg reconnaissance program and data acquisition,
- analysis and production of iceberg information,
- quality assurance of data and products,
- production of specialized reports and data management,
- research and development of the iceberg program,
- system maintenance and contingency planning, and
- corporate management.

The requirements for the field operations including iceberg data acquisition and processing have been defined as part of a separate submission described in the earlier section.

Staff levels required for IIP program management are outlined in Table 1.

TABLE 1
STAFF REQUIREMENTS
AND RESPONSIBILITIES

Section Head	1	Management of IIP Iceberg Mission
Forecaster	1.5	Database management and Product Preparation
Analyst	1.5	Quality Assurance/Analyses
Computer Scientist	1	System Maintenance and enhancements
Archivist	.5	Data Management
Scientist	1	Program Development
Computer Operator	1.5	System/Data Monitoring and Control
Clerk	1	Section Administration

A staff equivalence of nine has been identified to fully meet the requirements of the iceberg service. The primary responsibilities for the staff have been indicated. Other activities associated with the performance of this mission, such as training, system development, seasonal reviews, etc. will be included in the duties of the iceberg staff.

The section head will be responsible for the operation and management of the IIP mission. During the operational period of the IIP mission, a team consisting of an analyst and a forecaster will be responsible for planning iceberg reconnaissance, analysing data and preparing products. Throughout the operational period, these duties will be performed daily and will cover an eight hour work day with a call-back capability.

Computer operators will provide 24 hour monitoring of data reception and dissemination, undertake back-ups and perform other duties to maintain the reliability of the systems. This work will be performed in conjunction with associated monitoring of the ISB program. System maintenance will be available during normal week day work hours with call-back also available.

An iceberg specialist will be responsible for directing and managing iceberg program development.

An iceberg archivist will maintain a database of all associated data collected and produced from the performance of the IIP mission. This work will be performed in conjunction with activities of ISB.

Operating Conditions For IIP Mission

The ISB iceberg forecasters utilize BAPS on a daily basis to monitor and quality control environmental and iceberg data, analyze and maintain an iceberg data base and use IIP drift and deterioration models to prepare a suite of products.

ISB liaises with sources of iceberg data for quantity and quality and communication systems acquire and disseminate them to all users including BAPS and the iceberg Data Management and Prediction System (DMPS) at IIP.

The ISB communications system automatically disseminates completed chart and alphanumeric products to users including broadcast facilities via electronic mail, facsimile and the AES communications system. The practices and procedures used by the BAPS staff have been developed in coordination with the IIP. Therefore, they are quite similar to those used by the IIP

During the approximate six months that the IIP is in operation, ISB incorporates IIP aerial iceberg surveillance data along the LAKI and annotates the ISB standard products to attribute and utilize the IIP products in the vicinity of the LAKI. During this same period ISB relies on IIP for delivery of quality controlled sea surface temperature and wave files and updated current vectors for use in the BAPS current update model.

With the resources proposed in this response , the practices, procedures and products of the IIP could be incorporated at the direction of the US Coast Guard Contracting Officer's Technical Representative (COTR). The proposal provides for phase-in of the management of the IIP mission through the location of IIP staff at ICEC.

In the proposal it is assumed that:

- Communication (broadcast) facilities for chart and narrative products would remain available at Boston and other coastal stations.
- Communications facilities would be available to receive data by means other than the automated data interchange system (ADIS).
- Sea Surface Temperature and wave period and height would remain available from Fleet Numeric Meteorological and Oceanographic Center (FNMOC) Monterey, CA.
- Miscellaneous iceberg reports from DMAHT Washington, and presently being coded by IIP, would come directly to ISB for coding.
- IIP products issued by ISB would remain the same as presently issued unless otherwise negotiated.

Iceberg Reconnaissance and Data Acquisition Management

At the request of the COTR bi-monthly iceberg reconnaissance will be scheduled as outlined in the surveillance section. This proposal identifies the onsite resources and staff at St. John's, Newfoundland. Under that scenario, direction of the actual surveillance would be under a United States agency in coordination with an onsite mission manager. With full management of the IIP program, ISB would assume full responsibility for scheduling reconnaissance over the specified area adjacent to the LAKI and at the direction of the USCG COTR pre-season coverage may also be scheduled.

ISB operations has all information normally available in a Canadian AES Weather Office. ISB forecasters have experience in weather forecasting and this experience would, in conjunction with the onsite mission manager, be used to schedule optimum missions at or near the two weekly time frame. Under this concept and with dedicated and back-up resources available at St. John's, the entire LAKI could be covered in a two or three day period of favourable environmental and oceanographic conditions.

The ISB iceberg staff will use iceberg model guidance to selectively plan sorties to efficiently monitor the LAKI . Although coverage of the LAKI will be on a bi-monthly basis, missions will be coordinated through the partnership agreement with the DFO fisheries patrols. Mission plans prepared on the ISB Flight Planning System will indicate the area of coverage and the mission manager will select those targets along the LAKI to visually investigate.

Product Requirements

0000 and 1200Z descriptions of the LAKI and Ice Bulletins

At present ISB issues the Iceberg Bulletin for the Canadian East Coast Waters. This bulletin outlines the iceberg limit and the distribution of icebergs in the main shipping areas. It is similar in nature to the bulletin issued by the IIP.

When the IIP are in season, this bulletin incorporates the limit and targets produced by the IIP and the Area of Many Bergs. When completed this bulletin is automatically disseminated to marine radio stations and other users. Communications are monitored on a 24 hour basis by a computer operator. ISB could prepare and distribute the products predicted for 0000 and the following 1200Z exactly as prepared by IIP.

1200Z Ice Chart

When the IIP are in season ISB produces a 1200Z iceberg chart which incorporates the IIP limit and data along the limit. The IIP base map resides on BAPS and the 1200Z IIP formatted chart could be produced and distributed by facsimile and electronically to any dial-in system.

Immediate Safety Broadcasts

Presently most of the iceberg reports of opportunity (commercial ships) are received via Coast Guard Ice Operations Centre St. John's Newfoundland. There, sightings are screened for icebergs outside the limit and if necessary, a notice to shipping (NOTSHIP) is issued. BAPS contains a function that automatically checks new receptions of iceberg data and produces an ALERT if a sighting has been determined to be outside the limit . ALERTS can be automatically distributed to agencies responsible for safety broadcasts. The ALERTS would be cancelled if a new bulletin is issued within one hour.

Quality Assurance of Data

Reception of the data is continuously monitored by the computer operators who take action to retrieve missing information. ISB would continue to monitor winds from the Canadian Meteorological Centre (CMC) and continue to compare them with those produced by FNMOC. ISB would assume the responsibility for quality assurance of the sea surface temperatures and wave data produced by FNMOC. The iceberg analyst will graphically compare the temperature and wave data with environmental conditions reported from surface vessels. Alphanumeric edit would be performed, if necessary.

The computer operators will continue to monitor iceberg data turn-a-round. The iceberg analyst will alphanumerically correct format errors and graphically compare the data with other sources of information including the graphical depiction of surface vessel positions. Currently various datasets are archived. The data is retrievable for additional analysis and investigation.

Collection of WOCE Data and Identification of Local Currents

ISB would assume the purchasing and deployment of WOCE buoys. Currently ISB receives the Service Argos data directly into the BAPS workstations via the Global Telecommunications System in the World Meteorological Drifter Buoy code. It is considered that the quality control functions on BAPS and the dedicated effort by the iceberg forecaster will reproduce the level of effort presently incorporated by IIP before sending the data to DMPS. These procedures are expected to be finalized during the period of onsite IIP personnel during the phase-in period of the operation.

Operational Procedures

The IIP season will officially begin and end as directed by the USCG COTR. During the season the policies and procedures detailed in Commander, International Ice Patrol Instruction M3120B, Standing Orders for IIP Operations Center Duty Personnel, dated 18 December 1992 shall be used to guide the operation and use of BAPS, and be the fundamental guidance for retaining icebergs in the system to determine the LAKI.

The dedicated team of forecasters and analysts will be assigned daily during the IIP season to incorporate all data and evaluate model results in order to comply with the resight criteria. The resight capability would be enhanced with the complete bi-monthly coverage south of 52N as outlined as an option in the surveillance section of this response.

Specialized Reports and Data Management

The IIP mission requires the completion of several additional products and reports including:

- Annual Report of the Iceberg Operation.
- Financial Statement.
- Report on Program Planning and Development.
- Updates to iceberg sighting file and Labrador current file.

The financial and planning reports will be discussed under the "Corporate Management" section.

The annual "Report of the International Ice Patrol in the North Atlantic" is a comprehensive record of the operation of the IIP. To facilitate the production of this report and to establish a valuable data set for future studies and statistical analysis, all iceberg reports, environmental data, buoy reports, and iceberg products will be archived to established standards and practices. The annual report will be prepared during the off season to the standard established by the IIP.

The iceberg and buoy database will be configured to facilitate the updating of the iceberg sighting file and the Labrador current file to the required specifications.

The iceberg database that will be maintained at ISB will be made available to Canadian and US government agencies. Copies of the database as may be required will be provided to the National Snow and Ice Data Center in Boulder, Colorado.

Iceberg data provided to third parties will be on a cost recovery basis.

Iceberg Research and Development

It is recognized that a significant and continuing investment in improving the quality and efficiency of the iceberg program is important to the management of the IIP mission. ISB has made and continues to make major investments in the development of the Canadian ice program. In the forthcoming year, an improved data processing and analysis system (ISIS) and data distribution system (ISECS) will be implemented into the ISB operation.

The iceberg analysis and prediction capability which presently resides on BAPS will be incorporated into ISIS by April 1996. This will significantly improve the efficiency and performance of the iceberg analysis and product preparation. The aircraft track planning system will also be implemented on ISIS to further improve the capability of iceberg reconnaissance planning. The iceberg analysis and prediction modules will also be configured to a PC based system.

An iceberg specialist will direct and manage research and development for the IIP mission. A development plan addressing all aspects of the program will be prepared and annually updated. Liaisons will be established and regular meetings will be held with the research community both within and outside of government to establish priorities for research and development and for collaboration in iceberg studies and field experiments. It is anticipated that aspects of the development work would be contracted out.

The iceberg specialist will have specific responsibility for the operation and development of the iceberg models, model verification schemes, implementation of new techniques and model upgrades.

Technological advancements can be expected to improve data acquisition and analysis which will contribute to efficiencies and program cost reductions. Major improvements to ISB's operating systems are well underway and will provide significant benefits and cost reduction to the program. It is ISB's intention to continue to invest in iceberg program development through analysis of program deficiencies and to keep abreast of new technology and scientific advancements applicable to the iceberg program.

Satellite imagery is used extensively in the sea ice program at ISB. Radar imagery from the Canadian Radarsat satellite will become the prime source of sea ice data in 1996. This imagery as well as radar data from the ERS-2 satellite has the potential of providing limited iceberg data. The use of this data for the IIP mission will be investigated. Other technology such as the Ground Wave Over-The-Horizon Radar will be also further assessed for their application to iceberg detection.

System Maintenance and Contingency Planning

ISB has an informatics division which is responsible for the management and maintenance of ISB equipment, system upgrades and problem resolution. The IIP mission will require a dedicated computer scientist specifically trained to maintain the iceberg system. Maintenance of the hardware components of the iceberg program will be incorporated into the ISB maintenance contract.

Informatics staff work a normal work week but are available on call back at all times. Computer operators monitor system operation 24 hours a day and do first line trouble shooting and initiate call back when necessary. Problem reporting and resolution procedures presently part of the ISB will be incorporated for the IIP mission.

Dedicated workstations will be established for the IIP mission. With the incorporation of the iceberg functions in ISIS, back-up workstations will be available in the event of hardware failure. All ISIS workstations will operate the iceberg module and PC based systems will also be accessible.

The Informatics division has established contingencies for major system failures at ISB including complete loss of the Centre. Contingencies for the IIP mission will be incorporated into the plan.

Corporate Management

The corporate management of the IIP mission encompasses a number of aspects including financial accounting, program planning, reporting, administration, and personnel training and development and client services.

The iceberg section head will direct the overall operation of the IIP mission. Responsibilities will include financial management and program planning, work scheduling, and staff assignments. The accountability for financial matters, such as requisitions and invoices, travel arrangements, etc. will be incorporated into the administrative section of ISB and assigned to designated clerks.

An annual report of the iceberg operation will be prepared detailing all relevant costs. A report will also be prepared annually providing a multi-year plan for the iceberg operation. This plan will include recommendations for program improvements, efficiencies and capital investment.

The development of the skills of the iceberg staff is considered essential to the on-going operation of the iceberg program. Training programs will be established to improve the analytical and scientific capabilities of the personnel and opportunities will be provided for participation in iceberg studies and investigations.

The IIP information products are designed to alert the mariner of the danger of icebergs to ship navigation. It is, therefore, important to make regular contact with the client community to ensure this responsibility is met. In the management of this mission, it would be our intention to undertake user surveys, provide information brochures and meet regularly with users to measure mission results, update requirements and provide information on services.

IV. Service Arrangements

Provision of Services

Ice Services Environment Canada is mandated to provide services to other government departments, and other organizations whether they be public or commercial. Ice Services provides such services in a not-for-profit fashion. It is the current strategy of the Canadian Federal Government to account for the provision of such services using a full and appropriate cost recovery mechanism. Such costs are determined using activity based costing methodologies. These techniques have been used in assessing the cost profiles of providing services to the U.S. Coast Guard.

Refinement of Costs

The costs presented are our most realistic assessments of costs based on the 1992 season, prior to entering into negotiations with partners. If the decision is made to proceed into negotiations with the U.S Coast Guard to provide these services, we would refine our costs during the negotiations. Therefore, the costs presented are representative but are not final costs of delivering these services.

Agreement Term

The Surveillance service includes specialized assets such as FLAR and a data management subsystem that would be amortized over the term of the agreement. It would be our recommendation that a 5 year term is appropriate but with periodic review of costs and performance of the agreement. This periodic renewal of the agreement could be done on an annual or bi-annual basis. Provision for cost recovery of the specialized assets would need to be considered for an early termination for any reason.

Periodic Review

We would recommend an annual meeting to discuss the service provision and potential improvements in service as well as to foster a partnership relationship. It is our intent to meet and exceed expectations and in order to do this a high degree of feedback is desirable in conjunction with reviews of the annual reports.

V. Financial Summary

1995 Surveillance Service Cost Estimates

U.S. Dollars
Exchange Rate is 1.41

Direct Labour	**CDN $**	**US $**
Ice Observer Crew (1 MM, 2 ISS)		
Salaries		
Base	188	134
Overtime	76	54
Subtotal	264	187
Aircraft Costs		
Basing Charge (52.9K * 6 mths)	317	225
Flying Charge (845$/hr * 420 hrs)	355	252
Maintenance	145	103
Hangarage/De-icing	20	14
Contingencies	100	71
Subtotal	937	665
Equipment Costs		
Technical Support	120	85
SLAR Film	10	7
Subtotal	130	92
Direct Operating Costs		
Travel	153	109
Leased Equipment	9	6
Subtotal	162	115
Indirect Costs		
General Admin	30	21
Corporate Support	70	50
Subtotal	100	71
Capital Costs		
Depreciation		
Aircraft	434	308
Equipment	430	305
Interest	172	122
Subtotal	1036	735
TOTAL COST FOR ACTIVITY	**2629**	**1865**

Surveillance Service Projected Future Costs

US Dollars
Exchange Rate is 1.41

	PRESENT	1996	1997	1998	1999	2000
Labour	187	187	187	193	199	205
Aircraft	665	685	705	726	748	771
Equipment	92	95	98	101	104	107
Direct	115	119	122	126	130	134
Indirect	71	73	75	77	80	82
Capital	735	735	735	735	735	735
TOTAL COST	**1865**	**1893**	**1922**	**1958**	**1995**	**2033**
FEES FOR SERVICE	**1865**	**1893**	**1922**	**1958**	**1995**	**2033**

1995 IIP Management Service Program Costs

U.S. Dollars
Exchange Rate is 1.41

DIRECT COSTS	IIP COST CDN $	IIP COST US $
Salaries (Benefits, etc.)	390	277
Subtotal	390	277
Informatics and Operations		
Communications	25	18
Buoys (Purchase/Comm)	100	71
Printing/Supplies	60	43
System Maintenance	35	25
System Upgrades	30	21
Capital Depreciation	170	121
Subtotal	420	299
Corporate Support and Program Development		
Professional Services	100	71
Travel	50	35
Training	30	21
Facilities	70	50
Client Services	50	35
Branch Services	100	71
Subtotal	400	283
TOTAL COST FOR ACTIVITY	**1210**	**859**

NOTE: The costs for the management service are based on an integrated IIP and ISB iceberg service. Costs provided indicate the IIP mission share of the integrated service.

IIP Management Service Projected Future Program Costs

US Dollars
Exchange Rate is 1.41

	PRESENT	1996	1997	1998	1999	2000
Direct Costs	277	277	277	285	294	303
Informatics and Operations	298	307	316	326	335	345
Corporate Supp. & Program Dev.	284	293	301	310	320	329
TOTAL COSTS	**859**	**885**	**911**	**939**	**967**	**996**
FEE FOR SERVICE	**859**	**885**	**911**	**939**	**967**	**996**

Annex A: History of Ice Services in Canada

CHAPTER 1

Introduction

1.1 History of Ice Information Services In Canada

Ice reconnaissance was provided in Canada as early as 1940 when the Canadian Coast Guard (CCG) executed spring overflights of the Gulf of St. Lawrence and northern Hudson Strait. The service was initiated to provide increased ship safety in ice as well as to validate the requirements for vessel insurance for ship hulls. By 1954, the government implemented an ice information service within the Department of Transport's Meteorological Branch with the mandate to provide a fully-integrated ice information service which would be coordinated with Canadian Coast Guard icebreaking services.

By 1957, the Meteorological Branch had several ice reconnaissance analysts trained by the U.S. Navy, and was able to initiate an aerial ice reconnaissance program. In 1958 the program was expanded to include a central office, Ice Forecasting Central (IFC), at Shearwater, Nova Scotia. Regional ice offices were established in Cambridge Bay (Ikaluktutiak), Churchill, and Frobisher Bay (Iqaluit). The regional offices were established to supply area ice information based on data received from various sources. IFC served as the coordinating centre to which regional ice information was sent and integrated to generate a daily ice conditions chart.

In 1959 IFC was transferred to the Meteorological Branch in Halifax and began issuing bulletins on current ice conditions and forecast changes. Concurrent with the re-organization of IFC, the Ice Reconnaissance Division was created under the auspices of the Meteorological Branch Headquarters in Toronto with the mandate to provide ice reconnaissance aircraft duties.

As user requirements began to grow, IFC products expanded. In 1961 IFC began issuing seasonal outlooks to assist in the summer re-supply of northern communities. This in turn led to the issue of thirty-day updates throughout the season.

In 1967 the first long-term charter for aircraft ice reconnaissance was awarded to Kenting Aviation to provide two fully-equipped aircraft. At the same time, facsimile transmitters were installed at aircraft staging bases in

Gander, Summerside, and later Iqaluit and Inuvik. Installation of facsimile transmitters on the aircraft permitted the transmission of tactical ice charts to ships and CCG vessels.

During this time frame, IFC products were evolving with the advent of satellite imagery. The first imagery received was from the TIROS spacecraft in the early 1960s. Increased use of satellite data in IFC products reduced the requirements for seasonal and regional ice offices. By the early 1970s, IFC had phased out these offices and all IFC products were disseminated through its office in Halifax. In 1974 IFC began systematic reception of both LANDSAT and TIROS satellite hardcopy imagery on a daily basis, and the Ice Climatology Division was created to archive the satellite imagery and other types of ice information, including the ice charts generated by IFC.

In 1972 ice services came under the jurisdiction of AES of Environment Canada as the Ice Branch. IFC moved from Halifax to Ottawa to permit closer coordination of activities with CCG Fleet Systems, the major client for ice information. In the same year Nordair obtained a contract to provide two sensor-equipped Lockheed Electras for aerial ice reconnaissance. Significant improvements were made in the remote sensing of ice with the acquisition of side-looking airborne radar (SLAR) in 1978. For the first time winter ice reconnaissance operations could be conducted in the Arctic and over cloud-covered regions.

The Ice Branch program expanded in the late 1970s to meet required new areas of expertise and increased responsibility. In 1976 Ice Engineering Division was created to handle technical and maintenance issues involving the operation of the aircraft, communications, and to investigate the requirements for the next generation of ice reconnaissance aircraft. In 1978, the first computer was installed in Ice Forecasting Central. Known as the Regional Applications Computer (RAC), this computer was set up to receive meteorological data and ice reports, similar to what existed in met offices. RAC was used to record ice climatology parameters such as ice thickness reports, and it also ran freeze-up prediction models. Ice Research and Development Division was created in 1979 to investigate the potential for a radar satellite, serve as an advisory body to Ice Branch regarding present and future remote sensing technology, and to investigate microwave signatures of ice.

In 1982, IFC moved to a larger facility in Ottawa so that three divisions, IFC, Ice Climatology, and Ice Research, could consolidate and form Ice Central.

The Ice Branch Director, Ice Engineering, and Ice Reconnaissance divisions remained at AES headquarters in Downsview, Ontario. By 1983 Ice Central was receiving in-flight transmissions of ice charts from the ice reconnaissance aircraft and daily ice charts from CCG icebreakers staffed with ice reconnaissance personnel. Before the improvement in communications, shipboard ice messages were received via telex and had to be re-plotted at Ice Central.

In 1983, the Expanded Ice Information Services Program (EIISP) was initiated to meet new demands. The EIISP involved two major initiatives-expansion of the existing sea ice information program to support year-round Arctic navigation, and the introduction of an iceberg information service for the east coast. As part of the EIISP, a DeHavilland Dash-7 aircraft with improved remote sensing capabilities was acquired by Ice Reconnaissance in 1986.

In 1986, Ice Central took delivery of the Iceberg Analysis and Prediction System (BAPS) intended to provide computer-assisted iceberg analysis and forecasts. Two other systems were designed to enhance ice information services: the Ice Services Communications System (ICCS) intended to manage/route all internal and external data sources to the appropriate computing facilities and users, and the Ice Data Integration and Analysis System (IDIAS), a computer-based system designed to allow the daily charting of ice conditions directly from digital, remotely sensed imagery.

In early 1989, IFC was moved to the Lasalle Academy to accommodate the IDIAS system with its associated work stations, and it was renamed Ice Services, Environment Canada (Ice Services Branch (ISB)). Improved communication systems were installed at ISB and Gander, Charlottetown, Resolute and Iqaluit to facilitate the reception of radar imagery from the aircraft. In September 1989, ISB and CCG icebreakers began receiving radar imagery from ice reconnaissance aircraft while still in flight.

ISB contracted with Intera Technologies Ltd. in 1987 for a service to provide airborne synthetic aperture radar (SAR) imagery, and, the service became operational in January 1990. This imagery is transmitted while the aircraft is in flight to CCG icebreakers and Coast Guard Ice Offices (CGIO).

1.2 Canadian Ice Services Program

It is both the responsibility and mandate of the AES Ice Services Branch to provide timely and accurate ice information for Canadian waters (including lakes and major rivers) on an operational basis, and to provide a national archive for the data. The mandate as updated in 1988 reads in part:

> *"To provide Ice and Iceberg Information (analysis, prognoses and warnings) for the safety of Canadians involved In fishing, marine transportation and offshore petroleum exploration, and for the protection of life and property such as ships and drilling platforms; and to protect the quality of the marine environment by supporting the prevention of environmental disasters."*

The ISB operates several divisions which perform the requirements set out in the mandate. Ice information is gathered by the Ice Reconnaissance Division, accumulated, sorted, analyzed and issued to users by Ice Forecasting Division; archived and used for historical analysis by the Ice Climatology and Applications Division. Support for this operational process is provided by the Ice Product Development Division (for the aircraft, communications and sensors as well as improving ice products and developing new ones), Ice Research and Development (for remote sensing technology investigation and development).

The specific responsibilities and activities of each division within the Ice Branch can be summarized as follows:

Ice Reconnaissance Division (AWIR)

Ice Reconnaissance is responsible for the operation and maintenance of observing systems for the acquisition of aerial and ship-based ice reconnaissance information for Canadian waters. It provides tactical support to marine activities, and provides field support for scientific research work requiring ice information data and/or services. In addition to their ice observing program on board CCG icebreakers, Ice Services Specialists (ISS) provide briefings on current and expected ice conditions. Ice Reconnaissance also provides ISS to assist in the seasonal shipping support activities at the CCG Ice Offices in Dartmouth, St. John's and Iqaluit. AWIR also operates an AES Ice Office in Quebec City to provide ice information support for winter shipping along the St. Lawrence River east of Montreal.

Ice Forecasting Division (AWIF)

Ice Forecasting is responsible for the creation and dissemination of ice forecasts and products to the marine user community. It issues daily, monthly, and seasonal ice forecast products, including comprehensive analyses and forecasts of ice conditions, strategic and medium-range planning, and consultation on regional ice conditions to support the operational requirements of the user community. It also plans the day-to-day operations of the ice reconnaissance aircraft.

Ice Climatology and Applications Division (AWIC)

Ice Climatology provides climatological services to the user community to support any historical ice information requirements. It archives ice forecasting products, including satellite imagery, ice charts, and weather station information. It also archives aircraft data collected by or on behalf of Ice Branch. In addition, it provides climatological analyses, long-range planning support to marine activities, and maintains a library of all Ice Services publications.

Ice Product Development Division (AWIP)

Ice Product Development oversees the long term development and planning of Ice Branch systems. It networks with other meteorological services and supports the communications required to receive and transmit ice products to the user community.

Ice Research and Development Division (AWIS)

Ice Research and Development is responsible for the investigation of present and future remote sensing technology, including the potential for passive microwave radiometers and radar for ice definition and classification.

Funding for the Ice Services Branch comes from two major sources, the operating budget of Environment Canada and a transfer of funds from the Canadian Coast Guard of Transport Canada for the basic level of ice services, including funding the ice reconnaissance aircraft operations to meet their needs. Additional funding is available from time to time by arrangement with specific users to perform requested tasks or to perform special tasks beyond the basic mandate of Ice Branch. In addition, several services such as ice chart subscriptions are provided on a cost recovery basis.

1.3 Users of AES Ice Information

The purpose of ice information products is to provide information on ice conditions in Canadian waters to meet the needs of various users. Some users require up-to-the-minute information as an input for making operational decisions; others require data having daily, monthly, or long-term climatological significance.

Ice information provided by ISB is used by a variety of Canadian government agencies and commercial operators. These organizations include the Canadian Coast Guard, AES Meteorological Offices, Department of National Defence, commercial shipping companies, the fishing industry as well as the offshore oil and gas exploration industry and their regulatory authorities.

Foreign ice offices incorporate and exchange information with that of Ice Branch, particularly the U.S. International Ice Patrol, Greenland Ice Patrol and the U.S. Navy/NOAA National ISB.

Canadian Coast Guard

The ISB responds, in particular to the needs of the CCG, which funds the aircraft reconnaissance part of the program for this purpose. Ice information to assist in operational decision-making is provided to the CCG Ice Offices in Dartmouth, St. John's and Iqaluit, which maintain a complete and current picture of ice conditions in their area for dissemination to vessels. They also provide ship routing and direct CCG icebreaker support as required.

Ice services specialists are deployed in the field to serve on the major CCG icebreakers and at the Coast Guard Ice Offices. They provide a variety of services to CCG activities through the reception and interpretation of aircraft radar imagery, carrying out tactical ice reconnaissance sorties on helicopters as well as acquiring local ice data.

Commercial Shipping

Shipping remains active in many areas of the Canadian coastal waters during periods of extensive ice cover. Vessels regularly operate in the Gulf of St. Lawrence, east Newfoundland waters, the St. Lawrence River and the Great Lakes during the winter. A wide area of the Arctic is transited by ships during ice navigation season during the summer and fall. To support the planning and safe operation of these vessels, regular updates and forecasts of ice conditions are provided by the ice services program.

AES Meteorological Offices

These offices provide direct contact with users in all regions of Canada, and they disseminate operational ice information received from the ISB as required.

Department of National Defence

DND receives standard ice products from the Ice Branch on an operational basis, and may request additional specialized products required for military exercises in ice-covered waters.

Off shore Oil and Gas Exploration

From time to time the offshore drilling components of the oil and gas companies operate in ice and iceberg frequented waters, and require additional support from the ISB in a particular area of operation. Ice Reconnaissance responds to these needs with extra flights where possible, and ISB provides additional ice products which may be coordinated with weather and ice offices set up by the industry. Ice information support is also provided to the associated regulatory agencies such as the Canada - Newfoundland Offshore Petroleum Board.

Foreign Ice Offices

The International Ice Patrol, which is operated by the U.S. Coast Guard, pools information with the Ice Services on the iceberg population which enters the shipping lanes off the East Coast and the North Atlantic. Information is exchanged between the Ice Branch and the operating offices of the U.S. Navy/NOAA National Ice Services. The Greenland Ice Patrol is operated by the Danish Meteorological Institute in Narssarssuaq, Greenland, and they have an agreement with ISB to exchange information on icebergs.

Annex B: Flight Plans

Figure 1 shows the number of missions required to meet the stated surveillance coverage using the platform GCFR to COMPLETELY COVER the mid-season LAKI during the 1992 season.

Figure 1
DASH-7 5SORTIES TO COVER LAKI

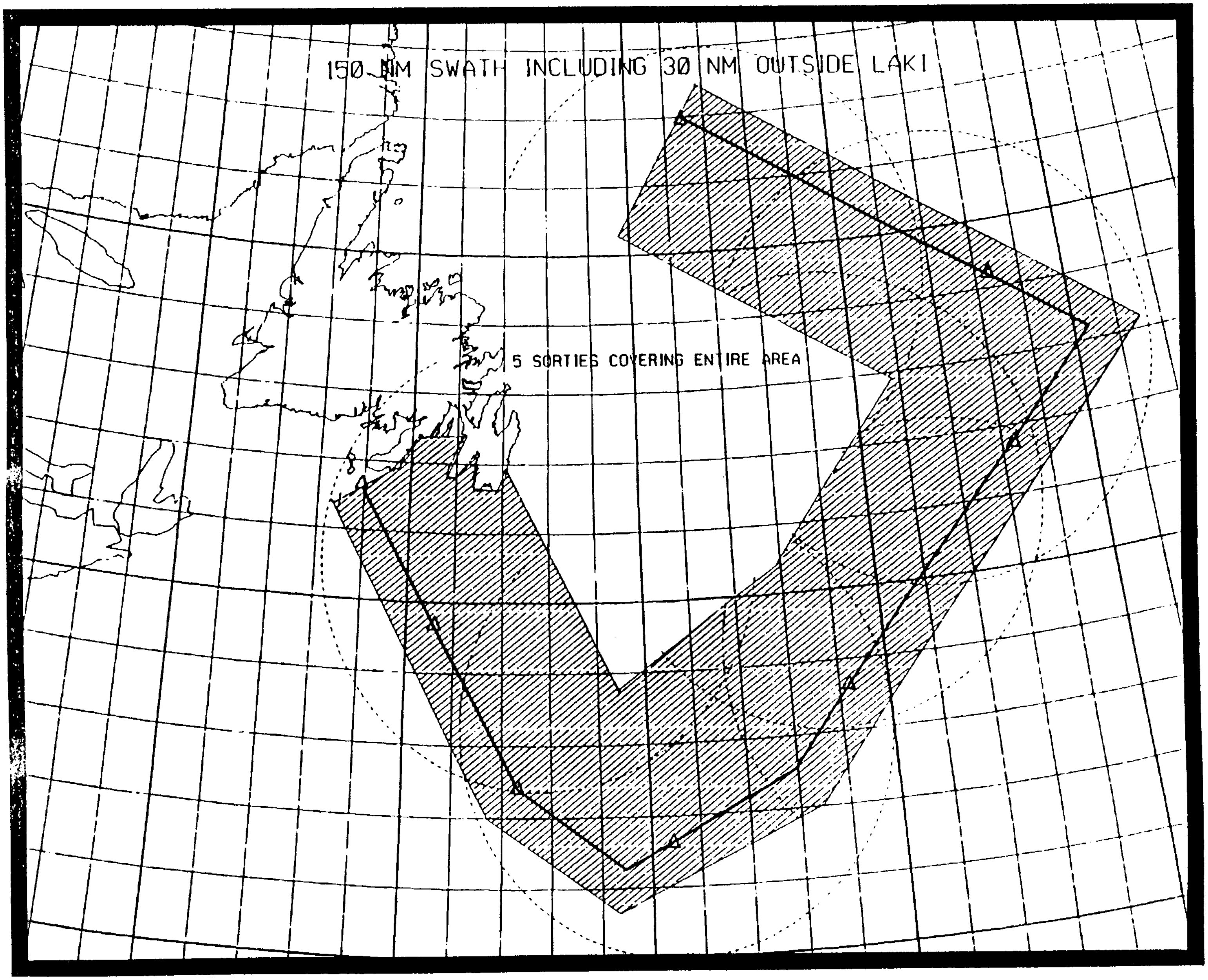


Figure 2
KING AIR 6SORTIES TO COVER LAKI

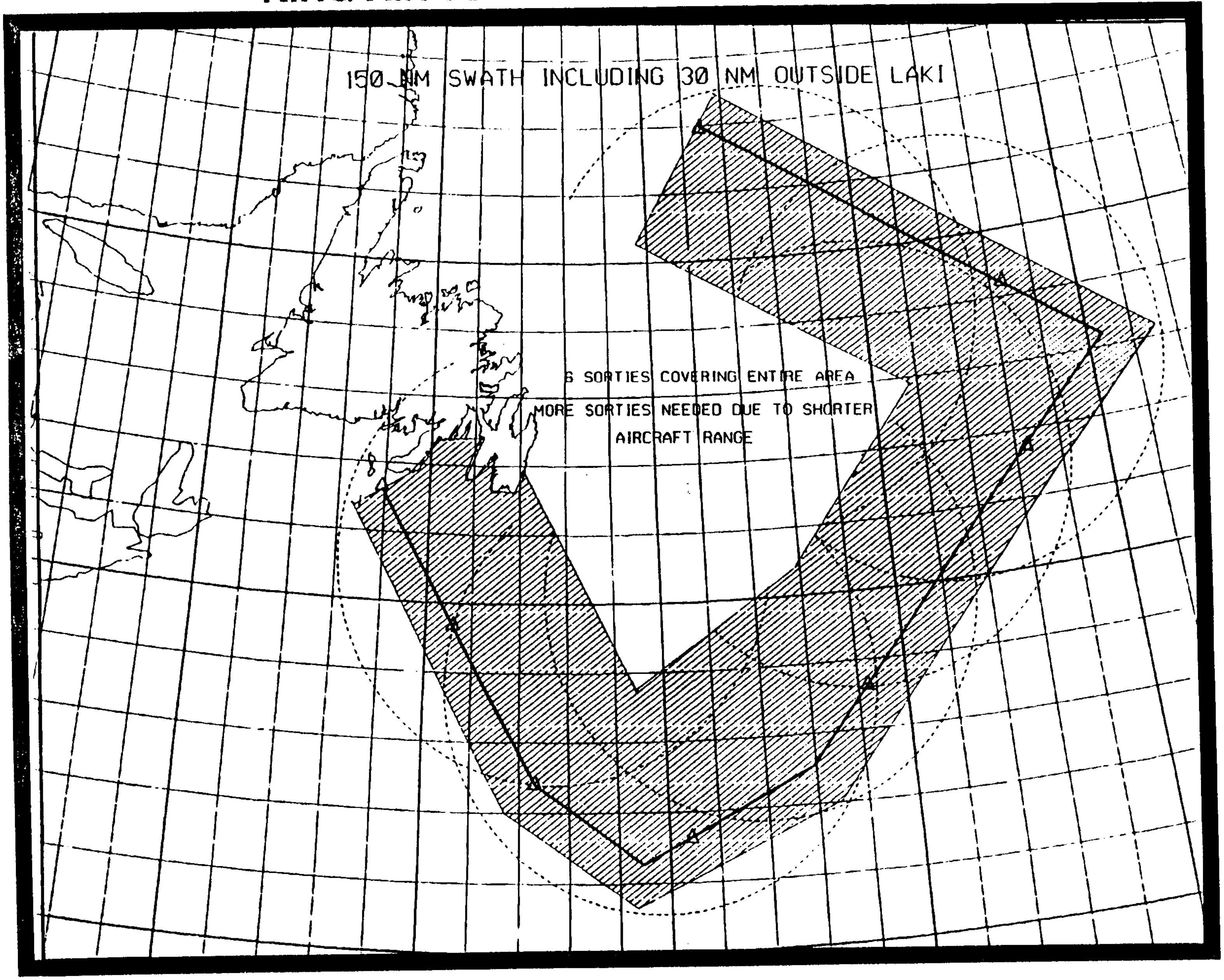


Figure 2 shows that similar calculations for the King-Air aircraft with a 1200 nm range would require 504 hours for the 1992 season.

Figure 3

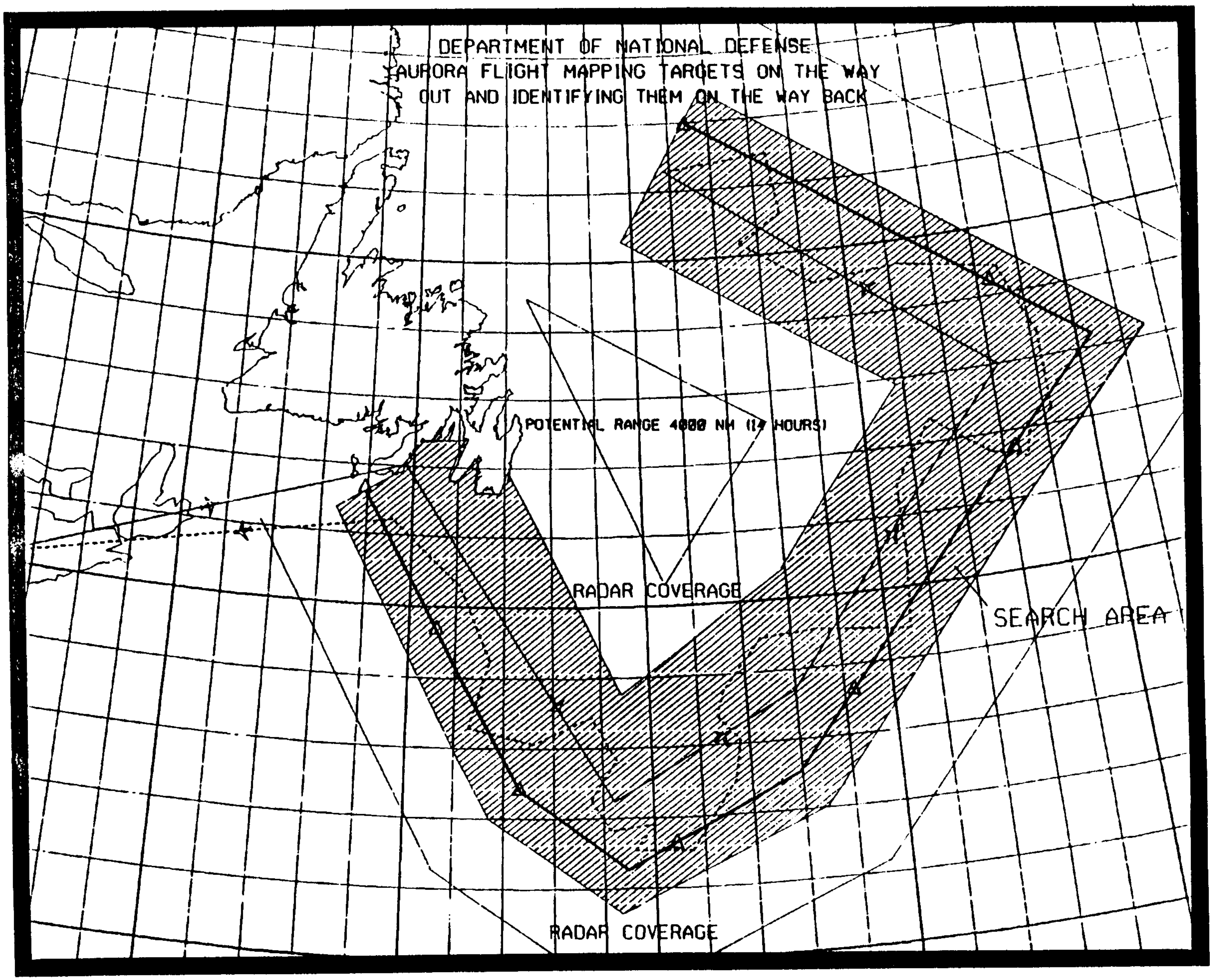
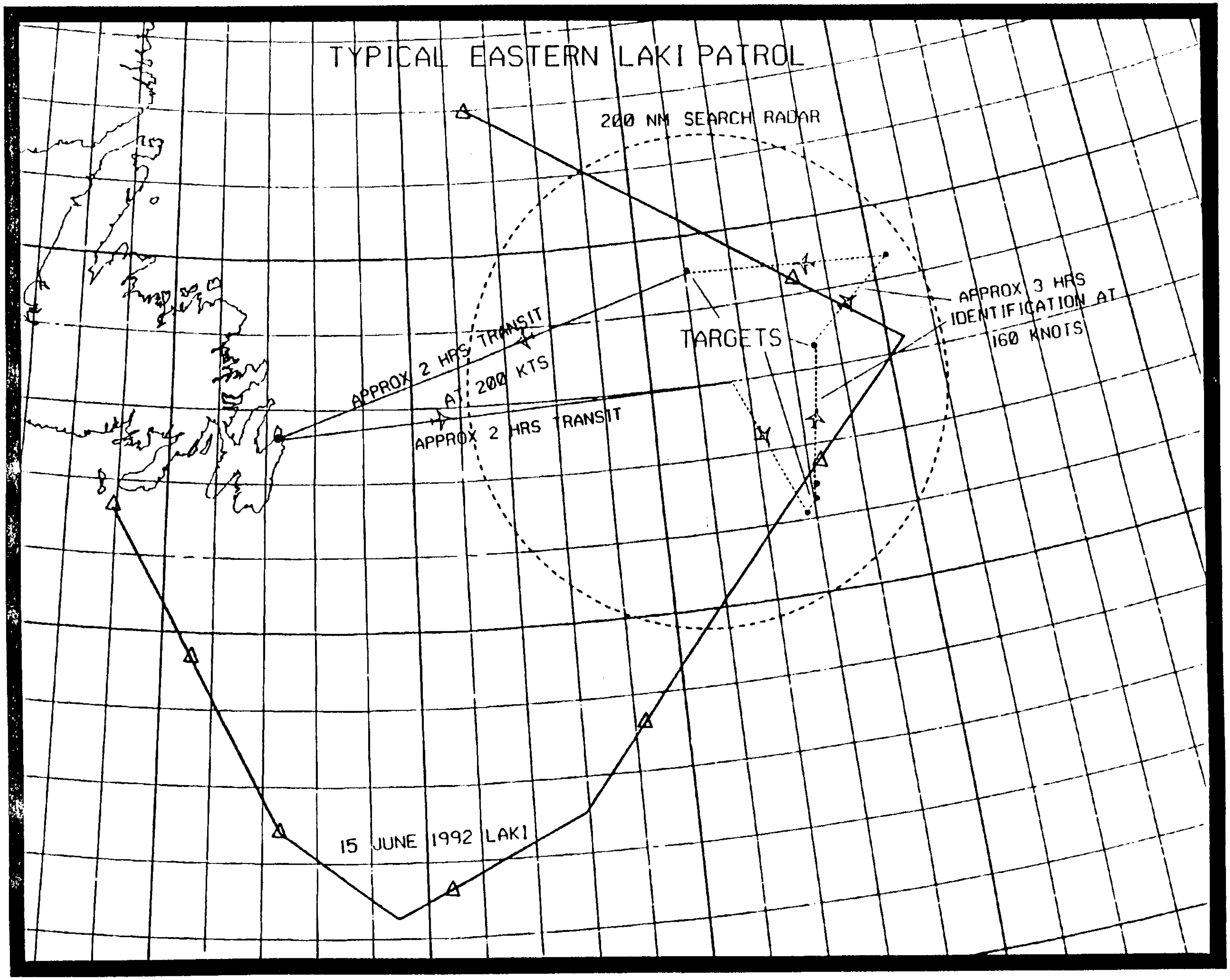

DEPARTMENT OF NATIONAL DEFENSE
AURORA FLIGHT MAPPING TARGETS ON THE WAY
OUT AND IDENTIFYING THEM ON THE WAY BACK
POTENTIAL RANGE 4000 NM (14 HOURS)
RADAR COVERAGE
SEARCH AREA
RADAR COVERAGE

Figure 3 shows a typical DND Aurora mission which could be utilized as secondary back-up.

Figure 4 shows a typical forward looking radar "locate and identify" mission of the eastern LAKI. Four hours are used in transit time and three hours are available for visually identifying all targets.

Figure 4


TYPICAL EASTERN LAKI PATROL
200 NM SEARCH RADAR
APPROX 3 HRS
IDENTIFICATION AT
160 KNOTS
TARGETS
APPROX 2 HRS TRANSIT
AT 200 KTS
APPROX 2 HRS TRANSIT
15 JUNE 1992 LAKI

Annex C: Terminologies/Acronyms

ADIS	....	Automated Data Interchange System
AES	....	Atmospheric Environment Services.
AXBT	....	Airborne eXpandable BathyThermograph.
BAPS	....	iceBerg Analysis and Prediction System.
CMC	....	Canadian Meteorological Centre
COTR	....	Contracting Officer's Technical Representative.
DFO	....	Department of Fisheries and Oceans.
DMPS	....	Data Management and Prediction System.
DMS	....	Data Management System
DND	....	Department of National Defence.
FLAR	....	Forward Looking Airborne Radar.
FNMOC	....	Fleet Numeric Meteorological and Oceanographic Center
GCFR	....	AES DASH-7 aircraft call sign.
ISB	....	Ice Services Branch
ICEC	....	Ice Centre Environment Canada.
IIP	....	International Ice Patrol.
ISB	....	Ice Services Branch
ISECS	....	Ice Services External Communication System.
ISIS	....	Ice Services Integrated Systems.
ISS	....	Ice Services Specialist
LAKI	....	Limit of All Known Ice.
MM	....	Mission Manager
MOU	....	Memorandum of Understanding
NOTSHIP	....	NOTices to SHIPping
SLAR	....	Side Looking Airborne Radar.
SOLAS	....	Safety Of Life At Sea.

[BLANK]

Appendix IV. Proposal for National Ice Center Management of the International Ice Patrol.

This Appendix includes the National Ice Center response to the Inquiry of Interest. The proposal is entitled "Proposal for National Ice Center Management of the International Ice Patrol."

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3140
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28 Mar 95

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Orlando, FL 32816-2450

Dear ~~Dr. Armacost,~~ Bob

In response to your letter of 16 February 1995 concerning an "Inquiry of Interest: National Ice Center Management of the International Ice Patrol", I am enclosing our proposal. It involves expanding the role of the USCG within the National Ice Center (NIC), by maintaining USCG funding and conduct of IIP operations within the management structure of the NIC.

We are very much interested in the future of the IIP and have proposed two options for your consideration. Both options involve relocating IIP personnel and operations to Suitland, MD, but differ regarding the primary platform for iceberg surveillance.

Having evaluated the information provided with your "Inquiry of Interest" and a variety of additional supporting documentation, we strongly recommend implementation of Option A. In this option, NIC/USCG maintains operational control over IIP, but primary surveillance is conducted by Canadian contract and military aircraft, in partnership with the Canadian Atmospheric Environment Service (AES). Option A projections reveal solid operational performance, substantial cost savings to USCG, and no increase in cost to AES. As we discussed, the numbers in this proposal are estimates only. Many issues and problems remain to be addressed if we seriously pursue one of these options.

The successful fulfillment of the IIP mission is of vital importance to those of us concerned with safety of navigation in ice-infested waters. We look forward to continued cooperation to realize this goal.

Feel free to contact us for additional information. My point of contact is LCDR Lisa Frailey, (301)457-5313 x300.

LARRY WARRENFELTZ
Captain, U.S. Navy
Director

Enclosure

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PROPOSAL FOR NATIONAL ICE CENTER MANAGEMENT OF THE INTERNATIONAL ICE PATROL

24 MARCH 1995

DIRECTOR, NATIONAL ICE CENTER
4251 SUITLAND ROAD, FB4
WASHINGTON, DC 20395
(301)457-5306

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PROPOSAL FOR NATIONAL ICE CENTER MANAGEMENT OF THE INTERNATIONAL ICE PATROL

References:

(a) Armacost, R.L., *Inquiry of Interest: National Ice Center Management of the International Ice Patrol,* EER Systems Corporation, February, 1995.

(b) Armacost, R.L., Jacob, R.F., Kollmeyer, R.C., and Super, A.D., *Interim Report on the Analysis of Current Operations of the International Ice Patrol,* EER Systems Corporation, September, 1994.

(c) Commander, International Ice Patrol Instruction M3120B, *Standing Orders for IIP Operations Duty Personnel,* 18 December 1992.

(d) Commander, International Ice Patrol letter 7100, *International Ice Patrol Costs for the 1994 Season,* 11 October 1994.

(e) Commander, Atlantic Area U.S. Coast Guard, *COMLANTAREA OPORDER 02-95.*

1.0 Introduction

This proposal is submitted in response to the Inquiry of Interest dated February 1995, submitted to the National Ice Center by Dr. Robert Armacost for EER Systems Corporation (reference (a)). The proposal reflects the interest of the National Ice Center in assuming management of the International Ice Patrol.

The National Ice Center (NIC) is a tri-agency operational center, tasked with the analysis and forecast of global sea ice, and freshwater ice in the Great Lakes and Chesapeake Bay. The NIC includes the Departments of Defense, Commerce, and Transportation, represented by the U.S. Navy, NOAA, and U.S. Coast Guard, respectively. While the Navy provides approximately 90% of the NIC manpower and fiscal resources, NOAA and USCG provide limited manpower and significant resources in the form of satellite data and aircraft hours. NIC works closely with various USCG organizations, and is dependent upon USCG aircraft for aerial ice reconnaissance. In return, NIC provides extensive tailored support for USCG operations in the Arctic, Antarctic, Great Lakes and Chesapeake Bay.

Currently, an active working relationship exists between NIC and IIP. The NIC is assigned a Marine Science Technician (MST) from USCG Ice Operations (G-NIO), who, as a member of NIC Ice Special Projects (ISP), is primarily responsible for iceberg input to IIP. NIC's location adjacent to National Maritime

Intelligence Command (NMIC) allows ISP personnel access to National Technical Means (NTM) data. Additionally, the daily IIP facsimile chart is rehosted on the NIC Autopolling (dial-in facsimile) system.

This proposal expands the current level of involvement of USCG in NIC, so that USCG retains responsibility for IIP, but within the management structure and physical location of the NIC. Funding for the program remains a USCG responsibility, and becomes part of USCG's annual contribution to NIC. G-NIO, already actively involved in NIC and a member of the US/Canada Joint Ice Working Group (JIWG), retains its responsibilities as IIP Program Manager. The mission of IIP remains as described in reference (b).

Two basic options are proposed, which differ primarily with regard to iceberg surveillance platforms. Both options require the personnel, equipment and operations of IIP to be moved to NIC in Suitland, MD. Option A eliminates the USCG HC-130 ICERECDETs and shifts the bulk of iceberg surveillance responsibilities to AES. Option B retains all surveillance platforms, including the USCG ICERECDETs. Both options are detailed in the following sections.

2.0 Option A

Option A allows the management and basic operations of IIP to be conducted at NIC, using USCG personnel and funds. USCG personnel and equipment are transferred to NIC in Suitland, MD, and all IIP planning, processing, production, and data distribution is handled from the new location. Iceberg surveillance responsibilities are shifted to Atmospheric Environment Service (AES), Ice Centre Environment Canada (ICEC), with data input to IIP at NIC.

2.1 Management and Operations

In Option A, IIP becomes a department of NIC, manned primarily by USCG personnel. Basic operations and production continue, to the maximum extent possible, in accordance with current procedures outlined in references (b) and (c).

2.1.1 Personnel Requirements

USCG personnel continue to conduct the daily IIP operations, including management, planning, watchstanding, science and systems maintenance functions. NIC's proposal reduces the current IIP manning, outlined in reference (d), from 17 personnel to 10. Cutbacks include the Commanding and Executive Officers, some administrative personnel and Aerial Ice Observers. The following billet structure is required to ensure coverage of IIP functions:

Billet		Description	Allowance
LCDR	(0-4)	Department Head	1
LT	(O-3)	Division Officer, DWO*	1
MSTC	(E-7)	Leading Chief, DWO	1
MST1	(E-6)	Duty Watch Officer(DWO)	1
YN1	(E-6)	Administration	1
MST2	(E-5)	Watch Stander (WS)	2
MST3	(E-4)	Watch Stander (WS)	1
CIV	(GS-14)	Chief Scientist	1
CIV	(GS-11)	Computer Specialist	1

*DWO - Duty Watch Officer

2.1.1.1 Watch Standing

IIP's current watch procedures, as described in reference (c), require a Duty Watch Officer (DWO) and Watch Stander (WS) team. The team stands watch onboard from 0700-1800, and is available via beeper after hours. The manning structure proposed in 2.1.1 allows for three DWOs and three WSs, operating in a 1-in-3 rotation. The on and off-season watch routine continues as outlined in reference (c). Personnel off watch will be tasked by the Division Officer.

2.1.1.2 Off-Season Requirements

IIP off-season requirements include evaluation and analysis of the previous season, preparation for the upcoming season, rate training for MSTs, and marine science support as listed in reference (b). As NIC support to USCG polar icebreakers continues year-round, off-season personnel may be invaluable in assisting with this support as liaisons, ship-riders, and ice imagery analysts.

2.1.2 Operating Spaces

NIC currently has limited operational space within Federal Building 4 of the Suitland Federal Center, and very little room for expansion. A move to Goddard Space Center has been proposed for the 1998 time frame. If Option A is approved, NIC will pursue efforts with General Services Administration to obtain additional working and storage space within Federal Building 4.

2.1.3 Information Acquisition, Processing, Distribution

Information acquisition, processing and distribution continues much as described in reference (b). All iceberg data sources remain, with deletion of HC-130 ICERECDET data (detailed in 2.2 Iceberg Surveillance), and remain channeled through ICEC. NIC has direct access to all the environmental data sources currently used by the Data Management and Prediction System

(DMPS), and close working relationships with agencies providing that data. Specifically, Fleet Numerical Meteorology and Oceanography Center (FNMOC), Naval Atlantic Meteorology and Oceanography Center (NLMOC), and Naval Ice Center (NAVICECEN is the Navy component of NIC) are all within the Commander, Naval Meteorology and Oceanography Command (CNMOC) claimancy. By employing the currently existing equipment, data, personnel and procedures, no recognizable loss in production capability or quality is anticipated.

DMPS will be operated in the NIC spaces. The current system is hosted on an Intergraph suite consisting of a Microvax workstation, a UNIX graphics workstation, and peripherals. IIP plans to upgrade to DMPS-2 in 1997. Developed by ICEC to be a compatible subset of their Ice Services Integrated System (ISIS), the DMPS-2 is hosted on a Hewlett-Packard workstation. The new system hardware should cost $350-$450K, and ICEC will provide software installation at minimal cost. A GS-11 Computer Specialist is assigned to support the DMPS system.

IIP products for external distribution, prepared in accordance with reference (c), will include:

- 0000Z and 1200Z descriptions of the Limits of All Known Ice (LAKI), distributed as safety broadcasts
- 0000Z and 1200Z Ice Bulletins
- 1200Z Ice Chart, distributed by facsimile
- Immediate safety broadcasts as required

Additional products for internal use and post-seasonal evaluation reports will be prepared as described in reference (b).

External distribution of products continues through Coast Guard Communications Station Boston (COMMSTA Boston), or through a closer COMMSTA as dictated by USCG procedures. This includes autodin distribution of Ice Bulletins and safety broadcasts, and HF facsimile broadcast of the Ice Chart. NIC has full capabilities to receive and transmit classified and unclassified AUTODIN message traffic, using the Gateguard system. NIC also has Internet connectivity for electronic mail and file transfer.

2.2 Iceberg Surveillance

Option A eliminates USCG HC-130 ICERECDETS as an iceberg surveillance platform, for reasons of efficiency and cost-effectiveness. Instead, responsibilities for primary iceberg surveillance are shifted to Canadian military and contract aircraft. USCG IIP augments AES funding for additional aircraft flight hours.

2.2.1 Comparison of Surveillance Data Inputs

Reference (b) describes the sources and quantities of iceberg surveillance data. Summarizing this data for the past three seasons yields the following inputs to the IIP DMPS:

Source	1992	1993	1994
IIP ICERECDET	685	1056	888
DFO: Atlantic Airways	1493	3908	2846
AES: Dash-7, Atl. Airways	159	1031	1817
Ships: (BAPS and relayed)	827	2031	2362
DOD/Other	6	32	0
Total	3170	8058	7915

Clearly, the IIP ICERECDET does not contribute the majority of iceberg inputs. Since the initiation of Atlantic Airways flights in 1992 (chartered by Canada's Department of Fisheries and Oceans (DFO)), ICERECDET flights have contributed a decreasingly smaller proportion of total inputs to DMPS - down to 11% of total inputs for the 1994 season. Reference (b) estimates total aircraft costs for ICERECDETs at nearly $2 million, paid by USCG. Conversely, Canadian aircraft, including Atlantic Airways and Dash-7 aircraft, contributed 59% of the DMPS inputs, at no cost to the U.S. government. Ships contribute the remaining 30% of iceberg inputs. Reference (b) does not describe the geographical distribution of the data inputs.

2.2.2 Surveillance by Canadian Aircraft

Nearly 60% of the iceberg data inputs to the IIP DMPS for 1994 originated from Canadian military or contract aircraft. The Department of Fisheries and Oceans (DFO) has a 5 year contract (1994-1999) with Atlantic Airways, which makes 3 King Air aircraft, equipped with Forward-Looking Airborne Radar (FLAR), available for DFO surveillance requirements. Contract prices include:

- $3,780,000/year basic charge: ensures full availability of 3 aircraft per year for 6000 available flight hours

- $1100/hr incremental flight charge: charge for individual flight hours, up to 6000 hours

DFO currently uses approximately 3600 flight hours per year for their surveillance needs, leaving 1400 hours available for use by other Canadian government agencies.

Atlantic Airways provides AES ICEC with iceberg and ice-edge data while conducting the DFO surveillance missions. By agreement, this data is also made available to IIP through ICEC. Additionally, ICEC is able to "piggyback" on the DFO contract to charter Atlantic Airways aircraft for ICEC-specific missions at the incremental flight chart of $1100 per hour.

AES, in conjunction with the Canadian Coast Guard (CCG) also employs the Side Looking Airborne Radar (SLAR) - equipped Dash-7 aircraft to conduct ice surveillance missions at a contract price of $1500/hr. In the course of these missions, the Dash-7 aircraft makes a significant contribution to iceberg inputs. Additionally, Dash-7 aircraft are able to deploy AXBTs in the IIP region of interest. AES anticipates increased use of the Dash-7 aircraft in 1995.

Canadian Department of National Defense (DND) Aurora aircraft are also employed by ICEC for ice reconnaissance missions. The aircraft are equipped with FLAR, which has proven very effective for iceberg surveillance.

2.2.3 IIP Supplementary Funding for Canadian Aircraft Hours

The NIC and its tri-agency members enjoy a close working relationship with AES through the formalized structure of the U.S./Canadian Joint Ice Working Group (JIWG). The JIWG is managed by NOAA's National Ocean Service and AES, and provides coordination and cooperation in operational ice services, including sea ice, lake ice, and icebergs. Through the JIWG, NIC and ICEC cooperate on varied operational and developmental projects. The JIWG provides a viable basis for continued coordination on iceberg surveillance and prediction.

Eliminating HC-130 ICERECDETs saves USCG nearly $2,000,000 per year in aircraft-related costs, but reduces the number of surveillance flight hours by approximately 600. Through AES, IIP may be able to purchase additional flight hours on Atlantic Airways or Dash-7 aircraft for dedicated iceberg surveillance missions, as contractual agreements allow. ICERECDETs have averaged 613 hours per season from 1992-1994. Averaging Atlantic Airways ($1100/hr) and Dash-7 ($1500/hr) flight hour costs, 613 flight hours could be purchased through AES for $800,000, yielding a net savings to IIP of $1,200,000.

The differences in performance characteristics for iceberg detection between HC-130 SLAR/FLAR, Atlantic Airways and DND FLAR, and Dash-7 SLAR have not been clearly identified. These differences may require more than 613 flight hours to compensate for the elimination of HC-130 ICERECDETs, or reconfiguration of radar systems on the Canadian aircraft. Current DFO tasking of Atlantic Airways aircraft leaves 1400 hours per year available for additional tasking. Additional tasking is available for Dash-7 and DND aircraft.

Reference (b) lists the quantity of iceberg data input by various sources, but not the geographical distribution of that data. King Air and Dash-7 aircraft have less endurance and range than the HC-130s, and may be unable to provide adequate coverage to determine LAKI. DND Aurora aircraft may need to be employed for surveillance of iceberg boundary areas.

2.2.4 Continued NIC Employment of HC-130 SLAR Aircraft

NIC depends heavily on USCG SLAR-equipped HC-130 aircraft for ice reconnaissance missions in the east and west Arctic regions. NIC Ice Reconnaissance Unit personnel deploy onboard HC-130 aircraft in frequent support of USCG polar class icebreakers on Arctic missions. The aircraft are also used as backups to the HU-25 Falcon aircraft, employed by NIC for ice reconnaissance of the Great Lakes in support of USCG District 9. Elimination of ICERECDETs will free up HC-130s for additional Arctic and Great Lakes ice reconnaissance missions, which often occur during the IIP season.

The estimated $2,000,000 per year in aircraft-related costs does not include the costs to maintain the CGAS Elizabeth City squadron. While IIP ICERECDET missions represent a significant proportion of the squadron's flight hours (600 of 1600 available hours), the aircraft are gainfully employed with various missions tasked by COMCOGARD LANTAREA. The elimination of ICERECDETs is not expected to precipitate the disestablishment of the HC-130 squadron. However, the SLAR capability may be adversely affected. The current palletized, film-based SLAR equipment is becoming rapidly obsolete, and USCG is funding development of a digital-based SLAR system. With the elimination of ICERECDETs, USCG is likely to discontinue digital SLAR funding. It is crucial to NIC's mission support of USCG polar class icebreakers that the HC-130 SLAR capability be maintained regardless of the continuance of ICERECDETs.

2.2.5 Deployment of AXBT Probes and WOCE Buoys

With the elimination of HC-130 ICERECDETs, an alternative means for deployment of AXBT probes and WOCE ocean drifter current buoys must be identified. CFR Dash-7 aircraft are capable of deploying AXBT probes, which are supplied by Canadian Forces Meteorology and Oceanography Command. Contracting Dash-7 flight hours provides a viable means of deploying AXBTs for IIP purposes.

WOCE buoys may be deployed by contracted cargo aircraft, HC-130's, or ships. For precision buoy placement, an excellent option is for the buoys to be airdropped from HC-130's on, or enroute to, a nearby NIC ice reconnaissance mission. IIP personnel currently embark upon USCG vessels to conduct marine science support during the off-season. These vessels, CCG vessels operating in the IIP area of concern, and DFO "ships of opportunity" may be used to deploy WOCE buoys.

2.2.6 Surveillance by Imagery Analysis

NIC's Ice Special Projects personnel, including a USCG Marine Science Technician, regularly analyze National Technical Means (NTM) data for icebergs. The analysts are trained to order, analyze and mensurate NTM data to extract iceberg position, size, shape and location. The imagery and mensuration equipment is available at the National Maritime Intelligence Center (NMIC), located adjacent to NIC in Suitland, MD. A formalized system to input this data to the IIP DWO is in place and operating for the 1995 season. With IIP personnel located at NIC, off-watch Duty Watch Officers and Watch Standers will be trained and detailed to analyze NTM data for iceberg input to DMPS.

2.3 Cost Accounting

Table 1 summarizes the recurring costs to operate the IIP if NIC Option A is implemented. Option A yields significant cost savings to USCG from the 1994 cost of $3.6 million, primarily by eliminating ICERECDET expenses in favor of purchasing Canadian aircraft hours. Operating cost overhead is also reduced, and IIP manning is reduced from 17 to 10 personnel. Buoy-related costs differ somewhat from those identified in reference (b), but reflect current costs obtained from IIP. Administrative costs include utilities, rent, telephone, vehicle charges, administrative supplies and equipment, and administrative microcomputer maintenance.

Table 2 summarizes one-time costs incurred to implement Option A. Estimates do not include the cost to physically move IIP to Suitland, MD.

Table 1. Option A Recurring Costs

Cost Category	Cost	Notes
Aerial Surveillance	800,000	613 contract hrs
Office of IIP at NIC:		
Personnel	(487,000)	10 vs 17 personnel
Travel/Lodging	(100,000)	
Total IIP Office	587,000	
Operations Equipment:		
WOCE Buoy Deployment	(6,000)	15 buoys @ $400
WOCE Buoys	(42,000)	15 buoys @ $2800
ARGOS Buoy Data Processing	(60,000)	$4000/buoy
IIP Bulletins/Public Affairs	(2,000)	
DMPS System Maintenance	(40,000)	
Total Operations Equipment	150,000	
Administrative Costs	110,000	Util, supplies, etc
TOTAL COSTS	**1,647,000**	

Table 2. Option A One-Time Costs

Cost Category	Cost	Notes
Acquisition of Working Space	Unknown	GSA Restoration
Microcomputers	15,000	NIC LAN Compatible
Upgrade to DMPS-2, 1996	450,000	+/- 50,000
Additional SLAR/FLAR radar	Unknown	Canadian Aircraft

3.0 **Option B**

Option B allows the management and basic operations of IIP to be conducted at NIC, using USCG personnel and funds. USCG personnel and equipment are transferred to NIC in Suitland, MD, and all IIP planning, processing, production, and data distribution is handled from the new location. Iceberg surveillance responsibilities remain with USCG HC-130s in accordance with procedures delineated in reference (e). Surveillance is augmented by existing data inputs from Canadian aircraft, ships, and NTM imagery analysis.

3.1 Management and Operations

In Option B, IIP becomes a department of NIC, manned primarily by USCG personnel. Basic operations and production continue, to the maximum extent possible, in accordance with current procedures outlined in references (b) and (c).

3.1.1 Personnel Requirements

USCG personnel continue to conduct the daily IIP operations, including management, planning, watchstanding, surveillance, science and systems maintenance functions. NIC's proposal reduces the current IIP manning, outlined in reference (d), from 17 personnel to 14. Cutbacks include the Commanding and Executive Officers, and one Lieutenant. The following billet structure is required to ensure coverage of IIP functions:

Billet	Description	Allowance
LCDR (O-4)	Department Head, DWO*, SIO+	1
LT (O-3)	Division Officer, DWO, SIO	1
MSTC (E-7)	Leading Chief, DWO, SIO	1
MST1 (E-6)	DWO, SIO	2
YN1 (E-6)	Administration	1
MST2 (E-5)	Watch Stander (WS)	3
MST3 (E-4)	Watch Stander (WS)	3
CIV (GS-14)	Chief Scientist	1
CIV (GS-11)	Computer Specialist	1

*DWO - Duty Watch Officer
+SIO - Senior Ice Observer

3.1.1.1 Watch Standing

IIP's current watch procedures, as described in reference (c), require a Duty Watch Officer (DWO) and Watch Stander (WS) team. The team stands watch onboard from 0700-1800, and is available via beeper after hours. The manning structure proposed in 3.1.1 allows for six DWOs and six WSs. DWOs also deploy as Senior Ice Observers (SIO) on ICERECDETs, while WSs deploy as junior observers. The on and off-season watch routine continues as outlined in reference (c). Personnel off watch will be tasked by the Division Officer.

3.1.1.2 ICERECDET Deployment

The IIP ICERECDET component consists of one SIO and three Watch Standers. Onboard personnel man the SLAR, FLAR, and visual observation posts. Deployments generally last nine days over a fourteen day period.

3.1.1.3 Off-Season Requirements

IIP off-season requirements include evaluation and analysis of the previous season, preparation for the upcoming season, rate training for MSTs, and marine science support as listed in reference (b). As NIC support to USCG polar icebreakers continues year-round, off-season personnel may be invaluable in assisting with this support as liaisons, ship-riders, and ice imagery analysts. Senior Ice Observers may be incorporated with the NIC Ice Reconnaissance Unit to provide aerial ice reconnaissance for Arctic ship operations.

3.1.2 Operating and Storage Spaces

NIC currently has limited operational and storage space within Federal Building 4 of the Suitland Federal Center, and very little room for expansion. A move to Goddard Space Center has been proposed for the 1998 time frame. If Option B is approved, NIC will pursue efforts with General Services Administration to obtain additional working and storage space within Federal Building 4. Limited on-site storage is available in an adjacent trailer for quick-access flight gear. Off-site storage must be secured for AXBT probes and WOCE buoys.

3.1.3 Information Acquisition, Processing, Distribution

Information acquisition, processing and distribution continues much as described in reference (b). All iceberg data sources remain, and are channeled through ICEC. NIC has direct access to all the environmental data sources currently used by the Data Management and Prediction System (DMPS), and close working relationships with agencies providing that data. Specifically, Fleet Numerical Meteorology and Oceanography Center (FNMOC), Naval Atlantic Meteorology and Oceanography Center (NLMOC), and Naval Ice Center (NAVICECEN is the Navy component of NIC) are all within the Commander, Naval Meteorology and Oceanography Command (CNMOC) claimancy. By employing the currently existing equipment, data, personnel and procedures, no recognizable loss in production capability or quality is anticipated.

DMPS will be operated in the NIC spaces. The current system is hosted on an Intergraph suite consisting of a Microvax workstation, a UNIX graphics workstation, and peripherals. IIP plans to upgrade to DMPS-2 in 1997. Developed by AES ICEC to be a compatible subset of their Ice Services Integrated System (ISIS), the DMPS-2 is hosted on a Hewlett-Packard workstation. The new system hardware should cost $350-$450K, and ICEC will provide software installation at minimal cost. A GS-11 Computer Specialist is assigned to support the DMPS system.

IIP products for external distribution, prepared in accordance with reference(c), will include:

- 0000Z and 1200Z descriptions of the Limits of All Known Ice (LAKI), distributed as safety broadcasts

- 0000Z and 1200Z Ice Bulletins

- 1200Z Ice Chart, distributed by facsimile

- Immediate safety broadcasts as required

Additional products for internal use and post-seasonal evaluation reports will be prepared as described in reference (b).

External distribution of products continues through Coast Guard Communications Station Boston (COMMSTA Boston), or through a closer COMMSTA as dictated by USCG procedures. This includes autodin distribution of Ice Bulletins and safety broadcasts, and HF facsimile broadcast of the Ice Chart. NIC has full capabilities to receive and transmit classified and unclassified autodin message traffic, using the Gateguard system. NIC also has Internet connectivity for electronic mail and file transfer.

3.2 Iceberg Surveillance

3.2.1 USCG ICERECDETs

Option B requires that IIP continue to conduct ICERECDETs using CGAS Elizabeth City SLAR/FLAR-equipped HC-130 aircraft. Procedures will be in accordance with those listed in references (c) and (e), with the exception of variations due to relocation of IIP to Suitland. By continuing use of current equipment, personnel and procedures, all surveillance requirements listed in reference (a) should be attained. No difference in performance parameters is anticipated.

Continued development of a digital SLAR capability for HC-130 and HU-25 aircraft will enhance the overall performance of ICERECDETs. It will also facilitate direct transmission of iceberg and sea ice data to surface operators. Polar class icebreakers, for example, will be to display real-time data for their operational area. This capability has enormous value to the missions of both IIP and NIC.

SLAR-equipped HU-25 Falcon aircraft from CGAS Cape Cod will be transferred to CGAS Corpus Cristi on 1 April 1995 leaving no SLAR capability in Cape Cod. Missions previously conducted by Cape Cod Falcons must be assumed by HC-130s or by Corpus Cristi aircraft.

3.2.2 Surveillance by Canadian Aircraft

Section 2.2.1 lists the sources for iceberg data input, showing the increasingly substantial contribution made by Canadian contracted and military aircraft. Close cooperation with AES must continue to ensure continuance of this valuable data source. Using the partnerships between NIC, AES, and DFO detailed in Sections 2.2.2 and 2.2.3, NIC IIP can supplement HC-130 ICERECDETs by tasking Atlantic Airways and Dash-7 aircraft at an average cost of $1300 per flight hour.

3.2.3 Deployment of AXBT Probes and WOCE Buoys

Deployment of AXBT probes and WOCE ocean drifter current buoys remains a surveillance requirement, and can continue via HC-130 airdrop. Additional deployment platforms for the AXBT probes, which are supplied by Canadian Forces Meteorology and Oceanography Command, include the CFR Dash-7 and DND Aurora aircraft.

For precision placement of WOCE buoys, airdrop by HC-130 aircraft remains the most effective and efficient platform. Alternative deployment platforms include surface ships, including USCG or CCG cutters and DFO "ships of opportunity". Deployment by ship eliminates the $400/buoy airdrop package charge.

3.2.4 Surveillance by Imagery Analysis

NIC's Ice Special Projects personnel, including a USCG Marine Science Technician, regularly analyze National Technical Means (NTM) data for icebergs. The analysts are trained to order, analyze and mensurate NTM imagery to extract iceberg position, size, shape and location. The data and mensuration equipment is available at the National Maritime Intelligence Center (NMIC), located adjacent to NIC in Suitland, MD. A formalized system to input this data to the IIP DWO is in place and operating for the 1995 season. With IIP personnel located at NIC, off-watch Duty Watch Officers and Watch Standers will be trained and detailed to analyze NTM data for iceberg input to DMPS.

3.3 Cost Accounting

Table 3 summarizes the recurring costs to operate the IIP if NIC Option B is implemented. Option B yields a cost savings to USCG of $700,000 (compared to the 1994 cost of $3.6 million). This is primarily achieved by reducing personnel and administrative costs. Operating cost overhead is also reduced, and IIP manning is reduced from 17 to 14 personnel. ICERECDET and buoy-related costs differ somewhat from those identified in reference (b), but reflect current costs obtained from IIP. Administrative costs include utilities, rent, telephone, vehicle charges, administrative supplies and equipment, and administrative microcomputer maintenance.

Table 4 summarizes one-time costs incurred to implement Option B. Estimates do not include the cost to physically move IIP to Suitland, MD.

Table 3. Option B Recurring Costs

Cost Category	Cost	Notes
Aerial Surveillance Costs:		
Personnel	(540,000)	
Aircraft Fuel	(560,000)	HC-130
Maintenance	(560,000)	
Leased Spaces/Flt Services	(520,000)	E-City, St John's
TELEX Charges	(9,000)	CGDONE COMCEN
SLAR Film	(14,500)	E City & Cape Cod
Flight Equipment Storage	(5,000)	Public Storage
Total Aerial Surveillance	2,208,500	
IIP Office at NIC:		
Personnel	(682,000)	14 vs 17 personnel
Travel/Lodging	(100,000)	
Total IIP Office	782,000	
Operations Equipment:		
WOCE Buoy Deployment	(6,000)	15 buoys @ $400
WOCE Buoys	(42,000)	15 buoys @ $2800
ARGOS Buoy Data Processing	(60,000)	$4000/buoy
IIP Bulletins/Public Affairs	(2,000)	
DMPS System Maintenance	(40,000)	
Total Operations Equipment	150,000	
Administrative Costs	110,000	Util, supplies, etc
TOTAL COSTS	**3,250,500**	

Table 4. Option B One-Time Costs

Cost Category	Cost	Notes
Acquisition of Working Space	Unknown	GSA Restoration
Development of Digital SLAR	Unknown	USCG HQ R&D
Microcomputers	15,000	NIC LAN Compatible
Upgrade to DMPS-2, 1996	450,000	+/- 50,000

4.0 Summary and Recommendations

4.1 Summary of Options

Two options are proposed for NIC's management of the International Ice Patrol (IIP). Both options expand the current level of involvement of USCG in NIC, allowing USCG to retain responsibility for IIP, but within the management structure and physical location of NIC in Suitland, MD. IIP will become a department of NIC, with operations and surveillance funded as part of USCG's annual contribution to NIC. USCG G-NIO retains responsibility as IIP Program Manager, and the mission of IIP remains as described in reference (b). Both Options A and B require the personnel, equipment and management operations of IIP to be relocated to NIC.

The basic difference between the two options is in the primary iceberg surveillance platform. Option A eliminates the USCG HC-130 ICERECDETs and shifts the bulk of iceberg surveillance responsibilities to AES, augmented by funding from USCG. This choice is based on the quantity of iceberg data input by various surveillance platforms, and the relative cost to USCG to operate those platforms. Option B employs the USCG ICERECDETs as the primary surveillance platform, to continue current coverage of the operational area. Data from all surveillance platforms is retained for incorporation into DMPS.

4.2 Cost Comparison

Table 5 illustrates the significant projected cost savings if NIC assumes management of IIP. IIP Reported Costs for 1994 are extracted from reference (d), and details of Options A and B projections are found in Tables 1 and 3 of this proposal. Option A yields a projected savings of $1,971,600 due primarily to eliminating HC-130 ICERECDETs and instead purchasing contract flight hours from Canadian aircraft. Savings in the areas of IIP Office and Administrative costs are apparent in both Options A and B, due to reduced manpower and overhead costs. Option B yields a projected savings of $368,100.

Greater cost savings may actually be realized, as some cost areas do not appear in the 1994 IIP Reported Costs, but are included in NIC projections. These include the leased space cost for HC-130 operations in St. John's, Newfoundland ($45,000 paid by LANTAREA), and a $32,000 underestimate for ARGOS data processing charges ($4000/buoy).

Table 5. Comparison of IIP Recurring Costs

Cost Category	**1994 (Reported)**	**Option A (Projected)**	**Option B (Projected)**
Aerial Surveillance	1,989,100	800,000	2,208,500
IIP Office	864,200	340,000	418,000
Operations Equipment	168,600	150,000	150,000
Administrative	596,700	100,000	110,000
TOTAL COSTS	**3,618,600**	**1,647,000**	**3,250,500**

4.3 NIC Recommendations

NIC recommends the implementation of Option A for the management of IIP. Evaluation of available information on costs, performance and iceberg data inputs reveals Option A to be the most cost-effective approach to successful completion of the IIP mission. Conducting IIP operations within the structure and location of NIC greatly reduces the amount of administrative overhead costs, and provides access to additional valuable data sources. Shifting aerial surveillance responsibilities to AES is the logical choice when reviewing the preponderance of data currently provided by Canadian aircraft, at no charge to the USCG. The location and capabilities of Canadian charter and military aircraft make them ideally suited to this function.

Elimination of USCG HC-130 ICERECDETs frees the aircraft for additional NIC aerial ice reconnaissance tasking in support of USCG and USN polar operations. It is crucial that the SLAR capability of this unique resource not be lost, and that development of digital SLAR capability continues.

As the newest member of the NIC, USCG has an opportunity to rapidly expand its involvement in the tri-agency organization. Both Options A and B allow IIP to take advantage of NIC's extensive data sources, management structure, and existing relationships with many of the agencies contributing data to the IIP mission. Additionally, the options greatly enhance direct USCG participation in NIC support of polar operations.