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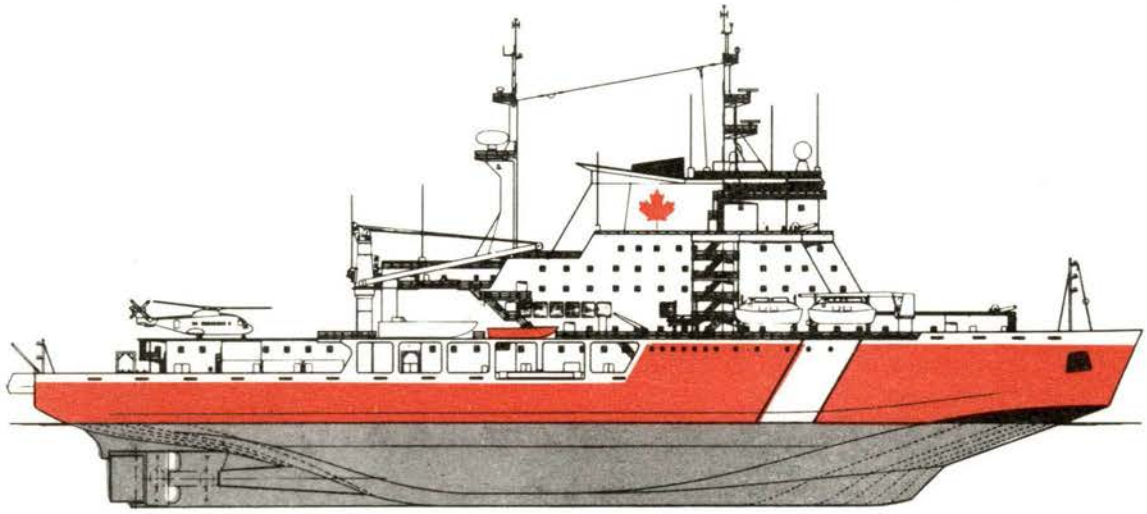

INITIAL ENVIRONMENTAL EVALUATION

ÉVALUATION ENVIRONNEMENTALE INITIALE

Canada

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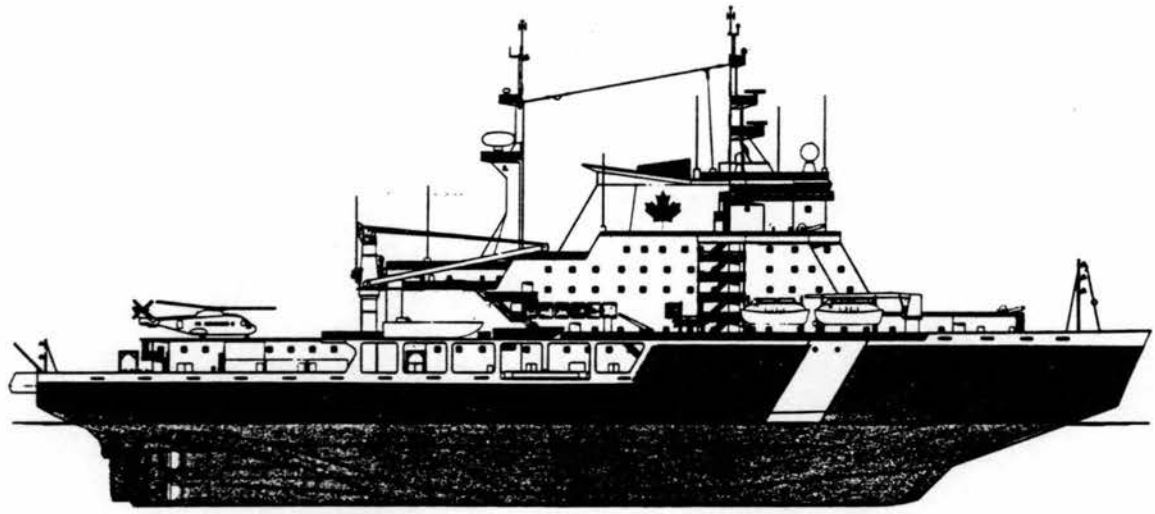

INITIAL ENVIRONMENTAL EVALUATION

ÉVALUATION ENVIRONNEMENTALE INITIALE

February 1, 1990 / 1 février, 1990

Canada

FOREWORD

This Initial Environmental Evaluation (IEE) of the Polar 8 icebreaker was conducted by a multi-disciplinary team drawn from a number of organizations. They are, in alphabetical order:

Bureau of Management Consulting

Canadian Coast Guard

LGL Limited

Lutra Associates Ltd.

Melville Shipping Ltd.

Norland Science & Engineering Ltd.

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SUMMARY OF THE INITIAL ENVIRONMENTAL EVALUATION OF THE POLAR 8 ICEBREAKER

INTRODUCTION

In late 1985, the Government of Canada announced its decision to design and construct a Polar icebreaker capable of year-round operations in the Arctic. Subject to final reviews and funding, the Canadian Coast Guard (CCG) is now poised to enter the construction phase of this vessel. A name for the ship will be chosen during the construction phase, and in the meantime, it will be referred to simply as the Polar 8.

The following summarizes the results of an Initial Environmental Evaluation (IEE) of the potential environmental impacts which may arise from the operation of the Polar 8. It forms part of the Environmental Assessment and Review Process which came into effect in 1977. The environmental issues addressed in this study were identified through prior consultations between the Coast Guard and interested environmental and community groups over the past 15 years, and through a review of similar environmental assessments carried out previously. The evaluations were based on available research data, on past experience, and on the opinions of leading experts in a wide range of fields. The evaluation was prepared by a study team consisting of personnel from the Bureau of Management Consulting, the Canadian Coast Guard, LGL Limited, Lutra Associates Ltd., Melville Shipping Ltd., and Norland Science and Engineering Ltd.

ROLES

The mission profile for the Polar 8, which is a statement of its major roles, emphasizes sovereignty, scientific support, strategic/national operations, emergency response and support to shipping. The Polar 8 will also assume all the normal duties and responsibilities of other Coast Guard fleet units, providing Coast Guard services to northern Canada on a year-round basis. The roles of the Polar 8, as specified in its mission profile, are as follows:

Sovereignty

The Polar 8 will project a visible Canadian presence for extended periods in Arctic regions in exercise of sovereignty concerns and enforcement. This will be accomplished by occasional and scheduled voyages to sites throughout the Arctic Archipelago, specifically during the Arctic closed season.

Scientific

The Polar 8 will provide a platform for Arctic seas scientific research and data collection, including studies measuring and monitoring weather and sea/ice conditions, environmental studies, research projects and surveys. As well, the Polar 8 will provide a facility for the conduct of research related to Arctic Class ship design and operation, regulatory development and operational experience.

Strategic/National

The Polar 8 will provide escort and assistance to vessels in the Arctic making exploratory or demonstration voyages of national interest. National security interests will be incorporated by making provision for the accommodation and installation of national defence systems and facilities. The ship will also possess long voyage, ocean going capability suitable for possible deployment to Antarctica for exploration and research purposes.

Emergencies and Logistics Support

The Polar 8 will provide an all-season platform and action centre for the coordination of responses to Arctic emergencies including Search and Rescue, Arctic community disasters, pollution incidents, blowouts and pipeline failures. To carry out this role, the Polar 8 will be capable of providing personnel, shelter, supplies and provisions, fuel, fresh water, communications, transport, diving equipment, medical services and a limited amount of electrical power. The Polar 8 will also carry pollution response equipment, personnel trained in its use, and have its own oil spill response plan.

The Polar 8 will have the capability to resupply remote sites and communities and will have cargo handling and storage facilities along with barge and helicopter support facilities for the transport ashore of stores and supplies.

Shipping Support

The Polar 8 will conduct all season Arctic trafficability studies (including studies on ice conditions, weather, currents, feasibility of transit, and environmental impacts) that examine considerations related to Arctic shipping.

The Polar 8 will contribute to the safe and efficient movement of Arctic marine traffic by providing escort when needed, and by providing assistance to beset ships and those experiencing difficulty in extreme sea/ice conditions.

Assistance in the maintenance of marine aids to navigation will be provided, as will surveillance and reporting of Arctic ice and environmental conditions along shipping routes. The ship will be capable of monitoring and recording pertinent ship navigational data and information.

SHIPBOARD FACILITIES, PERSONNEL AND EQUIPMENT

In order to carry out the roles identified in the mission profile, the Polar 8 will be outfitted with sophisticated equipment and highly trained personnel. The shipboard facilities have been designed to incorporate features that will be needed to support the ship's mission profile and its position as Coast Guard Northern's representative in the Arctic. These comprise:

- aviation facilities that will allow the ship to be a well-equipped mobile heliport capable of supporting the year-round, all-weather operation of three helicopters;
- medical facilities, including a doctor and a five-bed hospital;
- scientific facilities, including laboratories, extensive computer facilities and a moon pool (an opening through the bottom of the ship for entry to the water);
- fire monitors capable of pumping water for distances of up to 150 metres at a maximum rate of 9,600 cubic metres per hour;
- diving spaces, hot water and air equipment, and fixed and portable recompression chambers to support extensive diving operations;
- temporary accommodation for 150 people during emergencies or large-scale operations such as pollution clean-up activities;

- extensive communications facilities to provide for the reliable, long-range exchange of data and voice communications, plus space and equipment for the co-ordination of contingency operations;

- a towing winch and stern notch to allow for effective and efficient close coupled towing of ships of up to 100,000 tonnes;

- electrical, wood, avionics, small vehicle repair, and electronic workshops to repair and maintain equipment;

- several conference rooms capable of handling groups of up to 70 people, which will facilitate discussions with the Arctic community;

- law enforcement facilities, including detention facilities and an armoury for the storage of arms and ammunition; and

- stowage spaces and several cranes to support resupply activities.

The ship's crew will include special activities teams to be used in response to specific situations. These teams will include:

- a Dangerous and Toxic Materials Team trained in the containment of harmful materials and in the use of protective clothing and appropriate equipment;

- a Rescue Specialist Team trained in rescue techniques, that will deploy with the helicopters to act as winchmen, observers, rescue specialists and medical technicians;

- a First Aid Team trained to industrial standards to render first aid either in the shipboard facilities or at some distance, in conjunction with the ship's helicopters;

- a Diving Team trained to conduct inspection and scientific operations in the Arctic to a shallow depth; and

- a Boarding and Law Enforcement team capable of stopping and inspecting civil shipping or, if instructed, effecting seizure of a vessel.

The Polar 8 will provide transportation for personnel and equipment to and from the ship through the ship-based helicopters, surface transportation, or by sailing to the location. The transportation equipment will consist of:

- two large helicopters on the Polar 8 capable of flying in most weather conditions, day or night, plus one light helicopter for use in visual weather conditions;
- two Arktos, which are all-weather vehicles capable of movement in water or on ice;
- a variety of small vehicles including snowmobiles, all terrain wheeled vehicles, and tracked vehicles; and
- several small vessels, including landing barges and rigid hulled inflatables.

Finally, the ship will carry equipment such as shelters, pollution clean-up equipment, electrical generators, pumps, fire fighting equipment, and emergency medical equipment that will be available for deployment by helicopter or surface vehicle as required.

AIR SUPPORT

The three helicopters will provide fast, effective, and far-ranging air support, thereby extending the services offered by the Polar 8 well beyond the physical location of the ship, into areas of the Arctic that are socially or environmentally sensitive to icebreaking activities, inaccessible to a ship of this size, or located far from the ship.

Two of the helicopters will be equipped to operate under Instrument Flight Rules and will be able to fly year-round and in all weather conditions. These aircraft will be able to deploy safely to distant locations and carry up to 30 passengers, depending on the aircraft selected. The third helicopter will be similar to those now in service with other CCG ships, and will provide close support services during daylight, when Visual Flight Rules apply.

The all-weather capability of the aircraft will allow the helicopters to fly at appropriate altitudes regardless of the weather, enabling flight operations to be conducted in a manner that will minimize disturbance to wildlife or communities.

The mission of the helicopters is to satisfy the resupply and personnel transfer requirements of the ship, to provide a fast and effective pollution detection and response capability, and to support Polar 8 involvement in Search and Rescue, emergency response, scientific research, sovereignty, and reconnaissance operations. The mission also includes the provision of a visible presence for the Canadian government in areas of the Arctic that are inaccessible to the ship. In addition, the helicopters will provide reconnaissance information utilizing a suite of sensors capable of high resolution detection and the plotting of targets including oil spills, ships, vehicles, people and ice formations.

OPERATING DESCRIPTION

The Polar 8 will possess the capability and endurance to sail in severe ice-infested waters, during all seasons, without reliance on other ships for assistance. The ship's primary operating area will be through the Northwest Passage from Baffin Bay to the Beaufort Sea using Parry Channel and the Prince of Wales Strait or M'Clure Strait routes, depending on the circumstances. However, when conditions permit, it is expected that the ship will occasionally travel into the Arctic Ocean and other areas of the Arctic Archipelago.

The Polar 8 is being designed to spend up to four years at a time in the Arctic without returning to a port in southern Canada, and to meet a target of 300 operational days and 65 days of self-maintenance per year. It will be outfitted with provisions for up to 270 days of operations except for fuel and perishable supplies. When not actively carrying out operational programs, the ship normally will be stationed in Viscount Melville Sound near the south coast of Melville Island.

During the first two years of operations, the ship will conduct Proof of Performance Trials to demonstrate and prove the ship's full capability. The ship will also conduct operations of national and scientific interest throughout the Arctic, which may include mid-winter demonstration transits of the Northwest Passage in both directions via both Prince of Wales Strait and M'Clure Strait, and circumnavigation of the Queen Elizabeth Islands. A demonstration transit of the Arctic Ocean from the Pacific Ocean via the Chukchi Sea and the Greenland Sea to the Atlantic Ocean is also planned, with the objective of passing through the North Pole.

The research conducted will include an environmental assessment of the effects of these voyages. The information collected will be used to determine the limits of future operations in the region.

During subsequent years, distribution of the ship's operational duties will depend on the demand for the ship's time between environmental, scientific, sovereignty, defence, and transportation missions. Although priority will be given to emergency preparedness and response to regional requirements, a significant portion of the available operational time will be allocated to scientific and environmental missions which will be initiated and requested from outside the Coast Guard.

The operations of the Polar 8 will be governed, in part, by a navigational working instrument called an Environmental Pilot. This book will identify environmentally sensitive components of the Arctic that may be placed at risk due to the ship's passage. The ship's master will use this Environmental Pilot to plan and select routes and operational areas for the Polar 8 and its helicopters, launches and vehicles, such that provision is made for safe navigation while respecting environmentally sensitive areas.

PROJECT/ENVIRONMENT INTERACTIONS

This Initial Environmental Evaluation attempts to focus on important issues and questions concerning valued ecosystem components. Valued ecosystem components can include rare or threatened species or habitats, species or habitats that are unique to the area, or are valued for their aesthetic properties, and species that are hunted or fished by local populations. The culture and lifestyle of native peoples inhabiting the Polar 8's operational area are also valued ecosystem components. Potential interactions between the project and the environment are identified in a Level 1 Matrix, shown in Figure E.1. The matrix only lists possible interactions, making no assumptions about the probable impacts of those interactions.

EFFECTS OF NORMAL OPERATIONS

Discharges

The ship is designed so that no untreated grey or black water will be discharged overboard. Garbage will be incinerated, residues will be transferred to a resupply ship or stored for later disposal ashore and all oily wastes will be held in sludge tanks and incinerated from time to time. The main engines will burn high grade diesel fuel, thus, emissions will be clean relative to those of ships that burn heavy

Figure E.1
INTERACTION (LEVEL 1) MATRIX SHOWING POSSIBLE INTERACTIONS BETWEEN THE PROJECT AND THE ENVIRONMENT.

Environmental Components	Project Activities													
	Discharges					Operations					Accidents		Infrastructure	
	Grey Water	Garbage	Oily Waste	Exhaust Fumes	Ballast Water	Open Water	Ice Breaking	Helicopter Flights	On-Ice Vehicles	Small Boats	Oil Spill	Other Spills	Empl-oyment	Purch-asing
Physical/Chemical Effects														
Integrity of the Ice Sheet							X							
Premature Breakup							X							
Lead Formation							X							
Lead Refreezing							X							
Air Quality				X										
Water Quality	X	X			X						X	X		
Ecological Effects														
Lower Trophic Levels														
Plankton	X				X		X				X	X		
Benthos											X	X		
Underice Biota	X						X				X	X		
Fish							X				X	X		
Birds														
Northern Fulmar		X	X			X	X	X	X	X	X	X		
Waterfowl			X			X	X	X		X	X	X		
Shorebirds			X			X	X	X		X	X	X		
Black-legged Kittiwake			X			X	X	X	X	X	X	X		
Other Gulls, Terns, Jaegers		X	X			X	X	X		X	X	X		
Thick-billed Murre			X			X	X	X	X	X	X	X		
Black Guillemot			X			X	X	X		X	X	X		
Dovekie			X			X	X	X		X	X	X		
Marine Mammals														
Ringed Seal						X	X	X		X	X	X		
Bearded Seal						X		X		X	X	X		
Harp Seal						X		X		X	X	X		
Walrus						X		X		X	X	X		
White Whale						X	X	X		X	X	X		
Narwhal						X	X	X		X	X	X		
Bowhead Whale						X		X		X	X	X		
Polar Bear						X	X	X	X	X	X	X		
Arctic Fox							X	X	X					
Ice Edge Communities							X	X		X	X	X		
Polynya							X	X		X	X	X		
Socio-Economic Effects														
Hunting						X	X	X	X	X	X		X	
Fishing			X								X		X	
On-ice Travel							X							
Employment											X		X	X
Communities											X		X	X

residual fuels. These emissions should have no detectable effects on air quality, water quality, marine life or resource harvesting. The Polar 8 will have no ballast water in its tanks on arrival in the north. Therefore, the possibility of contamination by water taken from the south will be remote.

Icebreaking

Based on observations of other ship's tracks, it seems likely that the expected Polar 8 track width will be 36 to 50 m. The floe size distributions observed in the track of certain other vessels can be considered representative of those that will be produced by the Polar 8. Clusters of larger floes have been noted at narrow points in such ship tracks. Even after multiple transits, highly concentrated areas remain. The frequent occurrence of these concentrated regions has been found to provide ample possibility for track crossing on foot or by snowmobile.

Observation of natural ice edge deterioration indicates that, in most seasons, break-up and the subsequent freeing of confined multi-year ice floes occur annually, but the timing of the event can vary from one year to the next. A potential impact of icebreaking, that has been linked to ice edge break-up, is the subsequent release of previously confined multi-year ice. In areas where the Polar 8 transits might cross critical edges, they could be timed to minimize any potential influence the ship track might have on premature deterioration of the ice edge.

Icebreaking will have a "negligible" effect on phytoplankton and zooplankton since the areas affected by the ship track are so small. (The terms "negligible/minor/moderate", "local/regional", and "short/medium-term" are defined in Section 7.1.3.) The only effect could occur through the premature breakup of a large area of fast ice. Overall, such breakup patterns are unlikely and would probably be marginally positive for plankton.

Most Arctic fish are benthic or bottom feeding forms. The Polar 8's draft will limit normal operations to depths greater than 26 metres. Thus, benthic fish will be unaffected by icebreaking. Most anadromous fish, such as char, do not venture beyond the 5 m contour. Thus, few anadromous fish would be found within depths accessible to the Polar 8. When inhabiting the under surface of the ice in spring, a few individuals of pelagic Arctic cod could be affected by icebreaking.

Sea-associated birds occur throughout Canadian Arctic waters. However, large numbers occur regularly only during the spring, summer and early fall periods in association with areas of open water. In winter, most sea-associated birds

withdraw to more southerly waters associated with the edge of the winter pack ice and ice-free waters farther south. Since the Polar 8 may marginally increase the amount of accessible open water, there may be some incremental benefit to seabird populations. The Coast Guard is committed to ensuring that its activities do not affect major resources such as colonial seabirds. To this end, the Environmental Pilot, identifying important environmental areas, will be prepared before the ship is launched.

In open water situations, marine mammals have little trouble avoiding collisions with oncoming ships. Similarly, polar bears and Arctic foxes that occupy the sea ice have no trouble avoiding slow-moving icebreakers. In ice-covered waters, the situation may be somewhat different for seals since they have few alternate locations where they can breathe. In late March and early April, pregnant female ringed seals give birth to a single pup in lairs hollowed out of snow drifts on the surface of stable ice with relief features that are sufficient to cause accumulation of drifting snow. There is a period of about four weeks after birth during which the Polar 8 could cause some mortality to these ringed seal pups.

There is some concern that ringed seals may abandon the tracks of icebreakers such as the Polar 8. However, observations of other icebreaker tracks suggest that ringed seals may preferentially establish breathing holes in the rough, consolidated ice in the ship's track.

The available evidence suggests that whales will not follow leads created by icebreakers. Icebreaker tracks through fast ice are filled with broken ice rubble and there is virtually no open water in the track. Additionally, except for very late in the spring, the rubble rapidly refreezes creating complete ice cover within a few hours. The evidence indicates that white whales and narwhals take evasive action and avoid close approach by ships in spring. Thus, it is unlikely that whales would follow the Polar 8 closely, as it would be creating underwater noise as it breaks through fast ice.

Effects of Noise and Disturbance

Underwater noise from the Polar 8 will have "negligible" effects on invertebrates. The only fish species that regularly occurs in the deeper waters frequented by the Polar 8, and that is a Valued Ecosystem Component, is the Arctic cod. Overall, the effects of underwater noise from the Polar 8 on Arctic cod are expected to be "negligible".

The normal offshore activities of the Polar 8 are likely to have inconsequential effects on sea-associated birds. Direct effects are unlikely since seabirds are

highly mobile and can easily avoid the ship by flight or by diving. Energy expended in these infrequent evasive movements would be minor and have no effect on the individual's daily energy budget. There is concern that the ship, or its helicopters or accessory vessels, could disturb seabird colonies if operated in the vicinity of colonies. The Environmental Pilot will identify these important areas, so that they can be avoided.

Scientific evidence describing the reactions of seals on pan ice or in open water to vessels is very meagre. Nevertheless, the limited available information, together with data on reactions of seals to most other forms of disturbance, suggests that seals will normally show considerable tolerance to boat and ship activity.

The Environmental Pilot will map the locations of all known terrestrial haulout sites used by walruses in the High Arctic. During the haulout period from 15 July to 15 September, the Polar 8 and its helicopters, consistent with ship, aircraft and human safety, will maintain minimum horizontal distances of 2 km from walrus haulout sites. In addition, the helicopters will normally operate at a minimum altitude of 300 m (1,000 ft) to reduce potential disturbances to walruses and seals hauled out on ice and swimming in open water. An anti-harassment policy will be developed to prevent the helicopters from approaching walruses and other animals too closely for a "better look" or for unofficial photography.

The wide variety of whale responses to ship traffic make it difficult to predict the responses of white whales and narwhals to noise and disturbance from the Polar 8. The expected responses will probably vary with season, habitat and ice conditions. The effects of ship noise and disturbance on whales in open water conditions are likely to be "negligible to minor". Effects on concentrations of whales in leads or along ice edges in the spring could range from "minor to moderate". The frequency and intensity of these effects can be reduced to "negligible to minor" by avoiding areas where whales occur, particularly ice edges. These areas will be indicated in the Environmental Pilot.

All major estuaries used by white whales in July and August are known and will be listed in the Environmental Pilot. The Polar 8 cannot enter these shallow areas and will avoid conducting operations near the entrances to estuaries that are occupied by whales. The ship's helicopters and associated vessels will also avoid these estuaries.

The bowhead whale is the only baleen whale to occur regularly in the Canadian High Arctic and Beaufort Sea. However, the Eastern Arctic population is considered to be endangered and numbers only a few hundred individuals. The

Polar 8 will encounter a few bowheads in open water and loose pack-ice conditions. In some cases, these encounters may cause "short-term, local minor" effects to bowheads. The only regularly occupied concentration area for bowheads in the Eastern Arctic is Isabella Bay along the east coast of Baffin Island. The Polar 8 will not be near this area during the mid August to early October period when the whales are present.

The on-ice travel associated with the Polar 8 (e.g., snowmobiles or Arktos) is expected to have "negligible" effects on bird populations since birds do not use sea ice habitats with complete ice cover. The only concern regarding on-ice travel and birds would occur if the vehicles used coastal fast ice adjacent to major seabird colonies in May and June during the period of colony reoccupancy, egg-laying and early incubation. The limited amount of on-ice travel in pack ice habitat has little potential to affect those mammals occupying leads in the pack ice. Overall, the effects on polar bears and Arctic foxes of on-ice travel by vehicles from the Polar 8 are expected to be "negligible".

The small vessels based on the Polar 8, which are similar to those already in local use, have the potential to disturb marine mammals that are some distance away. This distance will be variable depending on boat type, species involved, ice conditions, propagation conditions, ambient noise levels and so on. There is little concern about small boats disturbing a few sea-associated birds in an open-water situation. However, there is some concern about repeated passages through important coastal concentration areas or near major seabird colonies. The Environmental Pilot will be used to plan routes that avoid these colonies.

Effects on Resource Harvesting

Icebreaking operations could potentially interfere with Inuit hunting activities by causing animals to vacate a hunting area, either permanently or temporarily. Inuit hunters have contended that increased icebreaker activity in the past decade has caused narwhals to permanently abandon their traditional summer range in Admiralty Inlet. Although icebreaker traffic can cause temporary displacement of some species of marine mammals such as narwhals and white whales, there is no clear evidence that vessel traffic *per se* has caused permanent abandonment of their traditional range. It is possible that the Polar 8 could cause changes to distributions of whales that would result in "short-term, local minor to moderate effects" on Inuit resource harvesting. However, with mitigation (routing, Environmental Pilot) effects are expected to be reduced to "minor".

The Polar 8 and its associated activities will normally avoid important hunting areas used by Inuit hunters. These core hunting areas have been identified in

published material, but the Coast Guard proposes to upgrade this material by direct consultation with hunters and the community Hunter's and Trapper's Associations. The areas of importance, the species of concern, the types of hunts, and the timing of hunts will be addressed.

Icebreaker activity could also potentially interfere with Inuit resource harvesting by altering the ice habitat of marine mammals. A major concern would be the potential alteration of fast ice which is occupied by breeding ringed seals. Destabilization of fast ice by icebreakers could potentially change the ice regime over a large region, thereby reducing the productivity of ringed seals, polar bears and, ultimately, the hunting opportunities of the Inuit. Nevertheless, the available evidence suggests that major changes to fast-ice sheets are unlikely to be caused by the Polar 8.

One of the major concerns in some Inuit settlements is that icebreaker traffic will disrupt travel routes to and between hunting grounds, by destabilization of fast ice, and that ship tracks themselves will act as barriers to travel. Information in the literature suggests that ship tracks do not pose a serious problem to over-ice travel except in late spring. At this time of year, Inuit hunters may be delayed in reaching their destination. Although only temporary delays in crossing ship tracks through fast ice are expected, it will be important to minimize the numbers of such delays, particularly in late spring when tracks are slow to refreeze or do not refreeze at all. The consultation process will address this issue and allow the Coast Guard to learn which on-ice travel routes are used and when they are most heavily travelled. If it is necessary for the Polar 8 to occasionally cross one of these routes then communication will be attempted with those affected, and where feasible, Coast Guard will assist in addressing the problem.

A potential concern is that icebreaker traffic will inhibit inter-island movements of caribou and muskoxen, thereby altering distribution patterns and limiting hunter opportunities. Inter-island movements across the Northwest Passage are not common except in Prince of Wales Strait. Two factors suggest that ship tracks may not be barriers. First, the animals must cross many naturally-occurring pressure ridges and areas of rough ice that could be more difficult to penetrate than a refrozen ship track. Second, the refrozen ship track is not likely to be uniformly rough. Some sections are likely to be relatively smooth, particularly as snow drifts across the rubble.

Socio-Cultural Effects

With the exception of Inuvik and Nanisivik, residents of the region depend on the resources of the land and sea. The use of country food and clothing from marine

and terrestrial animals is not only of high economic value to the communities but is the fabric of the social and cultural tradition of the communities. The Polar 8 will have few effects on mammal and bird distributions, and the IEE concludes that these effects would translate into an occasional "short-term minor" effect on local hunted populations. These rare events are not likely to cause anything but "negligible" effects on the overall nutritional health of communities or individuals.

Worker shift rotation and resupply of the Polar 8 could provide an opportunity for drugs and alcohol to move into northern communities. However, there will be very limited opportunities for interactions between local residents and Coast Guard personnel since none of the Inuit communities has port facilities that can be used by the Polar 8. To ensure that problems do not occur, Coast Guard will institute appropriate policies for its personnel, after consultation with the communities.

The Archaeological Survey records some 300 sites of historical and/or archaeological significance in the Lancaster Sound region alone. Many of the sites are traditional seasonal camping areas, while others are permanent camp sites. The value of preserving these areas is important to regional residents as there are often burial sites associated with the camps. The Polar 8 itself will not affect any archaeological or historical sites. The locations of known sites will be mapped in the Environmental Pilot and helicopters and small boat crews will be instructed not to disturb these sites.

Socio-Economic Effects

At present, it is not clear what employment benefits might flow to natives and other northerners from the Polar 8 project. There may be employment and income opportunities from the operations of the Polar 8, its attendant vehicles, and associated research programs. The regular operations positions on board the ship require levels of training that Northerners rarely undertake. Coast Guard Northern is committed to a consultation process with northern communities and an important part of this process will be to optimize northern employment consistent with Coast Guard's requirement for skilled personnel and the desires, if any, of Northerners for positions on the Polar 8.

The ship could result in increased business opportunities for local, regional and territorial business. The opportunity exists for the purchase of a range of goods and services from Northwest Passage regional communities. As planning for the Polar 8 proceeds, consultation with communities and local businesses will occur with a view to establishing policies that will provide northern benefits.

EFFECTS OF ACCIDENTS

The Polar 8 will use diesel oil (number 2 fuel) to power its engines. It will carry 13,000 tonnes of diesel fuel, about 875 tonnes of Jet fuel (similar to kerosene) for its helicopters and 455 tonnes of lubricating oil. An oil spill is very unlikely because the ship has been designed to exceed the structural strength requirements of the Arctic Shipping Pollution Prevention Regulations and, unlike its predecessors, will have high strength and high ductility steels throughout the critical areas of the hull. The ship's design takes into consideration the substantial body of structural performance data which has been built up over the last ten years. Any damage which does occur is likely to be localized dents that do not penetrate the outer hull. The ship will have a second hull between the fuel and the outer hull, and the fuel will be carried in 21 separate tanks. This inner hull will be between 1.8 and 4 metres from the outer hull. Along the bottom of the ship, the inner hull will be at least 3 metres from the outer hull. The spaces between inner and outer hulls will contain either void spaces (no contents) or ballast spaces which will either be empty or will contain sea water.

Coast Guard has recently commissioned a study to assess current icebreaker refuelling and fuel transfer practices and procedures. The study will also examine the Arctic Sealift delivery and transfer operations. This study will provide alternatives for remedial action so that Coast Guard activities will comply with current and planned legislation. The purpose of the study is to ensure that fuel handling procedures pose minimal risk to the environment. The results will be applicable to the Polar 8.

The methods of delivering fuel for the Polar 8 to the Arctic have not been finalized. Options include: leaving the region to obtain fuel, standard summer delivery to shore-based fuel storage tanks and/or the use of an ice-capable resupply ship that will transfer fuel directly to the Polar 8. A study will be conducted to determine the feasibility, cost effectiveness and environmental risks of the options and an environmentally acceptable alternative will be chosen. The results of the study will be available for review by interested parties.

Coast Guard is presently upgrading its Emergencies Plan which governs its reaction to pollution events. In addition, the Polar 8 will have its own oil spill response plan. The ship will carry in excess of $4.5 million in pollution control equipment, including state-of-the-art equipment for oil spill cleanup, and trained personnel will be prepared to respond immediately to any oil spill in the High Arctic.

Nevertheless, even though an oil spill is unlikely, it is possible. The consequences to the environment of an oil spill have been reviewed and the following conclusions drawn:

- Laboratory studies have shown that benthic animals, zooplankton, phytoplankton, and microbes can be killed or suffer serious sublethal effects when exposed to oil. However, because of their natural variability, it is almost impossible to detect effects of an open water accidental spill on these animals. The literature on oil spills shows that the largest possible spill that could result from the Polar 8 is unlikely to show detectable effects on lower trophic levels in open water.

- Anadromous fish do not venture far from shore and large numbers are unlikely to suffer direct mortality from the concentrations of oil that would reach the shoreline. Arctic cod, their eggs and larvae could contact spilled oil in the pelagic environment. Some mortality of cod could be expected in open water. In most cases, cod are widely dispersed and a spill would have negligible impact on populations.

- Seals and whales that are not under natural stress (e.g. starvation) would most likely survive oiling. Stressed animals or those exposed to heavy doses of diesel oil for prolonged periods of time could die. Polar bears are most vulnerable to contact with oil, but few individuals are likely to be exposed to any particular spill. Thus, effects on bears are likely, after mitigation, to be "negligible to minor" on a local scale.

- Seabirds rely on air trapped within and between feathers for insulation. Oil mats the feathers and destroys their insulative and water repellency properties. The underlying skin becomes wet, and the birds cannot compensate for the heat loss. In cold water, oiled birds die. In a worst case scenario with a worst-case spill location and worst-case wind conditions, it is possible that an accidental spill could have a "long-term, major regional impact" at a key colony in Lancaster Sound. However, the probability of such an event is so low that it is barely credible. If a spill occurs it is much more likely to have "medium-term moderate[1] effects" on "local" populations of sea-associated birds.

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[1]When the extremely low risk of an oil spill is considered, this impact rating becomes "negligible to minor".

The Polar 8 will carry a variety of other materials that could be hazardous to the environment. These materials include paint, cleansing agents, degreasing agents, deicing agents, and all of the numerous other materials necessary for the operation of a power plant and a self-contained community of up to 154 individuals. After use, this material will be stored and either incinerated or transferred to a resupply ship for disposal in the South. None of this material will be thrown over the side.

IMPACT SUMMARY

A summary of the impacts that could be caused by the possible project/environment interactions is provided in Figure E.2. Most impacts, after mitigation, are predicted to be negligible, although some minor disturbance effects on white whales and narwhals in open water could occur and these impacts could have a minor effect on the hunt of these animals. Socio-economic effects on the community infrastructure are evaluated in a slightly different way. Potential effects are evaluated in a more subjective manner that assumes that the mitigation measure of "consultation" is effectively pursued by Coast Guard and the potentially affected communities.

Most impacts can be mitigated by avoiding sensitive times and areas. The specifics of these measures will be described in the Environmental Pilot to be prepared before the Polar 8 becomes operational. Consistent with ship safety and human safety, the Environmental Pilot will guide ship operations in all but emergency situations.

MONITORING

The purposes of monitoring are: (1) to test hypotheses related to the impact predictions made in this IEE and to verify the efficacy of mitigation measures, (2) to develop the capability to predict impacts for other projects, and (3) to improve environmental protection and mitigation for future projects related to the Polar 8. Detailed monitoring programs have not yet been formulated for the Polar 8 project because the design of such projects should have input from those who might be affected and from those scientists with relevant experience. In general, monitoring will test the predictions contained in this IEE, namely, that the Polar 8 will have a minimal effect on the environment. Research programs will monitor the effect of the Polar 8 during both normal and experimental operations.

Figure E.2
IMPACT SUMMARY.

Project Activity/ Environmental Component	Season[1]	Habitat	Interaction/Effect	Before Mitigation Magnitude	(±)	Scale	Mitigation[3]	After Mitigation Magnitude	Scale	Text Reference
Grey/Black Water										
Lower Trophic Levels	All	All	Contamination	Negligible						8.1.1
Birds and Mammals	All	All	Contamination	Negligible						8.1.1
Garbage										
All	All	All	Contamination	Negligible						8.1.2
Oily Waste/Sludge										
All	All	All	Contamination	Negligible						8.1.3
Exhaust Fumes										
All	All	All	Contamination	Negligible						8.1.4
Ballast Water										
All	All	All	Contamination	Negligible						8.1.5
Icebreaking										
Ice Sheet	W	Fast Ice	Integrity of Tracks	Negligible						8.2.1
Plankton	F-W-Sp	Fast Ice	Premature Breakup	Negligible						8.2.4.1
Arctic Cod	F-W-Sp	Fast Ice	Mortality	Negligible						8.2.4.2
Underice Biota	Sp	Fast Ice	Loss of Habitat	Negligible						8.2.4.3
Birds	Sp	Fast Ice	Ice-Edge Changes	Negligible						8.2.5.1
Birds	Sp	Fast Ice	Premature Breakup	Negligible						8.2.5.2
Birds	Sp	Fast Ice	Creation of Open Water	Negligible						8.2.5.1
Ringed seal pups	Sp	Fast Ice	Death by Immersion	Minor	-	Local	Pilot	Negligible		8.2.6.1
Ringed Seal	F-W-Sp	Fast Ice	Disturbance	Negligible						8.2.6.2
Ringed Seal	F-W-Sp	Pack Ice	Disturbance	Negligible						8.2.6.2
Whales	Sp	Ice Edge	Entrapment in Leads	Negligible						8.2.6.3
Ice Edge Community	Sp	Ice Edge	Disturbance	Negligible						8.2.7
Ice Edge Community	Sp	Ice Edge	Premature Breakup	Negligible						8.2.7
Birds and Mammals	F-W-Sp	Polynyas	Disturbance	Negligible						8.2.8
On-Ice Travel for Hunt	F-W-Sp	Fast Ice	Disruption of Harvest	Minor	-	Local				8.5.3
Ringed seal Hunting	W-Sp	Fast Ice	Improved Habitat	Negl.- Minor	+	Local				8.5.2
Hunting	Sp	Ice Edge	Disruption of Harvest	Negligible						8.5.3
Caribou/Muskoxen	W	Fast Ice	Disruption of Movements	Negl.-Minor	-	Local				8.5.4
Nutritional Health	All	Communities	Disruption of Harvest	Negligible						8.6.1.1
Ship Movement										
Marine Mammals	All	Open Water	Collision	Negligible						8.2.6.1
Polar Bears	F-W-Sp	Fast Ice	Collision	Negligible						8.2.6.1
Murres	F	Open Water	Crushing	Negligible						8.2.6.1
Arctic Cod	F-W-Sp	Under Ice	Noise/Disturbance	Negligible						8.3.2
Birds	Sp-Su-F	Open Water	Noise/Disturbance	Negligible						8.3.3
Birds	Sp-Su-F	Colonies	Noise/Disturbance	Moderate	-	Local	Pilot	Negligible		8.3.3
Walrus	Su	Open Water	Noise/Disturbance	Minor	-	Local	Pilot	Negligible		8.3.4.1
Seals	All	Open Water	Noise/Disturbance	Negligible						8.3.4.1
White Whale/Narwhal	All	Open Water	Noise/Disturbance	Negl.-Minor	-	Local	None	Negl.-Minor	Local	8.3.4.2
White Whale/Narwhal	Sp	Ice Edge	Noise/Disturbance	Minor-Mod.	-	Local	Pilot	Negl.-Minor	Local	8.3.4.2
White Whale	Su	Estuaries	Noise/Disturbance	Minor-Major	-	Local	Pilot	Negligible		8.3.4.2
Bowhead Whale	Sp-Su-F	Open Water	Noise/Disturbance	Minor		Local				8.3.4.3

[1] Su = summer, F = Fall, W = Winter, and Sp = spring.
[2] See Section 7.1.3 for definitions of impact levels.
[3] Pilot means Environmental Pilot.

Figure E.2
CONTINUED.

Project Activity/ Environmental Component	Season[1]	Habitat	Interaction/Effect	Before Mitigation Magnitude[2]	(±)	Scale	Mitigation	After Mitigation Magnitude	Scale	Text Reference
Whale Hunt	Sp	Ice Edge	Displacement	Minor-Mod	-	Local	Pilot	Minor	Local	8.5.1
Helicopter Flights										
Birds	Sp-Su-F	Open Water	Noise/Disturbance	Negligible			Pilot	Negligible		8.4.1.1
Birds	Sp-Su-F	Colonies	Noise/Disturbance	Minor-Mod	-	Local	Pilot	Negligible		8.4.1.1
Seals	F-W-Sp	Fast Ice	Noise/Disturbance	Negl.-Minor		Local	Altitude	Negligible		8.4.1.2
Walrus	Su	Haul-outs	Noise/Disturbance	Minor	-	Local	Pilot	Negligible		8.4.1.2
Harp Seal	Su	Open water	Noise/Disturbance	Negligible						8.4.1.2
Polar Bear/Arctic Fox	F-W-Sp	Fast Ice	Noise/Disturbance	Negl.-Minor	-	Local	Altitude	Negligible		8.4.1.2
White Whale	Su	Estuaries	Noise/Disturbance	Minor-Mod.	-	Local	Pilot	Negligible		8.4.1.2
Whales	All	Open Water	Noise/Disturbance	Negl.-Minor	-	Local	Pilot	Negligible		8.4.1.2
Bowhead	All	Open Water	Noise/Disturbance	Negl.-Minor	-	Local	Altitude	Negligible		8.4.1.2
Polar Bear Hunt	W-Sp	Fast Ice	Displacement	Negligible						8.5.1
Seal Hunt	All	All	Displacement	Negl.-Minor	-	Local	Altitude	Negl.-Minor	Local	8.5.1
Whale Hunt	Sp-Su	All	Displacement	Negl.-Minor	-	Local	Pilot	Negligible		8.5.1
On Ice Vehicles										
Birds	Sp	Colonies	Noise/Disturbance	Minor	-	Local	Pilot	Negligible		8.4.2.1
Ringed Seal	F-W	Fast Ice	Noise/Disturbance	Negligible						8.4.2.2
Ringed Seal	Sp	Fast Ice	Noise/Disturbance	Negl.-Minor	-	Local	None	Negl.-Minor	Local	8.4.2.2
Small Vessels										
Birds	Sp-Su-F	Colonies	Noise/Disturbance	Minor-Mod.	-	Local	Pilot	Negligible		8.4.3.1
Bird Concentrations	F	Nearshore	Noise/Disturbance	Minor	-	Local	Pilot	Negligible		8.4.3.1
Mammals	Sp-Su-F	Open Water	Noise/Disturbance	Negl.-Mod.	-	Local	Pilot	Negligible		8.4.3.2
Oil Spill										
Plankton	All	Open Water	Lethal and Sublethal	Negligible						9.1.3.1
Benthos	All	Open Water	Lethal and Sublethal	Negligible						9.1.3.1
Benthos	All	Bay/Inlet	Lethal and Sublethal	Minor-Mod.	-	Local	Clean-up	Minor	Local	9.1.3.1
Fishery for Char	Su	Nearshore	Tainting	Minor-Maj.	-	Local	No Su Ops	Negligible		9.1.3.2
Benthic Fish	All	Bay/Inlet	Lethal and Sublethal	Minor	-	Local	Clean-up	Negligible		9.1.3.2
Arctic Cod	All	Open Water	Lethal and Sublethal	Negligible						9.1.3.2
Concentrations of Cod	All	Open water	Lethal and Sublethal	Minor-Mod.	-	Local	Clean-up	Minor ?	Local	9.1.3.2
Polar Bears/Young Seals	All	All	Lethal and Sublethal	Minor-Mod.	-	Local	Clean-up	Negl.-Minor?	Local	9.1.3.3
Seals/Whales	All	All	Lethal and Sublethal	Negligible						9.1.3.3
Birds	All	All	Lethal and Sublethal	Mod.-Maj.	-	Regional	Pilot	Moderate? [4]	Local?	9.1.3.4
Other Spills										
All	All	All	All	Negligible						9.2
Infrastructure										
Substance Abuse		Communities	Increased Availability	Neutral			Consultation			8.6.1.2
Local Customs		Communities	Erosion by Employment	Neutral			Consultation			8.6.1.3
Archaeological Sites		Many Sites	Damage	Negligible			Pilot			8.6.1.4
Employment		Communities	Increased Opportunity	Positive			Consultation			8.6.2.1
Northern Business		Communities	Increased Opportunity	Positive			Consultation			8.6.2.2

[1] Su = summer, F = Fall, W = Winter, and Sp = spring.
[2] See Section 7.1.3 for definitions of impact levels.
[3] Pilot means Environmental Pilot.
[4] When the extremely low risk of an oil spill is considered, this impact rating becomes negligible to minor.

CONSULTATION

The Polar 8 proposal is the culmination of a series of earlier ship designs, involving different sizes and propulsion systems. Through the years, as the project moved from the conceptual stage through the variations in power and size, presentations on the program were made several times a year to all interested audiences. Articles were written for the general public, technical papers were presented and informal updates given at every appropriate opportunity. Presentations were given to northern audiences, typically at Committee meetings of the groups dealing with northern transportation matters. During the 1970s and early 1980s, the plans were greeted with interest and with no particular concern. As those were the days when many projects were under development involving hydrocarbon and mineral shipments, some involving Arctic Class 10 tankers, the Polar icebreaker raised no concerns on its own. Instead, many important environmental hearings and reviews supported the construction of a large Coast Guard icebreaker.

In recent years, the Coast Guard has continued its efforts to advise Northerners about the Polar 8 and to gather their views, through organizations such as the Environmental Advisory Committee on Arctic Marine Transportation, through the Eastern Arctic Sealift conferences and through visits made to Arctic communities. Northerners' questions generally reflected environmental issues, such as the effects of noise on marine mammals and their concern for seal pups and ice camps during icebreaking operations.

The most generally stated concern was that the Polar 8 should not be deployed near communities during the spring when most hunting is done on the ice, and when the ship's track would not refreeze quickly, if at all. There were also frequent questions such as where and when the ship would operate, whether Northerners would be informed in advance of the ship entering their area, and what jobs and training would be available for Northerners who want to work on the ship.

In all of these meetings, the Coast Guard stressed its intention to minimize the negative effects of the Polar 8 on northern residents, and that the consultation process was seen to be an integral part of this commitment.

This Initial Environmental Evaluation is being distributed to a variety of federal and territorial agencies, public interest groups and native groups. Coast Guard Northern will visit the key communities to explain the project, answer questions and discuss local concerns. Future meetings will be held to obtain information from native resource users on animal concentration areas, important hunting

areas and on-ice travel routes. The meetings will also address the planning of procedures to be used during operations, and will discuss employment of Northerners and business opportunities for northern suppliers.

During the operational life of the Polar 8, the Coast Guard will hold regular meetings with the relevant communities. These meetings will be held to discuss the operational plans for the upcoming year and problems or concerns that arose during the previous year. In addition, the Northern Liaison Officer will work with the communities on behalf of Coast Guard Northern to ensure that their concerns and problems are communicated to the Coast Guard, and that mutually beneficial solutions are developed.

CONCLUSIONS

It is clear that there will be few adverse impacts on the environment, or on the socio-cultural or socio-economic life of northerners from the operation of the Polar 8. Those few adverse impacts which may occur will be very minor and will be mitigated by appropriate Coast Guard policies with respect to the routing of the ship and the use of its equipment. To offset these few adverse impacts there will be many benefits, both for the Government of Canada and for the northern communities.

Canada's claim to sovereignty over the Arctic archipelago will be greatly enhanced, the potential to carry out year-round research of the interaction between the ship and the environment will be established, and the Coast Guard's services in the North will be vastly improved.

To ensure that these benefits are achieved without a significant negative impact on the environment or culture of the north, the Coast Guard is committed to a process of consultation with northern communities and to the preparation of a document called an Environmental Pilot which will guide the ship's officers in avoiding important environmental and resource harvesting areas.

In conclusion, no significant adverse effects have been identified through this Initial Environmental Evaluation. A number of potential minor effects have been identified, and appropriate mitigating measures have been outlined including a monitoring program. Based on determination criteria 12(c) of the Environmental Assessment and Review Process Guidelines SOR/84-46, it is concluded that the project, along with its mitigation measures, may proceed.

CHAPTER 1

INTRODUCTION

In late 1985, the Government of Canada announced its decision to design and construct a Polar 8 icebreaker to serve as a guardian of Canadian sovereignty in Arctic waters, to assist in the protection of the environment, to serve as an emergency services facility for Northern people, and to assist in the long-term planning and development of Arctic resources.

Subject to final reviews and funding, the Canadian Coast Guard (CCG) is now poised to enter the construction phase of this vessel which will represent the leading edge of icebreaker technology, and provide Canada with an unsurpassed marine capability to serve the Arctic.

The ship (see Figure 1.1.1) will provide a substantial increase in the Canadian Coast Guard's ability to deal with pollution and other emergencies in Arctic waters. It will possess the capability and endurance to sail in severe ice-infested waters, during all seasons, without reliance on other ships for assistance. It will be outfitted with extensive stores and provisions to allow the ship to operate for up to 270 days without resupply, other than fuel and perishables.

A name for the ship will be chosen during the construction phase. In the meantime it will be referred to simply as the Polar 8.

1.1 OVERVIEW

This report contains the results of an Initial Environmental Evaluation (IEE) conducted by CCG to determine the potential environmental impacts which may arise from the operation of the Polar 8. It forms part of the Environmental Assessment and Review Process which came into effect in 1977. This study has been conducted in compliance with the guidelines established by the Federal Environmental Assessment Review Office.

The environmental issues addressed in this study were identified through prior consultations between the Coast Guard and interested environmental and community groups over the past 15 years, and through a review of similar environmental assessments carried out previously, such as the Beaufort Sea/

Figure 1.1.1
POLAR 8 ICEBREAKER

Mackenzie Delta, the Arctic Pilot Project and the Lancaster Sound Region development plans.

The evaluations in this study were based on available research data, on past experience and on the opinions of leading experts in a wide range of fields.

The environmental assessment for the Polar 8 differs from others that have been done in the past, in that it concerns a ship that will be capable of transiting to all regions in the Arctic. Hence, many of the environmental issues are not site specific. It should be noted that in cases where the potential environmental impacts in any specific area are considered to be unacceptable, the Coast Guard could prevent these impacts by not operating in that area.

The remainder of this chapter provides a review of historical events that led to the decision to build the Polar 8 icebreaker and to the development of its current design. Chapters 2 to 6 provide a description of the ship and current plans for its operation. Chapters 7 to 11 describe the potential environmental impacts and the extent to which these can be mitigated, while Chapters 12 and 13 look at the ongoing monitoring role for the ship and summarize the benefits. Chapter 14 presents the results of consultations with government officials, environmental groups and representatives of the Arctic community over the past 15 years. The conclusions of this report are presented in the final chapter.

1.2 BACKGROUND

Support of Arctic operations has been a role of the Department of Transport, under earlier names and organizational structures, for over 100 years. During that time, the marine role has evolved to include icebreaking assistance to cargo vessels, the placement and maintenance of aids to navigation, the operation of communication services, support to the Arctic Sealift and Arctic science programs, pollution prevention, Search and Rescue services and marine regulation enforcement. Until the late 1960s, the seasonal capability of the Canadian Coast Guard vessels was considered an adequate means of reaffirming Canadian sovereignty in the north, and providing the required services to the region.

Environmental studies conducted during the 1970s and early 1980s strongly recommended that the federal government build an Arctic Class ship to provide a year-round research, pollution control, and vessel escort capability in the region, as a prerequisite to further development of Arctic resources. These environmental studies were unanimous in their recommendations that the Coast Guard be able to carry out research and development programs in advance of

Arctic resource development and shipping activities, to ensure that their potential environmental impacts can be predicted.

Additionally, the final report of the Environmental Assessment Panel - Beaufort Sea Hydrocarbon Production and Transportation (July, 1984) specifically recommended that "A polar icebreaker of at least Arctic Class 8 specification should be built immediately." The latter recommendation was based on the need for a mobile, self-contained platform to conduct year-round research activities, and the requirement to have a highly capable emergency response and escort vessel which would be able to assist ships experiencing difficulty in icefield navigation, or installations experiencing emergencies beyond the operator's ability to control.

Recommendations from past studies and environmental assessments are discussed further in Appendix B.

Out of concern for Arctic sovereignty and environmental protection, the Canadian government, in 1970, created the Arctic Waters Pollution Prevention Act (AWPPA), from which the Arctic Waters Pollution Prevention Regulations (AWPPR) and the Arctic Shipping Pollution Prevention Regulations (ASPPR) have since been developed.

The ASPPR established procedures and rules for the conduct of Arctic shipping activities and pollution prevention, divided the Arctic into 16 shipping zones based on the severity of the ice regime in the area, and established design and safety regulations for the construction of vessels travelling in those areas. (See Figures 1.2.1 and 1.2.2.) A standard for classifying ships in terms of their ability to operate in ice-infested waters is included in the regulations, covering both special purpose, "Arctic Class" ships, and a standard of equivalency for "Arctic Type" ships.

Although Canada has developed these regulations for pollution prevention standards, the ability of this country to enforce these regulations is contingent upon other nations recognizing Canada's claim that the waters of the Arctic Archipelago are internal Canadian waters.

To date, the United States has taken the position that the Northwest Passage is an international strait and has made a formal protest against the AWPPA. To demonstrate its position, in 1985 the United States Coast Guard icebreaker, the Polar Sea, transited the Northwest Passage without first requesting Canadian authorization. While subsequent voyages of U.S. icebreakers have been made

Figure 1.2.1
CANADIAN ARCTIC SHIPPING SAFETY CONTROL ZONES

Figure 1.2.2
CANADIAN ARCTIC SHIPPING SAFETY CONTROL ZONES TABLE

Item	Category	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16
1.	Arctic Class 10	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
2.	Arctic Class 8	July 1 to Oct 15	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
3.	Arctic Class 7	Aug. 1 to Sept. 30	Aug. 1 to Nov. 30	July 1 to Dec. 31	July 1 to Dec. 15	July 1 to Dec. 15	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
4.	Arctic Class 6	Aug. 15 to Sept. 15	Aug. 1 to Oct. 31	July 15 to Nov. 30	July 15 to Nov. 30	Aug. 1 to Oct. 15	July 15 to Feb. 28	July 1 to Mar. 31	July 1 to Mar. 31	All Year	All Year	July 1 to Mar. 31	All Year	All Year	All Year	All Year	All Year
5.	Arctic Class 4	Aug. 15 to Sept. 15	Aug. 15 to Oct. 15	July 15 to Oct. 31	July 15 to Nov. 15	Aug. 15 to Sept. 30	July 20 to Dec. 31	July 15 to Jan. 15	July 15 to Jan. 15	July 10 to Mar. 31	July 10 to Feb. 28	July 5 to Jan. 15	June 1 to Jan. 31	June 1 to Feb. 15	June 15 to Feb. 15	June 15 to Mar. 15	June 1 to Feb. 15
6.	Arctic Class 3	Aug. 20 to Sept. 15	Aug. 20 to Sept. 30	July 25 to Oct. 15	July 20 to Nov. 5	Aug. 20 to Sept. 25	Aug. 1 to Nov. 30	July 20 to Dec. 15	July 20 to Dec. 31	July 20 to Jan. 20	July 15 to Jan. 25	July 5 to Dec. 15	June 10 to Dec. 31	June 10 to Dec. 31	June 20 to Jan. 10	June 20 to Jan. 31	June 5 to Jan. 10
7.	Arctic Class 2	No Entry	No Entry	Aug. 15 to Sept. 30	Aug. 1 to Oct. 31	No Entry	Aug. 15 to Nov. 20	Aug. 1 to Nov. 20	Aug. 1 to Nov. 30	Aug. 1 to Dec. 20	July 25 to Dec. 20	July 10 to Nov. 20	June 15 to Dec. 5	June 25 to Nov. 22	June 25 to Dec. 10	June 25 to Dec. 20	June 10 to Dec. 10
8.	Arctic Class 1A	No Entry	No Entry	Aug. 20 to Sept. 15	Aug. 20 to Sept. 30	No Entry	Aug. 25 to Oct. 31	Aug. 10 to Nov. 5	Aug. 10 to Nov. 20	Aug. 10 to Dec. 10	Aug. 1 to Dec. 10	July 15 to Nov. 10	July 1 to Nov. 10	July 15 to Oct. 31	July 1 to Nov. 30	July 1 to Dec. 10	June 20 to Nov. 30
9.	Arctic Class 1	No Entry	No Entry	No Entry	No Entry	No Entry	Aug. 25 to Sept. 30	Aug. 10 to Oct. 15	Aug. 10 to Oct. 31	Aug. 10 to Oct. 31	Aug. 1 to Oct. 31	July 15 to Oct. 20	July 1 to Oct. 31	July 15 to Oct. 15	July 1 to Nov. 30	July 1 to Nov. 30	June 20 to Nov. 15
10.	Type A	No Entry	No Entry	Aug. 20 to Sept. 10	Aug. 20 to Sept. 20	No Entry	Aug. 15 to Oct. 15	Aug. 1 to Oct. 25	Aug. 1 to Nov. 10	Aug. 1 to Nov. 20	July 25 to Nov. 20	July 10 to Oct. 31	June 15 to Nov. 10	June 25 to Oct. 22	June 25 to Nov. 30	June 25 to Dec. 5	June 20 to Nov. 20
11.	Type B	No Entry	No Entry	Aug. 20 to Sept. 5	Aug. 20 to Sept. 15	No Entry	Aug. 25 to Sept. 30	Aug. 10 to Oct. 15	Aug. 10 to Oct. 31	Aug. 10 to Oct. 31	Aug. 1 to Oct. 31	July 15 to Oct. 20	July 1 to Oct. 25	July 15 to Oct. 15	July 1 to Nov. 30	July 1 to Nov. 30	June 20 to Nov. 10
12.	Type C	No Entry	No Entry	No Entry	No Entry	No Entry	Aug. 25 to Sept. 25	Aug. 10 to Oct. 10	Aug. 10 to Oct. 25	Aug. 10 to Oct. 25	Aug. 1 to Oct. 25	July 15 to Oct. 15	July 1 to Oct. 25	July 15 to Oct. 10	July1 to Nov. 25	July 1 to Nov. 25	June 20 to Nov. 10
13.	Type D	No Entry	No Entry	No Entry	No Entry	No Entry	No Entry	Aug. 10 to Oct. 5	Aug. 15 to Oct. 20	Aug. 15 to Oct. 20	Aug. 5 to Oct. 20	July 15 to Oct. 10	July 1 to Oct. 20	July30 to Sept. 30	July 10 to Nov. 10	July 5 to Nov. 10	July 1 to Oct. 31
14.	Type E	No Entry	No Entry	No Entry	No Entry	No Entry	No Entry	Aug. 10 to Sept. 30	Aug. 20 to Oct. 20	Aug. 20 to Oct. 15	Aug. 10 to Oct. 20	July 15 to Sept. 30	July 1 to Oct. 20	Aug. 15 to Sept. 20	July 20 to Oct. 31	July 20 to Nov. 5	July 1 to Oct.31

under a Canadian/U.S. agreement on icebreaker transits, the United States does not support Canada's position on the status of the Northwest Passage and the internal waters of the Arctic. The Secretary of State for External Affairs continues, therefore, to support the need for the Polar 8 as the ship that affirms Canada's sovereignty position. If the American position that the Northwest Passage is an international strait were to be upheld, then it becomes questionable as to whether Canada can enforce the AWPPA on foreign shipping, such as oil tankers from the Alaskan side of the Beaufort Sea.

One of the requirements for any country to establish a claim to historic waters is to demonstrate that the country exercises an effective control over the maritime area being claimed. As noted by Pharand, "The claiming state must be able to show that it took whatever action was necessary to assert and maintain its exclusive authority over the area in question" (Pharand 1989).

At present, both the United States and the Soviet Union possess icebreakers which are larger than the current largest Canadian icebreaker, the Louis St. Laurent. If an emergency, ship breakdown or a Search and Rescue incident occurred in Arctic waters, and a foreign icebreaker had to respond due to lack of a capable Canadian icebreaker, this would weaken Canada's claim to Arctic sovereignty. The construction of the Polar 8 icebreaker is considered to be of significant strategic importance in establishing Canada's claim over Arctic waters, as this vessel would confirm Canada's presence and capacity for control of these waters.

Following the transit of the Northwest Passage by the United States Coast Guard icebreaker, the Polar Sea, the Secretary of State for External Affairs, Mr. Joe Clark, announced in the House of Commons on Sept. 10, 1985, that Canada had established baselines to define the area of the Arctic waters over which Canada would exercise pollution control and sovereignty and, furthermore, that an Arctic Class 8 icebreaker would be built to ensure environmental protection, serve as a scientific research platform, and enforce Canada's sovereignty in the region.

In December 1986, the Secretary of State for Foreign Affairs presented a Northern Foreign Policy which contained four major themes:

- affirming Canadian sovereignty;
- modernizing Canada's northern defences;
- preparing for commercial use of the Northwest Passage; and
- promoting enhanced circumpolar cooperation.

The policy statement concluded that the government had decided to acquire a Polar 8 icebreaker because the ship "would give Canada a substantially increased capacity to exercise effective control over these (Arctic) waters"; and, furthermore, that the ship would support the "long-term vision and planning" required to ensure "our ability to protect the natural environment and Arctic marine wildlife, and our responsibility to safeguard the interests of Canadian Inuit."

1.3 EVOLUTION OF THE POLAR 8

The initiative to design and build a Polar class icebreaker to patrol Canada's Arctic waters year round began in 1971 when the Government's Standing Committee on Indian and Northern Affairs recommended that the Coast Guard design at least one icebreaker capable of year-round Arctic navigation. The recommendation came as a result of growing government and public awareness of the evolving prospects of marine transportation and gas and oil exploration in the Canadian Arctic, added to the concern over the sovereignty implications of two passages through the Northwest Passage by the United States supertanker Manhattan.

In 1973 the Canadian Coast Guard acted on the Standing Committee's recommendation by issuing a request for proposals for the design of an Arctic Class 7 icebreaker. This request was issued to Canadian and foreign companies with proven expertise in icebreaker design.

While the Class 7 design was completed by 1975, the effect of rapidly escalating fossil fuel costs on operating budgets, and the increasing potential for rapid development of Arctic oil reserves to help Canada achieve energy self-sufficiency, led the Coast Guard to propose a nuclear-powered Class 10 icebreaker. The design of a nuclear power plant and supporting feasibility studies were subsequently completed. However, Cabinet directed that the nuclear option be set aside and that the Coast Guard proceed with designing and costing a less expensive, conventionally-powered Class 8 icebreaker.

In 1981, a contract was awarded for an Arctic Class 8 design which was completed in 1983. This was followed by a funded bid process for the preparation of fully detailed proposals and offers for the vessel's construction. Three qualified shipyards were contracted to submit proposals by March, 1985. The design was completed and costed at $417 million.

Following the transit of the Northwest Passage by the Polar Sea, and the subsequent announcement by Mr. Joe Clark, unsolicited proposals for the design and construction of a Polar Class Icebreaker, at a potentially lower cost and in a shorter time frame than previously proposed, were submitted by private industry. The Minister of Transport then established an independent private sector review committee, chaired by Dr. Angus Bruneau, to assess the potential of the unsolicited proposals. The Committee's final report concluded that the Government could confidently look to private industry for a design capable of meeting the CCG mission profile at a significantly lower capital cost than the existing design.

As a result, the Government decided to direct a funded design contract to Versatile Pacific Shipyard Industries (VPSI) for the design of the Polar 8 icebreaker, and the development of a turnkey construction proposal for a ship that would cost $317 million (1985 dollars) to build. This figure is $100 million less than the shipbuilders' lowest bid of March, 1985. A decision to develop an alternative propulsion system delayed completion of the design until April, 1989, and submission of a construction proposal has been further delayed by a change in shipyard ownership. The new owners, Shieldings Inc., are presently preparing a construction proposal, and it is anticipated that once this is received, a final submission to Cabinet for approval will be made, and a construction contract will be in place by early 1990. The submission will incorporate a report on this Initial Environmental Evaluation. In line with this schedule, the Polar 8 will clear Race Rocks, off Victoria, enroute to its first sea trials in the spring of 1994.

REFERENCES

Beaufort Sea Hydrocarbon Production and Transportation. Final Report of the Environmental Assessment Panel. 1984. 146 p.

Clark, J. 1986. Canada's International Relations. Response of the Government of Canada to the Report of the Special Committee of the Senate and the House of Commons.

Pharand, D. 1989. Canada's Sovereignty Over the Northwest Passage. Michigan Journal of International Law, 10: 653-678.

CHAPTER 2

ROLES

2.1 INTRODUCTION

Government directives and policy statements relating to the Arctic, as well as the recommendations contained in recent Environmental Assessments of other projects, clearly support the construction of a Polar Class icebreaker. The ship is to serve as a guardian of Canadian sovereignty in the Arctic, as an emergency services facility for Northern people, as a research platform, and as a means to protect environmentally sensitive Arctic resources and waterways.

The Government decision of January, 1986, authorizing the Coast Guard to initiate the current phase of the Polar 8 Icebreaker Project, approved a mission profile which states the major roles of this vessel. This mission profile emphasises sovereignty, scientific support, strategic/national operations, and emergency response operations, thereby expanding somewhat on the usual Coast Guard icebreaker mission statement. The Polar 8 will, however, assume all the normal duties and responsibilities of other Coast Guard fleet units. The ship will also be available to support the Department of National Defence in surveillance and control missions and, to this end, will be fitted for, but not with, military armaments and a secure communications centre.

2.2 COAST GUARD NORTHERN

The Coast Guard, like other Government departments, is divided into regions across the country. Until recently, Coast Guard's regional dividing lines went into the Arctic like slices of a pie, narrowing to an apex. Some years ago it was decided by the Coast Guard, that since the Arctic was becoming an integrated area politically and culturally as well as environmentally, the Coast Guard should establish a Northern Region. This was done to ensure that one agency would plan for Arctic operations in a way that dealt effectively with the geography, the growing involvement of the two Territorial Governments, and the effects of land claim settlements and land planning regimes.

The Polar 8 icebreaker will provide Coast Guard services to northern Canada on a year-round basis. The ship will act as a mobile District Office of the Coast Guard Northern Region, providing the technical support, communications, transportation, accommodation and catering required to conduct regional

programs and liaison with communities and industry throughout the Arctic. As well, the ship will have the mobility, equipment and personnel to carry out effectively such operational activities as Search and Rescue, pollution control, research, and vessel escort.

2.3 POLAR 8 MISSION PROFILE

The mission profile for the Polar 8 is the framework upon which all design and planning decisions for the vessel have been based, including the selection of equipment, the location of facilities and spaces, the development of operating procedures and budgets, and the size and training of crew members. The roles of the Polar 8, as specified in its mission profile, are:

- sovereignty;
- scientific;
- strategic/national;
- emergencies and logistic support; and
- shipping support.

Each of these are discussed below.

2.3.1 Sovereignty

The Polar 8 shall project a visible and uniquely capable Canadian presence for extended periods in Arctic regions in exercise of sovereignty concerns and enforcement. This shall be accomplished by making occasional and scheduled voyages to bases, communities and remote sites throughout the Arctic Archipelago, specifically during the Arctic closed season, and also by performing all operations and providing services described elsewhere in the mission profile.

2.3.2 Scientific

The Polar 8 shall provide a platform for Arctic scientific studies and data collection, such as measuring and monitoring weather and sea/ice conditions. The Polar 8 shall provide a facility for conducting research and development projects related to Arctic Class ship design and operation, regulatory development and operational experience. The Polar 8 shall continuously monitor and retrieve data relative to ship design and operations, including hull stresses and propulsion system performance, during all operations in ice, utilizing permanently installed instrumentation and data retrieval and processing equipment.

The Polar 8 shall provide a platform for the conduct of environmental studies, research, and surveys. It shall provide facilities and provision for laboratories and equipment, as well as accommodation for scientific personnel. The ship itself will be a platform with the capability to access remote ice-infested areas.

The information collected from these studies will, in turn, enable the Coast Guard and others to assess the adequacy of current regulations protecting the Arctic environment, and to predict and control potential environmental impacts.

2.3.3 Strategic/National

The Polar 8 shall provide escort and assistance to vessels making exploratory or demonstration voyages of national interest in the Arctic shipping safety zones. To support this role, the Polar 8 shall have the capability, endurance and manoeuvrability to escort and break out any vessel which may require assistance in the Arctic.

The Polar 8 shall also possess long voyage, ocean going capability suitable for possible deployment to Antarctica for exploration, and research and development purposes. This will enable Canada to support both national and international objectives in this southern polar area.

National security interests shall be incorporated by making provision for the accommodation and installation of national defence systems and facilities.

2.3.4 Emergencies and Logistics Support

The Polar 8 shall provide an all season platform and action centre for the coordination of large scale Arctic emergencies including Search and Rescue (SAR), Arctic community disasters, pollution, blowouts and pipeline failure.

To carry out this role the Polar 8 shall be capable of providing manpower, shelter, communications and transport. The shelter available will include temporary accommodation for up to 150 people, while the communications will include modern radio-telephone and telegraphy capability to ensure effective external communications. Transport and other operations at a distance from the ship will be assisted by three helicopters.

The Polar 8 will be capable of providing supplies and provisions, fuel and fresh water to Arctic sites, bases and communities during emergencies. The Polar 8 shall have available diving equipment and support facilities, and be capable of

providing emergency medical services. The Polar 8 shall also have an installed generating plant with sufficient reserve electrical power to supply limited capacity electrical power to Arctic sites.

The Polar 8 shall have the capability to resupply remote sites and communities and shall have cargo handling and storage facilities along with barge and helicopter support facilities for the transport ashore of stores and supplies.

2.3.5 Shipping Support

The Polar 8 shall conduct all season Arctic trafficability studies (including studies on ice conditions, weather, currents, feasibility of transit, and environmental impacts) to examine considerations related to Arctic shipping. The Polar 8 shall possess the capability and endurance to sail in severe ice-infested waters during all seasons without reliance on other ship assistance, and shall be capable of monitoring and recording pertinent ship navigational data and information.

The Polar 8 shall contribute to the safe and efficient movement of all Arctic marine traffic by providing escort when needed, by opening a track in the ice sufficient to allow lesser powered ships to progress easily, and by providing assistance to beset ships and those experiencing difficulty in extreme sea/ice conditions.

Assistance in the maintenance of marine aids to navigation shall be provided by accommodating personnel and equipment to repair, replace and maintain electronic beacons and other navigational aids.

The Polar 8 shall provide surveillance and reporting of Arctic ice and environmental conditions along shipping routes. It shall have on board ice observation and meteorological equipment and specialists capable of retrieving and transmitting data useful to mariners and Northern communities.

2.4 COAST GUARD DUTIES AND RESPONSIBILITIES

The authority from which the Coast Guard derives its mandate to perform services on behalf of the Government of Canada is essentially found in:

- the Department of Transport Act, RSC 1970;
- its predecessor Acts in respect of which the powers of the Minister of Marine are transferred to the Minister of Transport;

- several transfers of duties through Orders-in-Council, from the Department of Public Works to the Department of Transport;

- specific legislative enactments, such as the Canada Shipping Act and the Arctic Waters Pollution Prevention Act;

- historical links involving commitments to certain provinces undertaken by the federal government at the time of Confederation; and

- International agreements, federal/provincial/Territorial agreements and Treasury Board directions, as they affect Coast Guard responsibilities.

As stated earlier, the mission profile for the Polar 8 expands on the usual Coast Guard icebreaker mission statement, but the Polar 8 will also assume all the duties and responsibilities of other Coast Guard fleet units. These regular duties and responsibilities fall into four broad areas that are summarized as Coast Guard Planning Elements:

- Marine Navigation Systems

  - Short Range Navigational Aids
  - Long Range Navigational Aids
  - Waterways Maintenance and Development
  - Vessel Traffic Services
  - Safety and Public Correspondence Communication

- Icebreaking and Northern Operations

  - Route Assistance
  - Ice Management
  - Eastern Arctic Sealift
  - Aid to Other Government Programs

- Marine Search and Rescue

  - SAR Operations
  - SAR Prevention
  - Canadian Marine Auxiliary

- Marine Regulatory

    - Ship Regulatory
    - Personnel Regulatory
    - Pollution Regulatory
    - Marine Emergencies
    - Marine Casualty Investigations

These activities are presently conducted by the Coast Guard from shore-based facilities, from ships, or a combination of both, and are intended to ensure the safety and efficiency of marine operations in Canadian waters. The Polar 8 will provide the Coast Guard with an effective, well-equipped, mobile base from which to provide these services to Northern Canada.

CHAPTER 3

SHIPBOARD FACILITIES, PERSONNEL AND EQUIPMENT

3.1 INTRODUCTION

The Polar 8 will represent a significant increase in the operational capability of the present Coast Guard fleet, and will provide a wide range of administrative, emergency, and operational services that currently do not exist in the Arctic region. The current icebreaker fleet is capable of conducting activities in the Arctic only during a limited operational window through the summer months, whereas the Polar 8 will be able to operate throughout the Northwest Passage, year 'round. As a result, the Government of Canada will have a continual presence in the area, while the Coast Guard will have its first opportunity to provide effective services to the region throughout the year.

The ship will be able to offer the support necessary to conduct extensive personnel-intensive operations in an otherwise hostile environment. The ability of the ship to provide these services is best illustrated by describing four basic components:

- shipboard facilities;
- personnel;
- transportation; and
- transportable equipment.

Together, the Polar 8 icebreaker and its crew will provide the Coast Guard with a mobile and well-equipped resource capable of bringing essential services to the Arctic throughout the entire year.

3.2 SHIPBOARD FACILITIES

The shipboard facilities have been designed to incorporate features that will be needed to support the ship's mission profile and its position as Coast Guard Northern's representative in the Arctic. The main facilities are as follows:

a) Aviation Facilities

The ship is to be fitted with extensive aviation support facilities and will carry three helicopters. The shipboard facility will be a mobile heliport capable of supporting year-round all-weather flight operations. In addition to its own aircraft, the ship will be able to support other aircraft during any large operation through the provision of aircraft fuel, hangers and engineering support.

b) Medical Facilities

The ship will carry a doctor and have a five-bed hospital equipped to handle basic medical emergencies and to stabilize patients with serious problems in preparation for transfer to more extensive facilities. This will enable the Coast Guard to provide emergency medical support to nearby Arctic communities.

c) Scientific

The ship will have extensive facilities to support scientific research programs. These will include:

- laboratories and extensive computer facilities;
- a moon pool (an opening through the bottom of the ship for entry to the water) to facilitate scientific sampling, diving operations and remotely operated submersible vehicle operations in ice conditions.

d) Fire Monitors

The ship will be fitted with four fire monitors capable of pumping water for distances of up to 150 metres at a maximum rate of 9,600 cubic metres per hour. This capability will allow the Polar 8 to be used as an effective fire-fighting tool in the event of a major fire on an oil rig or ship.

e) Diving Equipment

The ship will be fitted with diving spaces and the hot water and air equipment required to support extensive diving operations. Additionally, the ship's doctor will be trained in procedures related to diving injuries. Fixed and portable recompression chambers will be available for emergencies. (See Figure 3.2.1.)

f) Accommodation

The ship is designed to accommodate 154 persons, of which more than 50 spaces are available for personnel not involved in normal ship operations. In addition, the on-board gymnasium can be converted to provide barracks-style accommodation for 150 people during emergencies or large-scale operations such as pollution clean-up activities or community emergencies.

The ship's galley will be able to feed large numbers of people during emergencies and in support of labour intensive operations that require additional personnel to be brought on board.

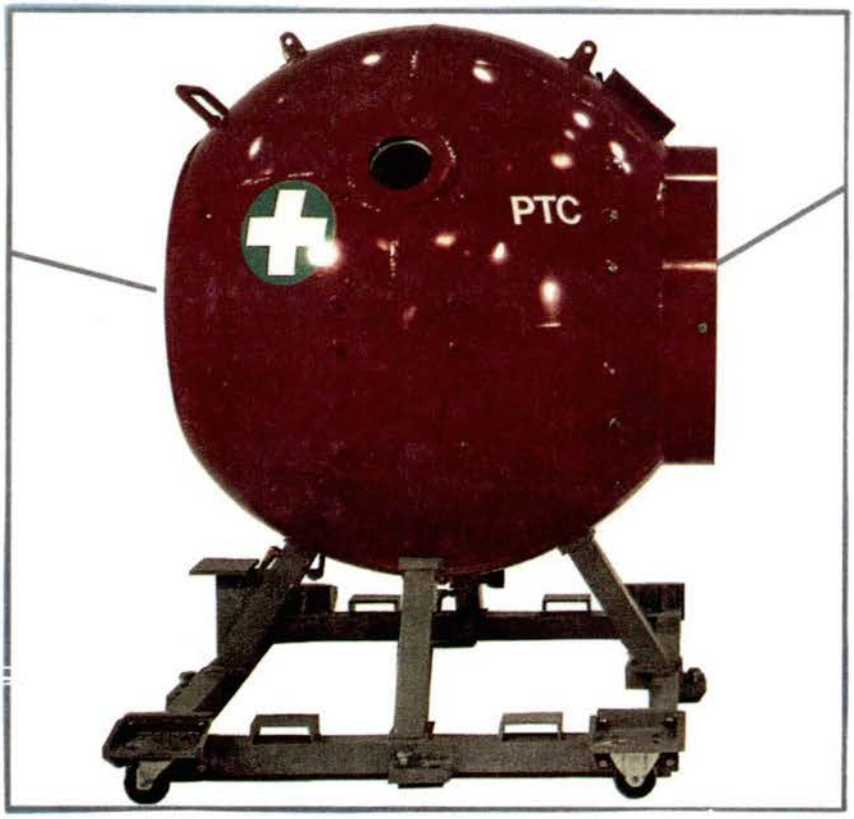
g) Communications and Contingency

The ship will be fitted with extensive communications facilities to provide for the reliable, long-range exchange of data and voice communications during normal and emergency operations. Spaces on-board the ship have been designated and equipped for the planning and co-ordination of contingency operations.

h) Towing

The ship is to be fitted with a towing winch and stern notch to allow for effective and efficient close coupled towing of ships of up to 100,000 tonnes in ice-infested waters. This will enable the Polar 8 to assist ships which are temporarily unable to proceed under their own power. This facility has proven effective in Soviet escort icebreaker operations as an efficient and safe method of offering escort assistance to vessels in severely ice-infested waters.

Figure 3.2.1
TRANSPORTABLE RECOMPRESSION CHAMBER
AND TRANSFER CHAMBER



i) Workshops

Electrical, wood, avionics, small vehicle repair, and electronic workshops have been included in the ship design to provide the facilities for self-sufficiency in the repair and maintenance of equipment, and a limited ability to construct special use items.

j) Conference Rooms

The design includes several conference rooms capable of handling groups of up to 70 people. These are to be used for planning operations and briefing participants, or liaising with community, industry, or government representatives. For example, these rooms will facilitate discussions with the Arctic community on their concerns about Coast Guard operations, environmental issues or industrial development.

k) Law Enforcement Facilities

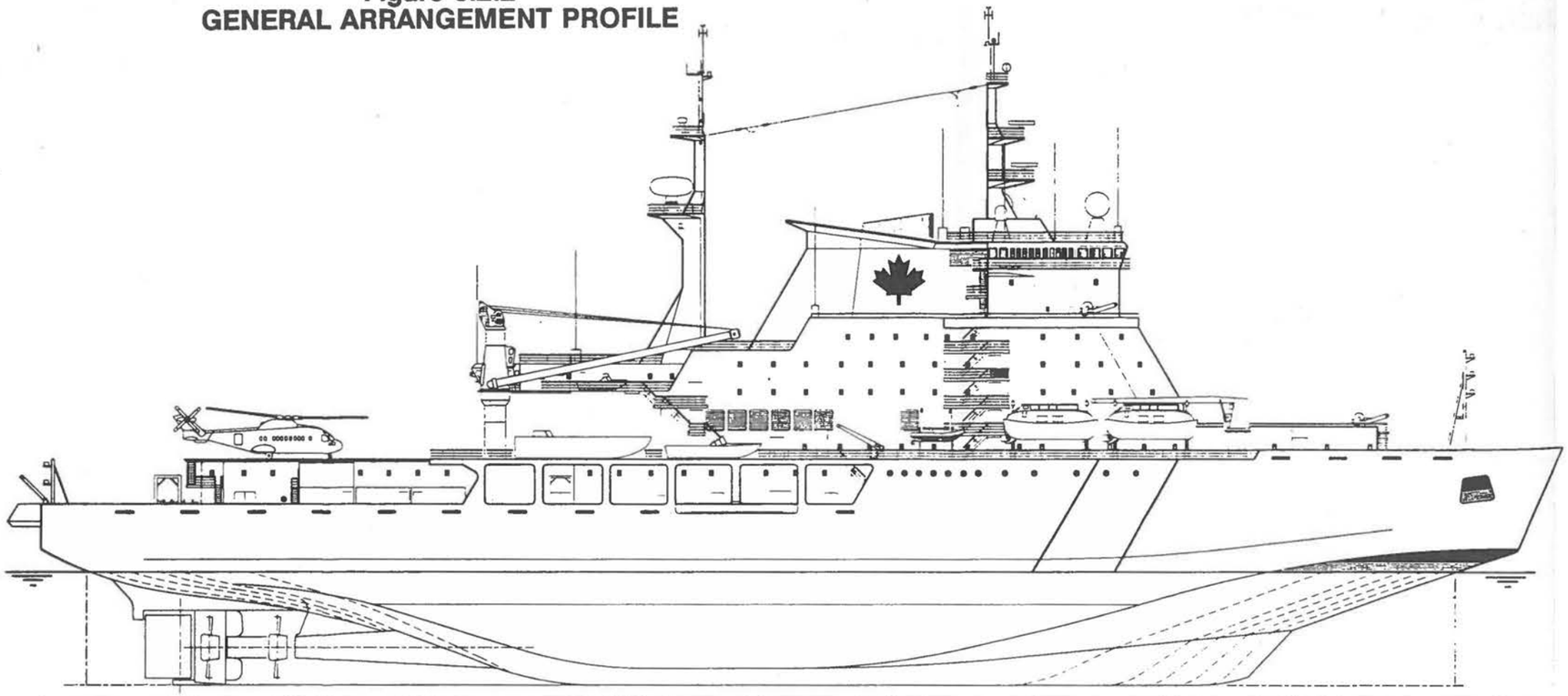
The Provost Marshall facilities will be equipped with detention facilities and an armoury for the storage of arms and ammunition.

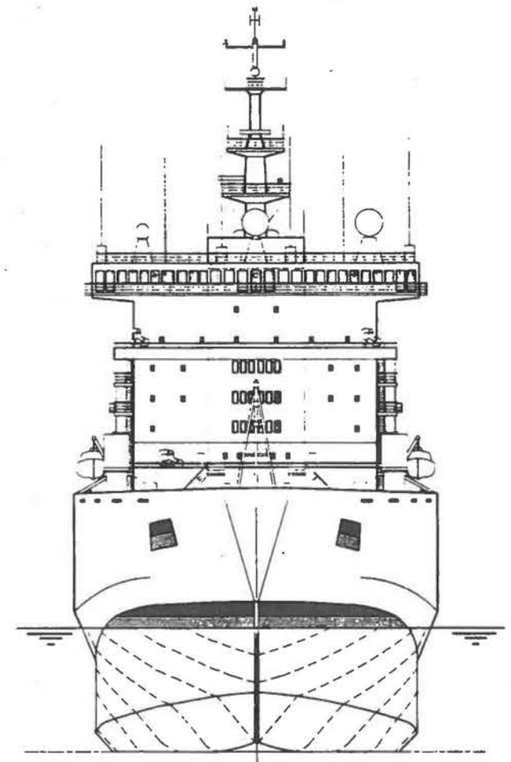
l) Resupply Facilities

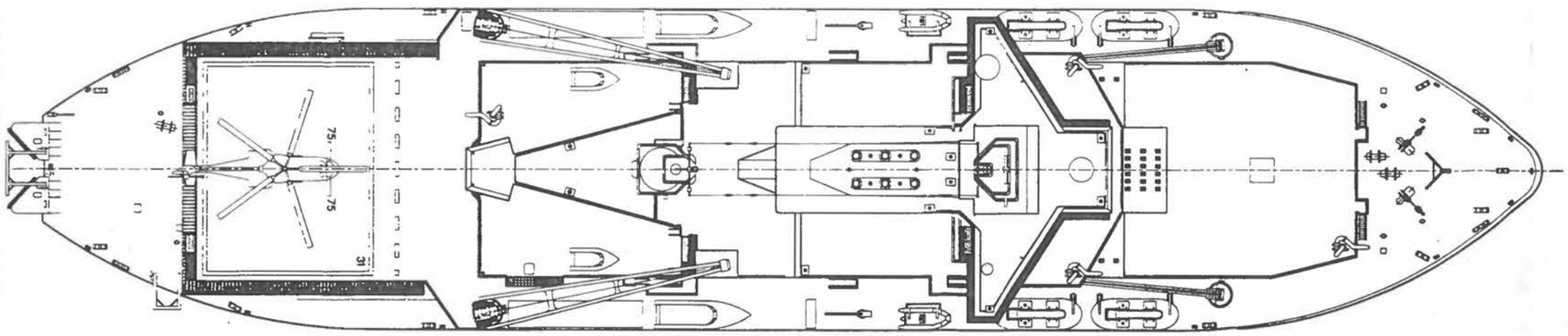
To support resupply operations the ship will be fitted with extensive cargo stowage spaces. The ship will also be fitted with several cranes, including one 40 tonne, one 25 tonne, two 20 tonne "A" frames and two 7.5 tonne capacity cranes. Additionally, the helicopters will have a sling capacity of 10,000 lbs.

Layouts of the facilities described above are shown in Figures 3.2.2 to 3.2.8.

Figure 3.2.2
GENERAL ARRANGEMENT PROFILE







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CHK.	GAP	10-11-88
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POLAR 8 ICEBREAKER
TRIPLE SCREW GEARED DIESEL

GENERAL ARRANGEMENT
PROFILE

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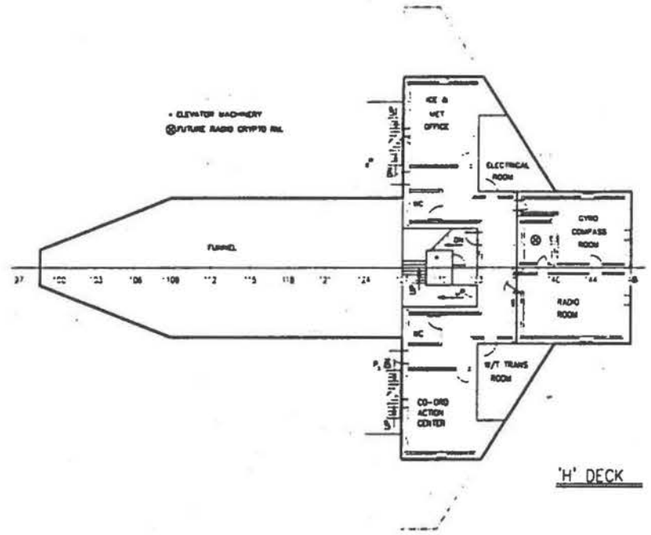
Figure 3.2.3
GENERAL ARRANGEMENT OF 'G' DECK, 'H' DECK, NAV. BRIDGE DECK & WHEELHOUSE TOP



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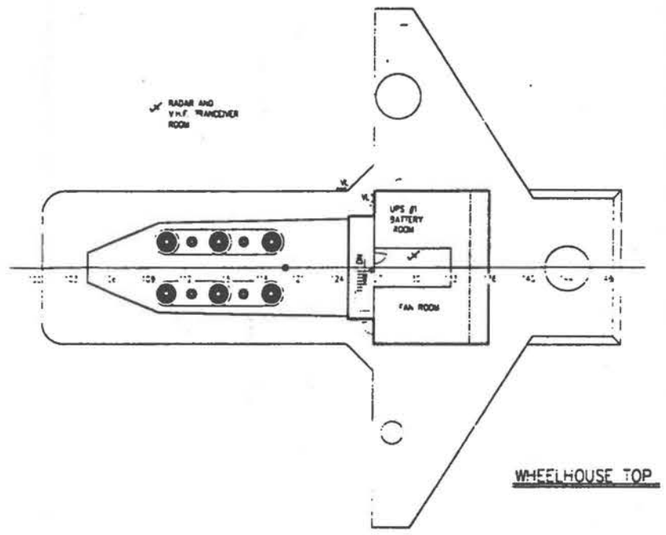
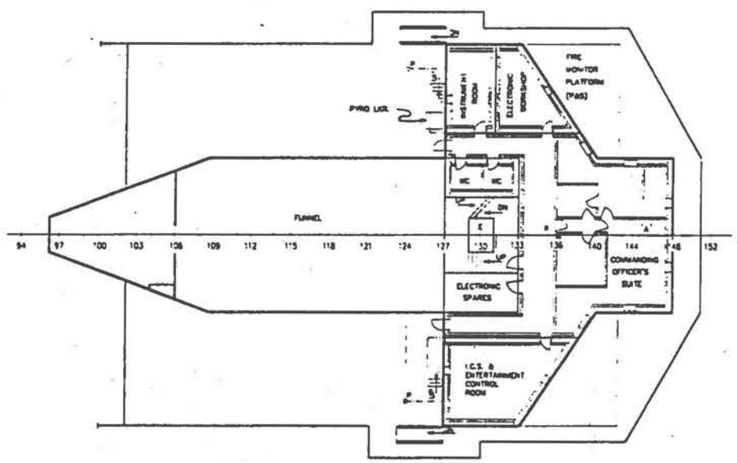


WHEELHOUSE TOP



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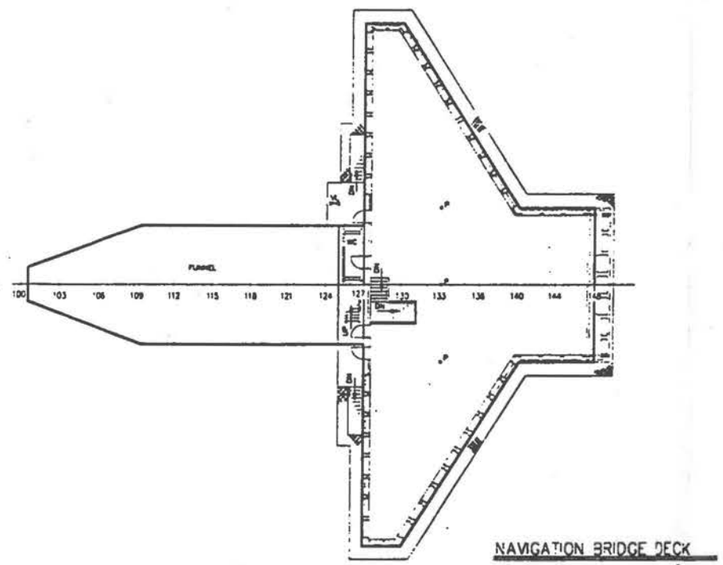

NAVIGATION BRIDGE DECK

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GENERAL ARRANGEMENT
'G' DECK, 'H' DECK, NAV.
BRIDGE DECK & WHEELHOUSE TOP

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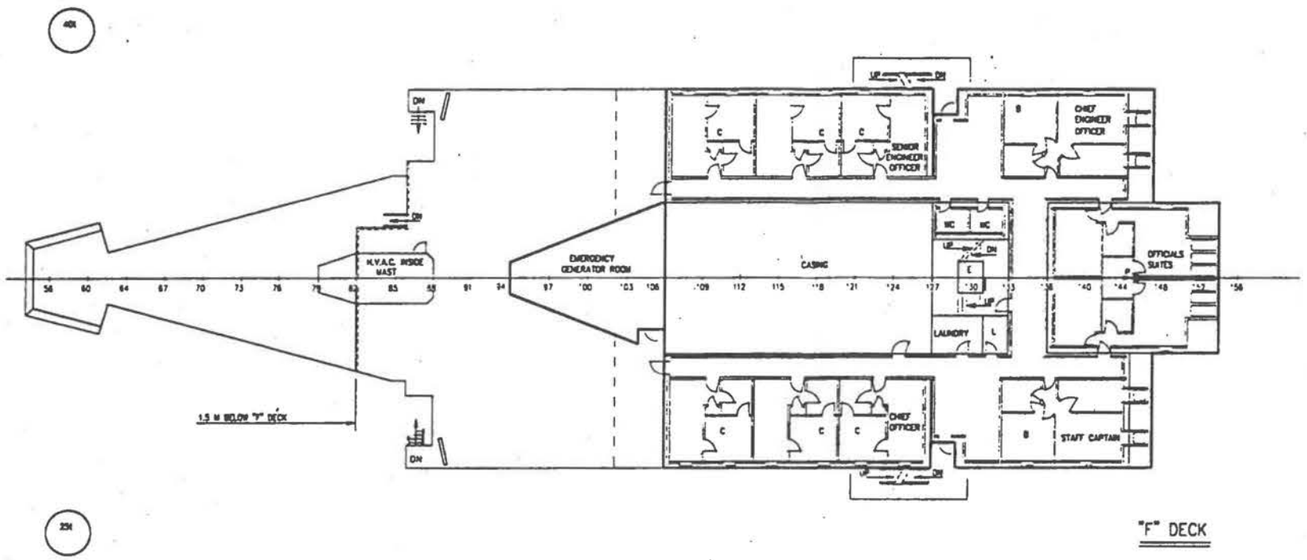
Figure 3.2.4
GENERAL ARRANGEMENT OF 'E' AND 'F' DECK



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GENERAL ARRANGEMENT
'E' DECK AND 'F' DECK

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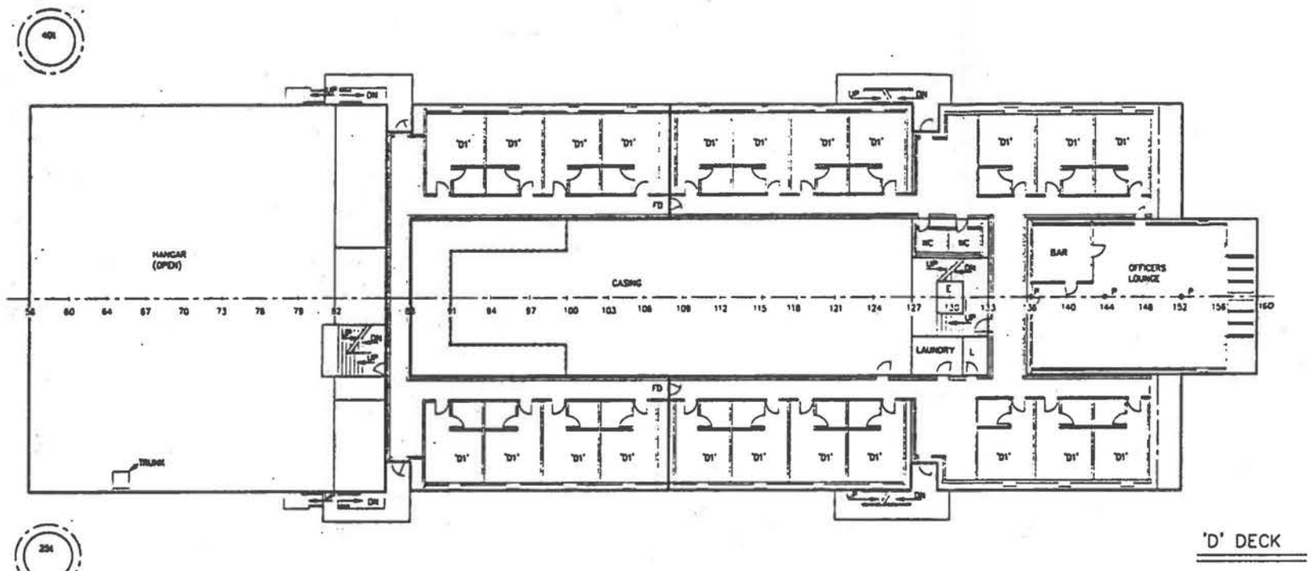
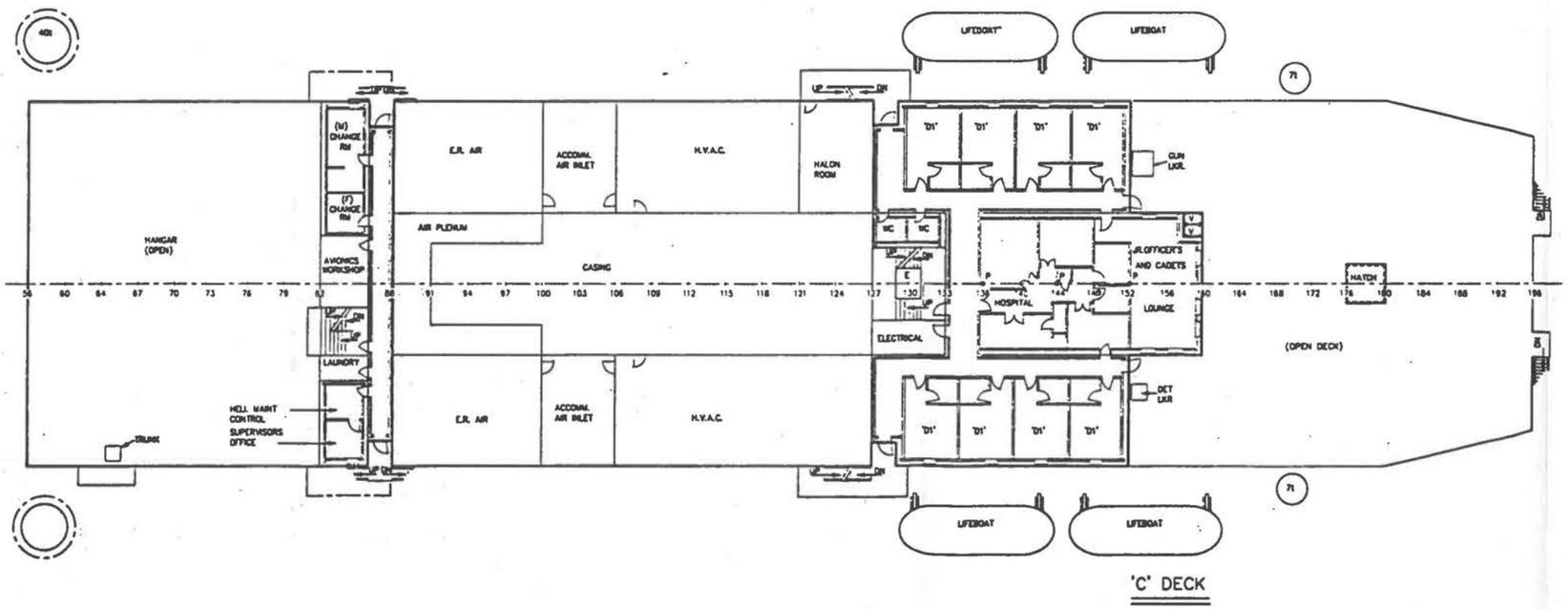
Figure 3.2.5
GENERAL ARRANGEMENT OF 'C' AND 'D' DECK





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GENERAL ARRANGEMENT
'C' AND 'D' DECK

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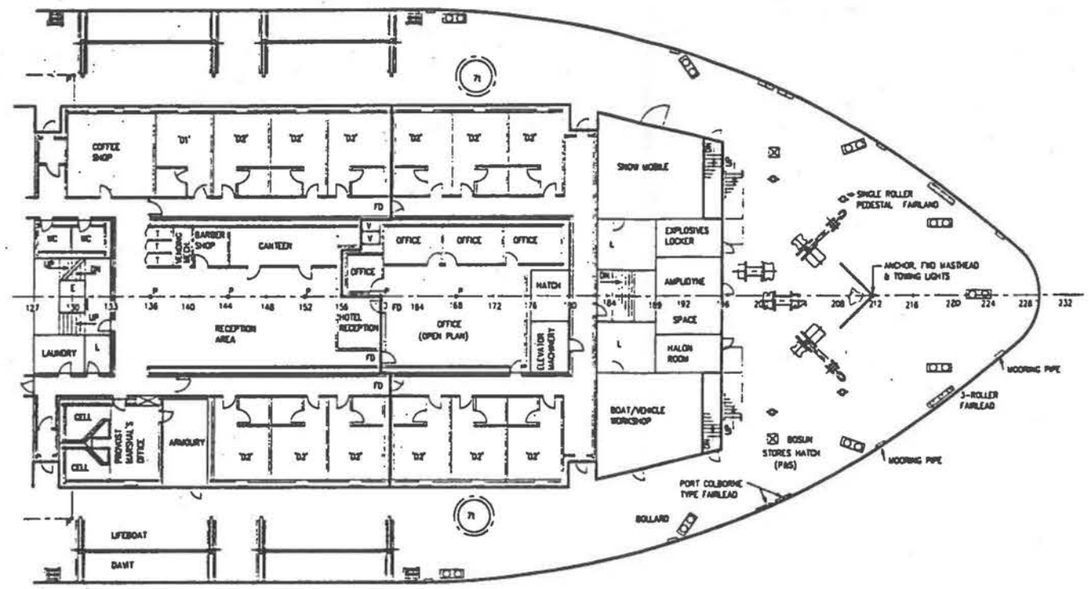
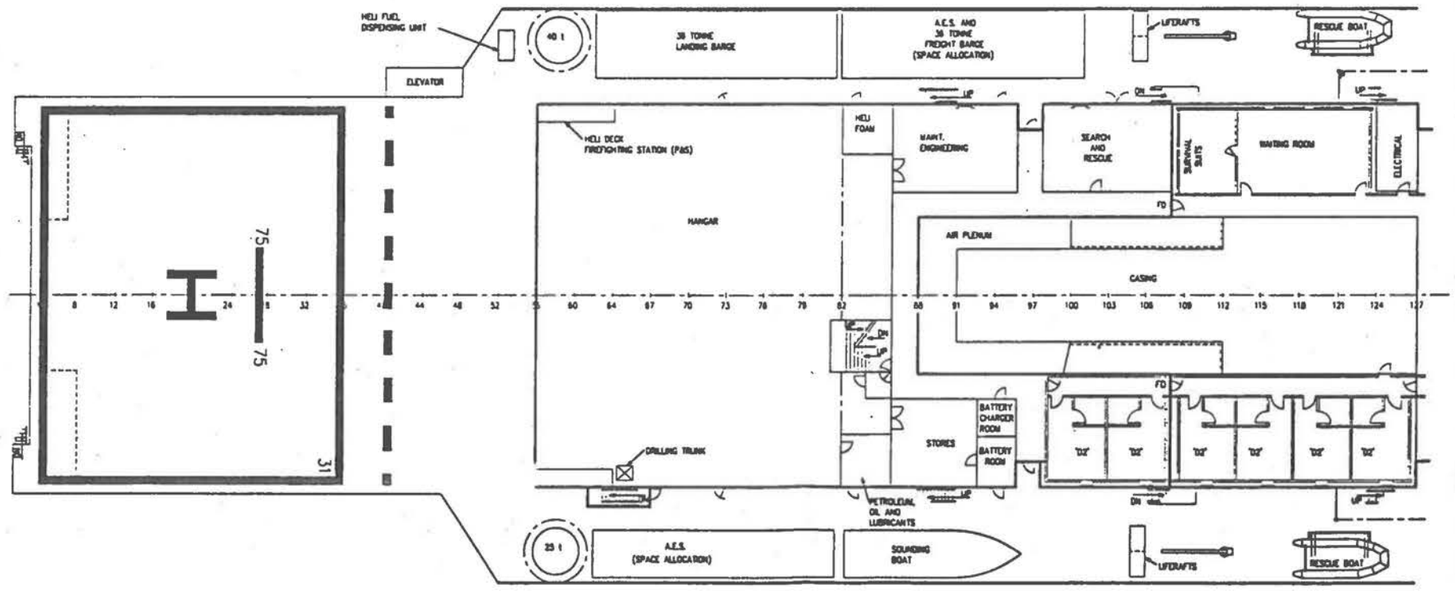
Figure 3.2.6
GENERAL ARRANGEMENT OF 'B' DECK





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TRIPLE SCREW GEARED DIESEL

GENERAL ARRANGEMENT
'B' DECK

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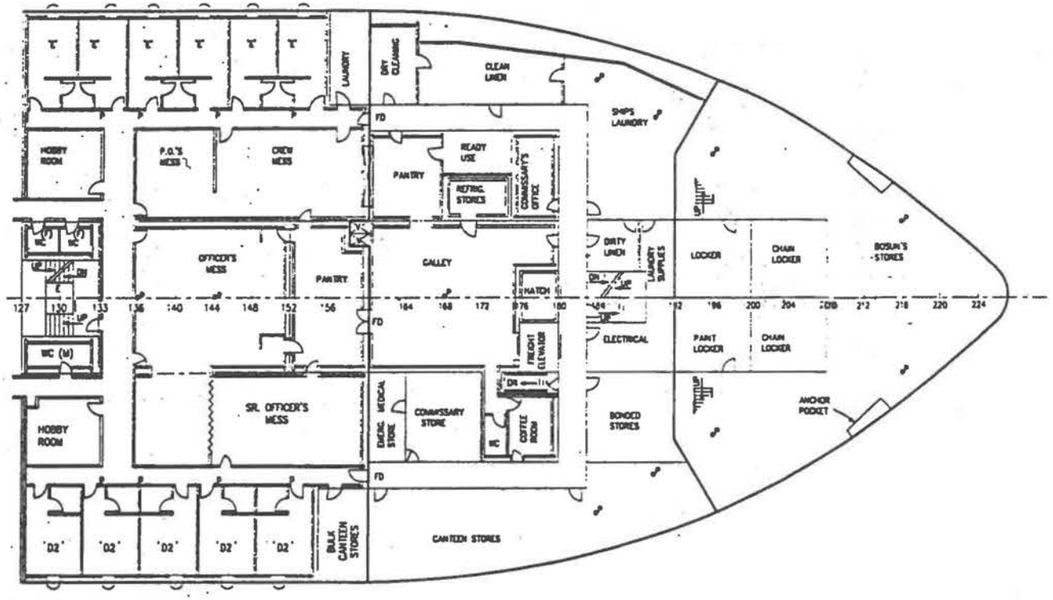
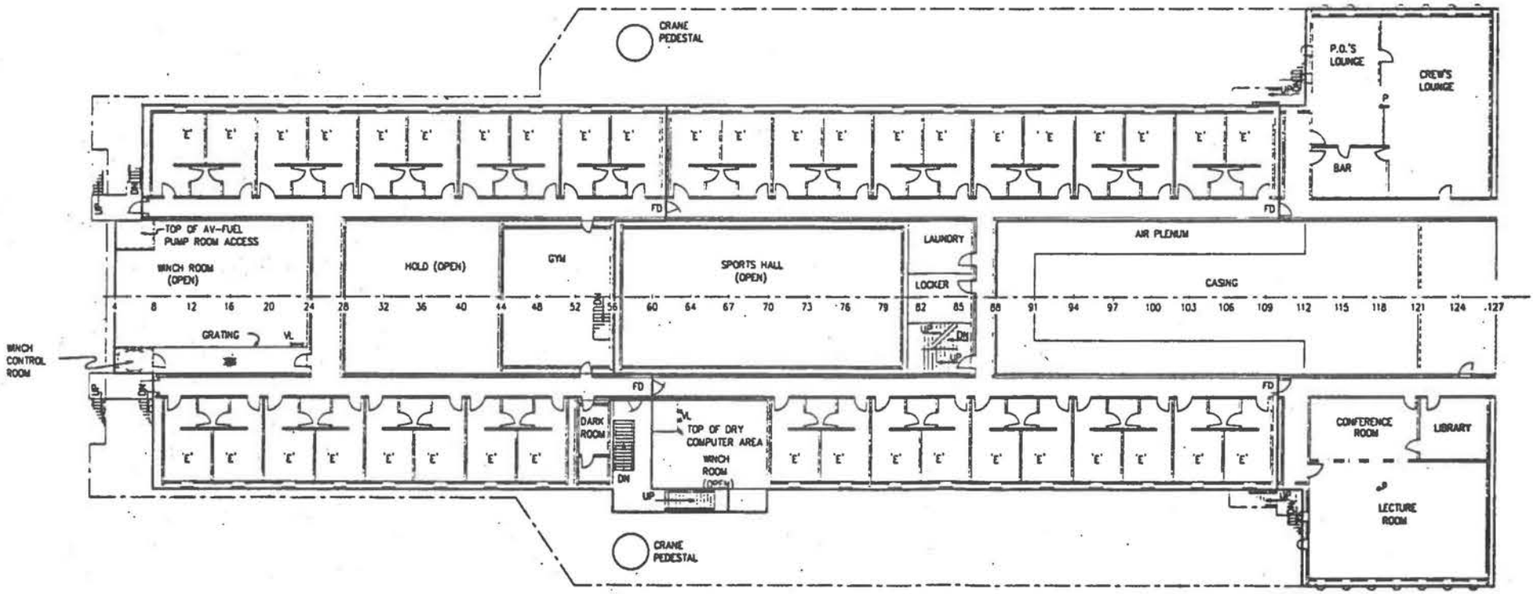
Figure 3.2.7
GENERAL ARRANGEMENT OF 'A' DECK





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TRIPLE SCREW GEARED DIESEL

GENERAL ARRANGEMENT
'A' DECK

SCALE	DRAWING No.	REV.
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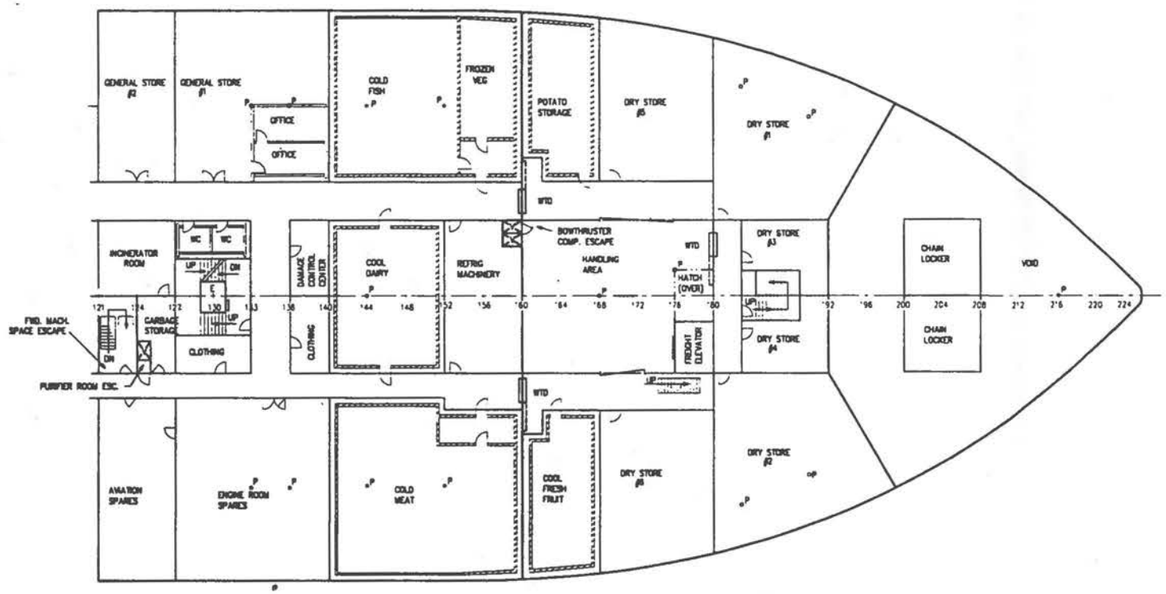
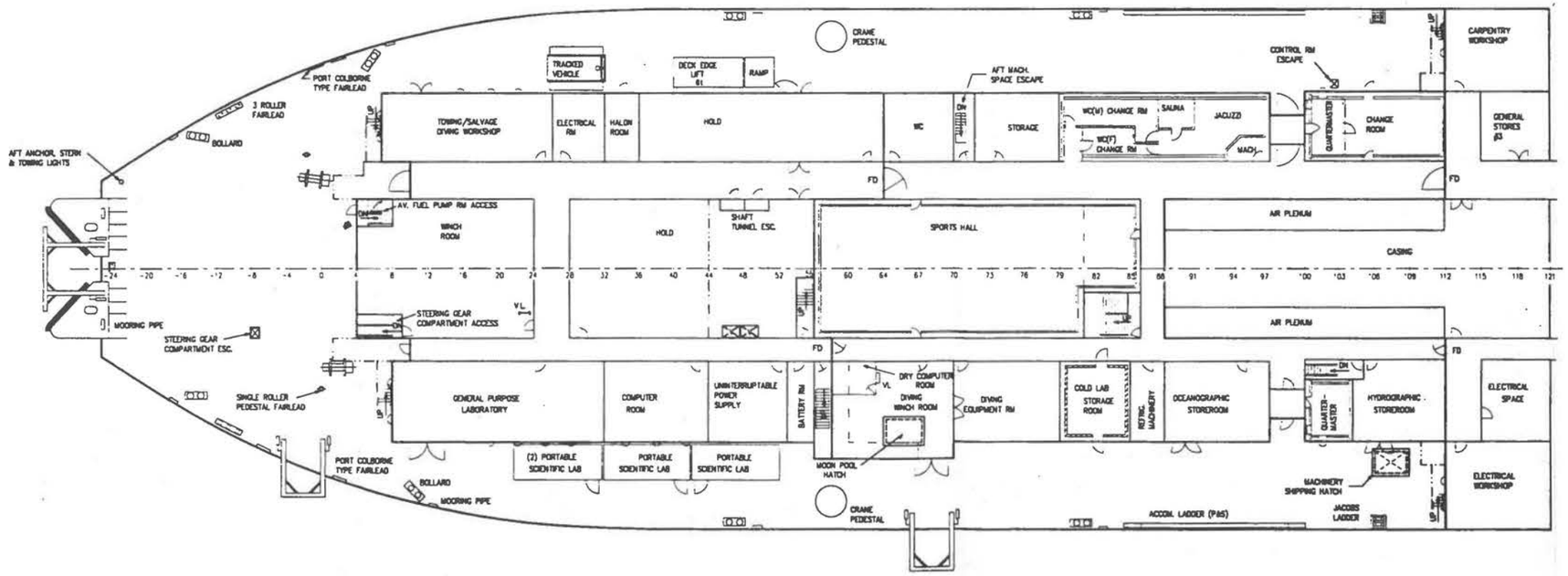
Figure 3.2.8
GENERAL ARRANGEMENT OF MAIN DECK





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REV.	DATE	DESCRIPTION	DR.	CHK.
D	89-01-17	ESCAPES REVISED	HAJ	GAP
C	89-12-21	MACHY SPACE ESCAPES	HAJ	GAP
B	89-12-08	GENERAL REVISIONS	HAJ	GAP
A	89-11-28	MINOR REVISIONS	HAJ	GAP

ACTIVITY		DATE
DR.	H.A.J.	89-11-20
DES.	G.A.P.	89-11-20
CHK.	G.A.P.	89-11-20
CHK.		

APPROVED	DATE
CLASSIFICATION	
C.C.G. - S.S.B.	
S.M.C.	

PREPARED BY
POLAR ICEBREAKER CONSTRUCTORS

OWNER
CANADIAN COAST GUARD

POLAR 8 ICEBREAKER
TRIPLE SCREW GEARED DIESEL

GENERAL ARRANGEMENT
MAIN DECK

SCALE	DRAWING No.	REV.
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3.3 PERSONNEL

The ship's crew will include a number of well-trained individuals who will have duties associated with the normal functioning of the ship, plus specific responsibilities as part of Special Activities Teams. Each team will have a specialized capability that will be used in response to specific situations such as law enforcement, Search and Rescue, or pollution control. When the teams are used in conjunction with the ship's helicopters, they will extend the area of coverage for Coast Guard services, and represent a substantial improvement over current Coast Guard capabilities in the area.

The Special Activity Teams carried on board the ship will include:

a) Dangerous and Toxic Materials Team

The Polar 8 will carry a team trained in the containment of harmful materials and in the use of protective clothing and appropriate equipment. This will include general pollution response expertise and will also extend to other more dangerous substances.

b) Rescue Specialist Team

A team of specialists trained in rescue techniques will be carried to conduct such operations. The team will deploy with the helicopters during Search and Rescue missions to act as winchmen, observers, rescue specialists and medical technicians.

c) First Aid Team

In addition to the small hospital and the doctor on board, the ship will provide a response team trained to industrial standards to render first aid either in the shipboard facilities or at some distance in conjunction with the ship's helicopters.

d) Diving Team

A team of Coast Guard divers will be trained for Arctic operations to the extent necessary to conduct inspection and scientific operations to a shallow depth. For deeper or more sophisticated diving operations such as propeller changes, highly skilled contract divers will be flown to the ship when needed.

e) Boarding and Law Enforcement

The ship will carry an armed boarding team capable of stopping and inspecting civil shipping or, if instructed, effecting seizure of a vessel.

3.4 TRANSPORTATION

The Polar 8 will provide transportation for personnel and equipment to and from the ship through the ship-based helicopters, surface transportation such as boats or tracked vehicles, or by sailing to the location. The transportation equipment will consist of the following:

a) Helicopters

The three helicopters on the Polar 8 will provide fast and effective transportation in most weather conditions, day or night. This resource will allow the Coast Guard to offer its services well beyond the physical location of the ship, as described in greater detail in the following chapter.

b) Arktos

The Arktos is a vehicle capable of movement in water or on ice (see Figure 3.4.1.). It is intended that two of these vehicles will be carried on board the Polar 8 in support of scientific and research activities on the sea ice. They will also provide a self-contained all-weather, on ice escape vehicle for the ship's crew.

c) Small Vehicles

A variety of small vehicles including snowmobiles, all-terrain wheeled vehicles, and tracked vehicles will be carried to provide surface transportation on the ice or on shore. Some of the vehicles will be transportable by helicopter to minimize the effects of transit, and to reduce the exposure of personnel to the rigours and dangers of Arctic travel.

Figure 3.4.1
ARKTOS

d) Small Vessels

An inventory of small vessels will be carried aboard the icebreaker including landing barges (see Figure 3.4.2) and rigid hull inflatables. These vessels will be used to transport personnel and equipment during resupply, pollution clean-up, enforcement, and scientific operations.

3.5 TRANSPORTABLE EQUIPMENT

The ship will carry equipment such as shelters, pollution clean-up equipment, electrical generators, pumps, fire-fighting equipment, and emergency medical equipment that will be available for deployment by helicopter or surface vehicle, as required. While the inventory of this equipment will not be decided until the ship nears completion in order to take advantage of technological advances, four and a half million dollars have been budgeted for the pollution clean-up equipment alone.

Figure 3.4.2
LANDING BARGES

CHAPTER 4

AIR SUPPORT

4.1 INTRODUCTION

The three helicopters and seventeen crew members that will make up the Aviation Department of the Polar 8 Icebreaker will play an essential role in the operations of the ship. By providing fast, effective, and far-ranging air support, the helicopters will extend the services offered by the Polar 8 into areas of the Arctic that are socially or environmentally sensitive to icebreaking activities, inaccessible to a ship of this size, or located far from the ship. At the same time, the helicopters' ability to carry out essential resupply missions at long range and without extensive repositioning of the ship will give the Commanding Officer flexibility in planning missions that will help to ensure that operations are conducted in an efficient and environmentally conscious manner.

Two of the helicopters will be equipped to operate under the Instrument Flight Rules (IFR) and will be able to fly year-round and in all weather conditions. These aircraft will be able to deploy safely to locations as far as 700 miles from the ship (see Figure 4.1.1) and carry up to 30 passengers, depending on the aircraft selected. The third helicopter will be similar to those now in service with other CCG ships, and will provide close support services during daylight, when Visual Flight Rules (VFR) apply.

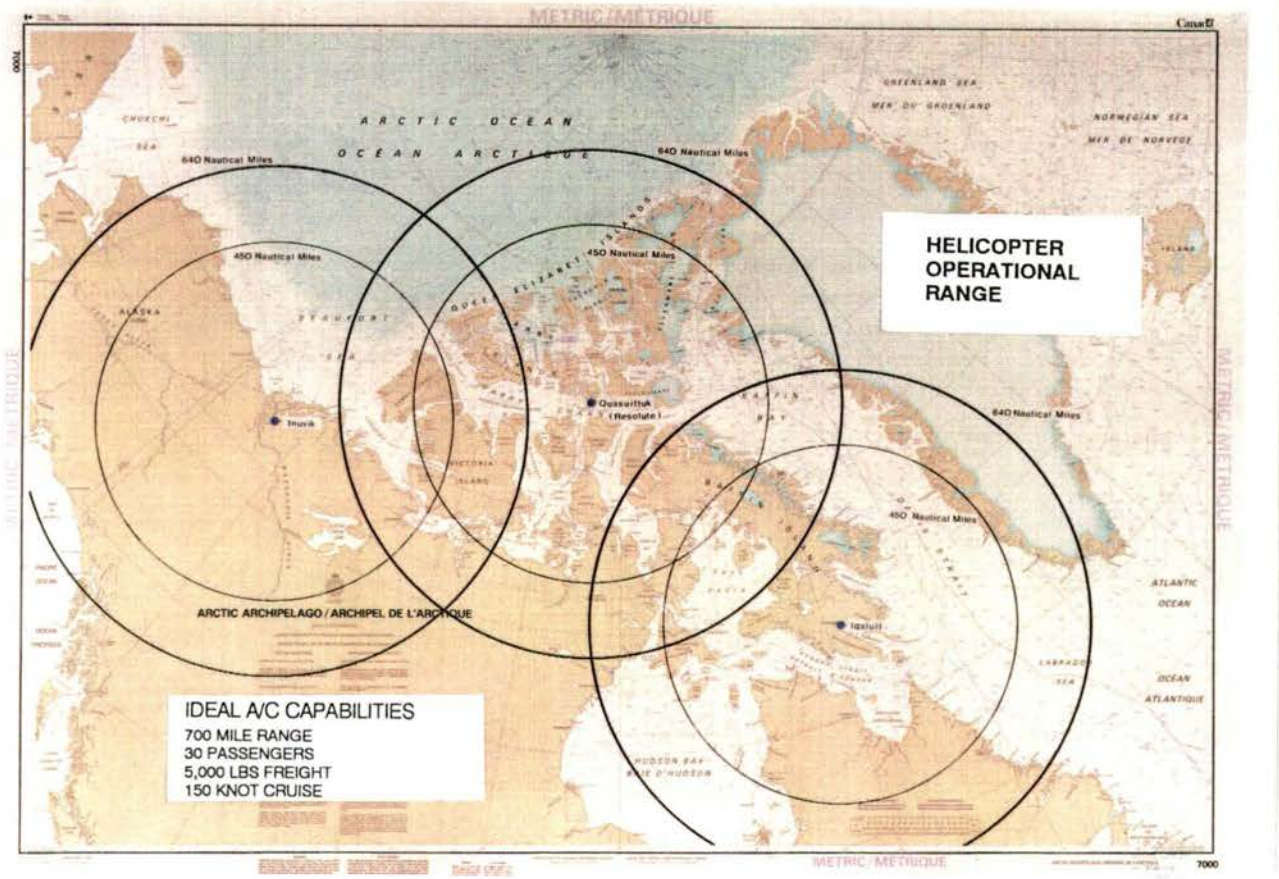
The all-weather capability of the aircraft will add to the operational flexibility inherent in helicopter operations by allowing them to fly at appropriate altitudes regardless of the weather. This, in turn, will enable flight operations to be planned and conducted in a manner that will minimize any disturbance to wildlife or communities.

While the helicopters will be multi-tasked to a variety of operations, they will have three basic mission objectives:

- to satisfy the resupply and personnel transfer requirements of the ship;

- to provide a fast and effective pollution detection and response capability; and

Figure 4.1.1
HELICOPTER OPERATIONAL RANGES



- to support Polar 8 involvement in Search and Rescue, emergency response, scientific research, sovereignty, and reconnaissance operations.

The mission of the helicopters also includes general support to Coast Guard programs and the provision of a visible presence for the Canadian government in areas of the Arctic that are inaccessible to the ship.

4.2 MISSION PROFILE

4.2.1 Personnel Transfer and Ship Resupply

Personnel and equipment transfers in support of search and rescue, sovereignty, emergencies, security problems, scientific and other special activities such as medical emergencies and pollution investigations will often be conducted by helicopter. Many of these operations will take place in remote locations on land, and on the sea ice. Additionally, the helicopters will be used to transfer community, Territorial government and industry representatives to and from the ship for community liaison, consultation and briefing purposes.

The resupply and personnel transfer movements that are essential to the effective and efficient operation of the ship will also take place by helicopter, at 2 to 3 week intervals on a year-round basis. The helicopters will rendezvous with charter flights from southern Canada at Arctic airports such as Resolute Bay to exchange inbound and outbound passengers and freight. It is anticipated that 100 to 120 people and 40,000 pounds of freight will be transferred monthly. Although much of this personnel and freight will be connected directly with the operation of the ship, a substantial portion of the movements will be in support of specialized operations.

4.2.2 Pollution Prevention, Detection and Control

Although prevention of any pollution event (through education, regulation, and monitoring) is the ultimate goal of the CCG, it is still necessary to conduct pollution detection and control operations. A rapid response to pollution incidents is essential in order to minimize the scope of the occurrence, and must include accurate reconnaissance to define the affected area, plus deployment of specialized equipment and personnel to confine the pollution and begin clean-up operations.

Having two large helicopters available will enable the Polar 8 to deploy a two-

part response to a pollution incident comprising reconnaissance and control activities. One aircraft will be mobilized to provide reconnaissance information, while the other is tasked to transport first response equipment and personnel to the site.

The CCG is presently developing a package of reconnaissance sensors for Polar 8 helicopters that will provide high quality imagery to support a variety of tasks including pollution detection. This remote sensing system will be used to detect pollution and accurately define the affected area during day or night operations, and in most weather conditions.

The helicopters will participate in pollution control and clean-up activities by transporting personnel and equipment, such as small boats and skimmers, to the site, and through the operation and deployment of specialized devices such as drip torch ignition systems, foam and water fire suppression systems, and containment booms.

4.2.3 Search and Rescue, Emergency, Community/Industry Assistance

Because of the great distances between Arctic communities, the lack of dedicated SAR resources in the area, and the extreme and unforgiving nature of the Arctic environment, it is essential that the Polar 8 provide SAR coverage to air and surface operations conducted from the ship. To ensure an effective, all-weather flight capability, the aircraft will be equipped with auto hover and auto search equipment, infra-red scanners and high intensity searchlights. During SAR operations the aircraft will carry a crew of five, a rescue hoist, air droppable assistance packages, medical equipment and deployable flares.

The existence of such a capable airborne SAR resource, based on a powerful and mobile platform, will bring a unique rescue facility to the High Arctic that at the present time has no equivalent. The helicopters will be able to respond to SAR and missing persons incidents virtually anywhere in the Arctic, either directly from the ship or via intermediate refuelling locations, while the ship provides the required communication, co-ordination, and medical support.

CCG involvement in three recent Arctic SAR operations, resulting in the successful location and rescue of 18 people from drifting ice floes by CCG helicopters and ships, underscores the effectiveness of a helicopter SAR resource supported by a mobile marine unit. The faster, bigger, and better equipped helicopters based on the Polar 8 will be even more effective because they will be

able to conduct SAR operations at night, in bad weather, and over a large search area. This type of effectiveness is especially important in the Arctic region, where delays caused by bad weather or darkness can rapidly jeopardize the success of any SAR incident, due to the extremes in climate and the distance involved in transiting from one area to another.

When emergency assistance is required by Arctic communities or commercial operators in dealing with situations such as natural disasters, power outages, major fires or oil well blow-outs, the helicopters will be available to transport personnel and equipment to the affected location, and provide evacuation for medical or safety reasons if necessary.

Additionally, if the successful completion of Arctic sealift operations is jeopardized by ice conditions or other factors, and the Polar 8 cannot provide vessel escort due to draft restrictions or other tasking, the helicopters will be able to transfer most essential cargoes to the destination communities either as sling loads or by carrying the loads internally.

4.2.4 Other Uses of the Helicopters

The helicopters will provide air support in the construction and maintenance of marine aids to navigation by transporting personnel and equipment to the site, and by slinging material into position.

In the unlikely event that the Polar 8 might have to be evacuated, the helicopters will be capable of moving people from the ship to adjacent ice fields, along with sufficient supplies and equipment for survival, until outside assistance arrives or the helicopters are then able to transfer all personnel to appropriate shore facilities.

4.3 RECONNAISSANCE

As part of their support to Polar 8 operations, the helicopters will provide reconnaissance information utilizing a suite of sensors capable of high resolution detection and the plotting of targets including oil spills, ships, vehicles, people and ice formations. The information gathered will become an essential element in ship navigation, pollution response, Search and Rescue and sovereignty operations

An integrated system designed to gather, display, store, and transmit high quality reconnaissance data during day or night, and during all-weather flight operations will be installed on Polar 8 helicopters. The system will be used to support ice

field navigation, pollution detection, oil spill tracking, and surface search operations. Data from the sensors will be processed on-board the helicopter, annotated with position information, displayed to aircrew and operators, recorded, and transmitted to CCG vessels. The main types of reconnaissance to be undertaken are as follows:

a) Ice Reconnaissance

At present, CCG depends on maps generated manually by ice observers carried in ship-board helicopters, plus strategic ice imagery transmitted from Atmospheric Environment Service and Interra overflights. The visual method of collecting tactical ice information depends on good weather and daylight, while the overflights are primarily for the collection of strategic ice information to be used in long-range planning.

The Polar 8's helicopters will carry sensors that are able to collect tactical ice information through cloud cover and at night. This information will assist in icefield navigation, and in determining the feasibility and impact of proposed voyages.

b) Pollution Detection

The helicopter reconnaissance system will be capable of collecting essential pollution information that will be used to determine accurately the extent of pollution spills. This information will be used for planning clean-up operations, locating the source of the pollution, and assessing damage. It will also become part of a data base that will be used by CCG to plan better ways to deal with pollution and predict its spread and effects.

c) Search and Rescue/Sovereignty/Strategic

The helicopter reconnaissance system will be used to support Search and Rescue, sovereignty, and strategic missions. The system will be used to locate and plot a wide range of targets, from a single person on the ice during SAR missions to large ships that have entered Canadian waters without permission and appropriate clearances. High resolution radar imagery will be used:

- during Search and Rescue missions to assist in the identification of search objects;

- during Strategic operations to identify and plot the position of surface targets; and,

- in routine flight operations to assist the flight crew in navigation, and in the identification of surface features and weather.

4.4 CANDIDATE HELICOPTERS

4.4.1 Heavy Helicopters

Although the operational requirements for the three helicopters to be carried on the Polar 8 have been identified, a final decision has not been made as to which makes of helicopter will be selected. As mentioned earlier, two of the helicopters will be capable of operating under IFR and will be able to operate in year-round Arctic weather conditions. The specific essential environmental operational parameters specified for these two helicopters are:

- temperature: -50°C to +40°C;
- winds: 60 knots with a 20 knot gust spread;
- icing: continuous flight in moderate icing conditions;
- sea state: 5.

There are at least three aircraft capable of supplying the required heavy helicopter air support. An aircraft will be selected through a formal evaluation and acquisition process that will be initiated when approval for construction of the Polar 8 has been received. The evaluation of competing types of helicopters will include assessment of their noise characteristics in order to minimize the impact of air operations on the Arctic environment.

A brief description of each candidate for the heavy helicopters is contained in Appendix A.

4.4.2 Light Helicopter

The light helicopter to be carried on the Polar 8 is expected to be an BO-105, which is currently the standard CCG shipboard helicopter. The CCG now operates 16 BO-105s from bases and ships across Canada. Specifications for this helicopter are also contained in Appendix A.

CHAPTER 5

OPERATING DESCRIPTION

5.1 INTRODUCTION

The operations of the Polar 8 will be governed by its mission profile. While representing and safeguarding Canadian sovereignty in the Arctic, the Polar 8 will provide emergency services to the communities and industries of the region, environmental protection through enforcement of the AWPPA regulations, pollution prevention and control through the provision of monitoring, surveillance and clean-up services, and support to scientific and environmental research.

Although the Polar 8 will also be a highly capable escort vessel, it is expected that in the early years of service the ship will not routinely escort summer shipping except to assist sufficiently ice-capable vessels such as the M.V. Arctic or foreign ships or foreign icebreakers, or any vessel in an emergency situation. The current level of shipping activity in the Arctic is adequately handled by the existing icebreaker fleet, in most years. It is not anticipated that the present patterns of Arctic marine traffic, in terms of the size, frequency or operational season, will change substantially in the near future. The Polar 8 will, however, take part in feasibility and environmental studies as part of ongoing marine trafficability planning and evaluation programs.

Because the Polar 8 will be owned and operated by the Canadian Coast Guard, the operation of the ship will be subject to established CCG policies and procedures for Arctic icebreaker operations. The Coast Guard has operated the world's second largest fleet of icebreakers for over 40 years, and has developed operational procedures based on extensive experience in the Arctic. The Polar 8 will be staffed by Coast Guard officers who have the most extensive icebreaking experience available in Canada. It is anticipated that the technical and operational scope of the Polar 8 will attract the most highly qualified and dedicated crews.

In preparation for the introduction of the ship into service, the Coast Guard has established a core group of senior operating personnel from all disciplines, some five years in advance of the ship's planned delivery, to address relevant issues. This team is assessing environmental, construction and operating issues, and working to ensure that the policies, procedures, and operating plans used by the

Polar 8 will reflect the concerns and needs of user groups, northerners, and the environment, while providing for effective ship operations.

Polar 8 operations will be coordinated by the Operations Section of the Coast Guard's Northern Region in response to user requests, Coast Guard needs, and emergencies. This group of experienced Coast Guard officers currently controls all Coast Guard Arctic operations, including the activities of eight icebreakers and the ships associated with the Eastern Arctic Sealift. Experience in Arctic operations, supported by extensive ice reconnaissance information, data on environmentally sensitive areas, and procedures developed specifically for Polar 8 operations will be used to ensure safe and efficient operations.

5.2 AREA OF OPERATIONS

The Polar 8's primary operating area will be through the Northwest Passage from Baffin Bay to the Beaufort Sea using Parry Channel and the Prince of Wales Strait or M'Clure Strait routes, depending on the circumstances. However, when conditions permit, it is expected that the ship will occasionally travel into the Arctic Ocean and other parts of the Arctic Archipelago to carry out scientific, environmental and engineering research operations, Search and Rescue missions, and resupply operations to existing DND and research facilities.

Current evaluations of ice conditions in Parry Channel support the general conclusion that the extremely severe conditions used as the design target for the Polar 8 are less extensive than previously believed. It will, therefore, be possible for the ship to conduct effective operations in all waters of the Arctic Archipelago and the Arctic Ocean by avoiding heavy concentrations of difficult multi-year ice. These operations will be planned well in advance, and supported by extensive reconnaissance information. Information on ice conditions is already being collected for use in planning Polar 8 operations in this area to ensure safe and efficient operations.

5.3 TIMES OF OPERATIONS

The Polar 8 is being designed to spend up to four years at a time in the Arctic without needing to return to a port in southern Canada, and to meet a target of 300 operational days per year. Each year of operations will include approximately 65 days of self-maintenance activities, usually during the summer months when other Coast Guard icebreakers are operating in the region. During

the non-operational periods near-normal crew levels and emergency response capabilities will be maintained.

When not carrying out operational programs, and during periods of self-maintenance, the ship normally will be stationed in Viscount Melville Sound near the south coast of Melville Island. This location will position the ship in a relatively unpopulated and normally untravelled area in the central Arctic, and allow the Polar 8, and its helicopters, an approximately equal response time to operational requirements or emergency situations in both the Eastern and Western Arctic.

5.4 LIAISON WITH ARCTIC COMMUNITIES AND ENVIRONMENTAL GROUPS

It is the Coast Guard's intention to continue with and build upon the community consultations that have already taken place with reference to the Polar 8. Ongoing liaison with northern communities regarding local activities, conditions, and interests will be used in planning Polar 8 operations. Considerations will include sensitive marine animal migration and breeding patterns, seasonal ice conditions, and the concerns of northern residents.

To facilitate this consultation, Coast Guard Northern has developed a Northern Relations Officer position within its organization. This Northern Relations Officer is responsible for liaison with northern communities regarding Polar 8 and other Coast Guard operations, and for responding to community interests and concerns.

In addition, the Coast Guard is proposing that annual general meetings be held between Coast Guard Northern and appropriate community representatives from local communities in the Eastern and Western Arctic. It is intended that these meetings provide a forum for discussions regarding upcoming Polar 8 operations.

5.5 INITIAL FIVE YEAR OPERATING PLAN

The five year operational plan represents a framework of operational periods within which proof of performance trials, scientific and environmental research programs, Coast Guard and other user department priorities, and self-maintenance requirements will be scheduled. To date, the outline of a five year operating plan has been established, from which a detailed operational plan will be developed as requests for the vessel's services are received.

5.5.1 Years 1 and 2

The priorities for the early part of this period will be to conduct performance trials, environmental impact assessments, emergency preparedness and communications exercises, and to define the limits of the Polar 8's operational capabilities and area. During the first two years of operations the ship will:

- conduct essential tests and trials to demonstrate and prove the ship's full capability;
- conduct environmental impact and scientific research studies; and
- publicize Canada's efforts and position as an active Arctic nation, and Canada's capability with respect to its sovereignty position.

The first priority of this period will be to conduct a Proof of Performance Trials program in the first year after completion of construction. This will include a series of pre-planned steps beginning with the non-operational testing of components and systems before the vessel leaves the shipyard, then open water operations off western Canada, and proceeding in steps to ice performance trials carried out in Canadian and international waters of the Arctic. This will involve operations in M'Clure Strait, Viscount Melville Sound, and the Arctic Ocean. At the end of this period, the ship will return to Victoria, B.C. for drydocking and warranty inspections.

A detailed series of tests and trials intended to prove and demonstrate the capabilities of the ship and its systems is presently under development. Because an icebreaker with the designed capabilities of the Polar 8 has never before been built in the western world, this program will be of vital importance in ensuring that the shipyard meets its contractual obligation to provide a ship that meets the technical and operational requirements, and that operational limitations and procedures are accurately defined in advance of the ship beginning full time Arctic operations. Additionally, the trial period will give the crew the opportunity to become familiar with the ship before the vessel is committed to full Arctic deployment.

The second priority of this period will be to conduct operations of national and scientific interest throughout the Arctic, and may include:

- mid-winter demonstration transits of the Northwest Passage in both directions via both Prince of Wales Strait, and M'Clure Strait, including an environmental assessment of the effects of the voyage.

The information collected during this voyage will be used to determine the limits of future operations in the region;

- circumnavigation of the Queen Elizabeth Islands, including an environmental assessment of the effects of the voyage, and practical accessibility trials of sites currently being evaluated by Coast Guard for future operations.

A demonstration transit of the Arctic Ocean from the Pacific Ocean via the Chukchi Sea and the Greenland Sea to the Atlantic Ocean is also planned, with the objective of passing through the North Pole and conducting research at points along the route. An appropriate environmental and scientific research program will be developed for this voyage involving routine stations for the conduct of research in the physical, meteorological, and biological sciences.

This voyage could then be followed up by a series of visits to interested nations in the European and Baltic area.

The return voyage of the Polar 8 to Canadian Arctic waters to take up station in its operational area could be accomplished four ways depending on the success of the initial voyage and the degree of associated interest:

- direct, via open water south of Greenland;
- via the Northeast Passage through the Barents, Kara, Laptev and East Siberian Seas with appropriate stops in the Soviet Union, subject to that nation's concurrence;
- north of Greenland via the Lincoln Sea; or
- by a second trans-polar voyage following an alternate route determined by research requirements.

5.5.2 Years 3 to 5

During the third year of operation, following its return to the Canadian Arctic, it is expected that the ship will begin to assume a more normal operational posture, undertake follow-up activities based on the results of the previous years' operations, and assume standby readiness to provide emergency and other mandated services in the Arctic. A significant portion of the available operational time during this period will be allocated to scientific and environmental missions which will be initiated and requested outside of the Coast Guard.

During years 4, 5 and subsequent years, distribution of the ship's operational time will depend on the demand for the ship's time between environmental, scientific, sovereignty, defence, and transportation missions. Priority will be given to emergency preparedness and response to regional requirements.

Although planning for environmental and scientific research activities has not yet been developed to the point specifying detailed programs, the scientific community has expressed a strong and continuing interest in using the Polar 8 as a platform from which to conduct environmental, biological, hydrographic, and geological investigations, amongst others. The Arctic Archipelago and the Arctic Ocean are a unique area of the world, about which only limited hard scientific information is known. Interested organizations include federal government departments working in the science fields, universities and Arctic science groups. Other countries, including the Soviet Union, Finland and Japan, also have expressed interest in the Polar 8 as an environmental science and technical platform. Requests for Polar 8 support to specific scientific programs will be incorporated into the operating plan as they are received, and Coast Guard Northern is developing a position within its organization to coordinate and implement requests for scientific activities.

5.6 ENVIRONMENTAL PILOT

The operations of the Polar 8 will be governed, in part, by a navigational working instrument, called an Environmental Pilot, which will identify environmentally sensitive components of the Arctic that may be placed at risk due to the ship's passage. The ship's master will use this Environmental Pilot to plan and select the safest environmental routes and operational areas for the Polar 8 and for the ship's helicopters, launches and vehicles. The Environmental Pilot will be a working instrument designed to provide Polar 8 navigators with information pertaining to the safe navigation of the ship with reference to environmentally sensitive areas.

The Pilot will be similar in language and presentation to the existing Sailing Directions, or Pilot Manuals, produced by the Canadian Hydrographic Service. It is mandatory under Canadian law that the Sailing Directions be carried on board ship. The Environmental Pilot will compliment the existing three volume Pilot for Arctic Canada used by mariners to ensure safe navigation.

There are three key elements that will guide the development of the Environmental Pilot:

- the Pilot will be written in a language style, and a technical manner familiar to navigation officers;

- an atlas of marine charts accurately displaying environmentally sensitive areas will be included; and

- the Pilot will be up-dated at regular intervals to ensure that the document contains the most current information.

The creation of a new navigational work instrument in this manner will ensure the easy and swift adoption of environmental information into the ship's navigating practices.

Although the Environmental Pilot will be used to select the safest environmental routes, the responsibility for the safe navigation of a vessel in all respects, including environmental aspects, ultimately lies with the ship's navigating officers. Occasions may arise when safety or tasking demand that the ship pass through a sensitive area defined in the Pilot. However, Coast Guard will ensure that every reasonable effort will be made to minimize the effects of such a passage.

5.7 RESUPPLY

At the present time, there are no port facilities in the Arctic capable of handling the Polar 8. Thus, in an effort to ensure effective operations, the ship has been designed to be self-sufficient, in terms of fuel and supplies, for extended operational periods. The substantial storage and fuel capacity built into the ship will allow major operations to be conducted in remote areas such as the Arctic Ocean, for extended periods without the need for regular resupply support.

5.8 STUDIES AND PLANNING

To prepare for the operation of the Polar 8, the Coast Guard has begun extensive investigations of the ice regimes, environmental concerns and existing support and navigation facilities in the operating area in preparation for the introduction of the Polar 8 into service. These studies and planning efforts will continue throughout the period of construction of the ship and during its early years of service, and will continue to evolve to reflect national priorities, environmental issues, and the needs of northern communities and industry.

Examples of the more important studies that have or are now being conducted are:

a) Arctic Marine Access Study

In preparation for Polar 8 operations, the Coast Guard has commissioned a study of Arctic waterways and communities, called the Marine Access Study, to catalogue known information regarding navigation, environmentally sensitive areas, and communities in the region. The results of the study will become part of the ship's working documents to be used as a source of route planning and facilities information. The information will also be used by the Polar 8 Operations group during the coming years to determine, in advance, where and when the ship can operate, the feasibility of proposed operations, and what additional information will be required to ensure efficient and environmentally sensitive operations.

b) Synthetic Aperture Radar Ice Atlas Winter Conditions 1986-87 and 1987-88 (Joint Project by Coast Guard, Canarctic Shipping, and Atmospheric Environment Service)

Ice in the more severely infested regions, such as ASPPR Zone 1 and Zone 2, and in particular among the islands of the Archipelago, does not move very quickly due to the slow rate of melting in the summer, and congestion. The Ice Atlas has provided the Coast Guard with a baseline of ice information. By continuing to monitor the position and movement of ice, it will be possible to plan operations to avoid heavy concentrations, and reduce the potential difficulties encountered by the Polar 8. The collection of ice information in the Arctic Ocean and other projected operating areas will continue throughout construction of the Polar 8, and beyond, to ensure that accurate data is available.

c) Report of Ice Conditions by Area (Levels of Service Project (1986))

The Coast Guard has developed eight levels of service for its current icebreaker operations, through an assessment of current and historical operations, user needs, and vessel limitations. These levels of service describe which clients will be served, the timing and priority for different tasks, and type of icebreaker that will provide the service. Although a level of service has not formally been established for the Polar 8, this project has established a framework of government policy, procedures and

considerations for existing icebreaker operations that will be used as the basis for levels of service for the Polar 8.

d) Parry Channel Accessibility Report (1986)

This report detailed the variability of ice conditions throughout western Parry Channel for a 12 year period (1974 - 85), and assessed the potential for operations of a Class 4 vessel. The results of the study confirmed the region's opening date for operation of a Class 4 vessel, and suggested that the end of the shipping season could be extended to the end of December in average ice years. The information gathered in this study was used in determining the ice classification required for year-round operations in the area.

e) Trials of the Motor Vessel Kalvik (1986)

In 1986, the Coast Guard conducted icebreaker performance trials in the Prince of Wales Strait, M'Clure Strait and Parry Channel using the M.V. Kalvik, a Class 4 ice-capable offshore supply vessel, used by the oil company Gulf in the Beaufort Sea exploration activities, and the Coast Guard icebreaker, John A. Macdonald. Extensive data were collected on the effects of icebreaking operations on hull structures and power requirements in various ice regimes. This information has been used in developing the design of the Polar 8, and in assessing what limitations will be imposed on the Polar 8 in planning operations into areas where large concentrations of multi-year ice exist.

f) Refuelling Studies

The Coast Guard is presently conducting a study of current refuelling practices. This information will be used as a baseline when CCG commissions a study to assess the environmental impacts, practicality, and effectiveness of refuelling options for the Polar 8. The results of both studies will lead to the development of the facilities, plans and procedures required to provide the Polar 8 with an effective method of refuelling in the Arctic that will pose no unacceptable hazards to the environment.

g) Communications

The Coast Guard's Telecom and Electronics directorate is currently evaluating the Polar 8's long range communications requirement on behalf of Coast Guard Northern. The Coast Guard will expand the existing

Arctic communications network, NORDREG, to provide Polar 8 operations with reliable data and voice communications throughout the Arctic. Known limitations to Arctic communications, and developmental systems such as meteor burst transmissions and mobile satellite systems, will be evaluated. A suitable system, or complementary arrangement of systems will then be selected to provide the required service.

5.9 FACILITIES FOR NAVIGATION

5.9.1 Communications

The Coast Guard's Vessel Traffic Service presently operates a reporting and information radio network throughout the Arctic, referred to as NORDREG, with a station in Iqaluit. The Coast Guard uses the system to monitor marine traffic, deploy icebreakers, and provide essential weather, ice, and traffic information to vessels sailing in Arctic waters.

Polar 8 operations will also be monitored by the NORDREG system. Since not all areas of the Arctic have access to satellite communications, this shore-based facility will provide a vital link between the Polar 8 and the satellite communications systems, allowing for the transfer of messages and data to and from southern locations when the ship is outside satellite coverage.

5.9.2 Ice Reconnaissance

Although the general operating plan for the Polar 8 will be developed well in advance, actual day to day operations, including ship routing, will depend on accurate and timely ice and weather information. An extensive system of sensors, receivers and display equipment will be carried to provide the Polar 8 with an ice reconnaissance capability second to none in the world. Information will be received from several sources as follows:

a) Satellite Indirect

Strategic reconnaissance information collected from the following satellites will be provided to the Polar 8 from the Atmospheric Environment Service, Ice Branch facilities in Ottawa:

- SSM/I Passive Microwave Radiometer
- ERS-1 Synthetic Aperture Radar
- RADARSAT Synthetic Aperture Radar

b) Satellite Direct

Visual and infra-red reconnaissance information will be received directly from the NOAA and METEOR satellites.

c) Synthetic Aperture Radar, Side-Looking Airborne Radar

Strategic ice information will be received directly from specially equipped fixed wing aircraft conducting high altitude reconnaissance overflights.

d) Tactical Helicopter Reconnaissance

The two large helicopters carried onboard will be equipped to provide tactical ice reconnaissance information directly to the ship. Although the sensors for these aircraft have not yet been chosen, passive microwave radiometer, infra-red and conventional high definition radar are being considered as a minimum.

e) STAR-VUE Display

The Polar 8 will be equipped with a STAR-VUE display system used to analyze, process and display ice reconnaissance information on-board the ship. The STAR-VUE is presently used by Coast Guard icebreakers to provide an integrated display of ice reconnaissance information used by ship's officers in ice field navigation. It is anticipated that the MARINE-VUE display system now under development, which will combine reconnaissance information from remote sources with the ship's radar and navigation systems, will be available by the time the Polar 8 sails.

f) METSIS

The ship will be fitted with a METSIS ground station for the receipt of meteorological and ice information from satellites. This level of information will be essential in planning aviation and on-ice operations.

CHAPTER 6

TECHNICAL DESCRIPTION - POLAR 8

6.1 INTRODUCTION

To ensure that the Polar 8 can safely and effectively carry out the tasks identified in the mission profile, the ship must possess a high degree of operational flexibility and reliability, carry facilities appropriate to the tasking, and be more powerful and capable than the largest vessel likely to require assistance.

In the design of the ship, the Coast Guard has adopted, as a minimum, the standards set out in the Arctic Shipping Pollution Prevention Regulations (ASPPR) for an Arctic Class 8 vessel, while specifying redundant systems and additional hull strength, power, and international classification standards that substantially increase the performance, safety and structural integrity of the ship. These stringent design features, and subsequent construction techniques, will result in a ship capable of withstanding the most severe pressures likely to be encountered in ice-field operations. As well, these features will provide a high degree of system redundancy that will allow the ship to continue operating even in the unlikely event of mechanical failure.

Although the Coast Guard has a proven ability to operate in ice-infested waters, the Polar 8 will represent an enormous increase in power, dimension, and performance over existing icebreakers. The Polar 8 will be one of the largest and most powerful escort icebreakers in the world (see Figure 6.2.1), and the facilities incorporated into the design are intended to ensure its effectiveness as a support platform for scientific and environmental research, and as a source of emergency services in the Arctic.

6.2 GENERAL DESCRIPTION AND PARTICULARS

6.2.1 General

The Polar 8 will be a triple screw, diesel mechanical, escort icebreaker. The hull, superstructure and deckhouses will be constructed of welded steel. The design incorporates a stepped freeboard deck that results in a two-tiered weather deck arrangement, with the forward deck higher than the aft deck. All

Figure 6.2.1
POLAR 8 ICEBREAKER

accommodations, galleys, messes, lounges, offices and the infirmary will be located on or above "A" Deck, with the exception of some offices and work spaces located on the Main Deck.

The Polar 8 will have a modern icebreaking bow and stern suitably contoured for specified ahead and astern in-ice operational manoeuvres. The hull design has been extensively tank tested in the National Research Council facilities in St. John's, Newfoundland. Test results indicate that the hull form and installed power will greatly exceed the performance requirements established by the Coast Guard for this vessel.

Specifications for the principal dimensions and power requirements were developed to meet all the operational requirements identified in the mission profile, while at the same time maintaining reasonable capital, operations and maintenance costs. These specifications, which are based on the considerable experience accumulated by Canadian and International marine industry experts in the design and operation of Coast Guard and civilian icebreakers, plus the results of extensive studies and the tank model tests referred to above, are as follows:

• Length overall	167.8 m
• Length at waterline	150.0 m
• Breadth overall	36.0 m
• Height above waterline (excluding antennas)	40.0 m
• Draft (Constant Displacement)	12.5-13.5 m
• Displacement	38,930 t
• Speed, Cruising	15 kt
• Speed, Maximum	19 kt
• Complement, normal	96 persons
• Complement, maximum	154 persons
• Installed power	80 megawatts (107,000 hp)

6.2.2 Performance

To meet operational requirements, specific requirements were established for the ship's performance both in open water and in ice. In open water, the Polar 8 will be capable of a cruising speed of 15 knots, with a maximum speed of 19 knots. The performance attributes and physical characteristics required for operation in ice are as follows:

a) Continuous Icebreaking Capability Ahead

The ship will be capable of maintaining steady progress of greater than 3 knots in all ice conditions up to and including 2.44 metres of consolidated 10/10 pack ice including 7/10 multi-year ice having a snow cover of 0.3 m, and with the vessel subjected to ice pressures in excess of those specified in the ASPPR.

b) Icebreaking Capability Astern

The ship will have a superior icebreaking capability in the astern mode in order to provide assistance to beset ships under escort. This includes the ability to manoeuvre astern in a controlled manner.

c) Ramming

The ship will be able to make effective progress through consolidated multi-year ice up to 8.7 metres thick by backing and ramming operations.

d) Turning Ability In Ice

The ship's escort role requires that it have superior turning capabilities in ice, both ahead and astern, in order that it may readily and swiftly turn out of its track and penetrate the solid ice sheet in freeing a trapped vessel.

6.2.3 Endurance and Range

The fuel and oil capacity of the shipboard tanks is in excess of 13,000 tonnes, which will provide an operating range in open water of approximately 30,000 sea miles at 15 knots with adequate reserves.

The Polar 8 will carry equipment to produce all of its requirements for fresh water. This fresh water capacity will be approximately 400 tonnes, sufficient for 300 litres per person per day in addition to other vessel requirements. In addition, in the event of a temporary breakdown of this equipment, the fresh water tank capacity will provide a minimum of 7 days supply.

The extensive stores and provisions capacity of the Polar 8 will allow the ship to operate for up to 270 days without resupply, other than perishables and fuel.

6.2.4 Environmental Conditions

Polar 8 has been designed for operation in the following environmental conditions:

Outside Air Temperature	:	Low -51° C High 35° C
Wind Velocity	:	185 km/hr
Water Temperature	:	Low - 2° C High 30° C
Dynamic Roll and Pitch Conditions	:	Maximum 22.5° port or starboard, 45° out to out, with cycle period of 15 seconds, together with a pitch of 7.5° by bow or stern.
Permanent List	:	Maximum 15° port or starboard, not cumulative with dynamic roll and pitch.
Pitch	:	Maximum 12° above or below horizontal.
Permanent Fore and Aft Trim	:	Maximum 5° above or below horizontal, not cumulative with pitch.
Accelerations	:	As expected from normal sea state in Polar 8's intended service. Support structure for equipment shall be designed for these accelerations or a shock load of 3 g horizontal and vertical for 10 milliseconds, whichever is the most stringent.
Vibration	:	0.5 g continuously at 10 Hertz.
Icing Conditions	:	150 mm thickness of ice on all exposed horizontal surfaces.

6.2.5 Emissions

The Polar 8 has been designed to meet or exceed all existing and applicable emission regulations, and the Coast Guard has included features in the design that address those areas where regulations do not exist.

6.2.5.1 Noise

In order to effectively deal with the noise produced by the Polar 8, a Noise Control Plan will be implemented by the shipyard during construction of the vessel. Noise levels will be controlled through the use of noise barriers, acoustical enclosures, mufflers, sound absorbing materials, duct wrapping, resonance damping, flexible connections and vibration and isolation mounts. Additionally, the noise characteristics of propeller designs will be tested in the development of efficient propellers that produce a minimum amount of noise.

During the proof of performance phase of the Polar 8 project, a detailed noise analysis will be conducted that will be used to develop a profile of the noise generated by the ship into surrounding waters at different ranges, out to the point where the noise cannot be heard. This information will be used in planning routes around sensitive areas of the Arctic to minimize, where possible, the impact on environmentally sensitive areas. This is discussed further in Chapter 8.

6.2.5.2 Airborne

There are three main sources of airborne emissions on board the Polar 8. These sources depend on a combustion process to provide heat, power and to dispose of waste, and are:

- diesel engines;
- incinerator; and
- thermal heaters.

The Polar 8 design respects the Canada Shipping Act (CSA), Air Pollution Regulations governing smoke emissions from shipboard sources, and because it is anticipated that these regulations will continue to evolve in response to environmental concerns, the Coast Guard will monitor these changes closely to ensure that the Polar 8 will continue to meet all air pollution requirements.

Equipment emissions will depend on the manufacturer and model selected, as well as on the power level being maintained, the condition of the equipment, and

the substance being consumed. However, in general, the composition of airborne emissions, expressed as a percentage of the volume of exhaust gas, is expected to be:

• nitrogen	77%
• oxygen	13%
• carbon dioxide	5%
• water vapour	5%
• misc (ash, soot, carbon monoxide etc.)	Negligible

6.2.5.3 Water

The Coast Guard has specified that the Polar 8 design include facilities to ensure that no untreated waste be discharged overboard, and that all MARPOL, ASPPR, and CSA Regulations regarding waste disposal be met. To meet this requirement, a sewage treatment plant, a water/oil separator, and an incinerator will be installed on the ship.

The sewage treatment plant will take grey and black water from the drains and vacuum toilet system on the ship and process it through a system consisting of aeration, settling, and sterilization chambers capable of handling 100 percent of the anticipated effluent. The end product of the process will consist of clear and sterilized water to be discharged overboard, and solid waste to be disposed of in the incinerator. Residues from the incinerator will be transferred to a resupply ship or to an approved land-based disposal site.

The ship's system will be able to handle all of the anticipated effluent, including situations where the Polar 8 is used as temporary accommodation during an emergency. It is estimated that the average volume of grey and black water processed in the sewage treatment system will be in the order of 19,000 litres per day based on 100 people on board the vessel.

The water/oil separator will take the oily water collected from the bilges of machinery spaces and held in a retention tank, separate it into clean water to be discharged overboard, and an oil sludge to be incinerated.

6.3 VESSEL DESIGN AND CONSTRUCTION CODES AND STANDARDS

The codes and standards governing the design and construction of ships expected to operate in ice-infested waters are based on the essential requirement to ensure safety of life at sea, and to prevent pollution.

The Polar 8 has been designed to meet, as a minimum, the technical and performance requirements of the Arctic Shipping Pollution Prevention Regulations (ASPPR) for an Arctic Class 8 vessel. In addition, the Coast Guard has specified performance requirements necessary for the vessel to achieve its assigned roles. This was done in recognition of the fact that modern structural design concepts must be taken into account in the design of the vessel. This also recognizes that hull scantlings generated solely by the current ASPPRs might not satisfy the Coast Guard's operational intentions for the Polar 8. Therefore, certain structural requirements are expressed in terms of ship performance. These performance requirements for continuous icebreaking capability ahead and for ramming were described earlier in Section 6.2.2.

Because these requirements led the designer into "state of the art" icebreaker technology, the Coast Guard specified that an in-depth structural analysis would be undertaken to ensure that the hull strength would be adequate to withstand the anticipated pressures, and to minimize the possibility of structural fatigue problems occurring during the service life of the vessel.

In order to reinforce the designer's appreciation of these structural performance requirements, the Coast Guard further specified that the ship would be designed and constructed for rigorous year-round service during a 30 year life span. The Coast Guard further specified that in an emergency or unforeseen circumstances the ship would be required to operate in conditions exceeding those anticipated for an Arctic Class 8 vessel.

In addition to referencing the Arctic Class 8 standards, the Coast Guard has directed the designer to conduct a classification process with "an internationally recognized classification society having well-proven experience in the classification of icebreakers for operations in Polar regions." Det Norske Veritas (DNV), has been selected, based on its reputation as the leading classification society for ice capable vessels.

Both DNV and the Coast Guard's Ship Safety Branch have reviewed the design and given approval in principal, indicating that no significant problem areas appear to exist in meeting their respective classification standards.

6.4 DESIGN FEATURES

Several unique features have been incorporated in the Polar 8 design to ensure the overall safety of the vessel and its crew, and to enhance its operational abilities. These include, fuel tank arrangement and design, flooding and fire protection, and the type of steel to be used in construction of the vessel, among others.

6.4.1 Stability

The intact and damage stability characteristics of the Polar 8 will greatly exceed the requirements contained in the CSA and the AWPPA, and in the regulations of the International Maritime Organization (IMO), the international ship safety organization. Intact stability refers to the ability of the ship to maintain trim during normal open water and icebreaking operations, even when coated with 150 mm of ice. To ensure damage stability, the ship must also be subdivided internally so that it will remain afloat and upright in the event of damage.

In the area of intact stability, the Coast Guard has specified that the vessel exceed the established criteria by a factor of six. At this point in the design process, detailed hydrostatic calculations and weight estimates indicate that the ship will exceed even those requirements.

The Polar 8 has been designed to withstand damage far in excess of that specified in the applicable regulations. Although the existing regulations would result in a ship with adequate protection from damage likely to occur during ship/ice interaction, the Coast Guard has specified that the more stringent IMO Safety of Life At Sea (SOLAS) convention for passenger ships be used in the design and construction of the Polar 8. As a result, the damage stability of the ship will be very high, and the ship will be able to withstand the complete flooding of two adjacent compartments without danger of sinking.

6.4.2 Fire Protection

To ensure exceptional fire protection, the Coast Guard has specified that the Safety Of Life At Sea requirements for fire protection in passenger vessels be

adopted for the ship, resulting in the highest possible standards for structural fire protection, detection and extinguishing. Additionally, the Coast Guard has specified that a sprinkler system be installed throughout the ship.

6.4.3 Fuel Tanks

The Polar 8 will carry approximately 13,000 tonnes of diesel fuel and 875 tonnes of aviation fuel in a number of tanks. To minimize the possibility of pollution and the quantity of fuel that might leak into surrounding waters in the event of damage to the ship's hull, the ship is designed with a double hull. The fuel tanks are separated from the outer hull of the ship by voids and ballast tanks to a minimum of 1.8 meters. In addition, the fuel will be stored in 21 separate tanks, 18 for diesel fuel and 3 for aviation fuel. The maximum amount of fuel in any one tank is 1,000 tonnes. (See Figure 6.4.1.)

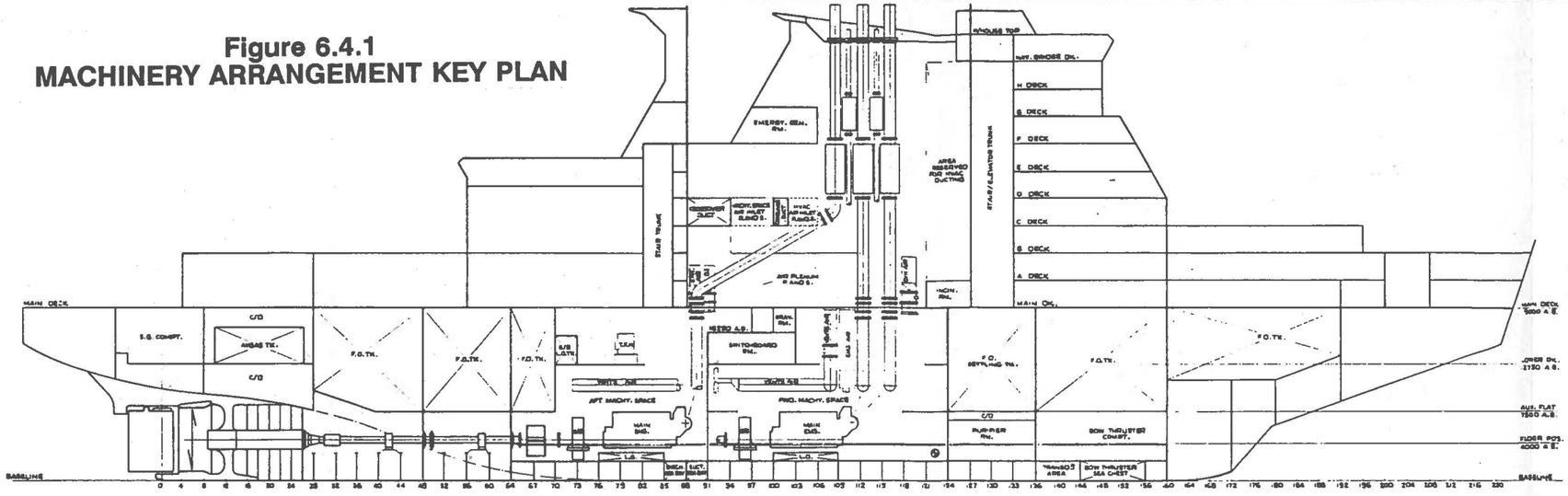
6.4.4 Steel

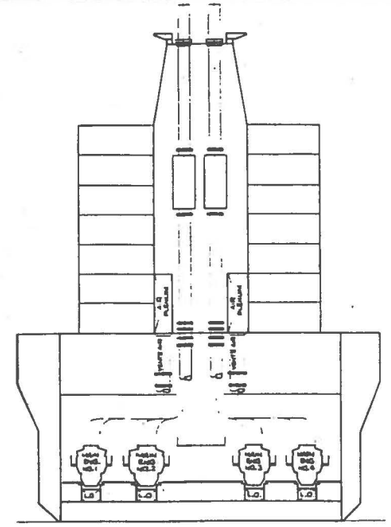
In recognition of the effects of continual exposure to very cold temperatures on steel, and the resulting brittleness of the material, the Coast Guard has specified that the steel used in the Polar 8 be tested for its fracture toughness using special drop-weight testing methods. As a result, the steel to be used in the Polar 8 will retain its ductility transition characteristics down to minus 60° Celsius.

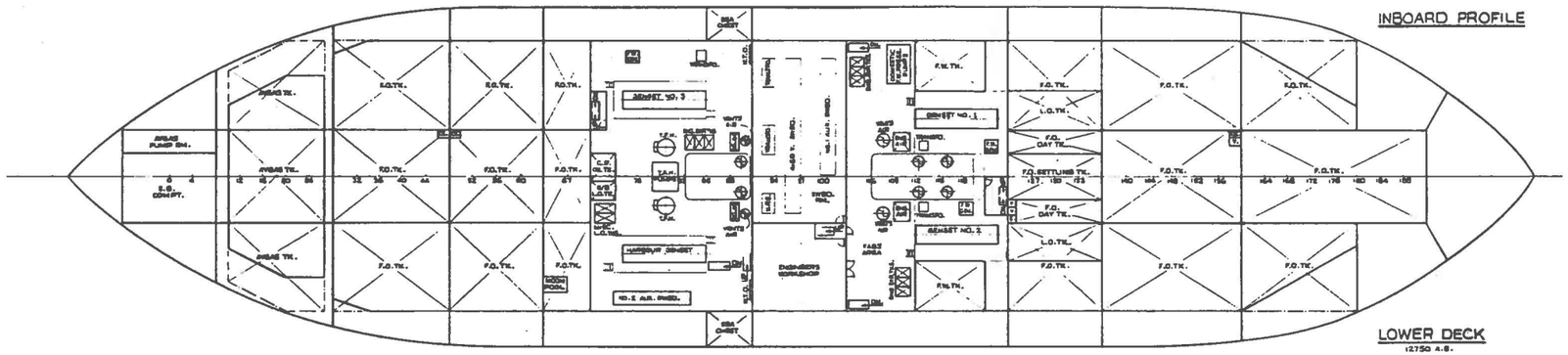
6.4.5 Lifesaving Equipment

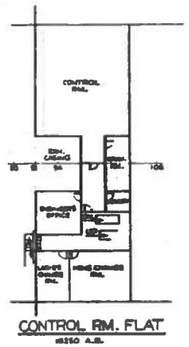
To ensure that adequate lifesaving equipment is available to the Polar 8's total complement in the event of an emergency, the Coast Guard has specified that the regulations governing lifesaving equipment required for passenger vessels be used in the design of the Polar 8. This will result in the vessel being equipped with more than double the covered lifeboats, life rafts and other safety equipment required for a non-passenger ship of its type. In addition, the Coast Guard has funded the development of the Arktos escape vehicle which has been designed as a mobile and self-contained Arctic emergency unit. This escape vehicle will be able to take people off the ship when full or partial ice cover precludes the use of conventional lifeboats. CCG has, as well, specified that suitable cold water immersion suits be available for all personnel on the ship.

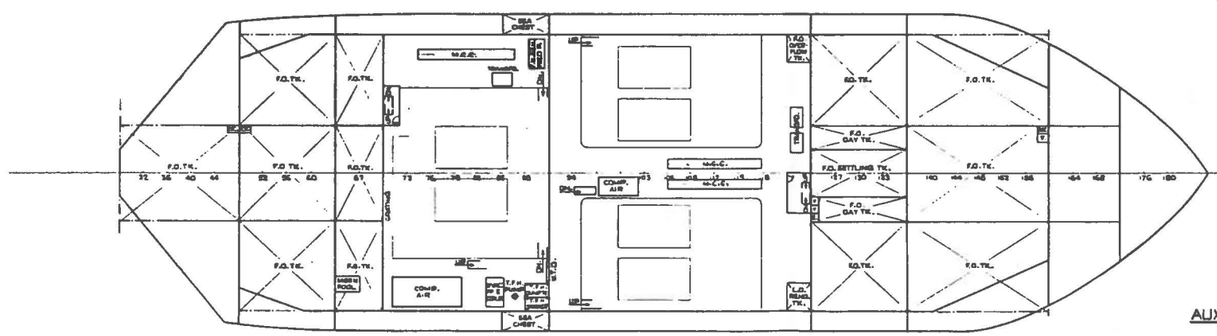
Figure 6.4.1
MACHINERY ARRANGEMENT KEY PLAN

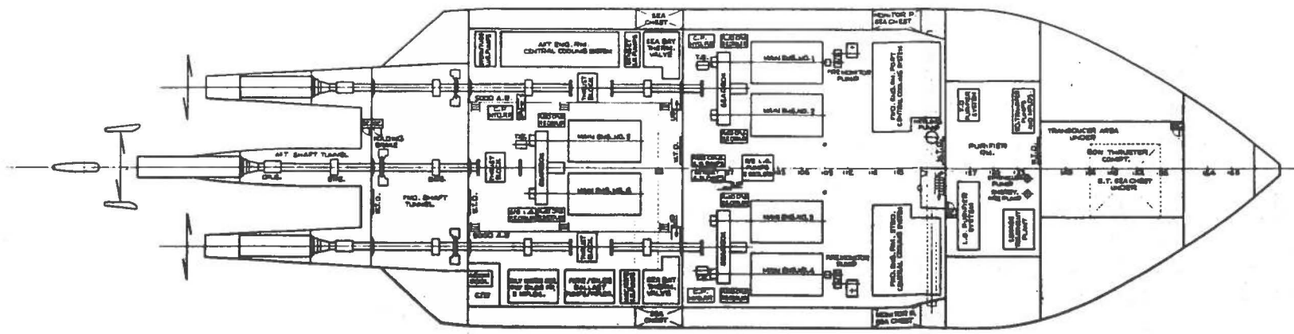












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REV.	DATE	DESCRIPTION	DR.	CHK.
H	11-01-05	AFT MACHY. SPACE ESCAPE REVISED.	J.D.	JL
G	05-01-05	MACHY. SPACE ESCAPES ADDED	J.D.	JL
F	12-12-08	REVISIONS TO SUIT CHKRS RESULTS.	J.D.	JL
E	22-11-05	UP-DATE	J.D.	JL
D	10-11-05	UP-DATE	S.A.P.	SP
C	4-11-05	PRE-DRAWING	J.D.	JL

ACTIVITY	DATE
DR. J.D.	4-11-05
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APPROVED	DATE
CLASSIFICATION	
C.C.G. – S.S.B.	
	FEB 22 2009
	FEB 26 2009

PREPARED BY
POLAR ICEBREAKER CONSTRUCTORS

OWNER
CANADIAN COAST GUARD

POLAR 8 ICEBREAKER
TRIPLE SCREW GEARED DIESEL

TITLE
MACHINERY ARRANGEMENT
KEY PLAN

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CHAPTER 7

PROJECT/ENVIRONMENT INTERACTIONS

The potential interactions between the Polar 8 and the environment are discussed in this chapter. The methodology used to evaluate potential impacts is described in the following sections. The main project activities are reviewed and the key components of the ecosystem that are of concern are summarized. Finally, a Level 1 Matrix (FEARO 1978; Duffy 1986) is constructed for the Polar 8 project. This matrix identifies possible interactions between the ship activities and the environment.

The study area for this IEE includes all Canadian Arctic waters. As previously mentioned, most operations will occur in the Canadian Archipelago and few will occur in Hudson Bay, Foxe Basin, Baffin Bay or Davis Strait. It will require 4 years to construct the icebreaker. Thus, project activities are not expected to commence before 1994.

7.1 METHODS OF IMPACT EVALUATION

This section describes methods of impact evaluation. Described in this section are environmental components that are considered in the IEE, types of potential impacts and a definition of each level of impact used in the IEE.

7.1.1 Valued Ecosystem Components

It is not possible to address all potential project interactions with the environment (Duffy 1986); there are many interactions that are unimportant. For example, millions of zooplankters may be killed by passage through the engine cooling system, however the numbers killed would be insignificant in relation to the size of local populations. This IEE attempts to focus on important issues and questions concerning valued ecosystem components, or VEC's.

Valued ecosystem components can include rare or threatened species or habitats, species or habitats that are unique to the area, or are valued for their aesthetic properties, and species that are hunted or fished by local populations. The culture and lifestyle of the people inhabiting the Polar 8's operational area are

also valued ecosystem components. Valued ecosystem components are identified in Section 7.3 Environmental Components.

7.1.2 Types of Potential Impacts

Potential interactions between the project and the environment are identified in a Level 1 Matrix (Section 7.4). The matrix identifies interactions only and makes no assumptions about actual impacts of the interactions. Interactions are then evaluated as to their potential for impact. An interaction is considered to have an impact if it:

a) Causes a change in the lifestyle of native peoples,

b) Causes a change in the health and safety of people,

c) Causes a change in the abundance or distribution of species that are valued ecosystem components, or in their prey species,

d) Causes a change in habitats used by species that are considered to be valued ecosystem components,

Impacts can be positive or negative. Examples of positive impacts could include providing early response to pollution events, thereby minimizing environmental damage, or conducting scientific research that could be used to mitigate effects of other developments in the Arctic. Negative impacts are those that cause a change that is considered to be deleterious. Examples of possible negative impacts are interference with native hunting activities on the ice and disturbance of marine mammals.

7.1.3 Levels of Potential Impacts

In an initial evaluation of the potential effects of the Polar 8, it is important that easily understood terminology is used. Words such as minor, moderate, significant and so on are subjective and mean different things to different people. For example, an impact may be considered to be significant by one reader but insignificant by another reader. Therefore, precise definitions for the ranking of potential impacts are used in this IEE. This has the benefit of making the impact ranking clear to the reader. On the other hand, it suggests that the actual impact ratings are precise, although this is not the case!

The impact rankings are based on the informed judgements of experienced scientists. They are based on the available data, but in many cases the data are

insufficient to allow certain or precise impact evaluations. When impact predictions are tenuous, this is noted in the text. We believe it is legitimate to define precisely the impact definitions even though it is not always possible to determine the precise levels of impact.

The following terms are used to rate impacts.

Major Impact - An impact is rated major if it is judged to result in a 10% or greater change in the carrying capacity of the environment, size of animal populations, or the size of a resource harvest.

Moderate Impact - An impact is rated moderate if it is judged to result in a 1% to 10% change in the carrying capacity of the environment, size of an animals population, or resource harvest.

Minor Impact - A impact is rated minor if it is judged to result in a change in the carrying capacity of the environment, animal population size, or resource harvest that is less than 1%.

Negligible Impact - Negligible impacts are those that are judged to have essentially no effects.

Regional Significance - An impact of regional significance is an interaction that is judged to have an impact at the regional level. For the purposes of this IEE, the regions are Eastern Arctic Islands, Central Arctic Islands, Western Arctic Islands, Hudson Bay, Foxe Basin, Baffin Bay - north of Lancaster Sound, Baffin Bay - south of Lancaster Sound, Davis Strait, Beaufort Sea and Arctic Ocean.

Local Significance - An impact of local significance is an interaction that is judged to have an impact at the local level. For the purposes of this IEE, local means one community, hunting area, or a discrete geographical area such as Prince Regent Inlet or Eclipse Sound.

Short Term - Impacts are considered to be short term if their effects on the environment last for a period of less than one year.

Medium Term - Impacts are considered to be of medium term if their effects last for periods of one to five years.

Long Term - Long term impacts are those whose effects are judged to last for more than five years.

Terms can be combined, as appropriate, to define an impact. For example an impact can be rated as a positive, long term impact of regional significance.

It is possible that impacts can be mitigated by changes in design, equipment or operational procedures. These mitigation measures are discussed in Chapter 11: Mitigation. In this IEE, the impacts of various project activities are evaluated both before and after the mitigation measures in Chapter 11 have been applied.

7.2 PROJECT ACTIVITIES

Normal operations conducted by the Polar 8 icebreaker are described in Chapters 4 to 6. These operations will include the following activities;

- travel in open water,
- icebreaking,
- flights by the ship's three helicopters,
- operations by the ship's launches and vehicles, and
- refuelling.

Travel in open water, icebreaking and operations by the ship's aircraft, vehicles and launches will generate noise and could cause some physical disturbance to the environment. These effects are discussed in Sections 8.2 (Effects of Icebreaking), 8.3 (Noise and Disturbance), and 8.5 (Effects on Resource Harvesting). Mitigation measures are discussed Chapter 11.

The support infrastructure necessary to maintain the ship on station will include arrangements for employment, purchasing and resupply. The effects of these activities are discussed in Section 8.6 (Socio-Economic Effects).

Because of design considerations and operational precautions, accidents including oil spills are only a very remote possibility. These are discussed in Chapter 9 (Effects of Accidents).

7.3 ENVIRONMENTAL COMPONENTS

Environmental components within the Polar 8's operational area in the Canadian Arctic are briefly identified in this section. However, this material is not meant to give a full description of the environment of the Canadian Arctic. This section

is intended to provide a brief review of the aspects of the environment which will or could be effected by the Polar 8, including:

- General ice conditions,
- Lower trophic levels,
- Fish,
- Birds,
- Marine mammals,
- Ice edges,
- Polynyas,
- Inuit resource harvesting, and
- socio-economic environment.

Overviews of the environment of large portions of the Canadian Arctic can be found in Arctic Pilot Project's Integrated Route Analysis (1982); LGL Ltd. (1982a,b; 1983) and Dome *et al.* 1982b.

7.3.1 General Ice Conditions

Sea ice is the environmental parameter that most affects, and will be most affected by, the operations of the Polar 8. The sea ice environment of the Canadian Arctic is characterized by large spatial and temporal variations in the extent of ice coverage, the types of ice present, and their distribution and surface roughness. This section briefly defines and describes those aspects of sea ice believed most relevant to the discussion of the environmental impact of the Polar 8 operations.

The ice cover throughout the Canadian Arctic can be described by three ice zones; a zone of landfast ice, a transition zone and a mobile pack ice zone. Features of the zones are discussed in the next subsections, beginning with the fast ice zone. This is followed by brief descriptions of the transition/shear zone and pack ice zone respectively relative to the Polar 8 operations. Also included is a brief description of the distribution of icebergs and ends with a description of the important elements of ice break-up and the locations of critical ice edges and bridges.

7.3.1.1 Fast Ice Zone

The Polar 8 will spend a significant portion of its time in regions covered by fast ice. Between freeze-up of the ice cover in the fall and break-up in the following spring, access to most sites within the Arctic Archipelago and along the Beaufort Sea coast will require breaking through channels and bays covered with fast ice.

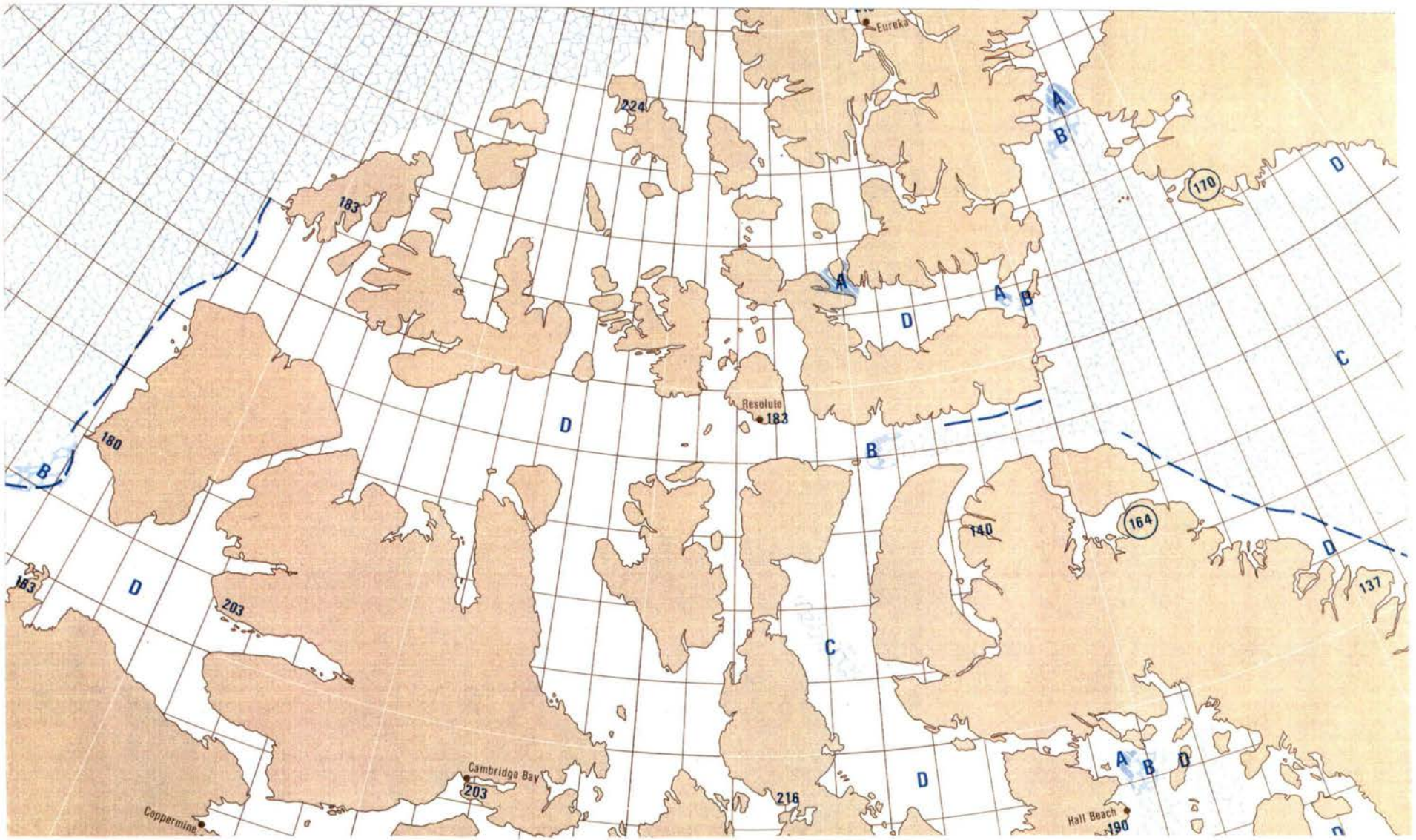
Fast ice is defined as ice which forms and remains fast along the coast, attached to the shore, to an ice front, between shoals or to grounded icebergs. It may be formed in-situ through freezing of floating ice and can extend a few metres or several hundred kilometres from the shore. It may be more than one-year old in which case it may be prefixed with an appropriate age category (old, second-year, multi-year) (AES 1989). The landfast or fast ice zone extends from the shoreline to a boundary that is usually located in the vicinity of the 20 to 25 m water depth contour depending on geographic location. The water depth corresponds to the limiting depth to which ice ridges and hummocks may ground, forming off-shore anchor points for the new season's fast ice (CHS 1982). Ice within the fast ice zone is laterally immobile and only moves vertically under the action of tides.

During formation, the fast ice edge may experience one or more events that produce ridges and/or rubble piles along it. These features result from pressure exerted by pack ice driven against the ice edge by onshore winds or the shearing action of pack ice against the edge. Part or all of the landfast ice may become detached from shore by offshore winds. Most of these types of events occur during the fall period when the ice is in its initial stages of growth, and when the likelihood of storms that drive the pack ice is higher. There are also periods of relative stability where the ice edge maintains the same position. During these periods ridges may form at the seaward edge, generally paralleling the landfast edge in existence at the time. The edge may subsequently relocate further away from shore, thus ridges that had formed in the earlier location become incorporated into the fast ice cover.

An area of fast ice may also include old ice floes that drift into it during its formation, becoming grounded or trapped within the ice matrix. Fast ice may also incorporate grounded icebergs which serve as anchor points for extended seaward development beyond the 25 m water depth.

The extent of fast ice varies considerably in the Canadian Arctic depending on the time of year. In the winter months, most of the channels in the Arctic Archipelago are covered by fast ice. It reaches its maximum extent near the end of April in most years, and is at a minimum in early September, just prior to the start of freezing conditions. Figure 7.3.1.1 presents the extent of coverage in late April (Markham 1981). This figure is representative of fast ice coverage in many, but not all, years. Minimum ice coverage in the Arctic, including both fast and pack ice, occurs around the end of August or early September. The extent of coverage is highly variable between years and between areas. Figures 7.3.1.2a and 7.3.1.2b show the maximum and minimum coverage of ice for the High Arctic regions for September 3 (Markham 1981).

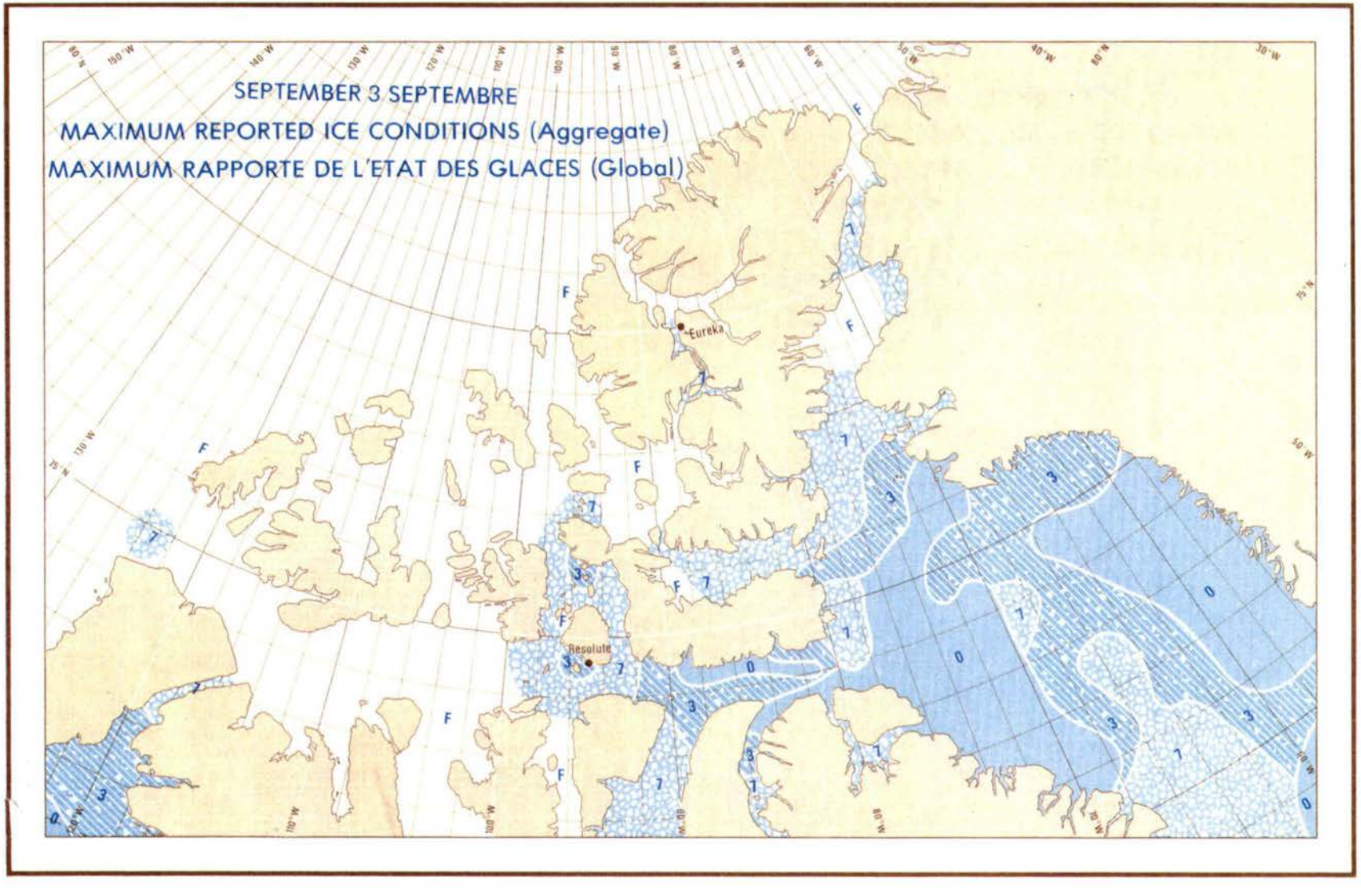
Figure 7.3.1.1
AVERAGE WINTER ICE CONDITIONS - CANADIAN ARCTIC, LATE APRIL



A - Well dispersed pack ice (appreciable open water), B - Partially dispersed pack ice (new ice and open water present), C - Moving pack ice (some new ice or open water present), D- Consolidated or fast ice

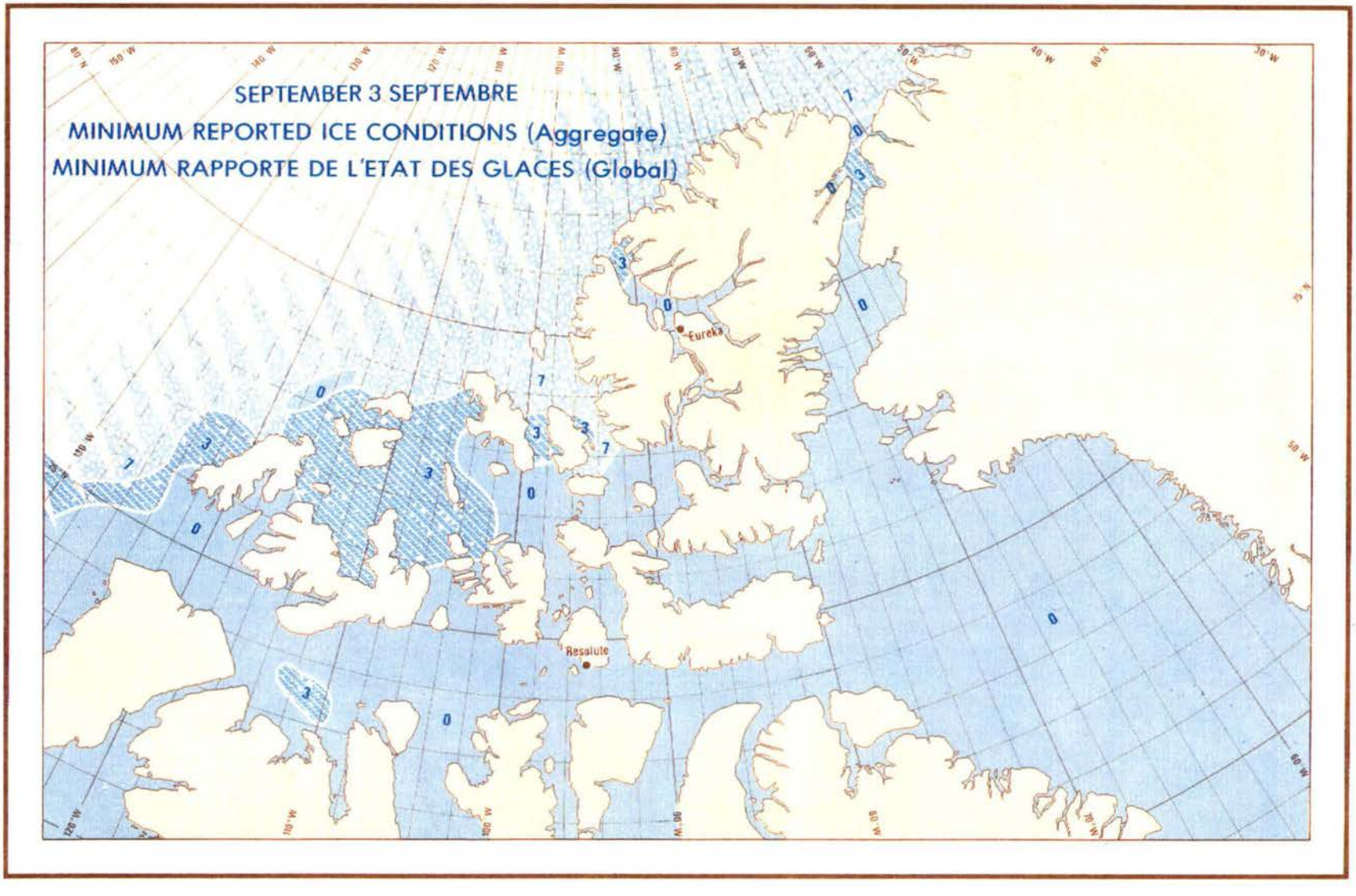
Source: Markham, 1982

Figure 7.3.1.2a
MAXIMUM ICE CONDITIONS - CANADIAN HIGH ARCTIC, SEPTEMBER 3



0 - open water, 3 - 1 to 5/10 pack ice, 7 - 6 to 9/10 pack ice, F - 10/10 consolidated of fast ice
Source: Markham, 1982

Figure 7.3.1.2b
MINIMUM ICE CONDITIONS - CANADIAN HIGH ARCTIC, SEPTEMBER 3



0 - open water, 3 - 1 to 5/10 pack ice, 7 - 6 to 9/10 pack ice, F - 10/10 consolidated of fast ice
Source: Markham, 1982

Ice thickness in fast ice regimes varies as a function of the time of year and geographic location. The ice type dominating the landfast zone is first-year ice which can grow to a maximum thickness of 2.2 metres each year. Multi-year floes are occasionally trapped within the landfast ice, and in the winter when much of the Archipelago is covered with fast ice, multi-year ice is the predominant ice type in many of the northern channels as well as channels such as Viscount Melville Sound and M'Clintock Channel. In the Beaufort Sea, the coastal landfast ice zone occasionally has multi-year floes which are 3 to 4 m thick, and can contain pressure ridges in excess of 25 m in total thickness (Wright *et al.* 1981).

Fast ice is level in many channels and bays, but in other consolidated fast ice areas such as Parry Channel in winter, there are areas of heavy ridging and rubble. This non-level ice presents a more formidable barrier to the Polar 8, and may necessitate backing and ramming procedures in order to transit the area. In fast ice regimes that develop from shorelines, the more significant pressure ridges and rubble fields are located near or at the seaward edge in the spring. These ridges mark the fast ice boundary, and the Polar 8 must cross these features to enter channels and bays.

Ridges have been the subject of investigation for many years and the data is normally presented in terms of number of ridges per kilometre, mean height, distribution of height and spatial recurrence of these heights (Dickins 1981). Much less work has been done on ridge keels, total ridge mass and degree of consolidation. The total thickness of the shear ridges at the edge of the fast ice may be as great as 25 m corresponding to the maximum grounding water depth.

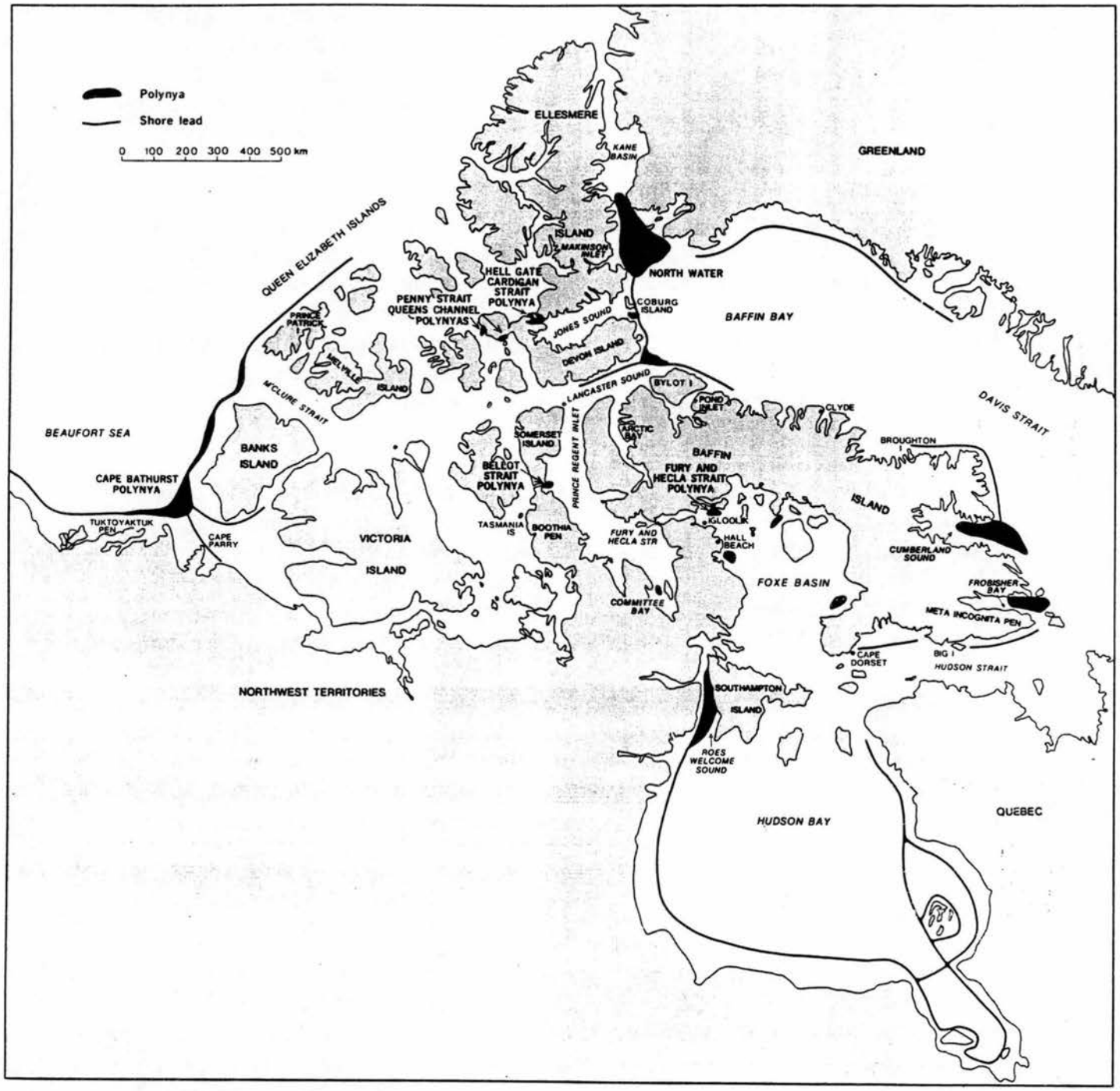
Another feature of the winter fast ice regime is the occurrence of polynyas, which are non-linear openings enclosed by ice that tend to reoccur in approximately the same location from year to year (AES 1989). Some polynyas may be present all winter, while others develop only for short periods in early spring. Figure 7.3.1.3 presents a map of the distribution of polynyas in the Canadian Arctic (Stirling 1981).

7.3.1.2 Transition/Shear Ice Zone

The transition or shear zone separates the fast ice zone from the moving pack ice. The shear zone develops from the shearing action of pack ice along the seaward face of the fast ice. This produces ridges and/or rubble fields paralleling the fast ice edge. The extent of the shear zone can be as narrow as the width of one shear ridge such as is commonly observed at the north end of Admiralty Inlet

Figure 7.3.1.3

DISTRIBUTION OF POLYNYAS IN THE CANADIAN ARCTIC



Source: Stirling and Cleator (1981)

in the spring, or it may be hundreds of kilometres wide in locations such as the Beaufort Sea.

The largest and most well-developed shear zone occurs in the Beaufort Sea. It is referred to as the seasonal ice zone, where shearing between the moving pack and landfast ice occurs. It can vary in width from a few to 300 kilometres depending on the northerly or southerly drifts of the pack (Beaufort EIS Summary 1982). With favourable offshore winds in winter and spring, an open lead can develop adjacent to the landfast edge that can extend for tens of kilometres and can persist for days or even weeks.

Shear zones are characterized by extensive ridging resulting from the relative movement of pack ice and the crushing of newer ice types that develop in leads. In the Beaufort Sea the frequency of ridging in the shear zone is higher than in the landfast ice zone, but the total ice thickness is lower when compared to the ridges near the seaward edge of the landfast ice. Total thicknesses in the order of 10 to 15 m are reported for ridges in the Beaufort Sea shear zone (Wright *et al* 1981).

7.3.1.3 Pack Ice Zone

The pack ice zone consists of individual ice floes that are reasonably free to move under the action of winds, currents or internal stresses. During ice formation, pack ice develops from a combination of ice pieces that break away from the fast ice and from the formation of new and young ice in the open sea. The new ice is continually broken up by waves and winds as it thickens. Throughout the winter period the pack ice grows progressively thicker, although there are still considerable leads and cracks which develop as the ice drifts and is shifted by winds. A common feature of the winter pack ice regime is the presence of leads and cracks as well as newer ice types that develop from refreezing of these features.

Many of the pack ice areas in the Canadian Arctic contain multi-year ice floes for part of or all of the year. Multi-year floes are thicker, stronger and generally larger than first-year ice floes and in some areas, particularly in the High Arctic waterways north of Parry Channel, are the dominant ice type in the area. The winter pack ice regime consists of ice of all sizes and ages from new ice that may be hours old to multi-year ice floes which are several years old. The same comments also apply to winter fast ice regimes.

During the break-up and melt period from May until the end of August to mid-September, pack ice coverage in the Arctic channels increases as the fast ice

cracks and breaks into individual floes. The newly formed floes are free to move under the action of winds and currents. These floes drift while continuing to melt, resulting in a decrease in overall total ice coverage, with some areas becoming free of ice entirely.

Figure 7.3.1.1 showed the distribution of pack ice regimes (< 10/10ths coverage) in the Canadian Arctic for late April when fast ice is at its maximum extent. The Polar 8 will be travelling through pack ice in the Beaufort Sea and Arctic Ocean north and west of the Arctic Archipelago. Figures 7.3.1.2a and 7.3.1.2b showed the distribution of pack ice at the time of minimum coverage in early September with the observed maximum and minimum extents providing an indication of the potential variability in ice extent.

7.3.1.4 Icebergs

Icebergs are an important ice feature in Davis Strait, Baffin Bay and Nares Strait. They are also found in very limited numbers in Lancaster Sound, Barrow Strait, Navy Board Inlet and Eureka Sound. Icebergs are principally calved from glaciers along the west coast of Greenland from Disko Island northwards. They drift, mostly in response to the prevailing water currents, in a counter-clockwise direction in Baffin Bay/Davis Strait along the west coast of Greenland through the North Water area and along the east coasts of Ellesmere, Devon and Baffin Island coasts. A large number of icebergs cross the eastern entrance to Lancaster Sound after being transported there from Melville Bay by the West Greenland Current (Melville 1983).

Icebergs in Baffin Bay and Davis Strait are generally located in much higher numbers near the West Greenland coast and East Baffin Island coast. Figure 7.3.1.4 presents a contour map of iceberg sightings derived from analysis of flights made by the International Ice Patrol. Much lower numbers of icebergs are present in the centre of Baffin Bay and Davis Strait. A route followed by the Polar 8 in the centre of these two waterways should minimize encounters with icebergs of all shapes and sizes.

There are also sources of icebergs from glaciers along the east coast of Ellesmere Island as well as along the west coast of Greenland along the length of Nares Strait. For the Polar 8 entry into Nares Strait, the icebreaker will encounter much higher numbers of icebergs located within a more restricted channel for navigation. The concentrations will be highest near the calving areas in bays and fiords, and if the Polar 8 follows a route through the centre of Nares Strait, the number of icebergs will be minimized.

Figure 7.3.1.4

AVERAGE JULY TO OCTOBER ICEBERG CONCENTRATIONS BAFFIN BAY AND DAVIS STRAIT

Source: Arctic Pilot Project, 1981

7.3.1.5 The Break-up Process

Break-up is summarized for four areas; a) Parry Channel; b) Prince of Wales Strait; c) Sverdrup Basin and d) Nares Strait. The ice climatology of these areas has been studied over the past 10-12 years and reported in various journal publications and contract reports. These studies have resulted from several Arctic development programs including the Arctic Pilot Project, the Eastern Arctic Marine Environmental Studies (EAMES) Program, the Beaufort Sea Environmental Impact Statement and the M.V. Arctic program. The descriptions presented here borrow heavily from these studies as well as an unpublished Master's thesis (Gorman 1988) on the subject of sea ice characteristics of the Parry Channel.

a) Parry Channel

Break-up of the ice cover follows a regular pattern of events between late April and mid-August (Gorman 1988). The channel can be divided into two distinct ice regimes based on predominant ice type, extent of fast ice and break-up and freeze-up patterns:

- the relatively stable, predominantly old ice in Viscount Melville Sound and eastern M'Clure Strait in the west; referred to as Western Parry Channel

- the dynamic, mostly first-year ice in Lancaster Sound in the east; referred to as Eastern Parry Channel

Barrow Strait is a transition zone between the two channel sections, and commonly experiences large annual variations in ice conditions as well as variations in conditions between years (Dickins 1983).

The early stages of fracturing and break-up in Parry Channel are influenced by the location of fast ice edges in early spring. In Eastern Parry Channel, the ice edge position (and the extent of fast ice) is highly variable between years. Over the 26 years from 1964 to 1989, the fast ice edge has been in one of six locations (Hotzel and Noble 1979; Marko 1982; Lapp 1984; Lapp *et al.* 1986; Gorman 1988) which are illustrated in Figure 7.3.1.5. Figure 7.3.1.6 presents the distribution by year of the six locations for the past 26 years.

The break-up sequence in Parry Channel is illustrated in Figure 7.3.1.7 showing the geographic location of 14 discrete events that describe fast ice break-up in Parry Channel and adjoining channels. Break-up proceeds in a westerly direction

Figure 7.3.1.5
LOCATIONS OF EARLY SPRING FAST ICE EDGES IN PARRY CHANNEL

Source: Gorman, 1988

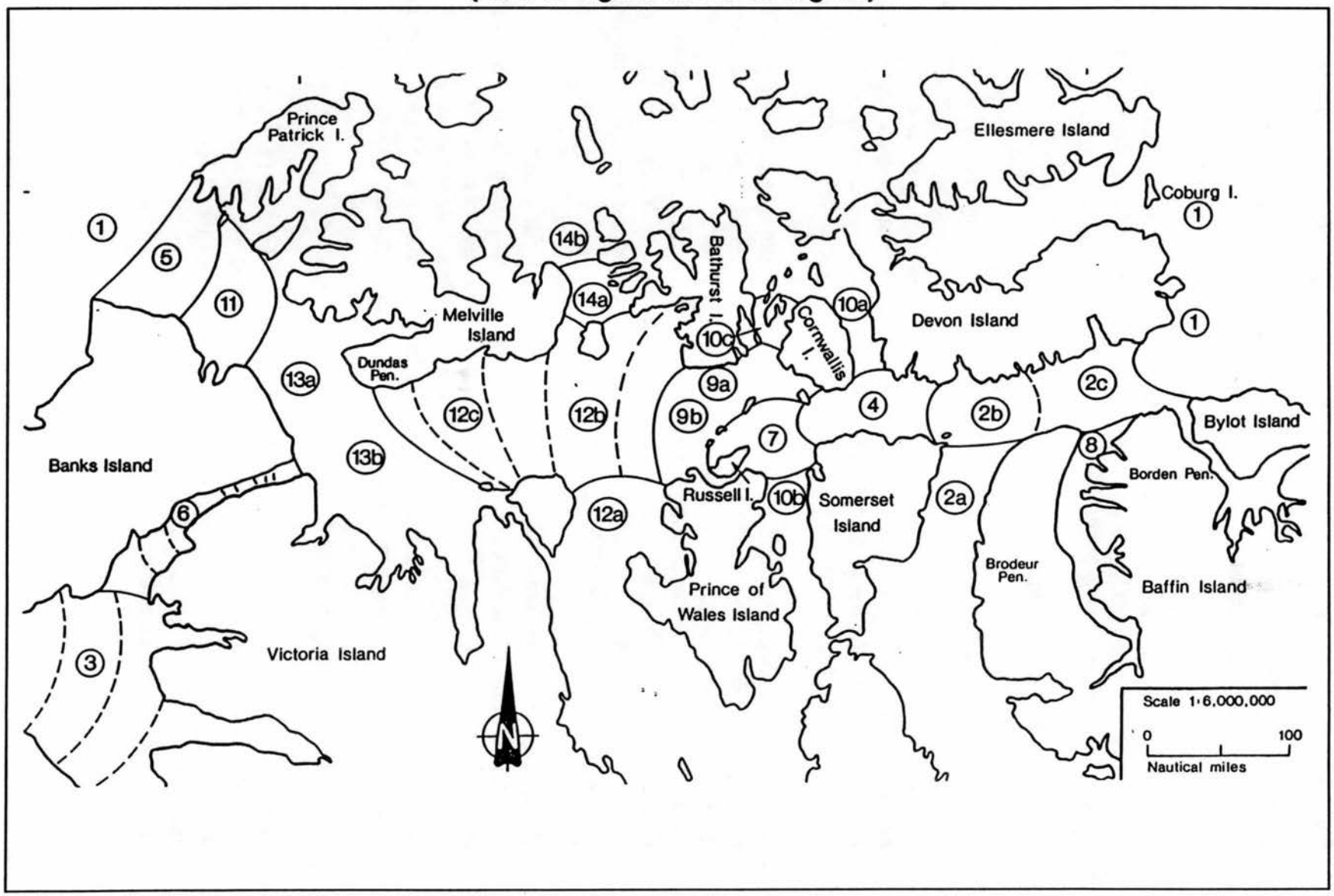
Figure 7.3.1.6

EARLY SPRING FAST ICE ICE EDGE LOCATIONS BARROW STRAIT AND LANCASTER SOUND 1964 - 1989

Location		Years	Percent of 26 year period
A)	Resolute to Griffith Island to Lowther Island to Russel Island.	1986	4
B)	Resolute to Griffith Island to Somerset Island.	1964 1969 1974 1976	15
C)	Devon Island to Prince Leopold Island to Somerset Island.	1965 1973 1988 1966 1975 1967 1977 1968 1980 1971 1981 1972 1985	50
D)	Devon Island to central Brodeur Peninsula, Baffin Island.	1982 1989	8
E)	Devon Island to Cape Charles Yorke, Baffin Island.	1970 1984	8
F)	Devon Island to Bylot Island east of Navy Board Inlet	1978 1987 1979 1983	15

Sources: This study and Gorman 1988, Lapp 1984, Hotzel and Noble 1979

Figure 7.3.1.7
BREAK-UP SEQUENCES FOR THE PARRY CHANNEL
(refer to Figure 7.3.1.8 for legend)



Source: Gorman, 1988