1 INTRODUCTION

The Arctic Canada/West Greenland Oil Supply study was commissioned by the Government of North West Territories in co-operation with the Greenland Home Rule Government, to review the planned arrangements for supply and distribution of oil products in Greenland and the Canadian North West Territories.

The scope of the study includes the sourcing, transportation and distribution of oil products, to evaluate the potential benefits in combining the Greenland and Canadian N.W.T. supply. It is envisaged that the potential outcome from such an integration would:

* Benefit the local Inuit communities and companies through a more economical and reliable supply of oil,

* Lower the cost for the supply of oil products through an optimization of the supply scheme and through combining the storage and transport facilities in Greenland and Arctic Canada,

* Strengthen relations between the communities of Greenland and Canadian North West Territories.

The first tasks of the study were to collect data on the current consumption and supply arrangements and to make a market analysis which identified political, economic, infrastructure and other likely developments or changes which may affect consumption patterns over the next five years. The result of these tasks is a comprehensive database for each community contained in an Interim Report issued on June 20, 1994.

In the second phase a number of scenarios have been analyzed including revised supply schedules for the different areas as well as for combined supply schemes. The results of this phase is given in this report.

The report first gives the background describing the differences and similarities between the two countries. This is needed to understand the limitations and the potential benefits arising from co-operation.

Secondly the present supply schemes for the two countries are described, and a number of key elements, which are important for the understanding of potential solutions are given.

Finally optimized supply systems for each country and a combination of common supply systems are described.

The results of this phase is given in Chapter 8, describing the scenarios and the cost analysis model. In the cost analysis an emphasis has been laid on the supply and distribution costs for the Canadian regions using the storage facilities at Polaroil in Greenland, as it was clear for the study group that the savings for those areas can be much larger than for the Greenland supply system.

The study has been carried out by Canarctic Shipping Company, representing GNWT, and N&R Consult and Royal Arctic Line representing the Greenland Home Rule company KNI. A steering committee with representatives from KNI and the participating companies directed the work in the study.

2 SUMMARY

The study has shown substantial differences between the supply systems in the two areas. This is due to historical development as well as to the different philosophy in the organisational approach used in the two countries.

The Greenlandic system is the result of long term development, started in the mid 60's. Since then emphasis has been placed upon security of supply, which has led to a long term concession to a government owned enterprise. This in turn has provided the basis for investments in permanent facilities, resulting in a highly efficient system with low marginal costs.

The Canadian system is built on an award of supply contracts on a competitive basis, quite often with fairly short term contracts. This has placed the emphasis upon the landed costs, but not encouraged long term investments. Today the system reflects this fact by fairly high operating costs compared to Greenland.

The study has clearly indicated, that substantial savings are possible, in particular in the Canadian part of the system. These savings can be reached by rethinking the supply system as a whole and making more use of direct import by seagoing tankers to suitable terminal ports in each supply area. Further savings might be possible by using coastal tankers direct to the beach instead of tug and barge in the final distribution.

For the Greenlandic part of the system only marginal savings seem obtainable. However, the future use of the Polaroil facility for transit of oil to Canada might benefit the Greenlandic economy.

The realisation of the proposed scheme calls for some investments in tank capacity over and above the requirements from the expected growth in consumption. The investments needed can be supported by the estimated savings which could be realised from an alternative system.

The legal and organisational framework for a change in the supply system has to be investigated in more depth before further optimisation of an alternative system is undertaken. Also the commercial and political considerations of a joint system should be addressed as one of the next steps.

3 BACKGROUND

3.1 Historical development of Northwest Territories and Greenland

The development of the infrastructure of Northwest Territories has taken place during this century. In the years previous communication was by hunters and miners operating out of Saskatchewan and Alberta. The development of the infrastructure reflects this. Most of the villages and hamlets are located near existing Inuit settlements or at places of strategic interest. Only a few of the settlements are located at places with good access from the sea; the shipping season is very short and access to the area has mainly been over land or ice cover. For this reason only a very few of the settlements today have adequate ports for ocean-going vessels.

In Greenland the infrastructure development has taken place during the last 250 years. In the beginning by whalers and missionaries and later during the colonisation by the Danes, Norwegians and other people. For these people it was important to have a port suitable for ocean going vessels whether or not there was an existing settlement at that location. The result is that all Greenland communities today have good natural harbours and with a few exceptions no towns are located at places where Inuit settlements existed before the colonisation.

The result of these differences in development is that the Canadian Arctic settlements often are located on flat terrain with poor harbours, while the Greenlandic towns are located near fiords with good natural harbours.

3.2 Topographical characteristics

Again the difference in the topography in Arctic Canada and Greenland has influenced the development of shipping conditions. The mountainous coast of West Greenland with deep fiords creates in many places excellent conditions for natural ports.

Except for the East coast of Baffin Island, the Canadian Arctic has flatter terrain, often with large stretches of flat lowland between the mountains and the coast, with shallow offshore conditions. In such areas it is very difficult to create deep water ports.

3.3 Climate

The West coast of Greenland and the most of the Canadian Arctic lies between the same latitude. However, the climate of west Greenland is influenced by a branch of the Golf current which gives the coast areas a relatively mild climate. Except for the Disco Bay area and North Greenland temperatures below -20C are unusual and the precipitation during the summertime is high.

In Arctic Canada temperatures below -40C are frequently observed in winter. The long time with sea ice cover creates a climate more similar to inland conditions.

3.4 Navigation possibilities and ice conditions

The waters of the Canadian Arctic archipelago and Hudson Bay are covered with a sea ice cover of varying concentrations for most of the year. Ice strengthened re-supply vessels regularly operate during a navigation season of 3 months duration which is reduced to about 2 months for some of the northern most settlements. The navigation season is extended by use of ice breakers or arctic ice class vessels.

In Greenland, the west coast south of the Disco Bay can be navigated year round. Only in short periods during spring and summer, is the navigation hampered by polar ice affecting access to the southernmost towns. The towns in Disco bay and the towns to the north are open to navigation for 5 to 7 months. Only the northern most town at Thule has a navigation season of more than four months.

3.5 Demography

The majority of the 55,000 inhabitants of Greenland lives on the West coast in towns ranging in population from 1 000 to 4 000 people. The capital, Nuuk has 12 000 inhabitants. Apart from the 14 towns, approx. 18 percent live in more than 50 small settlements with 50 to 500 people. 87 percent of the population is Greenlanders, the rest being mainly Danes.

The total population of the Northwest Territories is over 53 000. Over 90 percent of the population lives on navigable waters, and about 40 percent lives in coastal towns relying on the annual marine resupply which is of interest for this study. Only three towns, (Yellowknife, Iqaliut and Inuvik) have more than 3,000 inhabitants; the other settlements having from about 100 to over 1,000 people. On average, 60 to over 90 percent of coastal inhabitants are of Inuit decent, others are of Dene or European origin.

4 PRESENT FUEL SUPPLY SITUATION

4.1 Northwest Territories

The supply of oil products in the Arctic Canada (Northwest Territories) is sourced in three different ways depending on the area served. The areas are :

•Baffin Region (Eastern Arctic Sealift Area - EASL)

•Keewatin

•Kitikmeot and Inuvik

4.11 Baffin Region

The Baffin region comprises Baffin Island, Fox Basin and the islands to the north of Baffin Island. The 1993 consumption in the region totals 69,000 m³. This does not include Iqaluit Airport, which has an consumption of approx. 46 100 m³ of aviation fuel.

The 13 towns in the area are supplied by an annual sealift operation involving a number of ships, typically 12 - 24 000 dwt. These ships deliver the oil products from refineries in North America or Europe directly to the towns. Only a few of the towns receive more than one delivery of products a year.

The delivery tankers anchor up to ½ mile off shore and the products are pumped to the shore most often through 4" floating hoses. The long distance to the shore results in a relatively long time for hook-up and pumping.

4.12 Keewatin

The Keewatin Region comprises the west and north part of Hudson Bay. The present consumption is 27 800 m³.

The 7 towns are supplied from Churchill in the province of Manitoba. The oil products are brought to Churchill by rail tankers from refineries in central Canada. The delivery is carried out by tug and barges. The barges transport combined oil and dry cargo and can carry 3 - 4 000 m³ of oil products. Rankin Inlet receives up to 7 separate deliveries, and the other towns are resupplied once or twice during a 3 month summer season.

When unloading, the barges are pulled close to the shore and the products are pumped through floating hoses.

4.13 Kitikmeot and Inuvik

The Kitikmeot and Inuvik Regions comprise the north coast of the mainland of the central Arctic and the islands to the north. The total consumption is 22 750 m^3.

The 11 towns are supplied by tug and barges principally from a refinery in Norman Wells on the Mackenzie River and Hay River further south. The supply season is limited to 3 months.

4.14 Supply contracts and regulation

The supply is carried out by several companies under contract with GNWT. As Canada is a member of NAFTA, government contracts over $25,000 must be based on an open tender.

These contracts may include supply of all oil products, transport, storage facility management and retail distribution. The storage facilities are owned by, or will be transferred to the GNWT.

At present the principal transportation contract for onward distribution in the Keewatin and Kitikmeot is held by the Northern Transportation Company Limited (NTCL). The main transportation contract for the Baffin is with Clarendon. These contracts will expire with the completion of the 1995 resupply.

Canadian laws require that shipping between two Canadian destinations be made by Canadian flag ships. The consequence is that oil transport between two Canadian ports can not be carried out by foreign ships unless approved by the National Transportation Agency on the basis that no Canadian ships are available.

4.2 Greenland

4.2.1 West Greenland supply

The supply of West Greenland comprises import from refineries in Denmark and Norway by a 22 500 m^3 tanker 7-8 times annually. The total consumption (1998) is estimated to be 211,500 m3, including the two airports, Kangerlusseq and Narsuaq. The products are today imported to four terminals: Qaqortoq, Polaroil, Nuuk and Sisimiut. From the terminals, the products are distributed to the towns by a 3 000 m^3 tanker, which is occupied 5-6 months from June to December. A secondary distribution system exists between the towns and the settlements

4.2.2 Supply contracts and regulations

A supply contract exists between the KNI Company, (owned by the Greenland Home Rule Government) and The Greenland Oil Company (DGO). DGO is a private company owned by three Danish oil companies Shell, Statoil and Q8.

The contract is renewed every 5 years but the conditions are negotiated every year.

The contract includes supply of the products, transport to Greenland, management of the storage facilities in Polaroil, and the primary distribution. KNI takes care of the secondary distribution and the storage facilities in the towns.

There are no restrictions concerning country of registry for ships used on the Greenland coastal trade. At present the transport into Greenland is carried out by a Finnish ship while an annual of a Danish ship takes care of the primary distribution. Two small ships used for the secondary distribution are owned by KNI.

5 KEY ELEMENTS

The following key elements are considered to be the most important for the choice of delivery methods and cooperation between GNWT and Greenland.

5.1 Cost of products

A rough cost break down of the oil products at the retail level for Greenland indicate that the purchase cost covers more than 60 percent of the total, the rest being transportation costs, terminal cost, administration and overhead. It therefore most important to look at the possibilities for reducing the purchase cost.

In Greenland, the cost of oil products is based on world market prices with an overhead cost for DGO.

For Canada the purchase price is not known exactly, and it differs from region to region. But it is indicated, that the purchase cost FOB Churchill and Norman Wells is approx. 60 percent higher than the world market price. To achieve savings a reduction of this cost should be a priority for the Canadian supply.

A common purchase for Canada and Greenland may result in a slightly lower price because of a larger volume, but this is not considered to be significant.

5.2 Interest Costs On Inventory

The interest on the cost of the fuel in inventory is a major factor to be considered. The shorter the delivery season, the higher the carrying cost.

A resent study on oil distribution in Greenland has indicated that the inventory capital can be reduced from DKK 180 million to 100 million by increasing the delivery season and optimizing the delivery schedules.

5.3 Transportation costs

The transportation cost varies with the size and the ice capabilities of the tankers (daily charter rate).

The use of larger vessels will usually reduce the number of days on charter by reducing the number of trips, and a common import for Greenland and Canada may involve use of larger vessels and a more favourable transport contract because of the larger volume.

5.4 Product source

The purchase of products from North American or European refineries can be made at lower world market prices than those currently available at Churchill, Norman Wells and Hay River.

5.5 Terminal facilities

The future planned delivery schedule for Greenland only includes the use of three terminals and the storage facilities at Polaroil will not longer be needed. Even though new constructions costs will be incurred for improving the facilities in the remaining terminals, the overall cost will be reduced.

The facilities in Polaroil could be used to support the Canadian distribution system either for Canadian use alone or in a common distribution system.

As in Greenland, an efficient distribution system in the Canadian Arctic will require the use of several terminals. At present, several terminals could be available for the supply of the Baffin for example. Deception Bay and Iqaluit, like Polaroil, are not located at the centre of a resupply network, but are close enough to be considered.

Deception Bay, located on the north coast of Quebec, is an old asbestos mine which has storage facilities which could be used as terminal. Iqaluit has storage of over 63 000 m^3. The main drawback with the use of these communities as terminals is season length.

Access by a Type ship for onward fuel distribution is hampered by ice when Polaroil would be ice free. In addition Polaroil would not require the use of a Canadian flag vessel for local distribution in Canada.

Resolute in the northern part of Baffin Region has a large unused storage capacity, and could be used as terminal for the northern most settlements, but the remote location and poor port access does not make it desirable for a main import terminal.

In Kitikmeot, Tuktoyaktuk has served as a terminal for the oil supplied from Norman Wells.

For Keewatin, Churchill has served as terminal, but this town is located in an other province and is not at the centre of the supply area.

The best geographic location for local terminals for Keewatin and Kitikmeot would be Rankin Inlet and Coppermine respectively, as these towns are in the centre of the distribution area. But both harbour facilities and storage must be constructed in order to obtain sufficient capacity and security of supply.

5.6 Navigation season

As mentioned above, the Canadian shipping season is considerably shorter than in Greenland. Any extension of the distribution season for Canada will depend on the use of the higher ice class vessels not readily available off the open market.

A common distribution system could benefit from using the same vessels, these would serve in Canada during the shipping season in July-October and Greenland during the remaining part of the year. In this way the season in Greenland will automatically be extended without reducing the size of the distribution tankers.

5.7 Navigation and port time

The steaming time in days is dependent upon the distance and the speed made good, or vessel performance, given the ice and sea conditions.

In Greenland the number of days on charter for vessels in the transport system may be further reduced by an optimising of the distribution system.

The number of days on charter for the Canadian transport system may be reduced by the used of tankers versus tug and barges. The use of larger vessels could reduce the number of vessel trips and therefore the number of days on hire.

In the Keewatin and Kitikmeot region the distribution is carried out mainly by tug and barges. The tugs operate at 6 knots compared to the 12 to 15 knots that can be maintained by a tanker. However, draft limitations and supply hose length at most of the places makes it difficult to perform the distribution with conventional tankers of sufficient size. Alternatives include: increasing hose lengths, further hydrographic surveys and test voyages, and the consideration of special build, landing craft.

The port time for the ships is an other important cost factor. The discharge rates at anchor in the approaches to small northern communities result in port turnaround times lasting from one to several days. Navigational constraints such as manoeuvring room are greater at most of the Canadian ports compared to those in Greenland. Turnaround times could be reduced by increasing the discharging rates by using larger diameter hoses, or the use of longer hoses to reach tankers capable of higher discharge rates.

The port facilities in Greenland ports are more workable with the distance between tanker and shore averaging not more than 150 to 200 m. These facilities do not need to be changed significantly in the future.

5.8 Tanker vessels

The main part of the import to Greenland is carried out by the M/T Kihu on time charter in seven bottoms of 22,500 m3. The charter period extends through the entire supply season from June to December. The M/T Marie Terese with a capacity of 3,000m3, operates as a coastal supply vessel between the import terminals and all major west coast Greenland towns. The “Aquipi Ittuk” (400m3) and the “Orsiaat” (300m3) perform the secondary distribution to all the smaller Greenland settlements.

For the primary distribution the same ice class vessels are used (M/T Sofie Terese). The tankers for the secondary distribution is classified DvN ICE 1C.

In Canada different ships are used for delivering fuel to the Baffin Region. These vessels have included the Hubert Gaucher, J.C. Phillips, Arctic, Enerchem Avance, Irving Nordic, Romoe Maersk and the Vinga Polaris, among others. Some of these vessels carry between 15,000m3 and 26,000 m^3 of product. In The Keewatin area the tug Keewatin is used for the distribution together with a number of barges carrying both dry goods and fuel products. The product capacity of each barge is approx.1,700 m^3. In Kitikmeot, barges carrying approx.1,500 m^3 are towed by the Knut Lang and Kelly Hall.

In Arctic Canada, the vessels must be ice classed corresponding to the time of the year and the area. CASPPR (Canadian Arctic Shipping Pollution Prevention Regulations) Type B is considered the minimum to achieve the security of supply over the long term. For supply to the northernmost towns and for example Coppermine, arctic ice class ships such as M/V Arctic would be required.

A market survey has been carried out to determine available ice class tankers in the range of 6 ,000 to 40,000 m^3. The survey has shown that a number of ships would be available for import to Greenland, Baffin Region and Keewatin.

For the delivery to Baffin Region, where the discharging is made difficult by the long hose distance to the shore, use of special built vessels carrying the necessary floating hoses on reels should be considered.

For most of the communities in the Keewatin region, only tug and barges have been used until now because of draft limitations at most of the ports. Special built low draft tankers could be considered.

5.9 Consumption

The consumption of oil products is mainly related to the number of inhabitants in the settlements. In average the consumption in 1993 was 3,5 m^3/person in Greenland and 4,1 m^3/person in Arctic Canada.

Only locations with international airports have higher consumption, i.e. Iqaluit on Baffin Island and Kangerlussuaq in Greenland.

The increase in the consumption has been very high in Canada, up to 15 percent per year. For the purposes of this report an increase of 7 percent per year has been used.

In Greenland the increase allowed is lower, and only 2.4 percent for fuel oil is anticipated while no increase has been projected in the consumption for aviation fuel.

5.10 Storage facilities and capacity

The impact of increased consumption on existing storage capacities must be assessed. The total storage volume must be sufficient for the winter consumption, which means from the latest delivery to the first delivery next year.

Furthermore, the storage capacity will limit the volume, which can be imported at one time.

A safety margin has been imposed on the storage to allow for safety (safety storage) and fluctuations in the delivery (working storage). In Canada the safety storage allowed is 15 percent of the annual consumption. In Greenland the safety storage varies depending on the location. In the open water towns the safety storage is one month's consumption, in the Disco Bay area two month, and in North Greenland three months.

With the increase in consumption, a lack of storage capacity becomes evident in many of the towns in Arctic Canada. A delivery more than once a year in Baffin Region will, however, reduce the winter season and consequently reduce the necessary storage.

5.11 Fuel Specifications

In general three types of oil products are used in Greenland and Arctic Canada: Fuel oil, aviation fuel and gasoline. The Specifications, however are different in the two countries:

	Canada	**Greenland**
Fuel oil	P50	AGO
Aviation fuel	Turbo A	Jet-A1
Gasoline	Unleaded	Leaded

Furthermore, small quantities of NAPTHA and aviation gasoline are imported to Canada. In Greenland aviation gasoline is only imported to two airports, and is delivered in drums by the dry cargo ships.

In some towns in Kitikmeot, Turbo B is used instead of Turbo A, and at the Polaris and Nanisivik mines P20 and P 60 are used.

The specifications for P50 gas oil and Arctic Grade Gas Oil (AGO) are different: P50 can be used at lower temperatures. There are no plans in Greenland for changing from AGO to P20; on the contrary plans are made for using a heavier and cheaper fuel for special purposes.

The specifications for Turbo A and Jet-A1 are very similar, and international airlines use both fuel types. Turbo B is very different, but it is considered that the locations using this product could use Turbo A.

Within a few years in Greenland it is anticipated that only unleaded gasoline will be used.

No naphtha is imported to Greenland; Jet-A1 is used instead.

A reduction of the number of fuel types will be advantageous for a common supply system, but not necessarily if the tankers in use have the required number of tanks, and if the products can be handled separately at the terminals. It should be investigated, however, if it is possible to use the same specifications for aviation fuel. Furthermore, the possibilities of producing a product similar to P50 by mixing AGO with Jet-A1 should be evaluated.

6 OPTIMIZED SUPPLY SYSTEMS

Before examining common supply and distribution for Greenland and Arctic Canada, it is necessary to evaluate the possibilities for separately optimizing the supply system for each.

6.1 Canada

A number of possibilities for improving the Canadian delivery system have been recognised.

The most important factor is, as mentioned above, to create a system which involves direct import from European or North American refineries at world market prices instead of buying the expensive oil from Churchill and Norman Wells. If this system requires new terminals, the use of Polaroil in Greenland should be considered. A new harbour and terminal in Rankin Inlet for the Keewatin area would also be necessary.

A long term supply contract and government management of the distribution system will encourage higher investments in the infrastructure facilities. Better unloading facilities will reduce the port time and thus reduce the total shipping time. Furthermore investment in special tonnage for Keewatin and Kitikmeot to replace the tug and barge system should be considered.

6.2 Greenland

In Greenland an optimization of the primary distribution system is in progress. The aim of this optimization is to decrease the interest on the inventory by extending the delivery season. Furthermore, a computer based management system will be introduced in order to reduce the total sailing distance.

There are no plans for changing the import system except that Polaroil will no longer be used as terminal.

7 COMBINATIONS OF COMMON SUPPLY SYSTEMS

A number of scenarios for cooperation between Greenland and NWT have been investigated in the present study.

The differences of the two countries in relation to oil supply must, however, be observed.

In arctic Canada the shipping season is short, in some places very short, and the distances between the settlements are relatively long.

The most feasible scenario, therefore, is large tankers calling only once or maybe twice a year at each port.

The main object for Greenland is to reduce the interest on inventories, which means a long distribution period as possible with small distribution tankers.

Some possibilities, however, exist for cooperation from which both countries will benefit, as described below.

7.1 Purchase and Import

As mentioned above, no rebate on the world market price for oil products can be expected because of purchase of a larger amount in connection with a common supply. The average delivered quantities of 20-30.000 m^3, is sufficient to secure the lowest price. The shipping cost however could be cheaper, either because of a better contract for the total supply volume, or because of lower cost per ton-mile because of the use of larger tankers.

A common import system could also benefit from the common use of terminal facilities and/or distribution system. For example, the import tankers could deliver the Canadian products to Polaroil in conjunction with products to one of the Greenland terminals. This can be done even if the product specifications are different.

A common supply system may improve the security of delivery.

7.2 Terminals and Distribution

The use of Polaroil as a terminal for the supply to Arctic Canada is described above. Further use as common terminals, e.g. the Greenland terminals in the towns, is only possible, if Canada and Greenland have the same fuel specifications. For this reason this is not discussed further.

A common distribution system with the same tankers supplying locations both in Canada and in Greenland on the same voyage seems only feasible with common terminals. The cooperation on the distribution level could, however, result in the use of the same tankers but at different times. It has already been mentioned that the same tanker could be used for distribution in Canada in the short open period in July to September and in Greenland for the rest of the year. This ship will have sufficient time for supplying the towns in The Disco Bay area and to the north, where the navigation season extends until mid December.

The issues surrounding combined onward distribution have been approached and options such as a combined supply of the most northern Greenland and Canadian communities and the total integration of resupply have been discussed. However, the season length in Greenland favours a system which minimizes inventory costs (i.e., small resupply vessels over a longer period) and the shorter season in Canada favours economies achieved through the reduction of days on charter (i.e., larger vessels). A longer season in Canada may be possible through the use of high ice class tankers earlier in the year when it would be possible to unload fuel by a hose on the surface of shore fast ice. If this can be achieved, a common supply system may be beneficial in the northern most part of the Baffin Region and Qaanaaq in North Greenland. Qaanaaq is closer to the towns in Canada, e.g. Grise Fjord, than to the other towns in Greenland, and a common supply could be achieved by a single delivery with a high ice class ship to Arctic Bay, Resolute, Grise Fjord and Qaanaaq from a local terminal.

A secondary benefit of the cooperation is a closer relationship between the two countries which could lead to cooperation in other fields both cultural and commercial.

The mechanism of cooperation between GNWT and Greenland has not been addressed. This question must be investigated further.

8 TRANSPORTATION SCENARIOS AND COST MODELS

The first phase of this study accomplished the collection of the required data, which was reported in the Interim report dated June 20, 1994.

In the second phase an evaluation of different scenarios has taken place. This evaluation included several tasks as described in the figure below.

The completion of Task 4 resulted in the selection of a number of possible Arctic Fuel Resupply scenarios for GNWT and Greenland Coastal regions. With these as a basis, the work group began a more detailed analysis and scenario development.

Utilising the supply quantities forecast for 1998 (as provided by GNWT), the various navigational and scheduling scenarios for Arctic Resupply in all coastal GNWT regions were investigated in depth. Resupply regions considered included: Baffin, Keewatin and Kitikmeot (including northern Inuvik region). An integration of Keewatin, Baffin and Greenland resupply was also considered.

8.1 Canada

8.1.1 Transportation scenario analysis and schedule development

Each proposed scenario was considered against navigational and seasonal constraints, resupply and storage requirements and vessel and equipment capability and availability.

8.1.1.1 Consumption and Storage Facilities

GNWT information on present and future storage availability in conjunction with projected 1998 consumption formed the basis of the study. It was felt that for the purposes of this level of study, it would be sufficient to consider total aggregates of all grades of fuel, rather than quantities of each grade separately. This was considered valid as it had become apparent that available tonnage would most likely have sufficient flexibility to transport the various grades and quantities required.

For two of the scenarios, new terminal and storage facilities were proposed at Rankin Inlet in Keewatin Region and Coppermine in Kitikmeot. These facilities were introduced to consider potential reduction in overall costs.

Product transfer rates for all Baffin and Keewatin ports were provided by GNWT. No accurate transfer rates were available for Kitkmeot ports, therefore an average rate of 80m3/hour was used.

8.1.1.2 Navigational Data

Navigational data included information taken from CHS charts and Sailing Directions for all locations as well as extensive practical local knowledge of work group participants. Generalised routing was also developed, then displayed on MapInfo charts for general integration and comparison.

8.1.1.3 Ice Conditions

Seasonal port and routing data was based on CASPPR zone seasonal limits for type B vessels to develop first in/last out dates and possible routing speeds in relation to ice conditions. NORDREG/ECAREG annual reports of port accesses as well as a number of private company annual schedules and reports were also used as reference to consider historical access and routing.

8.1.1.4 Vessel and Equipment Capability

Various sources of technical data were accessed to consider vessel and equipment capability and flexibility. Historical Coast Guard and individual company data indicated previous vessel utilisation. More detailed vessel particulars were culled from Lloyd's Register of Ships 1993-94, company prospectus documents and published schedules.

8.1.1.4 Scenario Schedules

Detailed individual scenario schedules were completed to allow complete cost analysis. These schedules are included as Annex 1. Individual scenario summaries are included as Annex 2.

8.1.2 Scenario description

The following basic scenarios, as developed by the Steering Committee in Task 4, were used as the basis of all Task 5 studies. All used GNWT projected 1998 consumption figures. Speed for tankers was considered to be 14.5 knots in all Eastern Arctic areas within CASPPR Zones 10 or higher and 12.0 knots in lower zones.

8.1.2.1 Scenario 1 Status Quo, Baffin/Keewatin/Kitikmeot

Each region's resupply was scheduled using vessel and product source as utilised in the 1993 navigational season.

Baffin resupply was completed utilising two generic vessels based on the M/V Romoe Maersk and M/V Vinga Polaris of 30,361m3 and 15,025m3 capacity respectively. Both vessels entered the region with product loaded in Rotterdam. One transfer was required from the 30K vessel to the 15K vessel in Pond Inlet to enable a second series of deliveries to smaller ports to complete requirements.

Keewatin resupply utilised NTCL's single tug Keewatin towing two 1,700m3 barges out of the port of Churchill at 7 knots. A dry discharge rate was added to that of the fuel discharge time. This reflected dry cargo discharges interpolated from 1993 port arrival and departure data.

In the Kitikmeot region, resupply was sourced primarily from Norman Wells on the Mackenzie River. Non P50 products sourced from Hay River, would require a more detailed analysis of distance and charter time, therefore, the steaming schedule produced for the status quo assumes those distances and times required to move produce from Norman Wells to Tuktoyaktuk and into the western Arctic. One "tower tug" was required to tow up to three 1,500m3 barges from source to the NTCL relay point in

Tuktoyaktuk. Barges were then transferred to an "HT II" tug for transit to coastal ports in the region. Both tugs operate at an assumed speed of 7 knots. Dry cargo discharge time was not considered in this region as NTCL has excess tug and barge capacity and would be capable of meeting dry cargo carriage and delivery commitments without impacting on liquid cargo requirements.

8.1.2.2 Scenario 2, Baffin Resupply from Polaroil

Two generic tankers were employed. One 30,000m3 tanker delivered a single load approximately 30,500m3 to storage at Polaroil on the SW Greenland Coast. A second tanker of 11,000m3 delivered it's first load of Rotterdam product to selected ports then returned to Polaroil to load for three successive trips to complete resupply.

8.1.2.3 Scenario 3, Keewatin Resupply from Rankin Inlet

Based on the introduction of a new terminal and storage facility, this scenario utilised both a 30,000m3 and an 11,000m3 tanker to deliver Rotterdam product for storage and distribution.

Product was then delivered to coastal communities by tug towing two 1,700m3 barges. The centralised location of the Rankin terminal allowed for reduced steaming miles compared to the Status Quo scenario for subsequent "outport" delivery.

Without considerable outport infrastructure improvement, delivery by other than shallow draft barge in ports other than Rankin Inlet, Chesterfield Inlet, Coral Harbour and possibly Whale Cove is impracticable due to offshore anchorages being located greater than 1 nm from the shore. A shallow draft "landingship" design of approximately 3,000m^3 to 3,500 m3 capacity could be of value in these ports.

8.1.2.4 Scenario 4, Combined Keewatin/Baffin/Greenland Resupply

This scenario is based on an integration of all three resupply systems. A 30,000m3 tanker is utilized to deliver European product to Polaroil and Rankin Inlet at the beginning of the navigational season. In addition, an 11,000m3 tanker would deliver European product to Rankin Inlet, then continue on charter to deliver product from Polaroil to Baffin ports. This allows integration of chartered tonnage as well as full utilisation of storage facilities at Polaroil.

Keewatin ports will then be serviced by the same tug and barge combination as utilised in scenario 3.

8.1.2.5 Scenario 5, Kitikmeot Resupply from Coppermine

Based on the introduction of a new terminal and storage facility at Coppermine in central Western Arctic, the scenario envisages delivery of product by a ice class tanker.

Product is then transferred for delivery to coastal communities by tug, towing up to three 1,500m3 barges at a speed of 7 knots.

Central distribution results in greatly reduced steaming miles for delivery with subsequent reduction in ice navigational window required. Further optimisation could be achieved by ship delivery to high consumption locations.

Table 1. Summary of Steaming Schedule
All Scenarios

Scenario	Miles Steamed 30K m3 tanker	Miles Steamed 11K m3 tanker	Miles steamed tug & barge	Days required 30K m3 tanker	Days required 11K m3 tanker	Days required tug & barge
1. BAFFIN	6849	13890	N/A	32	70.7	N/A
1. KEEWATIN	N/A	N/A	7554	N/A	N/A	109.3
1. KITIKMEOT	N/A	N/A	16437	N/A	N/A	129.2
2. BAFFIN POLAROIL	4298	16046	N/A	19	95.8	N/A
3. KEEWATIN RANKIN INLET	6366	6366	3064	36	25.7	56.8
4. COMBINED	10664	22726	3064	60.2	126.2	56.8
5. KITIKMEOT COPPERMINE	7854	N/A	6714	29.8	N/A	64.2

8.1.3 Cost analysis

A simple cost analyses has been made for Baffin, Keewatin and Kitikmeot in NWT listing the purchase cost, import cost, and distribution cost for the present situation versus future scenarios.

8.1.3.1 Present situation

The purchase cost is based on information for 1993 cost at source of the oil products at European refineries for Baffin Region, at Churchill for Keewatin and at Norman Wells for Kitikmeot.

The import and distribution cost for Baffin is based on available charter hire and bunker consumption for ocean tankers supplying direct to the towns. For Keewatin and Kitikmeot the distribution costs are based on available information on barge delivery from Churchill and Norman Wells respectively..

8.1.3.2 Alternative scenarios

In the alternative scenarios the cost at source is for all regions based on 1993 FOB prices at European refineries. The import and distribution costs are calculated form the distance derived form the steaming schedules for the different scenarios and available costs for charter hire and bunker for the respective tanker sizes. For all areas, Polaroil is used as primary terminal, while Rankin Inlet and Coppermine are used as secondary terminals for Keewatin and Kitikmeot respectively.

From the last two mentioned terminals, the distribution takes place with tug and barges as in the base scenario.

8.1.3.3 Results

As seen in Appendix No. 1, there will be a considerably savings in the purchase for Keewatin and Kitikmeot as the cost at source is much lower FOB European terminals than FOB Churchill and Norman Wells respectively. The reason is, that the cost at European Refineries is World market prices while the cost at the other two locations are much higher; at Churchill because of pre-transport.

The transport distance and consequently the import cost will be higher, but considerably less than the saving in purchase cost.

Table 2. Cost Analysis Summary
(US$1000)

	Present	Alternative	Difference
Baffin:			
Purchase cost	13,567	13,567	0
Import cost	2,657	2,578	-79
Keewatin:			
Purchase cost	8,440	5,467	-2,973
Import to Rankin Inlet	0	1,067	1,067
Distribution	4,069	2,053	-2,016

Kitikmeot:			
Purchase cost	7,030	4,472	-2,558
Import to Coppermine	0	1,324	1,324
Distribution	5,834	2,875	-2,964
Total:			
Purchase	29,038	23,507	-5,531
Import and distribution	12,564	9,897	-2,667
Total	41,602	33,404	-8,198

Costs such as administration, terminal expenses (eg. Polaroil), construction costs for improving terminal facilities, etc. are **not included** in the above analyses. This is, however considered to be an order of magnitude less than the above mentioned savings.

8.2 Greenland

A detailed cost analyses has not been carried out, as it is believed that no significant savings could be accomplished by a change in the import and distribution system.

The major benefit for Greenland will be the use of larger tankers for import; e.g. the 22.000 m^3 tank is replaced by a 30.000 m^3 tanker the saving will be 0.13 cents per litre or total $280,000USD per year.

Furthermore will the use of Polaroil for the Canadian distribution be a benefit by an income from leasing out the facilities.

A supply of Qaanaaq in common with the northern towns in Canada will also be a benefit for Greenland.

9 CONCLUSIONS

A number of key conclusions can be drawn from the present analysis. The examination of various transportation scenarios demonstrated a saving of the number of days at sea and an indication that the status quo cannot be maintained without increasing storage capacity or modification of the method of resupply or both. These conclusions are summarised as they differ for each scenario.

- ◊ Iqaluit has drawbacks as a transhipment terminal based on the use of only one 10 inch hose to fill shore tanks, not ice free like Polaroil.
- ◊ Iqaluit consumes about four shipments of product annually, therefore its resupply should be direct.

◊ Elsewhere in the Baffin the resupply in 1998 would extend into October thus pushing the historical season. This necessitates the examination of earlier resupply by vessels of a greater ice strength and using shore hoses on top of the ice.

◊ Season length in the Keewatin is presently from July 15 to October 6 and this would increase by about one month thus necessitating the use of an ice class tanker at the beginning of the season, or with tug/barge supply beginning using capacity remaining from a previous year.

◊ Information was not available for the Kitikmeot from NTCL, it had to be recreated from NORDREG data and NTCL barge specifications. The status quo could be maintained in 1998.

◊ Polaroil is ice free and has a good location for serving the Baffin. Although using Polaroil increases the number of total days in the Baffin from status quo 102.7 to 115 days, savings are obtained from the use of a smaller tanker (11K DWT vs 15K DWT) to do the resupply, and the reduction in the charter time of the 30K tanker from 32 days to 19. The use of a 15K DWT tanker would probably reduce the number of steaming days, but would require storage to be built at most communities.

◊ The Keewatin area would be served from Rankin and the benefit would be cheaper fuel because of direct delivery to Rankin in two shipments, one from a 30K DWT tanker and the other from a 11K DWT tanker.

◊ Barge time for distribution in the Keewatin area in the scenarios is reduced from status quo 109 days to 57 days.

◊ The Kitikmeot resupply from Cherry Point would reduce the total number of on task days from the status quo of 129 to 94 with the use of a tanker for supply of a transhipment point at Coppermine. Importing the product from Europe and bringing it in from the eastern end of Coronation Gulf would further reduce the number of steaming days.

◊ The study has clearly indicated, that substantial savings are possible, in particular in the Canadian part of the system. These savings can be reached by rethinking the supply system as a whole and making more use of direct import by seagoing tankers to suitable terminal ports in each supply area. Further savings might be possible by using coastal tankers direct to the beach instead of tug and barge in the final distribution.

◊ For the Greenland part of the system only marginal savings seem obtainable. However, the future use of the Polaroil facility for transit of oil to Canada might benefit the Greenlandic economy.

◊ The realisation of the proposed scheme calls for some investments in tank capacity over and above the requirements from the expected growth in consumption. The investments needed can be supported by the estimated savings which could be realised from an alternative system.

The legal and organisational framework for a change in the supply system has to be investigated in more depth before further optimisation of an alternative system is undertaken. Also the commercial and political considerations of a joint system should be addressed as one of the next steps.