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RANNSÓKNASTOFNUN
HÁSKÓLANS Á AKUREYRI

TRANSSHIPMENT PORT IN EYJAFJÖRÐUR

Preliminary assessment of conditions

April 2006

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A report prepared for

Akureyri Port Authority

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1 MAIN CONCLUSIONS

Eyjafjörður is well situated with regard to sailing in the Arctic, especially as far as regards voyages to the east coast of North America. The natural conditions for a transshipment port in Eyjafjörður are particularly advantageous, in fact, among the best in existence. The fjord is well sheltered and unaffected by ocean swell. There are no significant restrictions (limitations) with regard to depth and maneuvring room in the fjord. The basic infrastructure of the local community is in many respects well-suited to a transshipment port with a high degree of services and a large labour market. Access to energy is excellent and good conditions for maintaining security.

On the whole, therefore, there are many reasons why Eyjafjörður could be recommended as a suitable location for a transshipment port on the Arctic navigation route.

2 INTRODUCTION

In February 2005 a report was published by a task force commissioned by the Ministry for Foreign Affairs with regard to possible navigation in the Arctic. The report is entitled OCEAN AHEAD and, among other things, it dealt with Iceland's potential concerning a transshipment port on the Arctic navigation route. There was little discussion, however, regarding the feasible placing of such a port, although three locations were named, one of which was Eyjafjörður.

This report has been compiled for Akureyri Port Authority and its aim is to throw light on conditions in Eyjafjörður with a view to the construction of a large transshipment port which could handle supersize ice class vessels plying the Arctic ocean. This is a preliminary assessment of conditions and by no means a proper blueprint for such a port. The next step could be the definition of potential options for a harbour site and the design of a port in the fjord.

The translation of this report from Icelandic to English was carried out by Rafn Kjartansson.

3 EYJAFJÖRÐUR'S PROXIMITY TO NAVIGATION ROUTES

Three main navigation routes should be kept in mind when looking at the basis for a transhipment port in Eyjafjörður.

The first of these is the route between Western Europe and North America. For many decades a considerable amount of cargo has been shipped by this route; it is, of course, the link between two of the largest economic powers in the world, the USA and Europe. This route, however, only plays an insignificant part in the matter of a transhipment port in Eyjafjörður.

The second route connects North West Russia to North America. This route has not seen a great deal of traffic along during the past decades, but there has been rapid increase in its use last years and it also lies just beyond the shores of Iceland.

Route number three is new and would cross the Arctic Ocean. This route has not been used so far but could become a realistic option with more powerful vessels. This would be by far the most important route to consider when examining the basis for a transshipment port in Iceland.

3.1 The navigation route through the Atlantic between Europe and North America.

Obviously ships cross the Atlantic to and from many ports, both in Europe and North America. Although the ports are in various locations, most of the ships from North America approach Europe from roughly the same direction. The reason for this is that the east coast of North America lies in a north east – south west direction and is the continent's most densely populated area. The exception to this rule is ships travelling from Florida or Mexico to European ports. The vessels from North America have a choice of mainly three routes.

The first of these heads for the Mediterranean Sea conveying goods to Portugal, the Mediterranean coast of Spain, southern France, Italy and other Mediterranean countries. The same route is used for countries with a Mediterranean coastline which are not European or which sail through the Suez Canal.

The second route lies through the English Channel with cargoes bound for England, northern France, The Benelux countries and Germany.

The third route follows a course leading to the northernmost point of Scotland with goods for Scotland, Scandinavia and other Baltic countries such as Poland and Russia.

Picture 1. The most important shipping routes between North America and Europe.

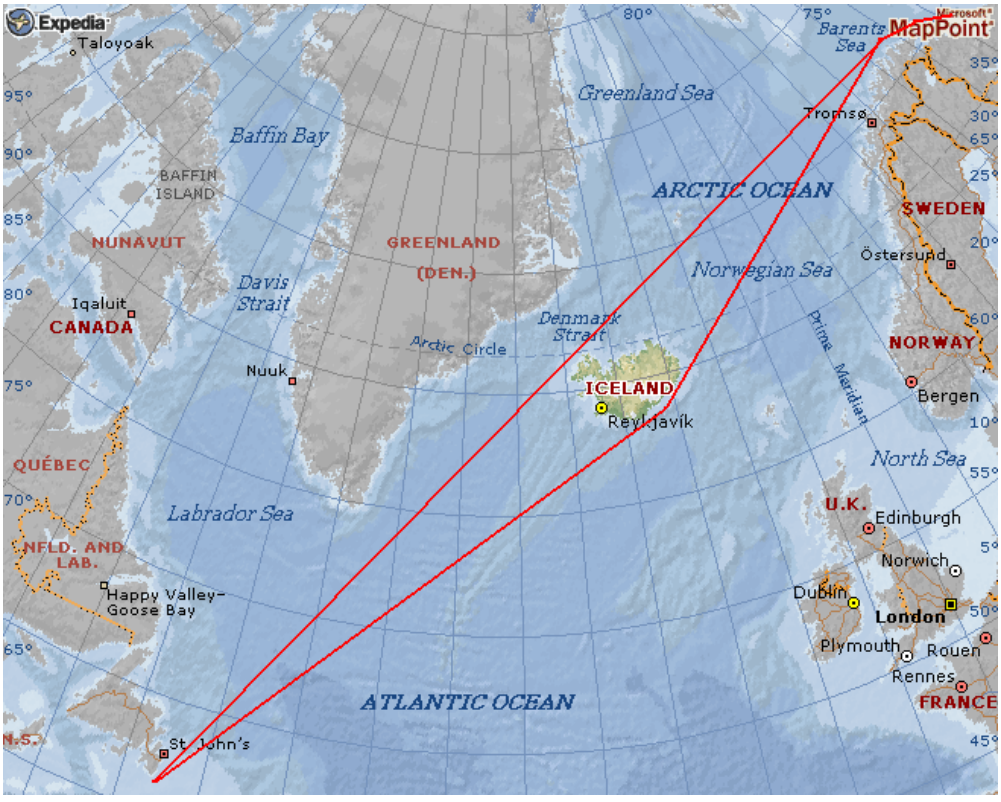
It is the shipping route from the east coast of North America, passing north of Scotland which is nearest to Iceland. Some part of the traffic between Europe and North America goes by this route. The compiler of this report does not have information regarding how large a part of the volume of traffic is concerned. The question then arises as to whether a transshipment port in Eyjafjörður would be of some use to vessels travelling by this route. The answer to this is that if a vessel sailing the North America – Baltic Sea route stopped off at Eyjafjörður it would lengthen the journey considerably. If sailing both west and the east of Iceland on this route, the added distance would be just under **700km**. On the other hand, if sailing only east of Iceland the voyage would be just under 1.200 km longer.

It is clear, therefore, that a transshipment port in Eyjafjörður would play little part in the transport of goods along the North America – Baltic Sea route. It would be too far out of the way to be useful. On the other hand, if Eyjafjörður

built a large harbour with relevant facilities aimed at a trading route through the Arctic Ocean, this would mean an automatic opening up of this route to all of the most important ports of the North Atlantic. Then it is not impossible that some containers on their way between North America and the Baltic Sea would travel by Eyjafjörður even though the route would be 700km longer than by the Pentland Firth and the Orkneys. But this would only be a fraction of the traffic between North America and the Baltic Sea.

3.2 Oil transportation routes from North West Russia to North America

If a direct course from Murmansk in Russia (or Hammerfest in Norway) is taken to North America, the shortest route is past Iceland's Western Fjords as can be seen in the next picture. It is only a matter of **100km** longer to sail by the south and east of Iceland.

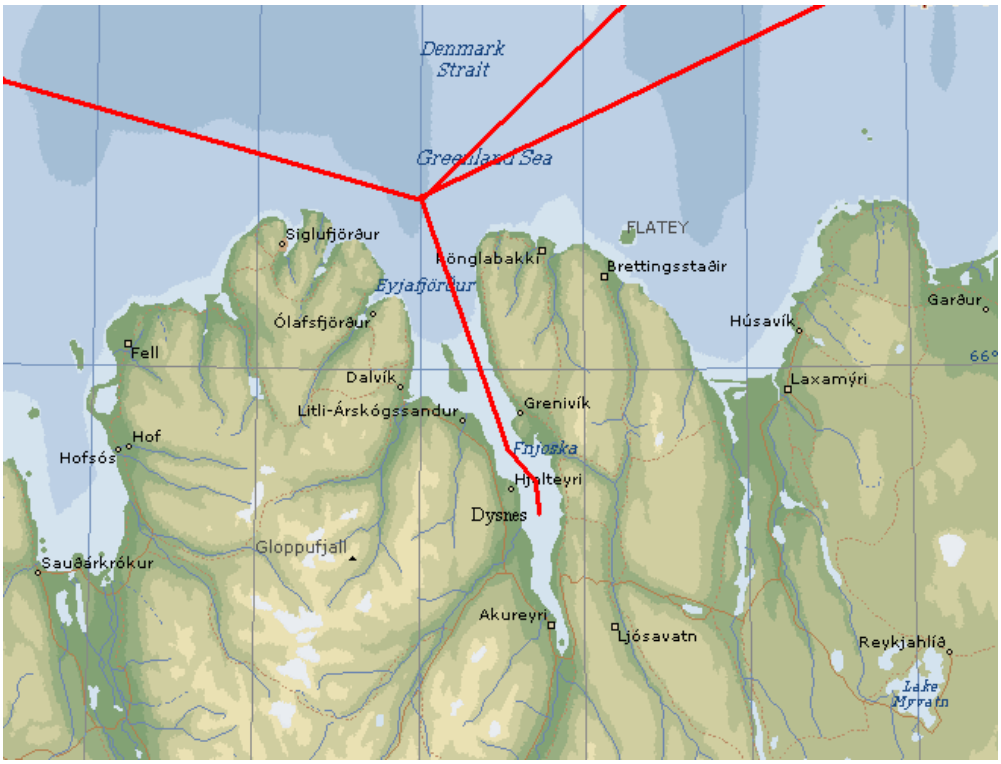


Picture 2. The shipping routes between North America and Murmansk on the Barents Sea.

As far as is known at present this route now takes shipping past the south of Iceland, even though this is the longer option. In winter conditions, this is understandable. At times, sea ice can interfere and weather conditions can be even worse in the Denmark Straight than to the east and south of Iceland. In the summer, on the other hand, it is hard to say why that course is taken, since it is **100km** longer. Perhaps it is just a matter of maintaining the habit of sailing all year round along a route which is undeniably the better option during the winter months.

If a vessel on this route stopped off at Eyjafjörður, it would only add an insignificant distance to the journey as compared to sailing past the Western Fjords i.e. **180km**. If, however, ships sail east of Iceland and also stop off at Eyjafjörður, the added distance would be **590km**. See the next two pictures.

Picture 3. Shipping routes to North America from the Arctic Ocean via Eyjafjörður



Picture 4. Eyjafjörður

3.3 Transportation by sea between East Asia and the North Atlantic

The report „Ocean Ahead", page 28, contains excellent information on the immense volume of goods transportation existing between East Asia and the North Atlantic at the present time. It is estimated that this volume was 5-6 million container units in the year 2003, of which at least 3.7 million container units went one way from Asia to the North Atlantic. This makes a total of over 10.000 container units per day. These shipments are, however, in a constant state of expansion which considerably exceeds world economic growth. The above mentioned report estimates that the volume will double over the next 10-15 years. Soon after 2015 it is expected that Asia will ship 20.000 container units a day to the North Atlantic, i.e. over 7 million container units a year. The route through the Arctic Ocean is the shortest one between East Asia and the North Atlantic. If the Arctic Ocean becomes navigable by cargo ships in the future, we can estimate that a large number, or perhaps even the majority of these will sail by this sea route.

3.4 A new sea route through the Arctic Ocean

Sea routes through the northern reaches of the Arctic Ocean are for the most part closed to shipping because of sea ice. But as mentioned before, these routes are also the shortest ones from East Asia to ports in regions bordering the North Atlantic. To make these routes navigable, it has mostly been considered to use giant vessels specially reinforced to stand up to sea ice, which sail back and forth continuously between two harbours; on one side the Atlantic Ocean port and on the other the Pacific Ocean port. If, however, the cargo at any given time is of such magnitude that two vessels must moor at the same harbour at the same time, the question arises as to whether it might be more economical to have two transshipment ports on the Atlantic side, meaning that only one ship need moor at each port at the same time. That is, one harbour for European trade and the other for North America.

This setup would be better from a competitive viewpoint. But where would it be best to have a transshipment port (or ports) on the Atlantic side; ports which could accommodate such giant ships? There are largely two deciding factors involved here. One, the locations of the best harbour sites and two, the shortest sea routes. The length of these routes will be examined here and a discussion of harbour conditions follows in Chapter 4.

We can imagine that ships coming from the Arctic Ocean carrying containers from Asia do not make a stop at any harbour but head straight for the destination port on the shores of the Atlantic. When the various options for a transshipment port on the Atlantic are examined, it is possible to study how long a detour a container would have to make if it were to be transshipped there instead of taking it straight to its destination by sea. Of course there will always be some detour involved no matter where the transshipment port is located, it is only a question of how long this would be for various routes.

If a cargo is coming in from the Pacific Ocean via the Arctic Ocean on a huge icebreaking vessel requiring considerable depth for underkeel clearance, the so-called North East Passage has to be selected. This lies between Novaya Zemlya and Franz Josef Land. At this point the route diverges, one passage leading to Europe and the other to the east coast of North America. If America is the destination, the shortest route is to veer north of Bearisland (Bjørnøya) (assuming that the ship would sail south of the island Hopen by Svalbard) and then on in a

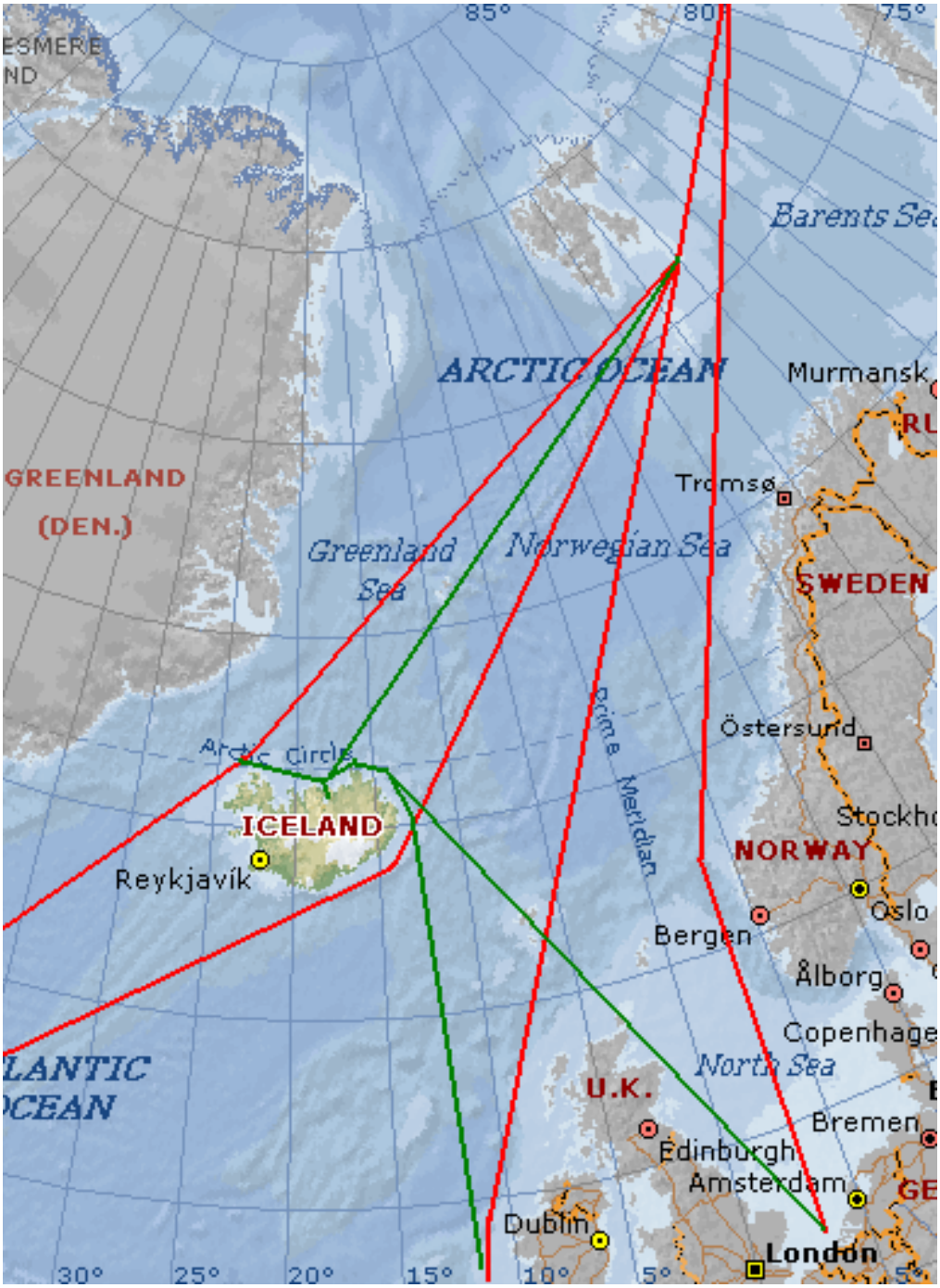
course north by Jan Mayen, passing by the Western Fiords of Iceland. If the destination port is in Europe, vessels sail south of Bjarnarey and along the Norwegian coast. If the destination is Eyjafjörður, the shortest route is north of Bearisland (Bjørnøya) as if heading for America, then round either side of Jan Mayen.

Picture 5. The Outer North East Passage. The western end of the route is terminated here, on the one hand, between the northernmost points of Norway and Bearisland (course set for Europe) and on the other hand, between Svalbard and Bearisland (course set for America). The narrow line shows the route to Eyjafjörður.

As mentioned before, the shortest route to America lies to the north and west of Iceland. It has also been shown that it is about 100 km longer to sail east and south of Murmansk. Coming from the Arctic Ocean, it is even more out of the way to sail east and south of Iceland if the destination is North America. It is then around **250km** longer than sailing past the Western Fjords of Iceland. In both cases, however, the shortest route is north of Bearisland (Bjørnøya).

Stopping at any harbour on their way, undeniably lengthens the journey of ships (or, rather, containers) on this route from the Arctic Ocean to destinations in the West. The question is by how much. A stop at Eyjafjörður, sailing west of Iceland, would lengthen the journey to America by only **230 km**. Sailing east and south of Iceland extends the passage by **500 km**.

If the destination is in Western Europe, the course chosen must depend on whether the vessel is making for ports in North West Europe through the North Sea or in South Western Europe (or even Southern Europe by the Mediterranean Sea) In the first instance, the course would be along the Norwegian coast and straight into the North sea, but in the second instance the route would be to the west of Scotland and Ireland. A stop at Eyjafjörður would increase the length of these routes considerably. The route out of the northern Arctic Ocean to Rotterdam would lengthen by **1.170 km** if a stop was made at Eyjafjörður, and the route from the Arctic Ocean and sailing west of Ireland, by **635 km**. These routes can be seen on next picture.



Picture 6. Shipping routes from the Arctic Ocean to Europe and N. America without stopping en route (red lines). Green lines show the same routes stopping at Eyjafjörður

The above figures can be set up in a table where the deviation from the direct route (the detour) is shown for the 4 routes in question.

Course taken when exiting the Arctic Ocean.	Deviation from direct course by stopping in Eyjafjörður	The same deviation in sea miles
To N-America by west of Iceland	230 km	124
To N-America by east of Iceland	500 km	270
To Rotterdam and North Sea ports	1.170 km	632
To Southern Europe sailing west of Ireland	635 km	343

From the table above, it can be seen how advantageous Eyjafjörður's position is regarding the shipping routes to and from North America. The position of the fjord is not so convenient for routes to and from Europe, although it is fairly suitable for voyages to Southern Europe. But what about other countries and places by the North Atlantic? Would a transshipment port be better placed anywhere there? It is not the task of this report to examine that possibility any further. It could, however, be an advantage to minimise the distance between the two transshipment ports used by the icebreakers (one port on the Atlantic and the other on the Pacific). It is by no means certain that it is more economical to sail a large icebreaker in an ice-free sea than in an ordinary vessel. It is highly probable that it is better to use the icebreakers in conditions for which they are built, i.e. to plough through the ice filled waters of the Arctic. Which country is in closest proximity when a vessel has passed Franz Josef Land? In the last picture it was assumed that a giant vessel coming out of the Arctic Ocean would sail through the point [79:00:00N 65:00:00E] between Novaya Zemlya and Franz Josef Land. Also, if applicable, through the point [76:15:00N 26:00:00E] south of the island Hopen at Svalbard. From the point between Novaya Zemlya and Franz Josef Land it is of course shortest to Norway and Russia but the distances to other lands and islands are shown in the next table.

Country/island	Distance from 79:00:00N 65:00:00E. Route through 76:15:00N 26:00:00E if applicable	Same distance in sea miles
Iceland (Langanes)	2.718 km	1.468
Faroe Islands (Fugloy)	2.912 km	1.572
The Shetlands (northern part)	2.951 km	1.593
The Orkneys (North Rolandsay)	3.137 km	1.694
Scotland (Duncansby Head)	3.225 km	1.741

As can be seen in the above table, the shortest route is to Iceland, if not heading for Norway or Russia.

4 NATURAL CONDITIONS FOR A TRANSSHIPMENT PORT IN EYJAFJÖRÐUR

There are no harbours in Iceland which can accept the supersize vessels which in this report are anticipated to ply the Arctic Ocean. And as if that was not enough, there is no port on the shores of the North Atlantic which can cope with that type of vessel. In order to make the passage of such ships feasible, two new ports must be constructed, on the North Atlantic the Pacific coasts respectively. A transshipment port for supersize vessels cannot be built just anywhere. Such a port demands good natural conditions far and beyond normal harbour requirements. Most important of all is berth depth and that there be sufficient flat land area extending from the edge of the pier to cope with handling a vast number of containers. It is very unusual to find both of these two premises fulfilled in a single location. Another condition is that the harbour be in such a sheltered a position that it acts as a wind and surf break; this makes a long fjord an ideal choice for such a port.

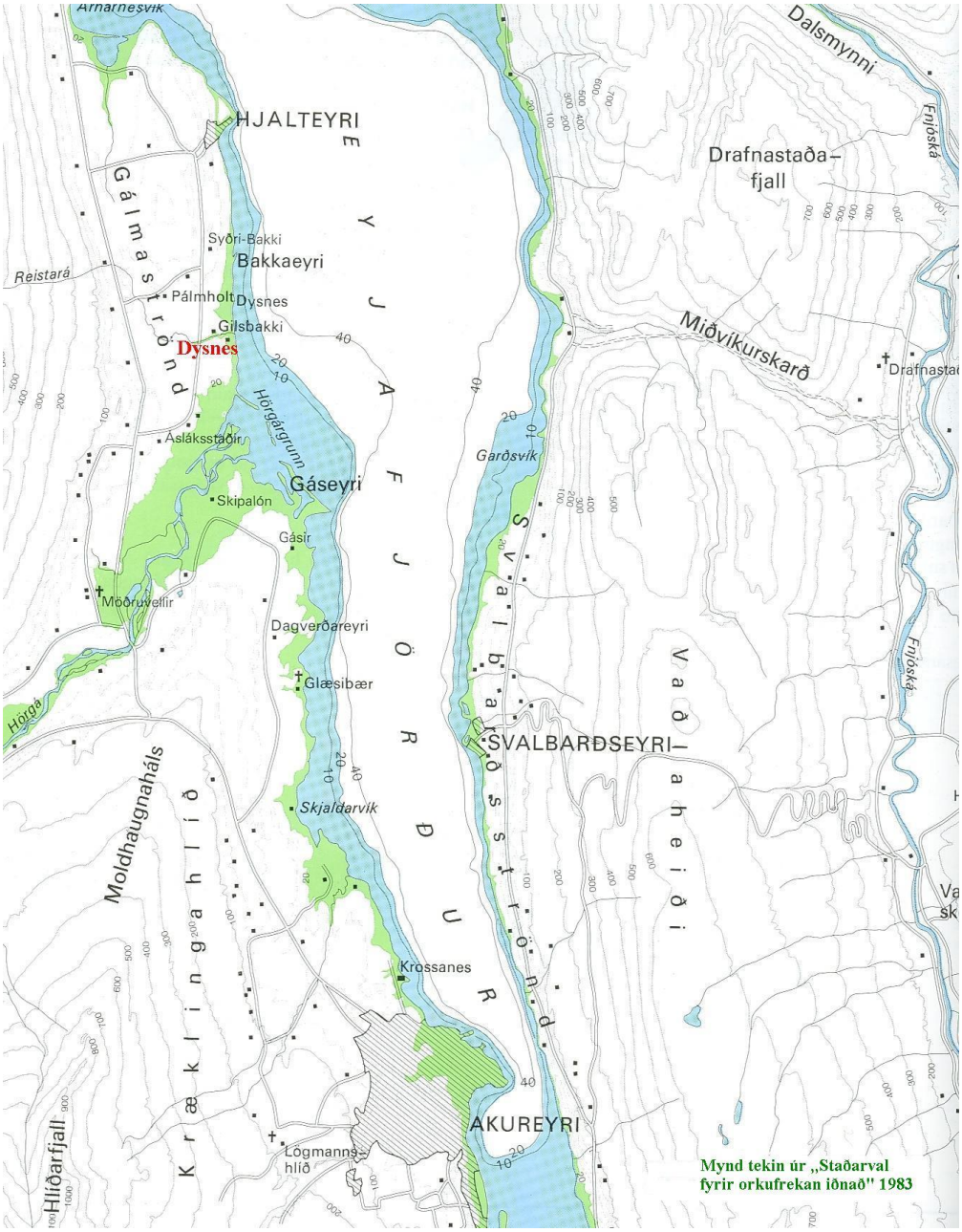
4.1 Depth

Supervessels which sail the Arctic Ocean require considerable depth, about 23m. This is the estimate for a 15,000 teu ship (400m long, 60m wide and with a 21m under keel clearance (Ocean Ahead 2005:27)). Fjords which are shallower than 23m cannot therefore be considered as possibilities for a transshipment port. It also has to be a fairly straightforward task to construct a long (500m) pier with a berth depth of about 23m. Eyjafjörður is a deep fjord with depth in excess of 40m all the way in to Akureyri. See next picture.

It is probably enough to meet the mooring requirements of one giant ship, to begin with. Such vessels require a 500m long dockside where the water depth is 23m. Besides this, a mooring dock for ordinary ships would be built with a berth depth of around 15m. It would probably suffice to provide mooring for two conventional vessels at the same time, to begin with; the length of pier required being 660m .(Ocean Ahead 2005:40). Altogether we are therefore looking at mooring docks of around 1,160m long. Considering the above mentioned volume of cargo transported between East Asia and the North Atlantic and the fact that such cargo shipment is on the increase it is not at all certain that these facilities will be sufficient in the long term. Very soon it would probably be

necessary to extend the mooring for supersize ships so that two such vessels could use the port simultaneously. And the same would apply to smaller vessels, more of those would need to be able to use the harbour at the same time. The length of the dock would then need to be over 2,000m. The alternative would be to build another harbour to meet an increasing volume of traffic. One of the ports would be chosen as the most suitable for routes to and from North America and the other for routes to and from Western Europe.

There are good natural conditions which recommend the western coast of Eyjafjörður inside of Hjalteyri as a site for the construction of a long dock with all the above mentioned premises regarding depth. There is little limit as to how long a dock could be at this location and the depth of water everywhere exceeds 40m.



Picture 7. Fjord depth in Eyjafjörður

The report „Ocean Ahead" states that it is probably most economical to have cargo vessels with a carriage capacity of 20,000 teu plying between two major ports. The report also says, on page 27:

> *In fact it is uncertain that the development will stop at 20,000 teu capacity. Vessels sailing ice-free Arctic routes could be much larger. To make this possible, however, harbour facilities would have to be adapted at destination points, as so far there are no ports capable of handling such immense vessels.*

With this in mind, it would not be sensible to choose a transshipment port where water depth was limited to 23m. If we look forward into the next 100 years, ports which handle giant ships sailing the north Arctic Ocean must be located where water depth considerably exceeds 23m. Otherwise the ports would be precluding the possibility of coping with shipping developments represented by larger and more economical vessels. It is probably wise, in this regard, to set the water depth requirements at over 30m. Eyjafjörður has almost no limits as to the depth of water it can provide. It is a simple matter to build a dock with a water depth of 30m and the entrance to the port would be of considerably greater depth. Even if the depth requirement were 40m, Eyjafjörður would remain as good a choice as before. This is easily seen on last picture.

4.2 Ocean swell

In order for transshipment to take place properly vessels must be steady. Ocean swells must not, therefore, reach the ships and rock them. Thus, large transshipment ports must be located where the influence of ocean swell is negligible. Eyjafjörður is long and narrow and the effect of ocean swells becomes less and less the further up the fjord the ship goes. Below is a quote from the report *Choice of location for power intensive industry* 1983:

> *The conditions for harbours in the upper areas of Eyjafjörður are the best that can be found here in Iceland. Overall depth is generally sufficient and the approach route is also good. Shelter keeps improving as one approaches Hjalteyri where there is absolute protection from ocean swells.*

As regards absence of ocean swells, Eyjafjörður has some of the best conditions to be found anywhere.

4.3 On land space

A transshipment port requires a great deal of land space on a flat plain (or as near to that as possible) which is on a level with the pier surface. The authors of the report „Ocean Ahead" estimate that a port to handle 2,000,000 containers would require a working area of 1 km^2 (100ha). Such a port would receive, on an average, 5,500 containers a day and the same number would depart daily. Such an area exists inside of Hjalteyri, offering significant expansion possibilities which is advantageous as it is estimated that within a short time the handling potential

may need to increase to deal with a possible 2,000,000 containers. If half of the shipments between East Asia and the North Atlantic go via the Arctic Ocean, after 2015 it may be estimated that around 3-4 million containers a year would pass through the port, and that is only in one direction. The total shipping volume could, therefore, quickly become 4-7 million containers a year if the port were to serve both Europe and North America.

4.4 Ebb and flow

There is less difference between high and low tide in Eyjafjörður than in most other places in Iceland. The greatest difference is in the western part of the country.

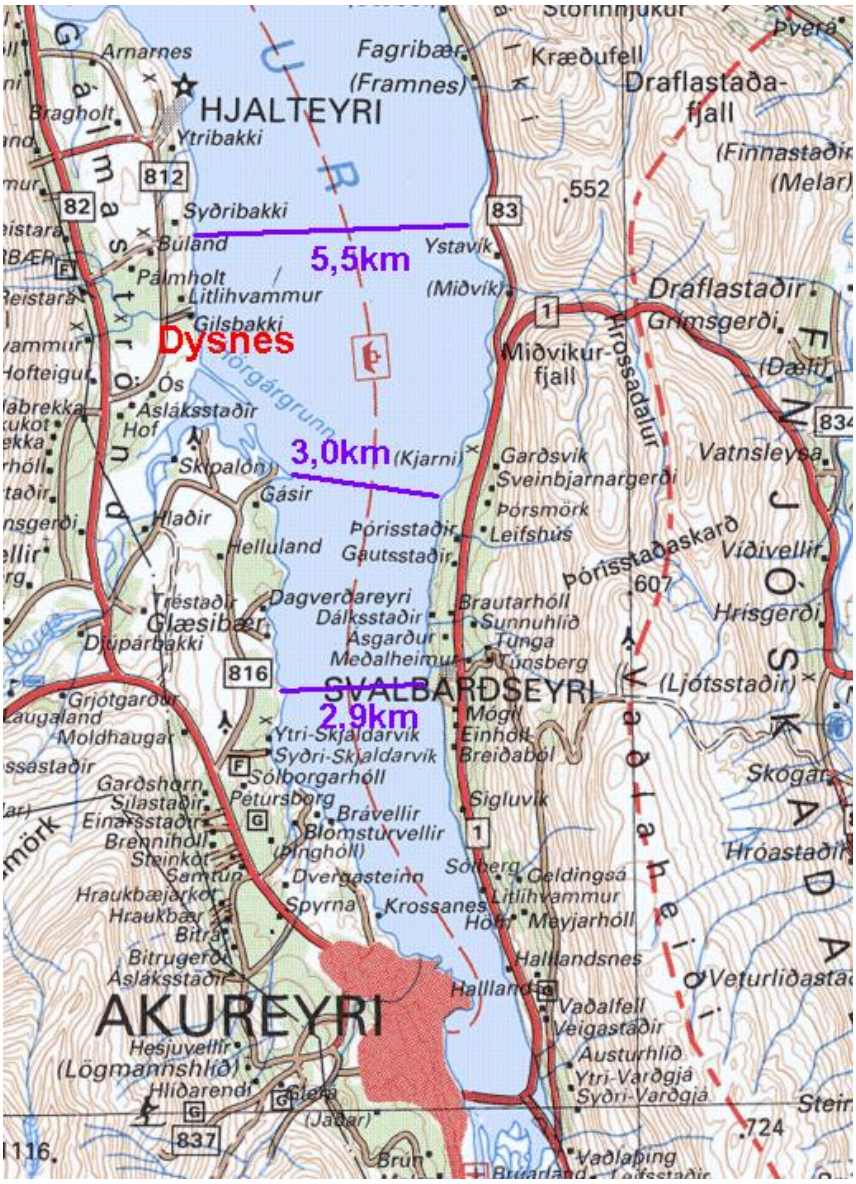
4.5 Wind patterns and shelter

Eyjafjörður is sheltered by mountains on all sides; consequently periods of calm weather constitute a characteristic feature of the local climate. As the fjord is like a deep cleft in the land, from north to south, the most common wind directions are northerly and southerly. Extensive research has been carried out on wind characteristics at Dysnes due to surveys over some decades concerning the possible building of an industrial plant there. These studies would be useful in the preparations for a transshipment port in the fjord, in the event that this became a reality. If we accept the findings on the pollution-reduction area relating to the aluminium plant at Dysnes, the prevailing wind direction is from the north, with the next most common direction being from the southwest. This means that the piers would have to lie in a north-south direction to ensure that the vessels are as steady as possible while moored. The location appears to offer good shelter from westerly winds and excellent with regard to winds blowing from the east.

4.6 Manoeuvring space at sea

As it may be assumed that the vessels sailing through the Arctic Ocean will be of huge proportions, probably at least 450m long, it stands to reason that they must be allowed a great deal of space to manoeuvre without the risk of touching bottom. For this reason it is important that the wind does not regularly blow from such a direction that it pushes the ship towards the land. There is good manoeuvring space for ships in Eyjafjörður as can be seen in the next picture, in most places about 3-5 km between the shores up-fjord from Hjalteyri. As

mentioned before, the prevailing wind directions are the same as the orientation of the fiord itself so that the winds do not force ships towards the land. As was also discussed before, the depth of the fiord is over 40m all the way up to Akureyri so that there is no danger that vessels would touch bottom even though it might be pushed a little towards the south by a strong north wind while exiting the harbour and turning on route out of the fjord.



Picture 8. The width of Eyjafjörður up-fjord from Hjalteyri.

Sailing out of and into Eyjafjörður is easy and there are no skerries to avoid. The route lies to the east of Hrísey and Hrólfssker where the depth of water is over 100m.

5 ACCESSING ENERGY, WATER AND OTHER SOURCES

A Transshipment port will require all the conventional energy sources, such as electricity, cold water, hot water and some type of net connection (e.g. broadband).

5.1 Fresh water

There is a plentiful supply of fresh water in Iceland, the only question being whether the existing reservoir in the fjord will be able to cope with the increase in volume which a transhipment port will require or whether another reservoir will be needed. If so this should be comparatively simple.

In the report by Dysnes (Almenna Construction Engineers hf, Verkfræðistofa Norðurlands ehf and Rafhönnun hf 2003:18) it is stated that the Akureyri Municipal Water Board (Norðurorka) should be able to supply a large aluminium plant with sufficient drinking water. This would be channelled through a new pipeline connected to the existing one at Moldhaugaháls. At present around 13% of this water comes from Vaglir at Þelamörk. In the same report it also says that much of the water required for industrial purposes could be taken from the River Hörgá or its delta.

5.2 Electricity

A transshipment port requires much energy. Exactly how much cannot be stated at this time as it depends on the size of the harbour. It is a better option to make it compulsory for ships to connect to a source of electricity on the dock rather than running their own a diesel generators with resulting contamination from emissions. Such options make a difference in Iceland as electricity from local sources is produced by environmentally friendly means (water power or geothermal heat) whereas fossil fuel operated on-board generators produce pollution-causing emissions. In countries where electricity is generated by the use of oil or coal this question is far less important; i.e. it makes little difference whether energy is produced by oil by a diesel generator or a machine on land which also burns fossil fuels.

In Iceland, electricity is sold at low rates to large consumer groups. It has not, however, been inexpensive for smaller users such as families. With free competition it is likely that the cost to those smaller consumer groups will go

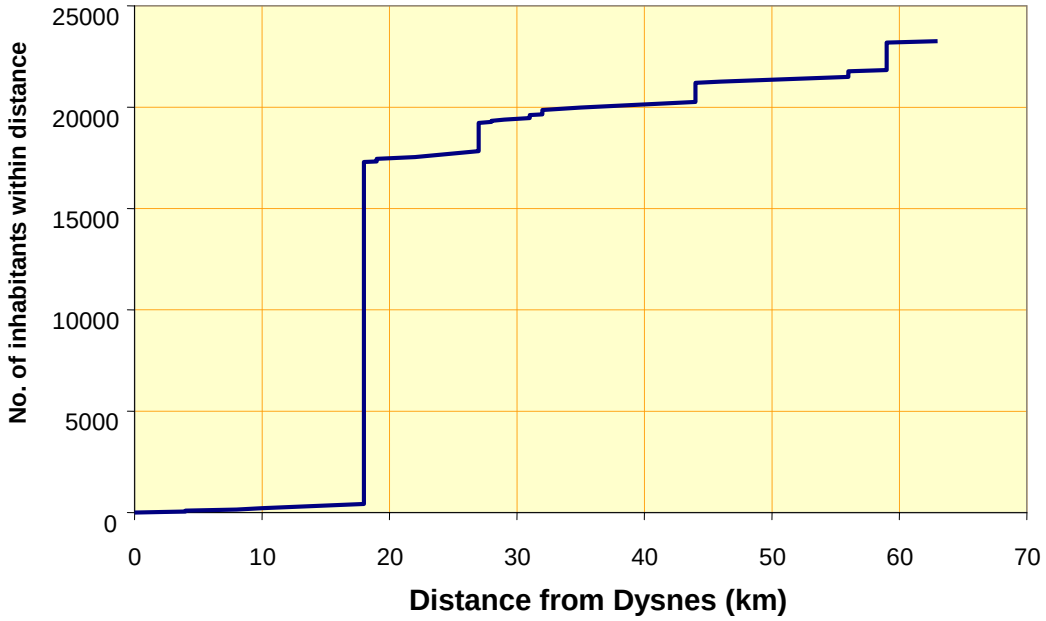
down in time but this trend has not yet taken off. The port would be a fairly large concern and should, therefore, be able to negotiate a fair price. The most important electricity grid in Iceland is the so called Byggðalína (132 kV) which lies from Hvalfjörður all round the country through North Iceland, the Eastern Fjords and East Iceland to Sigöldustöð Power Station in the south. Byggðalínan, along with a grid carrying an even higher voltage (220 kV), between Sigöldustöð Power Station and Hvalfjörður supply electricity to almost all consumers in Iceland apart from the Western Fjords. Rangárvellir, just above Akureyri, is the site of a switching station, from which a 66kV cable carries electricity north along the western side of Eyjafjörður to the town of Dalvík. It is therefore an easy matter to supply a port area on the western side of Eyjafjörður with a substantial amount of energy. If cables carrying less power to the area prove insufficient, it would be possible to hook up to the 66 kV cable. If that is still not enough for the required amount of power, it is only a short distance to the Byggðalína, either through the switching station at Rangárvellir or simply by creating a new 132V connection from Byggðalína at Moldhaugaháls to the harbour area. This is only a matter of about 10 km if we assume a port location at Dysnes.

5.3 Hot water

A large transshipment port incurs buildings which require heating. Also, it is likely that some kind of warehouse facilities on the site would need to be heated. There is a geothermal spring area at Hjalteyri and a hot water pipeline lies from there to Akureyri. It is, therefore, obviously a simple matter to supply the port area with water, provided that it lies on the western side of Eyjafjörður in-fjord from Hjalteyri. At the present time, Norðurorka, the Akureyri Municipal Water and Power Company, can offer plentiful hot water.

6 ACCESS TO MANPOWER AND SERVICES

There is abundant manpower in Eyjafjörður as this is by Icelandic standards an urban area. In a few years, the employment area will expand even more with the opening of a tunnel to Siglufjörður. With regard to Dysnes, we see from the graph below the connection which exists between collective population and the distance from Dysnes.



Picture 9. The manpower market around Dysnes. The connection between the collective population and the distance from Dysnes.

Akureyri is the service centre for a region which has over 20,000 inhabitants and this role is likely to become even greater with the opening of the Héðinsfjörður tunnel and the Vaðlaheiði tunnel. There is a wide range of services available in Akureyri which may be necessary to a transshipment port. The most important of these being:

- A high tech hospital (FSA) with a staff of 500. A base for emergency medical flights is already in place in Akureyri. With little notice, it is possible to fly patients to Reykjavík if they require such specialist treatment as is not provided in Akureyri.

- A fully equipped fire service is on round the clock shifts with 6-7 trained fire fighters on duty at any given time. The total number of fire fighters in the Fire Brigade is 34 and there is also the competence to deal with calls involving poisonous contamination since two of the staff are specially trained in this field. The Fire Brigade also has the role of ambulance service and there is always sufficient staff on duty to man two ambulances. It is also possible to call out additional crews so that four ambulances can be mobile at any time. In addition to the fire service in Akureyri there are Fire Brigades in Dalvík, Ólafsfjörður and Siglufjörður.

- The Customs Office in Akureyri, with a staff of two, operates under the auspices of the Office of the Akureyri Police Commissioner. A third employee is hired for the summer months. The Police Department assist the customs officers should this be required.

- There is an efficient and well-equipped police force in Akureyri as well as in Dalvík, Ólafsfjörður and Siglufjörður. In Akureyri there are four members of the National Police Special Branch. If a situation arises where more officers from this department are required they are flown in from Reykjavík. In Akureyri there is prison with cells to hold 8 inmates and it is planned to extend this so that 10 prisoners can be housed at the same time. Besides the prison, there are 8 holding cells in Dalvík and 2 in Ólafsfjörður. The Akureyri police force includes a special criminal investigation department with 4 trained officers as well as one position devoted to drugs investigation.

- A shipyard employs 100 people and there are numerous companies which specialise in equipment and goods connected with the shipping industry, while others provide general repair services.

- All kinds of waste can be disposed of in Akureyri, but those kinds which require special handling, e.g. substances which are potentially dangerous to the environment are removed from the area and often sent abroad. A transshipment port would therefore facilitate the disposal of various kinds of waste. General garbage is disposed of in Glerárdalur valley; a new location is currently being sought for this purpose, however.. If it is

deemed necessary to dispose of waste by burning there is a fully functional unit in Húsavík which has considerable excess capacity.

- Engineering companies and contracting firms.
- Various enterprises selling foodstuffs, other goods and leisure facilities and equipment.
- Besides this it should be mentioned that Eyjafjörður has a long tradition of technically advanced life-saving teams and rescue operations as are to be widely found in Iceland.

7 COMMUNICATIONS AND ACCESS TO INTERNATIONAL AIRPORTS

Communications by road are good in all directions from Eyjafjörður, and will become even better with the opening of the Héðinsfjörður and Vaðlaheiði tunnels. Goods are transported daily by road to and from Akureyri, especially to the south west corner of Iceland.

There is an international airport in Akureyri which will probably be extended by 400m, making the total length of the runway around 2.4 km which means that all but the largest of aircraft will be able to take off and land at Akureyri Airport. Scheduled flights to Copenhagen begins again in May 2006 and it is likely that such direct flights from the town will increase over the next few years. There are also frequent flights between Akureyri and Reykjavík and it is a simple matter to travel onwards from there to many destinations in Europe and North America.

A basis for operating cargo flights from Akureyri, involving fish transportation, has been developing in the past few years. Around 5,000 tons of fresh fish will in all probability be transported by road from the north and east of Iceland to Keflavík during this year where it will be flown to destinations abroad. No decisions have yet been made, however, regarding the transport of goods by air from Akureyri and thus it cannot be said with any certainty that this will become a reality in the future.

8 CONDITIONS FOR SECURITY MEASURES

Heavy security measures will most probably be required around the port area. No-one should be able to enter or leave the port area except through a security check point. No unauthorised persons will be able to gain admittance. It is therefore of utmost importance that when the location of the port is decided, the area of choice should be easily closed off by high fencing and that the transshipment port should be guarded by an efficient security system. There are no apparent drawbacks with regard to this matter in Eyjafjörður. There is plenty of space to fence off the port area without causing inconvenience to the daily life of the fjord's inhabitants. The site would also be within a short distance of the force police referred to earlier.

9 CONCLUSIONS

Eyjafjörður is in an excellent geographical position for navigation through the Arctic Ocean to the eastern shores of North America. It does not, however, lend itself so well to trips to Europe although it is fairly well placed for routes to ports in Southern Europe. It is a shorter distance to Iceland from the northern shores of the Arctic Ocean than to Scotland and the Western Isles. Natural harbour conditions are particularly suitable in Eyjafjörður, about as good as can be found, in fact. The fjord is very deep and yet offers good conditions for level onshore areas together with sufficient berth depths. Ocean swells are not a problem further up the fjord. The fjord is reasonably well sheltered and enough space to allow the easy manoeuvring of vessels. Access to water and electricity is easily available and of low cost. Access to hot water is very good. Manpower is not a problem as 20,000 people live within a 35 km radius. Akureyri and the surrounding district has excellent service capacity, both regarding official departments such as police, fire service and health and welfare and the more general company services, such as a shipyard and other building and construction firms as well as repair shops and traders in all kinds of goods. Communications to and from the fjord are good and will improve over the next years. There is an international airport in the fjord and the flights to and from foreign destinations will most likely increase in the future. Many flights a day between Akureyri and Reykjavík ensure that communications with Iceland's capital are as simple and convenient as possible. The conditions for an efficient security system are good in the fjord.

On the whole there is a great deal which recommends Akureyri as the site for a transshipment port dealing with traffic through the Arctic Ocean.

REFERENCES

Almenna verkfræðistofan hf [Almenna Consulting Engineers], Verkfræðistofa Norðurlands ehf and Rafhönnun hf (2003) *DYSNES-A Preliminary Site Study for a Primary Aluminum Plant in Eyjafjörður.* Invest in Iceland Agency-Energy marketing.

Landmælingar Íslands [the National Land Survey of Iceland] (2002) *Íslandskort Landmælinga Íslands. Kortadiskur 1, útgáfa 1.0.*[Map of Iceland, Map CD 1, Issue 1] Akranes: Landmælingar Íslands.

Staðarvalsnefnd um iðnrekstur [The Ministry of Industry, Localizing committee for. power intensive industry] (1983) *Staðarval fyrir orkufrekan iðnað* [Selecting a location for power intensive industry]. Reykjavík: Iðnaðarráðuneytið.

Starfshópur utanríkisráðuneytisins [task force of the Ministry for Foreign Affairs] (2005) *OCEAN AHEAD.* Reykjavík: Utanríkisráðuneytið.

LIST OF INTERVIEWEES

Björn Gunnarsson, Dean of the Faculty of Natural Resource Sciences, University of Akureyri. As a matter of fact, Björn was much more than an interviewee, he played a significant role as consultant during the compilation of the report. (Björn is also one of the authors of the report „Ocean Ahead")

Emil Ragnarsson, ship designer and lecturer at the University of Akureyri.

Erling Júlínusson, director of Akureyri Fire Department.

Gunnar Garðarsson, managing director of the recycling company Endurvinnslan in Akureyri.

Ólafur Ásgeirsson, assistant chief constable, Akureyri Police Force.

Steingrímur Jónsson, professor of oceanography at the University of Akureyri.

Þór Jakobsson, meterologist at Iceland Meteorogogical Office (has, among other things, conducted research on sea ice, and is one of the authors of the report „Ocean Ahead")

APPENDIX 1. NAVIGATIONAL POINTS OF REFERENCE

In all the discussion relating to navigation routes, it was assumed that vessels navigate between certain points on the globe and subsequently the distance between those points was worked out. Many of those points are shown in figure 6 with lines traced between them. The distance between points was calculated with the help of the website http://www.indo.com/distance/ and the points of reference are as follows:

70:00:00N 65:00:00E	between Novaya Zemlya and Franz Josefs Land
76:15:00N 26:00:00E	past Hopen near Svalbard
66:11:00N 18:30:00W	outside Eyjafjörður
65:50:00N 18:08:00W	opposite transshipment port in Eyjafjörður
66:45:00N 23:10:00W	outside the West Fiords
66:40:00N 16:45:00W	off Melrakkaslétta Plain
66:30:00N 14:15:00W	off Langanes Point
65:10:00N 13:00:00W	off the East Fiords
64:00:00N 14:00:00W	off Höfn in Hornafjörður
52:00:00N 4:00:00E	off Rotterdam
62:00:00N 3:00:00E	off Aalesund in Norway
54:00:00N 12:00:00W	to the west of Ireland
58:42:00N 3:00:00W	the Pentland firth between Scotland and Orkney
71:30:00N 28:00:00E	to the north of northern Norway from Murmansk
46:30:00N 53:00:00W	just off Cape Race in Newfoundland
57:40:00N 7:30:00E	to the south of Norway (on the way into the Baltic)