Marine Transport in the High North

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Edited by: John Grue and Roy H. Gabrielsen

Marine Transport in the High North

Novus forlag – Oslo
Det Norske Videnskaps-Akademi – Norges Tekniske Vitenskapsakademi
2011

ISBN 978-82-7099-641-4

Trykk: Interface Media AS, Oslo.

Preface

This publication contains the written papers of the talks presented at a symposium organized jointly between the Norwegian Academy of Science and Letters (DNVA) (www.dnva.no) and the Norwegian Academy of Technological Sciences (NTVA) (www.ntva.no). The symposium was held on the 19th October 2010 in the localities of DNVA in Oslo and had more than 100 registered participants.

The topic of the Symposium – Marine Transport in the High North – was chosen because of its political importance; Norway's Minister of Foreign Affairs, Jonas Gahr Støre, gave the introductory speech. Experts invited by the learned societies contributed with talks that reflected the current knowledge on the subject, viewed from the scientific, technological and juridical understanding.

Together, DNVA and NTVA represent the entire spectrum of the learned disciplines. By organizing an annual joint symposium on a topic of high political priority, the two academies want to develop this kind of science communication.

Some words about the chapters:
Minister of Foreign Affairs Jonas Gahr Støre expressed in his introductory speech, printed here in its full length, that the High North is the Government's most important strategic foreign policy priority. He referred to the successful establishment of the maritime boundary between Norway and Russia in 2010 which has opened several new possibilities for bilateral co-operation between the two countries. Topics he addressed, include: legal and political framework (in the Arctic), climate change and melting ice, oil and gas, ores and mineral,

the Northern sea route and cruise traffic, international agreements and development of the regulatory regime. He concluded by expressing a strong interest in exchange of knowledge and interaction between academia, the business sector and politicians.

The paper by Cecilie Mauritzen and Erik W. Kolstad treats the oceanic and meteorological conditions in the Arctic Ocean. The declining sea cover extension and the climate change which is stronger in the Arctic Region than in other regions worldwide are discussed. They write that the antropogenic influence on Arctic temperature is now detectable and distinguishable from the influence of natural forcings. The final part of the paper describes extreme weather in the Arctic and polar lows. This part was expanded after the Symposium, including Kolstad as co-author.

President Tor E. Svendsen of Det Norske Veritas writes about risk management of oil, gas and shipping activities in the High North, discussing also the dimension of emergency escape, evacuation and rescue operations. A complex risk picture and low tolerance for accidents mean that several layers of safety barriers are needed. The cross-country co-operation project Barents 2020 should be expanded by involving additional countries as well as various business interests engaged in the development activity. Legal instruments for shipping in Polar waters are briefly discussed.

Kaj Riska describes the Arctic potential in marine operations and shipping. The northern route cuts the distance between Russian Atlantic and Pacific ports in half. Moreover, 7.2 and 26.5 per cent of the world's oil and gas reserves, respectively, are located in the Arctic, according to a recent review by USCS. For shipping, it is more important to know where the ice cover exists than where it does not. Ice breaker escort vs. ice capability of merchant ships is discussed. Descriptions of future research needs on Arctic shipping relate basically to infrastructure, regulations and ship emissions, and not to ship technology. However, two recent year-round operations point to needs for improved ship design. Innovations for ship performance in ice and hull ice load are highlighted.

In the final paper, Ole Kristian Fauchald discusses the ability of Norway as a coastal state to regulate maritime transport in the Arctic. The United Nations Convention on the Law of the Sea (UNCLOS) represents the basic framework in this dimension and contains special rules for environmental protection. UNCLOS singles out ice-covered areas for special treatment (art. 234) and is of particular relevance for regulation of maritime transport in the territorial seas around Jan Mayen and Svalbard. How Norway can collaborate with Russia in marine affairs and how such an initiative may enhance the chances for a successful negotiation and implementation of a Polar Code are topics that are discussed.

An Appendix contains introductions to the symposium and summaries of the talks in Norwegian. Fauchald's summary was printed as cronicle in Teknisk Ukeblad on 17 March 2011.

We acknowledge with pleasure the technical assistance by Eirik Furu Baardsen and Paul K. Olsen of DNVA, and Dina Haraldsson of Department of Mathematics, University of Oslo for typesetting some of the chapters. The Symposium was jointly funded by DNVA and NTVA.

March 2011, *The Editors*

Contents

Shipping in the High North – interests, responsibilities and opportunities

Jonas Gahr Støre
Minister of Foreign Affairs

I would like to commend the science academies for creating arenas such as this, where the knowledge community, the business sector and politicians can meet and exchange perspectives, and where we can have a frank and dynamic debate.

Presence, activity, and knowledge are key words in our High North strategy – three pillars underpinning our efforts in the region. And the interplay between them is also of vital importance. I am therefore very pleased that you have arranged this event.

Developments in the High North entail both opportunities and challenges for Norwegian interests. The High North is the Government's most important strategic foreign policy priority, and has been so since we came to power in 2005. Much has happened since then, for example:

In March 2009, we presented the next step in the Government's High North strategy, New Building Blocks in the North, which sets out seven priority areas – or building blocks – and concrete projects that are to be implemented over the next 10 to 15 years. We are on schedule with this work; 80% of these projects have already been started.

In next year's budget we intend to allocate NOK 1.2 billion for measures to follow up our High North strategy. This is a 15% increase from this year. In particular, we will focus on improving safety at sea and developing maritime business activities.

We have established the maritime boundary between Norway and Russia.

At the international level, we note great interest in the High North and the Arctic, for example in the international media. A joint article that I recently wrote together with Russian Foreign Minister Sergei Lavrov on the management of resources in the Arctic and the delimitation line between Norway and Russia was published in more than 10 countries.

Countries such as China, Japan and South Korea are showing increasing engagement in Arctic affairs. They have sought status as permanent observers in the Arctic Council. They are also keen to have a dialogue with us on the High North and the Arctic. When I visited Beijing at the end of August, I found there was great interest in Norway's viewpoints on developments in the Arctic. We will take part in an energy dialogue with Germany later this month, and this topic is at the top of the agenda.

Why this increased international interest in the High North and the Arctic? Climate change and greater access to resources are two key answers. But before I say more about these drivers, I would like to comment briefly on the legal and political framework in the Arctic.

The legal and political framework in the Arctic

Firstly: with increasing international focus on the north, we are seeking to ensure that the High North continues to be a region of low tension. Increasing interest in the High North is neither negative, threatening nor necessarily a cause of conflict. We will exercise our sovereignty and authority in the north in a credible and predictable way.

Secondly: there is growing recognition of the fact that the Arctic is not an uninhabited legal vacuum. The Arctic Ocean is surrounded by states that have rights and obligations, also with regard to their sea areas and their continental shelf. The same rules apply to the Arctic Ocean as apply to other sea areas. The UN Convention on the Law of the Sea provides a solid basis and has clear provisions on issues of jurisdiction, including on the extent of the continental shelf. Last year, Norway was the first Arctic coastal state to receive the recommendations of the Commission on the Limits of the Continental Shelf.

Thirdly: the five coastal states bordering the Arctic Ocean – Canada, Denmark/Greenland, Norway, Russia and the US – met in Greenland in 2008, and again in Ottawa in March 2010, to confirm that they agree on their responsibilities in the High North and that international law provides an established basis for the coastal states' rights and obligations. The community of obligations and interests established by international law forms a natural basis for cooperation between the five coastal states on current Arctic Ocean issues.

Fourthly: the treaty on maritime delimitation and cooperation in the Barents Sea and the Arctic Ocean. After 40 years of negotiations, agreement has been reached on the maritime boundary between Norway and Russia. I had the pleasure of signing this treaty on behalf of Norway in Murmansk a few weeks ago. It increases the level of legal clarity and predictability in this area. The parties have reached a solution that is based on modern principles of international law.

The treaty also contains provisions that ensure the continuation of the extensive and fruitful Norwegian–Russian fisheries cooperation, as well as provisions concerning cooperation on the exploitation of any petroleum deposits in these waters that extend across the delimitation line.

Fifthly: the Arctic Council, the most important Arctic cooperation forum. We would like the Arctic Council to strengthen its role as a policy development body for Arctic issues. New countries are knocking at the door. Norway's position is that they could help to strengthen the Arctic Council. Many of the challenges in the Arctic must be addressed together with non-Arctic countries, particularly the challenges connected with climate change.

Climate change in general and the subsequent melting of ice in the Arctic in particular are key factors in the huge interest in the Arctic that we are now seeing from all corners of the world.

Climate change and melting ice

The northernmost sea areas have been difficult to access due to thick sea ice. Climate change is gradually changing this.

Here are some facts about the changes we are seeing in the northernmost seas:

Reduction of sea ice year by year: Satellite observations of the extent of sea ice from 1979 to 2006 show an annual reduction of 45 000 km^2, which is equivalent to 3.7% every ten years.

More rapid melting of ice in the summer: The ice cover has been shrinking at an average rate of 6.2% every ten years over the last 30 years. This summer, there was very little ice in the Arctic, as there also was in the summers of 2007 and 2008.

Thinner ice in winter that is easier to break through: The extent of the extremely hard multiyear ice is being reduced. In the winter of 2009, less than 10% of the Arctic sea ice was more than two years old.

The extent of the sea ice is changing: The edge of the sea ice in the summer has receded to north of Svalbard, and the Northern Sea

Route is almost ice free. This year, the whole of the North West Passage was ice free, as was the Beaufort Gyre north of Alaska.

The main message is that ice in the Arctic is melting at a rate that is dramatic and very serious, and this must be our main focus. The Arctic Climate Impact Assessment, the Intergovernmental Panel on Climate Change (IPCC), the report Melting snow and ice (commissioned by Al Gore and me, and presented in Tromsø in March–April 2009 and in Copenhagen in December the same year) all highlight these serious developments. We must maintain focus on both mitigation and adaptation. We are seeking to ensure that the United Nations Climate Change Conference in Mexico (COP 16) will bring us significantly closer to agreeing on permanent reductions in greenhouse gas emissions.

At the same time, the serious degree of climate change that we are seeing in the Arctic are also making the natural resources in the region more accessible. Over the next years, this could result in commercial activities in the Arctic.

Resources: oil and gas

The world's demand for oil and gas and other natural resources is growing. Here are some facts:

At the end of last year, the International Energy Agency (IEA) estimated that world demand for energy will increase by 40% by 2030, and that the demand for gas will increase by 42% in the same period. At the same time, nearly half the world's existing production capacity will be phased out. The remaining oil resources will be increasingly difficult to extract. Oil production will be more costly and require high levels of investment. This will also apply to the oil reserves in the High North and the Arctic.

The situation today is that the demand for oil has risen again after the financial crisis, and is now – in 2010 – higher than it was in 2007 (before the crisis). Oil prices have risen steadily since the low point just before Christmas 2008 when North Sea oil cost USD 40 per barrel. Today a barrel costs around USD 80.[1] The transport sector is the main driver of demand. The strongest growth has been in China, India and South East Asia.

The global demand for gas plummeted in 2009 as a result of the financial crisis. At the same time, two factors are affecting the supply of gas: an estimated 50% rise in liquefied natural gas (LNG) production in the period 2009–2013, and the increasing production of unconventional gas. This has led to a surplus of gas in many parts of the world, including in Europe, and has pushed prices down. However, demand has risen since the middle of 2009, and prices are now on their way back to pre-crisis levels. China's demand for gas continues to grow. At the same time, there is some uncertainty about how demand will develop. This is affecting investment decisions, particularly with regard to complex and costly projects, for example in Arctic areas.

The Arctic could be home to much of the world's remaining natural resources. According to US Geological Survey (USGS) estimates, undiscovered recoverable petroleum resources in the region could amount to as much as 22% of the world's total, i.e. 50 billion tones oil equivalents. There is a great deal of uncertainty attached to these estimates, but there is general agreement that these resources are mainly in the form of gas deposits offshore Siberia and in the Barents Sea.

The extraction of petroleum resources in the Arctic is increasing steadily, mainly in the Russian Arctic. Both the US and Canadian authorities have awarded new licences for oil and gas operations in Arctic areas, and the British oil company Cairn Energy started test drilling off West Greenland this summer.

Resources: ores and minerals

As a result of strong growth in the world economy and growing demand for metals in recent years, prices have increased by 80% since 2000. Despite the economic crisis, metal prices in May 2010 exceeded the 2007 peak by 4%. This significant increase in demand is mainly due to the rapid recovery of the Chinese economy after the economic crisis.

There are important ore and mineral resources in the Arctic:

There are several large mines in Arctic areas that produce nickel, zinc and other ores. For example, the Red Dog mine in Alaska is one of the world's largest zinc mines, and the mining company Northland Resources has started extracting iron ore in Pajala in Finland. The first estimates from Northland Resources indicate that there is sufficient ore to run the mines for at least 25 years. The company has decided to ship its annual production of more than 5 million tones via Narvik in North Norway.

According to plan, Nussir will start to mine copper in Kvalsund in North Norway in 2013. Estimates indicate deposits worth NOK 35 billion.

Bulk – the Northern Sea Route

These developments entail an increase in maritime traffic, and unless we develop efficient logistics systems, we will not be able to sell our geological resources at competitive prices.

Bulk transport of oil, gas, ores and minerals accounts for a significant share of shipping in Arctic waters. The Arctic Marine Shipping Assessment shows that in 2004, 20% of maritime transport in the Arctic was bulk transport of oil, gas and other natural resources.

This illustration shows the Northern Sea Route (North East Passage) – the most promising of the Arctic sea routes in terms of its potential for maritime transport.

It is estimated that the volume of goods transported via the Northern Sea Route will increase from 1.5 million tonnes in 2002 to 50 million tonnes in 2020.

Between 2002 and 2008, the volume of oil and gas transported via the Northern Sea Route increased from 4 million tonnes to 11.5 million tonnes. Today, it is mainly oil from Western Siberia that is shipped along this route and transhipped in the Barents Sea on both the Russian and Norwegian side. The Arctic Marine Shipping Assessment estimates that the volume of oil and gas transported via the western section of the Northern Sea Route (from the Pechora Sea to Europe) could reach 40 million tonnes a year in 2020.

The volumes for minerals are currently lower. Norilsk Nickel ships most of its production (mainly nickel and copper) – estimated at 1.3 million tonnes a year – from the port of Dudinka in the Kara Sea. The volumes transported along the Northern Sea Route in the future will depend on such factors as economic developments in importing countries like China, Japan and South Korea.

The Arctic Climate Impact Assessment from 2004 forecast an extended navigation season for the Northern Sea Route from 20–30 days in 2004 to 90–100 days in 2080. We have seen that the transport volume along this route has increased in recent years, and it can be expected to increase further in the years to come. Here is an example:

At the beginning of September, the 41 000 tonne bulk carrier MV Nordic Barents took 12 days to sail from Kirkenes in North Norway to the Bering Strait through the Northern Sea Route. It was carrying iron ore concentrate from the mining company Sydvaranger Gruve to China.

The Northern Sea Route (NSR) is partly covered by ice, the extent of which varies according to season. This means that vessels passing along this route need the assistance of icebreakers. Russia has the world's largest icebreaker fleet, and 54 of the estimated total of 80 icebreakers in the world operate in Russian waters. In 2008, 28 of these were active in Arctic areas and 7 of these are nuclear powered.

There are four main factors that affect the amount of time and money that can be saved by taking the Northern Sea Route:

Distance (the NSR is shorter and this reduces total fuel costs)

Speed (reduced speed along the NSR, which increases time and costs)

Insurance costs (higher for the NSR)

Icebreaker services (additional cost in connection with the NSR)

It is estimated that for the Yokohama–Hamburg route, the NSR is approximately 40% shorter than the route via the Suez Canal, and the fuel costs are approximately 20% less.[2]

Atomflot indicates that the voyage from Murmansk to Japan via the NSR is 13 days shorter than the voyage via the Suez Canal, and likewise that the voyage from Murmansk to South Korea is 11 days shorter and to China 8 days shorter.

The distance between Kirkenes in Norway and Qingdao in China via the NSR is 6 650 nautical miles (nm), compared with 12 405 nm via Suez and 15 842 nm via the Cape of Good Hope.

Cruise traffic in the Arctic

In addition to the transport of natural resources to the world markets, we are also seeing an increase in cruise tourism in the Arctic.

Cruise ships mainly sail through areas that are ice free, at least in the summer. However, they often pass close to land and the ice edge in order to give the passengers the best possible views. This increases the risk of encountering ice and of subsequent accidents.

According to one study, there were 1.2 million passengers aboard cruise ships operating in Arctic waters in 2004, and in 2007 the figure had almost doubled. In our own Arctic waters, we are seeing a marked increase in cruise tourism around Svalbard. The number of calls to Longyearbyen increased by 20% from 2008 to 2009.

The main challenge is that cruise ships are often so large that local rescue capacity would not be sufficient to deal with an accident if one occurred. Moreover, these ships pass through very inaccessible areas and low sea and air temperatures mean that it is vital to ensure a rapid and effective response in the event of an accident.

The infrastructure for search and rescue in the Arctic region is limited, although it is better in some areas than others. Norway has a robust system and adequate resources as a result of the Government's targeted efforts over several years. The strategy document New Building Blocks in the North sets out that the Government intends to "improve monitoring, emergency response and maritime safety systems in northern waters"

In other areas, there is little or no emergency response capacity to assist a cruise ship in distress. Among other things, there is a major shortage of helicopters that can tackle the distances involved and undertake heavy lifts. Helicopter operations can also be restricted by weather conditions, and there are few bunkering and service facilities in the Arctic.

International agreements and development of the regulatory regime

As a coastal state, Norway has obligations under international law with regard to search and rescue services. A number of agreements on search and rescue have been concluded. For example, in 1995, Norway entered into an agreement with Russia on search and rescue cooperation in the Barents Sea. As a result of this agreement, Norway and Russia carry out joint annual sea rescue exercises.

In addition, Norway and the other members of the Arctic Council are currently negotiating a new binding instrument for search and rescue in the Arctic. The aim is to improve regional organisation of search and rescue services in the Arctic, and to divide the region into national search and rescue areas in order to clarify the responsibility of the individual coastal states. The fourth meeting in this process was held in Helsinki 6–8 October, and the next will be held in Reykjavik in December. The aim is that an agreement will be signed during the Arctic Council's next Ministerial Meeting in Nuuk in May 2011.

But we must remember that a search and rescue agreement will not provide all the answers. The time factor will often be critical. Long distances may mean that it will not be possible to reach those in distress in time.

Although the legal framework for the Arctic Ocean is set out in the UN Convention on the Law of the Sea, new developments may make it necessary to further develop this framework in certain areas. Shipping is by nature international; it is a tool for international trade. The regulatory regime for international shipping must therefore be developed with the aim of achieving harmonised and universal rules.

Norway attaches great importance to further developing the rules for shipping in Arctic areas, and in particular to the ongoing work in the International Maritime Organization (IMO) to develop a new set of binding rules for the Arctic – a polar code. The next meeting of the Maritime Safety Committee will take place at the end of October. At this meeting, a working group will be established to draft such a polar code. Norway has been requested to lead this group, and the aim is to complete the polar code in 2012 with a view to it entering into force in 2014.

Conclusion – the need for more knowledge

There are considerable challenges related to shipping in Arctic waters. It is costly to build ice class vessels. Winter darkness, summer fog and ice formation on vessels all represent risks. The charts are not good enough and neither are the weather forecasts. We are therefore considering establishing an Arctic Regional Hydrographic Commission.

The Government intends to improve monitoring, emergency response and maritime safety systems in northern waters. This focus is being followed up in the government budget for this year and next. Emergency response capacity for dealing with oil spills and accidents will be increased through concrete measures such as competence-building for Coast Guard staff, increasing tugboat capacity in the north, continuing the allocations for oil spill response equipment, and research cooperation on oil spill response under difficult climatic conditions. In addition, we have started to develop an integrated maritime surveillance system for the High North – BarentsWatch.

Through the Barents 2020 programme, we are helping to build knowledge about, in and for the High North. For example we supported the establishment of the Centre for High North Logistics (CHNL).

Interaction and networking between the various actors in the knowledge and business sectors in Norway and Russia is vital. Since 2007, funds from the Barents 2020 programme have co-financed cooperation with Russian industry and authorities on the establishment of common environmental and safety standards in connection with developing oil and gas activities in the Barents Sea. We are now seeing that actors from other countries are interested in taking part in this project. The oil company Cairn Energy, which is currently engaged in exploration of Greenland's continental shelf, is taking part in two of the working groups in this project. The exchange of knowledge and experience can help to improve HSE standards for petroleum operations and associated

maritime transport in the whole Arctic region. The development of new knowledge is the basis for future value creation in the north.
Knowledge is a key factor in the Government's High North strategy – and I would like to stress this here today. With knowledge, we can meet the challenges and opportunities that maritime transport in the High North entails, and thus safeguard Norwegian interests in the region.

One month ago, I met President Nils Christian Stenseth for a discussion on science and politics in this splendid building. This gave me new input for my efforts to promote Norwegian interests internationally. I hope that today's symposium will likewise foster exchange of knowledge and interaction between academia, the business sector and politicians in a way that ensures the best possible development of maritime transport in the High North.
Thank you.

[1] Price of North Sea oil on 11 October: USD 83.06 per barrel
[2] Source: "Shipping in Arctic Waters", study by OceanFutures

The Arctic Ocean – an ocean in transition

Cecilie Mauritzen[1] and Erik W. Kolstad[2]

Introduction

The Arctic is a beautiful, magical, rich and inaccessible region, full of attraction to the adventurous; actually probably to most of us. Most of the year, the Arctic Ocean is ice covered, and a vibrant animal life blooms near the ice edge as the sun reappears in the spring. The upper Arctic Ocean has an intricate structure in the vertical: the top 200 meters or so are colder than minus 1ºC and relatively fresh, but warm waters from the Pacific and Atlantic oceans penetrate these cold surface waters; the Pacific waters in a thin layer around 50 meters depth, and the Atlantic waters as a very thick, warm and salty layer with a core at roughly 300-400 meters depth. The ocean is deep – in many places more than 4000 meters deep – with wide, shallow shelf seas along the periphery. The deep water masses are near freezing, but subtle differences in the salinity and temperature tell us about a complicated circulation system in the deep ocean, with narrow, strong currents over the steep topographic slopes.

During the entire satellite record – since 1978 – sea ice extent has been declining. This trend is most pronounced in the end of the

1 Physical Oceanographer, Norwegian Meteorological Institute
2 Meteorologist, StormGeo

summer season, i.e. in September, but all months show a declining trend. The year 2010 saw the third lowest level of September sea ice extent, only beaten by 2007 and 2008 (Figure 1). Why is this happening? The final distribution of sea ice each September depends on the exact development of weather patterns the preceding summer, especially when the ice is thin (easier to move). Since the satellites do not see thickness as easily as extent, we do not have direct measurements of thickness for extended periods, but it is possible to deduce sea ice age, which is a fairly good indicator of thickness. The amount of first-year ice has been increasing in the Arctic, at the expense of multi-year ice (Maslanik et al., 2007). So the thickness is much reduced at present, and the sea ice is much easier to move. In 2010, the September distribution was larger than average only in one region, namely north and northeast of Spitsbergen. Both the northeast and northwest passage was open to traffic, and the Beaufort gyre (in the Canadian Basin) was practically ice free (NSIDC.org). However, the period of ice "free" conditions is short; it generally lasts through August, September and October.

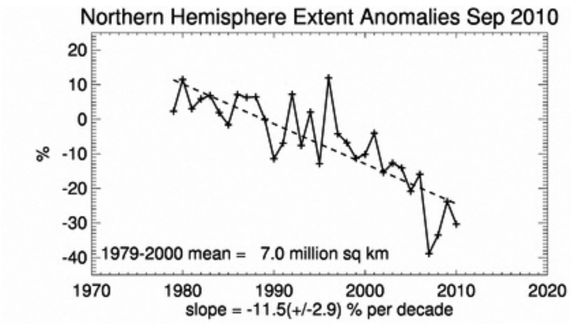

Figure 1. Monthly September ice extent for 1979 to 2010.
Credit: National Snow and Ice Data Center

Climate attribution in the Arctic

Even though the Arctic has been a much used, powerful visual image of climate change for decades, it is only in recent years that scientists have managed to make a connection between manmade emissions and some of the observed changes in the Arctic. It has taken this long because the time series are short, the year-to-year variability high, and because change – be it manmade or natural – is often amplified in the Arctic. As we know, the Arctic region has seen enormous changes also in the past, well before the industrial revolution. However, Gillett et al. (2008) made a formal "detection and attribution" study which showed that the anthropogenic influence on Arctic temperature is now detectable and distinguishable from the influence of natural forcings (Figure 2). The same year, Min et al. (2008) concluded that the recent downward trend in sea ice extent

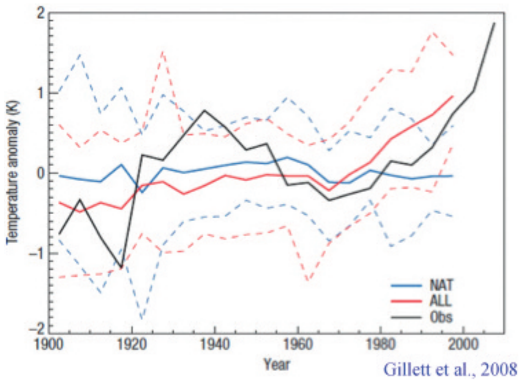

Figure 2: Simulated and observed Arctic five-year mean land temperature anomalies. Solid lines show observed temperature anomalies (black), the mean simulated response to natural forcings (solar irradiance changes and volcanic aerosol, denoted NAT; blue) and the mean simulated response to natural and anthropogenic forcings (greenhouse gas changes, stratospheric ozone depletion, sulphate aerosol, solar irradiance changes and volcanic aerosol, denoted ALL; red). Dashed lines show the warmest and coldest NAT (blue) and ALL (red) simulation in each 5-yr period, approximately representing 2.5th and 97.5th percentiles. Anomalies for 2005–2009 are based on observations up to July 2008. From Gillett et al., 2008.

would not have occurred without the human emissions (greenhouse gases, aerosols and ozone-reducing substances).

Looking into the future, the uncertainties increase, both because we do not know how large the human emissions will be and because no climate model is perfect. But by looking at a range of climate models, and a range of emission scenarios a fairly clear picture emerges: **The reduction in summer sea ice extent is likely to continue if the anthropogenic forcings are not greatly curbed (**Wang and Overland, 2009; Figure 3).

Extreme weather in the Arctic

A good weather forecast depends in particular on the quality of the numerical forecasting model and the knowledge of the initial state of the forecast (the data). In many ways Arctic meteorology is a field in its own, because the processes are very different in the Arctic than elsewhere, impacting on condition 1, and because obtaining data there is so difficult.

In addition to the typical Arctic weather variability and storms, which are important to forecast accurately in their own right, there exists small and dangerous *polar lows*. These are high-latitude, maritime, small-scale cyclones, and while there exist no clear and all-encompassing definition of *polar lows*, the term is usually reserved for cyclonic features that form in marine cold air outbreaks, i.e. in cold air masses that are transported over a relatively warm, open ocean. *Polar lows* normally do not exceed 1000 km in radius and often have wind speeds of 15 ms^{-1} or more (Rasmussen and Turner, 2003).

The most distinctive feature of cold air outbreaks over the ocean is their low static stability in the near-surface air masses. This is also the primary characteristic of *polar lows*. In general terms, most *polar low* developments go through two stages. The initial stage is typically associated with large local temperature differences at the leading edges of, or inside of, cold air outbreaks

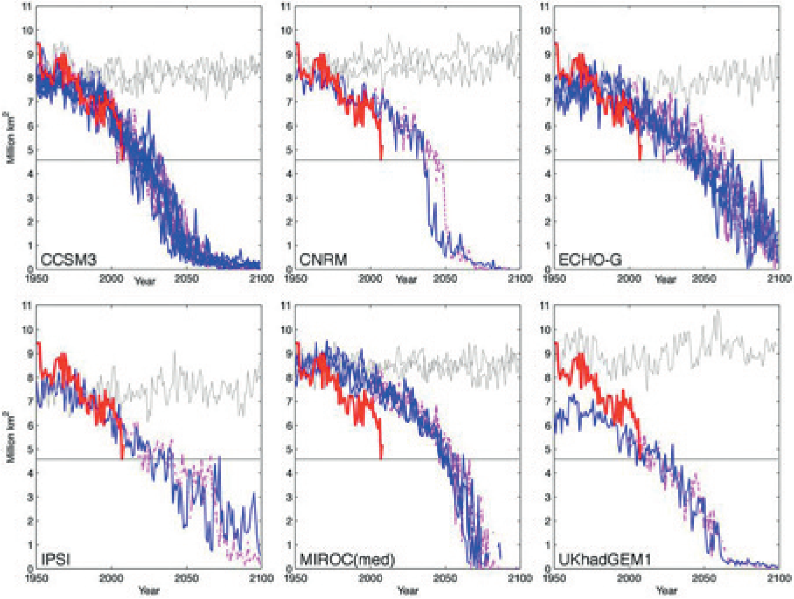

Figure 3: September sea ice extent as projected by the six models that simulated the mean minimum and seasonality with less than 20% error of the observations. The colored thin line represents each ensemble member from the same model under A1B (blue solid) and A2 (magenta dashed) emission scenarios, and the thick red line is based on HadISST analysis. Grey lines in each panel indicate the time series from the control runs (without anthropogenic forcing) of the same model in any given 150 year period. The horizontal black line shows the ice extent at 4.6 M km2 value, which is the minimum sea ice extent reached in September 2007 according to HadISST analysis. All six models show rapid decline in the ice extent and reach ice-free summer (<1.0 M km2) before the end of 21st century. From Wang and Overland (2009).

in or near the marginal ice zone. Many *polar lows* do not progress beyond the initial stage, but if the incipient *polar low* moves over warmer water, it may enter a new, mature stage associated with more widespread low-level instability and convection. It is in this convective stage that the classical spiral-shaped *polar lows* (such as the one in Fig. 4) develop.

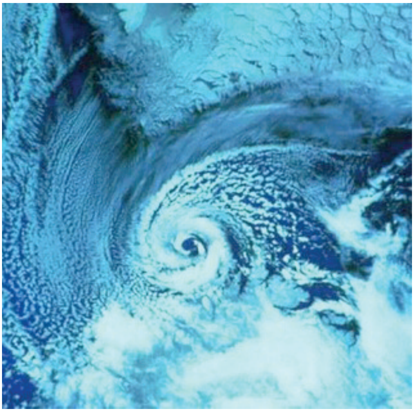

Figure 4: A famous satellite image of a *polar low* just north of Finnmark in northern Norway on 27 February 1987. The likeness to a tropical cyclone in this image contributed to a worldwide interest in the dynamics of *polar low* formation – were they ”Arctic hurricanes”? It turned out that while there are some similarities between tropical cyclones and *polar lows* (they both require substantial amounts of energy transfer from the ocean to the atmosphere), they are in fact two different phenomena.

In Fig. 5, *polar lows* in various stages of development over the Nordic Seas are shown. Stretching towards the south-west from Spitsbergen at the top of the image, a front separates the cold air streaming down from the sea ice to the east of Greenland from warmer air over the Norwegian Sea. The cold air is clearly identified by cloud streets, bands of low-level clouds in the cold air masses. Along the frontal zone at least four *polar lows* can be seen. The southernmost of these, just north of 65°N, has the strongest surface winds, while the large *polar low* just north of 70°N appears to be the most mature *polar low*, with a clearly defined closed circulation wind pattern around the center of the cyclone.

Why are polar lows dangerous?

There are three main reasons that *polar lows* represent a substantial part of the marine hazard in the Norwegian/Barents Seas:

1. They can appear suddenly and unexpectedly. Some *polar lows* move very fast and can appear in otherwise clear weather. This is because they often form in cold air outbreaks ”behind” regular, larger-scale cyclones. The textbook situation is that a large low moves into the Nordic Seas region from the south of

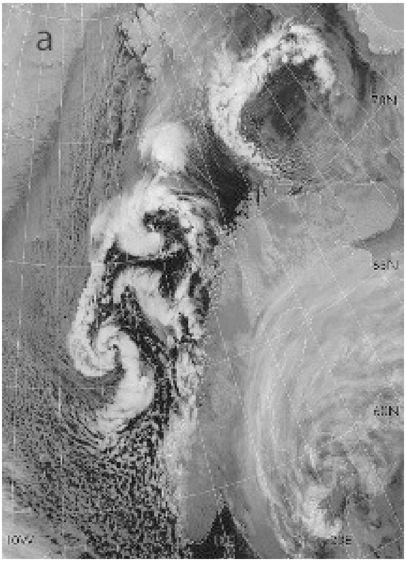

Figure 5: *Polar lows* over the Nordic Seas January25, 2002. Satellite image taken at 0156 UTC.

Iceland, eventually settling over north-eastern Scandinavia. This often leads to large-scale northerly flow and favorable conditions for *polar lows* over the Nordic Seas. It is thought that this chain of events has led to many accidents involving Norwegian fishermen – after having waited onshore for days while the large low passed by, it is understandable that they went out as soon as the weather cleared. It must have taken many years of experience to know that this situation could lead to *polar lows*.

2. They are often associated with strong surface winds and heavy snowfall. Most *polar lows* have winds in excess of 15 m/s in concentrated regions. Some *polar lows* have been known to have winds of hurricane force near the centers of the cyclones. The large temperature differences between the sea surface and the near-surface air in most *polar lows* lead to strong convection, which again may lead to the formation of thunderstorms and heavy snowfall.

3. They are difficult to forecast. Even with today's high-resolution numerical weather forecasting models, it is very hard to simulate the correct life cycle of *polar lows*. This is probably mainly because there exist very few observations in the Arctic, upstream of where the *polar lows* form. By contrast, ”normal” low-pressure systems normally originate in North America or near Iceland, where there are many more observations that can be used to initialize the forecasting models. Another important reason that *polar lows* are hard to forecast is that they have been studied much less than tropical and mid-latitude cyclones. There exist about 180 scientific studies with ”*polar low*” in the title, compared to about 30,000 with titles that include ”tropical cyclone”, ”hurricane” or ”typhoon”.

Where do polar lows occur?

Previously it was thought that *polar lows* was a phenomenon that was mostly confined to the Nordic Seas, and especially in the region between Finnmark in northern Norway and Spitsbergen. Figure 6 shows the tracks of the *polar lows* that had a measurable impact on mainland Norway, specifically on the winds recorded, during the period 1978–1982 (starting point: filled circles). Most of these *polar lows* originated north of 70°N and practically all of them moved southwards.

In recent years it has become clear that *polar lows* occur regularly also further south, such as near Japan, in the Sea of Okhotsk, on both sides of southern Greenland and even in the Southern Hemisphere.

Since *polar lows* sometimes occur on very small spatial scales and are therefore not reproduced by coarse-resolution hindcasts and re-analyses, Kolstad (2011) used several different index values as proxies for the likelihood of *polar lows* to form.

Figure 6: *Polar low* tracks in the period 1978–1982, based on the studies of K. Wilhelmsen (published in 1985 as part of the international *polar low* research project). The first recorded locations of the *polar lows* are shown as filled circles, and the last recorded locations are shown as open circles. Only *polar lows* that had an impact on mainland Norway were included in the study.

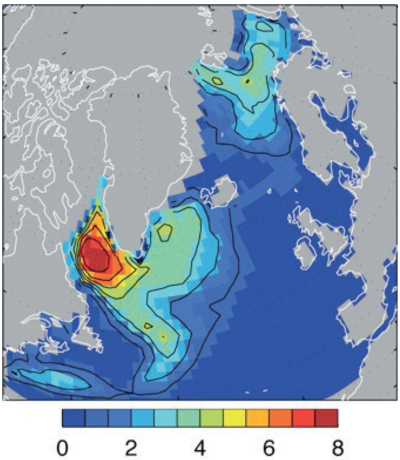

Figure 7**:** The climatological distribution of *polar lows* in the North Atlantic region, shown here as the percentage of time during winter (November to March) with favorable conditions for *polar lows* (according to a set of criteria defined by Kolstad 2011) in the period 1979–2010. Black contours are drawn with an interval of 1%, starting at 1%. This figure is taken from Kolstad (2011).

Figure 7 shows the percentage of the time during winter (November to March) that one of these indices indicates that the environment is favorable for *polar low* formation. The index detects conditions characterized by low vertical static stability in the air masses and the presence of upper-level disturbances, the two most important factors for *polar low* formation. The figure shows that *polar low* formation is most often likely to occur in the Labrador Sea, the Barents Sea and the Lofoten Basin.

Polar lows in the future

Because they are dependent on the cold air masses that form over sea ice, *polar lows* generally only form in the vicinity of large ice-covered oceans, such as the Arctic Ocean. An interesting question is therefore: How will global warming and the retreat of the Arctic sea ice influence *polar lows*? Two studies have tried to answer this question by making use of future projections from climate models.

Kolstad and Bracegirdle (2008) defined an index for cold air outbreaks by examining the difference between the temperatures at the sea surface and the ones in the lower atmosphere. When this difference is large, the likelihood of *polar lows* is also large. They found that the climate models predict that the atmosphere heats up faster than the ocean at high latitudes. This implies that the average vertical temperature difference will decrease, and therefore the average likelihood of *polar lows* will also decrease. However, this result is only valid for open ocean regions. **Near the edges of today's sea ice, the retreat of the sea ice will expose large new ocean regions to the atmosphere. In these regions, where *polar lows* and related weather have been non-existent so far (because *polar lows* need energy from the ocean), *polar lows* will make their first appearances in the future. These are the same regions that have been proposed as tomorrow's shipping lanes and oil/gas exploration areas.** A recent study by Zahn and von Storch (2010) in *Nature* reached the same conclusions: *polar lows* will be less common in the future in the regions that already experience *polar lows,* but the frequency of *polar lows* will increase dramatically in the regions that are covered by sea ice today.

Not only are the *polar lows* likely to move northward; it is a general projected trend of future climate scenarios that the stormtracks of the jet stream will move poleward (Yin, 2005, Trenberth et al., 2007). This would affect the Norwegian Sea and the Arctic Ocean, and one can already see signs that this is happening (McCabe et al., 2001).

Monitoring the Arctic

During recent years, it has become increasingly obvious that we need to prepare for a new era in the Arctic. Commercial activities will become ever more attractive as the sea ice retreats, and scientists are not able to provide answers to all the new questions that arise concerning what it implies to operate safely and sustainably in the High North. At the same time, climate is a global, not a regional issue, making changes in the Arctic of worldwide significance. To understand and minimize the impacts of human activities, we need continued monitoring and highly interdisciplinary research. Near-real-time monitoring of the Arctic atmosphere, ice and ocean allows more insights and shorter response time than would otherwise be possible. Continued monitoring ideally demands sustained co-sponsorship by the pan-Arctic nations.

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Risk management of increased activity in the Arctic Region

President Tor E. Svendsen, Det Norske Veritas

Introduction

The attention of explorers has been drawn towards the Arctic for at least a century and a half. These explorers risked their own lives but their presence caused minimal environmental and other impact. Those lucky enough to return safely after 2 or 3 years described vast areas with enormous amounts of ice, extreme temperatures, severe storms, prevailing darkness for months and a constant fight for survival.

In connection with proposed oil and gas development projects in this area, the needs for the maritime and offshore industry to take into account the additional challenges due to the severe arctic conditions in the Barents Sea have become apparent. In addition increased maritime tanker traffic from the Barents Sea along the Norwegian coast due to petroleum developments in the High North causes concerns. Recent trends indicate an Arctic Ocean with longer periods of reduced sea ice and thickness, implying improved ship accessibility around the margins of the Arctic Basin.

In parallel the recent accident with the Deepwater Horzion in the Gulf of Mexico underlines that how ever much we plan risk is still associated with the modern industrial society. But our society needs energy, and the search of the energy industry for new discoveries takes place in areas increasingly more remote and challenging locations, in the High North and/or in deep waters. What will be our most important challenges when ever more attention and effort is being directed towards the gigantic resources assumed to be hidden in the Arctic areas?

Challenges to oil, gas and shipping activities in the Arctic

Moving the oil and gas as well as shipping into the cold climate of the Arctic introduces several new challenges. Meeting these challenges we must make sure to draw on all the valuable lessons learned from ice navigation in the Baltic Sea, St. Lawrence River and other areas as well as from arctic fisheries and exploration. All such experience must be gathered, analysed and incorporated when designing for new operations in the Arctic.

Some of the main challenges and their corresponding impacts on Arctic operations are:

Low temperatures

Low temperatures, down to extremes such as -50°C, have major impacts on the working environment and introduce several limitations for the people doing out-door work. Low temperatures also change the properties of most of the materials used in structures and equipment. Because normal materials become more brittle at low temperatures, more expensive materials qualities have to be chosen. Testing and certification of equipment will be a requirement. More protection from wind and weather is required to reduce the wind chill effect for those working outside.

Ice

Ice will be present for large parts of the year both in terms of drifting sea ice and icing on equipment, in most of what is defined as polar waters. Additional strengthening and special designs of ships and platforms have to be included. For ships, the regime with different ice classes for different ice conditions is well established and has been used for decades. Ice, snow, darkness and low temperatures will slow down and reduce the effectiveness of most of operations. Examples are oil recovery in the case of an accidental oil spill, rescue operations, etc. Navigation in ice, identifying the actual ice condition and finding the easiest way through the ice requires special competencies as well as improved navigational equipment.

Human fatigue

Standard operations like cargo handling, ballast operations, and navigation are generally more challenging in polar waters. This is due to not only the technical consequences of low temperatures and ice, but also the impacts these factors have on the people working in this harsh environment: what we call the human factors. Of particular concern is human fatigue, which is exacerbated in the polar regions by low temperature, long periods of darkness or light, noise and vibration from ice, and the psychosocial aspects of living in remote areas. In addition, a multicultural working environment with its different perspectives on organisation, management and responsibilities in addition to language barriers will affect the performance of personnel in Arctic areas. Extreme and sudden weather changes combined with operation remote from normal infrastructure has a direct impact on emergency preparedness, medical assistance, rescue and evacuation, as well as access to spare parts and repair.

Environment

The Arctic environment is more vulnerable than more tempered sea areas. Impact may be more dramatic and the time it takes to restore longer. Operators, for example in the Barents Sea, must therefore also expect higher public attention to their activities with a corresponding low public tolerance for any harm they can be said to cause. This will result in more focus on minimising operational emissions and discharge to sea and to air. Additional barriers to avoid the worst case scenario—the accidental discharge of oil—will most probably become standard for units intended for operation in polar waters.

Emergency Escape, Evacuation and Rescue in the Barents Sea and Arctic Region

A wide range of different ice and weather conditions influence the potential consequences of an accident in the Barents Sea and other ice-infested regions of the world. Because of this, effective escape, evacuation and rescue (EER) operations must be capable of accommodating a full spectrum of ice or open-water situations, which are often complicated by many other environmental and logistical factors.

Some of the challenges that are potentially increasing the risks related to EER are:

- The full range of weather conditions which may be encountered, including ice, cold temperature, wind and icing.
- The logistics systems that may be available to support any required evacuations from an offshore structure or vessel, including the presence of helicopters and standby vessels.
- The distances to support bases and other emergency facilities.
- The capability of support vessels that may be called on for assistance, with regards to their manoeuvring and station-keeping abilities in ice.
- The effects of cold temperatures on human physiology and psychology, equipment, materials and supplies.

Today there is no single solution that fits all the different conditions. Hence different custom-made solutions must be developed and adapted for each specific area of operation, ice condition, temperature, etc.

A vessel in distress in the Arctic also faces additional hazards from rapidly changing ice conditions. Ice fields and ridges can impose extreme pressures against a vessel's hull. A power blackout for some hours in open waters does normally not represent extreme danger, but the same situation in ice may lead to damage of the hull or equipment located in heated areas. Hence a higher level of emergency preparedness may be required in Arctic waters and should be an integral part of the overall risk assessment for the maritime transport infrastructure and the installation itself.

Rapidly changing weather conditions may result in heavy icing on equipment, hull and other structures with acute redundancies and destabilisation among potential consequences.

International regulations in the Arctic Ocean

The Arctic Ocean is, like all other oceans, subject to international ocean law laid down in the U.N. Convention on the Law of the Sea, UNCLOS. This convention governs the relationship between the coastal states rights and obligations, i.e. to proclaim Exclusive Economic Zones (EEZ) and the rights granted to all of "innocent passage" and the use of international seabed and waters.

When sailing through the North West or North East passages, ships will for a large part pass through the waters and maritime jurisdictions of Arctic coastal states, especially Canada and Russia. National Canadian and Russian legislation therefore forms an important legal framework for sailing in these waters. The aim of these national laws and requirements will mainly be to protect the environment, resources in the sea and safety of navigation. There are, however, some jurisdictional controversies related to these routes.

To what extent therefore, there is a need to further supplement UNCLOS by other international instruments is a matter of debate. Forums such as the Arctic Council, might however come to play an increasing role as a rule maker related to for example search and rescue (SAR) and pollution response.

With regard to shipping in (international) polar waters, the International Maritime Organization (IMO) is in charge and the core legal instruments for safety and environmental protection at sea remains relevant. These are in particular:

- the Safety of Life at Sea (SOLAS) convention,
- the International Convention on Standards of Training, Certification and Watch keeping for Seafarers (STCW), and
- the International Convention for the Prevention of Pollution from Ships (MARPOL).

These conventions apply globally and therefore also include the Arctic Ocean.

In addition, the IMO developed non-binding *Guidelines for ships operating in Arctic ice-covered waters* in 2002. These guidelines were extended to Antarctica in 2009 and the IMO is now working on developing a mandatory set of requirements, the so called "Polar Code".

On top of the international and national regulatory schemes, serious industrial companies will as a part of their Corporate Governance and Social Responsibility have their own company standards relating to ethics and codes of conduct, compliance with laws, and safety, health and the environment (SHE).

Finally, the rights of indigenous peoples also play a role in this area. They are actively -and successfully - working for self-determination to preserve their own cultures and way of life, as well as securing a share in the resource development on the territories they have lived for centuries. Increased shipping, mining and oil and gas activities have both positive and negative influences on the lives of these peoples.

Risk Management in the High North

All human activity inherently represents some type of risk. Risk is defined as the product of the probability of an incident and the consequence of that incident. (Risk = Probability x Consequence). Risk can be managed to an acceptable level, either by controlling the probability of an unwanted event to occur, or by limiting the consequences of an event.

Exploring and making use of the resources in Arctic areas can not be sanctioned if the requirement is that it shall represent *no* risk.

The Arctic Region is not uniform with respect to hazards and risks related to maritime and offshore oil and gas operations. The western part is in many ways comparable to the North Sea where as additional Arctic challenges increase further east.

It is furthermore reasonable to deduct that the consequences of accidents - in terms of loss of lives, environmental damage and/ or economical loss – may be more serious in the Arctic due to

- remoteness, huge distances, and lack of infrastructure which make emergency response more challenging
- darkness which makes response more difficult
- extreme temperature and weather making response more challenging
- sea ice complicating rescue operations and oil spill response
- vulnerable marine and coastal environment
- potentially long down-time of operations after accidents, due to only seasonal access for repair
- high public attention to activities in the Arctic, low public tolerance for accidents, with potential for loss of reputation for all parties involved

If the consequences may be more serious in the Arctic Region, it means that the risk level also will be higher unless risk mitigating measures are defined and implemented.

However, some of the consequence driving factors, such as darkness, low temperatures, remoteness and vulnerable environment cannot easily be compensated for.

In order to maintain at least the same safety level (i.e. risk level) as for the offshore activities we have long experience from in the North Sea, it is more effective to address and reduce the probability of incidents, to prevent accidents from happening (figure).

Working to reduce the probability of an unwanted event is always the prioritized option, but normally one would seek a combination of probability and consequence reducing measures to meet a tolerable risk level.

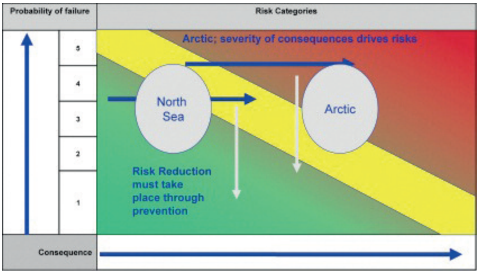

Figure 1 - Principle of risk management by reducing probability of hazardous event

Activities in the polar areas will be based on both area specific knowledge and experience from decades of developing maritime and oil & gas activities in new areas and with new technologies. The industry experience tells us that there are additional challenges associated with establishing new activities where we lack operating experience. The process to identify and manage such risk factors is therefore not new to the maritime or offshore industry. Hence the most important condition for safe activities in the polar areas is that the risk these activities may infer are identified and assessed in a structured way. You can not manage what you don't know. Any risk must then be investigated, and targeted risk reducing measures implemented in order to reduce the risk as far as practically possible.

As mentioned the maritime and oil & gas industry have entered new regions and challenging operational environment in the past, with the same need for identifying and controlling risk. What is new this time is the enormous awareness of the vulnerability of the polar areas. This creates a strong expectation that is put on the industry and the regulative regimes to demonstrate that the risks are managed. The statistics for major safety accidents in the North Sea has improved, throughout the period with more and more complex and challenging operations. There has been no major disaster within the oil & gas industry the North Sea since introduction of risk based legislation in Norway and UK. Very serious failures have occurred, but none of these have escalated into major accidents or disasters. The number of leaks from the main hydrocarbon containing process systems reported to UK HSE Executive is reduced with a factor of 10 the last 13 years. This shows that is should be feasible to engage in more and more complex and technological challenging operations, and still control and further reduce the associated risk level. This however requires a continuous focus on the requirements for safe operation – safety is not something that is built, it is a quality which is created every day by careful consideration and follow-up of the interaction of technology, organization and human factors. DNV believes that it is critical to maintain and use a continuously updated quantifiable safety and environmental risk model to support decision making to prevent major accidents. A holistic model is needed that addresses all aspects affecting the safety, such as technical, procedural, human and organizational and cultural aspects.

Risks that we are familiar with, where we perceive ourselves to be in control, and where we see a clear benefit of taking the risk, generally lead to a higher risk tolerability. Typically, society generally has high risk tolerability for road traffic fatalities, much lower risk acceptance related to industrial activities such as the offshore and maritime industries. Major accidents that occur suddenly and with a large impact with respect to fatalities and damage to environment are associated with a risk aversion, which is not seen when it comes to road traffic accidents which causes multiple fatalities every day.

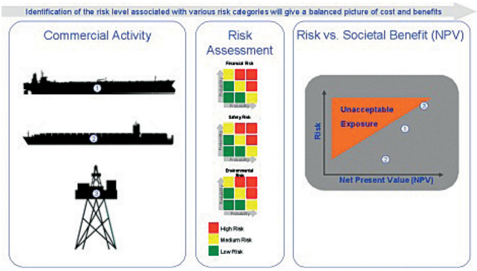

Figure 2 - Societal benefit vs Risk Exposure.

The figure illustrates the need to take the economic benefits to society into account when deciding on the activities in environmentally sensitive areas. If the economic benefit to society is relatively small, then it may not be correct to start the activity, even if the technical risk is within acceptable limits. On the contrary, if the economic benefits are large, we may accept a higher calculated risk. Different activities will represent different risks and benefits. The risk perceived is a function of interest that is represented, e.g. environmental organisations versus politicians versus operator companies.

The aim is to attain sufficient knowledge so that society at large as well those directly involved in the activities are able to make their decisions weighting the downside risk against the benefits of the activities. This will also be needed when evaluating the need, benefits and cost of measures that can be used to achieve optimal risk reduction. It is society at large that shall measure the balance of the pros and cons. In order to do this a knowledge based discourse is required, which can make reference to shared and holistic risk tolerance criteria as a basis for understanding the process of balancing risks.

A complex risk picture and low tolerance for accidents will contribute to the need for several layers of safety barriers. In particular in the early stages, when little experience data is available it is foreseeable with requirements for more safety barriers than what would normally be required. The strategy is to add barriers until one can assure that the tolerance criteria is met. As an example less precise calculations of ice loads due scarce ice and metocean data may increase the conservatism in the design and also give more rigid or narrow operational limits. Hence in such situations more resources and money will be spent to ensure that we manage the risk as expected. The cost of these additional safety barriers is something that the owners of the activity will need to consider, and evaluate against the benefit they get in return. The need for additional barriers should fundamentally be set by the society, by ensuring that risk tolerance levels are set which reflect the actual risk that society is willing to take to receive the benefits from developing activities in polar areas.

The risk based approach needs to reflect the complex interaction of technology, organization and people, in order to maintain safe activities (figure). DNV strongly advocates this perspective as fundamental to build a sufficient set of barriers to manage risks. Focusing on technology and design alone will not lead to safe operations; this limited perspective does not address all important failure modes. Learning from the history of major accidents, being it within transportation, energy production or process industry, shows us that it is not possible to isolate one single failure as the reason for an accident to occur.

Figure 3 - Three main focus areas

The investigation of major accidents all show that a holistic perspective on safety is required in order to find the complex causes for disaster-like events to occur. Focussing on technology alone as a tool to ensure safe operations is far from sufficient. In the polar areas the ability for humans to perform at the optimum level will be challenged by the cold and harsh environment, long periods of darkness, the feeling of isolation at remote locations, in addition to the significant responsibility felt for managing operations and taking care of colleagues in such a challenging environments. A multicultural working environment will also represent challenges to the safe performance of individuals and the organisation. It is clearly seen that the consideration of human and organisational factors is crucial in order to prepare for new developments in polar areas.

Ability to handle conflicting goals and adherence to procedures are examples of operational aspects that are crucial to manage in order to develop a robust safety culture that will act as barriers towards accidents. Considering the challenges to human and organisational performance in the polar areas, it should be the ambition of the industry to fully include the full set of barriers before going into operations in the High North. A typical example is the ability of the organization to promote continuous "mindfulness" of risks, e.g. creative worry for what can go wrong around the next turn. As an example the UK Safety Case regulations require Human factors to be addressed explicitly (Tørstad, 2010).

Performing safe activities requires designing inherently safe technology, but also to be able to implement this and follow up when going from design and into operations. Assumptions and pre-conditions are made and reflected in the design engineering, which are relevant for the operations phase. This requires that all the knowledge that is created during the design phase that relates to safety in operations need to be collected and transferred to next phase in a format that makes it verifiable during operations. The operator – being it a vessel or an offshore installation – needs to control that basis assumptions are complied with, and how any changes with respect to these assumptions affect the operational risk level.

The Barents 2020 Project – Developing a common risk and safety framework

DNV has worked with Arctic challenges for several years through research projects, as well as studies of ongoing projects in the Arctic. With the still ongoing Russian-Norwegian project "Barents 2020" (DNV, 2010), this work has been accelerated, intensified and widened, however.

The private-public funded Barents 2020 project was established with the purpose to recommend HSE standards for common Norwegian - Russian application in the Barents Sea, for safeguarding people, environment and asset values in connection with oil and gas activities, including sea transportation of oil and gas. The underlying assumption is that petroleum operations in the Barents Sea shall be at least as safe as those in the North Sea. Safety encompasses safety to personnel and the environment. To achieve this, the HSE standards must reflect the additional challenges and risk associated with activities in the Barents Sea.

The project took as a basic assumption that protection of the environment and the resources in the Barents Sea is a shared responsibility between Norway and Russia. This project has therefore aimed at creating a dialogue between relevant Norwegian and Russian parties regarding safety of petroleum related activities in the Barents Sea. The aim was to arrive at common acceptable standards for safeguarding people, environment and asset values in the oil and gas and maritime transport industries in the Barents Sea.

Development of offshore oil and gas fields represents major financial and technical undertakings which require international cooperation and risk sharing between several partners. A common set of internationally recognised safety standards adapted to Barents Sea conditions, which all parties can agree to, was and is, seen as a prerequisite for such projects to be developed. This will also lead to an acceptable and uniform safety level for activities in the Barents Sea, and a predictable HSE framework and improved basis for cooperation for all involved parties in the future.

The project has evaluated HSE and engineering standards for all petroleum related activities in the Barents Sea, including sea transportation of oil and gas by tankers and maritime supply and support services. The result of the work after completion of the first 3 of 4 phases is :

- Common agreed references to recognised international standards which may be used in the Barents Sea;
- Harmonised comments to standards and practices which need to be revised due to Barents Sea challenges;
- Proposals for revisions and amendments to key industry standards;
- Suggestions for any amendments to national and international regulations to allow for the application of industry standards proposed by the working groups; and
- Identification of research and development needs in areas where current knowledge is insufficient.

In total 130 recognised industry standards have been assessed, and while half of them may be used in the Barents Sea without amendments, revisions are recommended for the other half, in order to maintain an acceptable safety level.

The project has also pointed at three main areas where further work will be required;

Firstly maritime and offshore activities in the Arctic will put new and challenging requirements on human factors, both mentally and physically. Assurance of the physical working environment as well as the selection, training and competence development of personnel must reflect this.

Secondly it is without doubt that the technology to be used in the Arctic areas needs to be developed, tested and qualified for the specific environmental conditions. Technology developed for other geographical areas can not necessarily be applied in the Arctic areas, without an increase in the risk level.

Thirdly is seen that a tailor made regulative and monitoring regime must be established for the polar areas. The Barents 2020 project also clearly showed that it is important to align and coordinate the regulative regime across national borders.

Through targeted efforts within these three areas accident risk may be reduced significantly. If an accident should occur, rescue operations and emergency response to limit any environmental damage will be faced with severe challenges and limitations. Still, this may also be planned for and adapted to, and efficient and well coordinated work across national borders will be of outmost importance.

Conclusion

The search for natural resources in the Arctic Region has already started and will continue across borders involving different nations. There is no doubt that the additional risk factors in the Arctic Region will increase the probability of accidents. Additional risk reduction measures and safety barriers are therefore required in order to bring the overall risk down to a level considered acceptable when weighted against the potential societal benefits of making these natural resources available.

DNV believes that it is critical to maintain and use a living quantifiable safety and environmental risk model to support decision making to prevent major accidents. A holistic model is needed that addresses all aspects affecting the safety, such as technical, procedural, human and organizational and cultural aspects.

In order to achieve an acceptable level of safety for new or expanded activities confronted by Arctic challenges, existing technical and operational practices must be supplemented by:

- Definition of societal *and* company safety objectives;
- Suitable risk management from concept to execution and into operations;
- Survey and acquisition of site specific environmental data and loads;
- Definition of additional or modified functional requirements and standards.

The aim is to obtain sufficient knowledge so that society at large as well those directly involved in the activities are able to make their decisions weighting the risk against the benefits of the activities. It will be important to take the necessary time to acquire the knowledge, develop the technology and to build the required international regulatory framework for the Arctic Region. In this context we also have to consider the societal value of the activity against the possible consequences of accidents. Zero risk means zero activity and this may not necessarily be the best choice for society at large.

Ultimately, a decision about activities in the Arctic Region may become a decision about natural resources and sustainable development in a world with growing population demanding a higher standard of living. In order to address this complex mixture of issues, Norway and other countries in the High North must work together. An accident in the Arctic Region will affect all countries involved. Such multi national co-operation has started through i.e. the Barents 2020 project and must be expanded by involving additional countries as well as the various business interests engaged in the development activity. The ultimate goal must be to establish the tailored risk based regulatory framework that appropriately balances the societal values of the activity against the societal acceptable risk. Achieving this goal will require knowledge, technology, international co-operation and a good portion of political will.

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Challenges and Possibilities in Arctic Marine Operations

Kaj Riska[1]

1. Introduction

The decreasing trend in the extent of the summer ice cover in the Arctic is clear. One of the results of this trend is that both passages, North-West Passage and North-East Passage, leading from Europe to Far East have been ice free at some point in September. The trend of decreasing ice cover has triggered an interest in the Arctic marine transportation – Barents Observer reported that several ships have sailed the Northern Sea Route, NSR (as the Russian North-East Passage administration is called) during the 2010 season, these included (www.barentsobserver.com and www.scf-group.com 4.2.2011):

- Oil-tankers ”*Indiga*” and ”*Varzuga*”, each carrying 15,000 tons of oil sailed from Murmansk to Chukotka;
- The 100,000 dwt tanker “*Baltica*” was the first larger gas concentrate tanker to sail from Murmansk to China;
- The bulk-carrier “*MV Nordic Barents*” was the first foreign flag vessel to sail the Northern Sea Route in transit (without visiting

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a Russian port), when it sailed from Kirkenes in Northern Norway to China with iron-ore concentrate;

- The Norwegian trimaran "*Northern Passage*" and the Russian sailboat "*Peter I*" were the first vessels to ever sail both the Northern Sea Route and the North West Passage during one season;
- "*Georg Ots*" became the first ferry to sail the Northern Sea Route;
- The Norilsk-Nickel operated vessel "*Monchegorsk*" became the first cargo vessel to sail the entire Northern Sea Route without icebreaker assistance. The vessel brought metal from Murmansk and Dudinka to Shanghai and consumer goods on the return voyage and
- The 117,000 dwt tanker "*SCF Baltica*" transported 70,000 tonnes of gas condensate from the ports Vitino and Murmansk to Ningbo along the Northern Sea Route.

This shipping activity at least through the Northern Sea Route is thought to increase further in summer 2011.

The question is that are we going to see a change in transport patterns with a shift to northern routes? Will the utilization of the hydro-carbon and mineral resources in the Arctic areas increase significantly at the same time? The Arctic development has seen several booms which then have subsided – one of the largest booms occurred in early 1980's in the Beaufort Sea. This contribution analyses the potential in the Arctic and then the challenge of operating in the Arctic in economically and environmentally sustainable way. Especially the role of enhancing the sustainability by technological innovations relating to ships operating in ice and cold is discussed.

2. Arctic Potential

The Arctic has been one of the last white areas on the globe.

Fishing, fur trade and seek of the unknown tempted people to these cold ice covered waters. The problems of using the passages for reaching the Far East were shown by the first North-West Passage voyage by Amundsen and first North-East Passage voyage by Nordenskiöld to be well nigh insurmountable with ships of that day's propulsion and strength. Not only the length was considered prohibitive but the encountered conditions were harsh.

The Arctic area can be thought to consist of sectors of which Russia has the largest share, about 160^o. Canada is in these terms the second largest Arctic country with about 80^o sector followed by Denmark (Greenland), the US and Norway. The Arctic regions – be the definition any of the several ones proposed – are practically empty with a population density much less than 1 per km^2, as Fig. 1 shows. Only the Murmansk area in the Kola Peninsula in Russia the population density is somewhat larger. The low population density causes a lack of infrastructure for any operations in the Arctic.

The present technological advances in shipping make the passage through these northern sea routes mentioned above possible and the distance for example between Russian Atlantic and Pacific ports is cut in half using the northern route. The distance from Tokyo to Rotterdam via the Cape route is 14800 nautical miles and via the NSR only 7400 miles. If similar open water speeds can be maintained, the transit time between east and west is decreased several weeks. The use of both the North-East and North-West Passages become tempting if the matter is seen from the Chinese perspective as shown in Fig. 2. (L. Jakobson: China Prepares for an Ice-Free Arctic. SIPRI Insights on Peace and Security, No. 2010/2, March 2010).

The present increased interest in the Arctic areas is partly based on economical reasons; there is potential in using the shorter sea routes between the Atlantic and Pacific ports and in utilizing the large mineral resources located in the area. Fishing has traditionally been extensive in the Barents Sea and off the Canadian east coast but retreating ice cover opens new areas for fishing. The pristine

Arctic nature tempts also tourists, those who prefer comfort come with cruise liners but there are people coming on land. Other interests include the political aspect; during the Cold War the Arctic Ocean was a borderland and a lot of military interest was directed there. At present the political interest comes rather from ensuring mineral or oil/gas rights. There are still several disputes over borders in the Arctic – even if the discussion between Russia and Norway about the borderline in the Barents Sea has been resolved.

That there exist hydrocarbons in the Arctic has long been clear (e.g. the coal mines on Svalbard) but in the high Arctic oil production is at present going on only in northern Alaska. It has often been stated that the Arctic hydrocarbon reserves are large, but how large are they in relative terms? A recent study by the United States Geological Survey (USCS: Circum-Arctic Resource Appraisal 2008) suggested that 7.2 % of the world's oil reserves ($90 \cdot 10^9$ barrels of oil) and 26.5 % of the gas reserves are located in the Arctic whereas the Arctic comprises about 4.1 % of the surface area of the Earth. (These figures have been calculated using a common estimate of the world's reserves and using similar reserves – potential, probable etc. - as far as was possible). Even if the numbers must be seen as indicative, it is clear that especially gas reserves are large.

Mineral resources in the Arctic areas are substantial. The Norilsk Nickel mine in Russian Arctic is well known. There are also other minerals and diamonds produced from the mines in Siberia. The story of the large nickel deposit found on the Labrador Peninsula in Canada is well known. There are potential mineral discoveries in the high Arctic like the Baffinland iron ore, diamonds and minerals in the hinterland of the Bathurst Inlet and the zinc deposit at the Citronen Fjord in the northernmost Greenland.

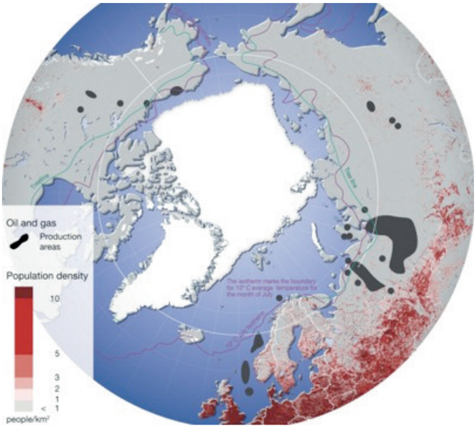


Fig. 1. The population density in the Arctic, the tree line is marked as green and 10 ^{o}C isotherm in July in purple (map from UNEP Grida Arendal home page www.grida.no 14.10.2010).

Fig. 2. The sea routes from Shanghai in China to New York and Rotterdam (L. Jakobson, op. cit.)

3. Arctic Challenges

Even if the potential for economic, transport or recreational activity in the Arctic is large, there exist challenges to operations which tend to filter the activity and act as a threshold for newcomers. These challenges can broadly be divided into those due to the climate, geography, jurisdiction and infrastructure.

The Arctic climate is cold and dry. Most of the Arctic land areas are Arctic desert i.e. the annual rainfall is just some 200 mm; and mostly comes as snow. The ice cover and especially the permanent ice cover is the largest single challenge to Arctic operations. It is an often stated fact that the minimum (late summer) extent of the ice cover is decreasing – this is demonstrated well in article C. Mauritzen & E. Kolstad: The Arctic Ocean – an

Ocean in transition, in this volume. This winter seems to be below even the all time low in year 2007 as the present observations suggest (National Snow and Ice Data Center, Boulder, Colorado, US). The forecasts when the Arctic is totally ice free vary between the end of this decade to about 2040.

For shipping it is even more important where ice cover exists than where it does not – both in strategic time perspective and tactical. In longer time perspective this statement refers to the long winter period when the Arctic is totally ice covered except some parts of the Barents Sea which are warmed by the tropical heat brought by the North Atlantic Drift (extension of the Gulf Stream), see Fig. 3. This maximum extent has not changed much during the year – especially much less than the change in the minimum extent in September each year. Thus at present the NE and NW Passages are navigable only during a short time window, about 2 months, each year. Economically a larger scale transport chain would require a year round operation to be feasible. The same applies to offshore operations for hydrocarbon exploration and production. If some voyages can be performed annually, some exploratory voyages may be carried out. It may be stated that the voyages through the northern passages are still suitable for the adventurously minded.

Fig. 3. The maximum ice extent in 2009 and the median extent (http://nsidc.org/arcticseaicenews/2009/033009.html).

In tactical, voyage planning sense, the daily changes in ice occurrence should be taken into account. The voyage must be planned at least one week ahead as the approach voyage to the northern passage may take a week. Thus one week's forecasts of ice conditions should be quite accurate. Ice drift forecasts depend on the weather forecasts as the weather (winds and temperatures) give the forcing to ice drift. Thus a single observation that the passage is ice free at any particular point in time is not enough for planning the whole voyage as the passage should stay quite ice free during the whole voyage. The variability in ice conditions is demonstrated in Fig. 4.

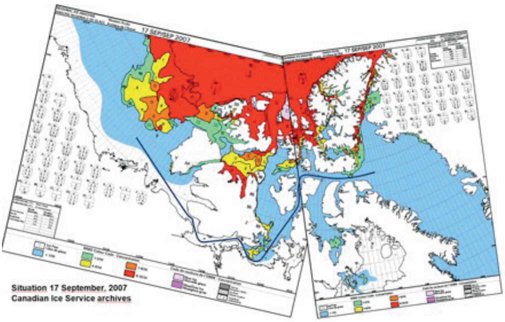
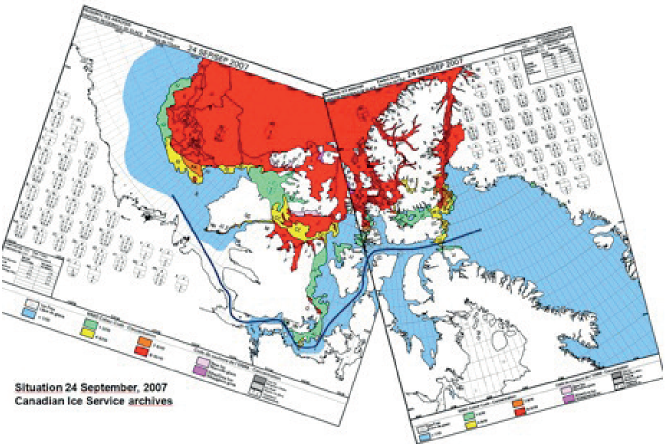


Fig. 4. The ice charts from the Canadian Arctic with one week time difference from autumn 2007. This instant has been claimed to be one of the first times when the whole North-West Passage was ice free (charts from the Canadian Ice Service http://ice-glaces.ec.gc.ca/).



The effects of ice can be mitigated by using adequate tonnage for the voyages; the strength and performance in ice should correspond to the ice conditions expected. The relevant question for economics is how low the ice class – and how close the ship can be to an open water ship – to make the voyage without undue risks. Higher ice class/ice performance means increased costs, capital costs (CAPEX) increase as the ships get more expensive and the operational costs (OPEX) increase as they are more expensive to operate. At present some transit voyages have been carried out with ships having an ice class IA (roughly equivalent to Russian Arc4 and PC7). This class is not intended to meet almost any older i.e. multi-year ice, thus the ice concentrations must be below, say, 30 % in order to safely navigate. Another way to mitigate the effects of ice is to use escort icebreakers. The use of icebreakers in Russian waters have been the rule but the experience from the advanced Norilsk Nickel ship series of high Arctic ships has shown that icebreakers are not necessarily needed, if the ship owner is prepared to accept the higher cost of the ships (some 30 % as compared to just ice strengthened ships). This is possible on routes where ice is present most of the year – for comparison the Baltic ice season is about 3 months long and in typical rotation a ship trading into Baltic is in ice about 30 days of a year.

The Arctic maritime infrastructure exists in a sense that there are light houses and beacons but not much else. Even the bathymetry is not very extensively covered as the soundings are scarce. This adds an element of risk into navigation especially as the local ice conditions may force ships out of commonly used routes. The lack of infrastructure is evident also in the lack of almost any SAR support. As such the travel times through the NSR or North-West Passages is not very long, some weeks, but the transit times may increase much if any heavier ice is encountered.

The commercial use of the Arctic waters requires some stable regulatory regime. This includes the fees and use of the navigation infrastructure which includes icebreaker support. The international rule system that applies to Arctic areas includes the Polar Guidelines given by International Maritime Organization, IMO, – these are being developed further at the moment to become mandatory Polar Code (see other presentations in this compendium). United Nations Convention on the Law of the Sea, UNCLOS, article 234 gives the coastal states right to place special requirements to ships when ice is present. Canada uses thus an Ice Regime System in their waters to make requirements for ships ice class – or to say this differently, to state what ice areas (regimes) defined by the Canadian Ice Service, a particular ship can enter. Finland and Sweden give traffic restrictions, which practically amount to requirement for some minimum ice class (and deadweight). Russian Maritime Register of Shipping has included in the classification rules a season per season, Arctic sea area per sea area, ice class requirement tables. How these are enforced by maritime authorities is somewhat unclear.

Part of the infrastructure and jurisdiction are the fees. These are very different along the NW and NE Passages. Russia charges fees for NSR according to the cargo type and amount – and the icebreaker escort is part of the services received. This is a common practice in countries where the winter time shipping is lively and ice cover seasonal. In this kind of environment the ice classed ships compete with open water ships during the open water season – and thus it is most cost effective to require the ice class ships to make only small structural additions due to ice and then use icebreakers to reduce the risks caused by ice. Thus it is a good idea to give the ships icebreaker escort and then include the icebreaking costs into the fees. It is an interesting question if the climate change will change the need for icebreakers – are we approaching a break even point when the extra investment cost on ice capability of the merchant ship is more cost effective than providing an icebreaker escort?

Finally as a challenge the risks and environmental concerns must be discussed. The Arctic nature is very vulnerable to any and all discharges, be they exhaust gases, oil pollution, garbage or even noise. One reason for this is the slow biological pace of the ecosystem. Material risks and risks to personnel are enhanced by the long distances, harsh nature and almost non-existent SAR. The emergency systems should be designed to the Arctic environment – even if there are no very good means for evacuation in ice conditions. Increase of discharges – be these under normal operations or accidental – is inevitable if the activities in the Arctic increase. The approach to this in the Antarctic is to ban all economic activity (except tourism and research). This does not work in the Arctic but the Gulf accident has pushed forward schedules of Arctic oil exploration projects.

The way IMO plans to approach the reduction of the green house gases from shipping is to use EEDI (Energy Efficiency Design Index). This is in fact an efficiency ratio how much – or little – green house gases are released per one unit of productive work (here this is in effect ton· miles of carried cargo). An EEDI value can be calculated for each ship type category and there is a limit, baseline, below which these EEDI values should lie. It has been stated that instead of favoring innovation in reducing the required propulsion power and/or increasing the amount of carried cargo, the EEDI acts as maximum allowed power limit or put in other way, as a speed limit. For ships in ice, the ice class rules give a minimum power – and if the ice performance is made even better, power is further increased from this regulatory minimum. The trends in EEDI and in ice performance seem to work in different directions. Especially in independent operation far away from any support, better ice performance increases safety. Environmentally it is better to have the needed power in one ship instead of using two ships i.e. an escort icebreaker. This balance depends naturally on the operational profile. How much time is spent in ice annually and how severe the ice conditions are, shift the balance.

At present EEDI formulation includes coefficients that correct the higher power values and lower deadweight values of ice classed tonnage to those of corresponding open water ships. The amount of correction is restricted so that more correction than an average ice class ship versus an average open water ship is not granted. Thus ships having an operational profile in high Arctic require a good ice performance resulting among other things in quite high power. Depending on how the EEDI is implemented, these ships might be penalized and forbidden in future. Another trend in the EEDI formulation at IMO is that the maximum allowed value of the EEDI (the baseline) will be gradually lowered in three time steps. The clash between required minimum allowed power in ice class rules and the maximum allowed power according to EEDI becomes even more probable. The EEDI development is still under way, and it remains to be seen how it impacts on the Arctic shipping.

4. The Facilitators

The challenges for Arctic shipping operations include several aspects that need development. Arctic Council has carried out a project 'Arctic Marine Shipping Assessment, AMSA' – the report was published in 2009. The study analyses most aspects of Arctic shipping and one of the conclusions of the study is a list of 'Areas and Issues for Research' (The Future of Arctic Marine Navigation in Mid-Century, Scenario Narratives Report, March 2008). In the list of future research there are many items related to infrastructure, regulations and ship emissions – but only one fully and one partly of the in total 27 items are related to ship technology. This is remarkable as the two new year-round operations that have started recently are related to improved design – and not at all on infrastructural related matters. These two are the delivery of high Arctic container carriers to the company Norilsk Nickel (about these ships a bit more later) and the other is opening of an offloading terminal at Varandey in the Pechora Sea in the Russian western Arctic (Fig. 5).

Is it a fact that we have perfected the ship technology aspects for Arctic ships? Practically no research related to ships in ice is needed; just some development of the infrastructure (regulatory framework, communications, ice forecasting, navigation aids, environmental issues etc.) is required. Several different effects (like personal experiences) may have led to this slightly visionless conclusion – visionless from the perspective of naval architecture which discipline the author represents. It is the opinion of the author that the main reason for this conclusion is that the so called innovation chain does not operate in a linear fashion in the development of Arctic ships.

Fig. 5. A tanker loading at the Lukoil Varandey terminal with a stand by icebreaker astern of the tanker (photo Captain Gregory Martyuk).

The idea of an innovation chain stems from the conviction that each new technological step forward (innovation) can be tracked from research results in basic research through add-ons in applied research towards product development and finally innovation. The view on the innovation chain as being a linear and causal path is in favour among the research administrators as it tells the correct and appropriate place on the path for each organization. It further indicates where cooperation should be set up – this is at the boundaries between adjacent slots e.g. between basic and applied research, between applied research and innovation activity, between innovations and design. This view of one dimensional chain is somewhat limited and a two dimensional view would be more appropriate. In two dimensional view the progress is made by all interacting with all, thus instead of a chain we should speak of a ring. A short study of the innovations or steps forward in the winter navigation (see appendix) shows that very often the designers made something new without having the physical background of the phenomena – scientists then later on explained why the new things works as it works. This state of affairs has naturally led designers sometimes astray but has also forced scientists to react and take up some research topics – but it has also led to the unfortunate conclusion that also universities should do design oriented work.

In order to illustrate this track of an idea through the innovation chain, the development related to the bow propellers in icebreakers is analyzed. When the navigation increased in the Great Lakes area, observation that ships going astern and ships having both bow and stern propellers have a better ice performance than ships having just the stern propeller. This observation led to construction of a ferry St. Ignace for the Mackinac Strait Lake Michigan and Lake Huron (2000 HP at stern and 1000 HP at the bow) and later Ste. Marie. When the second Finnish icebreaker was planned by the Icebreaker Committee in 1895-6, it was decided to adopt the ‘American’ invention, bow propeller. In the committee’s report there is a first theory for the advantageous effect of the bow propeller: ’Bow propeller removes the water from underneath the ice and ice then falls into the hole.’ The result was icebreaker Sampo in 1898, see Fig. 6.

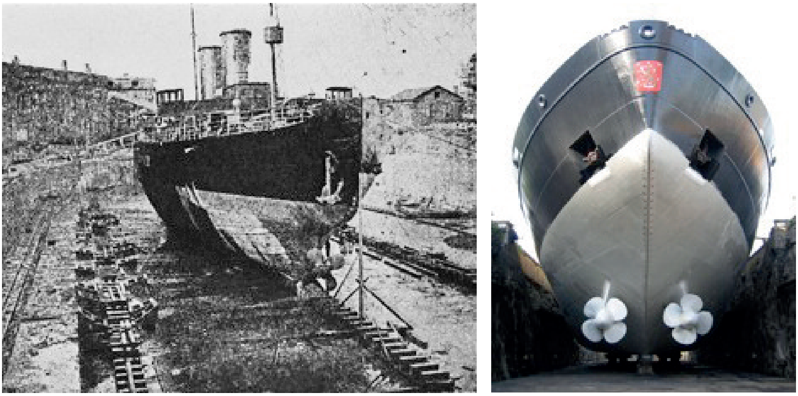


Fig. 6. The second Finnish icebreaker Sampo (left) and the modern Finnish icebreaker Urho (right) in a drydock.

The experience from the bow propellers was good and several series of icebreakers with bow propellers were built and it can be considered that this development reached the best icebreaker type when the Urho series of icebreakers were built (two to Finland and three to Sweden). After this it was decided to try icebreakers without bow propellers (IB Otso and Kontio) and now at the last stage of development in icebreaker propulsion is to use Z-drive thrusters like Azipod or Rolls-Royce. The development of icebreaker propulsion is sketched in Fig. 7.

During the development of the Urho-class icebreakers some research was carried out; this research showed among other things that the thrust deduction factor in open water for the bow propellers is much larger than for the normal stern propellers, about 0.3 for bow and 0.1 for stern propellers. The reason for the advantages of bow propellers was considered to be the propeller wake (propeller stream) flushing the hull and this way reducing the ice resistance. This was just a working hypothesis and no validation was carried out.

The development of azimuthing thrusters which are proven to be reliable in ice breaking ships meant that rudders were not

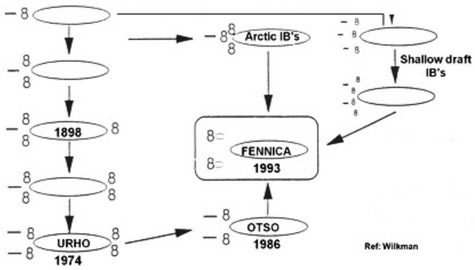


Fig. 7. The development of icebreaker propulsion arrangement from the first single screw icebreakers to multipurpose icebreakers with azimuthing thrusters. Modified from the original produced by G. Wilkman.

needed any more. Other advantages of the azimuthing thrusters like the possibility of dispersing ice ridges by turning the thrusters and this way flushing the ridge ice pieces away led to the concept of 'Double acting ship' or 'dual mode ships'. The idea is that the ship has azimuthing thrusters at the stern but in heavier ice goes astern (in thinner ice the high thrust deduction factors decrease the advantage that the bow propeller is having in ice). If stern is used for ice breaking, the bow ('real bow') can be designed for open water operation. First – and actually the only pure examples – of these kind of ships are the tankers Tempera and Mastera. The transport chain to Norilsk in the Russian Arctic relies on this kind of ships, see Fig. 8. As these ships have also an ice breaking bow, they do not represent 'pure' dual mode operation. The tests of these ships have also clearly showed that there is a cross-over ice thickness, in thicker ice it is advantageous to go astern. The location of this cross-over thickness depends on the bow and stern design.

Any serious research on the phenomenon of the bow propellers in ice was missing when this stage of technical development was reached. It was only in 2004, about 150 years from the first observation, that research to clarify the effect of the bow propellers was carried out. The research also shed some light in the physical background of the phenomenon; the reduction in the ice resistance by the flushing was observed to be one of the causes. This reduction of frictional resistance can be described by negative

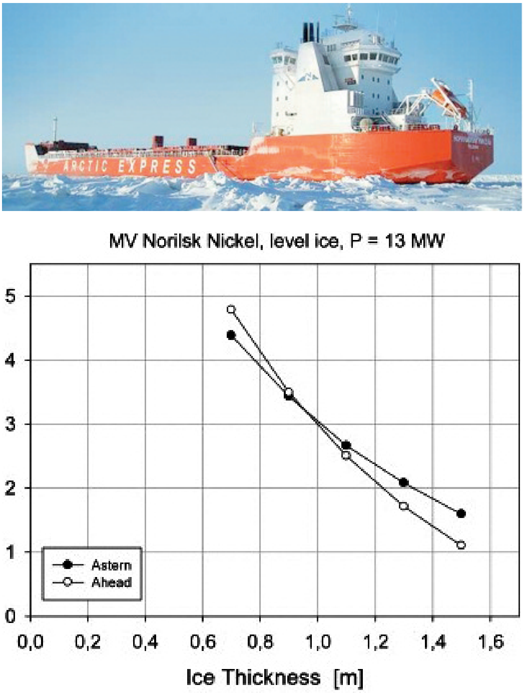


Fig. 8. The first ship in a series of six ships, Norilsk Nickel and her performance curves astern and ahead (from Gorskovskij, A. & Wilkman, G: 2007: 'Norilskiy Nickel' A breakthrough in cost effective Arctic transports. Presentation given at Aker Arctic Research Centre seminar, www.akerarctic.fi).

thrust deduction factors shown in Fig. 9. Comparison of the ice resistance in model tests using propulsion and with the bare hull indicated, however, that also the breaking part of the ice resistance is decreased. This is allocated to the water flow under the ice

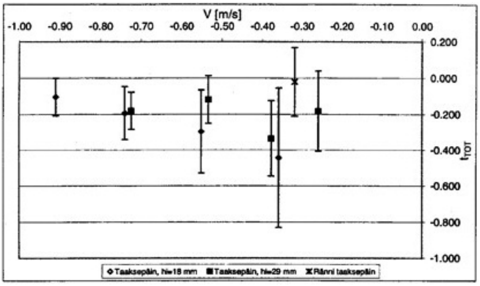


Fig. 9. Measured thrust deduction factors in level ice and in broken ice (crosses), measured in model ice (Leiviskä, T. 2004: The propulsion coefficients of ships in ice and in open water [in Finnish]. The Helsinki University of Technology, Ship Laboratory, Rpt. M-287, Espoo).

induced by the propeller, which decreased the dynamic pressure in water (cf. e.g. the Bernoulli equation) and thus ice has less support and breaks slightly easier. Thus both the historical hypotheses for operation of bow propellers in ice have an element of truth in them.

5. Concluding Remarks

The economic potential in the Arctic areas is large but there are several challenges in planning different activities in these areas. The analysis described in this article indicates that no short term changes are to be expected in Arctic shipping activities as long as the winter ice cover is as extensive and winter season as long as it at present is. A change in ice conditions allowing year-round operations would signal a large scale increase in Arctic shipping and oil/gas production activities.

The analysis of means to reduce the risks in the Arctic operations suggests that technological innovations are quite important in enhancing shipping and other maritime operations in the Arctic. Investigation of the path how technological innovations develop shows that often in case of innovations in winter navigation, the innovation takes place before the physical basis is clarified. This fact suggests partly that basic or applied research has not been able to produce tools for designers; it also suggests that in some cases the scientists have turned designers, leaving the first rooms in the innovation chain empty.

Acknowledgement

The author is very thankful for the invitation to the Marine Transport in the High North Symposium organized by The Norwegian Academy of Sciences and Letters (DNVA) together with the Norwegian Technical Academy of Sciences (NTVA). I am especially indebted to Prof. John Grue. The author is further very thankful for the post graduate students Hanna Leisti, Biao Su, Janne Valkonen and Li Zhou who read the paper and gave many valuable comments.

APPENDIX: CHRONOLOGY OF SOME RESEARCH AND INNOVATION MILESTONES

SHIP PERFORMANCE IN ICE	HULL ICE LOAD		TECHNOLOGY INNOVATION
		1877	EXPRESS II, year-round traffic from Hanko
First ice resistance formulation, (Runeberg)		1889	
		1890	MURTAJA, first Finnish icebreaker, first ice rules
		1921	First Finnish ice class rules
		1932	New ice class rules, percentage additions
		1939	Diesel-electric icebreaker SISU
	Ice pressure proportional to compressive strength (Korzhavin)	1962	
		1966	Year round traffic in the Gulf of Finland
	Ice damage based ice class rules (Johansson) Theory of ship ice load (Popov)	1967	
Division of ice resistance into components (Kasteljan)	Strength of propellers in ice (Enkvist)	1968	
		1969	First ice tank in Finland (WIMB)
	Drop ball tests for Russian hydrodynamic ice load model (Likhomanov & Kheisin)	1971	Year round traffic in the whole Baltic, first Finnish-Swedish ice class rules
Theory for ice model testing (Enkvist)		1972	
		1974	Urho-class icebreakers, polar steel from Rautaruukki
	Hydrodynamic ice load model (Kheisin)	1976	
Ridge resistance based on soil mechanics (Keinonen)	Statistics of ice loads (Varsta & al.)	1979	
	First pressure-area relationship	1980	
	Dynamic bending of ice cover (Varsta)	1983	Cykloconverter in RV Aranda
Drop in pressure in friction panel (Enkvist)	Observation about the line load (Joensuu & Riska)	1988	
Direct claculation of ice load (Valanto)		1992	
	Contact model based on physics (Daley, Tuhkuri)	1993	First multipurpose icebreaker FENNICA, Z-drive and Azipod
	Ice load model for propellers (Veitch)	1995	
		1999	Line traffic to the whole Baltic year-round, HSC GOTLAND designed partly for ice
Ridge resistance going astern		2000	Double Acting Tanker –concept
		2000	Ship power requirements based on performance requirement

Regulatory Frameworks for Maritime Transport in the Arctic: Will a Polar Code Contribute to Resolve Conflicting Interests?

Ole Kristian Fauchald[1]

1. Introduction

There is general agreement that maritime transport in the Arctic will increase, but there is significant uncertainty regarding the extent of increase of such transport and its future character (Global Business Network 2008 and Molenaar 2009:293-4). This contribution discusses the ability of Norway as a coastal state to regulate maritime transport in the Arctic in light of the major interests associated with such transportation. As a coastal state heavily dependent on marine resources, Norway has significant interests in protecting the environment against damages from maritime accidents and pollution from maritime transport activities. But Norway does also promote other interests. As an important flag

1 *Senior Researcher, Fridtjof Nansen Institute & Professor, Department of Public and International Law, University of Oslo.* I am grateful to researcher Øystein Jensen (FNI), professor Erik Røsæg (University of Oslo), senior researcher Olav Schram Stokke (FNI) and senior researcher Davor Vidas (FNI) for comments to drafts of this contribution.

state, Norway defends the freedom of navigation. As a country with an open economy depending on international trade, Norway has a strong interest in cost effective maritime transportation.

Identifying an appropriate balance between such interests is not easy. There is significant tension between Norway's interests as a coastal state and Norway's interests as a nation depending on shipping. We shall focus on the extent to which Norway remains free to define an appropriate and effective balance between such interests.

The countries bordering the Arctic can be divided into two groups; those that are coastal states in relation to the Northwest Passage (the USA, Canada and Denmark / Greenland), and those that are coastal states in relation to the Northern Sea Route (Russia and Norway). This contribution will focus on the latter. In addition to transport through the Northern Sea Route, Norway and Russia have common concerns regarding maritime transport to and from Norwegian and Russian areas in the Arctic. Norway and Russia have a long history of cooperation in marine affairs, ranging from joint management of fish stocks to negotiations about delimitation of sea areas and continental shelves. This contribution will consider how Norway can cooperate with Russia in order to secure an appropriate balance between relevant interests.

This contribution shall first discuss Norwegian jurisdiction under the current international regime in the Arctic. Thereafter follows an assessment of how Norway's regulatory jurisdiction may be affected by negotiation and adoption of a binding Polar Code. The final part of the contribution considers how Norway can ensure an appropriate balance of the interests should the negotiations of a Polar Code fail to provide appropriate results within a reasonable time frame.

2. Jurisdiction under the current regime

There is a complex web of international and national rules governing maritime transport in the Arctic. The United Nations

Convention on the Law of the Sea (1982, UNCLOS) provides the basic regulatory framework for maritime transportation. It contains special rules for environmental protection (Part XII) and it singles out 'ice-covered areas' for special treatment (art. 234). Essential features of UNCLOS are that it resolves a number of jurisdictional issues and that it contains a basic framework relevant to the rules adopted by the International Maritime Organization (IMO). Hence, the treaties and guidelines adopted by the IMO must be understood in the context of international law as reflected in UNCLOS.

In 2002, thirteen years after the Exxon Valdez accident, the IMO adopted Guidelines for Ships Operating in Arctic Ice-covered Waters (Jensen 2007). Seven years later, the IMO adopted revised Guidelines for Ships Operating in Polar Waters, *inter alia* extending the 2002 Guidelines to Antarctica. Currently, the IMO has engaged countries in negotiations to revise these Guidelines and make them mandatory through an International Code of Safety for Ships Operating in Polar Waters (Polar Code).[2]

The IMO is supported by a number of non-governmental institutions that provide more specific guidance on how to fulfill international standards and determine whether requirements are fulfilled in individual cases. Of particular interest is the work of the International Association of Classification Societies (IACS), which adopted Unified Requirements for Polar Ships in 2006.[3] These Requirements, which are widely applied, distinguish seven Polar Classes based on structural and machinery requirements.

In the following, we shall discuss Norway's jurisdiction under the current regime. Due to the fact that international and domestic rules vary significantly according to geographical areas, we will

2 Information concerning negotiations can be found at <www.sjofartsdir.no/en/Legislation_and_International_Relations/IMO-DE-Correspondence-group-on-the-development-of-the-draft-International-Code-of-safety-for-ships-operating-in-polar-waters/>.

3 See <www.iacs.org.uk/document/public/publications/unified_requirements/pdf/ur_i_pdf410.pdf>.

have to distinguish between geographical areas in order to identify the issues that are relevant for the geographical area in question.

Pursuant to the principle of territorial sovereignty, Norway has full regulatory jurisdiction within its *internal waters*. Within the *territorial sea*, Norway has to respect the right of other states to 'innocent passage' (articles 17-21 of UNCLOS). According to article 21.2 of UNCLOS, Norwegian legislation concerning navigation 'shall not apply to the design, construction, manning or equipment of foreign ships unless they are giving effect to generally accepted international rules or standards'. This means that as long as a ship fulfills such standards, Norway cannot deny it passage through its territorial sea. The first issue here is whether Norway is allowed to enforce stricter standards than those following from the 2009 Guidelines. Due to the limited geographical scope of the Guidelines, this question is only[4] relevant for the territorial sea around Jan Mayen and Svalbard (including Bear Island).

The first sub-question is whether the 2009 Guidelines shall be regarded as 'generally accepted international rules or standards'. One Committee of the International Law Association has concluded that this phrase should be understood as making 'compulsory for all states certain rules which had not taken the form of an international convention in force for the states concerned, but which were nevertheless respected by most states', and that such rules and standards 'are primarily based on state practice, attaching only secondary importance to the nature and status of the instrument containing the respective rule or standard' (ILA 2000:33). The 2009 Guidelines state that they 'are recommendatory and their wording should be interpreted as providing recommendations rather than mandatory direction' (para. P-1.4). Due to their short existence,

4 It can be discussed whether the Guidelines may be regarded as 'generally accepted international rules or standards' for ice-covered areas beyond the geographical areas to which the Guidelines apply. This question will not be further discussed here.

there is little state practice relating to these Guidelines. The above phrase was copied from the 2002 Guidelines, and coastal state practice, in particular that of Canada and Russia (see below and VanderZwaag et al. 2008:50-68 and 73), indicate that coastal states have regarded the Guidelines as non-binding. Moreover, the current discussion on making the Guidelines mandatory through a 'Polar Code' supports the general impression that states do not currently regard the Guidelines as binding according to relevant provisions of UNCLOS. We may thus conclude that the 2009 Guidelines, at least so far, do not qualify as 'generally accepted international rules or standards' according to article 21.2 of UNCLOS.

Against this background, the next sub-question is whether Norway is free to adopt rules concerning design, construction, manning or equipment of ships in the territorial sea. For areas along the coast of the Norwegian mainland the answer is that Norway is bound to comply with 'generally accepted international rules or standards' adopted by the IMO. The answer is more uncertain for the territorial sea around Svalbard and Jan Mayen, since it can be argued that these areas are 'ice-covered' in the sense of article 234 of UNCLOS and thus that Norway has 'the right to adopt and enforce non-discriminatory laws and regulations for the prevention … of marine pollution'. This provision applies 'within the limits of the exclusive economic zone' (EEZ). It can thus be discussed whether the provision extends to the territorial sea (Chircop 2009:371 and 372). It is of significance that neither the 2002 Guidelines nor the 2009 Guidelines contain any provisions limiting their geographical scope to EEZs. In cases where both the territorial sea and the EEZ qualify as 'ice-covered areas', it is the opinion of this author that the coastal state has at least as extensive regulatory jurisdiction within its territorial sea as it has within its EEZ.[5] We

5 Stokke 2007:403 argues along similar lines: 'The general pattern is that the right of coastal states to set and enforce rules on various activities decreases with distance from the coastline'.

may thus conclude that Norway has the right to regulate maritime transport in accordance with article 234 in the territorial sea around Jan Mayen and Svalbard.

For other measures than those relating to design, construction, manning or equipment of ships, in particular discharge and navigational standards,[6] Norway is in general free to adopt its own standards within the territorial sea, as long as such standards do not hamper the right of innocent passage (art. 17-21 of UNCLOS), are duly publicized (art. 21.3 of UNCLOS) and are non-discriminatory (art. 24.1 of UNCLOS, see also Tan 2010:295). In this context, it is of relevance that traffic separation schemes and recommended routes adopted by the IMO in 2006 have been located outside the territorial sea of the northern Norwegian mainland. These routes apply to ships in international traffic with a gross tonnage of more than 5,000, and they 'have altered the sailing patterns of a considerable number of ships' (Report 2008-9:47).

In the *EEZ*, Norway must respect the 'freedom of navigation' (articles 58, 87 and 90 of UNCLOS) with the reservation that Norway as a coastal state has certain rights to regulate transportation for environmental purposes (part XII of UNCLOS). Such regulation for the prevention, reduction and control of pollution from maritime transport must conform to and give effect to 'generally accepted international rules and standards' (art. 211.5 of UNCLOS). Norway has extended jurisdiction in areas of the EEZ that are 'ice-covered' (art. 234 of UNCLOS). One question is whether this rule only applies to areas around Svalbard and Jan Mayen (see above). There is some overlap between the geographical area covered by the 2009 Guidelines and the EEZ of the Norwegian mainland. It can be argued that the overlapping area

6 Molenaar 2009:300 distinguishes the following categories of standards: Discharge and emission standards; construction, design, equipment and manning standards; navigation standards; contingency planning and preparedness standards; and liability and insurance requirements.

qualifies as 'ice-covered'. While the Guidelines cannot be regarded as any authoritative delimitation of the geographical scope of application of article 234, they can arguably constitute evidence of states' practice and *opinio juris* concerning the minimum extension of ice-covered areas (see art. 31(3)(c) of the Vienna Convention on the Law of Treaties). Norway could thus declare this area as ice-covered for the purpose of article 234 and adopt relevant standards through legislation, as has been done by Russia and Canada (AMSA 2009:66-7). If other countries object to such a declaration, Norway would have a strong argument that such countries have the initial burden of proving that the area is not to be regarded as ice-covered for the purpose of article 234. It can also be argued that Norway may extend such a regime to areas south of the overlapping area to the extent that Norway can demonstrate that there exist 'severe climatic conditions and the presence of ice-covering for most of the year'. In this case, Norway would have the initial burden of proof. Norway has significant regulatory jurisdiction in ice-covered areas, and, as has been indicated above, we may assume that its regulatory jurisdiction in these areas would not be limited by the 2009 Guidelines.

The *areas beyond the territorial sea of Svalbard and Jan Mayen* are in a different position. Norway has not established full EEZs in these areas. Norway established a Fisheries Protection Zone around Svalbard in 1977 and a Fishery Zone around Jan Mayen in 1980. These zones were established to regulate fisheries. Norway has not established any legal basis for regulating maritime transport in these areas. However, if Norway decides to extend its regulatory power, for example by establishing full EEZs around Svalbard and Jan Mayen, Norway would gain such regulatory jurisdiction in relevant areas as is set out in article 234. The extent to which the areas in question would qualify as 'ice-covered' would have to be subject to separate consideration. Most of these areas, but not all, would fall within the geographical scope of the 2009 Guidelines. Norway is free to establish an EEZ around Jan Mayen, and it is not seriously contested that Norway may at least extend it jurisdiction to maritime transportation in the zone around Svalbard (Ulfstein 1995:421). Hence, it is mainly a political and not a legal issue whether Norway will extend its jurisdiction around these islands.

In sum, Norway's regulatory jurisdiction extends as follows:

1. In the territorial sea along the Norwegian coast, its regulatory jurisdiction is in general limited to some discharge and navigational standards.
2. In the territorial sea around the islands of Svalbard and Jan Mayen, its regulatory jurisdiction extends to design, construction, manning and equipment of ships.
3. In the EEZ along the Norwegian coast, its regulatory jurisdiction is in general limited to standards that give effect to 'generally accepted international rules or standards', but can arguably be extended to stricter standards for those areas that could be covered by article 234 of UNCLOS.
4. Norway could extend its jurisdiction in the zones around Jan Mayen and Svalbard, and could impose discharge and navigational standards, as well as standards for design, construction, manning and equipment of ships for those areas that would be covered by article 234.

Norway has not made use of its regulatory jurisdiction in accordance with article 234 or the possibilities it has to regulate maritime transportation in the zones around Jan Mayen and Svalbard. The analysis above indicates that the reasons why Norway has abstained from making use of its regulatory jurisdiction are political and not legal. Such political reasons may include potential consequences for negotiation and design of future international legal regimes.

3. Impacts on Norwegian regulatory jurisdiction of a Polar Code

Initially, it can be asked whether it is likely that a Polar Code will contain standards that would prevent Norway from applying requirements that would reflect an appropriate balance between relevant interests (see the introduction). Generally, it can be assumed that countries will more easily accept strict standards when they are non-binding than when they are binding. While there may be exceptions to such an assumption, it is not unlikely that the standards of a Polar Code will be weaker than the current Guidelines. In addition, it can be argued that the broader the geographical scope of application of such binding rules, i.e. their application to both the Arctic and the Antarctic, the more likely is it that their standards will be weaker. The fact that it took seven years to negotiate an extension of the 2002 Guidelines to Antarctic waters supports this point.[7] Against this background, it is likely that a binding Polar Code will contain weaker standards than those that Norway could be interested in applying without a Polar Code.

We may distinguish between two ways in which a Polar Code may lead to 'weaker' standards. On the one hand, standards may be 'less strict' in the sense that the requirements imposed on maritime transport are less likely to ensure safety of navigation and protection of the environment. This would be the result that could most significantly prevent Norway from applying requirements that would reflect an appropriate balance between relevant interests. On the other hand, standards may leave a broader margin of appreciation to relevant actors, including states. The decision to base the negotiations of a Polar Code on a 'risk-based/goal-based approach' (Sub-Committee 2010:5) will ensure a broad margin of

7 Considerations of a Polar Code covering both Arctic and Antarctic waters dates back even further, to the beginning of the 1990s, see Brigham 2000:246-54 for an overview of the historical background.

appreciation.[8] Such approaches will open for subsequent specification of the standards by various actors, and the initial broad margin of appreciation of states may thus be limited. The longer term result of this approach may thus be 'less strict' standards, but it could also be stricter standards.

Assuming that a Polar Code would be 'binding' in the sense that it would contain 'generally accepted international rules or standards' according to UNCLOS (in particular articles 21.2 and 211.5), it can significantly affect Norwegian regulatory jurisdiction. As has been shown above, Norwegian regulatory jurisdiction is, at least for some geographical areas, closely linked to article 234 of UNCLOS. Hence, one essential question is how a Polar Code would affect the interpretation and application of article 234.

The 2002 and 2009 Guidelines contain no rules concerning their relationship to article 234. The relationship between the Polar Code and article 234 has not been discussed in the documents that have been published so far during the negotiations. Hence, states seem to avoid taking steps to clarify this relationship. Such an approach is most likely the result of significant differences in opinion among the participating states. Bringing the issue into the negotiations could significantly complicate the negotiation process and possibly prevent its successful conclusion.

Article 234 does not contain any reference to 'generally accepted international rules or standards'. It can thus on the one hand be argued that the adoption of a Polar Code would not affect the freedom of states to adopt measures in accordance with article 234. On the other hand, it can be argued that such an argument would be contrary to the general approach of UNCLOS. For all

8 A 'risk-based/goal-based approach' would be parallel to approaches of other standardizing institutions, see in particular article 2.8 of the WTO Agreement on Technical Barriers to Trade (1994): 'Wherever appropriate, Members shall specify technical regulations based on product requirements in terms of performance rather than design or descriptive characteristics.'

areas beyond the internal waters of states, the general approach of UNCLOS is to limit coastal state jurisdiction so that navigation in accordance with generally accepted international rules or standards can take place without interference. This argument finds additional support in the reference to the freedom of navigation in article 234: 'laws and regulations shall have due regard to navigation' (Brubaker 2002:70-1). Moreover, it can be argued that article 234 must be read in light of the subsequent development of and reliance on standards adopted by the IMO. Against this background, it is the opinion of this author that a Polar Code which does not explicitly state that it is 'non-binding' would limit the regulatory jurisdiction of coastal states in areas covered by article 234.

If we conclude to the contrary, i.e. that coastal states would not be prevented from adopting stricter standards than those following from a Polar Code for areas covered by article 234, we must also ask which consequences the Polar Code would have for the exercise of coastal state jurisdiction in such areas. Where coastal states exercise such jurisdiction, article 234 should be read as placing on the coastal state the burden of proving that such requirements pay sufficient attention to other states' freedom of navigation and that maintaining such stricter standards are needed for specific purposes.

If the Polar Code is set up as a treaty, it will be binding for the states that accept it. Such states can no longer invoke article 234 as a basis for regulatory jurisdiction beyond what would be permitted under the Polar Code. Such a result would be in accordance with article 311 of UNCLOS. Norway has been appointed to head the Sub-Committee responsible for negotiating a Polar Code (IMO 2010:38). It would thus be politically difficult for Norway not to accept a binding Polar Code should the result of the negotiations be treaty obligations.

Against this background, it is not unlikely that the successful negotiation of a Polar Code could significantly limit Norwegian freedom under article 234 to adopt stricter standards than those set out in a Polar Code for maritime transport in areas under Norwegian jurisdiction. This may not be a problem in the current situation, since Norway has not made use of its opportunity to adopt such standards in areas that would be covered by a Polar Code. However, given that Norway may have interests in cooperating with Russia in matters regarding maritime transportation (see below) and that a Polar Code may not contain sufficiently strict standards, Norway may lose opportunities to ensure that shipping within its jurisdiction follow stricter standards than those set out in a Polar Code.

Moreover, even if the objective is to adopt a Polar Code within the near future, it is not unlikely that the negotiations may turn out to be a long-term undertaking. Currently, the objective is to make the Polar Code binding by the end of 2014, but in light of the time it took to negotiate the 2002 and 2009 Guidelines, this might seem overly optimistic. As long as Norway has a central role in the negotiations, Norway would probably refrain from adopting policies that would alienate other states participating in the negotiations, such as unilaterally adopting requirements that are stricter than those currently in place. It is thus likely that the negotiations as such will have a 'chilling effect' on Norwegian initiatives to secure an appropriate balance between relevant interests.

4. Norwegian and Russian cooperation regarding maritime transport

Before addressing questions concerning bilateral cooperation between Norway and Russia, we shall examine alternative approaches to develop rules concerning maritime transportation in the Arctic. The Arctic Council could arguably be used as a forum for setting standards for shipping. While the Arctic Council traditionally has not been regarded as a forum for standard-setting (Offerdal 2007:141-5), recent developments have changed this perception. At its ministerial meeting in Tromsø in 2009, the Arctic Council decided to establish a task force to 'develop and complete negotiation by the next Ministerial Meeting in 2011 of an international instrument on cooperation on search and rescue operations in the Arctic'. This is to be a 'legal instrument' and the Task Force is headed by representatives from the USA and Russia. Thus, the argument that the Arctic Council is a 'political' and not a 'regulatory' body is no longer any major argument against its adoption of standards for maritime transport in the Arctic. However, in light of Guidelines adopted by the IMO and its current initiative to negotiate a Polar Code it can be safely assumed that the Arctic Council will not take initiatives to adopt standards for maritime transport in the Arctic, at least not legally binding standards (Molenaar 2009:319, Young 2009:81 and Chircop 2009:365-7). Moreover, the Arctic Council is composed of a limited number of states, mainly coastal states, and standards adopted by such an institution would not qualify as 'generally accepted international rules or standards' within the meaning of UNCLOS. It can also be mentioned that the Arctic Council does not have observer status at the IMO and vice versa (Chircop 2009:363-4).

Another forum for cooperation is the Barents Euro-Arctic Council. The members of the Council are Denmark, Finland, Iceland, Norway, Russia, Sweden and the European Commission. The Council has established a Steering Committee for the Barents Euro-Arctic Pan-European Transport Area (MoU 1998) which has as its objective to create 'an efficient and integrated multimodal transport system of international significance in the Area' (article 1 of the MoU). Among its priorities is the sea route along the Norwegian and Northwest Russian coast with connections to and from all the major Barents Sea ports. The Committee has had a focus on development of coastal shipping and on sea safety. According to the current action programme, the Committee will address the regulatory and legal framework in the sphere of transport, and coordinate its activities with those of other international institutions (BEATA 2009). Even if the Barents Euro-

Arctic Council might thus be a relevant forum for setting standards for maritime transport, it is unlikely to take such initiatives in light of the role of the IMO and the fact that it has so far not been used as a forum for regulatory activities.

In relation to compliance and enforcement, it has been observed that 'there is no regional approach by Arctic states or another group of states specifically aimed at ensuring compliance with applicable international rules and standards and national laws and regulations' (Molenaar 2009:319).

Against this background, it is the conclusion of this author that the main option available to Norway beyond the ongoing negotiations within the IMO is to seek bilateral cooperation with Russia. While Russia and Norway have extensive bilateral cooperation on a broad range of marine issues, this author is not aware of any current initiatives to negotiate standards for maritime transport between Norway and Russia.[9] Bilateral cooperation on standards for maritime transport between Norway and Russia could include consultations with the Arctic Council and/or the Barents Euro-Arctic Council. This could increase the legitimacy of such standards since countries depending on maritime transport in the region would have possibilities of ensuring that their concerns are taken into account.

There are several reasons why Norway should be interested in exploring the opportunities for cooperation with Russia with regard to standard setting for maritime transport. First, to the extent that maritime transport along the Norwegian coast is not destined for Norwegian ports, such transport would essentially be to and from Russian ports or aim for or come from the Northern Sea Route. If Norway should want to impose stricter standards on shipping along

9 See, however, Koivurova & Molenaar (2009:25) informing that 'The Russian Federation has recently proposed establishing a new working group on 'Ecological Safety regarding Marine Transportation of Oil along the coasts of Norway and Russia'.'

its coast, it has been pointed out that such standards could be made effective by giving ships incentives to sail through Norway's internal waters or to use Norwegian port facilities (A.T. Falkanger 2007:343-4). While Norway could pass legislation that would only allow ships fulfilling certain standards into its ports or internal waters, such rules would not prevent ships that do not fulfill such requirements from sailing in the territorial sea or the EEZ. It is hard to imagine incentives that would be sufficient to ensure that ships that otherwise would not comply with such stricter standards would make use of Norwegian port facilities or internal waters. Hence, to the extent that such ships are destined for Russian ports or the Northern Sea Route, such Norwegian rules and control mechanisms would be ineffective. Norway would thus depend on cooperation with Russia if it wants to pursue such strategies.

Secondly, Russia has adopted strict requirements applicable to the Northern Sea Route. Russia has thus demonstrated its willingness to make use of its regulatory jurisdiction under article 234 (Brubaker 2002:30, AMSA 2009:67and 71-3 and Franckx 2009:338-9).[10] Arguably, Russia's practice is stricter than what is allowed under the provision (Brubaker 2002:123-6). Norway, on the other hand, has chosen not to use its regulatory jurisdiction under article 234 and its jurisdiction to regulate marine transportation around Jan Mayen and Svalbard. The Norwegian and Russian policies in this regard thus differ considerably. Norway may benefit from trying to find a middle ground between the two extremes, i.e. accepting to introduce a stricter regulatory regime within Norwegian waters, while moving Russia in the direction of reforming its restrictive regime. In addition, it is essential for Norway to ensure that the regulatory regimes of Norway and Russia combined give appropriate incentives to

10 Franckx (2009:342) observes that 'It is … likely that substantial changes are to be expected concerning the legal regime applicable to foreign shipping in the Russian Arctic in a not too distant future.'

vessels in the areas. Norway would thus have interest in ensuring that the Russian regulatory regime has an effective and efficient approach to preventing accidents and environmental harm. Coordination of the Norwegian and Russian regimes may also facilitate cooperation between Norway and Russia regarding enforcement of safety and environmental standards, and thus contribute to the effectiveness of such standards.

As shown above, a Polar Code may limit Norway's right to adopt stricter requirements concerning shipping in areas covered by article 234. Moreover, Norway is subject to a strong political incentive against adopting restrictive regimes for maritime transport in areas to be covered by the Polar Code as long as the negotiations are under way. This is particularly so due to the leading role of Norway in the negotiations. The opportunity of Norway to approach Russia in order to coordinate their regulatory regimes in areas covered by article 234 is thus considerably affected by the negotiation of a Polar Code.

Finally, it could be of considerable benefit to the shipping industry if Norway and Russia would establish a coordinated regulatory regime for transport in the relevant areas. Such coordination would facilitate transport in the area, including the use of port facilities. It can be argued that a binding Polar Code will constitute such a coordinated regulatory regime. However, its successfulness in this respect would depend on whether Russia will accept a Polar Code and adjust its regulatory regime accordingly. Russia is a member of the Correspondence Group in which the Polar Code is currently discussed. But its membership in this Group is not necessarily any guarantee that the final outcome will be acceptable to Russia. Moreover, as pointed out above, the negotiations are based on a 'risk-based/goal-based approach' (Sub-Committee 2010:5) which means that coastal states may still enjoy a broad margin of appreciation after joining a Polar Code. The consequence may be that even if a Polar Code is accepted and implemented by Russia, significant regulatory differences between

Russia and Norway may persist. There would thus be a need for coordination of Norwegian and Russian regulation regardless of a future Polar Code.

5. Concluding remarks

This contribution has shown that Norway has not yet taken measures to ensure an appropriate balance between interests associated with maritime transportation in large areas under its jurisdiction. While Norway has supported relevant processes within the IMO, the results of these processes have so far not been reflected in Norwegian regulatory reform.

This contribution has also indicated that major benefits may be achieved through bilateral cooperation with Russia in order to specify standards for maritime transportation that would ensure an appropriate balance between relevant interests. The current Norwegian priority of and approach to negotiations of a Polar Code may significantly delay and even prevent such bilateral cooperation. It is the opinion of this author that Norwegian authorities should explore how Norway can cooperate with Russia in order to define an appropriate balance between the interests associated with marine transportation in the Arctic. Such an initiative could possibly enhance the prospect of a successful conclusion of a Polar Code.

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Kaj Riska graduated as a M. Sc. 1978 and D. Sc. 1988 in Naval Architecture from the Helsinki University of Technology. He worked as group manager in winter navigation 1976–1988 at VTT Technical Research Center of Finland (multitechnological applied research organization), senior researcher 1988–1991 at the Academy of Finland, as Director, Arctic Offshore Research Centre 1991–1996 and Professor 1996-2005 in the Helsinki University of Technology. Since 2005 acted as Director, Helsinki, at ILS Oy. Professor II at the Norwegian Science and Technology University in Trondheim 2006 – present. Worked as a specialist on the Finnish-Swedish Ice Class Rules for the Finnish Maritime Administration since 1988. Contributed to design of several icebreakers, latest ones the IB Varandey and Toboy. About 100 scientific publications about ships and offshore structures in ice.

Ole Kristian Fauchald graduated as Cand. Jur. at the Law Faculty, University of Oslo in Oslo in 1991. He was awarded the degree of Dr. Juris by the Faculty for the thesis “Environmental Taxes and Trade Discrimination”, published by Kluwer International in 1998. Thereafter, he worked as an adviser to the Ministry of Environment for two years, before returning to the Faculty as post doctoral researcher on a project with the title ”International Environment-Related Standards. An Analysis of Their Nature, Functions and Legal Status”. From July of 2001, he has been employed full time as Associate Professor and from 2007 as Professor at the Department for Public and International Law. From 2010 he has worked part time as Research Professor at Fridtjof Nansen Institute. Fauchald has in particular worked on international trade law (WTO) and international environmental law, with a particular focus on biological diversity. He has also published on Norwegian environmental law and international human rights. He has been head of the Research Group on Internationalisation of Law.

Appendix: Introductions to the Symposium and summaries of the talks, in Norwegian

Et møtested for forskere og politikere

Kjell Arne Ingebrigtsen, president NTVA, professor II, NTNU

Nils Chr. Stenseth, preses DNVA, professor Universitet i Oslo

Roy H. Gabrielsen, påtroppende president NTVA, medlem DNVA, professor Universitetet i Oslo

John Grue, styremedlem DNVA, professor Universitetet i Oslo

Vi merker alle hver dag gjennom media, gjennom politiske debatter og i diskusjoner mellom forskere at vi lever i et samfunn som blir stadig mer komplisert og der viktige beslutninger krever stadig mer grunnleggende kunnskap. Eksempler på dette er klimadebatten og tiltak knyttet til ivaretagelse av miljøet, innvandrings- og integreringspolitikken og utvikling i og bruk av polarområdene. Dette er saksområder som krever god kommunikasjon mellom beslutningstakere og dem som berøres av beslutningene, nemlig folk flest. Samtidig er det flere grupper som leverer beslutningsgunnlaget, for eksempel nasjonale og internasjonale forskningmiljøer og en rekke interesseorgansasjoner som i variernde grad har politiske målsettinger. Kommunikasjonen mellom disse og de som tar de politiske beslutningene foregår i betydelig grad gjennom åpne kanaler som forvaltes av mediabedrifter som benytter radio, TV, film og aviser og i raskt økende grad elektroniske sosiale medier. At dette genererer kompliserte prosesser som i mange tilfelle får en overraskende dynamikk for deltakerne, er den mye omtalte programserien "Hjernevask" et godt eksempel på.

Vi lever et samfunn med stadig økende krav til raske beslutninger, der kompleksiteten i problemene som skal løses er eskalerende og der konsekvensene av beslutningene kan fortone seg - og antagelig ofte er - uoverskuelige. Under slike forhold er det grunn til å spørre: Har vi tid til å analysere problemet vi står ovenfor, til skaffe oss det kvalifiserte kunnskapsgrunnlaget som er nødvendig for å løse det og ro til å diskutere oss frem til de løsningene som er gode på lang sikt? Har vi evnet å utvikle beslutningsprosedyrer som er tilpasset behovet for å ta de riktige beslutningene? Muligens ikke.

Hva er så problemet med dagens beslutningssystem i de tilfellene der kompliserte og ferske forskningsresultater utgjør en vesentlig del beslutningsgrunnlaget? Dersom vi holder oss til Norge, er saken etter vårt syn den, at har vi ikke lykkes med å lage et system der det tas tilstrekkelig hensyn til at kompliserte problemstillinger så å si alltid er beheftet med uklare årsaks- og virkningssammenhenger, at de er preget av mange og ofte gjensidig avhengige variable og at usikkerheter av forskjellig størrelse og type preger konklusjonene. Dette krever et kommunikasjonsformat der det er satt av tid til å belyse saken fra mange sider og kanskje i flere omganger, og der usikkerheten i forskningsresultatene og derved utfallsrommet for beslutninger kan formidles og vurderes. Vi kan ikke se at det alltid er rom for denne typen kommunikasjon, selv i saker av den aller største viktighet for samfunnet. Vi har ikke lenger tid de grundige høringsrunder – og absolutt ikke til å gjøre dyptgripende forandringer i foreslåtte planer.

Det er behov for utvikling av nye strukturer for forskningskommunikasjon, ikke minst mellom forskningsverdenen og beslutningstakere. Dette må være et forum som preges av tid til diskusjon, drøfting av usikkerheter i forskningskonklusjonene og, ikke minst, gi plass til divergerende og nyanserte synspunkter.

De to største norske vitenskapsakademiene, Det Norske Videnskaps-Akademi (DNVA) og Norges Tekniske Vitenskapsakademi (NTVA) har begge sett dette problemet og har tatt mål av seg til å gjøre noe med det. Det er akademienes felles oppfatning at forskersamfunnet ikke alltid har vært like imøtekommende og forståelsesfulle overfor de politiske behov som i økende grad legger ti grunn beslutningsmateriale i form av forskningsresultater, at det av og til skapes et inntrykk av at forskersamfunnet utelukkende er opptatt av egen forskning og betingelsene ved egen forskningsinstitusjon og at det såkalte elfenbenstårnet er forskerenes foretrukne tumleplass. Bildet er langt mer nyansert. Forskere er alltid interessert i å dele sin kunnskap (ellers ville de neppe vært forskere og lærere ved våre universiteter, høyskoler og forskningsinstitutter) og de aller fleste tar et selvsagt samfunnsansvar ved å bidra med egne forskningsresulaterer når dette er ønskelig.

Som et første skritt i denne retningen, inviterer DNVA og NTVA i fellesskap til et seminar der temaet er knyttet til både store utfordringer den politiske hverdagen og som er et sentral tema i norsk forskning, nemlig transport til havs i de polare områdene. Dette temaet berører både klimautviklingen, tekniske aspekter som marin teknologi, sikkerhet til havs, internasjonal politikk og sikkerhetspolitikk og havrett. Alle disse sidene vil bli belyst og sentrale politiere er invitert for å komme med synspunkter og å møte sentrale forskere. Dersom dette viser seg å dekke et behov er akademienes intensjon å utvikle dette konseptet videre, for å imøtekomme de behovene som er identifiesrt ovenfor.

Dette initiativet ikke er ment å være til fortrengsel for annen forsknigsdebatt som foregår i skjæringspunktet mellom departementer, Norges forskningsråd, ikke-statlige organisasjoner og forskningsmiljøene. Intensjonen er å fylle et behov for et åpent forum der det er plass til å diskutere aktuelle tema på et tidspunkt hvor det fortsatt er rom for ettertenksom meningsutvikling og der forskningsmiljøene kan bidra med formidling av forskningsresultater og meninger om disse. Vi tror at et slikt forum vil dekke et behov som ikke er tilstrekkelig godt ivaretatt i dag.

Vitenskapsakademier som rådgivere

Nils Chr. Stenseth, preses i Det Norske Videnskaps-Akademi og professor ved Universitetet i Oslo

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Kan toppforskningen tas bedre i bruk for industri og samfunn? Kan ekspertråd fra forskerne mer aktivt benyttes i utforming av den offentlig politikken? Kan vitenskapsakademiene by på kunnskaper utover hva som framskaffes i direktorater, forskningsinstitutter og dedikerte sentere?

Internasjonale vitenskapsforeninger. Det Norske Videnskaps-Akademi (DNVA) består av utvalgte forskere i alle fag og er mest kjent for utdelingen av de internasjonale Abel- og Kavliprisene. DNVA har tett samarbeid med mellom 30 og 40 forskjellige internasjonale vitenskapsforeninger. Disse fungerer som internasjonale kontaktorganer og speiler nivået, trender og utviklinger på spekteret av forskningsdisiplinene i verden. DNVA er disse foreningenes kontaktakademi i Norge, og betaler medlemsavgifter for snaut en halv millon kroner årlig, gjennom et eget tilskudd fra Kunnskapsdepartementet.

Men hva får Norge tilbake for disse pengene? Kan akademimedlemmenes internasjonale forskningskunnskap brukes til noe mer enn avanserte foredrag i festlige møter? Kan Akademiet brukes til noe mer enn for eksempel å arrangere den årlige matematikkprisen? Nettopp DNVAs tette samarbeid med verdensunionen i matematikk sikrer at vi kårer verdens verdigste matematiker. På lignende måte peker DNVA ut Kavliprisvinnerne.

Vitenskapsakademier som rådgivere. DNVA og Norges Tekniske Vitenskapsakademi (NTVA) ønsker i fellesskap å bidra til klarere fokus på forskningens økende betydning i viktige beslutningsprosesser i det moderne samfunnet, og ønsker å åpne nye kanaler for dialog med opinionen og sentrale beslutningstakere. Som et første skritt i denne retningen, inviterer akademiene i fellesskap til et seminar der temaet omfatter store utfordringer i den politiske hverdagen og samtidig er aktuelt i norsk forskning, nemlig transport til havs i de polare områdene. Temaet berører klimautviklingen, oljeutvinning i nord, tekniske aspekter innen marin teknologi, sikkerhet til havs, internasjonal politikk, sikkerhetspolitikk og havrett.

Forskernettverk. Forskerne fremskaffer systematisk kunnskap over lang tid. De organiserer datainnsamlig og forbedrer og utvikler nye metoder. Toppforskningen er internasjonal, og forskerne er forpliktet til å sammenligne nye funn med resultater og forståelse som eksisterer andre steder i verden.

Banebrytende forskning i fagdisiplinen oppfattes raskt i de globale forskernettverkene, som kjennetegnes av gjensidig respekt og forståelse, og der internasjonal konkurranse samtidig bidrar til gjensidig kontroll, etterprøving av data og idéer og utvikling av nye forskningstema.

Forskningsbasert kunnskap. Kan toppforskningen tas bedre i bruk for industri og samfunn? Kan ekspertråd fra forskerne mer aktivt benyttes i utforming av den offentlig politikken? Kan vitenskapsakademiene by på kunnskaper utover hva som framskaffes i direktorater, forskningsinstitutter og dedikerte sentere?

Vi tror det. De to største vitenskapsakademiene i Norge – DNVA og NTVA – representerer samtlige vitenskaper, der f.eks. jurister, statsvitere, filosofer og eksperter i humaniora kan jobbe sammen med medisinere, naturvitere, teknologer og økonomer. De to akademiene arbeider sammen om å skape en ny møteplass der politikere, ledere i industrier og samfunnsinsitusjoner, samt representanter fra vitenskapene, sammen kan ta opp aktuelle problemstillinger til diskusjon. Akademienes uavhengighet, komplementære kompetanse og nettverk kan danne en fruktbar møteplass for ledere og eksperter med forskjellige kulturer og bakgrunn.

Problemkomplekser. Dagens samfunn eksisterer i en rivende utvikling teknologisk og materielt, kommunikasjonsmessig og kulturelt. Rammebetingelsene er i stadig endring hvilket byr på utfordringer for industrier som må fornye seg og søke nye metoder og markeder. Politikere og samfunnsledere utfordres hele tiden av nye trender og utviklinger i vår globale og konkurranseutsatte tilværelse, med press på bl.a. naturressurser og grenser. Dagsaktuelle politiske utfordringer øker i sammensetning, og gode løsninger og kompromisser utfordrer et behov for stadig bredere sammensatt forståelse. Vurderinger og beslutninger kan best søkes basert på tverrfaglige kunnskaper og råd. Akademiene kan formidle forskningsbasert grunnlagsmateriale og ekspertråd for beslutninger i offentlig politikk. Akademiene kan samle eksperter såvel som interessert publikum til symposier, workshops, møter og rundebordskonferanser, og spre informasjon og stimulere til dialog om diverse spørsmål som omfatter vitenskapen og dens praktiske anvendelse.

Beregning av hvalfangstkvoter og langtransportert sur nedbør er velkjente eksempler der systematisk forskningsdokumentasjon ble brukt i beslutninger på internasjonalt nivå. På bakgrunn av den internasjonale debatten om hvalfangst, ble Norge i 1986 presset til å innføre fangststopp. Regjeringen Brundtland oppnevnte da en internasjonal ekspertgruppe som skulle vurdere den faktiske kunnskapen om bestanden av vågehval i Nordøst-Atlanteren. Problemet var beregningene som den internasjonale hvalfangstkommisjonen la til grunn for fangstkvoter. Gjennom et uavhengig forskningsprogram kunne bestanden beregnes bedre. Norske forskere kunne dokumentere nye tall for fangstkvotene som tidligere hadde vært for konservative. De norske tallene for vågehvalbestanden har blitt internasjonalt akseptert. Hvalfangsten er basert på prinsippene om bevaring og bærekraft som er nedfelt i FN-planen Agenda 21.

En nedgang i bestanden av ferskvannslaks og ørret førte til at man rettet søkelyset mot langtransportert sur nedbør som årsak. Et regjeringsinitiert forskningsprosjekt i 1970-årene kunne konkludere med at sur nedbør var hovedårsaken til fiskedød i vassdrag i Sør-Norge. Konklusjonen ble styrket av en større undersøkelse i regi av det britiske Royal Society og det svenske og det norske vitenskapsakademi.

Modeller i andre land. Det amerikanske paraplyakademiet National Research Council (NRC) kan med dets etablering i 1916 vise til en nesten 100-årig tradisjon i å informere politikere, beslutningstakere, ledere i departementer, etater, råd, offentlige kontorer, private foretak og andre institusjoner. NRC som fungerer i regi av National Academy of Science, National Academy of Engineering og Institute of Medicine, alle USA, formidler hva man kan trekke ut av den systematiske og frie forskningen innen alle vitenskaper, inkludert teknologi og medisin, og finner gjennom sine toppforskere fram til den relevante kunnskapen som til enhver tid er tilgjengelig i den internasjonale forskningen. Med sine 200 rapporter årlig, er NRC en av verdens største bidragsytere av fri vitenskapelig og teknisk informasjon. Det er lange tradisjoner for en lignende rådgivningsaktivitet i det britiske Royal Society.

Med det amerikanske NRC som forbilde ble Council of Canadian Academies (CCA) etablert i 2006. Fellesakademiet hadde vokst fram etter behov for en forent stemme fra canadisk akademia, for aktive råd til regjeringen. Departementer, statlige kontorer og direktorater gir oppdrag til CCA, som har forpliktet seg til å levere et visst antall utredninger årlig, basert på arbeid i ekspertgrupper.

Arktis – et hav i endring

Cecilie Mauritzen, Meteorologisk institutt

Arktis er et fantastisk rikt område, og mer tilgjengelig enn noen gang i moderne tid. Ettersom vi bruker opp ressurser på resten av kloden er det ingen tvil om at Arktis vil bli et mer og mer yndet mål. En femtedel av jordas gjenværende petroleumsforekomster finnes der1}, det er også rikt på mineraler, ferskvann, marine ressurser, samt en ressurs mennesker mentalt er svært så avhengige av, nemlig skjønnhet: Isformasjonene, fargene, dyrelivet, lyset, roen gjør Arktis til et eksotisk turistmål. Men hvordan er det egentlig i Arktis, og hvordan blir det?

Den aller største delen av året er Arktis dekket av is – det er bare i 2-3 måneder (august, september, oktober) at det smelter langs kantene. Den store feltsesongen for forskere i Arktis er derfor nå i september måned. Og akkurat i disse dager (midten av september) stopper smeltingen og isen begynner å fryse på igjen for vinteren. Årets minimumsmåling var ikke rekord, men det var den tredje laveste utbredelsen siden satellittmålingene begynte i 1979 (bare slått av 2007 og 2008).

Siden 1970-tallet har is-utbredelsen blitt mindre, spesielt om sommeren. Hva kommer denne utviklingen av? Selv om endringer i Arktis lenge har vært et sterkt, visuelt ikon for menneskeskapte klimaendringer så er det ikke før helt nylig at man har kunnet bevise at det er en sammenheng. Kombinasjonen lengre dataserier og bedre modeller har gjort dette mulig. Nå kan man slå fast at den nedadgående trenden i isutbredelse siden 1970-tallet ikke ville ha skjedd uten menneskelig utslipp (av klimagasser, aerosoler (partikler) og oson-reduserende stoffer)1}. Man kan også slå fast at denne trenden vil fortsette hvis man ikke får bukt med utslippene1}, ja, selv hvis man klarer å begrense dem ganske kraftig1}. Dette poenget (ironien, vil mange si), at menneskene er med på å åpne Arktis, skal man være seg svært bevisst når man velger å utnytte ressursene i Arktis.

Det er ikke bare menneskene som påvirker isdekket i Arktis. Naturen selv påvirker også, gjennom endringer i sol-innstrålingen, gjennom vulkanutbrudd, og gjennom indre svingninger i dynamikken i hav og atmosfære. Arktis har opplevd enorme endringer i løpet av jordas levetid. Det har til og med vært helt isfritt før også, men det var på en tid da kontinentene lå plassert helt annerledes enn i dag. Selv siden 1970-tallet har det vært store svingningene i isutbredelsen fra år til år, og fra femårs-periode til femårsperiode. Disse svingningene ville skjedd selv uten menneskelige utslipp, og kommer til å fortsette uansett hva vi mennesker gjør. Slike svingninger gjør det vanskelig å planlegge aktiviteter i Arktis. De er vanskelige å forutsi år på forhånd, for det ligger mye tilfeldigheter her. Akkurat hvordan isdekket blir i september avhenger av vær og vind på sommeren, og som vi vet er vær og vind ikke noe man kan forutsi på så lenge på forhånd. Det vi kan si noe om flere år på forhånd er hva som blir den mest sannsynlige isutbredelsen, og hvor store svingningene rundt dette tallet sannsynligvis vil være.

Været i Arktis er gjerne tørt, rolig og kaldt (det kaldeste som er målt er minus 68 ºC). Det er som regel skyet, men siden solen om sommeren står så lavt på himmelen skinner den gjerne *under* skyene. Men tåke legger seg ofte til i dagesvis og ukesvis. Mesteparten av året er det bekmørkt. Plutselig kan krappe stormer blåse opp, og de varer gjerne et par-tre dager. Da driver isen raskt av gårde og hvis er tynn brekkes den lett opp. Tidevannsbølger (ja, man kan faktisk se bølger i havisen) bidrar også til å brekke opp tynn is, spesielt rundt fullmåne og nymåne.

Det er i skjæringspunktet is-åpent hav, i den marginale issonen, at stormene gjerne blåser opp. Kalde vinder over havisen møter plutselig åpent, relativt varmt vann (sjøvann kan ikke bli kaldere enn ca. 2 kuldegrader). Disse temperaturkontrastene er kilde til en enorme energi-utvekslinger, og polarstormer oppstår. Ettersom isen trekker seg tilbake følger disse stormene med lengre inn i Arktis. Slike stormer er usedvanlig vanskelige å varsle for de er så små i utstrekning og fordi vi har veldig få målestasjoner der. Samtidig er de livsfarlige for de som opplever dem.

Det et generelt trekk ved klimaendringene at stormbaner kommer til å gå lengre nordover. Selv den gode og gamle sørvesten, som bringer både godvær og uvær inn mot nordeuropa fra Nordatlanteren, flytter seg nordover i et varmere klima. Vi kan allerede se tendenser til at dette skjer1}, og vi fikk kanskje en forsmak på dette i Sør-Norge i sommer. Men slike uværsystemer er mye større, og datagrunnlaget i Nordatlanteren mye bedre enn i Arktis - dermed er de lettere å hanskes med i værvarslings-øyemed.

Aktiviteter i Arktis burde forutsette god kjennskap til de fysiske (, juridiske, sosiale?) forholdene, god overvåkning, gode værvarsler, og god beredskap ved ulykker. Og alt dette forutsetter et godt internasjonalt samarbeidsklima. Vi har ennå mye å gjøre på kunnskaps- og samarbeids-fronten, og det haster.

Vi får (vi gir faktisk oss selv) et nytt hav i gave, kanskje allerede i vår levetid. Måtte de som skal forvalte denne gaven tenke grundig over oppgaven sin – gaver kan brukes på mange måter. Og måtte de forstå og respektere at det kommer mange generasjoner etter oss.

Nordområdene: Norge må ta risiko

Tor E. Svensen, president i Det Norske Veritas

Utblåsningen i Mexico-gulfen har vært en vekker på mange områder, først og fremst når det gjelder miljø og sikkerhet under oljeutvinning på store dyp. Det er liten tvil om at de undersøkelser som nå pågår for å klarlegge årsakene til ulykken vil gi verdifull innsikt også for Norge som olje- og gassnasjon.

Samtidig har heftige diskusjoner som har pågått i kjølvannet av ulykken demonstrert i hvor liten grad det moderne samfunnet er villig til å erkjenne at det følger risiko med all form for menneskelig aktivitet. Slike diskusjoner har pågått over hele verden etter ulykken, ikke bare i Washington og USA, nå også i EU. I vår egen debatt om videre utnyttelse av naturressursene i nord synes mange å ha som utgangspunkt at slik aktivitet bare kan tillates dersom risiko er null. Men slik er det selvsagt ikke. Med all aktivitet følger risiko. Vårt felles ansvar er å forstå og ta stilling til risiko opp mot samfunnsmessig verdi og nytte.

Og jakten på ressursene i nordområdene er allerede i gang. De første lisenser for leteboring i stredet mellom Grønland og Canada er gitt og vår egen diskusjon om Lofoten er også en del av dette bildet. Transport av russisk jernmalm gjennom Nordøstpassasjen er under planlegging, og den norsk-russiske delelinjeavtalen vil sette ytterligere fart i denne utviklingen.

Generelt kan risiko reduseres til et samfunnsmessig akseptabelt nivå enten ved å redusere sannsynligheten for at det går galt eller ved å sørge for at konsekvensene begrenses, hvis det først går galt. Det er ingen tvil om at både sannsynligheten for hendelser og faren for uakseptable konsekvenser er betydelige i Nordområdene. Risikoen er med andre ord stor og i utgangspunktet større enn for aktivitet i de fleste andre geografiske områder. Men vi vet også at de samfunnsmessige gevinstene kan være enorme.

Det kan i sin ytterste konsekvens være et valg mellom å opprettholde det velferdsnivået vi har i dag eller akseptere at vi som samfunn får dramatisk færre ressurser til disposisjon. Det er selvfølgelig flere mulige utfall innenfor et slikt scenario, men vi må som samfunn ta stilling til både det mulighetsbildet og det trusselbildet som Nordområdene totalt sett representerer. Og truslene er i dette perspektivet først og fremst knyttet til sikker og pålitelig oljeutvinning for å hindre at liv går tapt, men også langvarige skader på miljø og økosystem. Det samme kan også være aktuelt når det gjelder skipstransport.

Den viktigste forutsetningen for sikker aktivitet i nordområdene blir å kartlegge utfordringene på en systematisk og faglig robust måte. Det betyr også at det må etableres aksepekriterier i forhold til hva samfunnet vil godta av sannsynlighet og konsekvenser. Et kritisk område er beredskap og kapasitet hvis ulykke skulle skje. Her må vi i Nordområdene være på et helt annet nivå enn vi er i dag. Det Norske Veritas (DNV) har i mange år arbeidet med slike problemstillinger gjennom forskning og utredning knyttet til aktiviteter som allerede er i gang i og rundt Arktis. Likevel er det først med det norsk-russiske ”Barents 2020” prosjektet at det virkelig kom fart i dette arbeidet. For første gang er det gjort en systematisk gjennomgang av de spesielle utfordringene som ressursutvinning og annen menneskelig og industriell aktivitet i nordområdene innebærer. Hovedfokus i Barents 2020 har vært rettet mot å identifisere og i neste omgang redusere risiko som følge av slik aktivitet.

Gjennom målrettet innsats når det gjelder kompetanse, teknologi og kontrollregimer kan risiko for ulykker i Nordområdene reduseres betraktelig. Skulle ulykken likevel være ute, vil redningsoperasjoner og begrensning av miljøskade stille store og helt spesielle krav til beredskap. Her vil et godt og forpliktende samarbeid og samkjørte responsplaner på tvers av nasjonale grenser være avgjørende viktig.

Basert på erfaring fra aktivitet under ekstreme forhold og de spesielle studier som så langt er utført for nordområdene, er vi ikke i tvil om at også for økonomisk utvikling i nordområdene kan risiko reduseres til et nivå som samfunnet bør kunne godta. Det vil i stor grad handle om å etablere nødvendige sikkerhetsbarrierer. En viktig forutsetning er at det utvikles klare kriterier for hva som er akseptabel risiko. Slike kriterier må fastsettes av samfunnet som helhet gjennom politiske prosesser. De må avveie forventet samfunnsmessig verdi mot samfunnsmessig akseptabel risiko.

En sikker utvikling av de ressurser som finnes i nord er en forutsetning for en bærekraftig utvikling ikke bare i Norge. For å nå dette målet er en risikobasert tilnærming basert på tett samarbeid på tvers av nasjonale grenser den eneste farbare vei.

Behövs tekniskt forskning för säker sjöfart i arktiska vattnen?

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När omfattningen av istäcket i polar områden minskar och istjockleken blir mindre, ökar intresset att använda de arktiska farvatten för sjötransport – både lokalt och för transito genom Nordost- och Nordvästpassagen. Även om det mångåriga istäcket försvinner, kommer dessa farvatten att frysa varje vinter för en ganska obestämd tid framåt; obestämd därför att forskare är oense om tidsfaktorer i klimatändring. Det behövs nya tekniska lösningar, innovationer, för fartyg för att göra trafiken i Arktis lönsamt. Hur kan vetenskapen hjälpa till att förbättra säkerheten samt lönsamheten eller är det skeppsbyggnadsingenjörer vilka planerar fartygen som driver utvecklingen?

Vintersjöfart räknas att ha börjat år 1877 när fartyget SS Express II började trafiken mellan Stockholm i Sverige och Hangö i Finland. Syftet för året runt trafik var att få den finska exporten (som bestod bl.a. av smör) till marknad. Även om starten var lite trög – rederiet som drev trafiken gick i konkurs efter första vintern – vidgades vintertrafiken snabbt och de första isbrytarna byggdes i slutet av 1800 talet (till exempel Mjölner 1877 till Oslo fjorden, Murtaja 1880 till sydvästra Finland). Den första riktiga isbrytaren betraktas vanligt att ha varit Eisbrecher I (1871) som byggdes till Hamburg hamn.

SS Express II planerades av Robert Runeberg, sonen till den finska nationalpoeten Johan Ludvig Runeberg. Han utgick från principen att fartygs tyngd bryter is och därför den vertikala kraften från stäven är ytterst viktig. Med en så liten stävvinkel som möjlig blir vertikala kraften maksimalt stor. Denna idé om en flat stäv hade används också i andra isbrytande fartyg och erfarenheter var goda med att isbrytningsförmågan var bra i sådana fartyg. Teorin om isbrytning och de första uppskattningarna av ismotståndet publicerades avsevärt senare, ett tiotal år efter fartyget hade levererats, av Robert Runeberg, år 1888/89 vid Institution of Civil Engineers i England. Är denna ordning att vetenskapen följer efter realiserade projekten bara en slump därför att planerare ville ha klart för sig varför sitt plan fungerade så bra i verkligheten eller är det mera vanligt?

När Arktisk Råd – the Arctic Eight – gjorde en studie av maritima transporter i arktiska områden, The Arctic Marine Shipping Assessment, AMSA, var det intressant att i slutsatser från projektet nästan inga skepptekniska teman för forskning kom upp. Forskare inom isbranschen kunde naturligtvis tänka många objekt för forskning men dessa objekt tycks inte hitta den praktiska arktiska skeppsdesignen. Det har ofta hävdats att skeppsteknologin inte är det största hindret när trafiken i norra farvatten planeras. De största frågorna ligger mera i politiska, miljö och ekonomiska effekter av trafiken. Men det är instruktivt att titta på historian av forskningen och utvecklingen av isgående fartyg. Tabellen nedan visar kort tidslinjen för forsknings- och utvecklingsresultat.

Typiskt för växelverkan mellan forskning och utveckling är evolutionen av bogpropellrar i isgående fartyg. De första bogpropellrar togs i bruk i USA mot slutet av 1800-talet. När den första finska isbrytaren projekterades, hade planeringskommittén bestående av mestadels ämbetsmän en teori av orsaken till bogpropellrars effekt i isbrytning; propellrar pumpar vattnet bort från isens undersida och då faller isen i gropen. Denna teori blev glömt och ersatts av idén om vattenspolning från propellrar vilket minskar friktionen mellan fartyg och is. Även om de första teorier inte är exakt rätta, har bogpropellrar använts nu i nästan alla isbrytare och konceptet har också utvecklats till fartyg som seglar bakåt i is (Double Acting Ship, DAS). Det var först 2004 som den första vetenskapliga forskningen om orsaker till bogpropellrars effekt i isbrytning publicerades. Man vet att någon tekniskt lösning fungerar bra men inte exakt varför.

Man kan nu fråga sig om detta är typiskt för många branscher av tekniskt utveckling eller bara för istekniken där tillämpningen tycks komma före forskningsresultaten. Man tänker ofta att den tekniska utvecklingen sker linjärt från grundforskning, till tillämpad forskning, till utveckling och output är innovationer. Den linjära framställningen inte är helt rätt eftersom innovationens utveckling innehåller inte bara tekniskt forskning; ett forskningsresultat eller en uppfinning måste också finansieras och marknadsföras förrän den kan bli en innovation.

Det har ofta hävdats – och AMSA utredningen antyder också detta – att tekniska lösningar inte är hindret för att börja skeppstrafiken i Arktis eller via Nordost- eller Nordvästpassagen. Det är hellre risken för miljökatastrofer, ekonomin, de lokala befolkningens rättigheter, politiska beslut av kuststaten eller den bristande infrastrukturen som måste beaktas. Att dessa frågor är viktiga, blir klart om man tänker till exempel på den transit resan som bulkfartyget MS Nordic Barents gör genom Nordostpassagen – fartyget assisteras av två atomisbrytare med dagskostnad minst 100 000 € per brytare – men naturligtvis en annan fråga är vad Ryssland kräver för betalning för transitresan. Den tekniska frågan är naturligtvis om bulkfartyget nödvändigt behöver isbrytarassistans.

Behovet för nya tekniska lösningar tycks inte finnas eller det bara finns i retrospekt när någon har kommit fram med en uppfinning som utvecklades till en innovation i arktisk sjöfart. Tyder detta att allt viktigt inom den vetenskapliga sidan av isgående fartyg har gjorts? Eller är det tvärtom så att forskningen har bara börjat och kan inte ännu stöda utvecklingen? Den tekniska isforskningen är visst splittrad med många konkurerande teorier och en enighet av de mest viktiga saken; teorin hur istäcket bryts under dynamiska krafter från ett fartyg finns inte. Vad saknas är en samverkan mellan forskare i universiteten och forskningsinstituten och skeppsdesignare i skeppsvarven, oljebolagen och designbyråer. Det är samverkan som behövs, inte till exempel forskare som börjar göra design. Ett nutida fenomen är att forskningen riktas till saker som är viktiga till politikerna – här typiska populära ämnen är miljökatastrofer. Vem kunde vägra finansiering för forskning som kunde hjälpa att undvika avsläpp av miljoner fat olja?

Forskare borde göra grundforskning och få fram resultat – teorier, modeller, kalkyleringsmetoder osv. av fysikaliska företeelser. Samverkan mellan forskare och ingenjörer behövs för att dessa resultat kan tillämpas i utvecklingen. Å andra sidan borde ingenjörer lyssna på forskare och ge dem frågeställningar och antydningar av brister på metoder som används – och också respektera den olika tidskalan som gäller i forskning och i näringsliv. Samarbetsprojekt finns, till exempel i Norge på nya fartygstyper och utveckling av propellrar och i Finland på roderpropellrar och på prognoser av istryck för sjöfart. Utmaningen i alla dessa projekten är att å ena handen forskare får fram nya resultat om fysikaliska företeelser som därefter kan tillämpas i utvecklingen å den andra att ingenjörer kan få fram brister i kunskap som leder till fruktbar fysikalisk forskning.

Forskningsresultat	År	Utvecklingsmilstolpe
	1860	Bogpropeller i isbrytning (USA)
	1871	Den första isbrytaren i Tyskland
	1877	Express II, året runt trafik mellan Sverige och Finland
Ismotståndformel (Runeberg)	1888	
	1890	De första isregler (Ryssland)
	1921	De första finska isregler
	1932	Den första diesel-elektriska isbrytaren Ymer
	1955	Den första islaboratoriet för fartyg (AARI, Ryssland)
Iskrafter mot pelare och strukturer (Korzhavin)	1962	
Modernt teori av ismotstånd (Kasteljan), propelbladets hållfasthet i is (Enkvist)	1968	
	1969	Tanker Manhattan seglade genom nordväst passagen
	1971	Året runt trafik i hela Östersjön
Teori för iskrafter på grund av isskador (Johansson)	1971	De först moderna isregler
Vetenskaplig grund för ismodelförsök (Enkvist)	1972	
	1974	Polarstål från Rauta-Ruukki
Vallmotstånd (Keinonen)	1979	
Istryck – area relation	1980	
	1983	Cyclo-converter på RV Aranda
	1993	De första kombinerade isbrytare och offshorefartyg med azimuthing trusters
Teori för iskrafter på propellrar (Veitch)	1995	
	1999	Linje trafik året runt på Östersjön, iskapabel HSC Gotland
	2000	Double Acting Ship koncept
Teori för bogpropellrar (Leiviskä)	2004	

Samarbeid med Russland: Aktuell strategi for krav til skipstransport i nord?[1]

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Hvor strenge bør kravene være til skip som ferdes i arktis? Bør Norge basere seg på forhandlinger i FNs sjøfartsorganisasjon (IMO) eller bør vi søke bilateral enighet med Russland? Selv om det fremdeles er langt fram til det blir aktuelt med betydelig transport gjennom Nordøst-passasjen, er det allerede nå klart at det vil være sterkt økende skipstransport i nordområdene. Denne transporten vil særlig angå utnytting av naturressurser, noe som aktualiseres av grenseavtalen mellom Norge og Russland. I tillegg vil det være betydelig transport knyttet til forskning og turisme. Innen overskuelig framtid vil transport i norske farvann stort sett foregå til og fra havner i Norge og Russland.

Det vil kanskje overraske mange at Norge har vært tilbakeholdende med å stille krav til skipsfart i områder under norsk jurisdiksjon. Dette gjelder særlig i sonene rundt Svalbard, Bjørnøya og Jan Mayen, men også tildels i norsk økonomisk sone i nord. Denne politikken står i kontrast til den strengere reguleringen av skipsfarten i russiske og canadiske farvann. Norge har også vært tilbakeholdende med å etablere verneområder utenfor norsk territorialfar-

1 Også trykket som kronikk i Teknisk Ukeblad nr. 10, årg. 158, 17. mars 2011.

vann. Grunnene til at Norge fører en slik politikk er mange og sammensatte. Resultatet er økt fare for ulykker som kan medføre store skader for mennesker og miljø.

Utgangspunktet for Norges mulighet til å regulere transport i nordområdene er havrettstraktaten som gir Norge vid adgang til å innføre regler og håndheve dem i territorialfarvannet og norsk økonomisk sone som strekker seg omtrent 370 kilometer ut i havet. Men i territorialfarvannet har andre lands skip rett til ”uskyldig gjennomfart” og i den økonomiske sonen har de en utvidet rett til skipsfart. Det som blir avgjørende for norsk regulering av skipstransporten blir dermed hva som skal til for at gjennomfarten er ”uskyldig” og hvilken mulighet man har til å regulere transporten i den økonomiske sonen. Utgangspunktet er at så lenge skip overholder krav som følger av internasjonale standarder vedtatt av FNs sjøfartsorganisasjon og videreutviklet av internasjonale klassifiseringsselskaper, så må Norge avstå fra å stille strengere krav. Slike standarder er vedtatt for skipsfart i de fleste havområder.

Da man forhandlet havrettstraktaten innså man at havområder med farlige is- og værforhold trenger spesielle regler. Dermed fikk kyststatene utvidet mulighet til å regulere skipsfarten i slike områder i artikkel 234. Denne bestemmelsen er veldig uklar. Dels er det vanskelig å avgjøre hvilke områder som er ”islagte”, dels er det vanskelig å avgjøre hvilke krav kyststatene kan stille til skipsfarten i disse områdene, og dels er det vanskelig å avgjøre hvilken rolle internasjonale standarder vil ha for kyststatenes reguleringsmulighet. Norge har ikke benyttet den reguleringsmuligheten som artikkel 234 åpner for.

FNs skipsfartsorganisasjon har siden Exxon Valdez-ulykken i 1989 arbeidet med å få på plass standarder for skipstransport i polare områder. I 2002 ble man enige om ikke-bindende retningslinjer for transport i arktiske områder, og i desember 2009 ble man omsider enige om å utvide disse retningslinjene til antarktiske områder (ofte omtalt som “Polar Code”). Det arbeides for tiden videre med å gjøre disse retningslinjene om til bindende standarder. Problemet med dette er selvsagt at det tar tid å bli enige om strenge standarder internasjonalt, særlig når disse skal være bindende. Dersom man ønsker strenge standarder for skip i nordområdene, kan det være bedre ikke å ha noen bindende internasjonale standarder enn å godta svake standarder.

Hvordan bør Norge forholde seg til det videre arbeidet i FNs sjøfartsorganisasjon? Hva er våre minstekrav for å kunne godta bindende standarder? Hva skal vi foreta oss mens vi venter på at akseptable standarder skal bli vedtatt?

Det er allerede nå, med de ikke-bindende retningslinjene, innført en viss usikkerhet om Norge kan stille strengere krav til skip enn det som følger av retningslinjene. Særlig skipsfartsnæringen, som selvsagt ønsker ensartede regler å forholde seg til, vil argumentere med at Norge ikke bør stille strengere krav enn retningslinjene. I lys av hva retningslinjene selv sier og av praksisen til Russland og Canada, mener jeg det er klart at retningslinjene i seg selv ikke legger rettslige begrensninger på Norges muligheter til strengere regulering av skipsfarten i nordområdene. Først når retningslinjene gjøres bindende vil de innebære begrensninger av Norges reguleringsmuligheter.

Det vil sannsynligvis ta lang tid før retningslinjene blir gjort bindende, i alle fall hvis de skal være strenge. Det at de har blitt utvidet til Antarktis gjør ikke saken enklere. Norge har inntatt en lederrolle i forhandlingene, og det er et mål at standardene skal virke fra 2014. Dersom Norge skal opprettholde et krav om tilstrekkelig strenge standarder, er dette målet ambisiøst.

Det burde være en selvfølge at Norge skal foreta en grundig vurdering av om vi vil være tjent med de begrensningene bindende standarder vil få for norsk regulering av skipsfarten i nordområdene. Norges rolle i forhandlingene gir grunn til frykt for at en slik vurdering ikke vil bli foretatt på et rent faglig grunnlag. Det vil være vanskelig for Norge å si nei til bindende standarder som vi har vært pådrivere for å forhandle fram, nesten uansett hvor svake de blir.

Hvis Norge er villig til å bruke den tiden som må til for å bygge enighet rundt tilstrekkelig strenge standarder, oppstår spørsmålet om hva som skal skje i mellomtiden. Skipsfartsnæringens behov for harmoniserte krav vil også være et argument for at Norge bør søke løsninger som kan fungere på kort sikt. Arktisk råd er uaktuell for å etablere slik enighet.

Et alternativ er å søke bilateral enighet med Russland om hvilke krav som bør stilles til skipsfarten i nordområdene. Norge er i en god posisjon for slike forhandlinger – Norge kan innføre strengere standarder enn de vi har i en del havområder, og vi kan ha som mål at Russland kvitter seg med krav som har liten betydning for sikkerhet og miljø. Så langt har Norge satset på å etablere nye seilingsleder og overvåkningssystemer, dels i samarbeid med Russland. Enigheten om grenselinjen mellom Norge og Russland vil være et godt utgangspunkt for å bygge videre enighet, i tillegg til Barents 2020-samarbeidet. Hvis Norge inntar en "vente og se" holdning der man baserer seg på IMO-retningslinjene i påvente av internasjonal enighet, kan vi risikere at en ulykke får store og varige negative konsekvenser for befolkningens støtte til videre utvikling av næringsliv i nordområdene.