2. The Future of Arctic Marine Operations and Shipping Logistics

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INTRODUCTION

The natural resource exploitation industries in the Arctic are faced with very challenging operational conditions including: a short drilling season, remoteness, extreme cold temperatures most of the year, storms, icing, darkness in winter, changing sea-ice conditions, heavy fog, offshore operations in deep waters, and increased coastal erosion and permafrost thawing in the summer impacting land-based infrastructure (such as roads and buildings) by destabilizing foundations.

Such destabilization of foundations could alone increase the cost of maintaining needed onshore infrastructure by tens to hundreds of billions of dollars in the decades to come for many of the Arctic countries – Russia, Canada and the United States (Alaska).

In addition to operational challenges in the Arctic, significant logistical, technological and infrastructural problems remain to be resolved both to improve accessibility to natural resources and make extraction and transport of hydrocarbons and minerals a safer operation. Extraction of hydrocarbons in offshore areas of the Arctic Ocean with seasonal sea-ice coverage will require ice-class drill ships, icebreakers and new technology for wells and ice management that increase costs to the point where such areas are currently not viable for development. New technologies and proper infrastructure for safety, logistics and export could change this situation. Balancing commercial activity in the region with environmental protection will remain a significant challenge during the years to come.

Similarly, several deficiencies in the current Arctic marine transport infrastructure have been identified that need to be overcome if the Arctic Ocean is to become widely used in the future as a transportation corridor and trade route between markets in Europe or North America and the Far East.

These include improvements to all the main components of a proper

Arctic marine transportation system, including: a) *physical infrastructure* such as adequate ports and terminals with deep-draft access; cargo handling and passenger/crew facilities; and refuge provided for ships, b) *information infrastructure* such as navigational charts with updated hydrographic and shoreline mapping data; aids to navigation and real-time navigation information; marine weather and sea ice forecasts; proper communication systems; and vessel traffic monitoring and reporting systems, c) *response services* such as services of icebreakers for icebreaking and for vessel escort; search and rescue and emergency response; oil spill prevention, preparedness and response; and available response technologies to clean up oil and other hazardous wastes spilled at sea, and d) *Arctic vessels*, namely a fleet of ice-strengthened cargo ships and specialized vessels operating in the harsh Arctic environment, possibly on a year-round basis.

Hydrocarbon and mining industries and support facilities need to operate on a year-round basis in the Arctic, onshore and offshore. The main shipping activity and transit traffic in Arctic waters now takes place during the summer and early fall (July to November). However, we should also consider the possibility in the near future of year-round shipping in Arctic waters.

The task at hand is to develop infrastructure capable of meeting the safety, security and environmental protection needs of present and future Arctic stakeholders and activities. Our logistics solutions should take advantage of the Arctic resource potential and Arctic shipping opportunities, but at the same time provide the needed safety and reliability of operations and adequate pollution prevention to safeguard the fragile Arctic environment.

FIRST STEP IN ADDRESSING LOGISTICAL CHALLENGES: ASSESSMENT STUDY

A detailed assessment of the existing logistics and transportation infrastructure as well as hydrocarbon and mining infrastructure in the Arctic needs to be done. This includes operational conditions and technical challenges in different parts of the Arctic, existing transport and logistics systems, and currently available support facilities and services of Arctic ports, terminals, and airfields. We need to know what is currently there and the conditions of these facilities. This information is needed to identify the state of affairs and is a necessary baseline for designing a new, improved transport and logistics system for the Arctic based on predicted future activities.

Two important prior assessments provided a clear picture and overview of our current deficiencies when it comes to Arctic marine transport infrastructure: the Arctic Council's Arctic Marine Shipping Assessment of 2009 and the Canadian Arctic Shipping Assessment of 2007 done for Transport Canada.

A new report by the U.S. Committee on The Marine Transportation System provides a detailed evaluation of the current state of the U.S. Arctic (Alaska) marine infrastructure and describes in detail the five main components and 16 infrastructure elements of a new preferred Arctic Marine Transportation System. For each of the infrastructure elements (e.g., communication, shoreline mapping, places of refuge for ships, etc.) information is provided on the a) status, challenges and current activities, b) case studies to highlight importance, c) federal actions needed and cooperation with non-federal partners, and d) milestones and timeframes for action.

Another important recent effort is the Arctic Council's Arctic Maritime and Aviation Transportation Infrastructure Initiative (AMATII). AMATII is meant to help decision makers evaluate northern infrastructure – ports, airports and response capabilities – by inventorying maritime and aviation assets in the Arctic. What infrastructure is in place and what is lacking? The effort has as deliverables an Arctic Maritime and Aviation Infrastructure Database and an interactive web-based map of current Arctic infrastructure.

SECOND STEP IN ADDRESSING LOGISTICAL CHALLENGES: MODELING AND VISUALIZATION STUDY

Based on the above studies we already know that we currently lack both adequate marine transportation and resource exploitation infrastructure in the Arctic. But more importantly, the question now becomes: what kind of infrastructure would we like to see put in place in the Arctic in the near future, for example by 2030, to satisfy our safety and environmental requirements?

The initial assessment study described above now needs to be followed by detailed circumpolar Arctic modeling of the needed infrastructure for reliable and safe cargo transport and proposed natural resource extraction along with related support facilities to carry out emergency response and search and rescue activities.

Results should be displayed as interactive GIS maps with effective visualization components, animations and as a series of videos showing the proposed structural and design features of the required physical infrastructure, communication and navigational systems, and response services.

Such detailed graphical visualizations of the whole shipping and natural resource infrastructure system are needed to give all stakeholders a clearer picture of how various components of the logistics chain are tied together and how the whole system should operate and function. Model simulations should be based on various development scenarios and feasibility and sensitivity analyses for different cargo types being shipped, volumes and trade flows, types and sizes of vessels being used, transshipment, seasonal or year-round operations, and other factors.

Full-scale, year-round transit shipping on the Northern Sea Route (NSR), to take a concrete example, requires different physical infrastructure and support services than the current seasonal operation during the five months of summer and early fall, which is taking place in largely ice-free waters. If an Arctic route is only feasible during the current navigation season, will it be economically viable on a large scale to use Arctic ice-class ships in the Baltic during the rest of the year, as currently practiced by the Danish shipping company Nordic Bulk Carriers?

This modeling of a new marine transportation and logistics infrastructure system should be a joint exercise between the industry and the research community (sciences/engineering) based on the safest, the most sensible, cost-effective and environmentally sound solutions – and be circumpolar in nature.

THIRD STEP IN ADDRESSING LOGISTICAL CHALLENGES: COSTS AND FINANCING STUDY

If an agreement is reached on a new marine transportation and logistics system for the whole Arctic, the next step is estimating the costs of the various infrastructure components of the new system and establishing international cooperation and partnerships for putting the required infrastructure in place.

The build-up of new infrastructure will take many years and will be costly. Is there a way to finance long-term, capital-intensive infrastructure? Some kind of funding mechanism needs to be put in place. Maybe, a transnational “Arctic Development Bank” or “Arctic Bank” along the lines of the European Bank for Reconstruction and Development (EBRD), Nordic Investment Bank (NIB) and others. But a mechanism is needed that can finance projects that cross borders within the Arctic. This could open up the possibility of attracting long-term financing such as the sovereign wealth funds (e.g., those in Norway, Europe and Alaska).

All eight Arctic nations and international shipping and natural resource companies need to be involved, as well as other nations and industries that see benefit in better excess to Arctic resources and shorter trade routes between the markets of the Eurasian Arctic, north and west Europe, the east coast of North America, and Asia (China, Japan, and South Korea). Without cost-sharing, the up-front capital costs of establishing proper infrastructure are prohibitive. Joint funding among interested parties and governments should be a viable solution. Infrastructure maintenance could also be partially funded through user fees.

With energy and mineral exploration currently driving increased marine transportation activities in the Arctic, we need to explore greater use of public-private partnerships (PPPs) with energy and mining companies to finance some parts of the needed infrastructure and/or leverage the infrastructure that directly supports these companies’ needs. Also, to make sure that when infrastructure is developed as part of resource extraction projects, all aspects of the new Arctic logistics and transportation system must be considered. Creative approaches to meeting the infrastructure requirements of the private sector will stretch scarce government financial resources and benefit all users of the Arctic logistics and transportation system.

What are some of the key issues to consider for Arctic routes to develop into predictable and commercially viable trade routes that attract large volumes on a recurring basis between markets in Europe, North America and the Far East? The main determinants will always be the availability of cargo, transport safety and reliability, and competitive cost levels compared to other more southerly routes (Suez, Cape and Panama). Some of these factors are discussed below with particular reference to future development of the NSR.

SIGNIFICANCE OF SEA-ICE REDUCTION FOR FUTURE ARCTIC NAVIGATION

The summer ice extent has declined by 40% since satellite observation began in 1979, and over the same period sea ice has thinned considerably, experiencing a decline in volume of 70%. The last six years, 2007-2012, have produced the six lowest sea ice minima since 1979. The 2012 September sea ice minimum was 49% below the average of 1979-2000 and 18% below the previous minimum in 2007. Over only seven years, 2005-2012, multiyear ice experienced a reduction of 50%.

Studies differ widely in their predictions of when summer sea ice (and remaining multiyear ice) will melt completely in the Arctic Ocean – perhaps before the mid-century or possibly before 2030. The sea ice is likely to collect and persist longest along the northern flanks of the Canadian Archipelago and Greenland, while the central and eastern part of the Arctic will see the most significant decline of ice, further promoting shipping on the NSR and along a possible new Transpolar Passage. Some year-to-year variability of sea ice in some coastal seas and straits will likely continue to remain a challenge, at least in the beginning and end of the summer navigational season.

The summer navigational season on the NSR is now five months, from July to November. For the last two years, in late August and the whole of September and October, the NSR has been nearly or completely free of sea ice, so transiting ships such as the 162,000 dwt Suezmax tanker "Vladimir Tikhonov" could keep the same speed as in open waters – an average of 14 knots – and transit the NSR in only eight days. In November the Laptev Sea and the East Siberian Sea are covered with new ice up to 30 cm thick that allows for safe passage of vessels supported by an icebreaker.

Diminishing sea ice and rapid melting of multiyear ice will further promote shipping activity in the Arctic. In fact, all NSR seaways are currently located in the area of one-year ice. In the Arctic, one-year ice grows up to 1.6 m in thickness. With less or no sea ice, the predictability and punctuality of NSR voyages will increase, both of which are important to global shipping operations. This will increase the attractiveness of the NSR as an optional trade route in the future, even for liner services (container shipping). Lack of schedule reliability and variable transit times have been noted as major obstacles to the development of Arctic shipping.

The Arctic Ocean will always refreeze during late autumn and sea ice cover will be present in the winter and spring, presenting a challenge to future traffic. But this would be relatively thin seasonal ice and navigable by high ice-class carriers and icebreakers. Arktika-class Russian icebreakers can open up water passages through ice that is 2.3 m thick. This fact opens up the possibility of year-round operations on the NSR if proper support infrastructure is put in place.

ENERGY AND MINERAL RESOURCE DEVELOPMENT IN THE ARCTIC

The U.S. Geological Survey (USGS) forecast in 2008 that almost one quarter of the undiscovered, technically recoverable hydrocarbons in the world are located north of the Arctic Circle. This amounts to 90 billion barrels of oil, 1,670 trillion cubic feet of natural gas and 44 billion barrels of natural gas liquids in 25 geologically defined areas thought to have potential for petroleum. According to the USGS, the Arctic accounts for around 13% of the undiscovered oil, 30% of the undiscovered natural gas, and 20% of the undiscovered natural gas liquids in the world.

A substantial part of this hydrocarbon resource potential lies in the Eurasian Arctic – in northwest Russia and offshore in the Barents and Kara seas – at the gateway of the NSR. In addition, an abundance of iron ore and other mineral resources are located in Northern Scandinavia and on the Kola Peninsula in Russia.

Current and future development of this resource base is the main driver for increased Arctic shipping in the coming decades, bringing Arctic natural resources to markets in the Far East via the NSR. This is also the main driver for the urgent need to build up the proper logistics and marine transport infrastructure with the goal of taking full advantage of this resource potential without harmful effects to the fragile Arctic environment.

THE FREIGHT MARKET, PRICE DIFFERENCES, AND TIME SENSITIVITY OF MARKETS AND CARGO

The main factor influencing the short-term usage of the NSR as a trade route is the inherently unpredictable freight market. This is even more difficult to assess because of fluctuations within the different shipping segments. The main factor is the economic savings achieved by using the NSR relative to traditional routes. Other important factors are price differences of products in Asian and Western markets, the delivery time sensitivity of various cargoes, and the repositioning cost of the vessels.

Overall, high commodity prices and in particular high demand and prices in the Far East are the current drivers of cargo transport along the NSR eastward. Transport of Arctic hydrocarbons and mineral ores from the resource-rich Barents region and Northwest Russia to Asian markets along the much shorter NSR is considered an alternative shipping route with potential savings too large to ignore. Today, as in the near future, we will primarily see dry bulk carriers and tankers transiting the NSR carrying Arctic resource materials to destinations outside the Arctic.

But a prerequisite for increased growth of transit shipping on the NSR is the availability of cargo transport in both east and west directions. Therefore, for further development, a new cargo base needs to be identified for shipment westward along the NSR. This will enable more effective use of Arctic vessels by reducing or even eliminating the costs of in-ballast transits and will thereby significantly increase the overall cost-effectiveness of each vessel's operation.

Global shipping operations are dependent on three key factors: predictability, punctuality and economy of scale, all of which are currently limited in Arctic shipping.

Container ships operate on regular schedules and follow set routes, calling at a number of ports to load and unload cargo. Profitability can only be achieved with large-scale shipping based on stable and predictable year-round operations. The ability to schedule voyages a long time in advance and to guarantee uninterrupted services is considered key for container ship operators.

Full-scale container shipping on the NSR as part of world trade is therefore problematic, as the above conditions cannot be easily met even during the current navigational season. Container shipping occurs on a just-in-time-schedule in order to reduce costs associated with warehousing and storage. During the summer navigational season on the NSR such accurate time scheduling could become a reality in the years to come. Though the NSR will in the future become increasingly ice-free during this season, still, large-scale container transport between the Far East and Europe requires year-round operation. For the NSR this means unpredictable navigational conditions due to the presence of seasonal sea ice covering the whole Arctic

Ocean during more than half of the year in winter and spring.

Dry bulk carriers and tankers, on the other hand, follow less predictable schedules and their routes depend more on changing supply and demand of less time-sensitive items. Bulk metal ores and concentrates can be stockpiled at the mine or destination port, and oil in large storage tanks. Such raw materials could then be shipped along the NSR if spot charters could be arranged on an opportunistic basis.

TIME AND COST SAVINGS BY USING THE NSR VS. THE SUEZ ROUTE

Shipping of ores and hydrocarbons from Murmansk through the NSR shaves 19 days off transport times to Kobe (Japan), 18.5 days to Busan (South Korea), and 16 days to Ningbo (China) compared to the Suez route, providing the average sailing speed is the same on both routes. By using the shorter NSR between Northern Europe and Asia one saves about 40% of travel time and subsequent fuel and freight shipping costs. The reduced number of days at sea allows a ship to make more return trips, resulting in increased revenue and potentially greater profits.

Cost savings can be achieved by simply burning less fuel because of a reduced number of days at sea, or through more energy-efficient slow steaming, or a combination of both. A vessel on slow steaming between China and Kirkenes/Murmansk can reduce its speed by 40% and still arrive at the same time as a ship sailing at full speed traveling the Suez route. Such slow steaming can double a vessel's energy efficiency performance and result in a significant reduction of greenhouse gas emissions. This could become important if future emissions control measures were to include global maritime transport. Reduction of emissions could thus also result in significant cost savings.

Shorter sailing distances allow for considerable fuel cost savings. As an example, a Panamax bulk carrier (about 75,000 dwt) sailing from Kirkenes in north Norway to Shanghai in China burns about 30 metric tons of heavy fuel oil per day at a cost of USD $650/ton. The travel time saved on the NSR compared to Suez one way is 21 days, hence 42 days saved on a round trip, or 1,260 metric tons of burned oil, which is a savings of about USD $820,000. Future price increases in bunker fuel will make the NSR even more competitive compared to the Suez.

Overall cost savings depend on the type of cargo being transported. A shorter shipping route for an expensive LNG tanker can add up to substantial savings. For an LNG tanker with a time-charter rate of USD $120,000 per day going from Statoil's LNG Melkøya Plant near Hammerfest in north Norway to Yokohama in Japan and back the same way in ballast, savings in time-charter alone can add up to USD $5 million. Total savings on a round trip can reach USD $6.8 million compared to the Suez. Russia's Yamal LNG is additional eight days (roundtrip) better positioned within the NSR than the Suez route, representing even more cost savings.

Other cost elements to consider are insurance and the NSR's transit tariffs vs. Suez Canal fees. Marine insurance costs on the NSR are currently higher than on the Suez route but are by no means prohibitive. These costs are expected to go down in line with increased traffic and transport volumes on the NSR, if no major accidents occur. Russian authorities are actively investigating ways to reduce perceived risks to shipping. Future insurance fees also need to consider the changing sea ice conditions, route optimization and more advanced sea ice reconnaissance. In general, as the proper marine infrastructure is put in place on the NSR, insurance costs will subsequently go down. At this time, there seems to be no solution to the piracy threat on the Suez route, leading to increased costs of insurance and protection, and increased risk of non-delivery of cargo.

The official NSR tariffs from June 7, 2011, are much higher than the listed Suez Canal fees, but it is stated clearly that these are maximum rates subject to negotiations between FUSC Atomflot in Murmansk (now the new NSR Administration in Moscow) and the ship owner/operator. At least some of these past negotiations led to agreed rates that were equal to the Suez Canal fees or approximately USD $5 per ton.

The new Russian federal law on navigation on the NSR being implemented for the first time during the 2013 navigational season states that the tariff rates on the NSR will depend on the tonnage of the vessel, ice-class of the vessel, distance of needed icebreaker guidance, and the time period of navigation. Previously, discounts were given based on the total volume being transported within a season (in excess of 200,000 tons) and for in-ballast return legs connected to loaded legs. Clearly, for the NSR to be competitive to the Suez route, the NSR tariffs need to be commercially reasonable.

REDUCED GREENHOUSE GAS EMISSIONS ON THE NSR

Shorter transit routes in the Arctic imply lower stack emissions into the lower atmosphere on a global scale. For the case presented above for a Panamax bulk carrier transiting the NSR from Kirkenes to Shanghai and burning 1,260 metric tons less heavy fuel oil compared to the Suez, savings in CO_2 emissions for a round trip are close to 4,000 tons. Additional savings in NOx and SOx emissions are 130 tons and 90 tons, respectively. As stated in the AMSA study, the presence of sea ice in the Arctic may require higher propulsion levels and ultimately similar or greater emissions during voyages compared with southerly routes. But this would only come into play during the winter and spring seasons if the NSR opened up for transit traffic on a year-round basis.

AVAILABILITY OF ICE-CLASS SHIPS IN DIFFERENT SEGMENTS AND SIZES

The numbers of vessels with an adequate ice class (1A or Arc 4) represent a limitation on the utilization of the NSR during the short navigational season. The availability of such vessels varies greatly between different segments and sizes.

The new Rules of Navigation in the NSR Water Area approved by the Ministry of Transport of the Russian Federation on January 17, 2013 allow vessels with lower ice classes (Ice1, Ice2, and Ice3) and even vessels without ice reinforcement to operate along the NSR in the period from July to October if ice conditions are favorable according to official information from Roshydromet, and without icebreaker assistance (and tariff payments) if sailing takes place in essentially open waters. The new navigational rules will further promote the use of the NSR and open up the possibility for less ice-strengthened vessels to use the route when sea ice conditions are favorable.

Still, there is a serious lack of ice-class vessels (Arc 4) in the dry bulk sector. Today only several ice-class Handymax and Panamax vessels can be involved in cargo transport on the NSR, while larger Capesize vessels are not available at all. This is the reason dry bulk transportation is still limited on the NSR, despite significant cost savings due to the shorter travel distance, time and reduced fuel consumption. This makes the NSR vulnerable to competition from much larger dry bulk vessels going via the Suez or Cape (economy of scale). Because of the depressed market for Capesize bulk vessels, it has been cheaper to transport iron ore from Kirkenes to China via the Cape instead of using Panamax vessels via the much shorter NSR.

Few LNG tankers with proper ice class have been delivered, but some are on order. Recent high demand in the Far East for LNG and positive prospects for increased natural gas development in the Russian Arctic (e.g., Yamal) are the drivers.

There seems to be a sufficient number of oil tankers with proper ice class to service oil production in the Russian Arctic today. Tankers that operate in the Baltic during the winter and early spring could be used on the NSR during summer-autumn navigation.

Also available are specialized ice-class vessels transporting project cargoes. But for these kinds of vessels, which call on Arctic ports, issues like draft and crane capacity are equally important. Oversized project cargoes and modules represent high values and are often critical to project schedules and could in the future be transported by high ice-class barges.

From the above it is clear that large-scale global investment is needed for the construction of a fleet of large, powerful ice-class cargo ships. The question is whether these ships will be icebreaking carriers in their own right and capable of independent ice operations or will require icebreaker support.

THE IMPORTANCE OF ARCTIC ICEBREAKERS

Icebreakers are essential in the Arctic today. Russian icebreakers servicing the NSR not only provide ice pilotage and icebreaking services for vessels but also act as important floating support units or infrastructure to ensure safety of navigation and provide various support to vessel operations as needed. This is important because of limited land-based infrastructure. These services include providing emergency and rescue services if needed, towing of vessels through ice-covered or ice-free waters and salvage support. Subsequently, the risk to the vessel and the corresponding financial risk to owners and insurers are substantially reduced.

With anticipated increased ship traffic on the NSR, these icebreaker services become even more critical. The Russian icebreaking fleet now consists of five powerful nuclear-powered vessels (in addition to a number of diesel-electric powered ones) which will be gradually decommissioned over the coming 20 years. The renewal process has already started; the construction of the first of three planned nuclear icebreakers of the LK-60 type started in the beginning of 2013 to be delivered at the end of 2017. This icebreaker will be a dual-draft type with the ability to work at a variable draught from 8.5 to 10.5 m, which will permit piloting vessels along the whole NSR, including the estuaries of the Ob and Yenisei Rivers. This will be the world's most powerful icebreaker, with propulsive power of 60 MW, able to break solid sea ice with a thickness of 2.8 m at a speed of 2 knots. The width of the icebreaker will be 34 m, which will allow large Aframax vessels to safely follow the icebreaker through the opened water passage.

The three planned LK-60 nuclear icebreakers are an important investment in future infrastructure development on the NSR, as they provide much-needed navigational support for intra-Arctic winter navigation, including possible commercial destination Arctic and trans-Arctic shipping in the winter. In other words, such powerful icebreakers could collectively keep the NSR open to commercial shipping on a year-round basis, provided other needed infrastructure is in place, and support convoys similar to those in the Baltic Sea during late winter and early spring.

The Russian icebreaking fleet is by far the largest and most powerful. In additon to the three planned LK-60 icebreakers, Russia plans to build new diesel-powered icebreakers, including the largest of them all, a 25 MW diesel icebreaker at the Baltiisky Yard in St. Petersburg for delivery at the end of 2015, designed for operations in Arctic waters. But as AMSA concludes, the world's icebreaker fleets are aging and will require significant investment during the coming years to maintain their effectiveness and capabilities. The average age of these icebreakers is now about 30 years.

INACCESSIBILITY AND POOR CONDITIONS OF EXISTING ARCTIC PORTS

Adequte port infrastructure and support facilities for commercial shipping such as deep water access, places of refuge, marine salvage, port reception facilities for ship-generated waste, and towing services are rarely available in the Arctic.

In recent years, however, Russian Arctic ports in the Barents Sea area, including the deep-water port of Murmansk, have expanded significantly and are providing increased services due to increased ore, coal and oil production and transport. Some other ports in satisfactory condition are located in the Kara Sea, including the port of Dudinka on the Yenisei River, but ports further east – on the shores of the Laptev, the East Siberian, Chukchi, and Bering seas – are in very poor condition and only support the basic needs of local settlements.

Even if Russian Arctic ports did provide better services and facilities, draft limitations make these ports and harbors inaccessible for larger cargo ships sailing on the NSR. These ships cannot sail into these ports for services, to load or unload cargo, or in case of trouble as they would run aground because the harbors are too shallow. This fact should be a reminder that future support facilities for cargo ships and the extraction industries need to include floating units, far removed from the shallow Arctic coastline. Loose infrastructure and mobile assets (vessels that move within the Arctic) need to be considered. Such floating support units give added flexibility since they can be relocated if needed. A floating LNG plant was even considered as one option for gas from Yamal to provide tankers with deep-water access to the plant.

IMPORTANCE OF TRANSSHIPMENT HUBS FOR THE NSR

A future increase in destination Arctic shipping and transit shipping on a year-round basis will require the establishment of transshipment hubs on either side of the NSR in order to fully utilize specialized Arctic vessels in the most economically efficient way, provide storage, and serve industrial purposes.

Shipping activity during the Arctic winter and spring will require a fleet of high ice-class cargo ships and support vessels that are able, with assistance from powerful icebreakers, to plough through winter seasonal ice in large convoys led by icebreakers at an acceptable speed. Because their design features are used to break through thick winter seasonal ice, these cargo ships or "Arctic shuttles" should not sail for long distances in ice-free waters and should deliver their cargo between ice-free transshipment hubs located on the west and east gateways to the NSR. Then, feeder ships that are notice-strengthened can take the cargo from the transshipment hubs and deliver it to the final destination. The same feeder ships will also deliver cargo to the hubs for transport along the NSR by the Arctic shuttles between markets in Europe and the Far East.

These specialized Arctic shuttles would be fully and solely employed on Arctic voyages. As pointed out in the AMSA study, the addition of transshipment hubs in the northern latitudes could add a new dimension to global trade routes and might add options for select cargoes to be carried from the Pacific to European ports.

One hub could be located in ice-free waters in the Barents Sea – perhaps in the Murmansk-Kirkenes area; the other would need to be located in ice-free waters past the Bering Strait in the North Pacific Ocean, perhaps in the Aleutian Islands.

The location of a Murmansk-Kirkenes hub is quite strategic, as this area is nine days sailing from both the North Pacific (Bering Strait) and the Mediterranean (Gibraltar), and close to major oil and gas deposits in the Barents Sea, as well as to ore mines in northern Sweden and Finland. A suitable location for the eastern hub in the U.S. Aleutian Islands could be Dutch Harbor or Adak. A location favored by the Russians is the port of Petropavlovsk on the coast of Kamchatka.

NAVIGATION AND COMMUNICATION

Improved Arctic charting and greatly enhanced Arctic marine observations are vital to current and future Arctic marine operations. Only an estimated 6-7% of the Arctic marine environment is charted to international navigation standards. This means that the Arctic needs extensive hydrographic surveying, in particular the coastal areas. Also needed is better real-time information concerning the operational environment. This includes ice charts, satellite images of ice-infested waters, text messages describing ice conditions, and accurate marine weather information such as forecasts for sea ice distribution, wave height, wind direction and speed, visability, temperature and superstructure icing. There are also communication difficulties in the high Arctic. Subsequently, improved voice and transmission coverage is needed.

Though conditions are better along the NSR than elsewhere in the Arctic, major improvements are still needed in support of navigation as well as better communication in light of increasing destinational and trans-

Arctic traffic on the NSR.

As mentioned earlier, Russian icebreakers play a major role here. The tariffs for icebreaker guidance on the NSR guarantee the best available navigational information, knowledge and safety of passage from experienced icebreaker captains. If senior navigating officers of international vessels do not have sufficient experience steering a vessel in Arctic conditions, it becomes obligatory by Russian navigation rules to have on board Russian ice pilots. The experience of steering vessels through the NSR has shown that ice pilots (ice navigators) not only are important in providing advice to the captain of the vessel in ice maneuvering, but also in communication with the icebreaker, interpretation of navigational charts and manuals (most of which are in Russian), and on safe speed and distance when following the icebreaker.

The organizations that provide icebreaker services (FUSE Atomflot and Far Eastern Shipping Company Ltd) form a convoy of transiting vessels guided by one or two icebreakers. Radio communication (16-channel VHF) between the icebreaker and the ships in the convoy is established, and the ships need to act in accordance with the icebreaker's instructions and report directly to the icebreaker captain. The arrangement of vessels in the convoy is determined by the icebreaker, including the allowed speed and distance to the vessel ahead.

LIMITED SAR AND OIL SPILL RESPONSE CAPABILITIES

The current search and rescue (SAR) infrastructure in the Arctic is limited. SAR is particularly challenging in the Arctic due to the remoteness and long distances that are involved in responding to emergencies, as well as cold temperatures and sea ice conditions. There is also a lack of adequate shore side infrastructure and communications to support and sustain a SAR response of any significant magnitude. The potential number of people needed to be rescued from, for example, a cruise/passenger ship far exceeds the capacity of SAR response in the Arctic. This includes lack of sufficient food, lodging and medical facilities.

The Arctic Council's 2011 agreement on developing a joint SAR framework for the eight Arctic states is important. In it, all Arctic states commit to coordinated assistance to those in distress and to cooperate with each other in SAR operations. The Arctic states agreed upon their respective areas of SAR responsibility and on promoting the establishment, operation and maintenance of an adequate and effective SAR capability within their areas of responsibility.

The accidental release of oil into the Arctic marine environment is the most significant threat from offshore oil exploitation and Arctic shipping. Oil spills in ice are more complicated to address than spills in open waters,and oil spilled in ice-covered waters can collect onto the ice, in open pools between ice floes, underthe ice, and drift with ice flows. All available oil spill response methods must be available and considered for each situtation (e.g., mechancial recovery, chemical dispersion, in-situ burning, biological degregation).

As a precaution against future threats of oil spills in Arctic waters, the Arctic Council agreed on another legally binding agreement in May 2013 on oil pollution preparedness and response. The new agreement provides for assistance between the Arctic states in response to oil pollution incidents in the Arctic that are beyond the capacity of a single state to respond to effectively. Such assistance includes provision of human resources, know-how, equipment and technology. The agreement also outlines other actions that are essential to spill response, such as maintaining national spill response systems, notifying other states of spills that may affect their marine areas, conducting monitoring activities to identify spills, and undertaking joint exercises and training. Prior to this, Norway and Russia had a bilateral oil spill response agreement for theBarents Sea and Russia and the U.S. for the Chukchi Sea.

To address the urgent need for improved SAR and oil spill response along the NSR, Russian authorities started designing new Marine Rescue Coordination Centers in 2011 that are also equipped with oil spill response equipment, with the aim that their construction would be complete by 2015. The main centers are in the ports of Murmansk and Dikson, with sub-centers in the ports of Tiksi, Pevek and Provideniya. Additional SAR units are based at the Archangelsk and Naryan-Mar airports. As before, Russian icebreakers will continue to act as "floating" SAR and oil spill response units on the NSR, accompanied in the near future by six new multifunctional rescue vessels of ice-class Arc5.

As pointed out by Tschudi, the develpment of economic activity in the Arctic region might be the best means to improve response capacity in general and emergency preparedness in particular. The more vessels in the area, such as ice-class offshore support vessels equipped with oil recovery equipment and other emergency features, the sooner assistance will be rendered in case of an emergency.

THE SIGNIFICANCE OF THE IMO POLAR CODE FOR ARCTIC SHIPPING

The International Maritime Organization (IMO), in an attempt to facilitate safer, more secure, and more reliable navigation in polar regions, approved purely voluntary guidelines in 2009 for vessels operating in Arctic and Antarctic ice-covered waters. Driven by increased vessel traffic in the Arctic, a new mandatory IMO Polar Code is currently in development with a target date for completion of 2014. The code will cover both poles and be used to guide polar states in developing legislation on the safety of ships in ice and polar navigation, training of seafarers, requirements for ship construction and polar classification as well as mandatory environmental standards for shipping.

The key environmental risks the IMO Polar Code should address are: a) use of heavy fuel oil, b) black carbon and other emissions, c) ballast water, d) routing measures and speed reductions, e) particularly sensitive areas and places of refuge, f) emergency response, and g) discharge of garbage and pollutants.

When the Polar Code is finalized and approved by IMO member states, its various measures are expected to take legal effect through amendments to existing IMO instruments, such as the Safety of Life at Sea Convention (SOLAS), the international Convention for the Prevention of Pollution from Ships (MARPOL), and others.

Clearly, Arctic marine safety and environmental protection will be greatly enhanced with the adoption and full implementation of a mandatory IMO Polar Code. But defining the risks for various classes of ships in ice-covered and ice-free polar waters has been a challenging process for the IMO's committees. Inclusion of additional environmental protection measures to those already provided under various IMO instruments has also proved to be difficult.

Environmental organizations are lobbying for the Code to include sections on oil spill response plans and black carbon emissions in the Arctic. Commercial shippers have expressed worries that if regulations are imposed that are too strict or costly, such as a full-scale ban on lower-cost heavy fuel oil (HFO) in the Arctic while more southerly routes can continue to use it, the NSR will be made uncompetitive from the start. Norway has already banned the use of HFO for the east coast of Svalbard. Shippers also ask: at what level will black carbon and other air emissions start to pose a threat to the Arctic environment? They point out that ship traffic on the NSR will always be just a small fraction of the current traffic on the Suez, Panama, and Cape routes. Will strict pollution prevention technologies be required on the NSR and even zero air emissions enforced?

With increased resource development and new shipping opportunities in the Arctic, new environmental challenges will emerge. But what are the true environmental risks in the Arctic from predicted future shipping activity, and what do we need to include in the IMO Polar Code and other instruments to manage these risks effectively? According to Tschudi, to address these new environmental challenges in the Arctic a holistic approach is needed in which environmental and safety concerns and the need for economic development are all included and integrated in a balanced way.

NEW INDUSTRIAL FRONTIER AND ARCTIC SHIPPING

During the next decade, according to a recent Lloyd's risk report, as much as USD $100 billion of investment will take place in the Arctic, mostly in offshore oil and gas. The Russian Arctic is likely to see most of this activity – in the Barents, White, Pechora, and Kara Seas – promoting commercial shipping activity along the NSR to bring these raw materials to resource-hungry markets in the Far East.

It is also likely that increased shipping activity will take place east of the Urals, where most of the Russian onshore oil activity is located together with several mines and heavy industries. Here the large Russian rivers, which all flow north into the Arctic Ocean, act as major transport connections to the NSR, essentially unlocking the large resource potential of Siberia. Siberian rivers also offer logistical possibilities for regional and destinational transportation from the NSR into the inner part of Siberia, promoting further development.

The abundance of energy and mineral/ore resources in the Eurasian Arctic within the same geographical locations – where gas meets ore – opens up the possibility of value-adding industrial processing in situ before shipment via the NSR. Subsequently, these new sources of industrial raw materials and energy not only offer closer sources of supplies but also the opportunity to develop a new industrial frontier in the Eurasian Arctic.

DESTINATION ARCTIC TRANSPORT ON THE NSR

Destination transport will be the most relevant activity on the NSR in the short to medium term. This includes transport of resource materials between ports inside and outside of the region, such as oil, gas condensate, LNG, coal, and minerals/ores by specialized ice-class shuttle carriers such as oil tankers, LNG carriers, and dry bulkers as well as purpose-built offshore vessels and multipurpose vessels for transport of equipment. This is in addition to NSR traffic supplying Siberian communities with goods and trade during the ice-free season.

Recent examples of such new Arctic shuttles include icebreaking and multipurpose general-cargo vessels serving Norilsk Nickel's industrial activity in Siberia on a year-round basis, and Sovcomflot's 70,000 dwt double-acting ice-breaking crude oil tankers.

It has recently been estimated that the total volume of all types of cargo transported on the NSR could reach 100 million tons annually by 2020 (including transits) and perhaps reach 150 million tons by 2030.

TRANSITS ON THE NSR

The NSR shortens the distance between the North Atlantic and the North Pacific by about 40% depending on the location of loading and discharging ports. International commercial shipping on the NSR started in 2010 (though the route was officially opened in July 1991), and the number of transits and volume amounts has steadily increased since then.

There were 46 transits on the NSR during the 2012 navigational season, up from 34 in 2011 and four in 2010. The cargo volume grew from 111,000 tons in 2010 to 820,000 tons in 2011, and reached 1.26 million tons in 2012. During the 2012 season, a total of 26 tankers transited the NSR with hydrocarbons (895,000 tons) and six dry bulk carriers with iron ore and coal (360,000 tons).

In 2012, the main loading port to the west of the NSR for both cargo types was Murmansk, in addition to Archangelsk for a few of the smaller tankers and Hammerfest in Norway for the trial run of the first loaded LNG tanker on the NSR, "Ob River," transporting 66,342 tons of LNG to Tobata (Japan). So in reality, most of the current transits on the NSR are transporting resources within the Eurasian Arctic eastbound to markets in the Far East, and are therefore destinational in character, as described above, though the loading ports in these cases lie outside the Russian-defined boundary for the NSR – Novaja Zemlya in the west to the Bering Strait in the east.

Few transits on the NSR with cargo now take place between loading and destination ports that are both located outside the Arctic, but some examples in 2012 include the tankers "Stena Poseidon," "Marika," and "Palva," all of which departed from Yosu in South Korea going to Porvoo in Finland, with 66,400, 66,550, and 66,280 tons of jet fuel, respectively. Another example of a shipment between markets in 2012 was the NSR transit of the dry bulk carrier "Nordic Odyssey" with 71,790 tons of coal, which went from Vancouver (Canada) to Hamburg (Germany).

Examples in 2013 include the tankers "Propontis" transporting 109,090 tons of diesel from Ulsan (South Korea) to Rotterdam, "Mari Ugland" with 62,115 tons of naphtha from Zeeland (Holland) to Mailiao (Taiwan), "Zaliv Amurskiy" with 96,131 tons of diesel from Onsan (South Korea) to Rotterdam, "Nordic Bothnia" with 41,573 tons of general cargo from Xingang (China) to Amsterdam, "Viktor Bakaev" with 88,024 tons of jet fuel from Yosu to Rotterdam, and "Nordic Odyssey" transporting 73,500 tons of coal from Vancouver to Pori (Finland).

During the 2013 navigational season a total of 71 transits took place with cargo volume reaching 1.35 million tons: 911,867 tons of liquid cargo (31 vessels), 276,939 tons of bulk cargo (4 vessels), 66,868 tons of LNG (one vessel, "Arctic Aurora" sailing from Hammerfest to Futtsu in Japan), and 100,223 tons of general cargo (13 vessels). Vessels in ballast or repositioning were 22 in total, including the LNG tanker Arctic Aurora departing from Vladivostok and sailing to Hammerfest.

Some sources estimate that the transit volume might reach 50 million tons by 2020. This may be a very optimistic figure, but the NSR opens up an interesting market for Arctic LNG, as Asia's appetite for gas has increased after the Fukushima nuclear disaster in Japan in 2011, and as the prices there are significantly higher than in Europe. As mentioned earlier, each large LNG tanker sailing the NSR can save close to USD $7 million on a round trip compared with vessels going through the Suez. But future pipelines across Eurasia and additional pipelines to central Europe appear to be strong competitors with the oil and LNG carriers sailing eastbound along the NSR.

It is clear that in the short to medium term, the NSR will not revolutionize world trade or be serious competition for the Suez route, which has close to 18,000 ships passing through the Suez Canal each year. But Russia is actively working to capitalize on changing conditions in the Arctic and wants to transform the NSR into a commercial shipping route of global importance, capable of competing with more traditional routes in price, safety and quality.

China, the world's biggest exporter, with 90% of its trade carried by sea, is looking at gaining more economic advantages from the opening of the new Arctic trade routes between China and Europe and facilitating stronger commercial ties with Russia. China is clearly eager to diversify its supply and trade routes, save on shipping costs, and reduce its reliance on the piracy-infested Suez route. One way that China seeks to reduce the carbon intensity of its economy is by increasing the amount of gas in its energy mix, so cooperating with Russia to secure access to Arctic gas resources is a high priority.

The first NSR transit voyage by a Chinese shipping company took place during the 2013 season with Cosco's container vessel "Yong Sheng" transporting 16,740 tons of general cargo (mainly steel and machinery) from Busan to Rotterdam.

CONCLUSION

For the NSR to become an important trade route, large-scale investments are needed in a new NSR marine transportation and logistics infrastructure.

With further development of the NSR the route could become an important transport option for certain cargo types and provide new and additional capacity for a growing transportation volume. The current limited seasonal window for trans-Arctic voyages, however, will be a limitation to the NSR's development and economic viability. Future year-round operation on the NSR will therefore be a prerequisite for the route's full integration into the world's transportation system.

The global maritime industry will decide if and when the potentially shorter Arctic routes are safe, efficient, reliable and economically viable in comparison with other routes across the world's oceans. The marine insurance industry and ship classification societies will have a significant influence in these route determinations, as will a host of other stakeholders and actors, including investors and shipbuilders.

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