Safety & Sustainability of Shipping and Offshore Activities in the Arctic

The Institute of Marine Engineering, Science and Technology: A ROUND TABLE REPORT
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## WHAT IS IMarEST DOING NEXT?

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## ABBREVIATIONS AND REFERENCES

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## LIST OF PARTICIPANTS

3. LIST OF PARTICIPANTS

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# ACKNOWLEDGEMENTS

This report has been prepared by the IMarEST Technical and Policy Team with the assistance of the Chair of the IMarEST Arctic Special Interest Group and the support of the IMarEST Technical Leadership Board.

In producing this report, we have been greatly assisted by many individuals and organisations who contributed to our survey and round table discussion. The individuals and organisations that responded to the survey provided a valuable insight into current thoughts on Arctic risk and resilience. The thought-leaders who attended the round table added much to this, sharing their own practical experiences and recommendations on the safety and sustainability of shipping and offshore activities in the Arctic. We are grateful to all who have supported us with their ideas and expertise.
Global warming is particularly evident in the Arctic. The steady reduction of the Arctic sea ice in recent years is documented, with the Intergovernmental Panel on Climate Change (IPCC) reporting that Arctic sea-ice extent has decreased by 2.9% per decade over the 1978-1996 period; sea ice has thinned, and there are now more melt days per summer. There is broad consensus that this warming trend will continue and that the Arctic may eventually become ice-free during the summer. Aside from the environmental effects of such a warming, other consequences are the augmented possibility of the opening up of the Northern Sea Route (NSR) for high volume commercial traffic, a likelihood of increased offshore activities as well as a higher volume of tourist activities. Any increase in commercial activity is likely to bring with it associated risks to the environment, to assets, and to people – and these are likely to be complex and interacting risks.

The IMarEST is uniquely placed to address some of these challenges through its combination of global expertise in marine engineering, science and technology from both academia and industry, and through its participation in national and international regulatory bodies.

IMarEST has initiated discussions about Arctic change among its membership with key stakeholders, convening a round table event in September 2015. The aim of the round table was to discuss key questions about the emerging risks, how those risks can be assessed and planned for, how they can be mitigated, whether policy and regulation are fit for purpose, and how Arctic activities and their effects can be monitored.

A survey conducted in advance of the round table explored the key Arctic risks, and formed the basis of the discussions.

This document is the report of this meeting and of the survey findings. It should be noted that the views described in this report may not represent a consensus view of the attendees of the round table nor of the IMarEST membership as a whole.

Following the round table, IMarEST has established a Special Interest Group (SIG) to examine a range of issues related to the Arctic and to support knowledge and data sharing among the key stakeholders. The main objective of the SIG is to ensure Arctic risks are better assessed and therefore prevented and mitigated. The Arctic SIG will contribute towards the international effort to tackle some of the challenges outlined but not limited in this report.
I. THE ARCTIC – AN OVERVIEW

The Arctic is most broadly described as the region lying north of the Arctic Circle, at 66° 30’ N. Other ways of defining the Arctic include:

- The climatic area defined by the 10°C July isotherm
- The geographic area which is the limit of Polar Night and Midnight Sun
- The ecological area lying north of the treelines of North America and Eurasia
- The geopolitical area formed by the northern territories of the eight circumpolar states
- The sociocultural area consisting of the traditional lands of the Indigenous Peoples of the Arctic.

These ‘multiple Arctics’ have implications for maritime operations in the region, because they reflect different information and policy contexts. These different contexts – and in some cases the conflicts and gaps between them – can create challenging conditions for otherwise routine technical and operational issues.

The climate of the Arctic is characterized by cold winters and cool summers. Precipitation mostly comes in the form of snow. The Arctic’s annual precipitation is low, with most of the area receiving less than 50 cm (20 in). High winds often stir up snow, creating the illusion of continuous snowfall. Average winter temperatures can be as low as −40 °C (−40 °F); the coldest recorded temperature is −68 °C (−90 °F). Coastal Arctic climates are moderated by oceanic influences, having generally higher temperatures and heavier snowfalls than the colder and drier interior areas.

For maritime activity, the combination of freezing cold conditions and turbulent weather means the Arctic is one of the most physically hostile marine environments.

The Arctic is often described as the ‘barometer of climate change’ as it is the region of the planet where climate is warming most rapidly, and the effects of warming are most visible.

THE ARCTIC OCEAN

Most of the Arctic region is taken up by the Arctic Ocean, a largely enclosed sea covering an area of about 14 million km². The six circumpolar coastal nations are Canada, Greenland, Iceland, Norway, Russia and the United States of America.

Frozen seawater covers large areas of the Arctic Ocean. This sea ice forms, grows and melts in the ocean (unlike icebergs calved from glaciers on land), and is a defining physical characteristic of the Arctic. The US National Snow and Ice Data Centre (NSIDC), one of the most important international environmental information centres, describes sea ice according to the area it covers, its thickness, its age, and its movement with the winds and ocean currents.
Sea ice keeps the region cool, as its bright surface reflects 80% of incoming sunlight back to space. As sea ice melts during the summer period or during periods of warmth, seawater is exposed. Rather than reflecting light, the dark ocean surface absorbs 90% of the sunlight, warming the water, melting the ice more rapidly, and causing regional temperature to rise further. In this way, the presence of sea ice helps moderate the global climate, and its loss amplifies global warming.

### Sea Ice

The Arctic sea ice has been shrinking for the last decades with accelerating losses in the new millennium. With relatively static sea ice coverage in the Arctic in the first half of the 20th century, fluctuations began in Arctic climate in the 1950s. A progressive decline in annual sea ice cover became apparent around 1980 (Figure 3). The median Arctic sea ice extent from 1979-2000 was approximately 7 million km². Recently, minimum ice extents have persisted year to year. The 2015 ice extent was 4.6 million km² (Figure 4).

September is the month when sea ice is at its lowest level annually. The changes in the Arctic sea ice extent in wintertime have not been as significant, although some decline is evident. However, the winter sea ice in the Arctic is becoming thinner, which accelerates the spring and summer melting of sea ice.

### Sea Ice Extent

In technical and scientific contexts, sea ice area and extent are different measures and provide slightly different information. Extent defines a region as either ‘ice-covered’ or ‘not ice-covered’, as long as ice is present in the water above a determined threshold.

1 The NSIDC explain the difference of extent versus area using the example of a slice of Swiss cheese. Extent would be a measure of the edges of the slice of cheese and all of the space inside it. Area would be the measure of where there is cheese only, not including the holes. If sea ice extent and area are compared in the same time period, extent is always bigger.
states that multi-year ice is generally the thickest type of Arctic sea ice and that it can be up to 30 metres thick, or as little as 0.9 metres. Because of this heterogeneity, this multi-year ice presents one of the major threats to vessels operating in the Arctic.

In August 2015, Arctic sea ice extent was reported to be well below average for the time of year, although ice was observed to have persisted locally in Baffin Bay and Hudson Bay. As a consequence, the Northern Sea Route (NSR) appeared to be mostly open, except for a narrow section along the Taymyr Peninsula. The Northwest Passage, however, was observed to be still clogged with ice. It is the understanding of any patterns and trends in these sea ice changes that will allow appreciation of the potential exploitation of the NSR and the Northwest Passage.

MARITIME OPERATIONS IN THE ARCTIC

Maritime operations in the Arctic are increasing, and are likely to increase further. A decline in sea ice potentially opens northern routes for sea-going vessels, offering reduced sea transit periods between Asia and Europe compared to the existing routes via the Suez Canal and the Panama Canal. In addition, hydrocarbon and mineral deposits which have until recently been isolated, are increasingly being exploited as both access and technology is improving.

Emerging Opportunities for Shipping

As Arctic ice cover reduces and as scientific consensus grows about the likelihood of continued ice reduction in coming decades, sea routes through the Arctic are beginning to look commercially viable. Since the first Suezmax-class supertanker crossing of the Northern Sea Route in 2011, there have been several ship transits each year. Figure 6 shows the two main emerging sea routes through the Arctic.

The Northwest Passage (Figure 6a) is the route connecting the Atlantic and Pacific Oceans through the Canadian Arctic Archipelagos. The potential benefits of transit through the Northwest Passage are significant, as ship routes from Europe to eastern Asia would be 4,000 km (2,500 miles) shorter than transiting through

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Panama Canal. The first unescorted cargo ship transit was in 2014. However, this route is not as attractive as the Northern Sea Route because ice conditions tend to be more hazardous, as more ice, particularly multi-year ice, accumulates in the region (Hass, 2015).

The Northern Sea Route (Figure 6b) connects North East Asia (i.e. Japan, South Korea and China) with North West Europe through the Arctic Ocean. In practical terms, this represents a reduction by about one third in the average shipping distances compared with the currently used Southern Sea Route (SSR) through the Suez Canal.

These reductions translate into fuel savings (although some other important factors should be also taken into consideration, e.g. the higher grade of fuel needed for compliance with the regulations, the additional fuel consumption for heating production, etc.), transport time savings and significant reductions in overall transport costs, which may effectively force supply chains in industries between East Asia and Europe to change (Bekkers et al, 2015).

**Offshore Operations – Natural Resource Exploration**

The Arctic is estimated to hold the world’s largest remaining untapped gas reserves and some of its largest undeveloped oil reserves. In an influential 2008 analysis, the U.S. Geological Survey reported that nearly one-quarter of the Earth’s undiscovered, recoverable petroleum resources lie in the region: 13 percent of the oil; 30 percent of the natural gas; and 20 percent of the liquefied natural gas. More than 80 percent of these are thought to be offshore.

Whilst climate change presents opportunities for increased exploration and exploitation due to potentially easier access, there are concerns that in the near term, Arctic oil and gas exploration may be beset by problems, with dangerous and difficult to predict environmental conditions, little contingency for equipment failures, and public campaigns against development in the region all adding to the risk and the cost. Many other factors are also likely to play a pivotal role in the rate and scale of Arctic development. These include global commodity prices, exploration and production technologies, geographic access and infrastructure, legal and political climates, and environmental concerns.
II. THE POLICY CONTEXT

THE IMPACT OF SHIPPING AND OFFSHORE OPERATIONS IN THE ARCTIC

Increased shipping and other operations in the Arctic will have multiple social and environmental effects in the region. These include the direct impact along routes and at the sites of operations, and indirect effects associated with supporting infrastructure.

Safety and Sustainability

The consequences of Arctic development present risks to the environment, to people undertaking the operations, and also to people living in the Arctic. In particular, the influence the maritime activity and the marine sector development may have on the Indigenous populations of the Arctic needs to be given special consideration. There is an increased risk associated with the operations themselves in the Arctic compared to operations elsewhere. If an operation cannot be completed sustainably or safely, this may result in financial loss to the operator, and in the event of an accident or incident, there could be a severe reputational risk with implications for the environment.

Impacts on the environment include, but are not limited to:

- Atmospheric emissions affecting climate and air quality - e.g. greenhouse gases, Black Carbon
- Ecological impacts - invasive species, harm to wildlife
- Chemical and biological contamination by hazardous materials
- Physico-chemical impacts - oil spills

These risks pose a significant threat. The Arctic is potentially more vulnerable to exposure to these threats than other ocean regions, due to the sensitive marine ecosystems being already under stress from climate change.

Risks to personnel include, but are not limited to:

- Inadequate search and rescue capability and capacity in the remote regions of the Arctic
- Lack of suitable personal protective equipment for often low-predictability conditions
- Fatigue and physical strain of operating in extreme conditions

The lack of experience of operating in the region combined with a potential lack of suitable training of operators can lead to an exacerbation of the risks.

Minimizing the Impact and Managing the Risks

History shows that preventative legislation is often not implemented, or the need for implementation is not recognised, until a major incident has occurred. Every measure must be taken to prevent this from happening in the Arctic region which is recognised as being one of the world’s few remaining near-pristine environments. A significant amount of work has already been undertaken by members of the marine community and wider in order to ensure that safety and environmental risks due to increasing maritime traffic and offshore exploration are controlled.

INTERNATIONAL LEGISLATION FOR SHIPPING AND OFFSHORE ACTIVITIES IN THE ARCTIC

One of the fundamental ways to reduce risk and to ensure that operations can be carried out safely and sustainably is to ensure that an adequate framework of both mandatory legislation and voluntary guidelines is in place. A number of international instruments exist to support this framework. The most important international instruments, from the point of view of safe and sustainable shipping and offshore operations, are introduced here. However, it is recognized that there are other instruments not listed here such as the Convention on Biological Diversity that play an important role to the protection of the Arctic.
<table>
<thead>
<tr>
<th>INSTRUMENT</th>
<th>YEAR</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Convention for the Safety of Life at Sea (SOLAS)</td>
<td>1974, as amended.</td>
<td>Generally regarded as the most important of all international treaties concerning the safety of merchant ships. The main objective of the SOLAS Convention is to specify minimum standards for the construction, equipment and operation of ships, compatible with their safety.</td>
</tr>
<tr>
<td>International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW)</td>
<td>1978</td>
<td>The main purpose of the Convention is to promote safety of life and property at sea and the protection of the marine environment by establishing common agreement on international standards of training, certification and watchkeeping for seafarers.</td>
</tr>
<tr>
<td>United Nations Convention on the Law of the Sea (UNCLOS)</td>
<td>1982</td>
<td>Also known as the Law of the Sea Treaty, this is the international agreement that defined the limits of the territorial seas of nations and the areas in which they could exploit marine resources. Territorial waters could be declared up to 12 nautical miles, and an exclusive economic zone (EEZ) of up to 200 nautical miles for commercial activities. Signatories could also extend their sovereignty beyond the EEZ by up to an additional 150 nautical miles if they could prove that their continental shelves extended beyond 200 nautical miles from the shore.</td>
</tr>
<tr>
<td>International Convention for the Safety of Fishing Vessels (Torremolinos Convention)</td>
<td>1977/1993 (not yet in force)</td>
<td>Focuses on the safety of fishing vessels, where the great differences in design and operation between fishing vessels and other types of ships have proved a major obstacle to their inclusion in the SOLAS Convention and other IMO Conventions. The 1993 Torremolinos Protocol will eventually replace the Torremolinos Convention.</td>
</tr>
<tr>
<td>International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea (HNS)</td>
<td>1996/2010 (not yet in force)</td>
<td>Aims to ensure adequate compensation is available for damage occurring as a result of the maritime transport of hazardous and noxious substances. The HNS Convention covers damage caused by HNS in the territory or territorial sea of a State Party; pollution damage in the EEZ, or equivalent area; and damage (other than pollution damage) from ships registered in the flag of the Member State outside the territorial sea of any State. Damage includes people, property, economic losses and costs of damage prevention and environmental restoration.</td>
</tr>
<tr>
<td>International Convention for the Control and Management of Ships’ Ballast Water and Sediments (BWM)</td>
<td>2004 (not yet in force)</td>
<td>Aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships’ ballast water and sediments.</td>
</tr>
</tbody>
</table>
**ARCTIC-RELATED ISSUES IN EXISTING INSTRUMENTS**

**Unclos**

UNCLOS Section 8, Article 234 covers ‘ice-covered’ areas. According to this Article, ‘Coastal States have the right to adopt and enforce non-discriminatory laws and regulations for the prevention, reduction and control of marine pollution from vessels in ice-covered areas within the limits of the exclusive economic zone (EEZ), where particularly severe climatic conditions and the presence of ice covering such areas for most of the year create obstructions or exceptional hazards to navigation, and pollution of the marine environment could cause major harm to or irreversible disturbance of the ecological balance. Such laws and regulations shall have due regard to navigation and the protection and preservation of the marine environment based on the best available scientific evidence.’

Arctic nations have made use of the special provisions provided by Article 234 of UNCLOS. Canada and Russia have both strengthened their authority over emerging Arctic shipping routes (the Northwest Passage and the Northern Sea Route) by regulating over ‘ice-covered’ waters (Depledge, 2015).

**Torremolinos Convention**

The 1993 Protocol to the Torremolinos Convention set out comprehensive safety provisions for fishing vessels that cover construction, stability, machineries, fire protection, protection of crew, lifesaving equipment, emergency procedures, radio communications, navigation equipment, vessel certification and port state control. Together with the 2005 Code of Safety for Fishermen and Fishing Vessels, it includes items relating to the causes of ice formation, vessel seaworthiness in ice formation conditions, and recommendations for skippers on how to deal with ice formation, including protective clothing, equipment and tools.

However, the Torremolinos Convention and its Protocol have not entered into force. The aim of the Cape Town Agreement of 2012 on the Implementation of the Provisions of the Torremolinos Protocol of 1993 relating to the Torremolinos International Convention for the Safety of Fishing Vessels, 1977, is to deal with the technical and legal issues that have prevented fishing at sea from coming under a binding international safety regime. Progress on improving safety standards on fishing vessels remains slow, so the increasing demand for fishing in northern waters potentially represents an area of emerging risk.

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**Ballast Water Management Convention**

Under the Ballast Water Management Convention, there are specific requirements for the uptake or discharge of ballast water in Arctic or Antarctic waters. These must be followed unless the safety of the ship is jeopardised by a ballast exchange, or where it is necessary for saving life at sea.

Increased shipping in the Arctic faces a policy gap under this Convention. At present there are only details provided for the Antarctic treaty area, and for the transport of ballast water between the poles.

**London Convention & London Protocol**

Under the London Protocol, all marine dumping is prohibited, except for possibly acceptable controlled release of wastes on the so-called ‘reverse list’. This list includes a. dredged material, b. sewage sludge, c. fish wastes, d. vessels and platforms, e. inert, inorganic geological material (e.g. mining wastes), f. organic material of natural origin, g. bulky items primarily comprising iron, steel and concrete and h. carbon dioxide streams from carbon dioxide capture processes for sequestration.

As yet, there are no specific guidelines on application of the London Convention and its Protocol in Arctic waters.

**CURRENT DEVELOPMENTS – THE POLAR CODE**

The MV Explorer incident in 2007 (Figure 7) highlighted the pressing need for better legislative controls on shipping in the polar regions. In recognition of the current levels of polar maritime traffic, and the further anticipated increase in transits of the Northern Sea Route and the Northwest Passage, the International Maritime Organization (IMO) has produced a draft Polar Code, which covers all aspects of shipping in the Arctic. The Polar Code is expected to come into force in January 2017.

According to the IMO, the Polar Code is intended to cover the full range of shipping-related matters relevant to navigation in waters surrounding the two poles. In this respect, the Polar Code covers the full range of ship design, construction and equipment, operational and training matters, search and rescue and the protection of the environment and ecosystems of the polar regions.

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Figure 7. The M/S Explorer was the first tourist vessel to sink off Antarctica (Image: Chilean Navy, via Associated Press)
The Polar Code includes mandatory measures and recommendatory provisions for safety and pollution prevention.

The mandatory safety regulations of the Code will be implemented through the SOLAS Convention. SOLAS applies to all ships, and covers issues related to activities in the Arctic regarding navigation, stability (due to icing) and cold weather survival contingency (Figure 8). It also provides guidance for passenger ships entering icy waters, guidelines on voyage planning and guidelines on fishing vessels.

The mandatory environmental protection regulations will supplement and be adopted via amendments to MARPOL. The MARPOL Convention applies to all ships, and covers issues related to the Arctic regarding the control and discharge of heavy grade oil, control of discharge of residues of noxious liquid substances, disposal of garbage, use and carriage of heavy grade oil, and oil spill response in snow and ice conditions (Figure 9). Oil spill response, at the time of writing, is under review by the Arctic Council. The Antarctic area is already established as a Special Area under MARPOL, and the Code aims to replicate many of those provisions for the Arctic area.

Amendments to the STCW Convention with respect to training and certification of deck and engine officers and masters required under the Polar Code are in the process of being approved. Under the new regime, masters, deck officers and engineers serving on vessels operating in polar waters may be required to undergo training at either a basic or advanced level depending on the vessel, the ice conditions and their position. Once approved, the amendments to Chapter V of STCW and Chapter 12 of the Polar Code on Manning and Training will include requirements for sea service, certification, revalidation, transitional provisions, and minimum standards of training.

Figure 8. An illustrative guide to the ship safety components of the Polar Code designed by the IMO to promote awareness (Source: http://www.imo.org/en/MediaCentre/HotTopics/polar/Pages/default.aspx)
NON-BINDING GUIDELINES

Arctic Council Offshore Oil and Gas Guidelines (2009)

These non-binding guidelines are intended to be of use to the Arctic nations for regulating the offshore oil and gas activities in the Arctic, including transportation and related onshore activities. The Guidelines aim to define a set of common recommended policies and practices for planning, exploration, development, production and decommissioning. They also outline strategic actions for consideration by those responsible for regulating offshore oil and gas activities by assisting regulators in developing standards that can be applied and enforced consistently for all offshore Arctic oil and gas operations.

Oil and Gas Producers HSE Guidelines for Metocean & Arctic Surveys

The OGP HSE Guidelines are industry guidelines on health, safety and environmental aspects of metocean and Arctic survey. Although not mandatory, they are widely accepted as best practice for dealing with additional risks in the Arctic. They were developed for geophysical surveys in the Arctic, but they can be more broadly applicable to other operations. Risks detailed in the guidelines include:

- Weather exposure (wind, temperature) – frost-bite and hypothermia
- Disorientation due to fog, blizzards
- Personnel or equipment breaking through floating ice
- Break-up of ice cover
- Ice encroaching onto beaches or man-made structures
- The consequences of sudden weather changes, such as changes in ice drift direction, ice encroachment into the offshore survey area, closing of escape routes, etc.
- Ice impact and pressure on vessels
- Marine icing on vessels
- Darkness in winter and solar exposure in summer
- Avalanches
- Glacier crevasses
- Slippery surfaces
- Wildlife (polar bears, wolves, walrus, etc.)
- Potential limited Search & Rescue

Figure 9. An illustrative guide of the Polar Code to the protection of the environment designed by the IMO to raise awareness (Source: http://www.imo.org/en/MediaCentre/HotTopics/polar/Pages/default.aspx)
III. SECTOR VIEWS – SURVEY AND ROUND TABLE OUTCOMES

ARCTIC RISKS – VIEWS FROM THE IMarEST SURVEY

Arctic operations engender a broad spectrum of risks. Therefore, the IMarEST conducted a short online survey among its international community of marine professionals, to gather current perceptions of risks associated with Arctic operations and to obtain an indication of the community’s awareness of existing measures to minimise those risks.

The types of risks outlined in the survey were taken from the DNV GL 2015 assessment of key Arctic risks, “Broader view – better decisions”.

400 responses to the survey were received. The 158 non-UK responses came from 35 countries, giving a robust international basis to the findings.

The survey responses indicated that the broad risk categories that are perceived as both important and likely to happen are:
1. Operational Risk – risk related to undertaking operations
2. Personnel Safety Risk – risk related to people on board vessels and structures
3. Technical Risk – risk related to equipment and technologies
4. Reputational Risk – risk related to how an operator is perceived to customers

However, over half of the responses received indicated that the overall risk of causing environmental damage and loss of life at sea were the most critical. The risk categories above were interlinked within that broader risk picture.

Respondents noted that it is hard to distinguish between operational and technical risks, and a need for better defining the risk categories was identified. Given the dominance of Arctic environmental conditions in determining the risks, operational and technical factors can generally be considered to be physical factors, i.e. those related to the surrounding environment, structures and infrastructure.

From this broader operational perspective, the survey responses yielded the following ranking of risk factors, by order of importance:

1. Uncertain meteorological, oceanographic and hydrographic data
2. Whether operations were established with adequate incident response contingencies
3. The ability to conduct accurate positioning and geometric control
4. Control of vessel traffic
5. Marine icing, increased loading straining the stability and integrity of structures
6. The effect of the physical environment on human operators, such as fatigue due to cold, lack of sunlight, etc.
7. Atmospheric icing on radar antenna, lifeboat coupling, and other moving parts
8. Extreme cold altering material properties of structures
9. Financial ability to operate

With regards to personnel safety, more than half of those responding to the survey felt that it is of primary importance to reduce the risk associated to personnel safety by having trained and competent crew. Of secondary importance was to have an effective Search & Rescue contingency plan and effective evacuation procedures including lifeboats’ handling and operating. Least attention was given on the provisions of personal protective equipment (PPE)/clothing. With regard to the technical risk of Arctic shipping and offshore operations, respondents also identified the human factor (fatigue due to cold, lack of sleep, sunlight effects) as an important concern.

The potential environmental risks were examined in more detail. Respondents were asked to rank several environmental risks in terms of importance. The top-ranked issues (Figure 10) were the impact of oil spills, and the impact of operations on sensitive marine ecosystems, both ranked as high or very high concern by the majority of respondents.

The survey also explored people’s awareness of legislation and guidelines, and their views on its effectiveness. The survey sought views on legislation and guidelines that have been established specifically to protect the Arctic and support shipping and offshore operations in the region, and also relevant instruments that have a broader marine focus but can be applied in the Arctic.

The results (Figure 11) demonstrate fairly good awareness of the major IMO Conventions dealing with safety of life at sea and environmental protection. More than half the respondents had some awareness of seven out of the eleven Conventions and guidelines included in the survey. Nevertheless, there is considerable work to be done.

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done to promote awareness of the relevant mandatory and voluntary guidelines to the broad community, especially for those instruments specific to the Arctic.

Those respondents who indicated awareness of the legislation and guidelines were further asked to comment on how effective they believed that legislation to be. Figure 12 suggests that there is also a need to promote wider compliance with the mandatory and voluntary guidelines for Arctic operations. Only MARPOL and STCW are seen as having a major impact. Legislation dealing with environmental discharges (ballast water, hazardous and noxious substances) are seen as having the least impact.

When respondents were asked to consider the responsibility for monitoring compliance with the international regulations for the Arctic shipping and offshore operations and for the data collection for improving operations, the majority of the respondents (60%) felt that there needed to be joint responsibility across the operators, Arctic governments and Flag States. Just 35% felt that the operator was solely responsible for undertaking these responsibilities.

### ARCTIC SAFETY AND SUSTAINABILITY – ROUND TABLE

An open discussion on identifying, evaluating and mitigating the risks related to the Arctic and the impact of increasing marine activities in the area was held in London in September 2015. Stakeholders from the marine sector shared their views on what they believe to be the major risks to assets, to the environment and to people, how can those risks be assessed and prevented, contained, managed and mitigated.

### Prospects for Future Development in the Arctic

As the sea ice melts, it is expected that further development will occur in the Arctic. At the time of writing, the low price of oil has slowed down Arctic exploration and production as there are more accessible resources elsewhere. However, there is consensus that there will be an inevitable increase in the demand for energy related to future global population growth. Improved access to the vast oil and gas resources in the region will trigger further exploration. In addition, an increase of fuel oil prices in future combined with an increasing demand for “goods on time” will be a strong driving force for navigation via shorter routes.

The cost of energy is a key factor in determining where goods are processed and manufactured. Because shipping is a relatively cheap mode of transport, many

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1. OGP HSE – International Association of Oil & Gas Producers Health, Safety and Environment Guidelines
2. AOOGG – Arctic Council Offshore Oil and Gas Guidelines
goods are shipped across the world to multiple countries for sequential processing before ending up as the final product. For example, the conversion of bauxite to aluminium goods involves extensive ship-borne trade between Asia and the Americas. The opening of the Arctic offers opportunities for improved trade routes, with the identification of the best options for managing the overall supply chain expected to improve with knowledge and experience over time.

Russia and the USA are leading in operations in the Arctic. The geopolitical situation, which has been fragile in the past, may seem stable now, but anxiety over regional claims has increased slightly in the recent past. There is broad international consensus, especially amongst the Arctic states, that the most important aspects of Arctic legislation will be followed and therefore the region’s stability will be safeguarded.

**Risks to the Environment**

The natural environment should always be considered when planning and undertaking shipping and offshore activities. The Arctic presents particular challenges, because of the role of the Polar Regions in regulating Earth’s temperature, and the fragility of Arctic ecosystems. Those concerned with the Arctic operations should be alerted to up-to-date scientific assessments that support the importance of environmental protection, and should be engaged with the wider community in issues that affect them and their surroundings.

The 2010 Deepwater Horizon oil spill in the Macondo field in the Gulf of Mexico illustrated the devastating consequences of shipping and offshore incidents, both in terms of environmental damage and loss of human life. If a similar disaster happened as a result of development in the Arctic, the consequences would be even more catastrophic. Shipping operations arguably present an additional hazard, because of the risk that their location might not be adequately known in the event of a serious incident. The risks are likely to differ between the alternative emerging shipping routes. A NWP transit would likely pose a greater risk than the NSR transit, because it has more severe ice conditions and many narrow straits, compared with the more open waters of the Russian Arctic.

Prevention of disaster should underpin all future Arctic operations, but still there are many open questions. These include how shipping and offshore operations could affect the physical environment and the ecosystems of Arctic, how oil spills can be managed and contained in icy seas, and how any potential impact will play out in a region already under great pressure due to climate change.

Alongside the need to prevent disastrous incidents, routine operations cause concern. As the ecosystems are still comparatively pristine, and vulnerable because of their special evolutionary adaptation to Arctic conditions, provisions are needed for the discharge of oil pollution, sewage, and waste, including food waste and ballast water. The discharge of sewage and waste is likely to have an impact on nutrient dynamics in the surrounding waters, whilst discharge of untreated ballast water can introduce harmful non-native species. Both have the potential to result in a consequential cascade of ecosystem impacts and species extinctions.

Fishing is becoming increasingly important in sub-Arctic seas, and as ice melts, Arctic fishing activities are also an area of new interest. However, there is some uncertainty here. Less sea ice results in more oxygen and an associated nutrient enrichment, which could lead to biomass growth but have a negative effect on fish populations. Although it is considered that fisheries are adaptable to changes, shifting nutrient supplies could give rise to invasive species. Changing temperatures may well drive some species further north, shifting the phytoplankton dynamics. Different areas, however, would experience different consequences on fish populations.

The environmental impact of Arctic activities also causes concern about the health of people in the region. For example, airborne pollutants (such as persistent organic pollutants) are present in high concentrations in the Arctic because of the atmospheric transport systems, and sub-
stances also accumulate in traditional foods. Engagement of the Arctic communities in protecting their own health is essential. Arctic communities are proud of their identities, and they also want to be involved in development as it occurs. Culturally, it is an extremely diverse region, and there are many social groups and multiple interests that need to be considered and included in decision-making. Who will benefit (or be affected adversely) from the changes that are taking place is an additional consideration for companies and national development agencies. The establishment of protected ecological areas and exclusivity zones is important for the protection of the Arctic environment, and the livelihoods of many Arctic inhabitants. According to the Antarctic Ocean Alliance, which might be considered as a useful analogue, marine protected areas can confer significant benefits in the context of climate change and ocean acidification. They can increase species abundance and diversity and therefore ecosystem resilience to climate change and ocean acidification by reducing stress from human activities. They also provide reference areas where the effects of climate change and ocean acidification can be researched and differentiated from the effects of natural variability and human activities.

**Operational Risks, Search and Rescue**

If shipping and offshore activities increase in the Arctic, decisions need to be made about how Search and Rescue (SAR) infrastructure is going to be set up along the potential shipping routes, and who will supply and fund this service. To date, discussion as to who is responsible for SAR and who should fund SAR services in the Arctic has been extremely protracted. The extensive work done by the IMO on the Polar Code has produced the Polar Water Operations Manual (PWOM, Chapter 2 of the Polar Code), which gives advice and guidelines on how to respond in worst case scenarios. The Polar Code also includes a requirement for operations to be conducted inside the operational proximity of other vessels.

The first and most important step to ensure safety is for vessels to be suitable for navigation in the Arctic region. The expansion of the icebreaker fleet is also vital, as these vessels are the first to attend in emergency and SAR circumstances. An evaluation of the number of ports in operational proximity is also necessary, and needs to be directly proportional to SAR capabilities.

Round table participants noted that the existing emergency stations have limited SAR capabilities, and in scantily populated regions it can sometimes be impossible to crew emergency vessels. SAR exercises in regions affected by ice have shown that for good chances of survival, response times must be within hours, but it can take from one to three days for rescue teams to respond and be able to reach casualties. This means that adequate survival equipment and training on use of that equipment are imperative so that those involved in an accident have a chance of surviving until they are rescued.

Personal Protective Equipment (PPE) constructed of suitable materials needs to be provided. It is difficult to design suitable lifeboats and liferafts for all types of conditions found in the Arctic. For example, rubber boats may be damaged by being dragged across the ice. Novel solutions need to be developed for rescue boats that are best suited to the environment. One example could be the use of hovercrafts that can travel across ice and water. Hovercrafts have been used as escape crafts from rigs, vessels or structures that are iced in.

The expected increase in tourism will also require the provision of improved SAR methods. Experience can be gained from the International Association of Antarctica Tour Operators (IAATO), who stage SAR workshops in the Antarctic region in conjunction with regional coastguards from countries such as Chile and Argentina. Similar programmes coordinated with regional services could be undertaken by tour operators in the Arctic.

Implementing SAR in practice is a very different task from the good intentions raised in guidance and legislation. Operators who want to be involved in the Arctic need to be aware of the wider repercussions of incidents for the sector. International regulators should not be expected to understand industry requirements, so additional engagement and feedback from operators is necessary.
Gaps in Existing Knowledge

There are many gaps in knowledge of the Arctic and its current processes of change, of how operations can be undertaken safely and efficiently, of what the environmental impact could be due to increased operations, and of the suitability of legislation for present-day issues. Knowledge gaps discussed at the round table included:

Structural effects of ice conditions: What is the behaviour of subsea structures and vessels in the extreme cold of the Arctic region? What are the appropriate methods for monitoring and managing subsea structures and vessels in ice conditions? The weight of ice on vessels and structures in the Arctic is immense. In addition, there is the risk of damage from icebergs to the subsea structures of platforms, pipeline systems and navigating vessels. Structural strengthening and reinforcement are essential for ice-going vessels and for platforms, and an effective system needs to be put in place for monitoring the integrity of vessels and structures operating in the Arctic. New forms of integrated engineering research are required to be able to address these risks.

Ice navigation: What is the impact of ice on shipping, in particular the unpredictable hazard of the ice ridging that forms when sea ice cracks and folds, or the extensive close-packed ice massifs that can drift away from their normal source region? In addition, what could be the limits of working in such conditions? Shipping exercises are often carried out in good weather conditions and as such expertise can be misjudged. The difficulty of ice navigation should not be underestimated. There is limited practical experience but further research and practice are essential. An example of good practice is the POLARIS ice regime methodology that combines the Canadian ice regime and the Russian ice passport system and provides a calculated risk assessment for route planning for a given route or region according to the vessel’s ice class in conjunction with ‘best information’ from multiple sources.

Regional operational metocean forecasting: How can reliable meteorological and oceanographic data be obtained? How can it be used to improve the predictability of environmental factors in the Arctic? Better data and metocean models play a key role in increasing the safety of operating in the region. Elsewhere in the world, data assimilation techniques can be used with models to improve medium-term forecast accuracy for up to two weeks, but in the Arctic, metocean models have low skill values and the acute shortage of operational data means users can only have a low degree of confidence in forecasts. In order to improve the models and their forecasts, there is a need for more data to be collected for all aspects of Arctic meteorology, oceanography, bathymetry and the cryosphere. Automation provides new opportunities: Unmanned Aerial Vehicles and Autonomous Underwater Vehicles are being developed to supplement research ships and ground-based surveys. Challenges include the quality of in-situ positioning infrastructure, the efficient collection and analysis of the data, and the appropriate transmission of information to users. Responding to these challenges involves deeper cooperation across engineering, science and technology for the Arctic.

Pollution incident response: What would be the response to a marine pollution incident in the Arctic? What are the requirements for pollution contingency, in particular aerial monitoring response? As expected, the response is different on a case by case basis. There is some evidence to suggest that the same processes take place during an oil spill in the Arctic seas as in other seas but long-term effects are not understood. There have been oil spills in the past, in Norway and Sweden, which have been recovered but experience and research are limited in this area. Transboundary pollution would be very difficult to manage in the Arctic because of the lack of any agreed intergovernmental standards. Much greater dialogue is required to improve effectiveness of any pollution response. Working through existing organisations is probably the best approach as potentially more players could slow down the process.

Knowledge exchange, retention and continuity: In the context of the rapidly changing physical and socioeconomic environment of the Arctic, sharing experiences and best practice is vitally important. Continuity of knowledge is a major challenge. The normal timeframes of research and operational projects do not enable the long-term data collection that is necessary for providing a robust picture of key processes and baseline variability. There is a high turnover of individuals in the region, making problems for institutional and practical knowledge retention. This is especially challenging in the State departments and other organisations involved in Arctic governance, where political appointments tend to have short-term cycles. Long-term planning has proved difficult. An example is the planned deep-water harbour in Finnafjörður, north eastern Iceland. Intended as a major stopover point in a potential transpolar sea route, it has experienced several delays in the planning stages. It is now hoped to be completed by 2030, to meet projected demand for shipping, tourism and other uses for the Arctic seas. Clear communication between stakeholders is vital for all Arctic operations. An example of a forum for information exchange is the recently established Arctic Portal, partly funded by industry. Every effort must be
made to construct a knowledge-sharing framework now, within which a forum of best practice can be built before the expected ‘opening of the Arctic’ really sets in.

Financial risks and opportunities: The Arctic is facing a pressing dilemma between economic development and ensuring protection of the environment. The financial sector plays a pivotal role in decision-making. The intermittent nature of funding and investment in Arctic operations creates problems for the continuity of knowledge about effective operations. This ends up to a vicious circle: financial institutions are only content to invest when they can quantify the associated risk, while a sensible risk can only be quantified with information fed back to investors and insurers by industry operators who are dependent on the financial investment. Nevertheless, operations are already ongoing in the Arctic, and experience should be drawn more widely from those stakeholders who are familiar with the region.

Training and Standards

Extreme diligence and well-trained crew are the most important factors for sustained shipping operations in the hostile environment of the Arctic. The extreme cold and poorly predictable conditions mean that specialized equipment and procedures are essential for Arctic operations. Routinely used navigational aids may not be accurate and effective in the high latitudes. With these factors in mind, expertly delivered crew training is crucial. Lessons can be learnt from experience in other high-risk shipping activities. Participants highlighted the LNG industry as a good example. Although it is potentially very hazardous, the actual risk associated with LNG vessel operations is considered to be low, because of industry adherence to rigorous training and safety standards.

The human factors also need attention. It is extremely important to understand the cold weather environment and the effects that cold could have on the safety of crew and operations. Fatigue and the reduced inability to concentrate due to the adverse weather conditions could potentially increase human errors with severe consequences. Emergencies in bad weather are far more serious and are associated with a lower rate of survival. Training for all crew should include ‘sign, symptoms & awareness’ courses even at a basic level, as a better understanding of these principal concepts would likely lead to fewer accidents. In addition, because most training exercises are carried out in relatively good weather conditions, special extreme-events training would also be valuable.

Accredited training for the Arctic regions could address several gaps in the current state of knowledge for crew. The IMO Maritime Safety Committee and the STCW subcommittee oversee the provision of training for personnel. Amendments to the STCW Convention related to the Polar Code include new mandatory minimum requirements for the training and qualifications of masters, deck officers, engineers and other personnel on board ships operating in polar water, along with the adoption of a guideline on ‘Cold Water Survival’. Even so, the development of any training model needs to be continuously updated, and requires industry feedback on best practice methods to remain relevant. At this point, the Polar Code training framework is still being finalised so it is crucial to gain as much industry feedback as possible.

Regulations and Incentives

The SOLAS and MARPOL Conventions have been shown to be effective in protecting the environment
and ensuring safety of shipping in international waters. For example, all oil major companies today transport oil in double-hull vessels, and port state control screen out grey-listed vessels by performing independent inspections on vessels’ operations and on the management of discharges and waste disposal. In addition, and in accordance with SOLAS, oil discharge in the Arctic is banned, except where discharge would prevent the loss of life. Oil spill prevention remains the biggest issue for major operators in the Arctic. Whilst major operators following best practice do not present the biggest problem, rogue operators could bring the whole industry into disrepute. Compliance is therefore still a concern. For instance, how frequently are discharges actually occurring in open seas under so-called ‘emergency’ situations? Perhaps the solution will be a total ban on the carriage of any hazardous cargo or fuels in emergency situations? Perhaps the solution will be a total ban on the carriage of any hazardous cargo or fuels in the Arctic region. However, the more stringent the legislation, the more challenging it is to achieve effective implementation.

The IMO Polar Code takes a step towards mitigating environmental damage by banning all discharge of waste in the Arctic region. It also provides recommendatory provisions on the discharge of ballast and grey water (Part II-B). Still, there are governance challenges ahead:

- **Implementation**: There are many practical issues to look at. For example, where are the locations where vessels can offload ballast and wastewater? The coastal infrastructure for waste transfer is yet to be established and the lack of development in this area will prove to be extremely problematic to the sustainability of, and expansion of, operations in the region.
- **Awareness**: As our survey of diverse marine professionals around the world has shown, there is a significant knowledge gap in this area. Despite the best efforts for the development of robust legislation, a key factor in environmental protection is the requirement for widespread awareness and understanding of the legislation and how it should be applied.
- **Enforcement**: There are already many rules and regulations governing Arctic shipping and offshore activities, but one of the main problems will be enforcement. There is no legal mechanism for the Arctic states to apply central enforcement at the moment. If an infraction does take place, collection of evidence to make a prosecution will be extremely problematic. With this in mind, prevention of environmental damage and other unwanted effects can only be facilitated by realistic and enforceable regulations.
- **Coordination**: The need to create a regional framework and a unified regional response to pollution incidents is necessary. IMO is working with the Arctic Council on the Arctic regulations. One example is the development of standards across all Arctic countries for oil spill prevention and response, which is intended to be internationally approved. Still, the multijurisdictional problem persists. Moreover, as oil persists in ice and does not evaporate, it can be carried by ocean currents across administrative boundaries beyond the Arctic states, and there is no international convention to address this issue.

**Conclusions and Recommendations from the Round Table**

Geopolitical perspectives are of foremost importance in addressing Arctic risks and opportunities at the global scale rather than just the regional one. There is a unique opportunity to put effective international legislation in place, but collaboration and coordination between stakeholders and operators is paramount to the implementation of legislation and in particular the Polar Code.

Policy and regulations need to be clear and easily understood in order to be successfully implemented. At the core lies the need for increased professional and public awareness of current Arctic operations. Investment in education, training, and understanding of policy and legislation is equally as important as investment in new technologies.

Arctic shipping and offshore activities present major new engineering, technical and technological challenges. Improved ship designs according to classification rules and requirements will safeguard Arctic operations. Port waste management facilities and marine monitoring and communication infrastructures are essential. More icebreakers and support vessels along with specialized port facilities are needed for improved emergency capabilities and Search and Rescue.

Ice navigation will remain complicated due to the complexities of ice formation and extremely low temperatures. Careful operational planning by well-trained professionals is necessary. However, for the time being the Arctic is comparatively poorly observed, and the lack of data will inevitably make planning difficult. An Arctic observation network could be the solution to this problem.

The Arctic is often described as a vast new economic frontier, but growth should be kept in line with infrastructure, and with the needs of the natural environment. Financing may be a key part of the answer to minimizing risks associated with Arctic development. Sustainability will only be achieved through a cohesive, concerted effort.
WHAT IS IMarEST DOING NEXT?

The IMarEST, through its Arctic Special Interest Group (SIG) and in coordination with other SIGs, can make a valuable contribution to ongoing debates on safe and sustainable Arctic shipping and offshore activities. The IMarEST:

- Provides a neutral platform for information exchange among the key stakeholders operating in the area, through its program of events and publications.
- Promotes and facilitates best international practices across a wide range of marine and maritime activities, through professional registration and standards.
- Contributes to knowledge sharing, through its activities in education and life-long learning.
- Contributes to public awareness and understanding of the importance of the marine sector.
- Represents the sector in the principal forums for policy formation on marine and maritime activities.

Activities and thematic areas that the Arctic SIG can focus on include:

- Sharing and promoting best international practices for businesses operating in the Arctic seas, on
  - financial risk management frameworks and licencing;
  - emergency preparedness response and Search and Rescue (regional framework for SAR, regional/sub-regional contingency plan for prevention and response from shipping and offshore related incidents);
- Promoting capacity-building projects (Polar Code, the risk indexing system POLARIS, Prevention and Response to incidents in icy waters).
- Promoting activities that make shipping and offshore activity more sustainable, such as improved ice charting and hydrography of the Arctic, for more efficient routes for projected shipping traffic; the use of new technologies (LNG/alternative fuels, ship design, propulsion systems).
- Cross-sector information exchange and positions on environmental issues:
  - Emissions from shipping (measurements of NOx and SOx and their long term impact on marine and atmospheric processes in the Arctic, including effects on seawater pH).
  - Black carbon in the Arctic (measurement and appropriate control methods).
  - Ecosystem change (invasive species, including northward migration of species induced by global warming; fisheries; effects of ballast water and biofouling from increased shipping activities).
  - Arctic carbon cycling (the impact of anthropogenic activities on ocean acidification, biogeochemistry, and high-latitude ecosystems; carbon capture and storage, methane release and effects of oil and gas exploration).
- Human Element (accredited training for masters, engineers and deck officers, aligning seafarers’ competences to the increased need for crew for the Arctic operations).
- Policy input on enhanced environmental protection, e.g., the ban on transport of Heavy Fuel Oils (HFOs), the moratorium on fisheries in the Arctic High Seas.
ABBREVIATIONS

IPCC: Intergovernmental Panel on Climate Change
NSIDC: National Snow and Ice Data Center
NRCC: National Research Council Canada
IMO: International Maritime Organization
MSC: Maritime Safety Committee
MEPC: Marine Environment Protection Committee
NSR: Northern Sea Route
SSR: Southern Sea Route
SOLAS: The International Convention for the Safety of Life at Sea 1974
MARPOL: Marine Pollution
STCW: Standards of Training, Certification and Watchkeeping for Seafarers
ATCM: Antarctic Treaty Consultative Meeting
EEZ: Exclusive Economic Zone
SSMI: Special Sensor Microwave Imager
NWP: Northwest Passage
MSC: Marine Safety Committee
SAR: Safety and Rescue
SIG: Special Interest Group
PPE: Personal Protective Equipment
IAATO: International Association of Antarctica Tour Operators
UAV: Unmanned Aerial Vehicles
AUV: Autonomous Underwater Vehicles
SIG: Special Interest Group
RIO: Risk Index Outcome
POLARIS: Polar Operational Limit Assessment Risk Indexing System
OGP HSE: International Association of Oil & Gas Producers Health, Safety and Environment Guidelines
AOOGG: Arctic Council Offshore Oil and Gas Guidelines

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