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DECODING THE POLAR CODE

"The Polar Code is an example of what we can achieve before a major disaster occurs"
Michael Kingston, Lawyer and IUMI representative at the IMO on polar issues

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Last word

DECODING THE
POLAR CODE

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A warm welcome to *Decoding the Polar Code*

Edwin Lampert, Editor

"IMPORTANT QUESTIONS ARE RAISED AROUND VETTING, INSURANCE, INSPECTIONS AND COMPETENCE... "

Through this publication, we hope to shed light on the International Code for Ships Operating in Polar Waters (the Polar Code). This landmark IMO convention has been designed to set out minimum international safety and pollution prevention requirements for ships operating in Arctic and Antarctic waters. These are new frontiers where the shipping industry has limited operational experience to draw upon.

We have deliberately timed the month of publication to coincide with the Polar Code's 1 January 2017 entry into force. We have also sought to mirror the co-operation and collaboration that brought the convention to fruition by recruiting leading figures involved in devising it to contribute articles on their areas of expertise. All are top experts in their field.

Vessels transiting the polar regions face increased and even novel technical and commercial challenges and hazards. The code imposes additional demands on ships, their systems and operations that go beyond Solas, Marpol and other IMO instruments.

But what does this mean in practice? In *Decoding the Polar Code* – an exclusive Riviera Maritime Media supplement – we have addressed that question. It breaks down the code and its implications into digestible parts that vessel owners and suppliers can use as a point of reference.

The essential information is logically organised and explained in clear, concise, and authoritative terms. We have also included a special directory in the middle of this guide, featuring coverage of leading companies serving this important sector.

The IMO Polar Code is impressive in its scope and ambition. Perhaps the biggest achievement has been in the way its architects have prioritised best practice over regulation in its formation. Inevitably, there are aspects that need development. Some parts could be made clearer or have a wider impact. And then there are the vessels that fall below its 500gt application threshold, including great swathes of the fishing and passenger ship fleets.

Important questions are raised in this publication around vetting, insurance, inspections and competence, along with winterisation, servicing and equipment standards.

These questions must be addressed, a point that is recognised by those who worked so diligently to bring this code into force: a best-practice information forum is due to be establised by the Arctic Council and the first meeting is scheduled for June in London.

As we explain in our article on page 43, it was Michael Kingston, a London-based lawyer and representative at IMO on Polar issues for the International Union of Marine Insurance, who first outlined the need for a best practice information forum when he formally addressed the Arctic Council's Protection of the Arctic Marine Environment working group in Stockholm in February 2016.

The proposal is that a forum can identify all the best standards that are in existence on a cross-jurisdictional basis in hydrography, meteorology, ice data, crew training, search and rescue logistics, communication, recommended industry guidelines, traditional and local knowledge, ecological knowledge, operational understanding and ship equipment, systems and structure.

We hope that in producing this publication that alongside decoding today's Polar Code we will in some small way assist the forum in its all-important work. *DPC*

Everything you need to know about the Polar Code

Capt John Mauger (USCG): The code's requirements are in addition to existing Marpol STCW and SOLAS requirements

As the Polar Code comes into force, the commanding officer of the USCG's Marine Safety Center, Capt John Mauger, offers a primer on where it came from and what it means

The Polar Code is a new mandatory code with specific requirements to enhance maritime safety, training and environmental protection in the polar regions. It consists of two parts, each of which includes both mandatory and recommendatory sections. Part I was adopted in November 2014 and addresses safe design, construction and operation. Part II was adopted in May 2015 and addresses environmental protection. Both parts come into effect on 1 January 2017.

Both parts apply in relation to their parent conventions. Part I follows the Safety of Life at Sea (Solas) convention – generally covering large international cargo ships over 500gt and passenger ships carrying more than 12 passengers on international routes. Part II follows the annexes to the International Convention for the Prevention of Pollution from Ships (Marpol). The environmental provisions apply to a much broader class of vessels, which are described in the applicability sections for Marpol's Annexes I, II, IV and V.

Training and certification for crew members working on polar ships are described in Part I of the code, with detailed training requirements provided in amendments to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW).

The Polar Code establishes requirements for both ships and mariners. Its requirements are in addition to the existing Solas and Marpol convention requirements and take account of the unique risks associated with operating in polar regions, such as ice, low temperatures, high latitude, remoteness, severe weather, limited charting and the pristine environment.

This combination of design and operational standards is reflected in one of the code's key elements: a ship's *Polar Water Operational Manual (PWOM)*. This outlines the design standards that the ship was built to, the operational assumptions that went into those standards and the operational limitations that will be put on the certificate. The *PWOM* also gives operating guidance to the master, crew and pilots on board the vessel.

While the Polar Code requirements will make ships safer and reduce their impact on the marine environment, ships are only one part of the maritime transportation system. Additional measures are needed to improve shipping safety more widely. These include improvements to charting, ice and weather forecasting, communications and maritime domain awareness.

It is important to remember that the code's requirements are in addition to the existing Marpol requirements. That convention already has special area requirements for operators in the Antarctic and the Polar Code did not do away with those. Rather, in some cases it built on top of existing special area requirements while, in other cases, it left them unchanged.

Marpol is divided into six different annexes covering different pollution discharge streams. The work in the Polar Code expanded on Annexes I, II, IV and V, which address prevention of pollution by oil and oily mixtures, liquid noxious substances in bulk, sewage and garbage, respectively.

The code includes limitations on operational discharges, such as zero discharge of oil and oily mixtures and of liquid noxious substances. With regard to the discharge of sewage and garbage, for the limited cases where discharge is currently allowed, added restrictions were put in place to increase the distance from ice where they may be discharged. The environmental requirements also include additional design and construction restrictions – such as added tank protection and increased resistance to damage – to reduce the chances of spilling oil or liquid noxious substances.

Because the Polar Code is built on top of the existing IMO conventions, port state control authorities will be able to leverage existing compliance and enforcement capabilities.

For example, implementation experience in the US Arctic shows that recent traffic from the past few years is predominately tug and towing vessels. Most of these are US domestic vessels that fall outside of the code's safety requirements, although they generally have to meet the garbage and oil discharge requirements, depending on the specific Marpol annex.

The vessels that will have to meet the safety provisions are the larger cargo vessels and tankers operating in Kotzebue and Nome in Alaska during their ice-free summer months. So if the historical trading patterns remain through 2017, implementation of the Polar Code in the US Arctic will primarily focus on implementing the environmental provisions on board US towing vessels and enforcing its safety and environmental provisions on board foreign cargo and tank vessels calling at US ports.

Although the US Coast Guard (USCG) does not currently have any resources permanently stationed in the region, the types of capabilities for enforcement are the same as those used now to enforce the current Solas and Marpol regulations.

In the US, USCG requires vessels to report casualties. Depending on the severity of the casualty, it will take various actions ranging from data collection to on-scene investigation and enforcement.

From 2011 to 2013, there were 25 vessel casualties reported to USCG involving operations above 60° north latitude. All except one of the incidents occurred between June and November, which is when US vessels operate in this area.

The type of vessels that are involved are mainly uninspected commercial fishing vessels and uninspected towing vessels. The types of casualties are mechanical, equipment and material failures, only one of which was the result of impact with ice. These casualties and the vessels involved are not covered by the safety provisions of the Polar Code but the USCG is addressing this through additional requirements for fishing vessels and through towing vessel regulations.

In July 2016, the US published a final rule that requires US domestic towing vessels to be inspected and certificated according to US regulations. These apply irrespective of where the towing vessel operates within US waters and, when fully implemented, should reduce casualties in the US Arctic.

Goal-based code suits polar risks

People who have been working in the Arctic understand that it is an incredibly diverse region; as such it is impossible to develop a one-size-fits-all solution for ship design and construction. With this in mind, the Polar Code was developed as a goal-based code in which standards for ice-strengthening and safe design vary depending on the risks associated with the activities.

With respect to ice-strengthening, ships are divided into three broad categories – A, B and C – in terms of what ice-strengthening requirements should be placed on each ship. For example, Category C ships are not ice-strengthened: they are normal Solas ships that are limited by the Polar Code to operating in minimal ice conditions appropriate to their design.

Category A and B ships are ice-strengthened and are designed to operate in more severe ice conditions. However, these design limitations require additional planning and operating guidance for the crew. Work continues to develop further risk-based guidance for ship masters to allow them to assess the condition in those geographic areas and plan accordingly.

Given the risks associated with operation in polar regions, the code also includes measures to protect vital safety equipment and ensure increased ability to respond to emergencies. These include a number of detailed technical requirements for the design, testing and installation of equipment to protect against low temperatures, ice accretions and other factors associated with extreme temperatures.

In addition, the standards for lifesaving arrangements specify escape routes are free of ice and navigable and that there is additional equipment on board to allow sufficient time to evacuate and for rescue resources to respond.

Charting is limited in polar waters and the code requires additional navigation equipment so that ships can know where the ice is. They have additional sensors to be able to see underwater, either for ice or for uncharted mounts.

Additionally, as ships travel into higher latitudes, there are a raft of further technical requirements for communications equipment to ensure safe operations. DPC

Still waters belie multiple hazards. As ships travel into higher latitudes, there are now additional technical and other requirements to ensure safe operations

More understanding needed of polar operations

As the Polar Code comes into force it is of paramount importance that decision-makers have a common understanding of its goal-based rules to ensure robust application. First, it is important to educate everyone about the impending regulations. Operators, flag states, insurers, financial institutions and port state control authorities need to understand its requirements but, more importantly, they need to develop a more thorough understanding of the operating environment. The reality is that there is a lack of understanding so a major effort is required to help in this process.

IMO, working with the world's delegations, has made major strides in increasing awareness and regulation in the polar regions through the Polar Code. A key strength of these regulations is that they are being implemented by way of amendment to three existing conventions, circumventing the need to wait – sometimes for years – for a standalone convention to be ratified. We are very fortunate to have made such progress and it is important for us now to use its rules to protect seafarers and the environment.

For these regulations to be applied correctly, all parties involved need to have a better understanding of the operational environment, industry standards and best practices. Under US leadership, the Arctic Council is endeavouring to assist in this process by proposing to establish an 'Arctic Shipping Best Practice Information Forum' in 2017, with input from the Antarctic states. Developed by experts within the council's working group on the Protection of the Arctic Marine Environment, this forum aims to identify all the best standards available anywhere. These include hydrography, meteorology, ice data, crew training, search and rescue logistics, communication, recommended industry guidelines, traditional and local knowledge, ecological knowledge, operational understanding and ship equipment, systems and structure.

The Polar Code is an example of what we can achieve in international regulation before a significant disaster has occurred in the region, demonstrating a pro-active approach where industry, governments, non-government organisations and international regulators have worked together to make a significant difference. It also provides a solid framework to incorporate additional detailed requirements as we gain more knowledge about this unique environment.

The Polar Code establishes requirements for both ships and mariners

"FOR THESE REGULATIONS TO BE APPLIED CORRECTLY, ALL PARTIES INVOLVED NEED TO HAVE A BETTER UNDERSTANDING OF THE OPERATIONAL ENVIRONMENT, INDUSTRY STANDARDS AND BEST PRACTICES "

Useful links

The following links provide useful material about the Polar Code.

- The code's text can be read at **http://bit.ly/Polarcode**
- In May 2014, the US Coast Guard hosted a workshop about the Polar Code. A summary of that event can be read at **http://bit.ly/PC-Workshop**
- In October 2014, IMO approved amendments to Marpol in connection with the Polar Code. The USCG's comments at the time can be read at **http://bit.ly/PC-Marpol**
- The US definition of the Arctic can be downloaded from **http://bit.ly/PC-Arctic**
- Arctic Council's working group on the Protection of the Arctic Marine Environment: **www.pame.is**

Where are the poles?

From a US perspective, the Arctic is defined in 15 USC 4111 of the US law (see the 'Useful links' box for more details). However, the Polar Code's boundary follows its own definition, which is closely related to the maximum historical extent of ice coverage. The code's boundary is the 60-degree latitude parallel across the Bering Sea to where it intersects with the western slope of Alaska and then continues northward. Everything above this boundary 'line' is considered within the applicability of the Code. Everything below, which includes the whole Aleutian Chain, is outside the applicability of the Polar Code.

Locations such as Prince William Sound and Cook Inlet are also outside the code's applicability. Ships that sail into Anchorage or Valdez may encounter ice, harsh weather and other risk factors, but they are not subject to the Polar Code. Its Antarctic boundary is at 60-degree south latitude. ***DPC***

Polaris: Operational risk management guidance under the Polar Code

At the heart of the Polar Code is a simple risk assessment method: Polaris. Lloyd's Register's Rob Hindley, ABS' James Bond and Vard Marine's Andrew Kendrick explain how it works*

Andrew Kendrick (Vard Marine): Ice strength is treated as 'binary' in Polaris

During the Polar Code's development, it was recognised that variability of ice conditions meant it would not be appropriate to set operational limitations based on geographic location. While a ship's ice class is an indication of its ability to resist ice loads, the conditions associated with ice class are typically described by classification societies in broad or nominal terms that are not especially useful for operational decision making.

So initial provisions for operational limitations were drafted for inclusion in the code's Part I-B guidance section, where they provide a tabular indication of the severity of certain ice types for different ice classes. Recognising that this was a first step, the International Association of Classification Societies (IACS) offered to co-ordinate work to refine this initial guidance by working with administrations that have experience in setting regulations for ice operations in their national waters.

The main goal was to document a process for establishing operational limitations for ships operating in ice that reflected the actual ice conditions encountered by the ship in a format that could be understood and consistently applied. This became the Polar Operational Limit Assessment Risk Indexing System (Polaris).

A technical working group of representatives from Canada, Finland, Sweden, Russia, Denmark (Greenland) and IACS undertook the effort of creating Polaris, which was presented as a paper by Canada, Finland, Sweden and IACS at IMO's 94th Maritime Safety Committee (MSC 94) in November 2014. Polaris was discussed as part of the finalisation of the Polar Code but was not included in the code's text, although it was acknowledged that Polaris, or methodologies like it, would form the basis of the ice operational limitations included in the Polar Water Operational Manual (PWOM).

After the Polar Code text was completed, work on Polaris proceeded through an IMO Correspondence Group, where amendments were made to reflect input from the administrations. This work concluded at MSC 96 in May 2016, where MSC.1/Circ.1519 was finalised as *Guidance on methodologies for assessing operational capabilities and limitations in ice*. This includes Polaris in its revised form as an appendix, and describes the requirements for methodologies to be included as part of the operational limitations in a ship's Polar Ship Certificate (PSC).

The PSC is a mandatory document that is issued by a flag state or classification society after a survey and is required to be on board every ship entering polar waters where the Polar Code is applicable. It confirms that a ship complies with the code's applicable safety-related provisions. It will be reviewed by port and coastal states and be used by owners, charterers, crew and others in assessing a ship's capabilities and limitations. These include operational limitations with respect to ice conditions, low temperature and high latitude, and must be explicitly stated on the PSC.

The developers of Polaris considered existing ice navigation safety management approaches applied worldwide, including the Baltic, Canadian and Russian systems.

Finland manages its icebreaker support operations on the basis of the current severity of ice conditions, matching these to a ship's ice class. Russia uses a number of mechanisms, including requiring certain ships to carry ice certificates that match safe operating speeds to ice class and conditions. A safe-speed tool was acknowledged to be a longer-term objective for operational research, but the current Russian system was considered to be too complex and costly to apply.

Canada has two navigational safety systems under its Arctic shipping regulations. The first, known as 'zone/date', was implemented in the early 1970s and sets entry and exit dates for ships of different ice classes to different areas of Canadian Arctic waters. This is simple but too rigid to be adapted to the huge year-on-year variability of ice conditions.

In the 1990s, Canada implemented the Arctic Ice Regime Shipping System (AIRSS), which links safety to actual ice conditions. Several important concepts from AIRSS informed the development of Polaris. One is the concept of the 'ice regime': ships in polar waters often operate in a mix of ice types and concentrations, including open water. Different ice types represent different levels of damage risk, depending on a ship's ice strengthening, and the ice regime takes account of all the ice along the ship's intended track to calculate an overall 'ice numeral' that determines whether the regime is safe or unsafe to enter.

Canada's shipping industry is a strong advocate for AIRSS, which has been used in offshore operations around Sakhalin and in the Beaufort and Chukchi seas. It has been the subject of considerable validation work, looking at both safe voyages and damage events on ships in Canadian and other waters. A number of recommendations have been made for potential enhancements, many of which were considered for incorporation into Polaris.

The Canadian National Research Council has assembled a large database of voyages in ice (approximately 2,000 records) to assist in validating AIRSS. This data was reused to test the predictions of the Polaris approach, looking both for false positives 'positive Risk Index Outcomes (RIOs) in which damage was incurred' and false negatives 'negative RIOs that actually were successful voyages'.

The percentages in both categories were considered to be acceptable, given that Polaris is a relatively simple system that does not account for all factors involved in safe navigation. For example, ice strength is rarely recorded and is treated as 'binary' in Polaris: either full strength or decayed. In reality, experienced operators can get a feel for ice strength and adjust course and speed accordingly.

Several other validation activities also were conducted with new data. A number of Antarctic cruise operators, through the International Association of Antarctica Tour Operators (IAATO), recorded ice data and associated observations over several seasons and provided them for analysis. There were no damage events during this period, but there were a number of occasions when a ship changed route or reversed course due to ice severity. This correlated very well with the transition from positive to negative RIOs.

Finland provided data, including hull stress measurements collected on the new, higher ice class South African research vessel *SA Agulhas II* during its Antarctic voyages. This showed similar trends. Meanwhile, Canada has continued to apply the AIRSS system to voyages in the Canadian Arctic, including the groundbreaking Northwest Passage transit by *Crystal Serenity* in 2016. In recent years, there have been few ice damage events of any kind, and no serious incidents for any ships using the approach.

The Polaris technical working group undertook a wide range of simulated calculations for vessels of different ice class against a variety of ice conditions. The objective was to assess whether the Risk Index Values (RIVs) appeared to give realistic values based on experience and knowledge. RIVs were adjusted as a result, particularly for the lower ice classes and for Category C vessels, which are designed for operation in open water or in the least-severe ice conditions. Of course, vessels that have fewer safeguards (such as these) risk greater damage. *DPC*

Rob Hindley (LR): Existing ice navigation safety management approaches were considered

James Bond (ABS): "The main goal was to document a process for establishing operational limitations"

*Rob Hindley is Lloyd's Register's global principal specialist in Arctic technology. James Bond is ABS' director of project management (technology). Andrew Kendrick is a vice president at Vard Marine.

Polaris in action

Polaris is based on an evaluation of the level of risk posed to the ship by ice conditions – as described using World Meteorological Organization nomenclature – and the ship's assigned ice class.

Polaris can be used for voyage planning or to support a master's on-board decision-making in real-time on the bridge. Using Polaris, operational risk is represented by a single numerical value, referred to as the Risk Index Outcome (RIO).

An RIO is determined by this simple calculation:
RIO = (C1×RIV1)+(C2×RIV2)+(C3×RIV3)+(C4×RIV4)+...(Cn×RIVn)

Where:

- C1...Cn are concentrations (in tenths) of ice types within the ice regime
- RIV1...RIVn are corresponding risk index values (RIVs) for the ice types for a given ice class

A positive RIO indicates an acceptable risk level where normal operations can proceed. A negative RIO indicates an increased risk level, potentially to unacceptable levels. As shown in Table 1, criteria are established for negative RIOs, suggesting that operations should stop and be reassessed, or that a vessel should proceed cautiously with reduced speeds.

The RIVs are functions of ice class, season of operation and operational mode (independent operation or icebreaker escort). Standard RIVs are used unless the presence of ice decay is confirmed. Risk levels increase with increasing ice thickness and decreasing ice class.

Polaris provides RIVs for the seven IACS polar classes, four Finnish-Swedish ice classes and non-ice-classed ships.

TABLE 1: RIO CRITERIA

RIO	Ice Classes PC1-PC7	Ice Classes below PC7 and non-ice class ships
RIO ≥ 0	Normal operation	Normal operation
-10 ≤ RIO < 0	Elevated operational risk	Operation subject to special consideration
RIO < -10	Operation subject to special consideration	Operation subject to special consideration

Integrating Polaris into the PWOM and voyage planning

Polaris is a decision-support tool, so it is important that the integration of Polaris with the Polar Water Operational Manual (PWOM) aligns as far as possible with existing procedures. It is recommended that alongside the Polaris system, operators provide additional ship-specific information to assist the master and crew in using the system, for example:

- Providing worked examples (step-by-step) for calculating the RIO. (The system's simplicity is easier to recognise through a practical example.)
- Identifying the RIVs to be used for a specific ship's ice class. (Operators may find it simpler if the RIVs for the ship are highlighted in the PWOM.)
- Providing further detail on what action is to be taken in regimes where a negative RIO is encountered. (Polaris describes, in broad terms, mitigating measures for elevated risk operations, but operators may wish to include company-specific guidelines.)

The vast expanses of Greenland's Arctic waters. Technical experts from this country helped shape Polaris

In addition, it may be useful to provide an *aide-memoire* for operators with respect to identifying different ice types and ice concentrations. The World Meteorological Organization's (WMO's) definitions for ice types could be included, as might extracts from other publications. Some ice types used in Polaris are not in the WMO definitions and may need further clarification.

There is no mandatory reporting requirement for Polaris but, to support good record-keeping and to enable feedback on operations, it is recommended that ship operators specify in the PWOM procedures:

- When Polaris should be used;
- How frequently RIOs should be calculated;
- Where calculated RIOs should be recorded (and what additional information should be recorded alongside them).

Polaris does not cover every eventuality. For some operators, where specific manoeuvres or activities are undertaken in ice, it might be necessary to supplement the Polaris methodology. In addition, Polaris does not necessarily take the place of national requirements, so any ice navigation systems that are specific to geographical areas should be included in the PWOM alongside Polaris with a clear definition of when either system is to be used.

Perhaps the most important aspect of integrating Polaris is to give navigating officers practise using its processes to understand which ice regimes result in negative RIOs for their ship. As a consequence, the operator should intuitively know what level of risk is associated with operation for the ship in the specified ice regime.

The new Standards of Training, Certification and Watchkeeping for Seafarers model training courses should include elements of Polaris once they are in place but, in addition to worked examples in the PWOM, it is recommended that operators provide training to their navigating officers regarding when and how Polaris will be used on board specific vessels. *DPC*


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Polar operations need bolstered winterisation

Arctic and Antarctic operations pose unique challenges that require new levels of vessel winterisation. The Polar Code is a useful first step, writes Mike Corkhill

Designers, builders and operators of ships active in ice-covered waters have traditionally referred to the ice class 1A Super and 1A notations detailed in the Swedish-Finnish rules for their most robust ships. While an excellent standard, they are predicated primarily on Baltic operations where ice is a winter-only phenomenon.

To underscore the extent of the winterisation challenges faced in Arctic and Antarctic regions consider the following: commercial operations at the Yamal LNG terminal at Sabetta in the Russian High Arctic are due to begin in the second half of 2017. Ice cover persists for 300 days of the year, the average annual temperature is -9˚C and winter readings of -40˚C are not unusual.

The polar environment presents many more hazards than ice cover and robust winterisation rules are needed to protect people, vessels and the environment from the effects of a cold climate, such as the effect of low temperatures on materials, equipment and systems, ship icing and particular propulsion and manoeuvring challenges in ice.

For Tronde Spande, winterisation expert and vice president offshore and marine solutions at Norway's Safe Yards, the measures covering winterisation in the Polar Code are a useful first step. But he foresees future revisions offering more precise definitions and including mandatory elements, such as making it mandatory that escape routes, muster stations and staircases are all available and free of ice.

He estimated that the cost of completely winterising a US$100 million vessel for polar operations would range between US$300,000 and US$400,000. This creates a market for winterisation services, he said, and his parent company has set up a new entity, Safe Arctic Technology, which is working with leading cable specialist Bartec.

A new era in LNG and Arctic operations

The world's first icebreaking LNG carrier is set for delivery by 31 January 2017, coinciding with the entry into force of the Polar Code and marking a new era in LNG shipping and Arctic transportation.

The inaugural icebreaking LNGC is the 172,000m^3 *Christophe de Margerie*, the first of 15 such vessels being constructed by Daewoo Shipbuilding & Marine Engineering to load cargoes at the Yamal LNG terminal at Sabetta in the Russian High Arctic. Although its keel was laid well before the new regime's stipulated January 2017 start date, the vessel has been constructed in anticipation of the code: on 1 January 2018 the Polar Code will also become mandatory for existing ships in polar regions.

The fact that the keels of several ships in the Yamal series will be laid after the code's entry into force was another driver for following the Polar Code for the entire series.

Its design, construction and equipment are in line with the ice rules of the vessel's twin class societies, Bureau Veritas and the Russian Maritime Register of Shipping, both of which were closely involved in developing the Polar Code.

The Unified Requirements Concerning Polar Class developed by the International Association of Classification Societies in 2008 also provided guidance, as did IMO's 2009 predecessor to the code, *Guidelines for Ships Operating in Polar Waters*.

The 15 Yamal icebreaking LNG carriers are being built to the RMRS Arc7 standard, which falls between the Polar Code's PC3 and PC4 classes. Their 45MW propulsion system uses three ABB Azipods to power through ice up to 2.5m thick in year-round operations.

Yamal LNG chose a double-acting design, with a heavy icebreaking profile and three azimuthing propellers aft, a moderate icebreaking bow, forward and aft ice belts and additional internal ribs. The LNGCs will move in a forward direction in light ice and open seas and stern-first in heavy ice.

The BV winterisation notation for the Yamal ships – COLD (-45,-52) – indicates the extent to which they are ready for harsh polar conditions. The hulls will be able to operate in ambient temperatures as low as -45˚C while equipment will function down to -52˚C. DPC

The enhanced winterisation requirements for the Russian Arctic have helped drive the Polar Code's agenda

Growing Arctic shipping faces major hazards

A flag state that was instrumental in creating the Polar Code has concerns about shipping growth amid safety and environmental risks

A training session on tackling an oil fire in Arctic conditions at the US Army Engineer Research and Development Center (ERDC) Cold Regions Research and Engineering Laboratory (credit: ERDC)

When Kostas Ladas, general manager of the London office for Liberian International Ship & Corporate Registry (LISCR), which manages the Liberian Register, addressed the *Tanker Shipping & Trade* conference in London in November, he predicted significant growth in Arctic traffic in the coming decades but warned of big safety and environmental risks.

He was delivering a paper written by Christian Mollitor, vice president of LISCR, which said that the leading intergovernmental forum promoting co-operation, co-ordination and interaction among the Arctic States – the Arctic Council – has predicted increased summer marine traffic for scientific exploration and tourism, fishing and trans-Arctic voyages in the future.

It also mentioned a guide issued in April 2016 by China's Maritime Safety Administration that is intended to encourage Chinese-flagged ships to use the Northwest Passage to cut travel times and distances.

Polar operations currently require icebreaker escorts, but another study mentioned in the paper predicted this will not always be the case: a study by researchers at the National Oceanography Centre in Southampton, UK, and the Nansen Environmental and Remote Sensing Center in Bergen, Norway, found that "unescorted navigation in the high Arctic in summer may be possible as early as the 2030-2040s and is probable after 2050."

This growth will produce both opportunities and challenges, and conference delegates heard that the Arctic Council had identified emergency response as particularly challenging in the Arctic. In Antarctic waters, things are better, the paper said. When the cruise ship *Explorer* sank in 2007, "Argentina and Chile had some infrastructure and response capability nearby," thanks to the established tourism interest in the area, along with military and scientific bases and the trade route around Cape Horn: "things that do not yet exist in the Arctic," the paper reported.

The council also said that increasing numbers of marine tourism and passenger vessels operating in Arctic waters represent the "most significant emerging challenge" to existing search and rescue (SAR) infrastructure. "Repatriation of thousands of passengers would be near impossible," Mr Mollitor's paper said.

Environmental risks are just as great. Just as there is a shortage of SAR resources, there is also "very limited (if any) pollution prevention equipment that can quickly appear in the case of a ship grounding, sinking or other case of pollution discharge," his paper said. In any case, clean-up operations would be nearly impossible in the Arctic, because of the treacherous stormy weather, freezing temperatures, icy conditions, short seasons and isolated locations.

The paper also highlighted another unmitigated hazard: less than 1 per cent of Arctic waters have been charted, because of the ice cover. It quoted Rear Adm Gerd Glang, director of the US National Oceanic and Atmospheric Administration, who has estimated that it would take over 100 years to chart just Alaska's Arctic coastline.

Delegates were told that the Arctic Council understands these risks and is trying to mitigate them through two co-operation agreements to make the most of the various Arctic nations' resources.

New testing regimes may be needed for LSAs to match the Polar Code (credit: Photoeverywhere)

Life-Saving Appliances Code needs a polar review

Even as the Polar Code comes into force, a significant aspect of ship operating in cold conditions is still being addressed: IMO's Life-Saving Appliances (LSA) Code.

IMO's Maritime Safety Committee (MSC) received a paper from five flag member states – Argentina, the Marshall Islands, New Zealand, Norway and Vanuatu – during its 97th meeting in November 2016. Their paper identified a large number of topics within the Polar Code that it suggests should be reviewed to assess how the LSA's testing standards should be amended to bring them into line with the Polar Code. Its recommendations were accepted by MSC 97.

They require IMO's sub-committee on Ship Systems and Equipment to review the LSA Code and relevant IMO resolutions "to adapt current testing and performance standards to the Polar Code provisions or to develop additional requirements."

They also instruct the sub-committee on Navigation, Communications and Search and Rescue to "consider current communication requirements in Solas" and "consider the need for a new performance standard for GNSS compasses." The two sub-committees will report back to MSC during 2017.

It is possible that any changes eventually proposed might make current LSAs on ships in polar regions unusable without modification, said Bob North, who leads the Marshall Islands' work on the Polar Code through its US-based provider of administrative and technical support, International Registries Inc (IRI).

Polar Code resources available online

A striking feature of the Polar Code is the amount of guidance notes included within it, providing clarifications of many of its detailed requirements. Among these are notes on what the operational assessment – which is required for every ship – should cover.

The Marshall Islands' US-based provider of administrative and technical support, International Registries Inc (IRI), has used these to develop an 11-page *Model Polar Waters Operational Assessment* form, which is available on its website (http://bit.ly/IRI-PolarModel).

IRI has also developed a set of frequently asked questions, which are also available online (**http://bit.ly/IRI-PolarFAQs**).

This five-page document covers a full range of topics, starting with the Polar Code's origin and purpose and continuing with such details as how it amends the Solas, Marpol and STCW conventions. It concludes with sections describing the actions that shipowners and operators should take to implement the code.

Code may require ship structure work

Some ships operating in polar regions may have to make modifications to comply with the Polar Code, warned Bob North – who is president of North Star Maritime and leads the Marshall Islands' work on the Polar Code through its US-based provider of administrative and technical support, International Registries Inc (IRI).

The code's limits on discharges of various waste products come into effect on 1 January, but reception facilities for ship-generated waste and oily waste "are limited to non-existent" in some polar areas. Ships "either need to develop capacity to retain that waste or not be there," he said.

How many ships will be affected is not clear. For example, bulk carriers entering the area to load cargoes of ore for delivery elsewhere may not stay long enough in the polar region for waste disposal to become an issue.

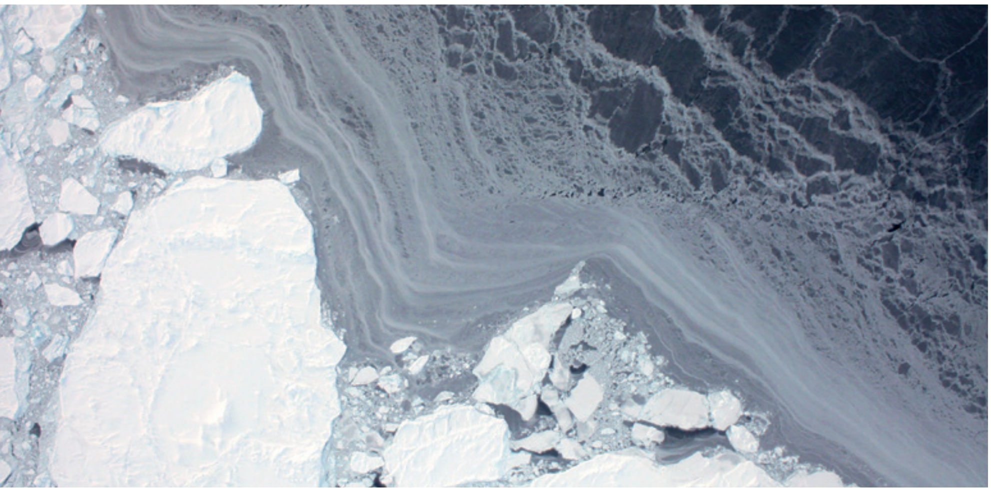
But in years to come, if transit traffic along the Northern Sea Route and the Northwest Passage becomes more common, the Polar Code will become relevant to more ships, and those few that currently use those routes will have to reassess their suitability when applying for Polar Ship Certificate (PSC).

Before shipowners currently operating in polar waters may receive their PSCs, the Marshall Islands Register has advised them that they must conduct an operational assessment "to see if they are currently in compliance or what additional equipment or structural modifications [for example] could be needed."

To help them in that task, the Marshall Islands Register can work alongside shipowners and their class societies to "consider the existing condition of a ship, what the Polar Code would require, what the gap [between them] is and how that can be closed," RADM North said. DPC

Bob North (IRI): Ships must either create waste storage on board "or not be there" (credit: IRI)

Monitoring ice from space reduces risks



NASA satellites can provide vital ice information to support Arctic navigation. Experts* involved in the technology explain its benefits

Vanessa Escobar (NASA): Risk does not recede when ice melts

Climate change has significantly affected the amount of thick, multi-year ice present in the Arctic[1], with the result that high-latitude shipping and commercial voyages are becoming more frequent. Under the Polar Code operators must hold a *Polar Water Operational Manual (PWOM)* that explains a plan for dealing with a worst-case scenario in the conditions that may be encountered.[2]

As a result, interpreting sea ice data from NASA satellites to assess opportunities and risks at sea is more important than ever. Ship operators in the Polar Regions depend on timely, accurate, and relevant information about sea ice extent and thickness in the navigable waters of the Arctic[3] and, according to a recent survey of Arctic ship operators, the most important risk was "uncertain meteorological, oceanographic and hydrographic data."[4]

NASA's Earth Science Applied Sciences Program (ASP) is mitigating this risk by working directly with the Arctic community and industry so that sea ice data is more easily interpreted, accessed and applied to the needs of operators and responsive to the changing conditions in the Arctic.

Variability in sea ice conditions makes information on sea ice – including its thickness and extent – particularly important for safe and efficient operations in the Arctic. September 2016 tied with September 2007 for the second lowest minimum ice extent in the Arctic on record, at 4.4 million km^2. Reductions in non-moving – known as 'fast' – ice near land-bound glaciers promotes the release of icebergs into the Arctic Ocean so high quality iceberg detection and estimates of ice concentration (the fraction of the surface covered), ice classification and storm forecasting can help in reducing risk.

Less multi-year sea ice means that northern sea routes will increasingly be used for shipping traffic and to service increased offshore and near-shore economic activity in the region. The potential benefits of transit through the Northwest Passage are significant, as ship routes from Europe to eastern Asia would be 4,000km shorter than transiting through the Panama Canal.

But while an increase in traffic can be seen as an economic opportunity, there is also the risk of environmental impact. Any increase in commercial activity will bring with it complex and interacting risks to the environment, to assets, and to people. These risks make frequent, continuous and comprehensive data coverage with satellites a priority for current and forecasted scenarios.

Two new satellites from NASA are helping improve the baseline knowledge of conditions in the Arctic. Their observations provide a direct measurement of ice height, ice thickness, iceberg location, ice extent and ice concentrations, while modelled data provide awareness and perspective to potential route closures, ice thickening and dangerous storms. Understanding sea ice concentration, its stage of development (age and structural characteristics) and form (horizontal shape, dimensions and maximum height above the sea surface) is key to development of sea ice products and services.

A fundamental way to reduce risk and ensure operations are carried out safely and sustainably is to ensure legislation and voluntary guidelines are based on the most up-to-date data and research. The US, Canada, Denmark, Russia, Finland, Norway, Iceland and Sweden have an operational responsibility to provide updates of sea ice conditions to vessels navigating in the Arctic. Sea ice and iceberg products and information provided by national and international ice services enable safe and efficient maritime operations. NASA provides satellite data directly to these centres and works with the developers to ensure data is relevant to the community they serve.

Satellite data provides continuous and comprehensive situational awareness of changing conditions that cannot be achieved by ships alone. However, validating this data with that from ship operators and ice centres provides an unprecedented opportunity to contribute to the safety of those at sea and to the environment and livelihoods that surround the Arctic.

NASA works directly with the Arctic industry and those end users who are early adopters of the technology to help validate satellite data and make it more relevant to communities that will apply the data. By working to improve the access, scale and format of the data, sea ice data providers and users provide feedback that is incorporated into product development.[5] The user community helps inform product development and identifies risks, further enhancing the value of the data.

Early adopters focused on sea ice mapping are using microwave remote sensing technology from NASA's Soil Moisture Active Passive Mission (SMAP) to map sea ice thicknesses, distinguish ice from multi-year ice, sea ice extent and sea ice concentration.

SMAP was launched in 2015 and uses passive L-band microwave remote sensing to detect moisture in the top 5cm of the Earth's soil surface. This information is highly valuable for agriculture, flooding, weather and health applications. However, SMAP's data also provides information to derive information regarding sea ice conditions, and early adopters for the SMAP mission provide Arctic-wide daily maps of sea ice thickness up to 1.5m. The use of SMAP through early adopters has improved previous data algorithms to increase the data record for a more up-to-date historical reference of ice condition.

Launching in 2018, NASA's Ice, Cloud and land Elevation Satellite-2 (ICESat-2), mission will use a six-beam Lidar (Light imaging, detection and ranging) surveying system to measure surface elevation across the globe.[6] The micro-pulse, multi-beam Advanced Topographic Laser Altimeter System (ATLAS) that will be used will enable global, seasonal and high-resolution observations and understanding of high altitude ice concentrations and behaviour.

The small footprints of ATLAS (about 15m) combined with dense along-track spacing (about 70cm), along with precision elevation measurements (<10cm over most surfaces) and geolocation knowledge (data located on Earth's surface to <6.5m) will allow ICESat-2 data to be used as a primary data source on sea ice thickness.

The mission will enable measurements of sea ice freeboard to an uncertainty of less than or equal to 3cm along 25km segments for the Arctic and Southern Oceans – under clear sky conditions and when sea surface height references are available through gaps in the ice. ICESat-2 will acquire year-round data over ice-covered oceans, different seasons and through seasonal transitions.

While ice is melting at record rates and technology has advanced, there are still substantial difficulties and risks of navigating through the Arctic. A clear understanding of the data that is readily available from NASA and the early adopters help mitigate risk and inform vessels of the real time hazards and forecast scenarios. This knowledge will help increase awareness, preserve the safety of passengers and the Arctic environment.

*This article was written by Vanessa Escobar, Lead Research Scientist/NASA Missions Applications Coordinator; Molly Brown, University of Maryland, College Park; Michael Sparrow, World Meteorological Organization; and Paolo Ruti, World Meteorological Organization

TWO-YEAR MISSION WILL IMPROVE POLAR PREDICTIONS

The two missions described in the article on these pages reflect just a sample of how NASA Earth Science Applications is using satellite observations to increase awareness, reduce risk and provide increased value to users. By working with the industry, NASA is responding directly to the needs of a changing environment as reflected in the Year of Polar Prediction (YOPP).

Despite its name, YOPP is a two-year project set to run from mid-2017 until mid-2019. It centres around an intensive observation and modelling campaign at both poles and follows a preparation phase that began in 2013. It will conclude with a consolidation phase that will continue until 2022.

YOPP is a flagship activity of the World Meteorological Organization's World Weather Research programme. It will enable a significant improvement in environmental prediction capabilities for the polar regions and beyond, by coordinating a period of intensive observing, modelling, prediction, verification, user-engagement and education activities.

The additional data collected during YOPP will be used to optimise the polar observing system and improve prediction services. *DPC*

Further reading

To follow up on some of the information referenced in this article, use these links to access the authors' background information.

[1]Parkinson, Claire L., and Nicolo E. DiGirolamo. "New visualizations highlight new information on the contrasting Arctic and Antarctic sea-ice trends since the late 1970s." **http://bit.ly/PC-Seaice**

[2]Kingston, Michael. Learning Lessons from History. The historic voyage of the Crystal Serenity cruise through the Northwest Passage marks an important early test for the new Polar Code regulations. **http://bit.ly/PC-Crystal-S**

[3]CGMS SETT, 2016, Fourth CGMS SETT Workshop Summary Report, September 20, 2016, Beijing China. [4]IMarEST Technical and Policy Team, 2016. Safety and sustainability of shipping and offshore activities in the Arctic: The Institute of Marine Engineering, Science and Technology: A round Table Report. **http://bit.ly/PC-Offshore**

[5]Escobar, V.M, et al. Improving NASA's Earth Observation Systems and Data Programs Through the Engagement of Mission Early Adopters, Chapter in *Earth Science Satellite Applications*, F. Hossain (ed). **http://bit.ly/PC-Earth-Obs**

[6]Brown, Molly E., Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2) Applications, Iceberg Tracking from Space White Paper, 2016.

ICE CHARTING PROVIDES VITAL SAFETY SUPPORT

Ice floating in the ocean is what makes navigation in the polar regions unique and challenging, writes John Falkingham of the International Ice Charting Working Group

ABOVE: Fednav's bulk-carrying icebreaker, *Umiak I* shuttles all year round between Vale's mine in Voisey's Bay, Labrador, and the Port of Quebec

Whether it is sea ice, formed of frozen sea water, or icebergs calved from coastal glaciers, floating ice presents a significant navigational hazard.

The Polar Code recognises this in typical understated fashion: "Ships shall have the ability to receive up-to-date information including ice information for safe navigation," it says. References to ice are numerous throughout its text, but the bottom line is that masters sailing in the polar regions must plan their passages with full knowledge of their expected ice conditions and make tactical navigation decisions based on up-to-date ice information.

This is where ice charting services are invaluable. All the Arctic states have national ice services that provide routine monitoring and charting of ice conditions. Within the Arctic Polar Code region, Canada, Denmark (Greenland), Norway, Russia, and the US all have sophisticated ice information programmes that incorporate large volumes of satellite imagery and computer models of ice dynamics, alongside experienced analysts and forecasters to produce timely ice charts.

In addition to producing ice charts for their own waters and economic zones, these ice services also collaborate to construct ice charts for the entire Arctic Ocean (www.bsis-ice.de/IcePortal/).

Ice charting is not as well established in the Antarctic Polar Code region. The US, Russia and Norway jointly produce weekly ice charts for the circumpolar Antarctic waters (http://ice.aari.aq) and Argentina has recently started producing daily ice charts for its Antarctic sector. Chile and Australia produce ice information on demand in support of their Antarctic re-supply operations and are contemplating a more routine service.

All of these national ice services have joined together, along with the Baltic services, in the International Ice Charting Working Group (IICWG), which was formed in 1999 as a working group primarily for the purpose of exchanging information and ideas. Since then, it has evolved into a recognised collaboration of national ice services promoting standardisation, product development and best practices to provide the most effective service to their collective clients.

Shipping, by its very nature, is international and IICWG believes that mariners should have access to ice information that is consistent in its quantity, quality and presentation when travelling among multiple national regimes. To that end, IICWG has worked continuously to implement standard notation and symbology to give a common "look-and-feel" to ice charts.

IICWG collaborates closely with the World Meteorological Organization to codify these standards and the best practices in publications such as *Sea-Ice Information Services in the World* (WMO-No.574) and the *Manual for Marine Meteorological Services* (WMO-No.558). To help ensure consistently high quality, IICWG conducts regular ice analyst workshops to share training opportunities among its member services.

At its core, the Polar Code is a risk-based system that allows a mariner to operate within an acceptable risk envelope determined by the vessel's capabilities, the environmental conditions, and the equipment and safety measures available. In the case of ice information, the Polar Code requires the vessel's *Polar Water Operating Manual* to contain "the methodology used to determine capabilities and limitations in ice." The methodology is not prescribed but one tool that has been widely discussed is POLARIS, described elsewhere in this supplement.

Whatever methodology is used, it must contain an assessment of the ice conditions – certainly concentration and thickness, perhaps strength, pressure and stage of decay.

For real-time navigating decisions, it is the master's view from the bridge that will determine the ice conditions and the associated level of risk. For longer-term passage planning, the primary source of ice information will be ice charts (see box). For the shorter term, covering today and perhaps tomorrow, ice masters will use an ice analysis ice chart together with their own experience.

This gives the master the basic information to apply his own knowledge and experience to estimate how those conditions will change over the coming hours and plan a route accordingly. For longer lead time planning, days to a couple of weeks, the master may turn to forecast ice charts that are becoming an increasingly common product from the ice services.

For even longer advance planning, for months and years in the future, voyage planners will use climatological ice charts in conjunction with analysis charts of current conditions and long-term forecasts prepared by the ice services. For example, a shipping company bidding on a contract to carry ore along an ice-infested route may choose to charter a vessel with an ice class sufficient to handle the most extreme ice conditions deemed probable. A cruise line planning a new route in waters where ice is a concern may alter its timing to a period when the ice conditions are most likely to be favourable.

As ecdis becomes the norm for navigation, under an initiative by IICWG, ice services are producing ice chart data in S-411 format, compatible with the S-100 family of ecdisstandards. These products are available on the Ice Logistics Portal operated by the German Ice Service (www.bsis-ice.de/IcePortal/). Ecdis manufacturers now need to provide the capability to display these data on their systems, an issue the IICWG is currently discussing with the industry.

A CHOICE OF CHARTS

There are many different types of ice charts available to mariners.

• Climatological, or historical, ice charts depict "normal" ice conditions, perhaps with extremes, of past years mainly for advance planning of maritime operations.

• Ice analysis charts show current ice conditions in a particular area, providing basic information aimed at enhancing marine safety in ice-frequented waters. Depending on need and resources, these are generally produced daily or a few times a week and are based primarily on satellite imagery received in near real-time at the ice services.

Most important are Synthetic Aperture Radar (SAR) images from satellites such as Sentinel-1 and Radarsat. These can image the ocean surface in all weather and light conditions. Analysts at the ice services analyse these images, calibrate them with other data, such as ship reports, extrapolate to fill gaps in the satellite coverage, and make adjustments for time differences between images to prepare the ice analysis charts broadcast to mariners.

• Forecast ice charts show the ice conditions expected within a few days. Based on coupled ocean-ice-atmosphere models, forecast charts typically include some human interpretation of the model results to provide a forecast of the ice conditions in the same format as the analysis charts. Computer models of ice dynamics are also permitting the calculation of ice drift, pressure, and strength that are beginning to make their way onto ice charts.

Ice charts show where sea ice, icebergs, and ice-free waters are located. Within the sea ice, areas of roughly homogeneous ice conditions are outlined. Within each area, the concentration (expressed in tenths of each ice type in the area) is given. They also show the ice type, which relates to its thickness, ranging from new ice (<10cm) to thick first year ice (>120cm) and multi-year ice, which is generally thicker than 150cm and is very hard and dangerous to ships.

As an example, a homogeneous ice area may be described as comprising 1/10 multi-year ice, 4/10 thick first year ice, and 2/10 new ice, for a total of 7/10 ice cover. *DPC*

RISK INDEX VALUES (RIVS) FOR EACH ICE TYPE

	ICE FREE	NEW ICE	GREY ICE	GREY WHITE ICE	THIN FIRST YEAR 1ST STAGE	THIN FIRST YEAR 2ND STAGE	MEDIUM FIRST YEAR	MEDIUM FIRST YEAR 2ND STAGE	THICK FIRST YEAR	SECOND YEAR	MULTI YEAR	HEAVY MULTI YEAR
PC1	3	3	3	3	2	2	2	2	2	2	1	1
PC2	3	3	3	3	2	2	2	2	2	1	1	0
PC3	3	3	3	3	2	2	2	2	2	1	0	-1
PC4	3	3	3	3	2	2	2	2	1	0	-1	-2
PC5	3	3	3	3	2	2	1	1	0	-1	-2	-2
PC6	3	2	2	2	2	1	1	0	-1	-2	-3	-3
PC7	3	2	2	2	1	1	0	-1	-2	-3	-3	-3
IAS	3	2	2	2	2	1	0	-1	-2	-3	-4	-4
IA	3	2	2	2	1	0	-1	-2	-3	-4	-5	-5
IB	3	2	2	1	0	-1	-2	-3	-4	-5	-6	-6
IC	3	2	1	0	-1	-2	-3	-4	-5	-6	-7	-8
NO ICE CLASS	3	1	0	-1	-2	-3	-4	-5	-6	-7	-8	-8

Ice management – the enabler of Arctic ice operations

The introduction of the Polar Code gives a fundamental framework for Arctic operations. From an ice management perspective, it does not give all the answers but for every operation in ice it will point towards some critical questions, such as methodical studies of potential ice conditions, dimensioning of tonnage for operations and other critical parts of planning an operation.

Ice operations in the high north are not a new development, but there has been an increased focus on the importance of ice management in recent years as Arctic operations in ice-free conditions have moved further north into ice conditions. This represents a paradigm shift in the risk analysis of such operations, making ice management expertise a critical factor.

Without the ability to manage ice, there are many scientific as well as commercial operations that cannot take place. An example is the Arctic Coring Expedition in the summer of 2004 that involved drilling for core-samples on the Lomonosov ridge. The result of the expedition has significantly deepened the understanding of the history of the Arctic basin during the past 55 million years.


Åke Rohlén

Several Arctic nations have issued licences for exploration of oil and gas on the continental shelf. In many of the licences it will be impossible to explore for resources without the ability to manage the ice. Oil and gas resources are desired by nations, as they bring energy independence, taxes and economic development. These goals are achievable because ice management makes it possible to operate on the continental shelf.

Ice management is performed to protect an operation at a fixed location from drifting ice. The reasons may be rescue of a vessel, dealing with an oil spill, works on the sea floor for scientific needs, or resource exploration or extraction.

The creation of predictable operating conditions is key to safety and efficiency, and makes it possible to plan and execute operations. Planning and executing the ice management must be performed so that any conditions can be handled according to a plan.

Ice management is an operational service with well-trained and experienced staff, supported by technology and data. Operational experience is key to the successful handling of the ice conditions as well as a pre-requisite for correct analysis in the planning stage of an operation.

The Polar Code specifies that a risk analysis should be performed for a particular voyage or operation, before which some considerations must be made.

There needs to be an analysis of the potential ice conditions in the operating area. What are the worst conditions that may occur? One should take note of the fact that 'average' is not an acceptable operating limit.


Anders Backman

Another consideration is to define the productivity of a given vessel during the potential ice conditions. What ice will it be able to break and what time will it take?

This is an area where the industry will have to develop methods on how to be able to distinguish the productivity of one icebreaker from that of another. From experience, there can be a difference in productivity of several hundred per cent between icebreakers of the same strength and power.

Ice management will be critical for safe and efficient Arctic operations, and the introduction of the Polar Code will give the opportunity for managing Arctic operations prudently. DPC

About the authors: Åke Rohlén is a partner in Arctic Marine Solutions a Swedish company specialising in Arctic ice management operations. Anders Backman is an associate of Arctic Marine Solutions. In 1991 he was the first Master to reach the North Pole with a conventionally powered ice-breaker, *Oden*.

Training lags a year behind the code

Thanks to IMO's meeting schedules, the Polar Code's training goals will take effect a year late. President of The Nautical Institute, David (Duke) Snider, explains what this will mean

It will be a year after the Polar Code comes into force before the sections that address crew training and certification requirements become effective. They are addressed in Part I-A Safety of the code's Chapter 12 and outline requirements for deck officers and masters on board Polar Code applicable vessels that will operate in polar waters. Their delayed entry into force is because of the fixed schedule of IMO committee meetings related to STCW amendments.

That timetable would not permit acceptance of these details until IMO's Maritime Safety Committee (MSC) held its 97th meeting in November 2016. This has delayed any entry into force of the sections relating to crew training and experience that must have STCW amendments to be enabled until well after the code's entry-into-force date.

As a result, these sections will not come into force until 1 January 2018. All other provisions enabled by Marpol and Solas were completed to fit the 2017 timeline, and the bulk of the Polar Code comes into force 1 January 2017, with an accompanying phase-in period for existing ships.

When the STCW amendments do come into force, deck officers and masters may be required to complete training and receive certification at either a basic or advanced level. As set out in the table below, the requirement to have these 'Polar Waters Training' courses and certificates will depend on the vessel, the ice conditions and the individual officer's position on board the vessel. It should be noted that these requirements apply only to Solas ships operating in polar waters as defined within the Polar Code, and future amendments may broaden the scope of applicability to other ships, including fishing vessels and smaller coastal ships.

The Basic Polar Waters Certificate of Proficiency will be issued after completion of an approved basic course and proof of meeting the standard of competence outlined in A-V4 of STCW; no sea service is required for this level of certification. To obtain the Advanced Polar Waters Certificate of Proficiency, an officer must first complete the basic level requirements then accumulate at least two months of approved sea service, either at a management level or while watchkeeping in polar waters or approved equivalent waters. Revalidations will be required every five years.

There is consideration for a transitional period as the new requirements gradually come into force after 1 January 2018, allowing deck officers and masters to obtain interim certificates of proficiency that will be permitted until two years after coming into force.

For the Basic Certificate of Proficiency, the officer must:

• hold a current STCW Certificate of Competency and have either
• completed polar waters sea service, or approved equivalent, of three months in the preceding five years;
• or attended a training course, provided the course meets the requirements of STCW B-V/g.

For the Advanced level, a senior deck officer or master must:

• hold a current STCW Certificate of Competency;
• have commenced approved sea service in polar waters prior to the date of entry into force and either
• establish that they meet the competency requirements with three months' sea service at the management level in the previous five years
• or have completed an approved course and completed two months' sea service in

LEFT: Polar Code/STCW training and certification misses a requirement for sea service in ice-infested waters (credit: Duke Sneider)

polar waters, or equivalent seagoing service.

At present there are no 'approved' courses, although non-approved courses appear alongside a number of ice navigation courses that have existed for numerous years in institutions experienced in ice and polar training. In some cases, guidance has been developed to cover the interim, such as the United States Coast Guard's guidance document *16715 CG-OES Policy Letter – Guidelines for Training Personnel on Ships Subject to the International Code for Ships Operating in Polar Waters (Polar Code).*

IMO is expected to approve model courses for the Basic level at the fourth meeting of IMO's Sub-Committee on Human Element, Training and Watchkeeping (HTW 4) in late January 2017. Several administrations have submitted draft model courses for IMO acceptance at the meeting but these courses are intended to meet only the specific requirements laid out in the Polar Code and the related STCW amendments.

As many who have been involved in the process admit, the courses will not address many concerns raised by operators and flag states with respect to actual ice operations competency and experience. Several institutions have conducted well developed 'ice navigation' courses over the years, and point out that IMO's requirements tend to be more focused on theoretical and regulatory knowledge at the expense of addressing the need to meet competency and proficiency in handling ships in ice.

For many, the most flagrant gap in Polar Code/STCW training and certification is this lack of requirement for sea service in ice-infested waters. This absence is causing concern in the experienced polar shipping community because a lack of experience within ice-covered waters is a clear safety weakness to all but those vessels that are guaranteed to operate in ice-free waters.

Some operators, insurers and other agencies are looking for standards above the present Polar Code requirements. In particular, the Nautical Institute is continuing to pursue implementation of its Ice Navigator Training Accreditation and Ice Navigator Certification schemes.

These schemes are intended to complement the requirements of the Polar Code and fill the gap, putting in place a recognised level of certification that ensures officers meet basic and advanced levels of skill in handling ships in ice, whether inside or outside polar waters. Once in place, the schemes will accredit training institutions that meet the Polar Code/STCW requirements and address additional needs to ensure competence and proficiency in operating vessels in ice-infested waters. The accompanying certification scheme will measure individuals against a known and common standard of proficiency and competence. DPC

Ice Conditions	Tanker	Passenger	Other
Ice-free	Not applicable	Not applicable	Not applicable
Open waters	Basic training for master, chief mate and officers in charge of a navigational watch	Basic training for master, chief mate and officers in charge of a navigational watch	Not applicable
Above open water (ice coverage above 10%)	Advanced training for master and chief mate. Basic training for officers in charge of a navigational watch	Advanced training for master and chief mate. Basic training for officers in charge of a navigational watch	Advanced training for master and chief mate. Basic training for officers in charge of a navigational watch

Azipod propulsors perform in polar adventure

Superior vessel manoeuvrability, better safety and comfort, and optimised power consumption make ABB Azipod units the natural starting point for polar cruise ships.

The growing popularity of Arctic and Antarctic cruising has brought a spike in orders for passenger ships capable of operating in icy waters. Ensuring their safety is no mean feat, and additional risks must be considered when designing the vessel and its propulsion.

ABB's Azipod has a strong track record across the ice-going sector. It satisfies Polar Code requirements and is available with PC notations for a range of ice conditions.

More than 60 vessels in operation or on order for icy waters use Azipods. Interaction between pods and ice is well understood, and no pods have encountered structural damage due to ice loads. Several Azipod-equipped cargo vessels have sailed the Northern Sea Route.

The latest vessels to use Azipods include *Polaris*, Finnish Transport Authority's new ice breaker. This LNG-fuelled ship can break 1.8m thick ice at 4kt. Another Azipod-powered icebreaker, for the Polar Research Institute of China, will be even tougher. The Azipod-equipped LNG carrier *Christophe de Margerie* is the most powerful vessel of its type, capable of navigating in ice more than 2m thick.

Azipod propulsion has largely superseded shaftline propulsion and rudder steering for cruising, and some of the its attributes are relevant to expedition ships. For example, Azipods achieve far shorter crash-stop distances than shaftline solutions: the unit rotates 180° while keeping positive propeller rpm, reducing the crash-stop distance by half while retaining full thrust.

Finland's new icebreaker *Polaris* relies on Azipods to break 1.8m thick ice at 4kt (credit: Arctech Helsinki Shipyard)

Azipods allow full thrust to be pointed in any direction, improving manoeuvrability near icebergs, in icefields or when approaching port. With rudder-based arrangements, thrust diminishes rapidly at higher helm angles.

Podded propulsion also helps avoid collisions. Conventional arrangements have aft tunnel thrusters but these do not work effectively at higher speeds, while the manoeuvrability offered by pods is consistent across the full speed range.

Eliminating stern tunnel thrusters and the shaft line is just one example of how pods give greater flexibility in ship design: designers have space to consider alternative power sources such as LNG, batteries, or fuel cells.

Operating in polar waters includes the risk of getting stuck in compressed ice, and the designer Aker Arctic relied on Azipod propulsion to develop a double-acting ship capable of navigating stern first. Benefits include:

- Propulsor thrust lubricates the hull, reducing ice friction;
- Pods can be rotated 360° to flush and break ice ridges;
- Installed power can be reduced by up to 40 per cent.

Podded propulsion eliminates the need for noisy gears and the pod motor and its shaft are outside the ship's hull. Because the Azipod's pulling propeller receives a steady wake field, it is easier to optimise for silent operation.

With Azipod propulsion, the electric motor is installed directly on the propeller shaft, and the gearless construction makes its shaftline more resilient to bending and high torque peaks under ice loading. It also reduces the risk of environmental contamination, because the amount of oil used is only a fraction of that in other arrangements. In addition, the shaft seal does not have an oil-water interface.

As a result, it came as little surprise that Azipod propulsion was selected for the 'discovery yacht' *Scenic Eclipse*, which will enter service in August 2018. It is the first passenger vessel to be constructed explicitly to Polar Code standards and has PC6 notation.

ABB's recommended starting point for PC expedition cruise vessel design is its gearless Azipod DO propulsor series, ranging from 1.5MW to 7.5MW per unit. A twin Azipod DO installation can achieve 10 per cent power saving compared to a twin shaftline installation with electric propulsion.

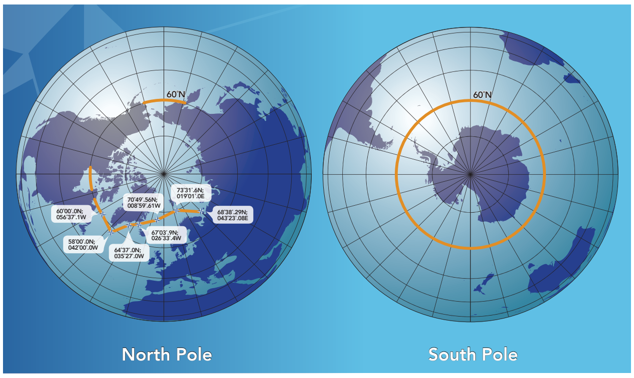
AT A GLANCE

COMPANY NAME: ABB

PRODUCT/SERVICE: ABB MARINE SYSTEMS IS A LEADING MANUFACTURER OF ELECTRIC POWER AND PROPULSION SYSTEMS FOR SHIPS

URL: WWW.NEW.ABB.COM

New course meets code's training requirement



Officers need certificates to operate within the defined polar regions

Finland's maritime Training centre Aboa Mare offers shipping companies training in ice navigation, fulfilling the requirements of the Polar Code. Its training course was launched in October 2016, making it one of the first within the industry. The Polar Code requires officers to have a Polar Code certificate if they are sailing in the areas shown in the illustration.

Aboa Mare offers Basic and Advanced courses. Each lasts three days but a combined course can be taken in five days.

The level of training depends on ice conditions in the operating area. If even a small part of the waters are covered with ice, the Basic Level course is mandatory for officers of tankers and passenger vessels. If more than 10 per cent of an area is ice covered, training is mandatory for officers of all vessel types. Masters and chief mates must also complete the advanced training.

Aboa Mare has more than 10 years of experience of ice navigation training, focused mostly on navigation in the Baltic Sea. But ice conditions in polar waters are very different: old ice is harder and thicker than first-year ice in the Baltic, and drifting blocks of old ice cause additional difficulties.

In co-operation with its partners, Aboa Mare is developing the Aker Arctic ice simulator. The goal is to model ice conditions as realistically as possible to train officers for polar conditions. The ice simulator has already been used for manoeuvring training for Arctia's new *Polaris* ice breaker, which entered into service on 1 November.

Aboa Mare offers degree and continuing education courses, including a captain's or marine engineer's Bachelor degree, along with a watchkeeping officer's degree for deck or engine. It also offers bachelor level education at the Novia University of Applied Sciences and secondary education at the Axxell vocational institute.

AT A GLANCE

COMPANY NAME: ABOA MARE

PRODUCT/SERVICE: TRAINING AND COMPETENCE MANAGEMENT

URL: WWW.ABOAMARE.FI

Chevron's lubes cope with all climates and conditions

Chevron Marine Lubricants provides lubricants and services to meet all marine lubrication needs. In some specific applications, ambient temperature can affect lubricant performance. Vane, gear and piston pumps in hydraulic systems, for example, demand hydraulic oils with excellent anti-wear performance. Chevron's Rando HDZ hydraulic oils feature a high viscosity index and a low pour point, allowing the flexibility to operate in both tropical and Arctic conditions.

In fact, every piece of machinery or system requires a specific type of lubricant. Even similar equipment from different manufacturers needs different lubricants, depending on the requirements set by the original equipment manufacturers (OEMs).

Chevron Marine Lubricants is one of the largest suppliers of marine lubricants in the world. Its products and services have been developed working closely with key marine partners and in its own advanced labs and have proven themselves in real-world performance.

All its lubricants are fully approved by OEMs after extensive field testing to ensure outstanding performance.

Its two-stroke cylinder lubricants provide a range of solutions and includes another new product developed to meet an issue identified in the ever changing marine environment: Taro Special HT Ultra is designed to combat cold corrosion found in the latest family of two-stroke engines on the market while running on high sulphur fuel at low speeds. This is the first product to have approval for use in both blend-on-board applications and as a direct-injection cylinder lubricant. The Chevron Marine Lubricants cylinder oil range now has a product or combination to meet virtually any requirement from 25BN to 140BN.

The Chevron Marine Lubricants range provides everything from needed stem to stern including EALs, gear oils, compressor oils and greases able to operate in the extreme conditions seen in today's marine environment anywhere in the world.

Chevron also offers drip oil analysis of engine lube oils, either on board or ashore, to manage an engine's lubrication and alert engineers to fuel problems.

Chevron's drip oil analysis can identify improper or insufficient fuel purification

AT A GLANCE

COMPANY NAME: CHEVRON MARINE LUBRICANTS

PRODUCT/SERVICE: MARINE LUBRICANTS

URL: WWW.CHEVRONMARINEPRODUCTS.COM

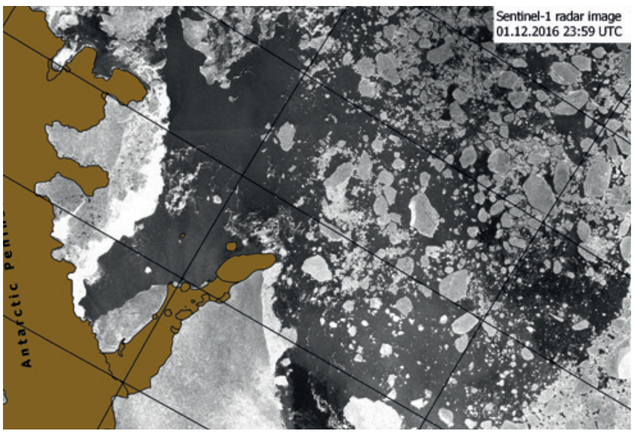
Reliable data ensure safety for ice operations

Drift & Noise Polar Services provides automated delivery of operational ice maps to vessels in polar regions. The ice maps show tailored satellite information such as near-real-time radar images or sea-ice concentrations and assist ships in finding the best passages through or around ice. Adapted processing ensures that the ice maps have small data sizes and are transferable via low-bandwidth internet connections. Ice maps can be delivered in various formats: complete integration into on board viewing systems as well as pdf documents or commonly readable graphic formats.

The time gap between satellite recording and onboard availability is crucial, given that sea ice may drift several nautical miles a day. The research ice breaker *Polarstern* receives our ice information between two and four hours after the satellite recording. During a recent cruise north east of Greenland a point of interest within the ice cover was reached within two days rather than the anticipated four days. This shows that Drift & Noise operational ice maps not only support Polar Code compliance but also increase a company's economic and ecological profile.

Drift & Noise was founded in 2014 as a spin-off of the Alfred Wegener Institute for Polar and Marine Research. It is a technology-driven consulting company, bringing new surveying solutions to the market. Areas of expertise include: geophysical surveying of icel remote sensing; and air- and shipborne ice thickness measurements using an advanced electromagnetic technology.

The services and products delivered by Drift & Noise are based on long-term field experience and are being continuously evolved through expeditions in polar waters.



Polar expeditions drive product development

AT A GLANCE

COMPANY NAME: DRIFT & NOISE POLAR SERVICES

PRODUCT/SERVICE: ICE MANAGEMENT PRODUCTS AND SERVICES

URL: WWW.DRIFTNOISE.COM

Guidance Marine puts Arctic vessels in their place

Guidance Marine's RangeGuard has a local DP position reference sensor

Guidance Marine is the leading global developer and supplier of position measurement technologies for high-value offshore marine markets, for real-time vessel positioning and manoeuvring with the highest level of safety, reliability and ease of use.

The manufacturer has taken measures to prepare its sensors for operations in cold and challenging climates on board ice class vessels including fail-safe measures on start-up. In particular, its CyScan and RadaScan XT systems are extreme low temperature -40°C variants of its standard position reference sensors.

The XT range enjoys all the functionality and operational benefits associated with typical laser and microwave technologies, but has been designed to operate in ice and Arctic conditions. For even more extreme temperatures, Guidance Marine has recently tested a RadaScan XXT sensor at -60°C designed to meet the latest winterisation polar temperature standard from class society DNV GL of -45°C.

The CyScan system has four type-approvals, including one from the Russian Maritime Register of Shipping.

The company's three-year warranty offers the best peace of mind available as standard today. It reflects the confidence that Guidance Marine has in its products and the benefits of years of continuous engineering improvement, and from experience gained by working with all dynamic positioning suppliers in the harshest environments.

Guidance Marine continues to position vessels safely and cost effectively whatever the environment.

AT A GLANCE

COMPANY NAME: GUIDANCE MARINE

PRODUCT/SERVICE: SUPPLIER OF DYNAMIC POSITIONING (DP) POSITION MEASUREMENT TECHNOLOGIES FOR HIGH-VALUE OFFSHORE MARINE MARKETS

URL: WWW.GUIDANCE.EU.COM

A new frontier in Arctic waters for ballast water treatment

Commissioning Ecochlor's system in its dedicated deckhouse

Harsh conditions in the Arctic are challenging for vessels, but with the promise of shorter sea routes it is becoming increasingly attractive to shipowners. Routes such as the Northern Sea Route have been considered, offering reductions in transport time of up to 40 per cent between Asia and Europe. As transits increase, however, there is rising concern about the potential for biological invasions that would threaten high-latitude ecosystems.

Within the Polar Code there are specific guidelines regarding ballast water treatment that include: "in selecting the ballast water management system, attention should be paid to … the temperature under which the system has been tested, in order to ensure its suitability and effectiveness in Polar waters."

This is a simplified statement of a basic difficulty: only certain ballast water treatment technologies are effective in cold water and sufficiently robust to withstand the violent weather and sea states of high-latitude voyages.

Addressing the 'Marine Technology and the North' symposium in October 2016 – which coincided with the plenary meetings of the Arctic Council in Portland, Maine – Pete Thompson, director of engineering at the ballast water management system (BWMS) manufacturer Ecochlor, spoke of the specific challenges in operating a BWMS in Polar waters. Extreme cold, wind and rain can cause severe icing conditions that can affect ship stability, power consumption and equipment functionality, he said.

Consideration of the vessel's power and fuel consumption must be made, often rendering some treatment systems with high power requirements inefficient or uneconomic for use on Polar class vessels. However, as observed by Roger Clement, chair of the symposium's co-host, the law firm Verrill Dana, "Ecochlor [makes] the only ballast water treatment technology shown to work effectively in sea water below 1°C without adding additional power to heat the water."

Ecochlor's system uses chlorine dioxide as a treatment technology, which has high water solubility, especially in cold water. Chlorine dioxide is very effective in low concentrations and reacts mostly with living cells and, to a much lesser extent, organic compounds. The chemicals do not degrade and are produced on demand and only created when treating the ballast water. "Additionally, the power requirements and footprint for the Ecochlor system are negligible in comparison to other treatment technologies," Mr Thoimpson said.

The 46,941 dwt *NS Stream*, owned by SCF Novoship, is an ICE-1C oil and chemical tanker that was built in 2006. It operates in operates in waters as cold as -30°C and has benefited from an Ecochlor BWMS retrofit. It has submerged ballast pumps so required a BWMS that treats ballast water only on intake.

With hazardous and non-hazardous zones to consider, the placement of the filters and the treatment system were particularly difficult. Because of limited space in the non-hazardous zone of the ship, a safe area was created within a hazardous zone on the main deck to house the generator and chemical storage tanks.

Argo Navis Marine Consulting and Engineering acted as the project engineer and was responsible for the engineering study and installation design. It also prepared classification-approved drawings and acted as the integrator during the entire process. Ecochlor's team and Argo Navis worked together during installation at the shipyard.

Much of the Ecochlor treatment system was prefabricated so installation progressed considerably prior to the vessel's arrival at Victor Lenac shipyard in Croatia. Commissioning was completed in July 2016 and the system was class-approved by DNV GL, which then issued a certificate of compliance with the BWMC.

This project was followed, in November 2016, by another Ecochlor BWMS installation, onboard the 47,125 dwt *SCF Neva*, also an ice-class product tanker, at Lisnave shipyard in Portugal.

AT A GLANCE

COMPANY NAME: ECOCHLOR

PRODUCT/SERVICE: BALLAST WATER TREATMENT

URL: WWW.ECOCHLOR.COM

Fednav's Arctic service uses its IceNav support system

As a pioneering presence in Canada's Arctic for over 60 years, Fednav's Arctic Operations and Projects Department has been at the forefront of mining and resupply transportation activities in the North American Arctic. Today, Fednav-operated vessels carry more than two million tonnes each year from remote northern mines. Fednav has participated in every major shipping project in the Canadian Arctic and, in 1998, became the first company to provide year-round polar shipping, unescorted, with the first winter voyage from Deception Bay.

Fednav owns and operates the 31,500 dwt *Umiak I* and *Nunavik*, the most powerful ice-breaking bulk carriers in the world, along with the 28,400 dwt *Arctic*, an oil-bulk-ore ice-breaking vessel. These vessels operate independently in the harsh polar environment and provide complete transport services to Canada's northern mines. In September 2014, *Nunavik* was the first cargo vessel to completely transit the Northwest Passage unescorted, with an Arctic cargo and Canadian expertise.

Enfotec Technical Services, a subsidiary of Fednav, specialises in ice analysis and vessel-routing services for ships operating in ice-covered waters. Enfotec supports the company's modern fleet – including the largest icebreaking bulk carriers currently operating – with respect to safe navigation in ice-infested waters world-wide and provides similar support to third-party clients in both the Arctic and the Antarctic.

Enfotec's shipboard ice navigation system IceNav has received industry accolades for innovation. In line with users' evolving requirements, IceNav features a dual-display computer system that includes both hardware and software components connected to the vessel's communication network. The system allows the most recent information (ice and weather charts, satellite images, weather bulletins and much more) to be received so that it can be displayed and shared on a map interface. The information is processed by the application to support various functions, such as route planning, target tracking and ice-drift calculations.

IceNav's hardware module taps into the ship's radar to provide a highly enhanced marine radar image, allowing for superior ice detection. Vessels using this technology can better identify open leads and improve forecast ice movement, leading to more efficient navigation, thereby reducing sailing time, fuel consumption and, potentially, ice damage to hull.

Fednav vessels operate independently in the harsh polar environment and provide complete transport services

It was first developed in 1994 to respond to the industry's need for reliable information while navigating in Arctic regions, and has evolved to become the authoritative system for route planning.

From 2014 to 2016, Enfotec completely overhauled its operating system to bring it up to modern IT standards, while introducing new tools and features. In this entirely redeveloped version, IceNav exceeds today's standards and expectations regarding specialised software. Its improved interface is intuitive and interactive and requires little training to operate the tools and functionalities the system offers. Moreover, the software architecture provides flexibility for eventual development and customisation.

Based on over 15 years of experience through the most challenging ice conditions, IceNav is at the cutting edge of ice navigation technology, integrating a new multilayer interface designed to handle concurrent use of multiple products and datasets in a modern geographic information system platform. Crucial information gives users a better understanding of prevailing and upcoming ice conditions when planning a voyage.

AT A GLANCE

COMPANY NAME: FEDNAV

PRODUCT/SERVICE: LEADING DRY BULK SHIPPING COMPANY SPECIALIST IN POLAR OPERATIONS AND TECHNOLOGY

URL: WWW.FEDNAV.COM

Fednav Ltd, formed in 1944, is a privately owned company and the largest dry bulk shipping group in Canada. It is headquartered in Montreal and maintains commercial offices in Antwerp, Hamburg, Rio de Janeiro, Singapore, St. John's, and Tokyo. It operates a fleet of 85 vessels – 50 of which are ice-class – ranging in size from 27,500 dwt to 64,000 dwt. Fednav's fleet performs over 800 voyages worldwide, transporting roughly 25 million tonnes annually.

New polar routes require new risk assessment approaches

When it comes to trading in polar regions, industry should not expect standard solutions

International Maritime Risk Rating Agency (IMRRA) has a dedicated professional risk assessment team that uses open-source data and research expertise to inspect, analyse and supply a risk rating for vessels and operators trading in Arctic conditions.

The challenge for authorities, insurers, charterers, operators and those tasked with upholding, implementing and vetting safety standards in these regions will be monitoring and adapting to a changing situation. There is a lot that we do not understand and the industry should not expect standard solutions.

Key details that the industry needs to wrestle with include:

• Charterer and insurance industry concerns. Both communities are largely supportive of the development of Arctic shipping routes but are wary about incurring large high-profile losses. They need guidance on how to price the risk.
• The practicalities of arranging observation-based verification and compliance inspections – which might be hurriedly requested through commercial necessity – may be difficult if they involve getting to ports based in colder regions.
• Whether the industry has sufficiently skilled inspectors capable of vetting polar trades and whether there is a pipeline of new talent ready to take over.
• Recruitment and retention of skilled seafarers who are proficient in polar operations. Demand for their skills and services will increase and crew with relevant 'ice' skills will see their market value rise in relation to the industry as a whole. Increased automation and operational requirements will see the emergence of smaller teams being required to work under greater pressure.
• A newly introduced Polar Code.

When preparing a vessel for trading in sub-zero temperatures the relevant industry agencies will confirm that the vessel hull meets ice-class requirements, the engine has the required power, the lifesaving equipment is of the requisite standard and the crew has the correct documentation.

However, most of these agencies focus on checking and verifying static factors and conditions. They do not consider variables connected to operational, geographical or human factors. Such considerations fall squarely on the operator to check.

This means that wider methods of evaluating vessel risk are needed to complete risk assessments before embarking on a polar voyage, and the ability to research and analyse public-domain data is critical. An added layer of risk-based guidance capable of calculating risk on a case-by-case, voyage-by-voyage basis is imperative. This guidance needs to be rooted in hard data and compiled by skilled professionals with an affinity for ice-class operations.

As part of the vessel rating risk assessments it undertakes, IMRRA homes in on apparently trivial yet hugely consequential details. IMRRA's experts are based in Greece, UK and Russia (St Petersburg) and they include many professionals with maritime, and especially Arctic, experience.

IT support and the database server are based in The Netherlands and run by Pharox, one of the marine industry's leading IT companies, while the data aggregation team is based in Ukraine (Odessa). IMRRA supplements its data analytics with targeted vessel inspections and information from an extensive intelligence network. This is an excellent way of corroborating data and challenging any inconsistencies or grey areas.

In short, IMRRA's vessel and operator risk assessments are an independent and authoritative business information tool that support business decisions, operational efficiency and mitigate risks for vessels globally, and especially those trading or looking to trade in polar climes.

This summary forms part of a fuller whitepaper, Why Polar Code Operations Need a Second Line of Defence, which can be downloaded from Riviera's Knowledge Bank:
www.tankershipping.com/s/knowledgebank/download,view_125

AT A GLANCE

COMPANY NAME: IMRRA

PRODUCT/SERVICE: INDEPENDENT VESSEL AND OPERATOR RISK ASSESSMENTS

URL: WWW.MARINERATING.COM

Inmarsat supports safety in polar regions

With its role in providing GMDSS communications, Inmarsat plays a key part in providing safety cover in remote regions

Inmarsat has provided the coverage to meet the performance A.1001(25) standards set out at IMO since the inception of the GMDSS more than 35 years ago

The entry into force of the IMO's Polar Code on 1 January 2017 and high-profile orders for expedition-style cruise ships ensure polar shipping remains a hot topic at Inmarsat, despite the sluggish offshore exploration market.

"As the only provider of satellite communications technology approved under IMO's Global Maritime Distress and Safety System (GMDSS), safety in the most remote waters is always a priority," said Peter Broadhurst, Inmarsat's senior vice president for safety and security services.

Inmarsat has provided the coverage to meet the performance A.1001(25) standards set out at IMO since the inception of the GMDSS more than 35 years ago. The mandatory performance framework for GMDSS includes four defined sea zones, kniwn as A1-A4, where A4 refers to areas above 70°N and below 70°S. To date, mandatory GMDSS coverage of A4 sea areas has been achieved via MF and HF bands.

"At Inmarsat, experience has been the key in meeting our public service commitments, which is why our contribution to the current review of GMDSS at IMO is critical," Mr Broadhurst said.

As the entry into force of the Polar Code demonstrates, regulators have been under pressure to cover growing commercial ship traffic in polar waters, he said. "Admittedly, the Northern Sea Route saw only 18 complete transits in 2015 – sharply down on the record-breaking 71 transits recorded in 2013. However, potential for the Northwest Passage remains high, especially after *Crystal Serenity* cruised through in August and September 2016," he pointed out.

Uptake of Inmarsat's Fleet Xpress since its March 2016 launch suggests that the maritime market has a substantial appetite for greater coverage and faster Internet speeds than is possible using traditional VSAT, he believes. Based on the new Inmarsat I-5 constellation, Fleet Xpress delivers high-speed Ka-band, with automated switching to back-up L-Band services via the I-4 network for continuous connectivity. High-speed connectivity is powering a revolution in maritime data, improving business intelligence, and enhancing vessel performance and crew welfare, Mr Broadhurst said.

"A Fleet Xpress trial on board the adventure cruise ship *Ocean Nova* has already demonstrated that these capabilities are available in polar waters," he added, referring to a project that led on to a commercial order. "That used a Cobham Sailor 100GX antenna to deliver on its promise of high-speed seamless mobile broadband at 55°S - 62°S in the Antarctic in low-horizon satellite views through heavy cloud cover and precipitation."

Elsewhere, Inmarsat's Fleet Xpress reference list for vessels trading in sub-Arctic waters already includes an Alaskan Leader Fisheries' vessel, with the service enabling easier capture of catch weight, quality, and location information, for more targeted sustainable fishing methods. The performance of the hardware and the service's crew welfare benefits are encouraging expectations of a fleet-wide adoption, Mr Broadhurst said.

"I think that the importance of robust hardware in Arctic operations is sometimes overlooked," he said. "The antenna supplied by our hardware partners was manufactured to withstand the toughest conditions and provide stable connectivity regardless of location."

In late 2015, on his 15,000 mile trek around the Canadian Arctic, explorer and artist Cory Trépanier stayed safe using an Inmarsat IsatPhone 2 mobile satellite phone and connected to his web audience using the IsatHub. "It's an example of how Inmarsat remains at the forefront of Arctic communications because it builds on experience," Mr Broadhurst said. "We know that commercial maritime customers value continuous reliability at reliable rates above everything else."

AT A GLANCE

COMPANY NAME: INMARSAT

PRODUCT/SERVICE: LEADER IN GLOBAL MARITIME SATELLITE COMMUNICATIONS

URL: WWW.INMARSAT.COM

Norsafe is ready for the Polar Code with specialised LSAs for extreme conditions

Norsafe Miriam 8.5 conventional lifeboat withstands Artic conditions

The IMO has adopted the International Code for Ships Operating in Polar Waters (Polar Code) and related amendments, making it mandatory under both the International Convention for the Safety of Life at Sea (Solas) and the International Convention for the Prevention of Pollution from Ships (Marpol).

Under the Polar Code, a specific risk analysis has to be undertaken to assess and mitigate potential risks to demonstrate compliance with it.

In readiness for the code's introduction, Norsafe has performed a number of full-scale tests and exercises in both simulated and realistic conditions to document product performance and mitigate potential risks associated with these hostile environments.

Norsafe is the first LSA supplier to have executed full-scale tests and trials during a joint search and rescue (known as SAREX) expedition in April 2016. Those taking part included Norwegian Coast Guard, Norwegian Maritime Authority, Norwegian Petroleum Safety Authority, the Italian energy company ENI, class society DNV GL and five universities.

Using a standard Norsafe Miriam 8.5 lifeboat, the expedition simulated a full scale escape, evacuation and rescue operation. It reflected a minimum five-day survival experience with the lifeboat as a habitat in ice-infested waters 80° north in the Barents Sea.

During this scenario, a risk assessment method was established to gain full understanding of the potential issues involved. This not only involved product performance but also key necessities for survival, such as food and water, survival kit and even what constitutes a sufficient habitable environment.

In addition, Norsafe conducted tests to address lifecycle issues with LSA equipment that may be exposed to polar conditions. This included a full-scale study to determine how to avoid the loss of warmth from a heated lifeboat in conditions of -30°C. Full-scale test studies were also carried out to test the performance of installed sprinklers in relation to iced conditions.

All the tests and studies were based on finding solutions that mitigate identified risks and hazards while complying with the various class-specific guidelines that require product adaptation. To prove compliance in general, Norsafe worked with DNV GL to establish a Technology Qualification project.

The SAREX expedition and Norsafe's participation gave a unique insight into understanding the risks involved and how best to mitigate them. As a result, Norsafe is in a unique position to offer shipowners, ship managers and offshore installation clients:

- Project risk assessment of any polar activity;
- Advice on mitigating all possible risks by product adaptations and/or safety instructions (rescue/evacuation/ maintenance guidelines);
- 'Norsafe works certificates' for products. These document Polar Code (or other winterisation standards) compliance based on the polar water operational manual for Norsafe LSAs, which is a project-specific document.

In fact, it has also led to the company being selected as a supplier of LSAs for the British Antarctic Survey's polar research vessel *Sir David Attenborough*, currently under construction at Cammell Laird shipyard in Birkenhead, UK.

Norsafe equipment will be specifically prepared for this polar operation after extensive discussions with the British Antarctic Survey. It has specified items from Norsafe's broad product spectrum and production locations, selecting JYN 100 conventional lifeboats for 90 persons along with Merlin 615 and Magnum 750 fast rescue boats.

Norsafe develops, manufactures and supplies marine lifesaving systems for all types of ships and offshore installations, and for military and professional use. As experts in the business of safety at sea, Norsafe has produced over 28,000 lifeboats since 1903. Norsafe's worldwide involvement includes production, sales, delivery and service of lifesaving equipment.

Norsafe's headquarters are situated in Arendal, Norway. Production facilities, sales and service companies are located in 13 countries worldwide.

AT A GLANCE

COMPANY NAME: NORSAFE

PRODUCT/SERVICE: MARINE LIFE-SAVING SYSTEMS FOR THE MERCHANT AND OFFSHORE MARKETS

URL: WWW.NORSAFE.COM

Panolin products offer performance and protection on polar routes

The very low temperatures experienced in the polar regions, the 'enclosed' non-wave pollutant dispersion characteristics of the polar seas, and the need to avoid marine species being exposed to oil pollution make the choice of lubricants much more critical than in other shipping operations.

Triglycerides have poor low- and high-temperature performance so are not good from an engineering perspective. Polyglycols have a good low temperature operating characteristic but there are questions about their toxicity, and there have been cases of metal corrosion due to their hygroscopy.

Oils based on polyalphaolefin (PAO) require viscosity improvers to provide higher viscosity lubricants such as gear oil but VI additives can be broken down under conditions of shear, which reduces their viscosity and compromises equipment performance and life. Regular monitoring is required to replace PAO oil when its viscosity drops.

This leaves esters. Unsaturated esters are susceptible to thermal oxidation, resulting in polymerisation and an increase in viscosity. Under thermal stress a lubricant can go into a piece of machinery as an oil and turn into a grease! Again, regular viscosity monitoring is required.

Top-tier saturated ester-based lubricants, on the other hand, such as those marketed by independent Swiss lubricant manufacturer Panolin, exhibit very good thermal oxidation resistance and shear stability, and meet all the current environmental requirements. Panolin products carry ISO 9001 and ISO 14001 certification. Some also are approved by ABS.

Stocking the right lubricants from the outset is the right approach, and will of course minimise the environmental impact should there be a continuous loss of oil from a vessel's lubrication systems. Panolin's lubricants have been designed with Solas and pollution prevention firmly in mind. That is an all-important consideration for any operator transiting polar routes.

AT A GLANCE

COMPANY NAME: PANOLIN
PRODUCT/SERVICE: INDEPENDENT LUBRICANTS MANUFACTURER
URL: WWW.PANOLIN.COM

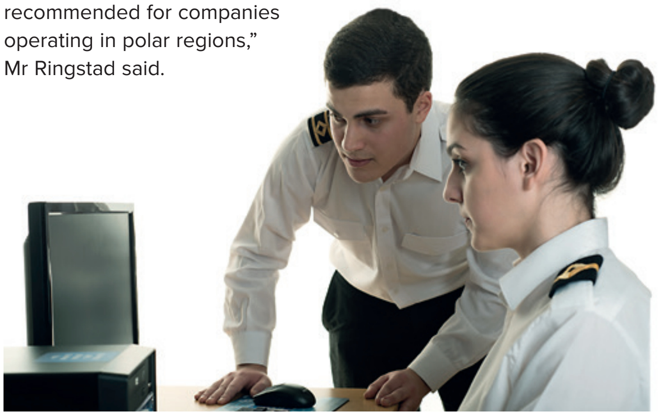
Training seafarers to perform in polar conditions

IMO has adopted the International Code of Safety for Ships Operating in Polar Waters (the Polar Code) and its related amendments to make it mandatory under both Solas and Marpol. As a result, it covers a range of design, construction, equipment, operational, training, search and rescue and environmental protection matters relevant to ships operating in the inhospitable waters surrounding the North and South poles.

Training seafarers to adapt to these demanding conditions and perform safely in them is a priority. Norway's Seagull Maritime, which has developed e-learning, competence and assessment systems for over 20 years, is taking a proactive approach to meeting the code's human resource requirements. Managing director Roger Ringstad said: "We are constantly looking into the requirements set by the Polar Code and their training implications. Seagull offers various ice- and Arctic-specific courses to meet the needs of the deck and engineering crew, and we plan to develop further courses for polar operations in the future."

Seagull's existing portfolio of courses relating to polar operations includes two e-learning courses: *Personal safety in cold environments* and *Engineering operations in cold environments*. It also offers an e-learning module with a related distance learning course: *Navigation in Ice*. The distance course follows the Ice Operation section of OCIMF's vessel inspection questionnaire and gives an understanding of passage planning in or near ice, basic rules governing ice navigation and the preparations required before entering ice-affected waters. The aim is to give deck officers tools to conduct effective, safe and economic voyages in these waters.

Many other components of Seagull's comprehensive e-learning library can help ensure crews are adequately trained to operate in polar waters. "Awareness training into most elements concerning the safety of life and the marine environment would be strongly recommended for companies operating in polar regions," Mr Ringstad said.



AT A GLANCE

COMPANY NAME: SEAGULL MARITIME
PRODUCT/SERVICE: TRAINING AND COMPETENCE MANAGEMENT
URL: WWW.SEAGULL.NO/MARITIME

'Zero discharge' areas will ban stern tube lube

Only water-lubricated stern tube bearings will be allowed in some regions, says Craig Carter, director of marketing and customer service at Thordon Bearings

As the shipping industry looks set to become more active in polar waters, there is a very high risk of significant environmental damage from oil-lubricated propeller shaft systems – a system that must leak oil in order for it to work.

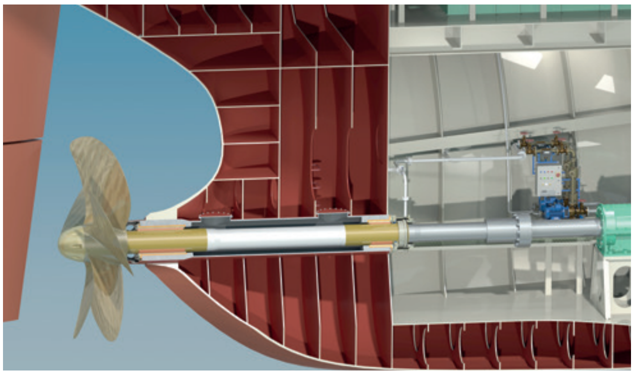
IMO's Polar Code states that there will be "zero discharge" areas under Marpol Annexes I and II (which address oil and noxious liquids respectively), with any discharge into the sea of oil or oily mixtures from ships prohibited. But shipowners looking to increase their Arctic operations may not be aware that their oil-lubricated stern tubes could render them non-compliant and susceptible to hefty fines.

Globally, it is estimated that the fleet of 45,000 ocean-going vessels that continue to operate out-dated oil-water-lubricated bearing technology are leaking 130,000m^3 and 244,000m^3 of operational oil into the ocean every year; that's the equivalent of up to five *Exxon Valdez* oil spills each year!

There is a cleaner and more cost-effective retrofit and newbuild alternative: Compac.

Since Thordon Bearings introduced its seawater-lubricated bearing systems in the early 1990s, Compac has prevented over 62,000m^3 of oil being discharged into the world's oceans.

A seawater-lubricated propeller shaft bearing system is the only technology that guarantees compliance with all pollution regulations and has zero impact on the environment. There are no oil discharges, since oil is not used: seawater lubricates the non-metallic polymer propeller shaft bearings and flows back into the sea.



Compac has stopped 62,000m^3 of oil being discharged into the world's oceans

While the environmental benefits are obvious, there are also commercial advantages, since new polymer bearing materials, shafting materials and system packages can increase bearing wear life and reduce ship maintenance costs.

When seawater-lubricated propeller shaft lines are used rather than oil lubricated shafts or pods, operating costs are reduced substantially over the life of the vessel as there is no aft seal, no lubricating oil, no oil storage, no oil sampling and no oil to dispose of. In addition, there are no costly aft seal repairs, which can range from US$150,000 to US$300,000.

The proven environmental and operational performance of seawater-lubricated propeller shafts is a result of the advances made in polymer materials science. Today, polymer bearing technology is such that all the major classification societies have now modified their rules for seawater-lubricated propeller shaft systems, meaning the shaft does not have to be withdrawn for inspection for 15 years or longer from the date of build, if certain monitoring condition criteria are met.

This is equal to an oil-lubricated propeller shaft and removes a major obstacle that shipowners had with water-based propeller shaft bearing systems.

Deck machinery greases and lubricants pose similar environmental risks and there is also a safety element to the continued use of bronze bearings. Given that crew members' time on deck will be limited, irregular maintenance and greasing of systems could have a serious effect on deck machinery performance.

Thordon's range of grease-free, low maintenance polymer bearing materials, however, removes completely the risk of bearing seizure, cable failure and environmental damage. The ThorPlas-Blue range of polymer bearings can operate in temperatures down to -50°C in dry conditions and -10°C in water. There is no need for grease as they are completely self-lubricating, so there is zero risk of grease polluting these ecologically sensitive areas.

Shipowners must consider not only the environmental and performance aspects of their bearing materials in Arctic waters but also the cost factors associated with equipment failure, emergency drydockings and the purchase, storage, application and disposal of lubricating oils and greases. Thordon Bearings' polymer bearings obviate all these risks.

AT A GLANCE

COMPANY NAME: THORDON BEARINGS

PRODUCT/SERVICE: DESIGNS/MANUFACTURES JOURNAL BEARING SYSTEMS

URL: WWW.THORDONBEARINGS.COM

White Glacier's Arctic 25: Redefining Safety in Polar Waters

The Arctic is uniquely dangerous to navigate because of frigid waters, ice formations and – the biggest risk of all – its remoteness should a rescue effort be needed. Michael Byers, Canada research chair in global politics and international law at the University of British Columbia and author of *International Law and the Arctic*, made this point in an interview with Radio Canada in April 2016.

Talking about a voyage through the Northwest Passage by the cruise ship *Crystal Serenity* that was to take place later that year, he said that the most obvious hazard it faced "concerns the possibility of an accident." If there were an incident, it would take a search-and-rescue helicopter up to two days to reach the area, he said, and when it did, "one helicopter is a rather small response to a situation where perhaps 1,600 people need to be taken off a sinking ship in an Arctic storm."

Because of this, IMO has taken a particular interest in the safety of all travellers while navigating the poles. New guidelines outlined in the Polar Code extend the need for protection from the elements for the maximum amount of time for rescue to all passenger and crew. Specifically for passenger ships, "a proper sized immersion suit or a thermal protective aid shall be provided for each person on board." (Polar Code section 8.3.3.1).

White Glacier set out to create a cold water immersion suit that could really save lives. The result was its Arctic 25, engineered and manufactured in the US. It is the first and only hypothermia protective cold water immersion suit that maintains body heat for days instead of hours.

Standard features include:

- Protection from hypothermia for at least 25 hours;
- Resistance from direct contact with flames for four seconds;
- Withstanding impact from jumps of up to 10m;
- Partial donning in 15 seconds or fully donned in 60 seconds;
- Restoration of core body temperature within 10 minutes;
- A retractable protective cabin for added protection;
- Pre-lubricated zips that require no maintenance; and
- Solas-compliant buddy line, whistle and light.

Solas states that immersion suits must protect against hypothermia for only six hours. When it comes to working in polar waters, that is not enough time for rescue in some of the world's harshest environments. An abandon-ship emergency in the middle of Arctic or Antarctic waters will leave every soul stranded in some of the world's most inaccessible and remote regions. Even with today's technology, six hours is not enough to consistently rescue stranded survivors in such desolate areas. DPC

Arctic 25 Cold Water Immersion Suit

AT A GLANCE

COMPANY NAME: WHITE GLACIER

PRODUCT/SERVICE: SUPPLIER OF SURVIVAL AND IMMERSION SUITS

URL: WWW.WHITEGLACIER.COM

IMO deserves credit for Polar Code's timely arrival

Bringing the Polar Code into force by amending three conventions has avoided damaging delays, says Michael Kingston*

Historically it has taken a disaster (such as the the oil tanker *Betelgeuse* explosion pictured) to galvanise the industry's rule makers (credit: Michael Corrs)

The environmental provisions under the Polar Code came into force on 1 January 2017 as an amendment to the International Convention for the Prevention of Pollution from Ships, known as Marpol 1973, which entered into force in 1983.

IMO's secretariat and its Marine Environment Protection Committee (MEPC), chaired by Arsenio Dominguez is Panama's Permanent Representative to IMO, deserve huge credit for their work. Indeed, before looking at the new Marpol provisions, it is worth reflecting on how fortunate we are that the Polar Code has come into force this year by taking a brief look at the mechanics employed by the secretariat to achieve this. Great credit must go to the 'Polar Code Working Group' and Chair, Turid Stemre of Norway.

A historical problem with IMO conventions is that after 'adoption' they require ratification by a certain threshold of countries before they enter into force. Some unratified conventions date back as far as the 1970s.

One stark example is the Torremolinos Convention for fishing boat safety, which has been lying on government shelves since 1977, only ratified by the Netherlands, Norway, Iceland, and South Africa. Another is the convention for pollution from fixed structures, also adopted in 1977. In the meantime, thousands of lives have been lost in the fishing industry and we have no international regulation surrounding pollution incidents such as the *Deep Water Horizon* disaster – an incident that brought Arctic regulation sharply into focus.

Often the pattern of development is that it takes a disaster for previously suggested industry best practice to be adopted as regulation, and then another disaster to accelerate ratification. When the oil tanker *Betelgeuse* exploded at Gulf Oil's Whiddy Island Oil Terminal in Bantry Bay, Ireland, on 8 January 1979 killing 50 people, it was not equipped with simple inert gas systems that had previously been suggested as best practice. Solas 1974 contained such measures but it took 51 lives and a huge pollution incident to wake everyone up and ratify Solas 1974.

To avoid this sort of situation, the Polar Code has come into force by way of an amendment to three existing conventions to avoid it needing ratification.

The environmental aspects fall under Marpol, the crew certification aspects under the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 (STCW) and the safety aspects under Solas.

Indeed it was Solas 1974 – which entered into force in 1983 – that first included the tacit acceptance procedure. This provides that an amendment shall enter into force on a specified date unless, before that date, objections to the amendment are received from an agreed number of parties.

Prior to Solas 1974, amendments required the same ratification as new conventions, which is why there were several versions of Solas prior to that.

Marpol and STCW also include the 'tacit acceptance' procedure, which allows IMO committees to agree amendments that will automatically become law 12 months after a period of six months from adoption, unless in that six-month period, more than one third of parties – the combined merchant fleets of which constitute not less than 50 per cent of the gross tonnage of the world's merchant shipping – have notified their objections to the amendments. This has never happened.

The Marpol provisions add additional requirements to those already contained in that convention, to be applied to ships operating in polar waters. As the Antarctic area is already established as a 'Special Area' under Marpol Annexes I and V, with stringent restrictions on discharges, the Polar Code aims to replicate many of those provisions in the Arctic area.

Its preamble, introduction and part II include mandatory provisions in chapters covering the following topics which are introduced by amendments to Annexes I, II, IV and V of Marpol:

- Prevention of pollution by oil, including discharge restrictions prohibiting any discharge into the sea of oil or oily mixtures from any ship, as well as structural requirements including protective location of fuel-oil and cargo tanks;
- Control of pollution by noxious liquid substances in bulk, prohibiting any discharge into the sea of noxious liquid substances, or mixtures containing such substances;
- Prevention of pollution by sewage from ships, prohibiting the discharge of sewage except for comminuted and disinfected sewage under specific circumstances, including a specified distance from ice;
- Prevention of pollution by garbage from ships, adding additional restrictions to the permitted discharges (under Marpol Annex V, discharge of all garbage into the sea is prohibited, except as provided otherwise). Food wastes shall not be discharged onto the ice and discharge into the sea of comminuted and ground food wastes is only permitted under specific circumstances including at a distance not less than 12 nautical miles from the nearest land, ice-shelf or fast ice. Only certain cargo residues, classified as not harmful to the marine environment, can be discharged.

Recommendations in Part II-B of the Polar Code were approved, including a recommendation to refrain from carrying heavy fuel oil as cargo or fuel in the Arctic (a regulation in Marpol Annex 1 already prohibits the use and carriage of such fuel in the Antarctic) and a recommendation to apply the standards contained in the International Convention for the Control and Management of Ships' Ballast Water and Sediments.

There are those who say that the environmental provisions do not go far enough, particularly in relation to recommendations rather than obligations in relation to HFO and grey water discharge. There is much merit in these arguments but, for the reasons that I have outlined, it is important to remember that what has been achieved deserves huge credit. There is a foundation to build on, rather than an unratified convention gathering dust for years to come.

It is also important to remember that the Polar Code is goal-based and that it could be arguable that some of these aspirational provisions in Arctic waters regarding HFO and grey water in certain operations should be considered and addressed in the required *Polar Water Operational Manual*, which should reflect best practice.

There is certainly scope for 'soft law' to apply where an abuse of the use of HFO both in its use as a fuel and in its transportation as cargo, or the discharge of grey water, is not adhering to best-practice standards in Arctic operations.

It is noteworthy that the Circumpolar Conservation Union and World Wide Fund for Nature have made representations to the Arctic Council's Protection of the Arctic Marine Environment (PAME) working group that provisions should be agreed as best practice in relation to the use of HFO and grey water discharge. The PAME working group is due to agree to establish an Arctic Shipping Best Practice Information Forum at its Copenhagen meeting in February 2017.

Any operator would be foolhardy to ignore such suggestions. Indeed, other players – such as financiers and the insurance industry – may impose such standards, not least for corporate social responsibility reasons.

In this context, given the effort taken to amend three conventions to implement it, the Polar Code will help prevent disaster if it is enforced and encourages the correct behavioural atmosphere for best practice to prevail to protect seafarers and our environment.

It is clear that prevention is better than cure. *DPC*

*Michael Kingston is a London-based lawyer and the International Union of Marine Insurance's representative at the IMO on polar issues

Potential bottlenecks in the IMO adoption approach have been overcome to bring the Polar Code into force

Code brings new focus for passenger operators

Passenger shipping welcomes the code, tempered with concerns, write Kim Crosbie of IAATO* and Frigg Jorgensen of AECO*

Each year about 40,000 passengers visit the Antarctic, the vast majority of them on board passenger ships that are covered by the Solas Convention. In the regions of the Arctic covered by the Polar Code, the number is even greater with an estimated 60,000-70,000 passengers heading north to experience the unique habitat of that high Arctic area.

Many of these visitors travel on dedicated passenger ships – "expedition ships" as they are known – while others travel on more conventional cruise vessels. This activity is not new: in early 2016 Antarctic tourism marked 50 years since Lars-Eric Lindblad first took passengers to Antarctica, while cruises to the high Arctic have been on offer since the late 1800s.

But the advent of the Polar Code marks a notable shift in regulation of polar cruising. While some vessels were specifically built for trading in these waters, others were not and all trade in these waters based on their certification to operate worldwide. Yet polar regions have their own set of challenges. Experienced operators, navigators, seafarers and guides who have worked in these regions for years know and understand these challenges but for others coming into these unique environments, they can be underestimated.

In many respects, the code can be regarded as good news. For those companies that have successfully operated in the regions for decades, complying with the code requires a review and formalisation of their current risk-assessment processes and mitigation procedures. Some operators may find that they need to amend these mitigation procedures slightly (for example to facilitate access to more water on survival craft to allow for the requirement to survive at least five days).

Many of the voluntary measures that the operators already have in place as members of IAATO or AECO – such as shared vessel tracking schemes, sharing information with the rescue co-ordination centres, or the strict environmental standards that operators have already agreed to operate by – will meet many of the operational safety and environmental requirements of the Polar Code.

But one challenge associated with formalising risk-assessment processes and procedures relates to voyage planning. To demonstrate that a vessel can undertake routes through specific locations, an assessment of the ship and its equipment must be conducted. This should take into account many aspects of the voyage including current and past ice information, current and past temperature data for the intended area and period of operation, along with availability and quality of charts in the intended area of operation.

More importantly, the code means that for any new passenger ship operators coming into the market-place, there is a clear outline of the hazards and risks that need to be considered when operating in these regions and mechanisms to minimise them. This should help ensure that newcomers have planned for the peculiarities of polar operations.

The code will not solve every issue; a sizable proportion of vessels will not need to comply with the code (see box). Additionally, to enable a consistency of application, the various stakeholders – such as operators, flag states, classification societies and the insurance industry – will always have to work together to maintain its intent and goals.

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*IAATO: International Association of Antarctica Tour Operators; AECO: Association of Arctic Expedition Cruise Operators

The advent of the Polar Code marks a notable shift in regulation of polar cruising

How cruise ships operate in polar waters

Currently Solas passenger ship operations engaged in polar water cruising take on two principal forms:

• Non-ice-strengthened cruise ships carrying several thousand passengers. These cruise in open water and only during the height of the summer when there is nearly 24 hours of light and temperatures are warmer. In the Antarctic, as a condition of IAATO membership (see below), any of these vessels carrying more than 500 passengers have voluntarily agreed not to make landings.

• Small expedition ships carrying fewer than 500 passengers operate throughout the summer months. These usually have some form of ice strengthening or polar class, and operate with a natural history and enrichment programme, taking clients ashore, accompanied by experienced guides.

In the Antarctic, there are approximately 35 Solas passenger ships operating annually, four of which carry more than 500 passengers. The vast majority transport 13-200 passengers.

In the 'Polar Code area' of the Arctic, approximately 60 Solas passenger ships operate annually, half of which are expedition cruise vessels carrying fewer than 200 passengers.

These must conform to the international – and, in the Arctic, coastal state – requirements that are expected of Solas vessels. However, in both the Arctic and Antarctic, tour operators have formed trade associations that bring in an additional layer of self-regulation. These are:

• International Association of Antarctica Tour Operators (IAATO; www.iaato.org). IAATO was founded in 1991 by the seven tour operators that were then operating in the Antarctic. In the region's unique political situation (it is governed by an international treaty with agreements based on consensus), IAATO's mission was to advocate and promote the practice of safe and environmentally responsible tourism, essentially using self-regulation to fill any potential gaps in the regulation. All the Solas passenger ship companies that operate in the Antarctic are members of IAATO.

• Association of Arctic Expedition Cruise Operators (AECO; www.aeco.no). In 2003, inspired by IAATO, eight expedition cruise operators that were operating in Svalbard founded AECO. Its objectives are similar to IAATO's: to ensure safe and considerate Arctic cruise operations at sea and on land. AECO also uses self-regulation, such as mandatory guidelines. Most expedition cruise vessels operating in the Arctic are members of AECO.

Weaknesses and work-arounds

There are two principle weaknesses in the application of the code from a passenger ship perspective.

First, the safety aspects of the code only apply to Solas-certified vessels on international voyages. This means that many of the government-owned and all fishing vessels are exempt from the code (these vessels account for over two thirds of the traffic in Antarctica). It also means that passenger vessels on domestic voyages are exempt.

The second potential weakness, like any international agreement, is how that agreement will be interpreted into national requirements: what is acceptable in one state, might not be acceptable in another.

Having the Solas passenger ship operators work collaboratively helps ensure that the spirit and intent of the code is maintained. For example, in June 2015 IAATO*, in conjunction with AECO* and Lloyd's Register, held a successful workshop in London to discuss how to apply the code. Bringing together a number of flag states, classification societies, the insurance industry and the majority of the polar passenger ship operators, enabled fruitful discussions on meeting the code's requirements and how to conduct its operational assessments.

Additionally, efforts have been made by IAATO and AECO , working with online platforms, such as the ice-tracking service PolarView.aq, to develop generic databases covering issues such as ice and temperature information, search and rescue considerations, and historic casualty data to provide a reliable database for member operators to use in supporting their assessments.

To address chart quality and availability concerns, IAATO and AECO are working with the International Hydrographic Office and each other in a crowd-sourcing bathymetric data-sharing scheme. The intention of these efforts is to ensure a level of standardisation in the data on which operators are basing their assessments.

These form just part of the constantly evolving framework that the IAATO and AECO operators voluntarily develop and work within to support the practice of safe and environmentally responsible operations, mutual collaboration and support. ***DPC***

LEFT: *Crystal Serenity* was fitted with forward looking sonar, ice searchlights, ice radar, and a thermal imaging system

CRYSTAL SERENITY BREAKS THE ICE FOR ARCTIC CRUISING

Crystal Cruises' *Crystal Serenity* successfully completed its voyage through the Northwest Passage in September 2016, and is set to repeat the journey in 2017. The Canadian Arctic route only became accessible to shipping for the first time in 2007 and *Crystal Serenity*'s voyage through the Arctic waters over the top of North America was the first by a passenger ship.

It took 32 days to cover the 7,297 nautical miles from Anchorage in Alaska to New York, carrying 1,080 passengers and an estimated total of 1,700 people. The voyage went largely without incident, with one call prevented by ice and some minor lessons learned for the next voyage.

During the northernmost portion of its journey, the 68,000gt ship was escorted by the ice-class research vessel *Ernest Shackleton*, chartered from British Antarctic Survey. In addition to being fully equipped as a first-response vessel for virtually any emergency situation, *Ernest Shackleton* provided ice-breaking capabilities, two helicopters for special adventures and additional expert expedition crew.

Worries over safety and the intrusion into remote and pristine Arctic waters and Inuit communities had generated controversy about the voyage and fears that it could tempt more cruise ship operators to send ships into such sensitive waters.

Among those who had expressed concern was the vice commandant of the United States Coast Guard (USCG), Charles Michel. He told a congressional subcommittee in July that the voyage would be in "a very treacherous area of the Earth" and he questioned *Ernest Shackleton*'s capability in the event of an accident. "If we needed to get a big helicopter up there, it's estimated it would take 15-20 hours if the weather is good," Adm Michel said.

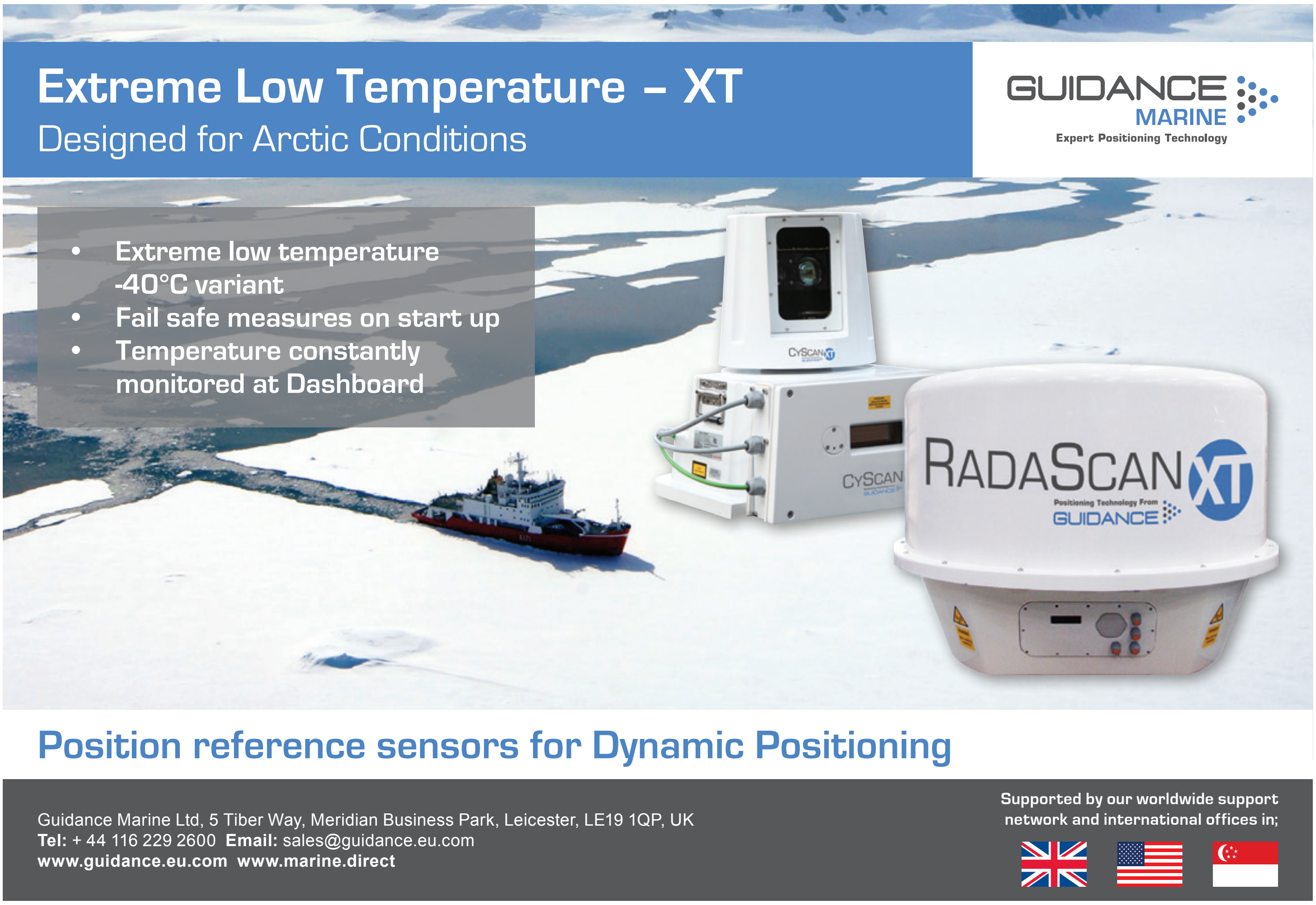
Another person with concerns was London-based lawyer Michael Kingston who had helped develop the Polar Code. Writing in the specialist magazine *Frontier Energy*, he described the voyage as "a showcase for the hypothetical application of the Polar Code" and warned: "There is simply no room for error in such a transit with so many people on board in such a remote area." But he acknowledged that "Crystal Cruises has engaged responsibly with the authorities and with recognised ice navigators."

After the voyage, Crystal Cruises president and chief executive Edie Rodriguez said: "The Northwest Passage represents an especially massive undertaking." The ship's master, Birger Vorland, commented: "In addition to carrying two veteran Canadian ice pilots, *Crystal Serenity*'s bridge team received ice navigation training to prepare ourselves for the conditions." That had been undertaken at a simulator in St John's in Newfoundland, Canada.

The ship had been fitted with forward-looking sonar, ice searchlights, ice radar, and a thermal imaging system. Much of that equipment was supplied by the Canadian manufacturer, Rutter. Its ice navigation system can display near real-time satellite ice imagery and ice forecasts. A key part of the system was Rutter's Sigma S6 Ice Navigator, which uses high-resolution image processing for ice imaging, detection and tracking.

Supporting *Crystal Serenity*'s bridge team were *Ernest Shackleton*'s crew, who are experienced in transiting the Northwest Passage. They had access to supplementary damage control and oil pollution containment equipment.

When the ship sets off for its 2017 cruise, the Polar Code will be in force and Crystal Cruises will have to prepare a *Polar Water Operational Manual* and obtain a Polar Ship Certificate (PSC), Mr Kingston pointed out in his article. That will take a lot of work, he predicted. The manual must explain "that they have a plan to deal with a worst-case scenario in the conditions that may be encountered. Only then can an operator obtain a Polar Ship Certificate," he wrote. DPC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Arctic Council backs 'best practice' forum

A new forum will help publicise information and standards to support the Polar Code

An international forum is expected to be established by May 2017 that will provide a platform "to educate all concerned about [the Polar Code's] provisions," according to London-based lawyer and representative at the IMO on polar issues for the International Union of Marine Insurance Michael Kingston. Mr Kingston is a leading campaigner for establishing the forum.

"The Polar Code is an example of what we can achieve before a major disaster occurs," he said. "But it will only be as good as we make it through education and enforcement, and we all have a duty to assist in that process." Explaining the thinking behind the forum, he said it was important "that all concerned are aware of the rules so that a third-party or a rogue operator does not bring the house down for everyone in the sensitive polar regions."

This forum will be set up by the Arctic Council, a significant diplomatic body that consists of the eight Arctic states: US, Canada, Norway, Sweden, Denmark, Iceland, Finland, and Russia. Each country holds the chairmanship for two years and the US will hand over to Finland in April 2017. There has been a significant emphasis on navigational safety during the US chairmanship and the plan is that the forum will be in place by the time Finland takes over.

It was Mr Kingston who first formally outlined the need for what he calls a best practice information forum when he addressed the Arctic Council's Protection of the Arctic Marine Environment (PAME) working group in Stockholm in February 2016.

His proposal was that the forum would identify all the best standards that are in existence on a cross-jurisdictional basis in hydrography, meteorology, ice data, crew training, search and rescue logistics, communication, recommended industry guidelines, traditional and local knowledge, ecological knowledge, operational understanding and ship equipment, systems and structure.

Michael Kingston: An international forum is expected by May 2017

PAME supported his initiative and its Shipping Expert Group drafted terms of reference for the forum, which were well received when they were discussed during a PAME meeting in September in Portland, Maine.

They are set for approval at PAME's next meeting in Denmark in early February 2017, and "if all goes to plan the proposal will then be recommended to the senior Arctic ambassadors from each Arctic state with a recommendation to each country's minister for states that the forum be established," Mr Kingston said.

The forum's advice is intended for all those affected by the code, such as ship operators, flag states, insurers, financial markets and port state control authorities.

To achieve this, it will hold annual meetings at which representatives from the various members will explain the latest developments. Antarctic states' interests will also be invited.

The plan is that they will update a website portal with the best standards as and when they are produced. This will be set up by PAME, and its aim is that "everyone would know where to go to get the best information, and so on, on a continual basis, or at least where to find out how to make productive further enquiries," Mr Kingston said.

He described this initiative as "a great opportunity for the Arctic Council to show how it is working with industry and IMO, and it is refreshing to see the leadership being shown by PAME and representatives from other Arctic Council groups."

He welcomed this collaboration, saying that the involvement of IMO, governments, industry, non-governmental organisations, the indigenous community and other players "will help to promote the correct behavioural atmosphere in relation to marine operations, the impact of which can extend to operations not covered by the Polar Code at present such as fishing vessels and leisure craft under 500gt." DPC

Baltic experience can benefit the Polar Code

Finland's experience of ice operations can become a basis for a wider debate on how the Polar Code should be updated and improved, says Jarkko Toivola, vice president of the Finnish towage and salvage company Alfons Håkans

Capt Jarkko Toivola: "Less-experienced operators are entering the business"

The Baltic Sea region is a very good example of where a multinational and systematic approach to managing prevailing ice conditions and winter navigation as a system has been successful. Many will say that Baltic ice is only first-year ice, but so is most Arctic sea ice that is encountered during normal operations. The important thing to understand is that all winter navigation and operations in ice are heavily influenced by operational factors, location and prevailing conditions.

Russia, Canada, the US and many other Arctic countries have considerable experience of Arctic shipping. But so do Baltic countries and their shipowners. Just to name a few, I can list Finnish flag operators on Arctic and Antarctic sea voyages and operations, including Neste, which has been operating in Arctic regions – such as the High Canadian Arctic and Greenland – since the 1970s. In 1997, its 16,000 dwt crude tanker *Uikku* became the first western vessel to transit the Northern Sea Route.

Other Finnish vessels operating in similar conditions include the Finnish Environment Institute, whose research vessel *Aranda* works in Antarctica, and Arctia, which has icebreakers in Greenland and Alaska. And here at Alfons Håkans, we have a fleet including a number of ice-breaking tugs and provide offshore ice management in Greenland. And since March 2016, ESL Shipping's 13,367 dwt bulk carrier *Pasila* has been chartered to transport building materials for the Yamal LNG project in the Russian Arctic.

Other Baltic experience can be found in Sweden, where the country's maritime administration's icebreaker *Oden* has made several North Pole research and Antarctic cargo voyages, and Viking Supply Ships has operated its vessels in various Arctic operations over the years.

Finland very actively participated in developing the technical and operational content of IMO's Polar Code. Experience of its systematic approach and multinational co-operation in winter navigation was valuable in developing the code's technical, human skills, environment safety and management aspects. All these are needed to tackle the challenges of extreme environment and remoteness of Arctic and Antarctic shipping.

The code is a good first step towards making Arctic shipping safer and less harmful to the environment. But more must be done: Arctic Council (AC) nations should deepen their co-operation and take a clear role in assessing the code's functionality and any suggestions to develop it. This should be done in co-operation with southern hemisphere countries closest to Antarctica, which have the most practical knowledge and experience on operating in ice-infested waters.

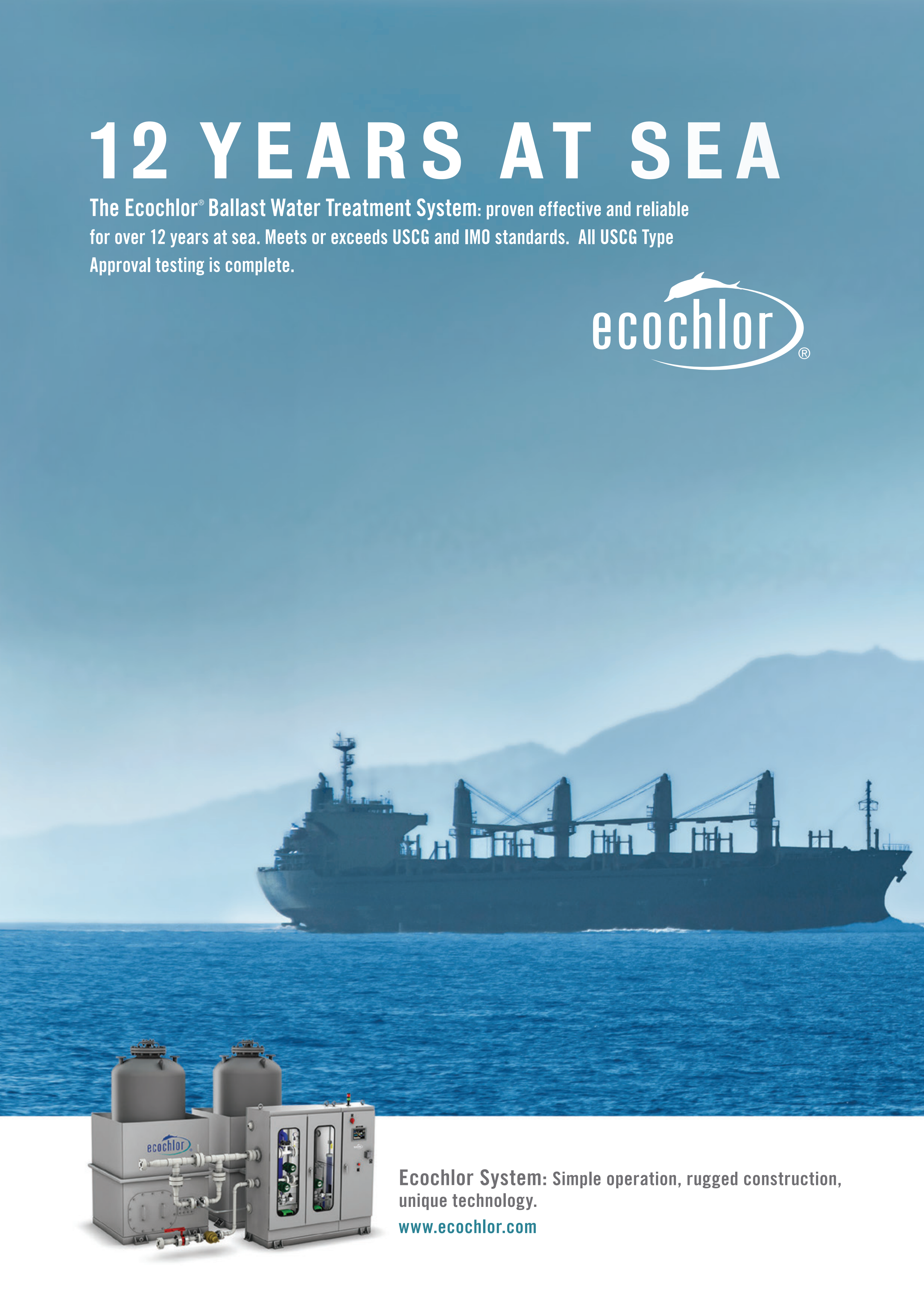
AC countries each have their own shores, sea areas and environment, which bear the brunt of Arctic shipping activities and incidents. They also carry the burden of first response search and rescue (SAR) operations for those areas.

A forum for these countries' operational winter navigation authorities could follow the good example of the Arctic Offshore Regulators Forum, which is a knowledge-sharing forum for drilling-permitting authorities in AC countries. Due to the Polar Code's nature and regional scope, this global winter navigation forum should also have authorities with SAR responsibilities in Antarctic countries as full members. Other interested countries and bodies could join as observers, but the core should consist only of these responsible authorities. Indeed it is pleasing to see that the Arctic Council may be establishing the Arcitc Shipping Best Practice Information Forum.

As Finland takes up the Arctic Council Chairmanship in May 2017 this is a great opportunity to ensure Finland's expertise is at the forefront of this initiative.

Although there is a good base of experience in Arctic shipping, knowledge is still developing and expanding. New areas and routes are being explored and less-experienced operators are entering the business. Authorities must carefully follow these developments and evaluate how the Polar Code is working and being interpreted. They should take account tof the huge and varying areas included in the Arctic and Antarctic regions and operations within them to recognise possible development needs for the Polar Code. *DPC*

About the author: Capt Jarkko Toivola has years of personal experience of Greenland trade, Sakhalin Arctic Offshore and Baltic Sea winter navigation. For five years he was head of the Winter Navigation Unit in the Finnish Transport Agency. His present position is vice president at Alfons Håkans, a towage and salvage company that has icebreaking contracts for Finnish, Swedish and Estonian winter navigation authorities.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