Martech Polar

Ice Pilotage – The Canadian Perspective

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Abstract

The role of the ice navigator or ice advisor has become an important component in safe shipping operations within polar and first year ice regimes. New standards and governance initiatives by IMO and various governments will impact the shipping industry in the future. This paper will provide and overview of the role of the ice navigator, and the need for ice pilotage in ice regimes within the Canadian context, both in summer Arctic shipping season and the winter Gulf of St Lawrence shipping season. It will provide an overview of the ice typically encountered in the Arctic and the Gulf of St Lawrence. From a pilotage perspective it will also address other operational issues particular to higher latitudes.

Canadian Ice Regimes

Canada possesses an almost unique context with respect to requirements in ice navigation in that it's geographic position results in the need to address both summer and winter seasons where ice will be encountered in two widely separated geographic regions with dramatically different ice regimes. Except for Hudson's Bay, which experiences only first year ice conditions, the summer Arctic shipping season along the north and north-east coasts of the country is characterized by potential presence of hard multi-year and glacial ice, while the winter Great Lakes, Gulf of St. Lawrence and East Coast shipping season is characterized by first year ice compounded by ridging and rafting similar to conditions encountered in the Baltic during winter months. Each region requires subtly different understanding of ice conditions, ship characteristics and operations in these differing ice conditions.

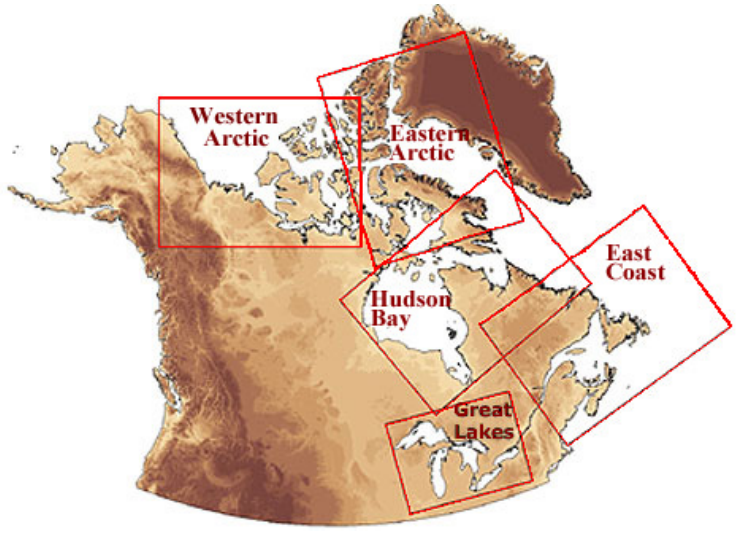
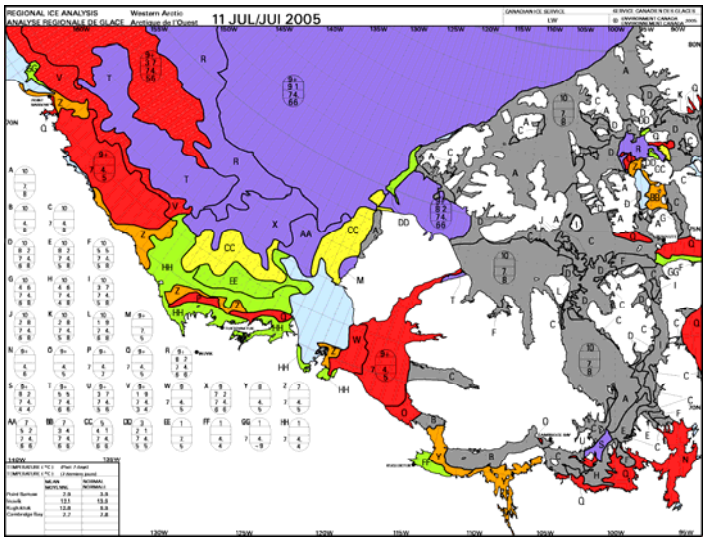


Figure 1. (Canadian Ice Service) Map of Canada showing areas of ice cover. Winter ice navigation season in the East Coast and Great Lakes is punctuated by first year ice. Hudson Bay is subject to first year ice conditions, however Arctic areas are subject to old and glacial ice conditions.

Arctic Ice Regimes

The Arctic region extends from the Beaufort Sea in the west, through the Arctic Archipelago and the Northwest Passage, down through Baffin Bay and Davis Strait in the east. The shipping season in this region takes advantage of summer melt, and generally extends from July to October. The primary differences in ice regimes encountered by shipping in this Arctic region are the presence of either multi-year pack ice or glacial ice calved off the glaciers of Greenland.

In the western arctic, multi-year pack ice closes down to the coastline in winter months along the Beaufort Sea, remnants of which can remain through out the shipping season. Within the Arctic Archipelago, incursions of multi-year pack ice occur from Parry Channel eastwards and M'Clintock Channel southwards and through channels such as Wellington Channel into Lancaster Sound and Nares Strait into Baffin Bay. First year ice within the Archipelago often survives a complete summer melt season and subsequently thickens and hardens over successive years.



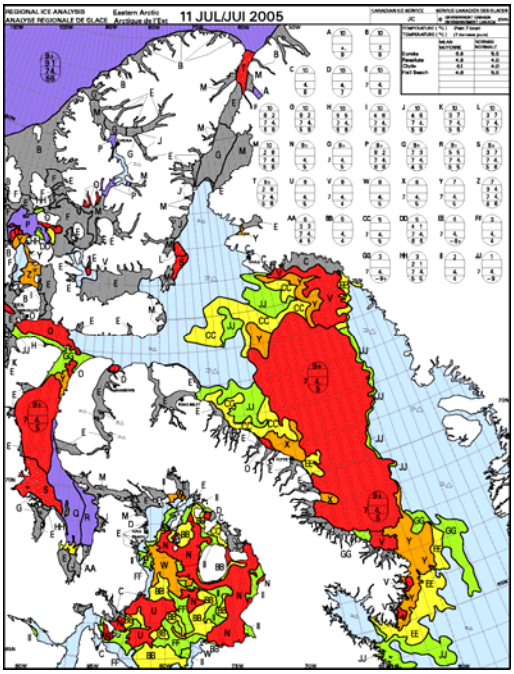


Figure 2 & 3. (Canadian Ice Service)Above - Western Arctic Ice Conditions, *Below left* – Eastern Arctic Ice Conditions 11 July 2005

Glacial iceberg elements are encountered most predominantly in the Eastern Canadian Arctic, having calved from the Greenland glaciers and transited with the currents first north into Baffin Bay, then occasionally into Lancaster Sound before running south in Davis Strait and into the North Atlantic. Hudson Bay is not usually affected with multi-year ice, as sea ice rarely survives the summer melt within the region.

The potential presence of these two more dense ice types within Arctic ice regimes is of great concern to shipping and pilotage. While transiting the passages of the Archipelago and the Northwest Passage, pressure and concentration must also be considered as the narrow passages may not allow for effective dispersal of ice while making way.

East Coast – Gulf of St. Lawrence Ice Regimes

The waters of the Gulf of St. Lawrence and the east coast of Canada north and east of Nova Scotia are affected by much the same conditions in the winter as are the waters of the Baltic Sea Area. Sea ice never survives a summer melt, and thus only first year ice is encountered. However current and wind effects result in considerable rafting and ridging, along with pressure conditions that can cause considerable concern for shipping. The Great Lakes are generally closed to shipping in the winter months.

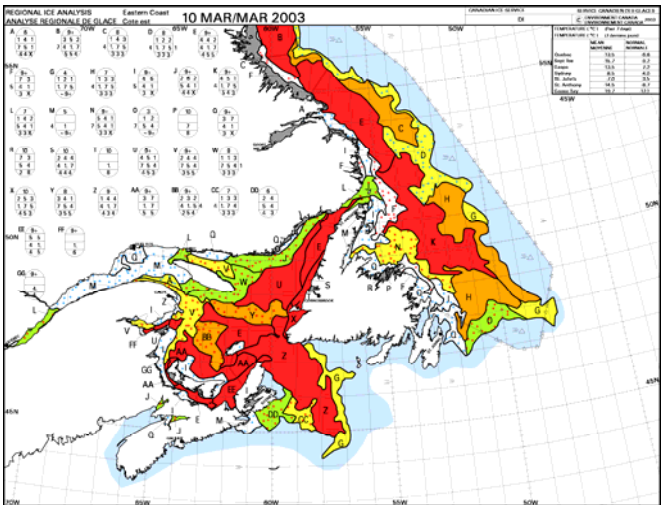


Figure 4. (Canadian Ice Service) East Coast Ice Conditions 10 March 2003

The Need for Ice Pilotage

It has been recognized from the earliest incursion by mariners into ice covered waters that specialized skills beyond those of the average mariner are required to safely and effectively transit these regions. In the Canadian context, whaling Captain William Scoresby stated in his 1820 *The Arctic Regions and the Northern Whale Fishery:*

> "the navigation of the Polar seas, which is peculiar, requires in a particular manner, an extensive knowledge of the nature, properties and usual motions of the ice, and it can only be performed to the best advantage by those who have long experience with working a ship in icy conditions."

We know that the early sailing vessels often employed "ice masters" in the crew, mariners with particular experience negotiating the hazardous ice fields, in both the Arctic and east coasts of Canada. These supernumerary officers provided the skill and knowledge of ice conditions that exploring Royal Naval officers did not possess.

The requirement to have onboard mariners with specific skill and knowledge to transit ice regimes is no less important today, even with the tremendous advances in technologies. Stena's Ulf Ryder is quoted in the September 1st, 2005 edition of Fairplay: "it takes as long to train an Ice Master as it does a brain surgeon" recognizing the years of development necessary to train an officer to handle a ship in ice.

By nature of their specialized work, the crews of modern icebreakers are well trained and skilled in the assessment of ice conditions en route and the execution of a passage. Just as Scoresby wrote almost 200 years ago, these skills are honed over years and

many miles of transit in ice regimes that challenge their growing skill. The average mariner however, rarely challenged by the extreme conditions within an ice passage, does not have the opportunity to gain from experience, to add to his or her knowledge base and therefore make appropriate decisions when faced with the ever changing and challenging ice conditions of the Northwest Passage. For this reason ship owners and regulators acknowledge the need for onboard specialists to assist and advise the bridge team when it comes to passage through ice regimes. However, unlike coastal, harbour or river pilots, ice pilotage has remained unique in its status and though recognized as required had until recently remained industry driven for the most part.

Modern Requirements for Specialized Skills

In the 1970's with the advent of petroleum exploration and potential exploitation, particularly in the western arctic, Transport Canada recognized the need to regulate marine traffic within Canadian Arctic waters in order to protect the fragile environment. The Arctic Waters Pollution Prevention Act and Regulations came into force in an effort to put in place regulations that would achieve that protection. In the mid nineties Transport Canada took another step, researching what skills and knowledge should be required of a bridge navigation officer when transiting arctic ice regimes. Due to the presence of heavier multi-year ice in the arctic, it was felt that even skills developed in more benign first year only ice conditions was not sufficient.

The research, conducted for Transport Canada by Canarctic Shipping Company, with subcontract to the Marine Institute to develop model instruction modules based on the skill sets, resulted in the International Ice Navigator Course Development position paper. This paper would be presented to IMO and become an integral foundation for what would become the Polar Code, and then eventually the IMO Guidelines for Ships Operating in Arctic Ice Covered Waters.

As lead author of the position paper, I was heartened to find that globally, there was a common agreement that the challenges faced by navigators while transiting arctic ice regimes were often beyond the scope of present or even future expectations of average mariner training and experience. Though many of the new skills and knowledge could be taught in well developed courses, the true skill came only with actual onboard experience. As predicted by Scoresby many years before and echoed by Ryder so recently, the final paper confirmed that specialized skills and knowledge were required of navigators onboard vessels transiting arctic ice regimes, detailed those skills and knowledge, presented model courses for training and recommended minimum experience onboard vessels engaged in navigation within arctic ice regimes for both junior watchkeeping officers and the Master. Endorsements to Certificates of Competency in two levels were recommended, one for Officers of the Watch that would be based on a syllabus of training and a second higher for the Master or at least one senior watchkeeper requiring quantified experience in arctic ice regimes.

The position paper identified the broad array of additional skills and knowledge required to safely navigate within the multi-year ice regimes of the Northwest Passage. The Ice Navigator must fully understand ice physics, and be able to identity ice types and forms, with particular attention to the more dangerous glacial and multi-year ice that may be encountered. This includes the ability to visually interpret conditions all around the vessel and the signs of ice in the vicinity as well as be able to interpret the various ice imagery, charts and reports that are available. He or she must understand the interaction of weather conditions, currents and ice, along with the prevailing conditions that should be expected at particular periods of transit. The Ice Navigator must be able to combine that knowledge with the more traditional aspects of passage planning in order to develop the most effective and safe routing under, at times, very dynamic conditions. Full knowledge of the limitations of ships based on ice class (or lack there of), due to hull strengthening, power and manoeuvrability are necessary to approach and enter an arctic ice regime safely and successfully direct a vessel through even the most innocuous ice regimes. He or she must be skilled at avoiding potential besetment, and if forced into that unenviable position, must be skilled at methods to free the ship and handling a damaged ship were that to occur. The Ice Navigator must have complete understanding of operations with icebreakers, the requirements and communications necessary.

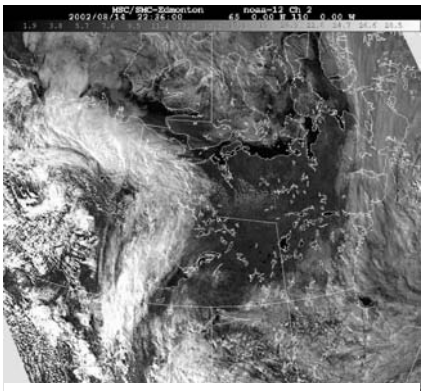


Figure 5. (NOAA) Channel 2 Imagery – Canadian Central Arctic

The immediate result of the position paper was a change to Canada's Arctic Shipping Pollution Prevention Regulations.

Ice Navigator Requirements in Canadian Arctic Waters

Today, section 26. (1) of the Canadian Arctic Shipping Pollution Prevention Regulations (CASPPR) requires any tanker transiting Canadian Arctic waters to carry an Ice Navigator at all times, and vessels other than tankers to carry an Ice Navigator if they intend to transit zones that would otherwise be closed to their vessel by virtue of the zone/date system of CASPPR by instituting the option to utilize the Arctic Ice Regime Shipping System. AIRSS permits an experienced ice navigator to make subjective assessments of present ice conditions, enter a calculation based on those assessments with a factor based on the vessel's ice class, then determine a go no go decision.

The Ice Navigator shall:

> (a) be qualified to act as a master or person in charge of the deck watch in accordance with regulations made pursuant to the Canada Shipping Act; and
>
> (b) have served on a ship in the capacity of master or person in charge of the deck watch for a total period of at least 50 days, of which 30 days must have

been served in Arctic waters while the ship was in ice conditions that required the ship to be assisted by an ice-breaker or to make manoeuvres to avoid concentrations of ice that might have endangered the ship.

IMO Polar Requirements

The 2002 IMO Guidelines for Ships Operating in Arctic Ice-covered Waters, though not compulsory, recommend a similar specialized skilled individual onboard vessels operating in Arctic ice covered waters, section 1.2.1 stating

> "all ships operating in Arctic ice-covered water should carry at least one Ice Navigator qualified in accordance with chapter 14."

Chapter 14 requires an Ice Navigator to

> "have documentary evidence of having satisfactorily completed an approved training program in ice navigation."

The original Polar Code required documented service in Arctic ice conditions. As yet neither IMO nor Canada has seen necessary to accept the recommendations of the position paper to pursue the concept of an Ice Navigator endorsement on Certificates of Competency.

Ice Advisor Requirement for East Coast Waters of Canada

The requirement of the special skill set and knowledge is also recognised in the East Coast waters of Canada during the winter ice navigation season. Though not affected by multi-year ice conditions, the Gulf experiences heavy ridging due to the dynamic current and wind effects. Here, the Joint Industry – Coast Guard Guidelines for the Control of Oil Tankers and Bulk Chemical Carriers in Ice Control Zones of Eastern Canada, otherwise known as JIGs, recognizes that most commercial vessels do not transit ice regimes with sufficient regularity to maintain ice navigation skills, and require the presence onboard of a person experienced in navigating an active Ice Control Zone. For many ships this person is the contracted "Ice Advisor". The person

> "must have a certificate of competency valid in Canadian waters, be medically fit and have sailed as Master or Senior Watchkeeping Officer or Ice Advisor during the last five year period, while making at least 6 one way trips, totalling a minimum 15 days experience navigating ice covered waters that required the ship to make extraordinary manoeuvres or to be assisted by an icebreaker."

The Shipping Federation of Canada annually publishes a list of recommended Ice Advisors for the use of member shipping companies. Accepted individuals must prove

that they meet the requirements of the JIGs before they are listed. Ice Advisors contracted by the shipping company will board vessels inbound before the vessels enter ice and provide professional advise to the Master and Bridge team through out an ice transit. Outbound, the Ice Advisor will depart once the ship is clear of ice. Many companies, such as Fednav have their own list of accepted Ice Advisors.

Figure 6. (Canadian Coast Guard) – Gulf of St. Lawrence Shipping following Ice Centre recommending routing

The many years of experience requiring Ice Advisors in the Gulf of St. Lawrence has proven that the concept of adding supernumerary especially skilled personnel to regular bridge teams during ice regime transits is workable, efficient and economical. Shipping and Ship Management Companies, rather than attempt to maintain high level skills required of Ice Navigators onboard ships where ice transits are few, can augment regular crew skill with experienced and effective advisors only when required. This same process is generally followed on most other non-icebreaking ships transiting the Northwest Passage today, fully in compliance with the intent of the Arctic Shipping Pollution Prevention Regulations and the IMO Guidelines.

Expanding the Ice Advisor Model

The ice advisor model is effective. The combination of National regulations, IMO guidelines, and insurance requirements work together to ensure that vessels that transit the ice infested waters along Canada's coastlines carry onboard mariners who possess the necessary skill and knowledge to ensure safe transit. Employing an Ice Advisor only when required, without the expensive proposition of trying to train or maintain skills of navigators that rarely transit the ice is the most economical method of meeting Ice Navigator requirements for most shipping companies.

The skilled Ice Advisor will board the vessel as a supernumerary officer prior to entering ice infested waters armed with latest ice information combining it with their specialized knowledge to interpret ice imagery and information, recommend both strategic and tactical routing and even advise the vessel's management team on cold weather precautions not directly related to navigation. With the full understanding of the physics of sea ice formation and degradation, the effects of wind and current combined with the local knowledge of the maze of passages within the Canadian Arctic Archipelago or Eastern Canadian waters, the Ice Advisor provides daily and hourly recommendations to the Bridge Team. Often one of the greatest challenges is in educating the Bridge Team to raise them to a higher operational skill level in ice navigation. A more safe and efficient transit of ice covered waters results.

Training and maintaining skills and knowledge in crews that less frequently transit ice infested waters can be time consuming, costly and less effective than hiring and placing onboard skilled Ice Advisors only during periods when these specialized skills are necessary.

Skill Development

Where do these advisors gain their skills? Many have gained their experience as watchkeeping officers on vessels that more regularly transit Arctic ice regimes. Companies such as Groupe Desgagnés, Nunavut Eastern Arctic Shipping and Northern Transportation Company and the Canadian Coast Guard have contributed to the ranks, their officers having built their skills with their regular presence in Arctic waters. A great deal of experience has also come from the petroleum exploration boom in the Western Arctic in the 1970's, 1980's and early 1990's. In the Beaufort Sea, bridge teams learned by trial and error what worked and what didn't.

Modern courses as envisaged by the Ice Navigator Position Paper do provide a valuable background, but as yet none of the practical skill development. Meriturva Training Institute here in Finland, the Netherlands William Barentsz Institute and Argentina have conducted classroom training to a very high degree of professionalism.

As technology improves, simulators will provide valuable and cost effective skill development opportunities. Transas has developed simulation programs and suites in conjunction with Russia's Arctic and Antarctic Research Institute that provide excellent visual representation. Enfotec Technical Services of Ottawa in conjunction with Philosoft has developed a PC based instructional Ice Navigation Training Module. The Marine Institute in St John's conducts their Fundamentals of Ice Navigation which utilizes their full motion simulator in an attempt to provide skill development on top of knowledge accumulation. Missing thus far in all of these simulators however, is the realistic interaction between ship and ice as represented in the visual simulations.

Figure 6 (left) (Transas) – Ice Navigation Simulation Suite

Figure 7 (Enfotec Technical Services) – Ice/Nav PC-based training system

Challenges in the Canadian Arctic

Unlike both the Baltic Sea Area and the Gulf of St. Lawrence where traffic density and proximity to population and technology centres affords well developed support to ice shipping, within the Canadian Arctic, support is extremely limited.

During the short shipping season, the Ice Pilot and Ship Master must be fully aware that unless in direct contact with one of only five government icebreakers assigned to Arctic summer operations, their ship is wholly on it's own once it enters the Arctic Shipping Safety Control zones. The Canadian Coast Guard vessels are assigned to escort duties as they are available, but their small numbers may result in a lone vessel operating on its own unless conditions are extremely serious, in favour of other vessels, widely dispersed that are at greater risk. NORDREG, the voluntary Arctic traffic reporting scheme is aware of all vessels that chose to report, and will provide vessel position if requested by the mariner.

Infrastructure in the Canadian Arctic is very limited. Vessels transiting the arctic ice regimes operate "come as you are". The small aboriginal communities in the Canadian Arctic provide no on site support except in the most rudimentary way. Supplies and parts must be pre-ordered ahead or long waits for delivery to remote gravel airfields must be expected. There are no ship repair facilities north of Newfoundland on the east coast, or Dutch Harbour on the west coast. Pollution response is limited to equipment carried onboard Canadian government icebreakers or stored in two remote locations. Since the reduction in Western Arctic petroleum exploration in the mid 1990's, no tugs or commercial assist companies are available.

Mariners familiar with the near instant communication afforded throughout the rest of the globe must be aware of the limitations that will be experienced in the Canadian Arctic. INMARSAT coverage is limited, particularly in the Western Arctic in the gap between AOR-P and AOR-A footprints. North American centric systems such as MSat and low earth orbit systems such as Globastar and Iridium provide somewhat better coverage. VHF Ship/Shore is limited to proximity to wide spread centres such as Inuvik, Cambridge Bay and Iqaluit. Mariners are generally forced to rely on HF radio for communications.

Another vital difference is the quality of ice information that is available in the Arctic. At present, the Canadian Ice Service has only one aircraft available for SLAR over-flights, and due to budget constraint, this aircraft is limited to 200 hrs flying in support of ice reconnaissance across the entire Canadian Arctic. As a result, ice charts are predominantly based on Radarsat imagery and secondarily on the direct visual sightings from the Ice Observers on the widely separated icebreakers. This results in often less than timely information as the Radarsat orbit paths and downloading of data may be several days apart for given areas of interest. This forces the Ice Pilot to rely on his own skills at interpreting the likely effects of wind and current since the last image several days past to determine routing and tactical passage planning.

Conclusions

As marine navigation pushes back the frontiers, transit in ice regimes will continue to be a challenge that must be met with skill, knowledge and innovation. The skills necessary to ensure a safe and efficient ice transit take years to develop over numerous encounters with challenging ice conditions. Specialists who possess those skills and knowledge will continue to be required to meet the needs of commercial shipping that by necessity or choice must transit ice-covered waters.

It has been generally found in the Canadian experience, in both the first year ice conditions encountered in the Great Lakes, the Gulf of St. Lawrence, the East Coast of Canada and Hudson's Bay, and in the multi-year ice conditions of the Canadian Arctic, that the Ice Advisor model, where mariners that possess the skills and experience necessary to ensure safe navigation are brought onboard when required is the most economical way to achieve safe and efficient transit. These specialists provide the necessary abilities and knowledge to aid the regular officers and crew's of commercial ships that may not have the opportunity to build or maintain the knowledge to safely and efficiently transit ice regimes.

Though differing regulations or guidelines may apply within the two distinct regions of ice navigation in the Canadian context, each recognizes that experience and training above that of most mariners is a necessity.

Within the Canadian context, industry and government continue to see to value in ensuring that the best skills are available to mariners. Recognizing that practical experience takes many years to develop, collaborative work continues to develop better training and simulation capability to provide the most efficient development of skilled ice navigators in the future.