7 Information about Navigation in Ice

The Canadian Coast Guard publication "Ice Navigation in Canadian Waters" indicates the necessary precautions to be taken by ships navigating in ice in all Canadian waters, including the Arctic. This document provides Masters and watch keeping crew of vessels transiting Canadian ice-covered waters with the necessary information to achieve an understanding of the hazards, navigation techniques, and response of the vessel.

The nautical publication is available to download, free-of-charge, from
http://www.ccg-gcc.gc.ca/Ice_home/Ice_Publications/Ice-Navigation-in-Canadian-Waters.

It is important to note that the paper version of the document is no longer available.

7.1 General

Ice is an obstacle to any ship, even an icebreaker. The first principle of successful ice navigation is to maintain freedom of manoeuvre. Once a ship becomes trapped, the vessel goes wherever the ice goes. Ice navigation requires great patience and can be a tiring business with or without icebreaker escort. The long way round a difficult ice area whose limits are known is often the fastest and safest way to port, or to the open sea.

Experience has proven that in ice of higher concentrations, three basic ship handling rules apply:
- keep moving - even very slowly, but keep moving;
- try to work with the ice movement, and not against it; and
- excessive speed means ice damage.

7.2 Requirements for Ships Operating in Ice

The propulsion plant and steering gear of any ship intending to operate in ice must be reliable and must be capable of a fast response to maneuvering orders. The navigational and communications equipment must be equally reliable and particular attention should be paid to maintaining radar at peak performance.

Light and partly loaded ships should be ballasted as deeply as possible, but excessive stern trim is not recommended, as it cuts down maneuverability and increases the possibility of ice damage to the more vulnerable lower area. Suction strainers should be able to be removed easily and to be cleared of ice and snow. Good searchlights should be available to aid in visibility in the event of night navigation with or without icebreaker support.

Ships navigating in ice-covered waters may experience delays and, therefore, should be stored with sufficient fresh-water supplies and maneuvering fuel.

7.3 Superstructure Icing

Ships and their equipment at sea in Canadian winters and in high latitudes are affected by the following:
- low surface temperatures
- high winds
- low sea-water injection temperatures
- low humidity
- ice conditions ranging from slush ice to solid pack
- snow, sleet, and freezing rain
- fog and overcast, especially at the ice/water interface
- superstructure icing when there is the great and dangerous possibility of heavy and rapid icing with consequent loss of stability.

Superstructure icing is a complicated process that depends upon meteorological conditions, condition of loading, and behavior of the vessel in stormy weather, as well as on the size and location of superstructure and rigging. The more common cause of ice formation is the deposit of water droplets on the vessel's structure. These droplets come from spray driven from wave crests and from ship-generated spray. Ice formation may also occur in conditions of snowfall, sea fog, (including Arctic sea smoke) a drastic fall in ambient temperature, and from the freezing of raindrops on contact with the vessel's structure. Ice formation may sometimes be caused or accentuated by water shipped on board and retained on deck.

Vessel icing is a function of the ship's course relative to the wind and seas and generally is most severe in the following areas: stem, bulwark and bulwark rail, windward side of the superstructure and deckhouses, hawse pipes, anchors, deck gear, forecastle deck and upper deck, freeing ports, aerials, stays, shrouds, masts, spars, and associated rigging. **It is important to maintain the anchor windlass free of ice so that the anchor may be dropped in case of emergency.**

Superstructure icing is possible whenever air temperatures are -2.2°C or less and winds are 17 knots or more, and when these conditions occur simultaneously. Generally speaking, winds of Beaufort Force 5 may produce slight icing; winds of Force 7, moderate icing; and winds of above Force 8, severe icing. Under these conditions, the most intensive ice formation takes place when wind and sea come from ahead. In beam and quartering winds, ice accumulates more quickly on the windward side of the vessel, thus leading to a constant list which is extremely dangerous. **Vessel icing may impair the stability and safety of a ship.**

7.4 Ship-handling in Ice

The route recommended by the Ice Operations Officer is based on the latest available ice information and Masters are advised to adjust their course accordingly. The following notes on ship-handling in ice have proven helpful:

a) Do not enter ice if an alternative, although longer, route is available.

b) It is very easy and extremely dangerous to underestimate the hardness of the ice.

c) Enter the ice at low speed to receive the initial impact; once into the pack, increase speed to maintain headway and control of the ship.

d) Be prepared to go "Full Astern" at any time.

e) Navigation in pack ice after dark should not be attempted without high-power searchlights which can be controlled easily from the bridge. If poor visibility precludes progress, heave to and keep the propeller turning slowly as it is less susceptible to ice damage than if it were completely stopped.

f) Propellers and rudders are the most vulnerable parts of the ship; ships should go astern in ice with extreme care - always with the rudder amidships.

g) All forms of glacial ice (icebergs, bergy bits, growlers) in the pack should be given a wide berth, as they are current-driven whereas the pack is wind-driven.

h) Wherever possible, pressure ridges should be avoided and a passage through pack ice under pressure should not be attempted.

i) When a ship navigating independently becomes beset, it usually requires icebreaker assistance to free it. However, ships in ballast can sometimes free themselves by pumping and transferring ballast from side to side, and it may require very little change in trim or list to release the ship.

Masters who are inexperienced in ice often find it useful to employ the services of an ice pilot/advisor for transiting the Gulf of St. Lawrence in winter or an Ice Navigator for voyages into the Arctic in the summer.

7.5 Main Engine Cooling Systems

There is potential for ice and slush to enter sea bays or sea inlet boxes, blocking sea-water flow to the cooling system. This problem is encountered by a majority of ships entering ice-covered waters.

If water cannot be obtained for the cooling system, the main engines will not perform properly and may overheat causing the engines to shut down, or to be seriously damaged. The design of ships which operate in ice must prevent the cooling system from becoming blocked by ice.

Warning: Blockage of the sea boxes can cause the main engine cooling system to overheat, requiring reduced power to be used or the engine to be shut down completely.

Means must be provided to clear the sea bays if they do become blocked by ice. There are several design features which can ease or eliminate these problems:

a) High and low inlet grilles can be provided as far apart as possible.

b) Weir-type sea inlet boxes will overcome the problem of suction pipe clogging. The principal is commonly used in Baltic icebreakers. The suction is separated from the sea inlet grilles by a vertical plate weir. Any ice entering the box can float to the top and is unlikely to be drawn back down to the suction level.

c) De-icing return(s) can be arranged to feed steam or hot water to the sea inlet box top, where frazil ice may have accumulated, or directly to the cooling system suction where a blockage may have occurred.

d) Ballast water recirculation through the cooling water system allows ballast tanks to be used as coolers, alleviating any need to use blocked sea inlet boxes. It should be noted that, while this solution is effective, it is usually a short-term solution unless vast quantities of ballast water are available or if the ship is fitted with shell circulation coolers because the recirculated ballast water will become too warm for effective cooling.

e) Means should be provided to clear the systems manually of blockage by ice.

The navigators and engineers should be aware of these potential problems and the solutions available to them on their ship.

7.6 Hull Fractures

Over the last several winter seasons, a number of bulk carriers and tankers developed fractures in their hulls while navigating in ice, off the East Coast of Canada or in the Gulf of St. Lawrence. The Load Line Regulations require that the master of every ship be supplied with a loading manual to enable him to arrange for the loading and ballasting of his ship in such a way as to avoid the creation of any unacceptable stresses.

Masters should be aware, while navigating in Canadian East Coast Waters and in the Gulf of St. Lawrence during the winter season, that low temperatures increase the brittleness of steel. This fact may be aggravated by wind force, sea conditions, and load distribution, temperatures of heated cargoes or oil fuels and length/beam ratio of vessels. Therefore, when there is a combination of:

(a) gale force winds;
(b) short, steep seas;
(c) very cold temperatures, and
(d) high length/beam ratio in vessels in ballast or in part-loaded condition.

Masters should minimize longitudinal stresses by reducing speed and maintaining the most advantageous ballast distribution as long as is necessary.

Authority: Canadian Coast Guard