On the cold but clear night of April 14th, 1912 on board the brand new steamer Titanic, the crow's nest bell suddenly rings three times, followed by the ringing of the nest telephone on the bridge. The telephone is answered by the Sixth Officer, who hears the Lookout's urgent warning, “Iceberg, right ahead!”

About ninety minutes later the ship had sunk and the tragedy started to dawn as 1,500 people drowned or froze to their deaths. What was believed to have been built by mankind to resist even the damage of striking an iceberg had now perished. Ice had proved tougher than expected.

The above incident is, of course, one of a kind in many aspects, but it shows that the forces of nature, in this case ice, never can nor should be underestimated.

The Swedish Club annually deals with a large number of ice-related claims. The Club’s experience is that masters and shipowners on many occasions seem to be surprised by the force, strength and toughness that ice constitutes and the severe damage it might inflict on a vessel.

The past winter showed us yet again how important it is for shipowners to be wary of the dangers in icy waters. Among other areas, the Gulf of Finland and the approach to St. Petersburg witnessed a lot of incidents where ships were not entirely fit for the purpose, masters not sufficiently trained for the task and shipowners did not seem to take the issue of ice seriously enough. These circumstances do not, of course, account for all the ships that experienced troubles in ice-infested waters during the past winter. Some were of course simply unlucky. The main reasons, however, are lack of knowledge and experience of ice, no doubt coupled with commercial reasons and considerations.

This article is intended to highlight some of the factors and dangers that seafarers are exposed to when navigating through icy waters.

**Navigation**

Navigation through ice-infested waters is always a difficult and delicate task. Poor visibility caused by fog and/or snowfall is often related to icy waters. Sight must be given very careful consideration, for false horizons are frequently observed in ice. One important aid is the radar, which has been found to be a most valuable tool for safe navigation when used judiciously. It is necessary to optimise the radar settings in order to be able to detect icebergs, or ice walls in ice-covered waters. Other valuable aids are the various electronic positioning fixing systems, such as the GPS. Good searchlights should also always be available during the hours of darkness.

**Beset**

The vessel’s speed in ice requires careful consideration by the master. If a vessel goes too slowly, she risks being beset, if too fast she risks damage from collision with floes.

Experience has shown that vessels that are not ice-strengthened, and that do not maintain a speed of about 12 knots in open water, often become firmly beset even in light ice conditions.

Furthermore, ships operating in ice should be ballasted and trimmed so that the propeller is completely submerged and as deep as possible, but without excessive stern trim which reduces manoeuvrability.

When operating in ice, the first principle for making a successful passage is to maintain freedom of manoeuvre. Once a ship becomes trapped, she will go wherever the ice goes. Any seafarer, who has navigated through ice, knows that operating under such conditions demands great patience and that it can be a tiring business, with or without an ice-breaking escort.

In ice concentration, three basic ship handling rules apply: (i) keep moving, even if very slowly, (ii) try to work with the ice movement and not against it, and (iii), do not forget that excessive speed leads to ice damage.

Another feature of ice is that its condition can change rapidly due to changes of wind, sometimes within hours.

Before deciding to enter the ice, the following factors need to be considered: type of ice; time of year, weather and temperature; area of operation; availability of icebreakers; vessel’s ice class in relation to the type of ice expected; state of hull, machinery and equipment; draught and depth of water over the propeller tips and the rudder and the experience the person in charge of the bridge has of ice.

Every opportunity should be taken to use leads through ice. When not accompanied by an icebreaker, it is unwise to follow a shore lead with an onshore wind blowing, as moving ice may force a vessel aground.

The most serious danger in connection with ice is from the pressure of the ice, which may crush the hull or nip and tear off the ship’s bottom. A ship beset in ice can drift with the ice against ice fronts, shoals and the shore. Every precaution should therefore be taken to avoid this situation.

**Ice accumulation**

Ice accumulation on ships is another serious danger of water in its frozen form. This can be a threat to the ship, cargo and crew when it accumulates on the hull and superstructure of a ship. Ice accumulation may occur from three causes namely; (i) fog, (ii) freezing drizzle, rain or wet snow, or (iii) spray or seawater breaking over the ship (when the air temperature is below the freezing point of seawater (-2°C)).

The ice on deck and on the rigging is liable to endanger those on deck by falling down or simply because of the plain slipperiness of it. Ice may also damage radio aerials and radar and satellite equipment. This is a subsequent danger to the further advance of the vessel.

However, by far the most dangerous situations are when a ship encounters heavy weather and rough sea, with heavy seas breaking over the vessel, while the temperature is running low. This can alter a ship’s GM to critical points. In extreme cases this has led to the capsizing of vessels.

The dangerous conditions are those in

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1. The metacentric height, which is a measure of ships stability.
which strong winds are experienced, above force 6\(^{2}\), and the air temperature falls below -2°C. A decreasing sea temperature increases the rate of accumulation but also other factors, such as the ship’s speed and course relative to wind and waves, and not least of all the particular design of the vessel.

As it is very difficult for forecasters to predict all the variables involved, the mariner should be advised to exercise all possible caution whenever gales are expected, and air temperatures simultaneously forecasted at -2°C or below.

**Propeller and rudder**

Engines must be prepared so they can go full astern at any time. However, as propellers together with the rudder are the most vulnerable part of a ship, ships should go astern in ice with extreme care, and always with the rudder amidships. Furthermore, violent rudder movements should only be used in emergencies. Frequent use of the rudder, especially in the hard over position, has the effect of slowing down the vessel’s passage through ice.

Anchoring should as a matter of course be avoided in a heavy concentration of ice. If the ice is moving, its tremendous force may break the cable.

Masters of icebreakers are highly skilled and experienced in the specialist field of ice navigation, icebreaking and ice escorting. It is therefore the master of the icebreaker who directs any ice-escorting operation. Some icebreakers carry helicopters that are able to guide ships along the best routes through the ice.

Escorted vessels must follow the path cleared by the icebreaker and not venture into the ice on their own; they must have towing gear rigged at all times, and officers on the bridge must be thoroughly acquainted with the icebreaker signals to acknowledge and execute signals made by the icebreaker promptly, whether by RT\(^{3}\), light or sound.

The master of the icebreaker decides on the minimum and maximum distances that a ship should be from the icebreaker. Before entering into ice, the master of the icebreaker will decide on the route to be taken. When a course is altered, an escorted ship must follow in the wake of the icebreaker along its exact route.

The speed of an escorted ship is ordered by the icebreaker. When an icebreaker comes to a standstill and is unable to make further progress without coming astern, she shows and sounds the appropriate signals. These signals should be related with extreme urgency. Engines should immediately be put astern and the rudder used to reduce headway. If a single-screw ship suddenly goes astern while passing through a narrow channel through ice, she may slew and damage her propeller and rudder on the ice. To avoid collision with a ship ahead, it is often preferable to ram the ice on one side of the channel if it is sufficiently thin to embed the bow without damage, rather than risking going astern.

All icebreakers are fitted with towing winches with a towing wire reeled on each winch drum. When an icebreaker decides to tow, the assisted ship must immediately prepare to take onboard and secure the towing wires quickly, particularly if there is ice screwing or ice pressure.

When an escorted ship becomes beset, she should normally keep her engines moving slowly ahead to keep ice away from the propellers. In thin ice, the icebreaker usually comes astern along the channel and cuts away the ice on either bow of the ship. The icebreaker then goes astern close along the whole length of the ice side of the beset ship, and then goes ahead, simultaneously ordering the ship to follow her.

In heavier ice, ships can usually be broken out by the icebreaker turning through 180 degrees, going back to the beset ship and passing close aboard her leeward side. The icebreaker then turns through 180 degrees astern of her, and returns along either her leeward side to thin out the ice or her windward side to relieve pressure on that side, at the same time ordering the ship to follow her.

**Convoys**

If several vessels are to be assisted at the same time, a convoy is to be formed. It is the master of the icebreaker who decides the sequence of the ships in the convoy and their distance apart. Particular attention must be paid to maintaining the distance ordered: it will vary with the ice conditions. If a ship’s speed is reduced, the ship astern must be informed immediately. Ships ahead and astern, as well as the ice, must be carefully watched.

**Ice advice**

If shipowners seek advice on the predicaments that ice may pose, guidance may be found by contacting the coast guard or the maritime authorities in the country of destination. Sweden, for example, due to its geographical position (together with the other Scandinavian countries, Russia, the Baltic States, the northern European countries, Canada etc.) has a long history and experience of fighting water in its frozen state during wintertime.

A word of advice is to closely study the Pilot – e.g. the Admiralty Sailing Directions – beforehand.

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2 Pursuant to the Beaufort scale, where a force 6 equals 10.8 to 13.8 m/s. 3 Radio Telephony