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NAVIGATION AND SEAMANSHIP IN ARCTIC AREAS

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The most perspective alternative is the Northern Sea Route. If the distance traveled by ships from the port of Rotterdam (Netherlands) to the port of Yokohama (Japan) through the Suez Canal is 12,840 nautical miles, the Northern Sea Route is only 5770 nautical miles. This allows to significantly optimize transportation costs.

However, in modern logistics, the most important factor is the predictability of transportation, which is not the case in the extreme northern conditions. The conditions of the Arctic and Antarctic are severe and peculiar compared to the usual conditions of navigation.

Navigation in such areas is a special activity, and knowledge and experience in this regard are available to a relatively small number of professionals. The application of traditional navigation standards in polar waters creates an unacceptable level of risk, as at the initial stage the decision will be made by the ones who do not have sufficient experience.

In order to increase the safety of navigation in the Arctic seas, the International Maritime Organization (IMO) has developed an «International Code for Ships Operating in Polar Waters» (Polar Code (IPC)), as amended to make it mandatory under International Convention for the Safety of Life at Sea (SOLAS).

The Code identifies 10 sources of hazards in polar waters that can increase the level of risk [13].

According to the IPC, for operation in polar waters, vessels are subject to a number of special requirements that will ensure the required level of reliability and survivability of the vessel when exposed to external factors.

In particular, the materials and dimensions of the structures must be sufficient to ensure the integrity of the hull during operation in ice. Vessels must be designed to minimize icing and be adequately equipped with ice removers.

Life-saving appliances must have thermal protection, taking into account the possibility of being in cold sea water (immersion suits with a heat-insulating layer at the rate of 110% of people on board). Additional special ship equipment must be installed: 2 additional 360-degree rotating searchlights, a red flashing light, anti-icing devices on antennas and portholes, a Global Navigation Satellite System (GNSS) satellite compass, and 2 additional echo sounders.

The main environment of navigation is not water, but ice, and navigation in ice is poses significant differences in the methods of ship management. Thus, the crew needs special training, understanding of the natural properties of ice and the dynamics of floating ice.

When solving tactical tasks, navigators must have methods of analysis of ice information to select the optimal path, methods of icebreaking and methods of forcing ice. The Code introduced a mandatory requirement for staff training.

Captains and chief officers must have advanced training, and officers of watch must complete basic polar water navigation training. Upon completion of the training, the competence must be demonstrated on a simulator or laboratory equipment and confirmed by the assessment of the results of preparation for the test in the form of an exam with the issuance of an appropriate certificate.

The master must obtain information on the state of the ice for the vessel going on a voyage in the area which ice encounters are possible and the weather in the area of the voyage both at the time of departure and the forecast for the time of the voyage.

He plans the passage basing on this information, i.e. chooses the path in the most favorable direction pays attention to such dangers as shoals, which can be squeezed by ice.

However, such information is rarely available to the captain.

Changes in weather/ice conditions/, temperatures in polar waters are unexpected, often

unpredictable, and decisions must be made about voyages that can last weeks and months. Mostly, the captain will deal with many issues on the spot during the voyages.

It is necessary to remove the logs and all objects protruding overboard, which may catch on the ice during preparation for ice navigation; to prepare all drainage devices; to check up condition of watertight doors; check the patch, emergency equipment and damage control equipment in accessible places in case there is a need to repair the damage to the hull; to inform the shipping company about the start of the ice navigation; to inform the engineers about the forthcoming voyage in the ice and to reduce the speed of the vessel so as to approach the edge of the ice at a speed which would allow the vessel to be stopped at any moment.

The ice areas should be entered only after receiving the appropriate permission from the shipping company, according to the Guidelines for the navigation of the vessels in the autumn-winter period. It is not allowed to enter the ice areas without such a permission.

However, it should be noted that if the ice navigation had been arranged before the voyage started, there is no need to wait for a special permit to enter the ice [14].

Navigators must be aware of the signs of approaching the edge of the cohesive ice in order to detect the ice in proper time and prepare the vessel for sailing in the ice.

The first signs of the proximity of ice may be:

- icy sky - whitish reflection of the sky above the horizon or a brighter reflection of ice with low clouds in the part of the horizon there is the ice. The icy sky may appear at different distances from the ship, but the probability of its detection from great distances increases in cloudy weather with low dark clouds and a large area of cohesive ice[6];
- reduction or absence of swell away from the shores with fresh long winds, which is a sign of the proximity of the ice edge on the windward side [6];
- a significant decrease in water temperature when navigating in mid-latitudes [6];
- the appearance of individual ice floes on the leeside of the probable location of the ice mass [6];
- the phenomenon of refraction, which occurs most often on cloudless days due to wind from the ice. Significantly raising the image of distant objects, refraction makes it possible to see the image of ice on the background of the lower part of the sky at a distance exceeding the range of visibility by 2-3 times[6];
- the appearance in large numbers of sea animals (walruses, seals, seals) and some species of birds (cairns, scavengers, sea ducks). This is very typical of the edge of melting ice, where there is always plenty of plankton, which serves as food for animals and birds. This sign indicates that large ice clusters are located at a distance of not more than 10-15 miles [6];
- fog formed on the edge of cohesive ice [6].

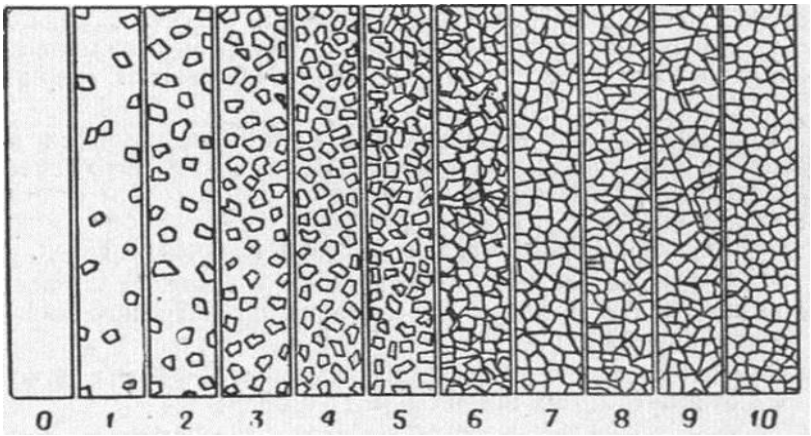

Fig. 1.Ice density on the surface

The leeward edge usually allows you to enter the iceareas always, because the strip of ice significantly calms the excitement that can be from the leeside edge. There is no danger of hitting the ice due to the relative movement of the ice and the vessel. The ice thickens gradually.

In many cases, the windward side edge is dangerous to pass through due to the fact that under the influence of waves, a certain strip of ice is in a dangerous motion for the ship [6].

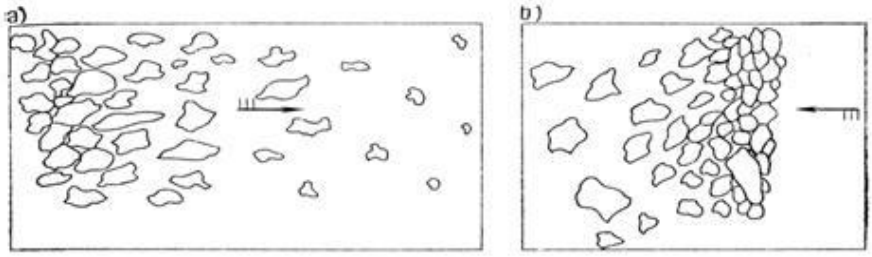

Fig.2. Schematicimageleeward (a) andwindward (b) ice edges

Therefore, in this case it is necessary to find a place that would safely allow the vessel to enter the ice. Such a place can be a strip of fine ice (Fig. 3), individual pieces of which are not dangerous to the vessel, or the protrusion of the ice field, under cover of which you can enter the ice [1].

Fig.3. Ice cake - any relatively flat piece of ice less than 20 m in diameter

If the place that allows you to enter the ice can not be found, and the ice is heavy, it is better not to enter the ice, and wait for the calming of the swell or waves.

In all cases, it is not recommended to enter the ice in the fog or at night. It is better to wait for the visibility to improve and then enter the ice, because with poor visibility the right choice of path will be impossible.

Once in the ice, you can gradually increase the speed. As the speed increases, the propeller will increase the flow of water, which will clear the ice behind the stern, which will make safer the operation of the propeller and the steering gear.

Fig.4. Navigation in ice

The speed of the vessel depends on the location of the ice, greatly. The speed of the ship should be such that the navigator has time to study the nature of the ice from afar, to choose the best way in advance and to bypass large ice floes. The captain must take into account the maneuverability of his vessel, ie the ability to stop in time or alter course from the dangerous ice, when assigning the maximum possible speed of his vessel in the ice.

The maneuverability of the ship is significantly reduced, during ice navigation. This is due to the fact that when throwing the stern, it rests on the ice and prevents the ship from returning. In addition, the risk increases, because the ship encounters ice of different densities and tends to dodge towards the lowest resistance. Maneuverability is further aggravated by the fact that the inertial motion quickly fades due to greater resistance than when navigating in clear waters.

It is necessary to take into account the depth of the coastal strip and the nature of the ice, when sailing along the coast in the presence of ice from the sea,

If the coast is shallow with a gradually decreasing bottom, and the ice is heavy and hummorous, then along the coast there will be a strip of clear water, which should be used for navigating. Such a clean strip is a consequence of the fact that the hummock ice is aground at great depths and does not allow the mass of ice to throw the ship into around in the event of ice from the sea.

If the coast is deep, then heavy ice, pressing on the coast, can run ship aground. Such places the vessel must pass at the time of ice thinning. When you can not go more seaward and try to pass there, the coastal bridge created by ice, you should stop under the cover of ice floes stranded on the beach, and wait for the ice to improve.

When passing near the icebergs, remember that about 7/10 of their mass is under water and can stretchnear the surface of the water in the horizontal direction at a great distance from the surface part [1] (Fig. 4).

Fig.5. Iceberg

Icebergs should be given a wide berth at a considerable distance, as many of them float in an unstable equilibrium and can capsize with a slight disturbance of this equilibrium. In addition, they should be bypassed on the windward side, because if the ship goes around the ice berg on the leeward side, it will drift more slowly than the ice berg, due to less impact of the wind [7].

If you find anice berg at a close range in a poor visibility, give full astern is the best to avoid a collision with it.

If you try to turn your shipmoving ahead, you may come across an underwater ram of an iceberg and damage the bottom or underwater part of the ship's side, constantly approaching it.

Generally speaking, when navigating in ice, it is impossible to avoid collisions with ice completely. However, each ship is able to withstand some impacts on the ice.

To move the vessel in the ice field, it is necessary to chosethe way along the crack, while the vessel has the ability to break the ice into the crack and move forward, even very slowly. Having found the entrance to the ice crack, it is necessary to look for a way out, that is, planning beforehand. Attempting to pass straight through the ice field can lead to jamming and even jamming of the hull, because the inertia of the ship drops sharply after entering the ice field, and the field

itself becomes stronger as it moves to its center. It should be borne in mind that even with a successful advance through a large field (if the engine power allows) the vessel can not make even the slightest turns in the field, it will lead to a sharp decrease in inertia or jamming of the vessel.

Crossing an ice jumperis a very risky operationwhen a vessel is sailing alone, because in addition to heavy loads on the hull and engine, the vessel has a probability of jamming.

Therefore, with the slightest doubt about the success of crossing such an attempt should not be made, so as not to get stuck in the ice for a long time, because the icebreaker will not be nearby and will not help anyone in the vacated vessels [5].

If the captain decides to cross the jumper, he must move with a little inertia, without accelerating the ship. If the movement is possible only by "blows", then the vessel should retreat along the canal until clear water appears in front of the nose in the canal to replace the broken ice (usually this distance is not more than the length of the hull). After that, the inertia of the vessel back should be smoothly extinguished, and, smoothly adding engine speed, start moving forward, with a small shift of the rudder to make a blow [8]. The small inertia of the vessel will not allow to damage the hull, and the relocation of the rudder - to avoid jamming of the hull of the vessel, as well as contribute to the expansion of the channel (Fig. 6). If the ice jumper cannot be broken immediately, the operation can be repeated several times until it is successful or it becomes clear that such attempts are futile.

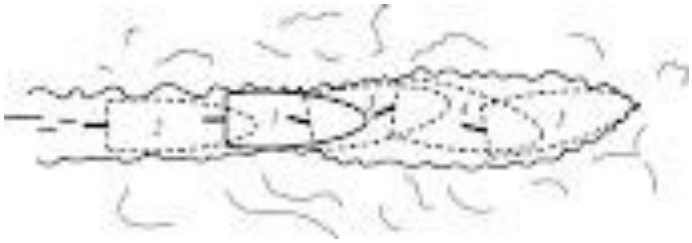

Fig. 6. Crossing ice

When crossing the ice, it is necessary to carefully observe the hull of the vessel and measure the water level in the hulls, as well as inspect the hull and hull set inside the vessel.

When moving astern, you should always put the steering wheel straight and send an experienced observer to the stern. When the vessel moves astern, the propeller must constantly rotate astern, due to a high risk of the damage to the stopped propeler. When movement astern stopped, it is necessary to give a dead slow ahead with the minimum possible r.p.m., that at first to dilute ice a little around screws.

If the ship finds itself in a situation where it becomes impossible to move forward and at the same time it is impossible to turn around to get out of the heavy ice in reverse, it is necessary to move astern. The rudder should be kept mid ship, and the navigator should be directed to the stern to observe the ice.

If the ship is surrounded by ice, it is necessary to form a space free of ice near the propeller and rudder before starting to move, (Fig. 7).

Fig.7. Exit from ice

To do this, start rotating the propeller at low r.p.m., so that the water thrust is formed, and

wash away pieces of ice. In such cases, long bamboo poles with metal tips can be used, you can clear the area of the propeller from ice, which is still unaffected by the water thrust or stuck in the propeller's gaps.

Navigation in the dark, fog and poor visibility is inefficient, so it is better to drift in the ice and wait for improved visibility. The best place to drift in will be fine ice. You should not stop in large solid ice fields.

Leaving the ice region is a dangerous and important issue it should be done from the windward edge during big swells. It is better to follow the path against the waves or swell, then hitting chunks of ice is less likely. It may be wiser in some cases to wait in the ice until the situation improves.

As we can see, navigation in the Arctic areas has significant and specific additions to traditional standards of navigation in normal conditions and in accordance with the requirements of the International Code for Vessels Operating in polar waters the need of the additional training for crew becomes apparent [11].

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