Winter navigation in Swedish waters

- Guidelines for safe operation of onboard systems

Report to the Winter Navigation Research Board (Styrelsen för vintersjöfartsforskning)

SSPA Sweden AB

April 2005

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REPORT

Subject	Report
Winter navigation in Swedish waters **- Guidelines for safe operation of onboard systems**	**40033398-1** S:\2003\40033398 Vintersjöfartsforskning SjöV\Projektfil\Winter navigation i Swedish waters - Guidelines 1 april 2005.doc
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SUMMARY

Sea ice and temperatures below freezing may occur in Swedish waters from November to May. It is important that seafarers are aware of potential malfunctions in onboard equipment and systems caused by ice and that they are prepared to solve any encountered problems to ensure safe navigation. This report is intended to provide basic guidelines for the safe operation of some vital onboard systems that may be affected by low temperatures and ice. It also refers some design aspects of critical systems and call attention to a few general recommendations for ship handling in ice. It is proposed that this first version of the guidelines, in a near future, will be further refined and complemented. Some of the main recommendations and guidelines of this report are addressing the following issues:

- Design and operation of cooling water inlet – recirculation to prevent ice clogging of strainers and practical measures for de-icing of blocked inlets and strainers.
- Preventive measures to ensure safe operation of LSA and vital deck equipment.
- Preventive measures to ensure safe operation of navaids and other vital bridge equipment
- General recommendations for safe ship handling in ice infested waters.

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1 INTRODUCTION

1.1 Background and objectives

Sea ice and temperatures below freezing may be encountered by ships navigating in Swedish waters from November to May. Navigation in ice-infested waters requires that the ships are designed with adequate hull strength and propulsive power but there are also a number of vital onboard systems and pieces of equipment whose function may be more or less affected by ice and low temperatures. Malfunction or failure of such systems and equipment may lead to electrical or propulsive blackout, reduced maneuverability etc and thereby also associated with risks for grounding, collisions, environmental pollution, personal injuries, loss of lives and damage of cargo.

Officers and crews who regularly operate ships in winter conditions have gained experience of operating various onboard systems in cold climate and identified specific critical components and preventive measures to avoid problems. Also for ships not routinely operating i winter conditions it is important that seafarers are aware of potential malfunctions in onboard equipment and systems caused by ice and that they are prepared to solve emerging problems to ensure safe navigation. This report is intended to provide basic practical guidelines for the safe operation of some vital onboard systems that may be affected by low temperatures and ice.

1.2 The report

SSPA Sweden has been commissioned by the Swedish Maritime Administration acting on behalf of the Swedish-Finnish Winter Navigation Research Board (Styrelsen för vintersjöfartsforskning) to elaborate a document with practical guidelines for safe operation of onboard systems in winter conditions. The report also describes and refers some design aspects of critical systems and it also highlights a few general recommendations for ship handling in icy waters.

The scope of the report has been outlined in cooperation with Mr Göran Liljeström, Swedish Maritime Administration. SSPA:s experience from previous research project related to winter navigation have been valuable in preparing the report and information has been compiled from data gathered by international literature surveys and by interviews with mariners experienced from winter navigation.

The report is not intended to give a complete review of all systems and problems associated with ice condition but provides a first version with a basic set of guidelines to be further elaborated in the future.

1.3 Proposals for further work

In order to further develop and elaborate this report into useful and practical information and guidance tool, a number of possible refinements and complementary sections have been identified. Some of these proposals are shortly described below:

- Continued identification of practical aspects and solutions to problems related to ice, snow and cold temperatures. This requires further cooperation and interviews with experienced seafarers.
- Include real case examples to illustrate problems and solutions.
- More illustrations by figures and pictures. This facilitates the practical use of the guidelines and makes the search process faster.
- Onboard validation. Let some ships with different “winter” experience review the document and validate the usability and give suggestion of improvements.
- Ranking of risks by frequencies and consequences. This allows the guidelines to give more focus on high risks subjects and maybe omit non-relevant parts.
- Introduction of complementary climate related information, with tables, statistics and maps.

2 STATUTORY REQUIREMENTS

2.1 International requirements

The ISM Code (mandatory by Ch. IX, SOLAS) is intended to address risks associated with ship operations and establish well-documented vessel-specific procedures and practices. The crewmembers designated to the vessel are required to possess skills and knowledge essential for the safe execution of tasks they are expected to perform in normal day-to-day operations and during emergency situations. Even if the code not explicitly address risks related to winter navigation it is applicable also with regard to ice skill requirements and availability of adequate safety manuals including routines for safe operation in ice.

2.2 National requirements

The Swedish Maritime Administration is authorised to issue regulations regarding ship operation in winter conditions. The regulations reflect the actual ice situation and are issued as Notices to Mariners, UfS. A standing seasonal attachment to the UfS includes all general regulation regarding ice navigation in Swedish Waters, [ref 2].

2.3 Classification rules

The rules for different ice classes issued by the classification societies can be compared and correlated to the specific Finnish Swedish Ice Class Rules issued by the maritime administrations by use of a specific correlation tables in ref 2.

2.4 Non-statutory documents

There are a number of non-statutory information documents on ice breaking services and assistance available from the Swedish Maritime Administration. Complementary information on weather and climatological information is also available from the Swedish Meteorological and Hydrological Institute, SMHI [ref 9].

3 COOLING WATER INLET

One of the most common problems encountered during ice navigation is blocking of cooling water inlets. Ice and slush may enter into various parts of the cooling water inlet, sea inlet box or sea bays. Insufficient supply of cooling water may cause overheating of main or auxilary engines, shut-down or serious engine failure. It is therefore important that chief and engine personnel are fully familiar with the sea inlet and the cooling water system and capable to prevent ice blockage as well as prepared to perform procedures for clearing sea water inlet from ice.

3.1 Design of Sea inlet boxes

Ships intended for operation in ice must be designed to prevent the cooling system from becoming blocked by ice. Various design solutions have been suggested and tested. The following guidelines, extracted from IMO Circular 504, provides one feasible design option to ensure that adequate cooling water flow is maintained to the ship's engine and/or generator. A schematic design is shown in ***Figure** 1*.

1. The ship should be provided with at least one sea bay from which pumps supplying cooling water to essential machinery, can draw.
2. The sea bay should:
    a. be supplied with water from at least two sea inlet boxes,
    b. be connected to the sea inlet boxes by pipes, valves and strainers with a cross sectional area at least equal to the total area of the suctions of served pumps and
    c. be vented to atmosphere by a valve to prevent tank over- or under pressurization.
3. The sea inlet box should:
    a. be fitted on each side of the ship,
    b. be as deeply submerged as possible,
    c. have an area open to sea of at least five times the total area of the pump suctions served by the sea bay,

d. be fitted with strainer plates at the ship's side having perforation of approximately 20 mm diameter to prevent ingress of large ice particles,

e. be fitted with a low pressure steam connection for clearing the strainer and

f. have a vent pipe from the sea inlet sized to prevent ice blockage in the suction piping. On small installations, the cross sectional area should be at least equal to that of the suction piping. In the case of larger installations, the ratio may be reduced but the minimum diameter is 150 mm. The valve fitted should be of full flow type.

g. Have the valves meet the requirements of SOLAS regulation II-1/48.3, protection against flooding, when used in unattended machinery space applications.

4. Diversion valves and piping should be provided at overboard cooling water discharges to permit warm water to be returned to the sea inlet boxes preventing ice blockages, and also to the sea bay to permit circulation in the event of total sea box blockage by ice.

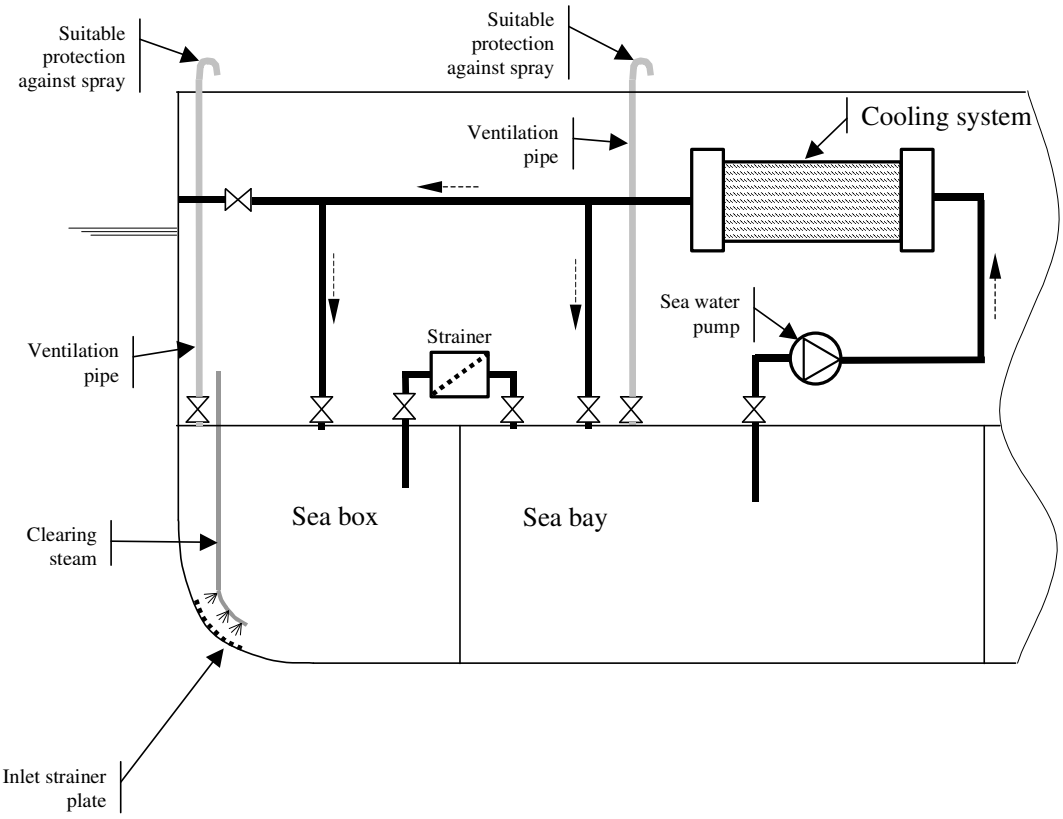

Figure 1 Schematic design of cooling water inlet

3.2 Guidance on operational procedures

With a cooling water inlet system designed in accordance with the recommendations outlined in the previous Chapter, various operational procedures can be applied to prevent blockage by ice. The procedures must be adapted for the system design of the specific ship, but some general guidelines are summarised below .

3.2.1 General guidelines for prevention of ice blockage

- Try to keep the incoming water to the sea strainer at a temperature above 20° C e.d. by recirculation of cooling water.
- Keep high sea suction closed.
- Keep overboard discharge valve near closed to obtain a positive re-circulation flow.
- Use sea water pump with lower capacity of to reduce the flow
- Use only one sea inlet box at a time to avoid blocking of both strainers at the same time.
- Be aware of the risk that valves can be stuck open due to ice accumulation
- Do not use seawater strainer without its perforated plate. Use of the strainer without perforated plate may lead to blocking of the cooling system in an unpredictable way

3.2.2 De-icing of cooling water system

If the sea inlet or strainer become blocked by accumulated ice, there are usually a number of alternative measures to be applied in order to de-ice the cooling water system. Some feasible options are outlined below:

- *Use of ballast water* - Some ships are designed to allow the use of ballast water in the cooling system. This solution can be applied to obtain a backflow for clearing strainer and inlet. It can sometimes also allow for using re-circulated ballast water for direct cooling on short-term basis or long-term basis depending on the amount of ballast water connected to the system and the heat exchange in the ballast tank. ***Figure 2*** shows an example of re-circulation of ballast water to clear a strainer.

- *Steam injection* - In some ship the inlet boxes if fitted with steam injection for clearing from ice. This can also be done in temporary solution by using a flexible hose. In heavy ice condition this method is not enough efficient and should only be regarded as a complement to other methods.

- *Recirculation flow by use of flexible hose* - If the cooling water system is not designed for recirculation of water to sea box and strainer an emergency solution can be arranged by connecting a flexible hose from the cooling water discharge pipe to either the vent pipe to the sea inlet box or directly to the strainer by reconstruction of the strainer cover with a valve connection. In the latter case it is important that caution is taken to avoid flooding of the engine room.

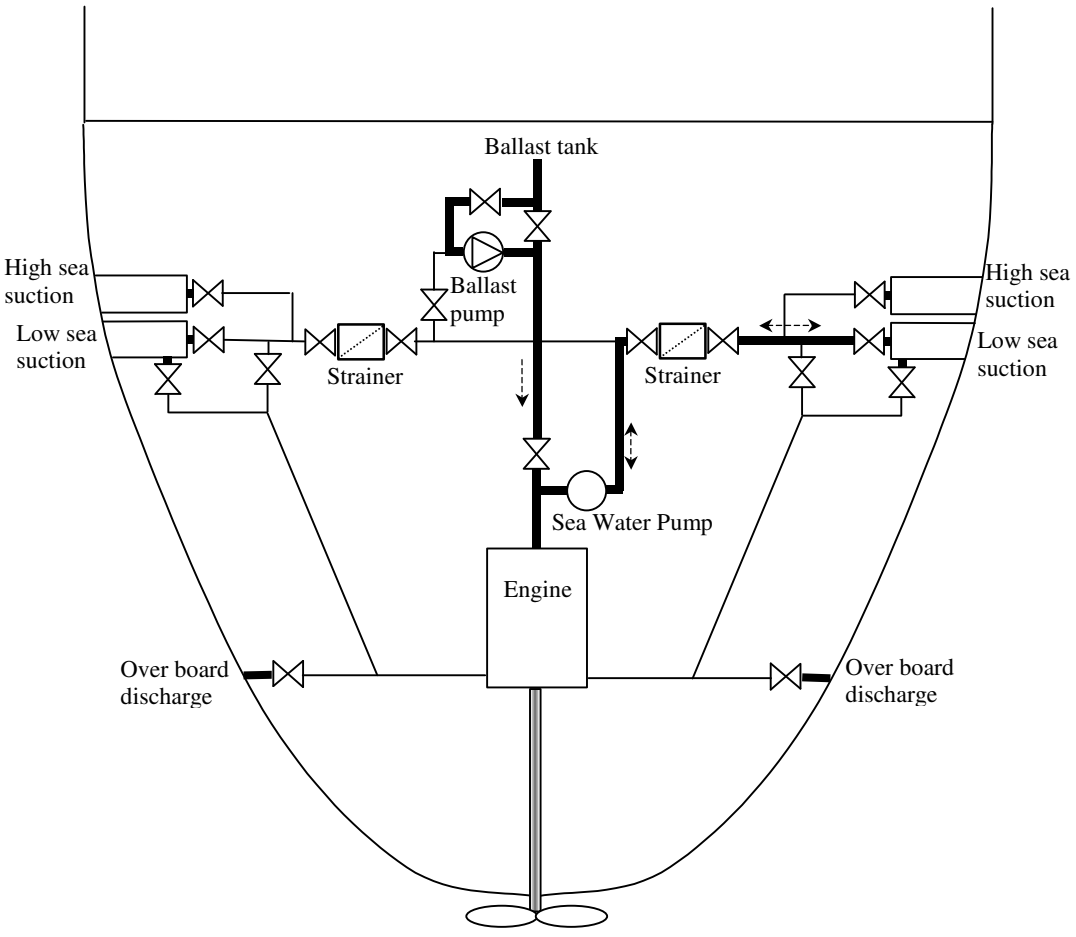

Figure 2 Method of clearing strainers and sea water inlet by use of ballast water

4 BALLAST SYSTEM

At low ambient temperatures some parts of the ballast water system, particularly those above waterline level, may freeze. Ice formation in the ballast system may cause problems during un- or reballsting with blocked pumps and strainers but structural damage may also occur if vent pipes etc. are blocked by ice. Various operational procedures can be applied to prevent freezing in the ballast system and to mitigate problems if parts of the ballast system is frozen or blocked. The procedures must be adapted for the system design of the specific ship, but some general guidelines are summarised below. Note that saline sea water freezes at around – 3^{o} C while less saline brackish ballast water loaded in the Baltic Sea may have a freezing point close to 0^{o} C.

4.1 General guidelines for the operation of ballast system

- Do not top the tank. If a tank is overfilled, let some water go and check that soundings and air pipes are clear from water.
  Take care of the water flooded on the deck before it is freezing.
- If the temperatures are extreme, check for freezing in the ballast tank and if freezing is expected take measures like circulation of ballast water or arrange with air bubbles in the tank.
  If the ice has become thick it is sometimes necessary to make a hole in the ice to be able to empty the tank.
  A hand-powered fisherman's drill is a useful tool for that task.
- Ballast water in tanks below waterline does not normally freeze. If practical, lower tank levels in ballast tanks below waterline.
- Do always check that tank ventilations are clear prior to ballast operation to avoid structural damage of the tank.
- Ensure and check that the steam supply to the heating coils in the freshwater tanks are open (if fitted).
  Monitor temperatures of freshwater tanks at regular intervals
- Keep steam heating opened on all wing ballast tanks (where fitted), even in empty tanks to prevent condensate freezing and damaging lines.

Regarding load condition recommendations, see also Chapter 8.6.

5 DECK EQUIPMENT

Different ships may have a number of various deck equipments that may be affected by low temperatures, icing or snow. In particular it is important to ensure that life saving appliances and other vital safety systems are designed or adapted for winter conditions prior to the ships' arrival in a cold region. Specific procedures must be established on each specific ship, but some general guidelines are summarised below.

5.1 Life rafts

Regularly get clear of ice and snow so that release and launching mechanics are functioning.

5.2 Life boats

- Regularly get clear of ice and snow so that release and launching mechanics and are functioning. An ice removal mallet should be in the vicinity of the lifeboats and life rafts.

- Make sure the freshwater containers are not damaged because of freezing.

- If available turn on heaters in the boats. A temporarily, portable heater can be installed near the engine. Covering the engine and heater with a fire resistant blanket will make the heating more effective.

- Make sure that the lifeboat engines are supplied with fuel, lubrication oil and cooling liquid suitable for expected minimum temperatures. If not change, fuel, luboil and add antifreeze liquid to cooling water (see lifeboat manufacturer's manual).

- Every pulley, drum and cable were water can infiltrate should be greased. Frozen water in these items can cause damage and/or obstruct them from moving.

5.3 Fire safety equipment

5.3.1 Fixed fire extinguishing system

- Make sure that used water inlets are prevented for ice accumulation or be prepared to shift water inlet if one gets choked with ice.
- Make sure that all pipes exposed to low temperatures are completely drained and all valves left open.
- Remove caps from fire posts.
- When fire line is used make sure to have a constant flow in all part of the system. This is achieved by slightly opening of valves and leading water overboard by hoses.
- After use, quickly drain the system (within 10 min).

5.3.2 Portable fire extinguishing system

Make sure that portable fire extinguishers are stored at places where they cannot be damage because of freezing.

5.3.3 Breathing apparatus (BA-sets)

Be aware that BA-sets can failure due to freezing of condensed air in hose and/or nozzle.

This risk is most obvious during tank inspection onboard tankers.

5.4 Hydraulic systems

Make sure that the hydraulic oil is intended for use at low temperatures. There is also a risk that the oil, if old, contains condensed water. Turn on oil tank heating, if fitted. If the hydraulics is not prepared for low temperature use, it is advisable to keep the system running during cold periods.

5.4.1 Anchor and mooring equipment

- Anchor and mooring winches are, especially on the forecastle, exposed to ice accretion. In order to quickly get them ready for use, cover them with tarpaulins.

- To assure to have anchor operable it is at good practice, if sea conditions allows, to lower the anchor a bit (0.5 m) in order to be able to pull it free from accumulated ice.

- Be aware that brakes can become slippery and ineffective.

Regarding preparation of anchor prior to towing by an icebreaker, see also Chapter 8.5.

5.5 Gangways and ladders

The ship should be equipped with gear for removal of snow and ice. Keep stores of sand or salt for non-skid passages. The work is facilitated and safety improved if gangways and ladders are cleared quickly. Cover motors and other sensitive parts such as switches of gangway with canvas protection.

5.5.1 Pilot ladder

- Keep the pilot ladder in a sheltered place and, before use, make sure that it is not ice-covered.

- If ice accretion is expected do not lower the ladder too early. It will be glazed with ice and it become slippery.

6 NAVIGATION BRIDGE AND RELATED EQUIPMENT

During winter conditions it is often particularly important to have a good view from inside the navigation bridge. Windows may be exposed to frosting or fogging on the inside as well as icing or malfunction of the outside cleaning system. Some general guidelines regarding bridge windows and other bridge related equipment are summarised below.

6.1 Bridge windows and their cleaning system

- Drain window-cleaning system or if possible add windscreen washer fluid (alcohol) to a concentration valid for expected temperature.
- If the windows do not have built-in defrosting equipments be prepared to arrange heaters and fans. Be careful not to damage the window by too intensive and/or poor distribution of the heat of the windows.
- For de-icing of windows ice scraper are needed

6.2 Search lights

During winter navigation it is essential to have quick access to a good searchlight. Test the searchlights in advance.

6.3 Antennas

Due to ice accretion the transmitting and emitting effectiveness may be reduced. During heavy ice accumulation or icing there is also a risk that the antennas may be damaged or collapse. Therefore do regularly check and remove ice from the antennas. Let radar antennas be running continuously.

7 CREW PERSONAL EQUIPMENT

It is obvious but still sometimes neglected that the crew must be equipped with warm and functional clothes. All personal onboard are to be instructed about the hazards of working exposed to wind and low temperatures.

The list below is considered as minimum of equipment:

- Warm and wind proof cap
- Mitts
- Gloves
- Socks
- Boots
- Wind proof and insulated suit
- Thermal underwear

8 SHIP HANDLING

There is a number of guidelines for maneuvering tactics in ice with or with out icebreaker assistance (see ref 1). Below a few basic general advises on how to minimize risk of damage to hull and maneuvering devices are summarized.

8.1 Hull

Be gentle to the ship. Be careful when turning the ship through partly open ice. The reinforcement at the quarters is on many ships poor despite their ice class.

At low temperatures the steel becomes brittle. Hard contact with ice, docks and fenders may result in damage. Make careful inspection if any hard impact has occurred.

8.2 Propeller

Next to hull damages, propeller damages are the most cost consuming in winter navigation. The risk of propeller damages increases during backing maneuvers, turning and when at small draught with the propeller operating close to the water surface.

8.3 Rudder

Put rudder amidships when vessel stops or when going astern. When going astern, keep an eye on the rudder indicator to check that the rudder is not taken by the ice. When pushed back by icebreaker or tug – keep if possible dead slow ahead to clear the rudder from ice. To prevent for rudder and propeller damages the ship should be loaded or ballasted so that the rudder is as deep as possible.

8.4 Power management

Due to contact with brash ice, peak loads on tunnel thrusters may be high. Therefore it can be advisable to keep extra generator capacity available to avoid tripping of the thruster or total electrical power blackout.

8.5 Towing by icebreaker

During towing by icebreaker, keep clear of the forecastle because the towing line may break. Also be careful when coupling and decoupling the heavy towing wire. The ship should be prepared to cat the anchor in order not to interfere with the icebreaker when attached to the stern, see ***Figure 3***. Make sure to have appropriate pieces of wire and carry out test in advance to ensure that the catting procedure works.

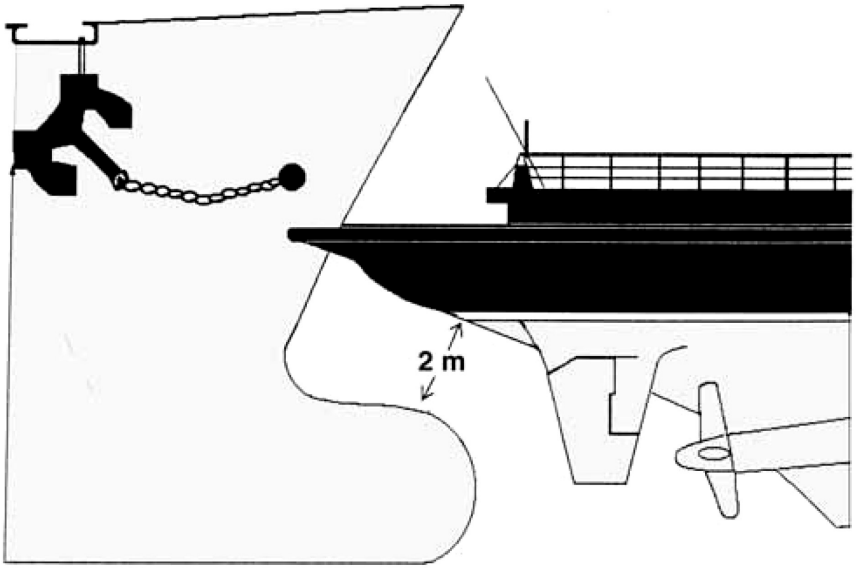

Figure 3 Catting of anchor [ref 2]

8.6 Load condition

- The ship should be loaded or ballasted so that ice impact is absorbed within the reinforcement zones on the hull. Bring the ship as low as possible to keep propellers and sea suctions well below water level.
- Restrict the trim (1 to 3 metres - preferably not more than 1 meter) to avoid the risk of ice moving under the bottom of the ship and being picked-up by the sea suction.
- Take in cargo prior to discharging ballast to maintain the maximum safe draught (seen in relation to the thickness of the ice cover).
- In case of heavy ice accumulation, the arrival draught have to be checked.

For further details regarding operation of the ballast system, see Chapter 4.

9 REFERENCES AND OTHER SOURCES OF INFORMATION

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