Research on Special Measures of Safe Abandonment of a Ship in Polar Waters

Wang Deling*, Geng Hejun, Fan Fuquan, Tao Qingfeng

Merchant Marine College, Shanghai Maritime University, Shanghai, China

Email address:
dlwang@shmtu.edu.cn (Wang Deling), genghj@shmtu.edu.cn (Geng Hejun), fanfq@shmtu.edu.cn (Fan Fuquan), qftao@shmtu.edu.cn (Tao Qingfeng)
*Corresponding author

To cite this article:
Wang Deling, Geng Hejun, Fan Fuquan, Tao Qingfeng. Research on Special Measures of Safe Abandonment of a Ship in Polar Waters. Journal of Water Resources and Ocean Science. Vol. 8, No. 4, 2019, pp. 44-49. doi: 10.11648/j.wros.20190804.11

Received: September 10, 2019; Accepted: October 4, 2019; Published: October 15, 2019

Abstract: Ice melting in polar waters caused by global warming has been making it practicable for merchant ships to sail in polar area. Sailing distances from Far-east to West of Europe and East of North America are shortened by around 30% by selecting polar routes, therefore, polar routes are considered as the golden routes. However, polar water has its unique risks for ships sailing in the areas. Those unique risks may cause adverse impacts to the survival of seafarers in case of emergencies. To ensure the safe abandonment of a ship in polar waters, this paper analyzes and summarizes the potential risks associated with polar shipping with respect to safe escape, evacuation and survival for seafarers in case of emergencies. Based on the analysis of unique potential hazards and inquiry with experts and seafarers who have experiences in polar ship operation and management, this paper provides practical measures to safeguard crew’s escape, evacuation and survival in extreme polar circumstances when abandoning a ship. The requirements as to Life Saving Appliances and Arrangements in Polar Code are also interpreted in this paper, and those practical measures provided will help the ship owners, ship operators, and ship masters and seafarers to better understand and comply with the requirements of the Polar Code.

Keywords: Polar Waters, Unique Circumstances, Safe Abandonment of a Ship, Polar Code

1. Introduction

With the trend of global warming up caused by Green House Effect, ice in polar water is melting dramatically, making it practicable for merchant ships to sail in polar area. Routes from Far East to West Europe and to East of North America through Arctic waters are the shortest of all the existing routes. Therefore, polar routes are considered as the golden routes. Polar shipping will undoubtedly grow in volume and diversify in nature over the coming years. Driven by an ever increasing global demand for commodities like energy and mining products, ship traffic is likely to increase dramatically in the near future -- a trend that will increase the pressure on this relatively pristine area.

Ships operating in the remote polar waters will face various unique risks including poor weather condition, extremely low air temperature, darkness, ice accretion, difficulties in search and rescue or environmental clean-up operations, etc. Poor weather conditions can compound the relative lack of good charts, communication systems and navigational aids. Search and rescue or environmental clean-up operations can be extremely difficult and, as a result, potentially very costly. The cold temperatures and harsh weather systems can cause malfunctions of ship’s machinery and equipment. Polar ice fields can impose additional loads on the ships' hull and propulsion.

To ensure the safety of shipping in polar waters, IMO has adopted the International Code for Ships Operating in Polar Waters (The Polar Code hereafter) and related amendments to make it mandatory under both SOLAS and MARPOL convention. The polar code entered into force on 1 January 2017. Due to the exceptional circumstances in polar waters, it is extremely hard for seafarers to survive in case of emergency and following ship abandonment. The polar code Chapter 8-Life Saving Appliances and Arrangements, regulates the basic requirements, provides for safe escape, evacuation and survival. However, those regulations are only the basic requirements. Based on the analysis of unique potential hazards and inquiry with experienced seafarers sailing in polar waters, this paper...
this paper analyzes and provides practical measures to safeguard crew’s escape, evacuation and survival in extreme polar circumstances in case of abandoning a ship.

2. Analysis of Hazards in Polar Shipping with Respect to Safe Escape, Evacuation and Survival

2.1. Potential Hazards Associated with Polar Shipping

IMO Sub-committee on Ship Design and Equipment (DE 54/WP.3) presented on its 54th session, a hazard matrix identified on development of a Mandatory Polar Code. This matrix identified various hazards and their consequences in polar shipping. By referring to the matrix, a table of “Identified various hazards and their consequences in polar waters” is produced in this paper. These hazards uniquely endanger the seafarers in polar waters. To ensure the safe escape, evacuation and survival, those unique risks shall be fully taken into consideration. See table 1 below “Identified various hazards and their consequences in polar waters”.

| Hazards | Consequences of the hazards | Affecting the seafarers’ safe abandonment of a ship? |
|---------|-----------------------------|---------------------------------------------------|
| Low air temperature | Loss of performance of material, exposed to low temperature Yes, survival boats | Yes, survival boats |
| | Malfunction of machinery Yes, boat engines | |
| | Freezing of fluid/cargo No | |
| | Thicker viscosity fluid/cargo and machinery Yes, boat engine fuels | |
| | Effect of cold cargo to hull materials No | |
| | Loss of functionality of operating and emergency equipment Yes, emergency escaping equipment | |
| | Loss of functionality of doors and closing appliances Yes, escape routes | |
| | Reduced survival time/hypothermia Yes, coldness and less survival time | |
| | Reduced human performance, physical and cognitive functions Yes, human performance | |
| | Ice on deck and superstructure Yes, escape route blocked | |
| | Freezing of ballast No | |
| | Limitation of SAR capabilities Yes, SAR operations | |
| | Reduced maneuverability No | |
| | Reduced survival time Yes, coldness and less survival time | |
| Low water temperature | Malfunction of fluid systems Yes, boat engine fuels | |
| | Clogging of inlets and outlets Yes, boat engine cooling system | |
| | Difficult to prepare for or avoid dangerous weather conditions Yes | |
| Extreme and rapidly changing weather condition | Reduced survivability/hypothermia Yes, coldness and less survival time | |
| | Increased risk of human error Yes | |
| | Injuries due to ice flow/falling on deck Yes | |
| | Capsize and operational threats to smaller vessels, auxiliary boats and tenders Yes, survival boat | |
| | Limitation of SAR capabilities Yes, SAR operations | |
| | Structure failure due to impact with ice or pressured ice Yes, survival boats | |
| | Hull penetration and structure deformation Yes, survival boats | |
| | Disturbance in navigation due to icebergs No | |
| Presence and variability of sea ice | Propulsion and/or maneuvering difficulties/failure Yes, survival boats | |
| | Different stability characteristics in ice No | |
| | Damage to anti-collision systems No | |
| | Reduced propulsion system capacities No | |
| | Inability to operate evacuation systems due to surrounding ice Yes | |
| | Reduced stability No | |
| | Mal or no function of equipment and systems (including LSA and FP) on deck Yes | |
| | Malfunction of navigational aids No | |
| | Injuries to personnel Yes | |
| Ice on deck and superstructures | Blocking of air intakes, air ventilation and pressure release valves Yes, survival boats | |
| | Exposure of personnel to de-ice (chemicals) Yes | |
| | Possibility of damage to equipment during de-icing No | |
| | Malfunctioning of deck machinery No | |
| | Overload due to ice Yes, survival boats | |
| | Restrictions of human activities Yes | |
| | Hypothermia Yes | |
| | Grounding, stranding, trapped in ice No | |
| | Impact with ice to other structures No | |
| | Lack of signals/disturbance DGPS Yes | |
| | Unstable gyro No | |
| Reduced navigational aids | Grounding, stranding No | |
| | Voyage planning No | |
| Varying availability of charts/hydro-graphical information | Anchoring No | |
| Varying availability | Voyage planning No | |
Note: The Table 1 above gives 13 types of hazard faced by ships when sailing in polar waters, and the possible consequences for each hazards are listed in column 2. Not all the hazards in the table pose a danger to the crew abandoning the ship in an emergency. Therefore, in column 3 whether the hazard and consequences affecting the abandonment of the ship is given, If yes, a short explanation is followed to indicate the effects.

| Hazards                              | Consequences of the hazards                                                                 | Affecting the seafarers' safe abandonment of a ship? |
|--------------------------------------|---------------------------------------------------------------------------------------------|--------------------------------------------------------|
| meteorological information/ice data  | Difficult to prepare for or avoid dangerous weather conditions/ situations                   | Yes                                                    |
|                                       | Insufficient clothing and supplies (optimistic planning)                                     | Yes, hypothermia                                        |
|                                       | Insufficient actions to incidents and accidents                                              | Yes                                                    |
| Variable infrastructure               | Limited compliance and enforcement (local infrastructure, waste reception faciliation)     | No                                                     |
| Interference with long-range          | Potential for incidences to escalate                                                        | No                                                     |
| electronic communications             | Loss of possibility to send distress messages/contact SAR                                   | Yes                                                    |
|                                       | No weather/ice forecast                                                                     | Yes                                                    |
|                                       | Loss of communication possibilities                                                         | Yes                                                    |
| Variable communication capabilities   | Communication difficulties                                                                  | Yes                                                    |
| Limited search and rescue capabilities | Insufficient response to incidents and accidents                                             | Yes                                                    |
|                                       | Lack of medical support                                                                     | Yes                                                    |
|                                       | Capability of emergency source of electrical power                                          | Yes                                                    |
|                                       | Insufficient response to spills                                                             | No                                                     |
| Limited availability of oil spill     | Damage to ecological systems                                                                | No                                                     |
| preparedness                          | Damage to flora and fauna                                                                   | No                                                     |
|                                       | Potential for incidences to escalate                                                        | No                                                     |

2.2. Potential Hazards with Respect to Safe Escape, Evacuation and Survival

Based on the specific hazards and consequences above, this paper analyzed and selected all potential hazards associated closely with seafarers' safe escape, evacuation and survival in case of emergency when sailing in polar waters, and grouped them into five categorizes as follows.

1) Low temperature affecting the stowage and deployment of life-saving appliances

For ships sailing in polar waters, coldness is one of the greatest dangers. The temperature of polar region can reach to below -50°C. Low temperature increase the viscosity of oil products, decrease the self-priming capacity of oil pump and the pressure of hydraulic system, thus causing the hydraulic system fail. The low temperature effect on all liquids in the lifeboats should be taken into consideration when installed, e.g. special fuel, lubrication oil cooling water for the engine. 

2) Ice built-up hampering life-saving appliances

It is possible that sub-zero temperatures would cause ice accretion. The life-saving appliances may malfunction when covered by ice. All the life-saving appliances should be designed or protected against ice accretion so that it is operable in case of abandoning the ship.

3) Launching of survival craft on ice-covered waters

The standard free-fall lifeboat in accordance with IMO provisions includes arrangements that allow only a lowering aft of the ship. It is impossible for a vessel to launch free-fall life boat onto ice. If a lifeboat should be lowered onto ice, the slope of the bottom of the boat hull must be considered and equipment for limiting the heel must be provided.

4) Threats to survival in polar waters after abandonment

Survivors in lifeboats and life rafts, after a casualty in polar waters, may be expected to spend longer time on board such survival craft than is considered normal for survivors in most other parts of the world. Additionally, they will be exposed to climate conditions that are much more demanding and which require specific mitigating measures such as proper clothing, immersion suits or heating appliances in order to prevent hypothermia.

5) Limited search and rescue capabilities

In the remote polar waters, due to the sparse population along the polar coast and less vessel traffic, few rescue forces are stationed. Once a ship disaster take place, even if the distress signal could be sent immediately, it may take several hours or even a few days for the rescue force to arrive. Seafarers in distress will face the threats of drifting at sea and waiting for rescue resources for much longer time than that in normal shipping waters.

In addition to those identified hazards above, there may be some other hazards that are not identified for lack of resources and experiences in polar shipping. Further work should be continued and further resources related to polar shipping should be gathered.

3. Requirements of Polar Code Chapter 8

- Life Saving Appliances and Arrangements

The influence of polar environment on life saving and communication equipment is mainly manifested in four aspects: low temperature, ice and snow accumulation, abandonment of ships in ice area and lack of rescue resources. Low temperature may cause some life-saving and communication equipment to fail, such as the lifeboat releasing device, machinery, the batteries, etc.; Ice and snow accumulation snow may cause the escape route and access to
muster station blocked; In case of abandoning a ship in the ice area, it may be difficult to release the survival rafts, and even the rafts can be launched, it may quite difficult to operate them in ice; Lack of rescue resources may lead to longer awaiting time for the survivors.

In view of the adverse effects of polar environment on marine survival, to ensure the life safety of seafarers during and after abandonment, the Polar Code provides mandatory provisions on the life-saving appliances and arrangement of polar vessels in Chapter 8, Part I-A. In brief, those requirements/regulations are divided into three sections: Escape, evacuation and survival. To make it more clear, a table interpreting the requirements is created in this paper. See Table 2 below.

**Table 2. Requirements of Life Saving Appliances and Arrangements in Polar Code.**

| LSA and arrangement | Requirements in Polar Code |
|---------------------|---------------------------|
| Escaping routes     | 1. For ships exposed to ice accretion, means shall be provided to remove or prevent ice and snow accretion; 2. For ships constructed on or after 1 January 2017, exposed escape routes shall be arranged so as not to hinder passage by persons wearing suitable polar clothing. |
| Muster stations     | 1. For ships exposed to ice accretion, means shall be provided to remove or prevent ice and snow accretion; 2. Adequacy of embarkation arrangements shall be assessed, having full regard to any effect of persons wearing additional polar clothing. |
| Survival equipment  | For ships exposed to ice accretion, means shall be provided to remove or prevent ice and snow accretion; 1. For ships exposed to ice accretion, means shall be provided to remove or prevent ice and snow accretion; 2. Have sufficient capacity for additional equipment. |
| Access to survival craft | For ships exposed to ice accretion, means shall be provided to remove or prevent ice and snow accretion; ships shall have means to ensure safe evacuation of persons, including safe deployment of survival equipment, when operating in ice-covered waters, or directly onto the ice, as applicable. |
| Source of power     | 1. for passenger ships, a proper sized immersion suit or a thermal protective aid shall be provided for each person on board; 2. shall be of the insulated type. |
| Immersion suit or a thermal protective aid | For ships intended to operate in extended periods of darkness, searchlight suitable for continuous use to facilitate identification of ice shall be provided for each lifeboat. |
| Searchlights        | Shall be partially or totally enclosed type. |
| Life boats          | Be shall be of the insulated type. |
| Personal survival equipment and Group survival equipment | 1. life-saving appliances and group survival equipment that provide effective protection against direct wind chill for all persons on board; 2. sufficient thermal insulation to maintain the core temperature of persons; 3. personal survival equipment that provide sufficient protection to prevent frostbite of all extremities. |
| Survival rations    | Whenever there exist a potential of abandonment onto ice or land, the following apply: 1. group survival equipment shall be carried, unless an equivalent level of functionality for survival is provided by the ship's normal life-saving appliances; 2. when required, personal and group survival equipment sufficient for 110% of the persons on board shall be stowed in easily accessible locations, as close as practical to the muster or embarkation stations; 3. containers for group survival equipment shall be designed to be easily movable over the ice and be floatable; 4. whenever the assessment identifies the need to carry personal and group survival equipment, means shall be identified of ensuring that this equipment is accessible following abandonment; 5. if carried in addition to persons, in the survival craft, the survival craft and launching appliances shall have sufficient capacity to accommodate the additional equipment; 6. passengers shall be instructed in the use of the personal survival equipment and the action to take in an emergency; and 7. the crew shall be trained in the use of the personal survival equipment and group survival equipment. |

4. Recommended Measures Taken by Polar Ships

The Polar Code is a mandatory code enforced by SOLAS and MARPOL convention to ensure the safe operation of ships in polar waters. All the ships sailing in polar region shall comply with the requirements. However, those regulations provide only the basic requirements, and those clauses usually do not give specific measures, and the specific measures are usually realized by the ship itself, as long as it meets the mandatory requirements.

By inquiry to and/or questionnaires feedback from various experienced mariners and experts engaged in polar shipping, and based on the potential risks along with polar shipping, preventive measures are extracted and recommended to be taken to ensure the safe operation in polar shipping.

1) In addition to the equipment stated in the Code, extra protective clothing is recommended to carry on board such as winter hats, winter gloves, winter socks, face and neck protections, and make them ready for use in case of cold weather encountered.

Sufficient de-icing tools should be provided such as long handle axes, glue bars, round strong wood, spanners, pneumatic guns, and machinery tools to remove ice accretion near the survival rafts and escape routes.

2) When evacuating in polar waters, crew members may need to wear bulky thermal clothes, and ordinary escape routes may not allow them to pass through quickly and smoothly. Therefore, Escaping routes should be designed as wide as possible to ensure the safe passage by persons wearing suitable polar clothing.
and should not be blocked by any obstruction;

3) For exposed liquids e.g. fuel oil and cooling water for boat engines, if possible, arrange the piping systems in covered spaces with heating protections. Otherwise, protect them with insulting lagging to prevent from frozen or other protective measures;

4) When considering resources to be included with the personal and group survival equipment, reference can be made to Polar Code Part I-B Chapter 9 - Additional guidance to Ch 8 (Life-Saving Appliances and Arrangements). See table 3 “Suggested Equipment for group survival equipment”. Shelter e.g. tents or storm shelters or equivalent, thermal protective aids or similar, sleeping bags or foam sleeping mats or similar, and stove and fuel as listed in table 3 are considered as essential equipment, and are recommended to be provided on board, as they can provide effective protections to survivors in extremely code atmosphere.

Table 3. Suggested Equipment for group survival equipment.

| Suggested Equipment                                                                 |
|-------------------------------------------------------------------------------------|
| Shelter—tents or storm shelters or equivalent—sufficient for maximum number of persons |
| Thermal protective aids or similar—sufficient for maximum number of persons           |
| Sleeping bags—sufficient for at least one between two persons                         |
| Foam sleeping mats or similar—sufficient for at least one between two.                |
| Shovels—at least two                                                                  |
| Sanitation (e.g. toilet paper)                                                        |
| Stove and fuel—Sufficient for maximum number of persons ashore and maximum anticipated time of rescue |
| Emergency food—Sufficient for maximum number of persons ashore and maximum anticipated time of rescue |
| Flashlights—one per shelter                                                           |
| Waterproof and windproof matches—two boxes per shelter                                |
| Whistle                                                                              |
| Signal mirror                                                                        |
| Water containers & water purification tablets                                         |
| Spare set of personal survival equipment                                              |
| Group survival equipment container (waterproof and float-able)                        |

5) Sufficient emergency food ration and fresh water shall be provided more than that of ships sailing in ordinary waters for the expected longer waiting periods, e.g. double the amount.

6) For ships intended to operate in extended periods of darkness, each lifeboat needs to be provided with additional searchlights suitable for continuous use to facilitate identification of ice.

7) SOLAS requires that ships built after 1 July 1986 shall be equipped with partially or fully enclosed lifeboats. In general, it is expected that such lifeboats provide a good protection against the harsh environmental conditions. Therefore, only ships with partially or fully enclosed lifeboats should operate in polar waters. This requirement has been included in Guidelines for Ships Operating in Polar Waters (resolution A. 1024 (26)). However, due to the harsh environment, both partially enclosed and enclosed lifeboats will operate with doors closed, thus with very low ventilation. It may cause lack of oxygen and concentration of CO₂ in the lifeboats. In view of this, bottles containing sufficient oxygen are recommended to be included in the group survival equipment for emergency use in case that the ventilation is not practicable due to extreme coldness.

8) For individual ships operating in ice-covered waters, LSA should be provided in such a way that e.g. lowering of a lifeboat onto the ice is possible. The standard free-fall lifeboat in accordance with IMO provisions includes arrangements that allow only a lowering aft of the ship. Another means of launching may need to be required since the area aft of the ship will be closed again by drifting ice. Alternatively to the installation of a davit system, the shape of lifeboat could be optimized and the hull strengthened so that the lifeboat can withstand the ice interaction. If lifeboats should be lowered onto the ice, the slope of the bottom of the lifeboat hull must be considered and equipment for limiting the heel must be provided. To solve these problems proposed by Germany to DE Sub-committee on its 56th session, a complete modification shall be done to lifeboats, e.g. bottom of lifeboat hull shall be modified to be flat for polar ships.

9) Any other measures that are deemed helpful in polar operation should be actively promoted.

5. Conclusions

The anticipated growth in polar traffic for a variety of shipping sectors brings a number of challenges to mariners and ship operators, of which safety is of vital importance, especially when a ship is in disaster followed by its abandonment.

The unique characteristics in polar water e.g. remoteness, high latitude, harsh weather condition, darkness, and existence of ice, impose great dangers to safe polar shipping. It will be even much more dangerous in polar waters than that in other waters for ship's crew to escape and survive in case of emergency. To enhance the safe abandonment of a ship in polar waters, this paper identifies a variety of potential hazards, and provided targeted solutions for the hazards faced by mariners. However, there may be some hazards that are not identified due to lack of resources and experiences in polar shipping, and further work should be continued and further resources related to polar shipping should be gathered.
so as to make continuous amendment to polar and related conventions and codes, thus enhancing constant improvement in safe shipping in polar waters.

These measures serve only as a guidance for operators. Alternative measures can be introduced and encouraged, as long as the measures implemented can meet the requirements of the Polar Code and helps to cope with the expected dangers in polar shipping.

References

[1] IMO. the International Code for Ships Operating in Polar Waters [M]. London, International Maritime Organization, 2016.

[2] Fedi, Faury, Gritsenko. The impact of the Polar Code on risk mitigation in Arctic waters: a “toolbox” for underwriters? [J]. Maritime Policy & Management, 2018, 45 (4).

[3] IMO. IMO Resolution A. 1024 (26), GUIDELINES FOR SHIPS OPERATING IN POLAR WATERS [S].

[4] LI Weifang, HUANG Yan. International code for ships operating in polar waters: challenges to polar shipping safety rules in China [J]. Advances in Polar Science, 2016, 27 (03): 146-153.

[5] K E Solberg. Implications caused by SARex on the implementation of the IMO polar code on survival at sea [J]. IOP Conference Series: Materials Science and Engineering, 2017, 276 (1).

[6] IMO. SOLAS, consolidated edition 2014: consolidated text of the International Convention for the Safety of Life at Sea, 1974, and its Protocol of 1988: articles, annexes and certificates [M]. London, International Maritime Organization, 2014.

[7] IMO. MARPOL: consolidated edition 2017 [M]. London, International Maritime Organization, 2017.

[8] IMO. DE sub-committee, 54th session, Report of the Working Group on Development of a Mandatory Polar Code, 27 October 2010 [EB/OL]. https://docs.imo.org/Category.aspx?cid=3

[9] HAN Jialin. Research on governance of HFO use and carriage on ships in accordance with the Polar Code [J]. Advances in Polar Science, 2018, 29 (04): 283-290.

[10] Sanderson T J. Ice Mechanics-risks to offshore Structures. London: Graham & Trotman, 1988.

[11] Risca K. Design of icebreaker ships. Cold Regions Science and Marine Technology, Encyclopedia of Life Support Systems (EOLSS), 2012.

[12] Samrat Ghosh, Christopher Rubly. The emergence of Arctic shipping: issues, threats, costs, and risk-mitigating strategies of the Polar Code [J]. Australian Journal of Maritime & Ocean Affairs, 2015, 7 (3).

[13] White, Jonathan. The Polar Code-Bringing Order to Polar Shipping [J]. Sea Technology, 2015, 56 (4).

[14] Gold, Edgar. Shipping in Arctic Waters: A Comparison of the Northeast, Northwest and Trans Polar Passages [J]. Journal of Maritime Law and Commerce, 2014, 45 (2).

[15] Jabour, Julia. Progress towards the mandatory code for polar shipping [J]. Australian Journal of Maritime and Ocean Affairs, 2014, 6 (1).

[16] Anderson, H Edwin. Polar Shipping, The Forthcoming Polar Code and Implications for the Polar Environments [J]. Journal of Maritime Law and Commerce, 2012, 43 (1).

[17] Pelletier, Sébastien, Lasserre, Frédéric. Arctic Shipping: Future Polar Express Seaways? Shipowners’ Opinion [J]. Journal of Maritime Law and Commerce, 2012, 43 (4).