

# Ice Conditions and Human Factors in Marine Accidents at the Arctic

Nataliya Marchenko

*The University Centre in Svalbard, Longyearbyen, Norway*

*The Norwegian University of Science and Technology, Department of Civil and Transport Engineering, Trondheim, Norway*

*State Oceanographic Institute, Moscow, Russia*

**ABSTRACT:** All activities in the Arctic are conducted near the limit of technological opportunities and human abilities. But the drain of resources in the areas convenient for development obliges us to look at this severe polar region. The main objectives of the PetroArctic project (offshore and coastal technology for petroleum production and transport from arctic water) as a part of PETROMAX and MarSafe project (Marine Safety Management) are to obtain and provide information for safety of Arctic operation such as hydrocarbons production and transport from Polar seas. One of the tasks is a collection of ice pilot experiences from the people involved in the Arctic activities to learn how they felt in these conditions, how they solved difficult tasks and managed the ice. Items of special interest are connected to lost vessels and other marine accidents. Appreciable amount of written documentation and interviews have been processed and organized into a data base of marine accidents in Russian Arctic since 1900. It includes a set of maps where the locations of the accidents are shown with a description of the accidents (date, geographical environment, vessel type, what happened and how the people acted, etc). This paper includes the map for Kara Sea and descriptions of several accidents in the eastern part of Arctic as example of different situations, as well as the principles of the data base construction and accidents classification.

## 1 INTRODUCTION

For a modern development of the operation in the northern seas it is very important to learn from the previous ice pilot experiences. Russian sailors have for many centuries experienced the navigation in the ice conditions. As seafarers the pomors (inhabitants of Russian North) dominated an enormous zone from the shore areas of White, Barents and Kara seas to the archipelagos of New Land and Spitsbergen since the 16th century. The major factors which allowed pomors to overcome the difficult and challenging Arctic routes were the usage of specialized ships, called “koch”, and inheritable skills and customs.

Through the centuries Russian sailors accumulated extremely impressive skills for the operations in the Arctic waters. The experiences of the Russian ice pilots were summarized in the special textbooks for the future captains. There are at least 9 such textbooks written by captains who took part in the Northern Sea Route cruises (for example, Arikeynen, Chubakov, 1987, Gotskiy, 1957). The first such textbook was published in 1940. Key points of the Russian Arctic history and specifics of the seas are well known to the foreign society and researchers as well as it was presented in articles by Terence

Armstrong (1952) and William Barr with co-author (Barr, 1974-1985), working papers of INSROP (International Northern Sea Route Programme, June 1993 – March 1999), CRREL (Cold Region Research and Engineering Laboratory) reports and others. The translations introduced western audience to the most important and dramatic pages of the NSR history, such as, for example, the cruise of *Sv. Anna* and Al'banov's sledge journey (Barr, 1975), the Rusanov's *Gerkules* expedition in the Kara Sea in 1913 (Barr, 1984) and the shipping crisis in the eastern Arctic at the close of the 1983 navigation (Barr, Wilson, 1985).

However, some pages of this heroic epic are not known even in Russia. The investigation of the Russian ice pilot experience has become very relevant nowadays in the light of new activities in oil-gas exploration spreading out in the Arctic and the new transportation possibilities appearing due to the global warming.

Information about Russian activities in the Arctic is gathered in the frame of the PetroArctic and MarSafe projects. The data about extreme situations (ice drift and ice jet, icing and hummocking, ridging ice opening and closing, etc) and special weather and ice conditions are collected. Items of special interest are connected to the shipwrecks and other accidents.

Data about vessel type, location and time of wrecks and damages, weather and ice conditions, description of events has been organized into a data base. To prevent the future losses we need to know where and when accidents used to take place, under what weather and ice conditions, what happened and how did the crew react. For many accidents the information on distinguished features and the behavior of humans in the Arctic waters (reactions in stressful situations and reasons for deaths) has been collected. The most original part of the presented investigation is a set of maps showing the accident locations and the ways of ice drifts.

Only accidents connected with the ice conditions that reveal the role of human factors are taken into consideration in this paper. Analyzing marine accidents in the Arctic enables us to find a whole series of events when the wrecks were not avoidable due to extremely difficult circumstances. But there are also accidents when the ice conditions looked rather good and nothing denoted on the approaching disaster. The rest of the events fall in between the two extremes.

## 2 EXPLORING OF MARINE ACCIDENTS IN THE ARCTIC

### 2.1 *The objectives and sources of information*

The objective of this investigation is to increase the knowledge about ice conditions and human reactions for safety in the Arctic region. The main aim is a sustainable development and exploitation of the Arctic region. The collection of the ice pilot experiences is a mixture of history, geography, technology and sometimes psychology, because we have to know how people operated in the Arctic and how they solved difficult tasks, how man would feel and act in the extreme conditions. The investigation presented in this article is devoted mainly to the accidents induced by the natural causes in the Arctic since 1900. The detailed descriptions of such accidents can give us not only great examples of a heroic behavior, but also provide information on natural, weather and ice conditions and show special techniques used by crew to survive.

Among the different sources of information are museum exhibits and written documentation, books and journals, newspapers and internet articles as well as oral evidences of the persons involved. The most thrilling part of the work is interviewing ice masters, mates and pilots. They can be found in special communities and on real vessels. Several organizations affiliate people like that, such as Russian Geographical Society with Department of Polar Region Geography and Association of polar researchers and polar workers, integrating remarkable people with extraordinary fates, connected to sea ice. Conversations with them are newsworthy and entertain-

ing. The same applies to interviewing the people on board the vessels, who brave ice out almost every day and can demonstrate actual techniques and provide real life documentation such as check-lists.

### 2.2 *Marine accidents classification.*

For our purposes we can divide all the accidents into two main groups: with ice and without ice. There are four main groups among the accidents in the ice conditions. These are forced drift, forced overwintering, shipwrecks and serious ice damage when the crew has managed to rescue the ship with the help of other vessels. Both forced drift and forced overwintering can have lethal outcome (Look for example № 3 the map – figure 1). Among the accidents without the ice we can distinguish shipwrecks and serious damage.

All these types of accidents are quite received and understandable. But there is a special case of forced drift deserving of particular attention, as this is not very common in the international science literature. This is so called ice jet, the forced drift with considerable speed. Ice flow in ice jet is so powerful that even the modern icebreakers can not resist it. This phenomenon has been described by V.Kupetskii (Kupetskii, 1983) and modeled and mathematically presented by V. Benzeman (1989). V.Benzeman (1989) determined “ice jet” as “non-stationary jet stream of compact ice cake, sometimes with compressing, drifting with high velocity near the boundary of the fast ice or motionless ice massif in a strait, bay or open region of freezing sea”. Ice jet displays itself as a drift with huge speed and has lead to shipwrecks several times. The shipwreck of freighter *Nina Sagaidak* in Chukchi Sea, October 1983 is a great example. Before she sank, she was slammed to the freighter *Kamenesk-Ural'skii*, while they drifted helplessly apart (see also, Barr, 1985). (see father)

## 3 ACCIDENT DATA BASE

It might not be completely accurate to call our collection of accidents a data base, because not all of the accidents in it are presented with equal accuracy and under the same circumstances. There are sets of books, movies and other information available for the most famous shipwrecks such as *Sv. Anna* (1912-1914) and *Cheluskin* (1934). Other vessels are represented by pages of several reminiscence and sets of photos, but have only mentions about the essential parts of accidents. The main task remaining is to accumulate as much information as possible and organize it in an appropriate way.

Massive amount of data is organized both geographically and chronologically. It includes a set of maps, tables and connected files. The maps for each Russian Arctic sea show accident locations. Expla-

nation of the maps lists the dates, names and types of the ships with accidents itemized according to their types (see above). More detailed maps reflect explicit accident location, lines of ship drift and ice conditions if available. The numbers on the map correspond to the numbers in the table with a short description and a destination of the folder with detailed description.

### 3.1 The Kara Sea example

As an illustration of the “Accidents data base” construction the short extraction for the Kara Sea is presented here. The example includes only one map (figure 1) for accidents which had been induced by hard ice condition, explanation to the map and the beginning of the table with short description of the accidents. It should be stated that the ice drift has usually very complicated and chaotic configuration and only the main direction without any loops and zigzags is presented on this map. References in the table are given on only the essential sources in Russian and in English.



Figure 1. Accidents in Kara Sea since 1900, induced by ice conditions.

Explanation to the map “Accidents in Kara Sea since 1900, induced by ice conditions (figure 1)

#### Forced drift with ice – 14

- 1 - 1900. September-October. Wooden yacht *Mechta*
- 2 - 1907. July- August. Research vessel *Belgica*
- 3 - 1912-1914. Wooden schooner *Svyataya Anna*
- 4 - 1920. January- June. Steamer *Solovey Budimirovich* (later recalled to *Malygin*).
- 5 - 1930. August (7 days). Icebreaking steamer (IS) *Sedov*.
- 6 - 1934. (23 days). IS *Sadko*.
- 7 - 1936. (28 days) IS *Sibiryakov*.
- 8 - 1937. August. IS *Sadko*.
- 9 - 1937. September. The whole caravan of vessels with IS *Yermak*.
- 10 - 1937. Summer. Several weeks. Research vessel *Professor Vize*.
- 11 - 1963. October. Caravan of vessels with icebreaker *Lenin*
- 12 - 1963. October. Steamer *Novovoronezh*.
- 13 - 1977. November. Icebreaker *Captain Sorokin*.
- 14 - 1980. March-April. 2 nuclear icebreakers *Sibir’*, *Arktika* and icebreaker *Kiev*.

#### Forced overwintering – 7

- 15 - 26. September 1900 - 30. August 1901. Schooner *Zarya*
- 16 - 12. September 1914- 11. August 1915. Schooner *Eklips*
- 17 - 9. September 1914 - 2. August 1915. IS *Taymyr*.
- 18 - 9. September 1914 - 2. August 1915. IS *Vaygach*.
- 19 - Autumn 1936 - summer 1937. Survey vessel *Toros*.
- 20 - October 1937 - June 1938. Almost half of the transport vessels (26 ships) and the entire icebreaker fleet (7 icebreakers) overwintered in the Arctic. *Litke*, *Mossovet*, *Uriskiy*, *Pravda*, *Krest’yanka*, *Molokov* were beset at the south-east coast of *Bol’shevik* Island.

- 21 - October 1937 - June 1938. 6 cargo ships

#### Shipwreck - 5

- 22 - 1912-1913?. Sealing ship *Gerkules*
- 23 - 1921. 17. September. Steamer *Enisey*.
- 24 - 1921. 20. September. Steamer *Ob’*.
- 25 - 1924. Schooner *Agnessa*.
- 26 - 1985. June. Freighter *Nina Kuroverova*.

#### Damage by ice - 3

- 27 - 1933. August. Steamer *Cheluskin*.
- 28 - 1937. August. Icebreaking steamer *Sedov*.
- 29 - 1937. August. Freighter *Sura*.

Table. Short description of accidents in Kara Sea since 1900, induced by ice conditions.

№	Short description	References	Links
<b>Forced drift with ice - 14</b>			
1	<b>1900. September- October. Wooden yacht <i>Mechta</i></b> (led by A.A.Borisov). Forced drift with ice along the east coast of South Island Novaya Zemlya since the end of September. The crew left her at 10. October 1900 and walked and swam through the ice, reached the land near the mouth of Savina River, crossed Novaya Zemlya and arrived to Pomorskaya Guba at 12. November 1900.	Vize, 1948	<a href="http://www.solovki.ca/art/borisov.php">http://www.solovki.ca/art/borisov.php</a>
2	<b>1907. July- August. Research vessel <i>Belgica</i></b> (led by Philippe duke d’Orléans). Nipped by the ice in Matochkin Shar at the end of July. Current carried her with the ice to the south and drove upon Barents Sea through Kara Gate (16. August 1907), saved by herself.	Vize, 1948	
3	<b>1912-1914. Wooden schooner <i>Svyataya Anna</i></b> (captain Brusilov). The ship became beset just west to Yamal Peninsula in October 1912 and drifted steadily northward in the ice. By April 1914 she was still drifting 100 km north of Franz Josef Land and further to the north - Evidently wrecked - Crew dead, except for 2 men (V.Al’banov, Konrad) who managed to reach Franz Josef Land.	Al’banov, 1917- 1978, Barr, 1978	<a href="http://www.kapustin.boom.ru/journal/albanov01.htm">http://www.kapustin.boom.ru/journal/albanov01.htm</a> <a href="http://www.rusk.ru/st.php?idar=708035">http://www.rusk.ru/st.php?idar=708035</a>

These accidents had been described by Yu.Vize (1948), M.Belov (1959), Pinkhenson (1962), V. Kupetskiy (1983), Benzeman (1989) and other. There is also information in English (Barr, 1974, 1984, etc).

### 3.2 The accident examples

The two events in eastern sector of the Arctic will be described below as an example of the accidents. The first one is about a human factor, the second one illustrates the invincible natural forces action. See photo and location on fig.2,3.

#### 3.3 Example 1. 1955. East-Siberian Sea. Motor vessel *Kamenets-Podolsk*

Accident with motor vessel *Kamenets-Podolsk* have been described in the reminiscences of captain Pacel Kuyantsev (1998). At the end of September 1955 she sailed from the Ugol'naya bay to the cape of Shmidta (Mys Shmidta) with a full load of coal. She was convoyed by an icebreaker. But northern winds brought a lot of heavy ice and made further movement impossible at the distance of 50 km before the aim. The ships waited the whole earth-day and after that gave the order to go back to Pevek. The ice condition was very hard till Mys Billingsa and the speed was extremely slow. The case demanded skilled use of energy and concentration of everybody's attention. To the west of Mys Shalaurova the conditions improved and the compactness of ice decreased to 5 balls. The exhausted crew respired, captain was able to afford a short coffee break and went down to his cabin. He had left the bridge for only 10 minutes, but when he returned, he immediately realized that an unavoidable accident was already unfolding. An ice-free clearing spread before the bow had been left by an icebreaker sailing half a mile ahead. Pieces of ice drifted here and there. Their position relative to the ice field was changing. The second mate noticed a small piece of ice and thought it was also floating separately from the ice field. When he put the helm to port to avoid it, Captain noticed at once that this piece of ice was not moving and realized it was the top of a submerged ice ledge. It was too late to turn starboard. At the vessel's speed of about seven knots, a submerged ice ledge, if collided with the fore holds, could rip the vessel from the bow to the bridge. The only decision at this point was to stop the vessel. "Back\_Full" command was given and it worked at once as forward motion was reduced. However, the propeller operation astern caused the moving vessel's bow to swing to starboard at the speed of 4 knots, brushing the forward port quarter against the ice. The terrible racket of tearing metal was heard and the vessel listed sharply to starboard. Captain turned the key for general alarm and immediately heard a splashing sound of a waterfall as water rushed into the hull to the first hold, maybe to the second hold, and the forepeak. The hole was 1 meter x 1 meter in the size and an opening of 10 cm wide also appeared in the stern after collision. The ship was settling down quickly bows on, the stern was lifting dangerously. Captain

was ready to give the order to leave the ship and go down to the ice. But in a minute the dressed sleeping staff was on the place and rescue operation began.

In seven minutes patch was placed and the bow stopped submerging. The first and second holds were opened. The first hold was filled up to the sea level and over a half of twin deck. The bow submerged under water up to the anchors. Fortunately the screw and the helm were in the water as she moved by the stern before collision (trim was near 1 meter). It was impossible to pump the water away, because the pipes were blocked by the coal. But water lever in the holds rose up very slowly. After discussions it was decided to continue the voyage and sail to the cape behind the icebreaker with low speed while monitoring water in the holds. *Kamenets-Podolsk* reached the port of Pevek at a speed of 10 knots.

Two jokes spread to ice pilot society after that accident. The first lesson was that during Arctic Navigation the captain "should drink coffee on the bridge, not downstairs". When captain Kuyantsev reported that it was his mistake due to inexperience in his first ice navigation, the chief of the headquarters M.V.Gotskii (very famous and revered captain) replayed that according to Russian tradition, arriving of ship with crushed stem is not a dishonor for captain, it is the sign of his sureness and courage. But if the screw and the helm were broken, captain has to feel the shame.

#### 3.4 Example 2. 1983. Chukchi Sea. Freighter *Nina Sagaydak* (figure.2,3)



Figure 2. Location of accidents



Figure 2 Nina Sagaydak sinking  
<http://www.yaplakal.com/uploads/post-3-12340193324991.jpg>

The second accident to be described here is a well-known shipwreck of freighter *Nina Sagaidak* in Chukchi Sea during terrible ending of navigation season(?) in 1983. An unusually early freeze-up and persistent northwesterly winds that drove heavy multi-year ice into Proliv Longa and against the north coast of Chukotka resulted in a critical situation. During September several ports were prematurely closed by ice, leaving Pevek as the only functioning port in this part of the Arctic. Dozens of ships were beset. Practically all available ice breakers were transferred from the western to the eastern Arctic to free the jammed ships. Many ships were forced to head west from Pevek to the Atlantic, rather than attempt to battle their way through the heavy ice in Proliv Longa in order to return to their Pacific home ports. One early report put the number of damaged ships as being in excess of 30 (Bratchikov, 1983). Fortunately, there were no lives lost.

Let's remember this event in English presentation by W. Barr and E. Wilson (Barr, Wilson, 1985)

“Early in October the freighter *Nina Sagaydak* one of a convoy of ships westward bound to Pevek that was caught by the ice near Kosa Dvukh Pilotov, a little to the east of Mys Shmidta, found herself in serious difficulties. Built at Rostock, East Germany, by the Schiffswerft Neptun in 1970, *Nina Sagaydak* was one of a class of 31 almost identical small freighters of between 341 1 and 3684 gross tons; she was 105.7 m long, with a beam of 15.65 m and engines of 3250 bhp, giving her a top speed of 3.75 knots. On 6 October 1983 the freighter *Nina Sagaydak* was caught in multi-year ice 3-m thick being driven against the edge of the fast ice, and soon irresistible ice pressures began to build up. Massive pressure ridges piled up against her sides, with enormous ice blocks tumbling over her rails. Her stern was forced against the fast ice and her rudder and propeller were jammed. To compound the difficulties the freighter next collided with the tanker *Kamensk-Urul'skiy*, also drifting helplessly in the ice. For over half an hour the ships ground against each other, and despite frantic efforts to place fenders between the two hulls, both ships received some damage; *Nina Sagaydak* came off worst. Her crew was rather startled to see the tanker's crew pouring water down the sides of their ship at the points of contact between the hulls in case sparks caused by the grinding and pounding might ignite fumes from the tanker's cargo. The two ships ultimately drifted apart, but even worse was in store for *Nina Sagaydak*. As the ice pressures continued, her hull plates began to crack and the water began to rise inexorably in the engine room. Despite every effort her pumps were unable to cope with the enormous influx of water and the ship began to list heavily to starboard. When the list had reached the alarming angle of 40° the chief engineer brought all his men on deck and the captain gave orders for the crew of

45, and a further 6 men accompanying the ship's cargo, to be lifted off by helicopters from the icebreakers *Kapitan Sorokin* and *Vladivostok*, which were standing by, unable to save the sinking vessel. The ship stubbornly remained afloat, held up by the ice and with her engines and pumps still running unattended for almost a day. Finally, early on the evening of 8 October, while her crew watched helplessly from *Kapitan Sorokin* barely a ship's length away, *Nina Sagaydak* sank by the head. Her crew was flown south to Vladivostok, and a commission of enquiry into the loss of the ship was convened at Pevek. It concluded that no blame attached to any of the officers or crew members and that everything possible had been done to save the ship”.

On the day after *Nina Sagaydak* sank, her sister ship *Kolya Myagotin* was caught between two massive ice floes and badly holed (see figure 2). As a precaution most of her crew was evacuated by helicopter and only five of the crew battled to keep the ship afloat and they managed to rescue her. But it is another story.

#### 4 CONCLUSIONS AND ACKNOWLEDGEMENTS

Creation of Accident Data Base is not finished yet because of the new circumstances and details that have been and can be found. It seems to be an endless process. But even now this set of accident descriptions can be useful for understanding the ice, weather and human conditions in the Arctic and for planning the future activities in this severe region. A more thorough review of the “data base” is, however, in preparation (Marchenko, 2009).

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