The 1939 Northern Sea Route expedition for the GULAG of the NKVD: a study of vessel ice protection

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Abstract. Arctic navigation has always been a challenge both to the mariner and his vessel. Before the epoch of icebreakers, many polar expeditions used conventional ships, which were often strengthened to cope with the ice-infested waters of the Arctic Ocean. Unfortunately, little is known on the design of this technology and its effectiveness. This paper aims to give some insights on this problem by describing the ice protection used during a Soviet Northern Sea Route expedition staged by the GULAG of the NKVD in 1939.

1. Introduction

The practice of sheathing ship hulls with metals (primarily copper) to protect the wood from accumulating marine life has a long history. As a massive technical innovation in shipbuilding this technique arrived only during the closing decades of the eighteenth century [1]. Along with being an effective means of protection against biological fouling, sheathing had another important application – hull protection against polar ice. And, as the age of wooden ships gradually drew to an end, sheathing became associated not with the copper-bottoms of Nelson’s navy, but with the ice protection for polar vessels (see, for example, the meaning of sheathing in the dictionary of Newfoundland English [2]).

The evolution of polar ship design has largely been limited to the history of icebreakers with researchers occasionally enhancing their paper by adding some passages on the history of polar shipbuilding before the epoch of icebreakers. These additions, however, are often limited to the description of specialized polar vessels such as Fridtjof Nansen’s Fram [3], ignoring conventional ships that were deliberately strengthened for operating in icy waters. Until the 1950’s and the epoch of intense icebreaker construction, the main vehicles of the busiest Arctic marine highway, the Northern Sea Route (NSR), were conventional vessels. In some cases these ships were equipped with limited means of ice protection. This is especially true for the vessels of the voyages that pioneered the NSR in the second half of the nineteenth century, and the annual expeditions organized during the Soviet era (especially the Kara Sea (Barter) Expeditions of the 1920’s).

Arctic expeditions of the Industrial Revolution had their ships covered with so-called ‘ice belts’ which protected those parts of the hull which were exposed to the ice and, hence, could be damaged. Unfortunately, there is very little knowledge on the way this specific protection was installed, the materials used for its production, and how effective the ice belts were. For instance, Frederick William Beechey the commander of the British polar expedition aboard the HMS Blossom, modestly mentions that his ship (which sailed in the Chukchi Sea in 1826) was “partially strengthened, and otherwise adapted to the service” [4, p. iv]. We see the same situation on the pages of narratives, written by other polar explores of the age [5 p.; 6, p. iii].

There is much more knowledge on the construction of the ice belts on the HMS Erebus and Terror of Sir John Franklin’s Arctic expedition, mainly because of the intense discussion around this expedition due to its tragic fate. Significant interest among scholarship was generated around the ships’ design after the discovery of both ships in 2014 and 2016. From topical publications, we learn that some of the reinforcements to the ships’ hulls included diagonally cross-planked decks, a second layer of planking, which doubled the hull thickness, watertight bulkheads, and iron casing on the bows [7].

Another example of strengthening a wooden vessel for polar navigation during the Franklin era is that of Fox, the steam yacht used during Francis Leopold McClintock’s Arctic search expedition of 1857. This is how McClintock describes the process of adapting Fox to Arctic navigation:

‘... the whole vessel had to be externally sheathed with stout planking, and internally fortified by strong cross beams, longitudinal beams, iron stanchions, and diagonal fastenings; the false keel taken off, the slender brass propeller replaced by a massive iron one, the boiler taken out, altered, and enlarged; the
sharp stem to be cased in iron until it resembled a ponderous chisel set up edgeways ... " [8, p. 6].

These two schemes illustrates the basic concept for protecting polar vessels, which consisted of the following modifications: (1) adding protection to the hull by increasing its thickness and partially casing the hull with metal to reduce skin friction; (2) adding framing to transverse stiffen the ship (in some cases longitudinal stiffing may have also been applied).

None of these vessels were, of course, designed to cope with heavy ice conditions and withstand the immense force exerted onto their hulls by shifting ice fields. The conversion of former military and civil vessels into polar ships continued through the nineteenth and early twentieth century. Notable examples include the Philomel-Class Jeannette and Blencathra (the second vessel was later renamed to Sviataia Anna). Blencathra was even equipped with such a piece of technology as an ice ram [9], the construction of which is not specified in available historical sources. Most likely, the ram was a casing of iron on the ship’s bow, which protected it from impact with ice (likely, similar to the stem of Fox). The workhorse of polar expeditions during the first decades of the twentieth century was the Dundee whaler and other whalers, which operated in the polar seas of both hemispheres.

Having briefly discussed the milestones of polar ship protection development to the twentieth century, we can now proceed to investigating an episode in the history of designing and exploiting ice protection for the hulls of conventional vessels. A method for constructing such a protection was developed by Soviet naval engineer Andrei Ivanovich Dubravin (1898–1988). While he remains largely an unknown figure in the history of the Northern Sea Route (especially for the Anglophone reader), Dubravin played an important role in the development of icebreaking technology in the Soviet Union. He is best known by his book on the 1929–1930 Kolyma expedition aboard the steamer Stavropol’ [10]. During this expedition, Dubravin (then, an engineering student) performed a series of important investigations on the behavior of ship hulls in ice, greatly contributing to this area of materials science and naval engineering. In 1939, Dubravin successfully tested his ice protection during a transit Northern Sea Route Expedition. His design was used for protecting various vessels traversing the sea route (one episode even includes covering the Soviet Navy Shchuka-class submarine Shch-423 with a wood and metal sheath for the voyage [11]). However, despite its impact on Soviet Arctic navigation, the architecture of metal-and-wooden ice protection has not yet been thoroughly discussed in scientific literature. At the same time, if we give a detailed description of the ice protection, another question inevitably arises, “How efficient was this ice protection?” Considering this, we shall address these two questions in this paper.

2. The 1939 NKVD expedition. During the 1930’s, the industrialization of the Soviet Far East and the northeastern part of Siberia was well under way. It was based primarily on the extraction of natural resources (especially minerals), which were vital both to the industrial plants of European Russia and to Soviet international trade. However, despite the abundance of many raw materials in Siberia and the Far East, their development was often impossible due to the absence of effective ways of communication to these remote territories. Not surprisingly, the Soviet government invested greatly into such massive projects as the Northern Sea Route and developing river navigation on all the major rivers of the Asiatic part of the country. Such were the settings for the polar shipping expedition of 1939.

In March 1939, the People’s Commissariat of Domestic Affairs (the NKVD) arranged the delivery of cargo vessels and river dredges to the GULAG facilities in the Far East (the port of Nikolaevsk on the River Amur) [12, l. 121]. The vessels had been purchased in Western Europe and included one suction dredge and three bucket ladder dredges. The latter were identical and had the following technical characteristics: (1) the vessels had one deck; (2) the vessels did not have double bottoms; (3) the stern of each of the vessels had a slit to accommodate the dredging machinery, having, thus, a double hull (there were two rudders and screws, which made the transportation of the vessel through ice extremely difficult); (4) the vessels had low freeboards; (5) the vessels had tall superstructures; this had negative effect stability. The table below contains the dimensions of the three Lena-type dredges (Lena, Pechora, Msta) and the suction dredge Zeia [12, l. 74–76].

| Vessel          | Maximum length | Maximum breadth | Board height | Maximum draft | Displacement   |
|-----------------|----------------|-----------------|--------------|---------------|----------------|
| Lena-type dredges | 73.2 m         | 12.9 m          | 5.7 m        | 4 m           | 3,000 tons     |
| Zeia suction dredge | 67.6 m         | 16 m            | 5.33 m       | 4 m           | 3,350 tons     |
As the dredges were extremely expensive, special measures had to be taken to make them as ice resistant as possible. While such techniques as electric arc welding were comparatively novel, the overall concept of building a special ice protection for the ships’ hulls, basically, repeated designs used in earlier polar vessels. A special commission consisting of academics, naval engineers, and NKVD authorities gathered to decide whether it was safe to transport these vessels from Leningrad to the Far East via the Northern Sea Route [12, l. 121–121verso]. However, the southern route through the Panama Canal was considered even more dangerous for the shallow-draft vessels. Moreover, with the approaching world war, the commission decided that it was much safer (and cheaper) to deliver the dredges by way of the Northern Sea Route. This decision triggered immediate actions for providing the ships with satisfactory protection against the ice; the option of staging the expedition without properly fitting the vessels was not even discussed. For instance, the maritime authorities of the Baltic Steam Shipping Company concluded that without providing the vessels with proper ice protection for the hulls and additional structural reinforcement, they cannot be taken to the Arctic [12, l. 98]. It was also suggested that each ship should be equipped with at least two motor-driven water pumps. By the time the ships were ready for the voyage, this list of safety equipment had been significantly expanded. Each vessel was equipped with: (1) electric arc welding equipment (including welding rods for working underwater); (2) spare steel sheets, girders, bolts, pins, and other fasteners; (3) one motorized marine pump with a capacity of 40 tons/hour. Besides the individual equipment for each vessel, the expedition carried two powerful (250–300-ton/hour) marine pumps and diving gear (including underwater lighting and telephone systems) [12, l. 90].

3. Constructing the ice protection.

The most important part of the project was, of course, the ice protection (Figs. 1, 2). Its design is exhaustively described by Dubravin.

A strip of steel 5 × 60 mm was welded along the length of each frame. Threaded pins having a diameter of 5/8 inch were welded perpendicular onto the strip. The first layer of wood was then mounted onto these pins. The layer consisted out of planks having a thickness of 90 mm, width of 120 – 200 mm (depending on the vessel), and a length of 6 m. The nuts and washers were sunk into the wood so that another layer of planking could be added. It consisted of thinner planks (65–75 mm) with the same width and length as those of the first layer. The planks were attached to the first layer using wire nails. Finally, a layer of metal was applied to protect the wood. The iron sheets (plates) were attached to the planking with rag bolts. The sheets overlapped one another and the joints between them were electric arc welded (a continuous lap weld with a pitch spacing of 60 × 120 mm). The iron sheets were overlapped in such a manner that when the ship moved forwards, the sheets would cover the joints offering minimum skin friction.

Fig. 1. Cross-section view of sheathing (a – ship frame; b – hull plate; c – first timber layer; d – second timber layer; e – metal sheathing (outer) layer; f – threaded pin; g – steel strip).

The protection was extended below the waterline almost to the chine; here the planks and metal structures
were rounded so that the entire construction had a streamlined design eliminating any protruding components. This curvature was also covered by iron sheets 2–3 mm thick, which were welded both to the iron sheets of the ice layer and the chine hull of the vessel using intermitted seam welds.

The sheathing covered only those parts of the hull that were at risk of being damaged by ice; therefore emphasis was made on protecting the bow. Here the ice layer was extended almost to the deck [12, l. 81 – 83]. The vessel hulls were also strengthened from the inside in order for them to be able to resist the immense pressure of the ice in case they are beset in ice. Thus, according to Dubravin’s description on the reinforcing structure, the longitudinal elements (or stringers) were additionally joined to an additional set of strengthened frames. Each frame had a wall height of 500 mm and a protruding band with a width of 120 mm and a thickness of 12 mm. The frames and stringers were joined using steel knees 700 long, 400 mm wide, and 10 mm thick. The whole structure was then secured using 100-mm-long fillet welds having a pitch length of 100 mm. The frames were welded to the floor and the cross-tie beams with a continuous fillet weld (throat gauge 7–10 mm). In addition, the forepeaks of the vessels were reinforced by timber cribs built between the floors and frames [12, l. 84].

The total mass of the metal reinforcements for each vessel was quite significant. From the table below we can see how the mass was distributed for each vessel.

| Table 2. Mass of dredges. |
|---------------------------|
| **Msta** | **Lena** | **Pechora** | **Zeia** |
| 38,000 kg | 32,290 kg | 32,290 kg | 30,270 kg |

The difference in the mass of the reinforcement for the three identical vessels (Msta, Lena, and Pechora) is explained by the fact that the shipyard of Murmansk was incapable of completing the massive assignment of ice-strengthening four vessels in the planned eight days (beginning from 15 July 1939). In his note to Joseph Stalin [12, l. 12], Andrei Dubravin wrote that the shipyard did not provide the vessels with a dry dock. In result, only Zeia was furnished according to the original project. The rest of the vessels set sail in different stages of completion. Nonetheless, even the incomplete reinforcement and hull sheathing greatly enhanced the dredges. The table below compares the strength of Lena before and after strengthening [12, l. 89].

| Table 3. Strength of vessels before and after reinforcement. |
|-----------------------------|
| **Hull section** | **Maximum evenly distributed stress on each frame** | **Maximum evenly distributed stress on hull plates (tons/m²)** | **Maximum evenly distributed stress longitudinal elements** |
| **Msta** |  |  |  |
| **Lena** |  |  |  |
| **Pechora** |  |  |  |
| **Zeia** |  |  |  |
As we can see, the strength of the vessel increased significantly. Dubraving calculated that this protection would suffice the ships to sail through the icy waters of the Northern Sea Route and withstand both transverse pressure exerted by the ice floes and mechanical deformation that could be caused by the hulls repeatedly beating the ice.

### 4. The voyage.

In late July 1939, the ships Zeia, Msta, Pechora, and Lena sailed from Murmansk [12, l. 102]. The tugs Groza, Tucha, Poliarvik, and Borets (towed) departed from Arkangel’sk. Escorted by the icebreaker Lenin, the caravan passed the strait of Iugorskii Shar encountering rare ice fields and called in Port Dikson. The cargo steamer Mossovet carried supplies of fresh water, coal, and spare parts to the riverine vessels. From Dikson, the caravan was escorted by the icebreaker Stalin, and then the icebreaker Fedor Litke. Having favorable ice conditions, the four dredges sailed without icebreaker escort from the Medvezhyi Islands in the East Siberian Sea to Providence Bay, where they called in on 29 August [12, l. 107verso]. Further, the caravan sailed along the Asian coast to the Sea of Okhotsk, arriving at Nikolaevik on 25 September. The whole voyage took just over 55 days [12, l. 102verso]. The average speed of the caravan was 5 – 5.5 kn along the Northern Sea Route. It was reduced to 2 – 4 kn in ice (in total, 500 nautical miles of the voyage were in ice-infested waters). The damage to the hulls was minimal (Fig. 3).

![Fig. 3. Bow section of ice protection damaged by ice. Source: RGAVMF file R-2234/1/521/40](image)

### 4. Conclusion

In the long run the expedition of 1939 was just a commonplace shipping operation on the Northern Sea Route, which by the end of the 1930’s had been more or less developed for seasonal navigation. The uniqueness of the expedition was in its vessels – expensive imported machinery, which required special ice protection. While there is no direct evidence that Dubravin used the experience of earlier shipwrights in his design of the hull sheathing and interior reinforcement, it is reasonable to suggest that he grasped some of the engineering solutions from polar literature on past expeditions. If this is so, then from the aforementioned description we can derive the construction of the ice protection of polar ships, used in earlier epochs.

### References

[1] Knight R J B 2013 The introduction of copper sheathing into the Royal Navy, 1779–1789 The Mariner’s Mirror 59(3) pp. 299–309.

[2] Dictionary of Newfoundland English (Story G M, Kirwin W J, Widdowson J D A (eds.)) 1990 (University of Toronto Press).
[3] Nansen F 2008 Farthest North: the epic adventure of a visionary explorer (The Norwegian Polar Expedition, 1893–1896) (Skyhorse Publishing, Inc).

[4] Beechey F W 1832 Narrative of a voyage to the Pacific and Beering’s Strait to cooperate with polar expeditions: performed in HMS Blossom, under the command of Captain F.W. Beechey in the years 1825, 26, 27, 28 (Philadelphia: Carey & Lea).

[5] Parry W E 1821 Journal of a voyage for the discovery of a North-West Passage from the Atlantic to the Pacific: performed in the years 1819–20 in HMS Helca and Griper, under the orders of William Edward Parry (London: John Murray).

[6] Parry W E 1824 Journal of a second voyage for the discovery of a North-West Passage from the Atlantic to the Pacific: performed in the years 1821–22–23, in HMS Fury and Hecla, under the orders of William Edward Parry (London: John Murray).

[7] Battersby W and Carney P 2013 Equipping HM ships Erebus and Terror, 1845, The International Journal for the History of Engineering & Technology, 2013, 81:2, pp. 192–211, DOI: 10.1179/175812111X13033852943147

[8] McClintock F L 1859 The voyage of the ‘Fox’ in the Arctic Seas. A narrative of the discovery and the fate of Sir John Franklin and his companions (London: John Murray).

[9] Peel H 1894 Polar Gleams (London : E. Arnold).

[10] Dubravin A I 1983 Kolymskii reis parokhoda “Stavropol’” [The Kolyma voyage of the steamer Stavropol’] (Magadan: Knizhnoe izdatel’stvo).

[11] Belov M I 1969 Nauchnoe i khozyaystvennoe osvoenie Sovetskogo Severa 1933 – 1945 gg. [The scientific and economic development of the Soviet North, 1933 – 1945] (Leningrad).

[12] Russian State Naval Archive (RGAVMF) (St Petersburg, Russia) file R-2234/1/42.