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Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources
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Paper #6-7

OFFTAKE AND TANKERING

Prepared for the
Technology & Operations Subgroup

On March 27, 2015, the National Petroleum Council (NPC) in approving its report, *Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources*, also approved the making available of certain materials used in the study process, including detailed, specific subject matter papers prepared or used by the study's Technology & Operations Subgroup. These Topic Papers were working documents that were part of the analyses that led to development of the summary results presented in the report's Executive Summary and Chapters.

These Topic Papers represent the views and conclusions of the authors. The National Petroleum Council has not endorsed or approved the statements and conclusions contained in these documents, but approved the publication of these materials as part of the study process.

The NPC believes that these papers will be of interest to the readers of the report and will help them better understand the results. These materials are being made available in the interest of transparency.

The attached paper is one of 46 such working documents used in the study analyses. Appendix D of the final NPC report provides a complete list of the 46 Topic Papers. The full papers can be viewed and downloaded from the report section of the NPC website (www.npc.org).

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Topic Paper

(Prepared for the National Petroleum Council Study on Research to Facilitate Prudent Arctic Development)

6-7	**Offtake and Tankering**
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SUMMARY

The use of tankers is well established as a means to transport hydrocarbons in ice-prone waters as demonstrated with long experience in sub-Arctic areas such as the Baltic, Great Lakes and St Lawrence River, Far East Russia and in Cook Inlet Alaska, where navigation continues throughout the winter season.

In addition, there have been regular fuel oil deliveries made to Arctic communities in North America and Russia for decades and a few pilot programs have been undertaken such as the Bent Horn oil export in Canada from 1985-96.

There is more limited, but growing experience with such tanker traffic, year round, in the Arctic.

Since the Oil Pollution Act of 1990, and further reinforced by international regulations all tankers operating in the Arctic are required to be double skinned, i.e. no cargo oil is carried against the outside shell plating.

In addition the IMO Polar Code is expected to be fully in force by 2016 where by ships operating in Arctic waters will be subject to regulations governing design (including a requirement for no pollutants against the shell), equipment (certificated against temperature) and operational aspects (recommendation of limitations for ice conditions versus ice class).

Technical developments of ships and offtake structures are well advanced, and opportunities for improvement lie mainly in training and operational experience development and in enhancement of aids to navigation and charting of Arctic waters

I. INTRODUCTION

There is limited, but growing experience, with offtake and tankering in offshore arctic waters. On the other hand there exists a large body of experience with design, construction and operational use of tankers in sub-arctic ice-prone waters in Europe, Far East Russia and North America and in seasonal use in the Canadian and Russian Arctic.

II. TANKER LOADING AND NAVIGATING IN ICE

There is a long successful history over many decades of using tankers to transport hydrocarbons in ice-prone waters, such as the Great Lakes and St Lawrence Seaway, Cook Inlet, Alaska, in the Baltic and along the Northern Sea Route off Russia's northern coast. There have been some pilot programs in the Arctic such as the 1969-70 voyages of the SS Manhattan from the US East Coast to the North Slope of AK and the seasonal export of oil from the small Bent Horn field in the Canadian Arctic Archipelago.

The following paragraph describe some of the recent experience with tanker offtake and transport in Arctic and Sub-Arctic waters, which illustrate well the advance state of the art of design, construction and operation of the physical plant required.

III. MODERN TANKER OPERATIONS IN BALTIC ICE

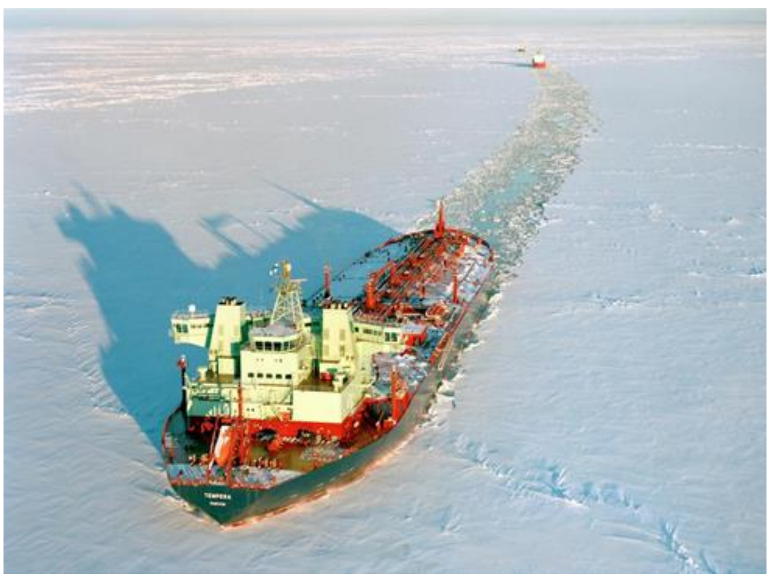

Figure 1. MV *Tempera* - double acting icebreaking tanker. (Photo: Aker Arctic)

In 2001 the Finnish oil company Fortum ordered two 106,000 DWT double acting tankers from Sumitomo Heavy Industries to replace the company's older tankers that, because of their lower ice class, could not deliver their cargo all the way to the refineries in western Finland dues to traffic restrictions during the worst part of the winter because they were not given icebreaker assistance. The new ships are equipped with a single tractor-type 16 MW Azipod unit and have the highest Finnish-Swedish ice class, 1A Super. They are designed to be capable of independent navigation and icebreaking in Baltic ice conditions with a possibility to operate also in the Pechora Sea, in the Russian Arctic. The ships follow the double acting principle with a bulbous bow for open water performance and a stern designed with icebreaking performance in mind. The ships can break level ice up to 3.3 ft. thick at 3 knots when operating in the astern mode.

IV. SS MANHATTAN - NORTHWEST PASSAGE

Figure 2 – SS Manhattan Icebreaking Tanker 1969 (Photo: ExxonMobil)

The oil tanker SS *Manhattan* was built in 1962 in Quincy, Massachusetts and became the first commercial ship to cross the Northwest Passage in 1969. Extensive research and design development went into developing a conversion suitable for Arctic transits. She was fitted with an icebreaker bow and other reinforcements in 1968–69.

Manhattan's first Arctic voyage began in August 1969 on the east coast of North America and transited the passage from east to west and then returned to the US East Coast. The following year, 1970, the *Manhattan* again went into the Arctic on an experimental voyage, however the decision to build the Trans Alaska Pipeline was made and oil is now tankered from southern AK to US ports in the lower 48.

V. BENT HORN OIL EXPORT

Figure 3 – MV *Arctic* (Photo: Fednav Limited)

In 1985, Panarctic Oil Company became a commercial oil producer in the Arctic on an experimental scale, exporting oil during the summer season from the Cameron Island field in the Canadian Archipelago.

This began with a single 100,000 bbl. tanker load of oil from the Bent Horn oil field to Montreal via the double hulled obo MV *Arctic*. The MV *Arctic* carried two shipments per year until Bent Horn operations ceased in 1996.

VI. SAKHAKLIN 1 PROJECT TANKER OFFTAKE

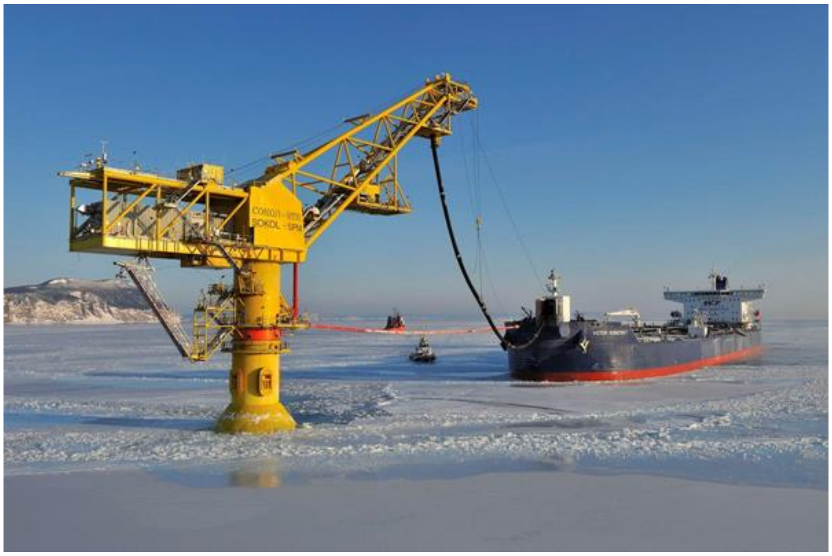

Figure 4. Loading at Dekastri Single Point Mooring Loading Platform in light ice. (Photo: Sakhalin 1 Project)

Sakhalin-1's oil transportation system was commissioned in August 2006. Construction was completed on a 226 kilometer (140 mile) pipeline to transport crude from the onshore processing facility across Sakhalin Island and the Tatar Strait to the De-Kastri Terminal in Russia's Khabarovsk Krai. Tanker loading operations began at De-Kastri in September 2006.

The De-Kastri Terminal includes two 100,000 cubic meters (650,000 barrel) capacity storage tanks to hold the Sakhalin-1 crude oil. From storage the crude is transported via a sub-sea loading line to the single point mooring facility, located 5.7 kilometers east of the Klykov Peninsula in Chikhacheva Bay.

A dedicated fleet of double-hulled Aframax-class tankers carrying up to 100,000 tons (720,000 barrels) of crude is used for export of crude oil from the De-Kastri Terminal to world markets. Sakhalin-1 was the first project to successfully operate tankers year-round in the sub-arctic conditions of Russia's Far East.

In November 2009, the De-Kastri Terminal was named Terminal of the Year 2009 at the Oil Terminal Conference in St. Petersburg. This prestigious award was voted on by top industry experts and government officials and granted to the international terminal achieving the best results in terms of the efficiency of its operations in such areas as: economics, environmental, and social.

As of July 2011, the Sakhalin-1 Consortium had uploaded over 400 tankers from the De-Kastri Terminal without a single offshore spill incident.

VII. VARANDEY OFFSHORE LOADING & TANKER OFFTAKE – PECHORA SEA

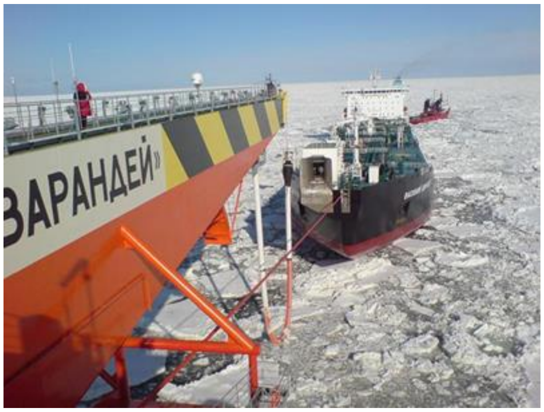

Figure 5. Tanker Loading at Varandey Terminal (Photo: MacGregor Pusnes AS)

The Varandey terminal was placed in service in 2008 and in the first 5 years of operation**,** 26.37 million tons of oil were shipped by 381 ice-class tanker-loads through the fixed offshore ice-resistant oil terminal (FOIROT), a steel conical structure equipped with a loading boom for bow loading of tankers. The FOIROT is located approximately 15 miles offshore and is in about 56 feet of water.

The terminal is serviced by 3 specially designed icebreaking tankers of 70,000 DW, built by Samsung in Korea. These ships operate year round and are supported, at the terminal only, by two ice-management vessels, built in Singapore by Keppel.

The Varandey oil terminal serves as a venue for annual maneuvers dedicated to emergency oil spill response. No actual emergency situations were registered during the above five-year period.

VIII. NORILSK NICKEL TANKER

Photo deleted due to copyright considerations

Figure 6. Norlisk Nickel Tanker *Yenisei*

Norilsk-Nickel, one of the leading nickel mining companies, has built a number of ships for year round navigation to Dudinka on the Taimyr Peninsula in Siberia. The initial ships in the fleet were cargo ships, but recently the company built a tanker to provide year round service to its facilities.

The tanker "*Yenisei*", built in Germany, is capable of breaking ice up to 5 ft. thick and is capable of operating in temperatures as low as -50 degrees Celsius.

IX. DIRECT OFFTAKE LOADING TO TANKER – PRIRAZLOMNOYE PLATFORM

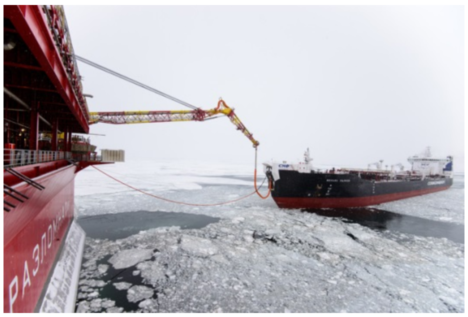

Figure 7 Direct offtake loading to Tanker – Prirazlomnoye Platform Pechora Sea (Photo: Gazprom)

The field development for this project is based on the single stationary fixed platform. The oil platform, constructed by Sevmash shipyard in Severodvinsk, and entered service in the spring of 2013. Produced oil is directly loaded onto tankers using arms at the opposite corners of the platform and is transported by 2 icebreaking tankers built in Admiralty Shipyard, St Petersburg and operated by Sovcomflot, to floating storage and offloading vessel Belokamenka, located in Kola Bay near Murmansk.

X. YAMAL ARCTIC LNG CARRIER ON ORDER

The double acting ship concept has also been selected as the main transportation concept for the Yamal LNG project. In July 2013, Daewoo Shipbuilding & Marine Engineering (DSME) won the tender for the construction of sixteen Arc7 ice class LNG carriers and the contract for the first vessel, worth 339.3 billion won ($316.4 million), was signed in March 2014. The Arctic LNG carriers, fitted with three 15 MW ABB Azipod propulsion units, will be the largest icebreaking vessels in the world with an independent ice-going capability in level ice up to 7 ft. in thickness.

XI. RESEARCH AND TRAINING SIMULATORS FOR ARCTIC NAVIGATION

As Arctic navigation expands there is a need for more trained operational personnel. Within the IMO Polar Code there are specific requirements for the competence and experience of deck officers on ships in Polar waters.

This requirement combined with the need to establish operating envelopes as part of the front end design process suggest that the design, construction and operation of ice navigation simulators might be desirable.

Such simulators could be used during the design process to test out various design features and to research operational techniques such as active ice-management around a drilling unit. In addition these facilities could be used for direct training of deck officers who will be responsible for safe and efficient navigation of their ships in ice-prone waters.

XII. AIDS TO NAVIGATION

The Arctic is an area of the world where aids to navigation and bathymetric charting may be are less available, or less accurate, than in southern waters and enhancement of these systems and while this is a governmental responsibility, the industry may have more assets available, so some level of cooperation should be of benefit to all parties

XIII. INTERNATIONAL REGULATIONS – POLAR CODE – IACS POLAR CLASS

During the past decade considerable international effort has resulted in the creation a set of unified requirements for the construction of Polar Class ships. These are now contained in the Rules of members of the International Association of Classification Society (IACS) resulting in a harmonized set of design and construction requirements know as Polar Class with ice classes PC1 through PC7 reflecting ship operational capability in ice conditions varying from PC1 in year-round operation in all Polar waters to PC7 in summer/autumn operation in thin first-year ice which may include old ice inclusions.

Further, the multi-year effort at the International Maritime Organization (IMO) to create a "Polar Code" (formally the "International Code for Ships Operating in Polar Waters") is being finalized and is anticipated to come into force in 2017. The safety provisions in the Polar Code are incorporated into the IMO Safety of Life Sea (SOLAS) regulations as the new Chapter 14 (approved at MSC93 in May 2014). The pollution prevention measure in the Polar Code are incorporated into IMO Marine Pollution (MARPOL) regulations as amendments to Annexes I, II, V and VI (anticipated to be approved at MEPC67 in October 2014). It is noted that the IACS Polar Class rules are included in the Polar Code by reference.

All ships that are certificated under SOLAS and operating in Polar waters will be required to comply with the Polar Code. Ships of 500 gross tonnage, engaged on international voyages are, in general, required to be in compliance with SOLAS and are certificated as such.