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SHIPPING OIL FROM THE RUSSIAN ARCTIC: PAST EXPERIENCES AND FUTURE PROSPECTS

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ABSTRACT

Transport of oil from Russian Arctic ports to Western markets was insignificant prior to 2002. In 2002, there was a major surge, with 5 million tonnes delivered westwards through the Barents Sea. By 2004, this had increased to 12 million tonnes. Since then, annual volumes have been on levels between 9 and 15 million tonnes. In the near future, the flow of oil cargo in the Arctic may rise significantly, as a result of the development of oil and gas fields and port capacities in the North. Oil offloading terminals in the Russian Arctic have been developed and overall shipping capacity has been enlarged, though each terminal has its history of ups and downs. Various logistic schemes have been developed for shipping oil and gas produced in the Northern regions and bringing petroleum cargo to the Arctic coast over long distances using pipelines, railways and river ships.

In this paper, we present an overview of experiences with transport schemes at onshore and offshore terminals along the Russian Arctic coast and indicate the prospects for future oil and gas shipping in the North. We examine logistic solutions that reflect Arctic shipping challenges, and pay attention to oil pollution prevention and response systems. We find that logistics solutions are more varied, flexible and complex than often assumed, and that estimates of potential cargo and terminal capacity will need to reflect oil and gas production beyond the Arctic regions. Finally, we note the trend towards greater centralisation of terminal and oil-spill response capacity during the last 15 years.

INTRODUCTION

The steady growth of global demand in energy resources and the depletion of hydrocarbon reserved in traditional oil-and-gas production regions have been key driving forces in moving petroleum industry to the Arctic (BP 2014a; ERI RAS and ACRF 2014). According to Gautier et al. (2009), as much as 84% of undiscovered oil and gas resources in the Arctic may occur offshore. As yet, the only Russian Arctic oil production platform operating offshore is Prirazlomnaya in the south-eastern part of the Barents Sea, or the Pechora Sea. The platform began commercial production in December 2013 and loaded four tankers with about 70 000 tons of Arctic crude each during 2014 (Gazprom Neft 2015).

Prior to this, Russian Arctic ports and terminals had been sending up to 15 million tons of oil and products for export via the Barents Sea annually (Frantzen and Bambulyak 2003; Bambulyak and Frantzen 2011). Petroleum cargo flow grew from 5 million tonnes in 2002 to 12 million in 2004. Crude oil produced in the northern petroleum regions and shipped via terminals in the Kara and Pechora Seas represented less than 1 out of those 12 million tonnes in 2004; most petroleum was transported by pipelines and railways to ports in the White and Barents Seas and then offloaded to seagoing tankers (Bambulyak and Frantzen 2005a). At the time, several small and medium-sized oil offloading terminals were in operation along the Russian Arctic coastline, and there were plans for infrastructure developments, including a

trunk oil pipeline from Western Siberia to Murmansk. That gave rise to expectations that annual export volumes of Russian oil shipped via the Barents Sea would increase to 150 million tonnes by 2015 (Frantzen and Bambulyak 2003; Bambulyak and Frantzen 2005b). The planned oil pipeline project, with a capacity of 100 million tonnes, was proposed by the five largest Russian oil companies in 2002. The project was granted to oil trunk pipeline monopolist Transneft; it was reduced to a 50-million-tonne Surgut-Indiga pipeline project in 2004, further to a 12-million-tonne Kharyaga-Indiga pipeline project in 2005 (Bambulyak and Frantzen 2007), and was finally struck from the state company's project list (Transneft 2015). Bambulyak and Frantzen (2011) estimated that, even without a trunk pipeline to the Barents Sea coast, overall capacity of terminals shipping petroleum for export along the Russian Arctic could reach 100 million tonnes, with half of this related to railway–port transportation possibilities, stating it was a capacity evaluation not a cargo flow forecast.

Whereas offshore terminals, pipelines, and liquefied natural gas (LNG) plants in the North are linked to and dependent on oil or gas projects in the region, the railway grid connected to ports in the Russian Euro-Arctic can be used as much for petroleum as for other cargo transport (Rautio and Bambulyak 2012). Therefore, forecasts for petroleum shipping from the North should be based on oil and gas production plans for related projects (Bogoyavlensky 2013; Grigoriev 2009, 2014) and the available railway–port capacity, which can provide added volumes. These flexible volumes can be significant and are important for oil-spill risk assessments and response planning (Bambulyak 2011). The oil-spill response system in the Russian Arctic has undergone many changes over the past 15 years, in terms of structural reformation and capacity building (Ivanova 2011; Bambulyak et al. 2014). We can expect more attention to be paid to oil pollution prevention in the Arctic in line with new rules and regulations adopted at the national and international levels (Arctic Council 2013; IMO 2014; Bambulyak et al. forthcoming).

In the following sections, we give a brief description of existing and planned terminals and logistic schemes, as well as trends and prospects for shipping oil and gas from the Russian Arctic. We also consider changes related to oil-spill response to handle these developments.

RUSSIAN OIL AND GAS: UPSTREAM AND DOWNSTREAM

Russian is among the world’s the largest producers and exporters of oil and gas (BP 2014b). Annual natural gas production has been between 570 and 670 billion cubic metres during the last 20 years, with about one third of this exported westward via the Gazprom pipeline grid. In 2009, Russia opened its first LNG plant on Sakhalin in the Okhotsk Sea; since 2010 it has produced and exported between 20 and 26 million cubic metres of LNG, equal to some 12 to 16 billion cubic metres of dry natural gas, to the Asia-Pacific region (BP 2014b). Since 2000, Russian oil production has grown steadily: in 2010, it exceeded 500 million tonnes per year and by 2014 had reached almost 527 million tonnes.

Between 140 and 260 million tonnes per year, or about half of the oil produced in Russia, has been exported as crude since 2000; in addition, the country exported between 62 and 152 million tonnes of refined products. Since 2005, annual export of liquid hydrocarbons from Russia has exceeded 350 million tonnes (see Figure 1).

More than 90% of the oil and gas produced in Russia is transported by trunk pipelines of the state-owned Transneft and Gazprom. The largest gas producer, Gazprom, has a monopoly on dry natural gas export and delivers gas through the Unified Gas Supply System to domestic and foreign customers. Transneft pipes crude oil and products for export using onshore grid and seaport terminals at the Baltic, Black, Azov and Okhotsk Seas, with the largest terminal being Primorsk at the Baltic Sea (Bambulyak and Frantzen 2011; Transneft 2015). Russian Baltic port terminals tranship more than 100 million tonnes of oil and products annually (133 million tonnes in 2014), receiving cargo by both trunk pipelines and railways (ASCP 2015).

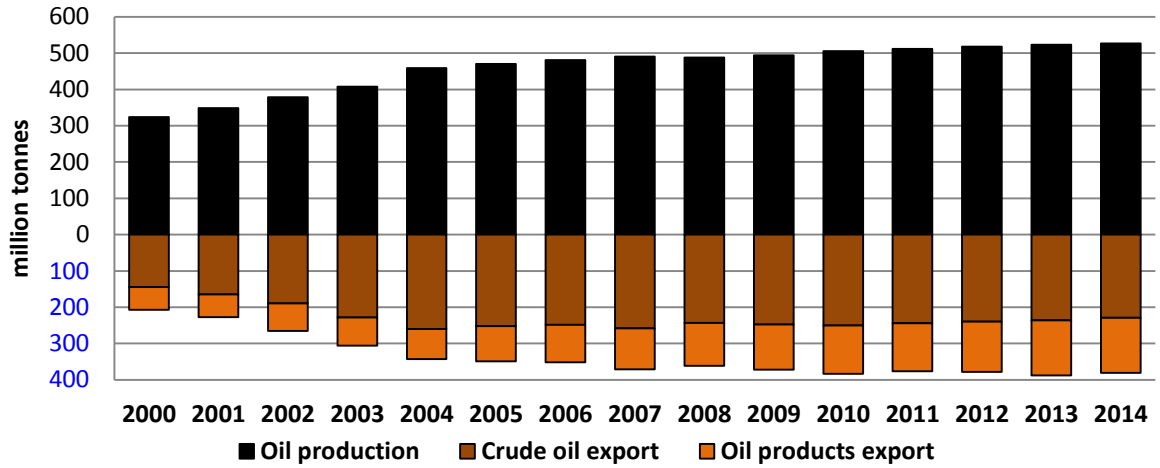

Figure 1. Annual oil and products export from Russia (Source: Rosstat, Russian Customs).

ARCTIC SHIPPING OF RUSSIAN PETROLEUM: TERMINALS AND ROUTES

Russian oil shipping for export along the Arctic coast had insignificant volumes before the beginning of 2000s. In 2002, there was a sharp increase in petroleum cargo flow, with over 5 million tons going to Western Europe via the Barents Sea. In 2003, those volumes increased to 8 million, and to 12 million tonnes in 2004. Each year after 2004, sea-going tankers have delivered between 9 and 15 million tonnes of Russian crude oil, products and gas condensate for export from terminals in the Kara, White, Pechora and Barents Seas (see Figure 2). Most of this cargo went westwards to major European harbours (Bambulyak and Frantzen 2011; Kystverket 2014). From 2010, petroleum cargo has also been exported eastwards through the Northern Sea Route (NSR). In 2013, 650 thousand tonnes of liquid gas products, including 67 thousand tonnes of LNG from Statoil's Melkøya in the Norwegian Barents Sea, were delivered to Asian markets through the NSR (NSR IO 2014).

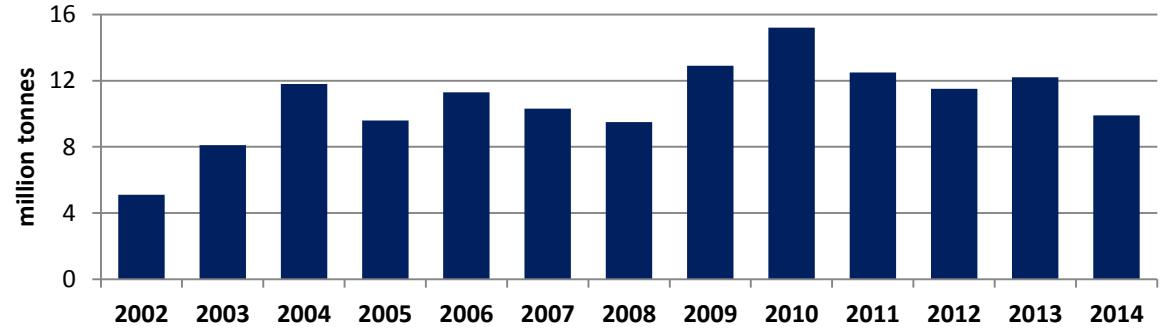

Figure 2. Arctic shipping of Russian petroleum cargoes for export.

Over the past 15 years, terminals in the Russian Arctic for offloading crude oil, gas condensate and refined products for export have been developed and overall shipping capacity has been enlarged. There have been some relative decreases in shipping volumes, but these have been due to various external factors, e.g. changes in export taxes and railway rates, construction of new trunk pipelines and ports in the Baltic and Far East, bankruptcy of key actors, rather than lack of capacity or logistics problems in utilising the potentials of Arctic terminals (Bambulyak and Frantzen 2011). Altogether, 20 terminals of various types and scales along the Arctic coast from Tiksi in the east to the North Cape in the west have been used to offload Russian crude oil, refined products and gas condensate for export, with more to come (see Figure 3 and Table 1).

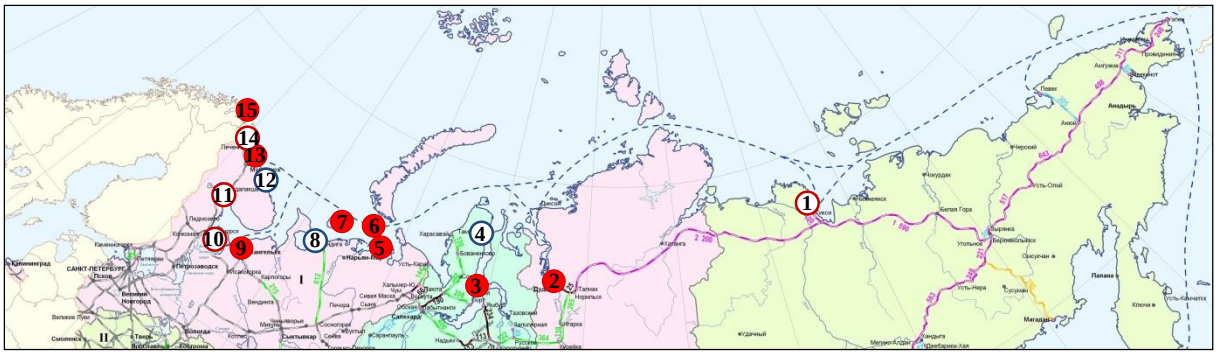

Figure 3. Terminal locations: 1 – Tiksi; 2 – Dudinka; 3 – Novy Port and Cape Kamenny; 4 – Sabetta; 5 – Varandey; 6 – Prirazlomnaya; 7 – Kolguyev; 8 – Indiga; 9 – Talagi; 10 – Osinki; 11 – Vitino; 12 – Teriberka; 13 – Murmansk, Kola Bay; 14 – Pechenga and Kirkenes; 15 – Honningsvåg. Filled red circles – terminals in operation in 2014; circles with blue contour – planned LNGs (Map source: Railway grid development map, section © Giprotranstei RZD).

Table 1. Russian Arctic terminals offloaded petroleum to sea tankers for export in 2002–2014.

		Petroleum shipped for export (thousand tonnes per year)						
(N)*	**Location**	**2002**	**2004**	**2006**	**2008**	**2010**	**2012**	**2014**
(1)	Tiksi	60	–	–	–	–	–	–
(2)	Dudinka	20	30	30	40	60	90	120
(3)	C. Kamenny / Novy Port	110	240	450	240	270	150	220
(5)	Varandey	200	560	500	1900	7440	3120	5880
(6)	Prirazlomnaya	–	–	–	–	–	–	270
(7)	Kolguyev	120	80	80	50	40	30	30
(9)	Talagi	1930	3630	3100	2350	1250	2260	2230
(10)	Osinki	–	–	–	–	–	–	–
(11)	Vitino	2900	3700	4760	4400	4380	3770	–
(12)	Murmansk Fishing port	–	2000	300	340	1160	1270	320
(12)	Shipyard #35	–	1500	1200	60	–	–	–
(12)	Mokhnatkina Pakhta	–	–	730	440	1220	970	670

* Numbers (N) refer to terminal locations on Figure 3.

Further, we give a brief description of terminals and transportation schemes, as well as main trends and prospects for shipping oil and gas from the Russian Arctic. These are based on Bambulyak and Frantzen (2005b, 2011), updated using official press releases and reports.

The Laptev Sea

There have been no deliveries of oil for export from the Laptev Sea after 2002. However, the logistics of those few shipments arranged in the early 2000s were remarkable. Oil produced in Talakanskoye field in the south of Eastern Siberia was carried through a 110 km long local pipeline to a terminal in Vitim on the Lena River and offloaded to 2000 deadweight (dwt) *Lenaneft* river tankers that brought the crude 3000 km to the sea port of Tiksi. There, oil was offloaded to tankers up to 20 000 dwt of the Murmansk Shipping Company (MSCo) that delivered cargo westbound via the NSR and further all the way to Rotterdam. The route was operated during summer navigation; there were two sea shipments in 2001 and three in 2002. Although the Talakan-Vitim-Tiksi-Rotterdam transport route was unique in its logistics, similar schemes for shipping oil in the Arctic have been used in the Ob Bay of the Kara Sea and the Onega Bay of the White Sea. Now, Talakanskoye oil is piped for export eastwards by the East Siberia – Pacific Ocean trunk pipeline of Transneft to Kozmino at the Okhotsk Sea.

The Kara Sea

Terminals in the Kara Sea have been shipping crude oil and gas condensate produced in the north of the Western Siberia. Natural gas produced by Taimyrgas, a subsidiary of Norilsk Nikel, on the Taymir peninsula is used for energy supply of Norilsk town and the Norilsk Nikel smelter, while gas condensate, some 20–120 thousand tonnes per year, is delivered to Dudinka port at the Yenisey River and then offloaded to Arc7 ice-class 20 000 dwt *Enisey* tanker of Norilsk Nikel for export westbound or eastbound via the NSR.

RITEK company, owned by LUKOIL, uses the pipeline–river–sea transport scheme for exporting part of its oil production. Crude is piped by local pipelines to terminals in Andra on the Ob River and Numgi on the Nyda River, shipped by *Lenaneft* tankers to an offshore terminal near the Cape Kamenny in the Ob Bay where offloaded to 20 000 dwt tankers ship-to-ship (STS) or via a floating storage and offloading vessel (FSO). Crude has been delivered westbound to FSO *Belokamenka* in the Kola Bay of the Barents Sea and transhipped to line tankers of up to 100 000 dwt that brought oil to western ports. RITEK's northern export route has been used during the summer navigation, and operations in the Ob Bay been supported by *Taimyr* or *Vaygach* atomic icebreakers. A record-high 454 thousand tonnes of crude oil were transhipped at the terminal in 2006 when 40 000 dwt *Severomorsk* worked there as FSO. Most of RITEK's oil from the Western Siberia is transported westwards by the railway.

In 2013, Gazprom Neft launched a project for construction of an oil terminal at Novy Port in the Ob Bay, south of Cape Kamenny. The offshore facilities will be connected with an onshore oil depot by a 105 km long pipeline, and oil will be offloaded to 40 000 dwt tankers all year round. The terminal's cargo turnover will correspond to Novoportovskoye oil production and can reach 8.5 million tonnes a year by 2020. The plan is to export crude of a new Novy Port blend via transhipment facilities in the Barents Sea or bring it to a large West European ports directly. At present, part of the oil produced at the Novoportovskoye field is transported by shuttle motor vehicles to the nearest railway station. In the ice-free period of 2014, there were four shipments of Novy Port crude to 40 000 dwt tankers in the Ob Bay.

The largest project in the Ob Bay is currently the construction of the Sabetta port and the LNG plant, known as Yamal LNG, on the eastern coast of the Yamal peninsula. The Yamal LNG project is being developed by a joint venture of the second-largest Russian natural gas producer NOVATEK, French Total and Chinese CNPC, and in cooperation with Gazprom. It is planned in three phases – three trains for 5 million tonnes of LNG each are to be completed in 2016, 2017 and 2018. The plant will receive natural gas from NOVATEK's Yuzhno-Tambeyskoye field and neighbouring fields in the north-east of Yamal, including Gazprom's Zapadno- and Severo-Tambeyskoye fields. LNG is to be shipped from the new Sabetta port to ice-reinforced gas carriers of 77 000 dwt, or 170 000 cubic metres LNG. In addition, the port will ship one million tonnes of gas condensate. The Yamal LNG plant and Sabetta port are to operate all the year with gas carriers delivering cargoes for export through the NSR eastbound during the summer navigation, usually June to October, and westbound the rest of the year.

Most the natural gas produced in Yamal will be transported by a unified pipeline system of the Russian natural gas export monopolist Gazprom. The trunk pipeline was brought through Baydaratskaya Bay of the Kara Sea to the huge Bovanenkovskoye field in the west of Yamal that came on stream in 2012. Under Gazprom's Yamal Mega-project, also other fields in the west of the peninsula will be connected to the unified gas pipeline grid.

The Pechora Sea

Shipment of crude oil to sea tankers in the south-eastern Barents Sea started back in the 1980s with production on Kolguyev Island. Since 2000, Varandey terminal has taken the lead in sending oil for export from the Pechora Sea, and will maintain this lead even when Prirazlomnaya platform achieves maximum production level.

The Peschanoozyorskoye oil and gas condensate field on Kolguyev Island came on stream in 1987. Production reached 125 000 tonnes per year in 2001, and then decreased. Oil is extracted on Kolguyev by Arktikmorneftegazrazvedka of Zarubezhneft and Arcticneft of Urals Energy and piped to onshore crude oil topping units or the export tank farm. Oil is shipped to sea tankers of up to 40 000 dwt via the Arcticneft's terminal located offshore east of the island. Tankers deliver petroleum cargo to Murmansk for transhipment or export customs clearance. Kolguyev oil exports are limited by both annual production (on the level of 30 000 tonnes in recent years) and the summer navigation season.

Oil shipping from the Pechora Sea has been growing significantly with the development of the Varandey terminal. The first offshore oil terminal at Varandey came on stream under MSCo project in 2000, upgraded in 2002. Solid steel structure (12 m in diameter, 3 m high) was emplaced on the sea floor, connected by a 4.8 km long pipeline with an onshore oil depot of Naryanmarneftegaz, a company of LUKOIL, and operated year-round until 2008, feeding tankers of up to 20 000 dwt. Shuttle tankers delivered crude oil to FSO in the Kola Bay. In 2005, the first Varandey terminal offloaded its maximum of 600 000 tonnes per year, but stopped operation in 2008 when LUKOIL put on stream the new Varandey terminal.

LUKOIL launched construction of the 12.5 million tonne Varandey terminal in 2004 to ship crude from oil fields in the north of Timano-Pechora province – primarily the Yuzhno-Khylchuyu field, developed by a joint venture of LUKOIL and ConocoPhillips. A 150 km pipeline connected the field with the tank farm at Varandey, which was upgraded, and a 22.6 km sub-sea pipeline linked the onshore oil depot with the Fixed Offshore Ice-Resistant Offloading Terminal (FOIROT) – a 130 000 tonne octagonal base structure (43 m wide, 55 m high) supporting the topside, installed 20 km offshore at sea depths of 17 m. In June 2008, the new Varandey terminal shipped crude to the first 70 000 dwt double-action ice-class tanker *Vasily Dinkov* of Sovcomflot that brought oil all the way to the east Canadian port of Come by Chance. During 2010, Varandey offloaded almost 7.5 million tonnes of oil, delivered by the 70 000 dwt tankers *Vasily Dinkov*, *Kapitan Gotsky* and *Timofei Guzhenko* of Sovcomflot to FSO *Belokamenka* in the Kola Bay. From 2011, oil production at Yuzhnoye Khylchuyu and shipment volumes at Varandey dropped significantly. LUKOIL constructed a 4-million-tonne pipeline from Kharyaga oil field to send crude northwards to Varandey instead of southwards to the Transneft trunk pipeline system. In 2014, Varandey terminal shipped 5.9 million tonnes of Timano-Pechora oil for export via STS terminals in the Norwegian Barents Sea. Varandey terminal turnover is expected to grow with the development of Trebs and Titov oil fields and other projects in the north of Timano-Pechora, and can be kept at 10–12 million tonnes per year after 2020.

Varandey FOIROT was the world's northernmost offshore facility operating all year round until Prirazlomnaya platform came on stream in the Pechora Sea. Prirazlomnoye, one of the largest oil fields opened on the Russian Arctic continental shelf, was discovered in 1989, with commercial production started in 2013. The oil field is developed by Gazprom Neft Shelf, a subsidiary of Gazprom. Prirazlomnaya platform, with an ice- and wave-resistant gravity-type caisson (126 m wide in the bottom, and 102 m wide in the upper part) and an oil production and offloading unit topside, was installed at its location 60 km offshore in the Pechora Sea in 2011. The platform shipped its first crude of a new Arctic crude blend ARCO in March 2014. During the first year of production, 300 000 tonnes of oil were extracted and four offloading operations carried out. The maximum oil production of 6.5 million tonnes per year should be reached at the field within five years' time. Crude will be shipped all year round to the 70 000 dwt double-action ice-class tankers *Mikhail Ulyanov* and *Kirill Lavrov*, which were constructed for Sovcomflot to serve the Prirazlomnoye project. The oil will be delivered to Western markets directly or with transhipments in ice-free areas of the Barents Sea.

Another terminal on the Pechora Sea coast is planned in Indiga within the Pechora LNG project that was initiated by CH-Invest and EvroSeverNeft companies of the Altech Group and joined by Rosneft. The plan is to construct a 5-million-tonne LNG plant with offloading facilities near Indiga, to be connected by a 395 km pipeline with Kumzhinskoye and Korovinskoye gas and condensate fields in the delta of the Pechora River. The terminal is intended for year-round operation, and feeding ice-reinforced 80 000 dwt gas carriers that could deliver export cargo westbound and eastbound via the NSR. Russian railways also plan to build a 612 km long railroad to Indiga, to connect with the public railway grid.

The White Sea

While terminals in the Kara and Pechora Seas are constructed to offload oil and gas produced in the region, the port terminals along the coasts of the White Sea and the Barents Seas receive petroleum cargo delivered by railway from refineries or trunk pipeline terminals.

Since 2002, RN-Arkhangelsknefteprodukt, a subsidiary of Rosneft, has been using and developing an oil depot and offloading terminal in Talagi, at the outlet of the Severnaya Dvina River, to ship crude oil and refined products for export. Crude oil produced in Timano-Pechora has been carried by a trunk pipeline to Privodino railway station, and there offloaded to rail tanks and delivered north to Talagi. The terminal also ships gas condensate and light oil products. The maximum of 4.4 million tonnes of petroleum cargo was offloaded at Talagi in 2005, when export crude was delivered to FSO *Belokamenka* and other products were brought directly to West European ports. In 2006, Rosneft ordered three 30 000 dwt ice-reinforced tankers to serve Talagi export terminal; and received RN *Arkhangelsk*, RN *Murmansk* and RN *Privodino* by the end of 2009. However, since 2007 crude oil transhipment volumes at Talagi have been reduced, as oil been piped by the Transneft system from Timano-Pechora all the way to Primorsk terminal by the Baltic Sea.

The transport scheme used in Talagi is similar to the one first implemented in Vitino, in Kandalaksha Bay of the White Sea. Vitino, the first private seaport in Russia, was the main reason for the increase in Russian oil shipments to Europe along the Arctic coast in the early 2000s. Vitino carried out its first operation in 1995, offloading export crude oil to the 31 000 dwt tanker *Probitas* under the Maltese flag. In 2002, the port began year-round operation; and in 2005, terminal capacity was expanded to 11 million tonnes per year. In 2003, Vitino offloaded as much as 5.7 million tonnes of petroleum, mainly crude oil of Yukos. From 2006, the main cargo handled by the terminal was gas condensate of NOVATEK. Vitino received crude oil, gas condensate and refined products by rail, and fed sea tankers of up to 80 000 dwt that delivered petroleum cargo for STS transhipment in ice-free areas of the Russian or Norwegian sectors of the Barents Sea, or directly to major European and even Asian ports. In 2011, almost 700 000 tonnes of NOVATEK gas condensate were delivered from Vitino to Asian markets via the NSR. In 2014, Vitino was not in operation, as NOVATEK had re-oriented its cargo to Ust'-Luga port on the Baltic Sea coast.

In addition to Talagi and Vitino, there was one more export oil terminal in the White Sea. The Volgotanker company established an offshore terminal near the Osinki Islands in the Onega Bay and ran STS transhipment operations delivering heavy fuel oil with 3000 dwt *Nefterudovoz* type river-sea tankers via the White Sea–Baltic Canal and feeding the 30 000 dwt sea-going tankers *Zoja-I* and *Zoja-II* of the Latvian Shipping Company during the ice-free navigation season of 2003. Terminal operations were ended when tankers collision resulted in an oil spill of 50 tonnes in September 2003, and were not resumed after Volgotanker was declared bankrupt.

There have been other plans for constructing new port facilities and terminals, *inter alia* in Arkhangelsk, Severodvinsk and Onega, to tranship petroleum cargoes from railway to sea tankers. Some projects have been cancelled; others have been indefinitely postponed.

The Barents Sea

Following the Varandey and Vitino developments in the early 2000s, onshore and offshore transhipment facilities have been established along the Kola Bay, as well as STS terminals in Norwegian fjords of the Barents Sea to handle petroleum cargoes from Russia.

While offshore STS and FSO terminals in the Kola Bay – RPK-1 of MSCo, RPK-2 of the White Sea Service (Vitino), and RPK-3 Belokamenka of Rosneft and Sovcomflot – have received oil from shuttle tankers for transhipment to carrier tankers, terminals along the eastern coast of the Kola Bay, i.e. in the Fishing port, Shipyard # 35 and Mokhnatkina Pakhta have shipped petroleum cargoes delivered by rail.

A terminal established at the facilities of the Fishing port in Murmansk, now called the First Oil Terminal, uses a transport scheme similar to those in Vitino and Talagi. Tangra Oil started developing the export terminal in 2003, and offloaded its maximum of 2 million tonnes in 2004 when the oil cargo flow was re-oriented from Vitino to Murmansk. Since 2010, the First Oil Terminal has been handling about one million tonne of export petroleum per year, feeding 15 000 dwt shuttle tankers that deliver cargo to RPK-1 in the Kola Bay for transhipment.

The export oil terminal at the Shipyard # 35, constructed by the factory in cooperation with Tangra Oil, applied similar logistics. The main difference from the Murmansk Fishing port terminal was that depths at the shipyard allowed mooring the 127 000 dwt *Trader* as FSO and offloading oil to 100 000 dwt carrier tankers. Shipyard # 35 handled crude and heavy fuel oil, offloaded up to 1.5 million tonnes of petroleum cargo per year and had an estimated annual capacity of 7.5 million tonnes. In 2008, the oil terminal stopped operations.

Also in the early 2000s, Commandit Service of Progetra Group and Sudkomgroup constructed an export terminal using facilities of the Northern Navy on Mokhnatkina Pakhta Cape. Heavy fuel oil is brought by railway to an oil depot and then piped to the 61 000 dwt FSO *Kola Bay* that feed carrier tankers up to 60 000 dwt. This terminal, with a capacity of 2.5 million tonnes, has exported between 0.4 to 1.2 million tonnes of heavy fuel oil annually.

The first offshore oil transhipment terminal, called RPK-1, in the Kola Bay was established by MSCo in 2002. RPK-1 worked as an STS and FSO terminal, receiving oil carried by shuttle tankers from terminals in Dudinka, Ob Bay, Varandey, Kolguyev, Vitino and Murmansk and offloading cargo to carrier tankers of up to 150 000 dwt. In 2004, RPK-1 shipped its maximum 4.3 million tonnes per year. Now, the terminal tranships petroleum cargo from the First Oil Terminal in Murmansk. RPK-2 of the White Sea Service was in operation as an STS facility for three months in 2003, transhipping crude from Vitino.

The largest offshore terminal thus far in the Kola Bay, RPK-3 with the 360 000 dwt *Belokamenka*, former *Berge Pioneer*, was established in 2004. Rosneft chartered the tanker from the Norwegian Bergesen for 20 years to optimise the route for delivering crude from Timano-Pechora via Talagi and FSO *Belokamenka* for export. RPK-3 has received crude from the Ob Bay, Varandey and Talagi terminals. With a projected capacity of 10 million tonnes, it offloaded as much as 7.9 million tonnes of crude in 2009, mainly delivered from Varandey. Since January 2014, Varandey cargo has been bypassing FSO *Belokamenka*, going further west for STS transhipment in the Norwegian Barents Sea. Now, Varandey oil is handled by Norterminal, a company of Stolt-Nielsen, currently running STS terminal in Bøkfjord and building a new terminal near Kirkenes in North Norway. In the future, FSO *Belokamenka* can be used for transhipment of Prirazlomnoye crude oil.

There are plans to construct oil terminals on the western coast of the Kola Bay capable of receiving tankers up to 300 000 dwt and having annual overall offloading capacity of 30 million tonnes, within an ambitious Murmansk multi-modal port complex project. New oil terminals have also been planned in the Pechenga Bay, close to the border with Norway, with port facilities and railway connection development, as well as installing FSO offshore. While these transhipment capacities are projected, other capacities are also available.

Since 2002, offshore oil transhipment terminals have been established in North Norway to tranship Russian export petroleum cargoes. In May 2002, ShipCargo ran STS operations in Bøkfjord near Kirkenes, transhipping crude from three 15 000 dwt Arctic tankers of LUKOIL to the Greek vessel *Shinoussa*. In winter 2005-2006, Kirkenes Transit arranged STS operations in Bøkfjord, transhipping NOVATEK's gas condensate that had been delivered from Vitino in the White Sea. In 2006, Tschudi Arctic Shipping, formerly Kirkenes Transit, moved its STS terminal from Bøkfjord to Sarnesfjord near the North Cape, as ordered by the Norwegian pollution control authorities, and transhipped around 500 thousand tonnes of gas condensate per year until 2010. In 2014, crude oil from the Varandey terminal was sent for transhipment at STS terminals in Northern Norway instead of FSO *Belokamenka* in the Kola Bay. Initially, STS operations were handled at the Tschudi Arctic Shipping STS terminal in Honningsvåg in Sarnesfjord, and then moved to the Norterminal STS location in Bøkfjord near Kirkenes. Offshore operations will continue in Bøkfjord until Norterminal of Stolt-Nielsen opens a new oil terminal near Kirkenes. Norterminal has launched a project for construction of an onshore oil depot and port facilities in the Kirkenes area, capable of receiving 300 000 dwt tankers and with annual offloading capacity of 10 to 20 million tonnes. The terminal is to receive cargo from the Russian Arctic terminals and is intended to serve new oil production projects in the region that will come following development of Prirazlomnoye in the Russian sector and Goliat in the Norwegian sector of the Barents Sea.

OIL SPILL RESPONSE SYSTEM IN THE RUSSIAN ARCTIC

Industrial developments in the North and shipping along the Arctic coast increase the risks of oil spills in the region (AMAP/CAFF/SDWG 2013; Bambulyak et al. 2014). In the course of the past 15 years, the Russian system for oil pollution prevention in the Arctic has undergone several changes, including the approval of new laws and regulations, organisational reforms, as well as technological improvements (Bambulyak et al. forthcoming). All terminal operators are required to have contingency plans. In addition, they are expected to establish systems for environmental monitoring (including oil-spill detection and early warning) and communications, as well as having financial provision for covering oil-spill response (OSR) costs, including compensation for environmental damage. An important legal requirement is that operators are to establish OSR teams or hire professional ones. Initially, there was some market competition for OSR services at sea between public and private providers (see Ivanova and Sydnes 2010), but today the state unit under the Ministry of Transport is in charge of oil pollution prevention and clean-up activities at most export terminals operating in the Russian Arctic (Ivanova and Sydnes 2010; Bambulyak et al. forthcoming).

The Northern Branch of the Marine Rescue Service (MRS) under the Russian Ministry of Transport is responsible for implementing the state oil-spill contingency plan for the Western sector of the Russian Arctic. It also provides OSR services for all offshore and coastal oil offloading terminals operating in the Kola Bay of the Barents Sea, as well as in Vitino and Talagi in the White Sea, and at Varandey in the Pechora Sea, the latter in cooperation with the private company ArktikSpetsServis (Bambulyak et al. forthcoming). The Northern Branch of MRS has also been assigned responsibility for OSR in connection with the exploration drilling in the Kara Sea conducted by Rosneft and ExxonMobil in 2014. The headquarters of the Northern Branch of MRS as well as most of OSR equipment are located in Murmansk, while the area of state responsibility extends from the border to Norway in the Barents Sea in the west to 125°E in the Laptev Sea in the east (Bambulyak et al. 2014). Due to the distances in the Russian Arctic, the OSR system relies on a fleet of equipped vessels for effective response. During the NSR navigation season, the OSR equipment and response teams are placed on two icebreakers working within the NSR area. These icebreakers also serve as OSR headquarters for the eastern sector of the Russian Arctic (Korenev 2014).

Initiatives taken during the past decade have involved strengthening the legislative framework, improving organisational capabilities, and capacity building. This has put the state in a stronger position to regulate commercial activities. Furthermore, the federal level has assumed main responsibility for developing the OSR system. All the same, we estimate that given the enormous distances involved, the available resources appear insufficient for adequate and rapid response to emerging threats and risks in large parts of the Arctic region.

DISCUSSION AND CONCLUSIONS

In the early 2000s, there was a rapid increase of petroleum shipments from the Russian North. This has been followed by the development of onshore and offshore terminals along the Arctic coast. Since 2006, cargo flow has been between 9 to 15 million tonnes per year. This might lead one to assume that the existing Russian Arctic shipping system had stabilised close to its capacity limit. However, there have been many dynamic changes within those 9–15 million tonnes shipped for export, in terms of cargo type, sources, logistics and transportation schemes. Utilisation of the aggregate capacity of the terminals was below 50%, as shown in the sections above. In the course of the past 15 years, the Russian Arctic shipping system has been affected more by external economic and political factors, such as the development of routes through the Baltic and Okhotsk Seas, than by any natural or technological challenges in shipping petroleum through the Barents Sea.

The experiences at Vitino and Varandey have shown that oil terminals can operate all year round in Russian Arctic waters with ice presence. These two terminals have shipped between 6 and 8 million tonnes per year each and volumes could be increased if there is demand.

Russian petroleum and transportation companies have been using local pipelines, inland waterways and railroads to bring oil and gas cargoes to the Arctic sea coast. As yet, Prirazlomnaya is the only oil production platform operating offshore in the Russian Arctic. In terms of logistic solutions, routes can be grouped by the transport schemes employed: whether river tankers, railways or local pipelines are used. We can also group terminals by those established in ice-covered waters, i.e. in the White, Pechora and Kara Seas, and operating throughout the year or during ice-free periods only. Although Vitino had all-year operations, it employed different logistics for summer and winter navigation: feeding up to 80 000 dwt carrier tankers in summer, and using 20 000 dwt ice-class shuttle tankers, ice-breaking assistance and cargo transhipment in ice-free waters of the Barents Sea during the winter.

Each terminal presented in the sections above has a specific history and has contributed valuable experience for Arctic shipping. As a general trend, logistic schemes have been optimised and, to some extent, monopolised by big actors like Gazprom, Rosneft, LUKOIL, NOVATEK and Sovcomflot. Smaller companies have had to adapt and diversify their operations. The same trend is seen in oil and gas production in the Arctic. Regarding OSR at sea, everything has now been placed under control of the state Marine Rescue Service, *de jure* and *de facto* (Bambulyak et al. forthcoming).

Forecasts for Russian Arctic oil and gas production and shipping have varied. The more pragmatic ones estimate that about 60 million tonnes of petroleum cargo can be shipped from the Kara and Pechora Sea regions by the year 2020 (Bogoyavlensky 2013; Grigoriev 2014). Shtokman in the Barents Sea with the LNG in Teriberka will not start feeding gas carriers within the next decade. However, when the project is realised, it may add 15 million tonnes to the annual Russian Arctic petroleum cargo flow (Bambulyak and Frantzen 2011). The Arctic shipping route appears optimal for delivering oil and gas produced in the northern areas of Timano-Pechora and the West Siberian provinces to European or Asian markets (Rautio and Bambulyak 2012; Grigoriev 2014). As for natural gas, trunk pipelines are the only transport alternative to LNG, but fairly feasible alternatives like Gazprom’s pipeline system have already reached Bovanenkovo in the Yamal Peninsula.

There are various options for transporting oil. It can be offloaded to sea tankers from offshore production platforms, delivered by pipeline or railway over long distances. With existing and planned infrastructure, there are several possibilities for bringing oil to the north and shipping it for export along the Arctic coast. Offshore terminals in the Kara and Pechora Seas, i.e. Novy Port, Prirazlomnaya and Varandey, will increase their turnover with oil production development in the related fields. While the first two have been constructed to offload crude oil produced at the immediately adjacent fields, Varandey is already connected by local pipelines to several onshore fields in the north of Timano-Pechora and will be able to serve offshore fields to be developed in the area. All oil produced in the Kara and Barents (Pechora) Seas, offshore and close to shore areas, some 20–30 million tonnes, can be expected to be shipped for export along the Arctic coast with or without transhipment in ice-free areas of the Barents Sea. Once on-stream, Yamal and Pechora LNGs can offload 20–25 million tonnes of LNG and gas condensate. Port oil terminals along the coasts of the White Sea and the Barents Sea connected with the public railway grid now have overall capacity of 25 million tonnes that can be utilised and doubled or tripled after announced infrastructure development projects have been implemented. Those rail–sea terminals can handle petroleum products delivered from Western Siberia or European Russia, if export routes are to be diversified.

The main direction for the Russian Arctic oil shipping has been westwards, and will remain so. Cargo flows eastwards via the NSR can be increased significantly, but there are limitations. We estimate that petroleum cargo flows will not exceed 5 million tonnes per year with the use of current logistic schemes involving convoys under atomic icebreaker pilotage.

In a ten-year perspective, we can expect 25 million tonnes of crude oil plus up to 20 million tonnes of LNG and gas condensate to be shipped for export from the Russia's northern petroleum regions. If port facilities along the western Arctic coast are utilised and developed, they can add up to 50 million tonnes of petroleum cargo annually. An important challenge with these developments will be to provide an adequate OSR system for the Arctic.

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