INTERESTS OF SWITZERLAND IN THE ARCTIC

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The article studies the main interests of Switzerland in the Arctic. In 2017 Switzerland obtained the official status of observer to the Arctic Council and in recent years has been active in enhancing scientific cooperation with the Arctic states. The author analyses the reasons for the Swiss interest to the Arctic region, the work of the key institutions responsible for the arctic issues and gives his view on future cooperation between Switzerland and Russian in the Arctic.

Keywords: geopolitics, Switzerland, Russia, international relations, the Arctic region, the Arctic Council

In May 2017, Switzerland became another European country to get an observer status in the Arctic council. Unlike countries with a long history of affiliation to Arctic affairs such as France, Germany and United Kingdom, Switzerland is a new player in the region. However, in recent years the Swiss Confederation has begun to give a high priority to the arctic policy and establish dynamic cooperation with the arctic states.

The Swiss government explains country's interest to the Far North by pointing to the problem of ice melting [1]. Indeed Switzerland scientists made a large contribution to the studying of climate change in the Arctic. Swiss state officials usually present their country as a "Vertical Arctic Nation", referring to the similarities between alpine high-altitude zones and the climate of the polar region. In particular, the Ambassador of the Swiss Confederation in Russia, Yves Rossier [2], declared this.

One of the main reasons of Swiss activity in the Arctic is of economic nature. The scientific research conducted there provides data needed for better understanding the processes taking place in the Alps. Due to changes in climate the period of snow cover in the Swiss mountains is currently about 40% shorter than 50 years ago [3]. As a result, the tourist season in national ski resorts has been noticeably reduced, which leads to a decrease in financial revenues to the state budget. The Swiss believe that climate changes in the Alps and the melting of Arctic ice are interrelated and have the same origin.

Securing the status of an observer in the Arctic Council, Switzerland emphasized its scientific achievements. As the Swiss delegates noticed at 2016 Arctic Circle international conference, Switzerland engaged in polar research before it became a common academic practice. The best example is scientific expeditions to Greenland in 1909 and 1912-1913. Greenland remains a priority area for the Swiss researchers to this day. Recent studies focus on the impact of the island's ice erosion on the local environment [4].

The leading role of promotion of the state interests in the Arctic belongs to the Swiss Polar Institute. The Institute was established in 2016 on the basis of Swiss Federal Institute of Technology in Lausanne. The Institute is the facilitator between state authorities and research institutions of Switzerland. The financial sponsor of the Institute is the Paulsen Publishing House, which promotes the topic of Arctic and Antarctic development among the Swiss society. The institute is officially supported by the State Secretariat for Education, Research and Innovation, which operates within the Federal Department of Economic Affairs, Education and Research [5]. Besides the Swiss Polar Institute, several other institutes conduct arctic research projects in Switzerland, for example, the WSL Institute for Snow and Avalanche Research SLF in Davos, the Paul Scherrer Institute, Swiss Federal Institute of Technology in Zurich, Swiss Federal Institute of Technology in Lausanne, Universities of Zurich, Bern, Geneva, etc.

Switzerland actively establishes contacts with the Arctic countries and engages them to collaboration in its research projects. For example, 2016 Swiss international scientific expedition to the Antarctic was carried out on the Russian vessel "Akademik Treshnikov" [6]. In July 2017, experts from Switzerland and Russia conducted joint research in the Arctic territories of the Russian Federation [7]. Currently Swiss scientists are planning to use Russian ships in several future arctic expeditions. It is important to mention that Russian Honorary Consul in Lausanne, a citizen of Sweden F. Paulsen makes a huge contribution into developing contacts between Swiss scientists and academic communities of the arctic states. In 2007 Paulsen partially financed the Russian Arctic-2007 expedition, during which the titanium flag of Russia was set at the bottom of the North Pole. He is also a founder of the Russian branch of the Paulsen publishing house, which co-finances the Swiss Polar Institute.

It is clear that Switzerland uses science as a diplomatic tool in Arctic affairs. Largely becoming an observer in the Arctic Council in 2017 is a merit of Swiss accomplishments in the Arctic research and the establishment of the Swiss Polar Institute. Being a member of the most influential international organization in the region gives multiple advantages to the Swiss. Even the observer status in the Arctic Council boosts pursuing of the national interest of Switzerland in the Arctic. Furthermore, as Switzerland aspires to maintain a neutral status and the role of a reliable international mediator, the Arctic Council is an ideal platform for that. The organization protocol provides for the adoption of any decision by consensus. In the context of general growth of tensions in international relations, the ability to consolidate the arctic states is very positive for the organization. In this regard, Switzerland has a rich historical experience of maintaining pragmatism and coordinating the interests of various confessional, linguistic and ethnic groups within the country.

The fact that Russia is one of Switzerland's main partners in the Arctic research projects could become the basis for mutually beneficial cooperation. Switzerland could be Russia's ally in different areas, first of all, in the field of environmental protection. Traditionally Switzerland tends to operate an independent foreign policy (Switzerland is neither member of the European Union nor participant of the European Economic Area) and supports the decisions that respond to interests of most of the parts concerned.

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GEOPOLITICAL ASPECTS OF NATIONAL METEOROLOGICAL OBSERVATIONS SYSTEM REBUILD IN THE ARCTIC REGION

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The article analyzes the existing system of meteorological observations on the territory of the Russian Arctic. The two-fold reduction in the number of weather stations during the economic recession of the 1990s. negatively affected the forecasts quality. Northern Sea Route and extractive sectors security requires up-to-date weather forecasts ice data. The author concludes that the existing system of meteorological observations is dependent on data coming from foreign states and requires the equipment of modern devices for obtaining primary information.

Keywords: Arctic region, forecasting, meteorology, Northern Sea Route

The climate change in the Arctic has opened new opportunities for economic activity in the region. The shrinking of the sea ice allows to increase freight traffic along the Northern Sea Route (NSR) and develop new hydrocarbon fields. At the same time, the new economic reality in the Arctic creates an urgent need to modernize the system of hydro and meteorological observations.

The soviet system of meteorological observation in the Arctic was heavily damaged during 1990-s. The number of meteorological stations was reduced more than twice, which led to incomplete primary data collecting. As a result, the accuracy of meteorological forecasts declined as well as forecasting in general had become ineffective. Russian hydrometeorological services became dependent on data provided by foreign research centers (European Center for Medium-Range Forecasts, The Met Office, etc.) and satellites.

Today, at least 20 civilian meteorological satellites simultaneously monitor the Earth's polar caps. They are US spacecrafts NOAA-16, NOAA-17, NOAA-18. NOAA-19, Terra, Aqua, Aura, Coriolis, Calipso, CloudSat, Canadian Radarsat-2, European Parasol and Metop-A, Chinese Fengyun-1D, Fengyun-3A, Korean COMS-1 and Russian Meteor-M. In accordance with the decision of the World Meteorological Organization (WMO), space satellites transmit the received data in open mode. Thus, commercial and military vessels receive data on ice movement in the Arctic from

Norwegian satellite operator KSAT [1].

Today Russia is working on its own space-based hydro-meteorological monitoring system "Arktika". The spacecrafts will carry out wide range of meteorology, hydrology, agrometeorology, climate monitoring and the environment tasks in the Arctic region. According to Roskosmos, the first launch of the devices of the "Arktika" system is scheduled for 2019 [2].

The current system of primary data collecting in the Russian Arctic consists of a network of hydrometeorological stations and drifting stations, three observatories, three scientific vessels and the research base of the Arctic and Antarctic Research Institute (AARI). Available technical equipment allows providing medium-term forecasts with 70-71% accuracy.

Approved by the Government of the Russian Federation "Strategy of Activities in the Field of Hydrometeorology and in the Adjacent Fields for the Period up to 2030" is aimed at increasing the number of meteorological stations. The document pays special attention to the development of hydrometeorological and heliogeophysical services for the Russian activities in the Arctic.

It is planned to restore the number of hydrometeorological and heliogeophysical observatory stations to the minimum necessary level. This will increase the accuracy of short-term weather forecasts and minimize the consequences of hydrometeorological hazards. Moreover, according to the strategy, automatic meteorological stations will be installed in remote high-altitude areas. Traditional man-operated stations will be equipped with automated meteorological complexes as well. General modernization and updating of technical basis is in plan [3].

As a means to secure national interests of the Russian Federation in high-altitude and polar regions, the Strategy suggests designing and building an ice-class research vessel fitted with modern equipment for oceanographic, geochemical, ice, meteorological and geophysical observations.

The restoration of the system of meteorological observations in Russia takes place not solely within the framework of state programs, but also at the initiative of private companies. For example, in 2015 Rosneft Oil Company announced the installation of an automatic meteorological station on Wrangel Island. Earlier, the company's specialists opened six stations in the seas of the Arctic Ocean. The data collected there is used not only in the extractive activities of Rosneft, but also in climate research programs in the Arctic [4].

Russia takes the eighth-ninth place in the world in terms of the accuracy of weather forecasts based on the data from space satellites and ground-based meteorological stations. Meanwhile, the ice maps and layer-by-

navigation, they are edited in accordance with the data from the stations of The Federal Service for Hydrometeorology and Environmental Monitoring of Russia (Roshydromet) and analyzed by scientist.

Along with greater economic opportunities shifting climate conditions in the Arctic created new challenges for meteorological services. To make the Northern Sea Route safe and operational it is very important to provide it with precise information on ice masses conditions, natural hazards movement, the

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layer atmospheric models are based on the images from Canadian, European and even Japanese satellites. Before the purchased images are used in

pollution of the Arctic seas, etc. The solution of this problem is impossible without primary data collected by hydrological buoys, research vessels, underwater vehicles and meteorological drones. Setting up a unified system for collecting, analyzing and transmitting meteorological data to oil and gas operators, shipbuilders, shipowners, shippers is an essential component of a safe and effective development of the Arctic region.

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ENVIRONMENTAL PROBLEMS OF OPERATION OF FLOATING NUCLEAR POWER PLANT IN THE ARCTIC REGION

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The article is devoted to the analysis of environmental consequences of the impact on the environment of floating nuclear power plant, which is being built in Pevek, Chukotka Autonomous district. A brief technical description of the station is given, the history of the development of this project abroad and in Russia is considered. It is concluded that in the process of operation of floating nuclear thermal power plant of the territory and the water area included in its zone of influence, will experience radiation, thermal and mechanical effects, which will negatively affect the sensitive Arctic ecosystems.

Keywords: Floating nuclear power plant, floating power unit, nuclear energy, Arctic region, environment

Introduction

On the Russian arctic coast near the city of Pevek of the Chukotka Autonomous Region, a floating nuclear power plant (FNPP) is currently being built. Its purpose is to provide coastal civil areas and factories with energy and heat. After the FNPP is finished it will completely replace the Chaunskaya power station and the Bilibino nuclear power plant which have been operating since 1944 and 1974 respectively [1]. The construction of the onshore facilities started in Pevek in the fall of 2016.

The FNPP is a Russian collaborative project developed by the state-owned Atomic Energy Corporation Rosatom, the Baltic Shipyard Ltd., “Malaya Energetika” JSC, “Iceberg” Central Design Bureau and other organizations.

The FNPP structure includes a Floating Power Unit (FPU), hydrotechnical and onshore facilities. The basic element of the station is a flat-bottomed non-self-propelled vessel that houses heat and power generating equipment. The FPU is constructed separately at the shipyard and delivered to the location by sea in a finished form.

The FPU has a displacement 21.5 thousand tons. Its length - 140 m, width - 30 m, draught - 5.56 m, drop-side height - 10 m, superstructure height - about 30 m. The crew - 70 people, working three watches. The Crew includes administration, technical staff, security and coastal service.

The power unit houses two KLT-40S nuclear reactors which prototype are the reactors installed on the atomic icebreakers “Taimyr” and “Vaigach” and the lighter aboard ship "Sevmorput". Together these reactors are capable of providing up to 70 MW of electricity or 50 Gcal/h of heat. The body of the FPU also houses repositories of fresh and spent fuel and solid and liquid radioactive waste, an automatic control system, general ship systems, residential and office space [2]. There are no analogues of vessels fitted with such a large number of potentially dangerous equipment and materials.

The commissioning of hydrotechnical structures and coastal infrastructure in the area of Pevek is scheduled on August 2019. The FNPP will become operational in December 2019.

The construction of the FPU "Akademik Lomonosov" began at JSC "Sevmash" in the city of Severodvinsk on April 15, 2007. In 2008, the FPU project was transferred to the Baltic Shipyard Ltd. in St. Petersburg.

The FNPP project implementation was accompanied by series of legal proceedings, bankruptcies, disputes of right owners and regular delays. Today, the project is behind its own schedule for a decade, its budget is exceeded by millions of dollars. However, the project is moving towards its completion [3].

At the end of April 2018 The FPU "Akademik Lomonosov" was towed to the city of Murmansk, where in the fall of 2018 the reactor will be loaded with nuclear fuel and put into operation. In June-July 2019, the FPU will be transported to the work site via the Northern Sea Route and connected to the coastal infrastructure at the port of Pevek. Rosenergoatom believes that transportation will be possible without the intervention of icebreakers [4].

According to Rosatom the FNPP is a new generation energy provider being constructed on the base of Russian nuclear shipbuilding technologies. It will be a reliable year-round energy supplier for industrial and civil facilities as well as infrastructure in remote regions of the Arctic and the Russian Far East, the country's fuel-deficient and extremely harsh climate regions [5].

Key project objectives are:

- total restructuring of energy production on the basis of floating nuclear power plants;
- rapid and sustainable industrial and socio-economic development of remote areas of the Arctic and the Far East - regions of Russia's strategic interests.

Floating power plants will allow to:

1. Renounce the importation of fossil fuels.
2. Create conditions for the development of industrial and infrastructural projects.

3. Boost exploitation of mineral deposits, including those on the shelf of the Arctic and Far Eastern seas.

4. Improve the living conditions of the population.

Rosatom is also considering the possibility of concluding contracts for the supply of floating nuclear power plants to a number of countries, such as the Republic of Cape Verde, China, Indonesia, India, Brazil, etc. The interest of the developing countries to the FNPP is due to its option to desalinate the seawater. One FNPP unit can produce from 40 to 240 thousand cubic meters of fresh water per day.

History of the FNPP construction

Richard Eckert, vice president of Public Service Electric & Gas, introduced the original idea of commercial use of floating nuclear power plants in 1969 in the US. In 1970, in attempt to put this idea to practice, Westinghouse and Newport News shipyard created the company Offshore Power Systems. They planned to build eight 1-1.2 thousand MW floating power plants for Public Service Electric & Gas and deploy them off the coast of the United States [6]. The next idea was to build artificial islands with two similar power units. The project, however, failed primarily due to financial problems at the Public Service Electric & Gas and incorrect marketing: they planned to supply floating nuclear power plants to heavily populated northeastern US states, where was no need in extra electricity production. In addition, the incident at the nuclear power plant “Three Mile Island” (March 28, 1979) had a very negative impact and literally stopped the development of nuclear power engineering in the United States. As a result, both orders (Atlantic 1 and Atlantic 2) were canceled and Westinghouse had to stop working on the project after investing in it $180 million.

Nonetheless, the United States became the first country to use a floating nuclear power unit. It was a mobile nuclear power plant operated in the Panama Canal area from 1968 to 1975. 10 MW light-water reactor was housed on a transport vessel Sturgis (type Liberty). Today this station is the only FNPP in the world that was in practical operation. However, the system wasn’t perfect: it had extremely expensive maintenance and high demands to personnel (due to its “non-seriality”) [7, 8].

In the USSR, the idea of using low-power nuclear power plants for electricity and heat supply of remote regions of the Far North and the Far East arose at dawn of domestic nuclear industry. The first example of a low power nuclear plant in the USSR was the 48 MW Bilibino NPP. It was built in 1974 in the village of Bilibino, in the permafrost, to provide energy to the developing mining industry in the Chaun-Bilibinsky district of the Chukotka Autonomous Region [9].

In the 1980s the series of large-scale feasibility studies in areas of the Russian North identified more than 80 locations suitable for the placement of small nuclear power plants. After more detailed studies, the number of potential sites was reduced to thirty-three, and they were submitted for approval to the USSR Council of Ministers. The Chernobyl accident on April 26, 1986 interrupted this process and postponed the development of low-power nuclear units in Russia for many years [10].

Today the need to develop remote regions with high economic potential brings back the idea of low-power nuclear plants in Russia. The increasing geopolitical influence and strengthening of the national security of Russia in the Arctic also contributes to this. One of the means of bringing the nuclear energy to these areas is the use of FNPPs.

One of the main arguments of Rosatom in favor of using nuclear power plants in these areas is higher economic efficiency compared to alternative power supply options. Diesel-fueled power plants – the primary source of energy in the remote regions – produce very expensive electricity primarily due to the difficulties of fuel delivery. Local prices of electricity exceeds those in the European part of Russia 10 or more times. That makes the placement of nuclear power facilities in remote regions very relevant. Low-power nuclear units will allow to replace the diesel-fueled power plants and significantly reduce the cost of electricity and heat [11].

Environmental and climactic conditions of the FNPP operation

Pevek is the northernmost city of Russia. It stands on the east coast of the strait of the same name, which connects the Chaun Bay and the East Siberian Sea, opposite the Routan Islands, in 640 km from Anadyr. The city is located beyond the Arctic Circle and belongs to the region of the marine climate of the Arctic zone [12]. This area is distinguished by long, frosty winters and a short (2-3 months) summers with low temperatures and frequent frosts even in the warmest periods (July - early August). The average annual temperature of Pevek is -10.4 °C. The transition of the average daily temperatures to positive figures usually occurs in the first decade of June. The average temperatures of the warmest month (July) do not exceed 7-8 °C in the Pevek region. In September, average daily temperatures become negative again. The coldest month with average temperatures of -22-32 °C is January, less often - February. The polar night lasts from November 27 to January 16 [13].

From the north, the Chaun region is washed by the East Siberian Sea (the Arctic Ocean basin). The distinguishing features of the northern seas of the Chukotka region are difficult ice conditions, storms, fogs, and strong flood currents. Most of the year the East Siberian Sea is covered with ice. Floating ice often remains near the coast, even in summer. The largest river of the Chaun region is the Chaun. It flows along the lowland of the same name into the Chaun Bay. The river length is 350 km. After spring floods the Chaun changes the direction of its riverbed [14].

The arctic tundra of the Chaun region is characterized by a poor supply of organic life and an extremely low increment of phytomass. Therefore, the vegetation cover is rare even in the flat areas and the spots of gravelly loam occupy large zones of the land. Permafrost soils, icing, etc. are highly common.

Periodically Pevek comes under the power of Yuzhak - a very strong gusty dry southern wind that falls on the city from the coastal hills. Before Yuzhak emerges, light cumulus clouds appear above the mountain peaks. The wind starts blowing abruptly, accompanied by snow whirls, with a sharp drop in atmospheric pressure. Within one hour, the wind speed can reach 40 m/s with gusts up to 60–80 m/s [15]. Yuzhak lasts from several days to two weeks. The city of Pevek was designed to confront this threat. The houses were built so that each city district had a shield building, blocking a strong airflow and protecting other constructions.

The FNPP occupies the coastal water area and part of the coast. The geological structure of the Pevek coastal area consists of permafrost soils containing ice within. Due to uneven distribution of the ground ice, the permafrost soils are extremely heterogeneous and variable. The permafrost zone has almost consistent distribution on land. Under the bottom of the seas, frozen soils are covered under fast ice, in the remaining areas they are preserved by small islands [16, 17].

Environmental and climactic conditions of the area around the city of Pevek are undoubtedly of paramount importance for ensuring the ecological safety of the FNPP operation in the region.

The FNPP impact on the environment

The first thing that troubles ecologists is the possible radiation effect from the FNPP caused by its usual operation as well as by miscalculations in the design or possible accidents, including when towing the FNPP to the operational area.

The FNPP constructors claim that their project fully complies with the requirements of the modern regulatory framework in terms of ensuring the safety of nuclear power plants and vessels with nuclear power reactors.

Preliminary expert estimates of the possible radiation impact of the FNPP on the environment revealed the following results.

In accordance with the requirements of the SP ATES [18], the power of γ-radiation on the exterior surface of the FPU will not exceed:

- on the surface of open deck in the zone of controlled access - 0.2 μSv/h;
- on the surface of open deck in the free mode zone - 0.1 μSv/h;
- on the board above the waterline - 0.2 μSv/h;
- on the board below the waterline and at the bottom - 2 μSv/h.

The maximum daily emission of the FPU ventilation system in normal operations of the reactor will be 0.01 mCi/day of argon-41.

The estimates of the average annual concentrations of argon-41 in in the surface layer of the atmosphere show that the maximum figures will be reached at a distance of 200-300 m from the FPU and will be about 1.2x10-2 Bq/m^3 [19].

According to calculations, γ-radiation doses from the ejection cloud at a distance of 200-500 m from the FPU will not exceed 20mSv and will decrease more than 10 times at a distance of 2-3 km.

Considering all obtained data, the possible radiation level hike in the intended FNPP operational area will be 0.002% of the natural dose there.

In the scenario of an accident with the worst radiological consequences the radiation exposure is determined by [20]:

- external γ-irradiation of the body due to the presence of radioactive products in the surface layer of air;
- external γ-irradiation due to exposure to radionuclides accumulated in the surface layer of the soil;
- internal irradiation of organs and tissues due to inhalation of radionuclides in the human body;
- internal irradiation of organs and tissues due to oral intake of radionuclides into the human body with contaminated food products of local production.

The biggest contributor into the organism irradiation is the γ-radiation of the radionuclides contained in the emission cloud (48-55%). On the second place is the irradiation due to radionuclides fallen on the terrain (from 23 to 28%). The third and fourth place is taken by the irradiation dose from inhalation of radioactive substances (6-16%) and from the intake of radionuclides with local food products (8-12%).

Analysis of γ-radiation from the emission cloud indicates that main sources of radioactive contamination will be Xenon-133, Xenon-135 and Krypton-85. Iodine-133 and Iodine-131 will contribute to the contamination in the form of radioactive fallout. Cesium-137 share in the contamination will be about 10%.

The conservative estimate of the radiation exposure in case of an accidental release reveals that the maximum concentrations of nuclides in the surface layer of the atmosphere will be a fraction of a percent of the tolerable level of contamination. Cesium-137 soil contamination will not exceed 5 MBq/km^2 and will not increase the background radiation level.

The irradiation of the population living in the area of the possible accident will be about 0.002% of annual atmospheric peak dose and about 0.05% of the soil background radiation level [21].

Preliminary conservative estimates data leads to the conclusion that the possible accident on the FPU does not go beyond the scope of the "incident" on the IAEA scale. According to international recommendations and national requirements, this class of accidents does not require conducting special protective procedures for the population and outside the territory of the source of radiation [19]. This circumstance makes it possible to limit the sanitary protection zone to the territory of the FNPP site with the water area at the FPU parking site.

Considering the above, we can make a preliminary conclusion that the radiative effect of the FNPP on a population is limited to its site, and even in case of accidents, including beyond design-basis accidents, no emergency measures to protect the population will be required.

The following malfunctions are considered as the initiating event for the beyond design-basis accidents [22]:

- cross section rupture of the coolant supply pipe;
- cross section rupture of the steam collector of the steam generator;
- rupture of the I-III circuits of the heat exchanger tube.

The automation failure of the localization valves is considered as the independent initial event.

In the worst scenario of a beyond design-basis accident γ-radiation doses will not exceed 0.5 mSv, which is far below the maximum tolerable radiation dose of 5 mSv.

The effective radiation dose of critical groups of the population from the radiation exposure will not exceed 0.15 mSv at all distances from the FPU.

In the event of an accident at the FNPP the ecological harm will be