Chapter 3

Russian Vision of the Problems and Prospects of the International Legal Framework in the Context of Small Modular Reactors and Transportable Nuclear Power Units

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Abstract Small modular reactors (SMRs) could be key to providing developing regions with clean and affordable (and cost-effective) electricity. Deployment of SMRs requires a transparent and balanced legal framework that will define the specifics and boundaries of shared responsibility between the host and supplier country, especially in the case of innovative floating SMR projects. Legal experience in nuclear-powered vessels and nuclear installations can be used in the development of regulatory approaches for floating SMRs. This chapter provides an analysis of the applicability of the existing international conventions, including the 1974 International Convention for the Safety of Life at Sea, the IAEA safeguards agreements, and civil liability instruments, to the floating SMRs. In addition, some considerations for the future development of the legal framework for floating SMRs are proposed.

Keywords Small Modular Reactors (SMR) · Floating power unit · 1974 International Convention for the Safety of Life at Sea (SOLAS) · IAEA safeguards · Civil liability · Reactor technology

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Fig. 3.1 The Akademik Lomonosov floating power unit at the site in Pevek. *Source* Rosatom 2019

3.1 Introduction

As environmental awareness grows, the challenges of decarbonizing and finding effective alternatives to meet the increasing need for energy become important. Achieving the Sustainable Development Goals (SDG) set forth by the United Nations (UN) in the 2030 Agenda for Sustainable Development¹ requires providing developing regions with clean and affordable (and cost-effective) electricity.

According to the IAEA report, *Advances in Small Modular Reactor Technology Developments*² there are more than 70 different onshore, offshore and submarine SMR projects worldwide. Among these 70 projects, 17 were developed by the Russian design companies. There is no common definition of SMR today, so for the purposes of this essay, SMR means a nuclear plant with a modular reactor of up to 300 MW(e).

Most existing SMR projects are based on mature and widely adopted PWR reactor technology. KLT-40S reactor, which relies on over 400 reactor-years of operating experience of this type of reactor on nuclear icebreakers, is no exception. KLT-40S is installed on the Akademik Lomonosov floating power unit (see Fig. 3.1), which was successfully put into commercial operation in 2020 and demonstrates high performance in the harsh conditions of the Russian North. Given the accumulated global experience in operating PWR reactors, as well as the experience of operating

¹UNGA 2015.

²IAEA 2020a.

icebreakers' reactor plants in the Arctic, we can say that from a technical and safety point of view, the Russian SMRs are ready for wide commercialization (Fig. 3.1).

Addressing the issue of cost-effectiveness opened a 'window of opportunities' for international cooperation in SMR projects and, at the same time, demonstrated that, in addition to mastering the technology and proving its economic attractiveness, effective implementation requires a transparent and balanced legal framework that will define the specifics and boundaries of shared responsibility between the host and supplier country, especially in case of innovative floating SMR projects. Due to its technological sophistication and long life cycles, the nuclear power industry should not be affected by momentary changes in the political environment, and this can only be achieved through clear and consistent legal regulation of international nuclear projects.

3.2 Regulatory Control Approaches for Floating SMRs

The cross-border life cycle of floating SMRs raises cross-border issues related to the division of responsibility among project stakeholders.

The first projects, where a nuclear facility is operated by an operating organization of one State, moves by sea, and can cross boundaries of other States, were implemented back in the 1950s and 1970s. The N.S. Savannah nuclear-powered liner (United States of America), the Otto Hahn nuclear-powered merchant ship (Germany), and the Mutsu nuclear-powered merchant ship (Japan) were self-propelled vessels powered by small-sized nuclear power plants. Also, the USSR implemented several nuclear-powered icebreaker projects, such as the Lenin, Arctic and Siberia. Based on the experience of implementing these unique projects, a special regulatory framework started to form at the international level. In particular, Chapter VIII devoted to nuclear-powered self-propelled ships was added in the 1974 International Convention for the Safety of Life at Sea (SOLAS Convention),³ and a draft of the 1962 International Convention on the Liability of Nuclear Ships' Operators was developed.

The experience of implementing these unique projects became the basis for a special international regulatory framework.

The legal and regulatory framework development stalled when nuclear-powered self-propelled vessel technology failed to achieve the required profitability indicators and was not in demand on the market. In particular, the 1962 Convention on the Liability of Operators of Nuclear Ships has not entered into force because no nuclear ship owner State has signed it.⁴ Today, the fleet of civil self-propelled nuclear ships operates exclusively in the Russian Arctic, providing piloting in challenging ice conditions and solving tasks in support of the Northern Sea Route development. The

³International Convention for the Safety of Life at Sea, opened for signature 1 November 1974, entered into force 25 May 1980 (SOLAS Convention).

⁴Convention on the Liability of Operators of Nuclear Ships, opened for signature 25 May 1962.

nuclear-powered icebreakers and Sevmorput nuclear-powered freighter comply with the requirements of the SOLAS Convention, and the requirements of the Russian national nuclear and maritime legislation; the safety of their operation is confirmed by the corresponding licences of Rostekhnadzor (the Russian Nuclear Regulator) and certificates of the Russian Maritime Register of Shipping (the Russian Maritime Regulator).

Legal experience in nuclear-powered vessels can be used in the development of regulatory approaches for floating SMRs. Of course, international documents, including the 1982 UN Convention on the Law of the Sea, were formed over half a century ago and do not contain specific rules for non-self-propelled vessels with nuclear power units, but they can be adapted for application. In particular, the 1981 Code of Safety for Nuclear Merchant Ships⁵ takes into account established and recognized principles of shipbuilding, marine and nuclear technology that existed when it was developed and is limited to types of ships propelled by nuclear power units. At the same time, Chapter I of the Code of Safety for Nuclear Merchant Ships provides for the need for its revision as technology advances.⁶

The SOLAS Convention is one of the key international instruments governing the safe operation of ships. To date, the SOLAS Convention requires clarification regarding its application to floating SMRs. Compliance with the SOLAS Convention requirements is necessary to promote enhanced protection of human life at sea. In this regard, the design and construction of the Akademik Lomonosov floating power unit, as well as the design of optimized floating power units, de facto respects all existing codes and requirements for ships, both national and international. The emerging certainty of the legal status of floating SMRs will reduce the influence of political factors in the implementation of international projects and make the regulation of their life cycle more predictable and well-ordered on a global scale.

At the next stage, as experience is gained in operating floating SMRs at the national level in supplier countries, it will be necessary to form internationally agreed criteria and requirements for the safety of non-self-propelled vessels with nuclear power units, which can be combined into a separate special code similar to the Code of Safety for Nuclear Merchant Ships.⁷ Such criteria will allow the developer and operating organization to form in advance the required amount of documentation to justify the operation, and stakeholders to objectively assess the safety of operation.

3.3 Licensing Specifics and Approaches of the SOLAS Convention

The specifics of the floating SMR life cycle prevent direct application of the procedures used in the conventional nuclear power industry.

⁵IMO 1981.

⁶SOLAS Convention, above n.3.

⁷IMO 1981.

It is usually required to obtain a construction licence from the national regulator of the host country, which then issues an operating licence. Floating SMRs are designed and constructed in the supplier country and should fully comply with the regulations of the supplier country. Once construction is complete, the regulator of the supplier country issues an operating licence, with transportation to the host country being one of the stages of the unit's operation. Since floating SMRs will also be operated in the host country, the conventional approach assumes that the regulator of the host country should also assess the floating SMR's compliance with national regulations. This procedure leads to another review of the same set of documentation by two national regulators. Besides, making changes to the design based on the comments of the host country's regulator is absolutely impossible for floating SMRs, since the construction, fuel loading, first criticality of the reactor, and its commissioning take place in the supplier country in accordance with its standards.

The procedures developed for nuclear vessels and enshrined in the SOLAS Convention contain prerequisites for an optimized approach to licensing floating SMRs. In accordance with the SOLAS Convention, the design, construction, and inspection standards for the manufacture and installation of a reactor plant should meet the requirements of and be approved by the flag country of the nuclear vessel. Based on the Safety Analysis Report (SAR), the operating organization prepares and approves with the flag country a Safety Information document to confirm that the plant is free from excessive radiation or other nuclear hazard.

Safety Information is provided well in advance to the governments of the countries crossed by the nuclear vessel or hosting it.

Applying the principles set forth in the SOLAS Convention to floating nuclear power units with nuclear installations will prevent dual licensing when meeting safety requirements, where the regulator of the host country can be involved in reviewing the vessel's Safety Information to make an informed decision on whether a floating power unit can be operated in the host country. For effective implementation, this procedure can be detailed within an intergovernmental agreement between the supplier and the host country.

3.4 Legal Support for Floating SMR Transportation

The transportation stage, where the floating SMR is moved with the reactor plant loaded with fuel and in a shutdown state, is a novel stage of the floating SMR life cycle and one of the most complicated in terms of legal support. The floating SMR can be transported either by under tow or on board of a special dock ship. Akademik Lomonosov was moved from St. Petersburg to Murmansk under tow, but this method is quite sophisticated for moving over long distances, since it requires the formation of a tow order, calm weather and consideration of other variable factors.

Moving on a dock ship seems to be a more efficient way to transport over long distances, because the self-propelled dock ship is more resistant to weather changes. Transportation by dock ships is a common practice when transporting such complex

engineering facilities as offshore oil rigs. There is also a vast experience in using dock ships to transport nuclear facilities.

The dock ship transportation option is close to maritime nuclear fuel transport, but the requirements applicable to nuclear fuel transport casks cannot be directly applied to floating SMRs. As a ship, a floating SMR can be categorized as a means of transport with nuclear material being an integral part of the nuclear power plant, as opposed to a nuclear material carrier ship, where a cask is cargo on the ship and easily removed by altering the vessel.

International legal regulation in force does not prohibit the maritime transport of a floating SMR loaded with nuclear fuel on board another ship, but there are no special rules for such transport. A floating SMR can be transported on a dock ship as a cargo. In accordance with the 1982 UN Convention on the Law of the Sea,⁸ a ship carrying a floating SMR enjoys the right of freedom of navigation in the high seas and exclusive economic zones, as well as the right of innocent passage through the territorial sea of third countries.

However, even with regard to nuclear material transportation covered by an elaborate legal framework, there have been precedents in international practice when certain countries expressed their discontent with the transit of dangerous cargo through their exclusive economic zone.

This practice demonstrates the dependence of nuclear energy decisions on political factors and public opinion, and stresses the importance of the IAEA's awareness raising activities regarding a safe transport of nuclear materials. As the knowledge and experience of accident-free operation are accumulated, this dependence can be reduced in future.

For now, the regulatory framework is quite sufficient for the implementation of pilot projects. At the same time, individual procedures may be specified within the framework of special agreements.

3.5 IAEA Safeguards

One of the main features of floating SMRs is their transportation between different States during their life cycle. Nuclear material is subject to safeguards agreement between the supplier State and the IAEA until the liability is transferred, and not later than the arrival of the SMR in the host country. From then on, nuclear material will be subject to the host country's agreement with the IAEA and, therefore, the host country is responsible for accounting, monitoring, reporting and granting access to nuclear material to IAEA inspectors.

It should be noted that safeguards requirements are essentially different in non-nuclear weapon States with comprehensive safeguards agreements⁹ and in nuclear

⁸United Nations Convention on the Law of the Sea, opened for signature 10 December 1982, entered into force 16 November 1994 (UNCLOS).

⁹IAEA 1972.

weapon States with voluntary offer safeguards agreements.¹⁰ Unlike the non-nuclear weapon States, there is no obligation for nuclear weapon States to provide the IAEA with facility design information or to provide the IAEA inspectors access to the SMR fuel for verification prior to shipment.

Thus, the application of IAEA safeguards will require new legal and technical solutions. Under the Safeguards Member State Support Programme, the IAEA and the Russian Federation cooperate to develop approaches in implementing IAEA safeguards to floating nuclear power units designed in the Russian Federation taking into account the safeguards by design concept.

3.6 Floating SMRs and Civil Liability for Nuclear Damage

The 1963 Vienna Convention on Civil Liability for Nuclear Damage (Vienna Convention),¹¹ the 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy (Paris Convention),¹² and the 1997 Convention on Supplementary Compensation (CSC)¹³ contain rules that exempt nuclear reactors on ships, whether the reactor is used to propel the ship or for any other purpose. According to findings of the IAEA International Expert Group on Nuclear Liability (INLEX), an advisory body to the IAEA Director General, the exemption should not apply to floating SMRs. The updated Comments on the Vienna Convention as in force in 1997 and the CSC published by the IAEA in 2020¹⁴ note that a transported nuclear power plant in a fixed position (in particular, for a floating reactor plant, this means anchored or moored to shore and connected to shore by power cables) would be qualified as a ‘nuclear facility’ and thus would be subject to the civil liability for nuclear damage. In this case, the State in which the reactor is operated (including territorial waters) will be the “State responsible for the plant”.

Based on INLEX’s position on the shared liability for nuclear damage when moving floating SMRs, it should be taken into account that the transportation of this facility would be considered to be the transportation of nuclear material under the Vienna Convention.

Thus, the Vienna Convention currently provides the most transparent scenario in terms of the implementation of floating SMR projects. Without prejudice to the provisions of the Vienna Convention with respect to its members, issues of civil liability for nuclear damage may be settled in an intergovernmental agreement between the

¹⁰ As an example, see IAEA 1985.

¹¹ Vienna Convention on Civil Liability for Nuclear Damage, opened for signature 21 May 1963, entered into force 12 November 1977 (Vienna Convention).

¹² Convention on Third Party Liability in the Field of Nuclear Energy, opened for signature 29 July 1960, entered into force 1 April 1968 (Paris Convention).

¹³ Convention on Supplementary Compensation for Nuclear Damage, opened for signature 29 September 1997, entered into force 15 April 2015 (CSC).

¹⁴ IAEA 2020b.

supplier country and the host country and, if necessary, in agreements with transit countries.

Most member countries listen to the INLEX position. Expert consensus at the international level is encouragingly positive in terms of the prospects for the implementation of pilot floating SMR projects and shows interest in such projects at the international level. Using similar approaches in respect of the Paris Convention could consolidate the established approach and facilitate the development of floating SMR projects.

3.7 IAEA Initiatives for the Study of Legal Support of Floating SMRs

Understanding the urgency of the task to form common approaches to the legal and regulatory framework of floating SMRs, the IAEA proposed the issues of floating SMR life cycle regulation for discussion by the expert community in the framework of various projects, in addition to the INLEX platform. Among other things, the IAEA, under the coordination of the Nuclear Energy Department, is implementing a pan-agency SMR project to comprehensively address issues arising from the use of this technology. Furthermore, a standing SMR group also exists to study these issues.

In particular, the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) has been analyzing the legal and institutional aspects of implementing transportable onshore, offshore and submarine SMR projects since 2011. Based on the first phase results, *Legal and Institutional Issues of Transportable Nuclear Power Plants: A Preliminary Study* report was issued in 2013, which provides an upper-level, multidimensional analysis of the implementation of transportable SMR projects. Currently, the second phase of this work is being completed, which involved experts from the United States of America, France, Canada, the Russian Federation, Finland, Armenia, Romania and Indonesia. The *Case Study for the Deployment of a Factory Fuelled SMR* report is scheduled for publication in 2022. The importance of the second project phase is that the issues of life cycle implementation are addressed systematically, not separately, with regard to their mutual influence.

In the absence of practical experience in the implementation of cross-border SMR-based projects, the work to comprehend the issues to be solved by the countries involved in the project seems relevant. At the same time, the real project may differ significantly from the theoretical one, and further development of the legal framework for SMR projects will be based on the experience gained during the implementation of pilot projects. The best practices of implemented projects and commissioning of SMRs in different designs will serve as a basis for establishing the legal and regulatory framework for SMRs, including for floating nuclear power units.

During 2021, conceptual approaches to nuclear and radiation safety requirements for transporting SMRs of various designs have been discussed at multiple IAEA sites. An ad hoc Working Group within the IAEA's Committee on Safety Standards for the Transport of Radioactive Materials is being established. The Working Group will examine the relationship between IAEA documents, in particular the Regulations for the Safe Transport of Radioactive Material,¹⁵ and existing maritime law documents, with the involvement of the International Maritime Organization. The experts involved in this work should rely on cross-sectoral approaches to integrate maritime and nuclear law to find common ground for an effective cooperation.

3.8 Conclusion

Historically, legal frameworks are time-lagged in relation to innovative technologies, where sometimes the lag can persist for decades. For SMR deployment to be possible, the time lag between the formation of the legal framework and the development and deployment of technology should be reduced. The pace and intensity of work with the international legal and regulatory framework should be increased.

The COVID-19 situation has shown that a steady supply of electricity plays an important role to prevent diseases, from providing medical facilities with electricity and clean water to ensure the necessary hygiene to providing communications and information technology services. The development of SMR in this case had never been more relevant.

The international legal framework currently does not prohibit innovative SMR projects. At the same time, the lack of international experience in the implementation of transportable SMR projects makes it impossible to create a detailed legal and regulatory framework, which is now in place for conventional high-power NPPs. In this regard, pilot projects will require basic agreements and changes to key conventions that will extend to floating SMRs those requirements, rules and procedures that are already in place to ensure safety. Detailed elaboration is possible within the framework of intergovernmental agreements, which will take into account the specifics of unique pilot projects. The best practices will form the basis of the legal and regulatory framework for SMRs in the next stages of project development.

The IAEA's initiative of the first nuclear law conference is extremely timely. The IAEA conference can serve as a platform to share experience and opinions to identify current challenges in the development of innovative energy sources. It is important that the conference results be reflected in a practical action plan for the necessary areas of international cooperation. ROSATOM, with all of its experience in nuclear power, is ready to further work on updating international codes to ensure the stable implementation of SMR projects.

¹⁵IAEA 2018.

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