Ensuring nuclear safety of nuclear floating power units from the point of view of the maritime law

Sirotkina D.S.
Brykalov S.M., Salnikova N.A., Baklanov A.V., Malev V.V.
Afrikantov OKBM JSC

21st INPRO Dialogue Forum on the Deployment of Small Modular Reactor Projects and Technologies to Support the Sustainable Development Goals (SMRs for SDGs)
2023

Introduction

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In the context of worsening energy problems, accelerating scientific and technological progress and the emergence of a new technological structure, the use of progressive developments in the field of energy supply is of great importance.

The global trend for decarbonization and the need to solve modern problems in the energy sector led to the intensive development of innovative technologies in the nuclear sphere, including small modular reactors (SMR), low-power nuclear power plants and nuclear floating power units (FPUs) based on SMRs.

In regard to the size, mobility, the ability to minimize of CO2 emissions and other advantages, Russian FNPU projects based on RITM series reactor units are able to provide consumers with safe and efficient electricity, while minimally affecting the environment.

The goal of the study is to consider approaches to approving safety of nuclear floating power units from the point of view of the maritime law

Objectives:

- Present the current status of development of nuclear floating power units designed by Russia
- Analyze the classification of nuclear floating power units within the framework of the maritime law
- Determine approaches to approving safety of nuclear floating power units in operation from the point of view of the maritime law

Small modular reactors in ARIS data base

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THERE ARE APPROXIMATELY **50** DESIGNS OF SMALL MODULAR REACTORS.

IT IS ~ **2/3** OF ALL REACTOR DESIGNS IN ARIS DATA BASE

Russian projects based on the RITM series marine reactor units

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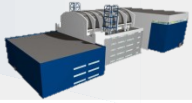
RITM series reactor

MFPU 	**RITM-200S** Planned to be commissioned in **2027**		**106 MW(e)**
OFPU 	**RITM-200M** Planned to be commissioned in **2029**		**100 MW(e)**
FPU 	**RITM-400M** Planned to be commissioned in **2030**		**up to 200 MW(e)**
Land-based NPP 	**RITM-200N** Planned to be commissioned in **2028**		**50 MW(e)**

Optimized floating power unit with RITM-200M for foreign customers

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OFPU project 23870

2 reactor units RITM-200M

Service life

60 years

Refueling interval

up to 10 years

Electric power

100 MW(e)

Thermal power

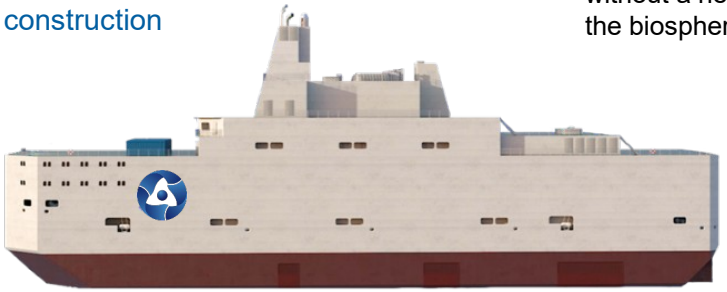
up to 198 MW(t)

REFERENCE SOLUTIONS:

- 6 RITM-200 are operated on 3 nuclear icebreakers;
- 2 nuclear icebreakers under construction

The possibility of installing a desalination module

Power supply for remote territories and industrial facilities without a negative impact on the biosphere



Dimensions cost:

112 m	length
18 670 t	displacement
5,8 m	draught

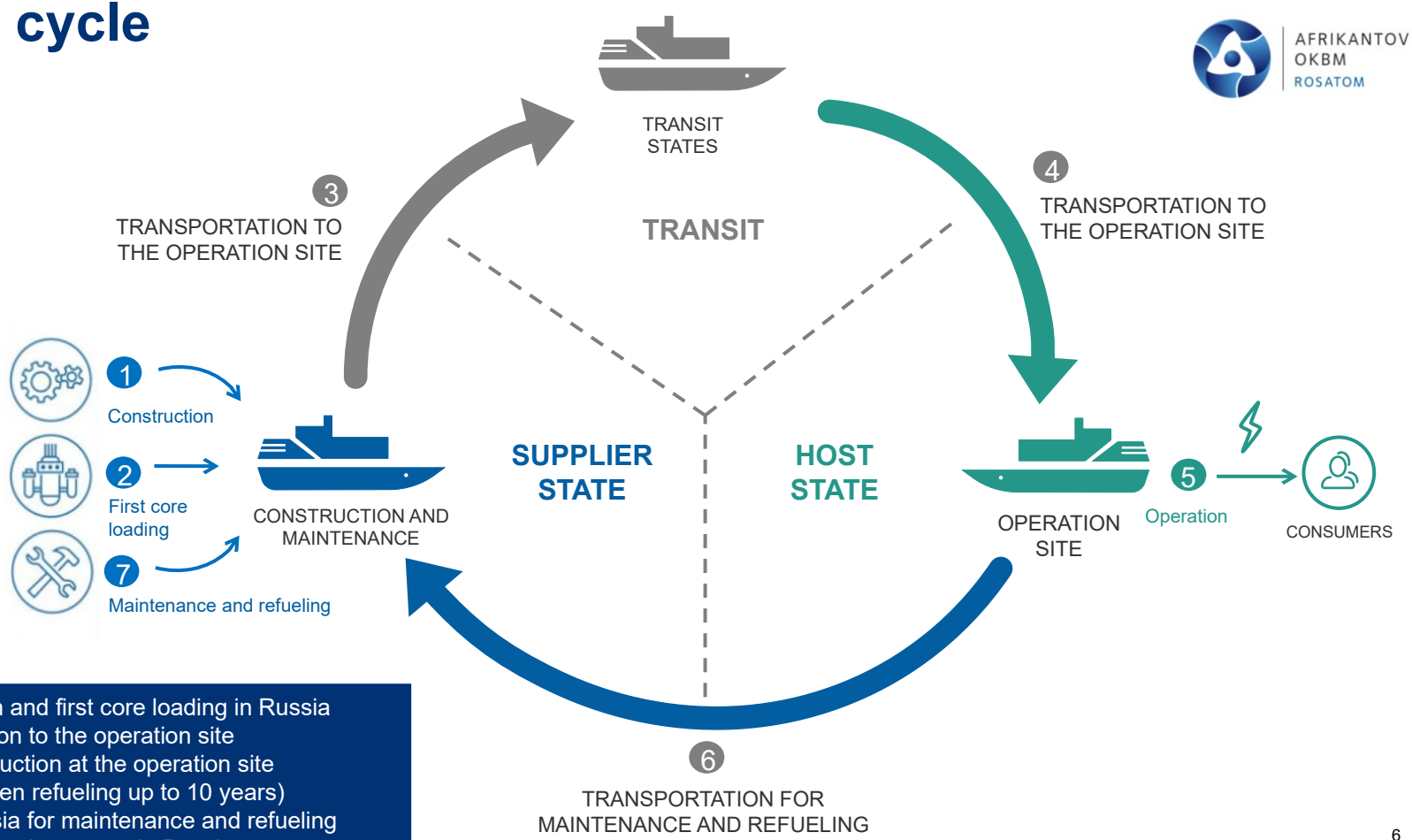
LESS 20 %
fuel enrichment

ENSURED

resistance to external influences in accordance with the requirements of the regulatory documentation of the Russian Federation and the IAEA recommendations.

* OFPU – Optimized floating power unit

FPU life cycle



1, 2 – Construction and first core loading in Russia
3, 4 – Transportation to the operation site
5 – Electricity production at the operation site (time period between refueling up to 10 years)
6 – Return to Russia for maintenance and refueling
7 – Refueling and maintenance in Russia

Energyfleet: prospective deployment model for FPU projects

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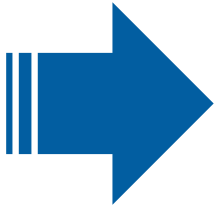
Under the **Energyfleet deployment model** the handover of the FPU to the Host State does not occur.

The authorized organization of the Supplier State builds the FPUs, the Supplier State operating organization owns the FPU and it is responsible for:

- the FPU transportation to the Host State and back
- the FPU operation at all stages of the life cycle, including operation in the Host State
- maintenance and decommissioning of the FPU at the authorized organization of the Supplier State

After transportation to the Host State, the FPU is connected to the power grid of the Host State, i.e. to the onshore infrastructure already constructed by the Host State according to the initial technical requirements provided by the Supplier State.



Electricity Purchase Agreement

Feauters of classification of nuclear floating power units from the point of view of the maritime law

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<table>
<tr><th colspan="2">Criteria for assigning a floating object to a vessel</th><th rowspan="2">Identified criteria for classifying facilities as vessels</th></tr>
<tr><th>International law</th><th>Russian law</th></tr>
<tr><td>MARPOL-73/78, Item 4, Article 2:
a) operated in the marine environment,
b) broad identification of the vessel, including hydroofoil boats, air-cushion vehicles, submersibles, floating craft and fixed or floating platforms;
COLREG-72, Item «a», Rule 3:
a) watercraft,
b) used as a means of transportation on water.
There is no uniform definition of the term «vessel».
SOLAS Convention, UNCLOS: no definition of «vessel».</td><td>The Merchant Shipping Code of the Russian Federation, Article 7:
a) watercraft,
b) self-propelled or non-self-propelled,
c) used for merchant shipping purposes;
«RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS», Article 1.1.1:
a) self-propelled or non-self-propelled,
b) designed for use in coastal marine areas and inland waterways.</td><td rowspan="2">Taking into account the terms of «vessel» in international and national documents of the maritime law, the following characteristics are inherent only for a vessel:
- presence of seaworthy properties (buoyancy, stability, unsinkability, etc.);
- specific scope of use of the vessel, its functionality;
- special design, which is confirmed by ship documents of the maritime classification society from among the IACS;
- legal characteristics (class and number of the vessel, vessel name), presence of crew on board;
- use for commercial purposes in the field of merchant shipping.</td></tr>
<tr><td colspan="2">The criteria for identifying an object as a «vessel» in numerous documents of the maritime law differ depending on the objectives of the document itself and the scope of its regulation.
There is a more elaborated definition of the term «vessel» in the legal framework of the Russian Federation.</td></tr>
</table>

Thus, FPU can be classified as a vessel, since FPU has the seaworthy properties of a vessel, is classified by the Maritime Classification Society and is registered in the Russian Open Register of Ships.

International Atomic Energy Agency and International Maritime Organization: developing safety standards

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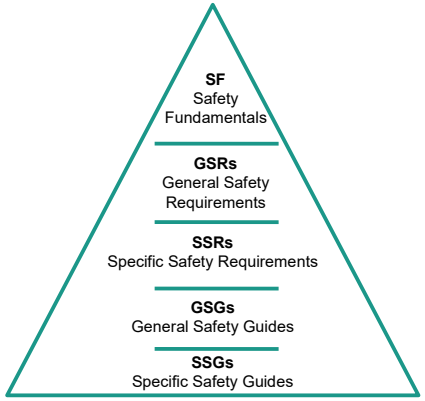
IAEA

The IAEA Safety Requirements

Under the terms of Article III of its Statute, the IAEA is authorized **to establish or adopt standards of safety** for protection of health and minimization of danger to life and property, and to provide for the application of these standards.

The publications by means of which the IAEA establishes standards are issued in **the IAEA Safety Standards Series**, which covers nuclear safety, radiation safety, transport safety and waste safety.
These requirements **are not binding**.



IMO

Structure of the maritime law

The United Nations Convention on the Law of the Sea, 1982

Thematic clusters of Conventions and Agreements (e.g. the cluster of Conventions and Agreements in the field of maritime safety, in particular The International Convention for the Safety of Life at Sea, 1974)

Regional and bilateral agreements on various maritime activities (e.g. The Convention on the Protection of the Black Sea Against Pollution, 1992)

National rules and regulations (e.g. The Merchant Shipping Code of the Russian Federation, 1999)

Safety at sea: the IMO specific activities

The main objectives of the Organization are addressed in the **IMO Convention**: «Safe, secure and efficient shipping on clean oceans».

- ✓ The IMO facilitated the adoption of about 50 conventions and protocols, more than 1,000 codes and requirements i**n regard to safety and protection at sea**.
- ✓ Maritime regulations, including those issued by the IMO, **do not have a strict and generally accepted hierarchy**.
- ✓ In addition, IMO recommendations are usually not legally binding on governments, rather a**cting as guidance for the development of national rules and requirements**. However, some codes have become binding under the relevant provisions of the SOLAS Convention and/or the MARPOL Convention.
- ✓ At the same time, **the key issues of international navigation** covered by the provisions of international law **are binding on all maritime users**, including those States that are not members of the IMO.

Features of nuclear safety requirements for FPUs

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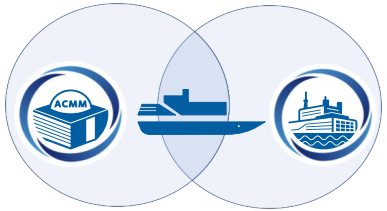
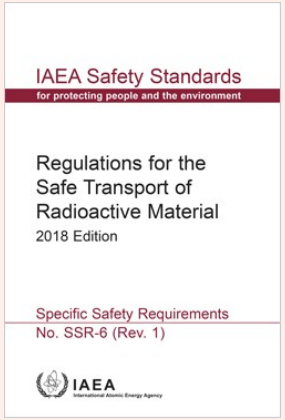
NUCLEAR FLOATING POWER UNIT IS NOT ONLY A VESSEL, BUT ALSO A NUCLEAR FACILITY



In regard to the dual status of the FPU, this facility is simultaneously regulated by the maritime and nuclear laws

The existing regulatory framework in the Russian Federation covers all aspects of the FPUs life cycle.

Transportation of FPUs



- In the international regulatory framework there are no prohibitions with regard to the operation of FPUs
- Regulations for the safe transport of nuclear material are contained in the IAEA document – **SSR-6** and in the IMO codes – **IMDG Code** и **INF Code**.
- These documents regulate transportation of nuclear material in containers or packages and do not apply to **nuclear material that is an integral part of the means of transportation**.
- FPUs are not subject to these documents, since the reactor unit on board is an integral part of the vessel. The safety of the reactor unit is ensured by safety systems that the container does not have.

IT IS NECCESSARY TO ESTABLISH INTERNATIONALLY AGREED APPROACHES TO THE SAFETY CRITERIA FOR NON-SELF-PROPELLED UNITS WITH NUCLEAR FACILITIES

Maritime safety requirements: SOLAS Convention and codes

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International Convention for the Safety of Life at Sea, 1974 is an international document for the safety of maritime navigation.

According to the SOLAS Convention «nuclear ship» (Chapter I, part A, Rule 2) is *a ship provided with a nuclear power plant.*

- Nuclear floating power units as an object of regulation falls out of the coverage of the SOLAS Convention as it is a non-self-propelled vessel (Chapter I, Part A, Rule 3)
- However, **under no circumstances a nuclear vessel can be exempted from fulfilling the requirements of any of the rules of the SOLAS Convention** (Chapter VIII, Rule 3)

TECHNICALLY, **A NUCLEAR FLOATING POWER UNIT — IS A NUCLEAR VESSEL:**

- It has a nuclear facility on board
- It has the necessary nautical properties of the vessel
- It classified by the classification society

According to the SOLAS Convention the safety of the vessel is confirmed by Safety assessment of the vessel (Chapter VIII, Rule 7):

Development of **Safety Analysis Report** for the FPU

Preparation of
Safety assessment
(in accordance with Chapter VIII of the SOLAS Convention)

The Host State **makes a decision on the entry of the FPU into the port** of operation for a long-term parking with the possibility of performing power supply functions

Additional documents with a more specific object of regulation based on the first-level documents in the field of the maritime and nuclear law::

- Code of Safety for Nuclear Merchant Ships, 1981
- INF Code
- IMDG Code
- United Nations Recommendations on the Transport of Dangerous Goods: Model Regulations, also known as the Orange Book

Developing of international approaches to safety of FPUs

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Approaches to developing of specialized nuclear safety requirements for nuclear floating power units:		
Criteria / Approaches	✗ **Adjustment of the SSR-6**	✓ **Elaboration of specialized document**
REQUIRED REVISION OF THE REGULATORY FRAMEWORK	Introduction of a new type of packages into the SSR-6, which may include reactors loaded with nuclear fuel	Extension of Chapter VIII of the SOLAS Convention to non-self-propelled vessels with reactor units (transportable nuclear modules)
EXPECTATION	Development and harmonization of the requirements for a new type of packages within the framework of documents on the law of the sea and SSR-6	Development of the requirements for non-self-propelled vessels with reactor units (transportable nuclear modules) as a new type of nuclear vessels
THE STRUCTURE OF THE DOCUMENT	Uses a prescriptive approach	Assumes the use of a perfomance approach
THE STAGE OF THE LIFE CYCLE OF THE OFPU COVERED BY THE DOCUMENT	Transportation stage only	All stages of the life cycle, including the transportation

Establishing of internationally agreed approaches to the safety criteria for FPUs allows:

- **Developers and operators** — to form a required scope of documentation in advance to prove safe operation
- **Stakeholders —** to objectively assess safety of operation

Currently, at the IAEA site, together with representatives of the IMO, aspects of legal support for nuclear safety of facilities such as nuclear floating power units are already being worked out within the framework of the following working groups:
1) Design Safety and Security Considerations for Transportable Nuclear Power Plants
2) Working Group on Transportable Nuclear Power Plants.

Conclusion

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01

The development of reactor installations of the RITM series for floating power units is based on the experience of marine reactor units. The experience of designing, manufacturing and operating RITM series reactors allows to guarantee reliability and short development time

02

Currently, there are no legislative prohibitions on the implementation of international FPU projects, but in order to accelerate the deployment of FPUs, the adaptation of international safety standards in the field of both nuclear and maritime law is necessary

03

Since the FPU is a nuclear vessel, special attention should be paid to maritime safety within the framework of the mariime law, which currently do not take into account the features of innovative projects in the atomic energy

04

The IAEA and the IMO should cooperate on the issues of international legal work to address aspects on nuclear and maritime safety with regard to FPUs

Thanks for attention!

Sirotkina D.S.
Afrikantov OKBM JSC

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