FEDERAL ENVIRONMENTAL, INDUSTRIAL AND NUCLEAR SUPERVISION SERVICE OF RUSSIA
(ROSTECHNADZOR)

Safety Regulation Aspects for Nuclear Power Plant with RITM-200N Small Modular Reactor (RITM-200N SMR)

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MDEP Management Board Chair

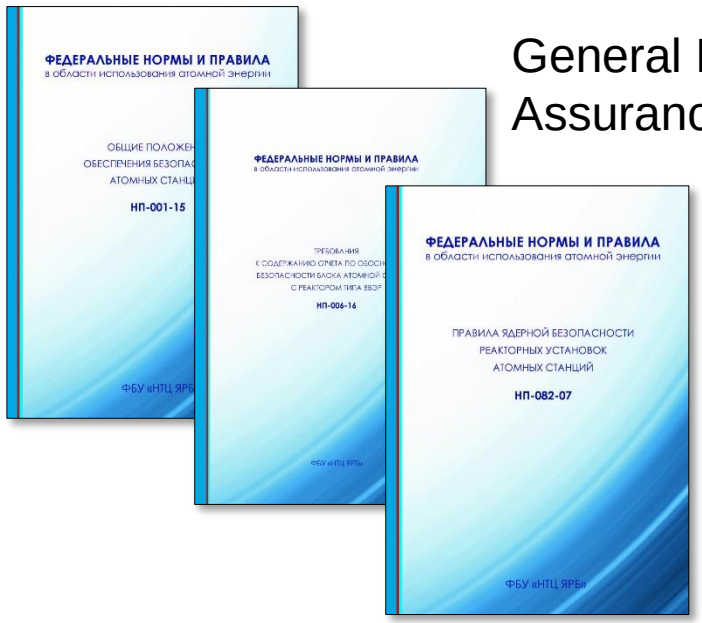
Workshop on Small, Medium-Sized and Modular Reactors (SMMR)
Multinational Design Evaluation Programme (MDEP)

NPP with RITM-200N SMR Project under the State Program

Power thermal (electric)	190 (55) MWt
Reactor type	Pressurized water reactor
Number of MCP	4
Fuel assembly	Hexagonal
Fuel elements	Cylindrical
Number of fuel assemblies	199
Enrichment ^{235}U	< 20 %
Fuel type	UO_2 (CerMet)
Pressure on the outlet of the core	15,7 MPa
Temperature on the outlet of the core	321 °C
Safety provisions	Active and passive safety systems

Ust-Kuiga village, Republic of Sakha (Yakutia)

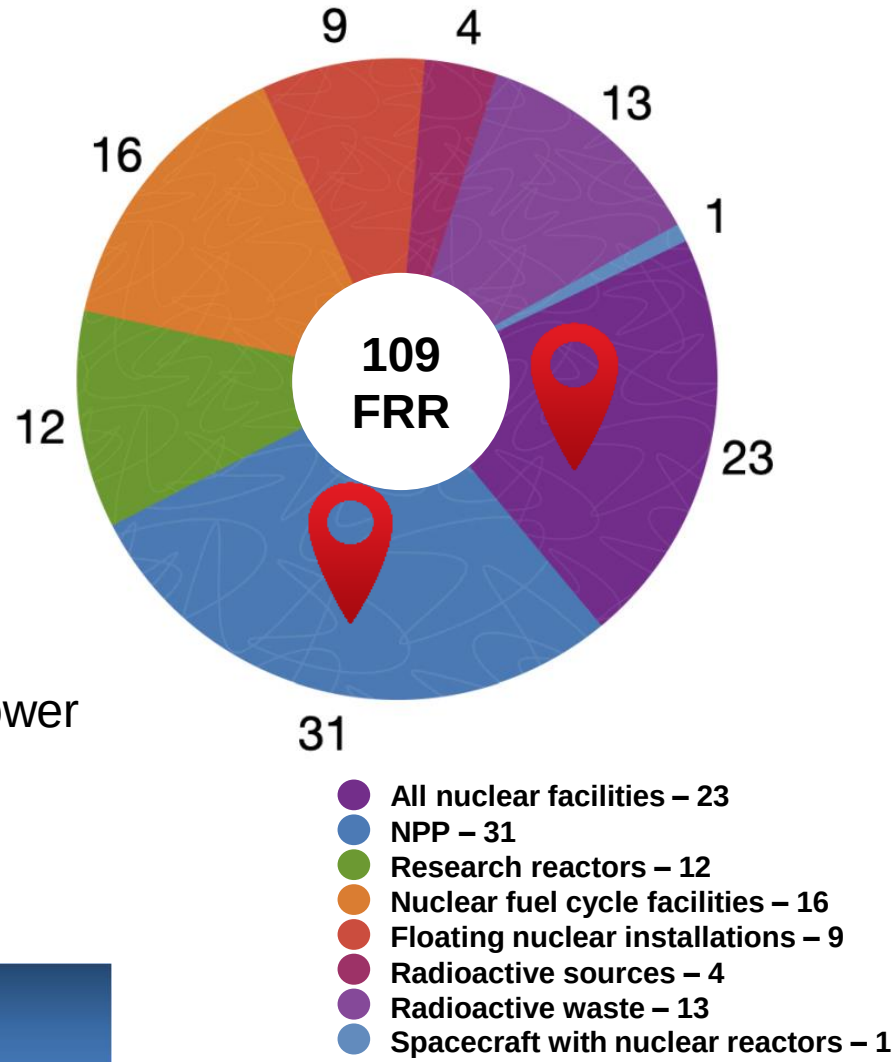
NPP with SMR RITM-200N SMR licensing – in accordance with the requirements of existing Federal rules and regulations (FRR) applicable for NPPs



General Provisions for Nuclear Power Plant Safety Assurance (NP-001-15)

Requirements for the Content of Safety Analysis Reports for Nuclear Power Plant Units With VVER Reactors (NP-006-16)

Rules of Nuclear Safety of the Nuclear Power Plants Reactor Units (NP-082-07)



FRR requirements for NPPs – harmonized with the IAEA recommendations

Defense-in-Depth Concept (DiD)

Implementation of DiD principle, established in the IAEA documents (INSAG Series No. 10) and national requirements (NP-001-15)

Level 1	NPP siting conditions and prevention of abnormal operation
Level 2	Prevention of design basis accidents by normal operation systems
Level 3	Prevention of beyond design basis accidents by safety systems
Level 4	Beyond design basis accidents management
Level 5	Emergency planning

DiD principles – applicable to NPP with SMRs (INSAG Series No. 28/ IAEA Preprint)

Large Emergency Release Exclusion Concept

Achievement of NPP safety milestones related to exclusion of large emergency releases established in the IAEA documents (SSR-2/1) and national requirements (NP-001-15)

Probability of severe accident occurrence	$\leq 10^{-5}$
Probability of large emergency release	$\leq 10^{-7}$

Technical solutions for NPP reactor installation (RITM-200N) assimilated from Universal Nuclear Icebreaker reactor installation (RITM-200S)

Advantages

- **Compact dimensions of the reactor installation** (main equipment of the reactor unit is located in the protective shell 9 × 22 m)
- **Pre-fabricated reactor unit** (installation of ready for operation reactor units on NPP site)
- **Extended period of continuous operation** (refueling every 7 years)
- **Extended service lifetime** (from 40 years to 60 years in comparison with RITM-200S for Universal Nuclear Icebreakers)
- **Capability of power maneuvering**
- **Use of accident-tolerant fuel** (no zirconium-steam reaction)

Specifics that should be taken into account for legal regulation

- **Integral layout of the reactor coolant circuit** (steam-generators and main circulation pumps are located in the reactor vessel)
- **Use of titanium alloys in steam-generator design** (specific of the reactor units for civil ships)
- **Use of threaded-soldered joints** (specific of the reactor units for civil ships)
- **Specifics of performing operational control of base metal and welded joints**
- **Nuclear fuel innovative for land-based nuclear plants** (uranium dioxide in silicon-aluminum alloy matrix)

Civil Ships and other Floating Crafts with Nuclear Reactors Operational Experience

- Total operational experience > 400 reactor-years
- Availability of operational data on reliability parameters of the RITM reactor unit systems and components
- Initial data for probabilistic safety assessment – operational experience of the prototypes and similar reactor installations in civil ships is used as

8 RITM reactor installations in operation on Universal Nuclear Icebreakers “Arktika”, “Sibir”, “Ural” and “Yakutia”

2 RITM reactor installations manufactured for Universal Nuclear Icebreaker “Chukotka”

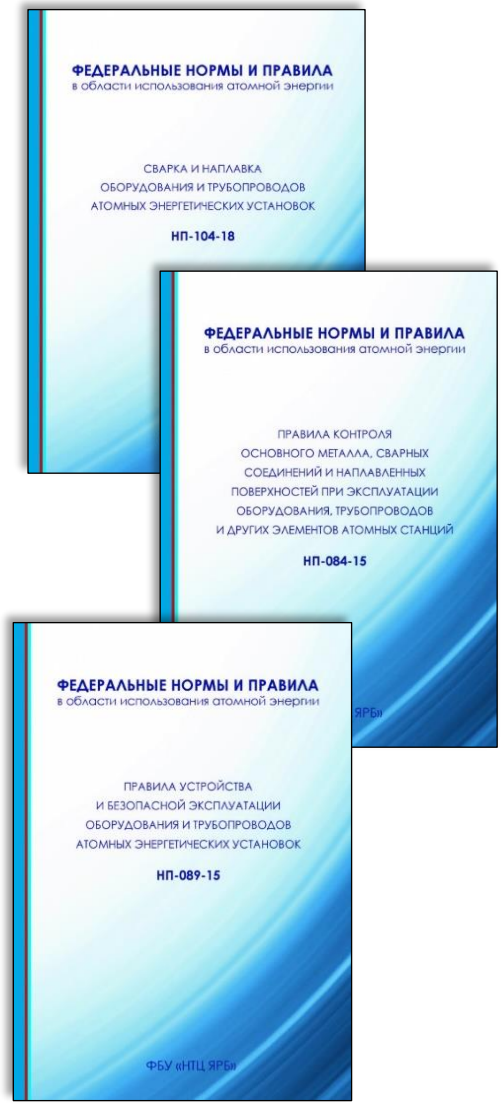
6 RITM reactor installations being manufactured for Modernized Floating Power Unit and for 5 and 6 serial Universal Nuclear Icebreakers

Safety Regulation of Civil Ships and Other Floating Craft with Nuclear Reactors

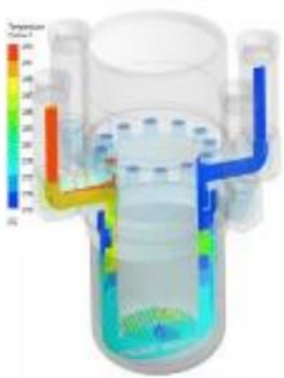
Improvement of the Regulatory framework advance

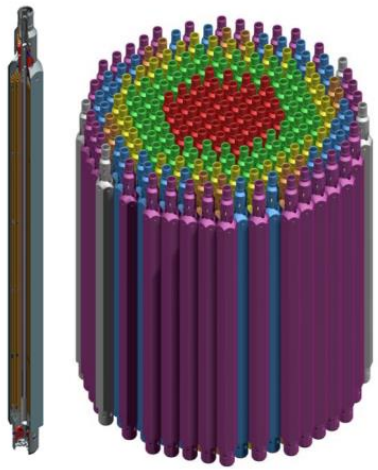
- General Safety Assurance Provisions for Ships and Other Floating Craft with Nuclear Reactors
- Requirements for Safety Analysis Reports for Ships and Other Floating Craft with Nuclear Reactors
- Nuclear Safety Rules for Ships and Other Floating Craft with Nuclear Reactors
- Requirements to Planning of Measures for Actions and Protection of Personnel during Nuclear and Radiological Accidents on Ships and Other Floating Craft with Nuclear Reactors
- Requirements to Nuclear Security for Ships and Other Floating Craft with Nuclear Reactors, Nuclear Service Vessels, Ships Transporting Nuclear Materials and Floating Nuclear Power Plants

Regulatory Documents Improvement Areas



- New types of materials, welded joints and welding techniques
- Compactness and prefabrication of the reactor vessel (integral type reactor)
- Specifics of in-service inspection of metal and joints
- Possibility for advanced irradiation of surveillance specimens (in research reactor)





Validated and Verified Codes for Safety Justification

Calculation type	Codes
Thermohydraulic calculation	KRATER, KANAL, Piping System Fluid Flow 3
Modelling of coupled transients	SOKRAT/V1
Containment parameters calculations	«KUPOL-MT»
Computational analysis of reactivity accidents	ESKM-3D
Neutronic calculations for reactor core	MCU-TR BKH-07
Analysis of accidents associated with change in reactivity and failure of heat removal	RASNAR-2.1
Strength calculations Stress-strain state calculations	ANSYS, LOGOS-PROCHNOST, FLANARM, RANT-1, DELTA

Inter-agency Working Group on Regulatory Documentation for RITM-200N SMR

Coordinates the activity related to analysis of application and development of additional safety requirements (the Federal Rules and Regulations and standardization documents)

№ п/п	Наименование документа	Кем и когда утверждён документ	Предложения по разработке (внесению изменений)	Разработчик документа	Сроки разработки	Заказчик разработки	Примечание
2	НП-033-11 «Общие положения обеспечения безопасности исследовательских ядерных установок»						
3	ФНП «Правила обеспечения безопасности исследовательских реакторов с распределенными и растворами ядерных материалов»						
4	НП-049-17 «Требования к содержанию отчета обоснованию безопасности исследовательских ядерных установок»						

СОГЛАСОВАНО
Генеральный директор
АО «Концерн Росэнергоатом»
_____ А.В. Шутиков
«23» 10 2023 г.

УТВЕРЖДАЮ
Управляющий проектом
Президент АО «Русатом Оверсиз»
_____ Е.М. Пакерманов
«__» _____ 2023 г.

ДОРОЖНАЯ КАРТА
(план мероприятий)
внесения изменений в федеральные нормы и правила в области использования атомной энергии и разработки документов по стандартизации по проекту АСММ с РУ РИТМ-200Н (на 2023 - 2025 годы)

№ п/п	Наименование работы	Исполнитель работ	Соисполнитель работ	Сроки	Результат
	Внесение изменений в ФНП				
1	**Разработка, в соответствии с приказом Госкорпорация «Росатом» от 19.12. 2018 № 1/1471-П, изменений в федеральные нормы и правила в области использования атомной энергии в части РУ (НП-084-15, НП-089-15, НП-104-18)**				
1.1	Подготовка и отправка в Генеральную инспекцию Госкорпорация «Росатом» пакета документации с предложениями по внесению изменений в действующие ФНП для АЭС для включения в перечень Федеральных норм и правил в области использования атомной энергии, подлежащих разработке и изменению	АО РАОС	АО «ГСПИ» АО «ОКБМ Африкантов»	05.05.2023 в соответствии с п. 3.2.2.5 приказа ГК «Росатом» от 19.12.2018 №1/1471-П	Выполнено Предложения в перечень Федеральных норм и правил в области использования атомной энергии, подлежащих разработке и изменению, пояснительная записка направлены в ГК «Росатом»

Federal Rules and Regulations Amendment Roadmap

- Federal Rules and Regulations amendment activities considering the technical solutions and elimination of detected safety regulation deficiencies
- Development of industrial standardization documents establishing requirements to:
  1. use of titanium alloys
  2. materials, manufacturing and control of threaded-soldered joints
  3. implementation of new types of welding and their control

NPP with RITM-200N SMR Project Roadmap

Siting License

Amendment Roadmap Approval

Federal Rules and Regulations Amendments Development

2021 → 2022 → 2023 → 2024 → 2025 → 2026

Standardization Documents Development and Approval

Construction License

Operation License

Conclusion

- At present, Rostechnadzor possesses experience in the safety regulation of prospective nuclear installations with low and medium power pressurized water reactors, both as part of ground-based nuclear power plants and as part of floating power units.
- Existing requirements for nuclear plant units are fully applicable; however, minor amendments to the regulatory and standardization documents may be needed to account for some distinct innovative technical solutions implemented in reactor installations.
- Detection of the lack of safety regulations during implementation of innovative technological decisions and analysis of possible approaches to its elimination may serve as one of the goals of activities within the framework of MDEP SMMR WG.

Thank you for attention!