

NUWARD SMR Joint Early Review Summary Report (September, 2023)

1. INTRODUCTION

From June 2022 to June 2023, three national nuclear safety regulators, ASN (France), STUK (Finland) and SUJB (Czech Republic), and two of their Technical and Scientific Support Organizations (TSO) (IRSN from France and SURO from Czech Republic), have conducted a Joint Early Review (JER) of the NUWARD SMR design.

The intent of the NUWARD team is to develop a standardised design, suitable and licensable in multiple countries. The JER is one of the initiatives launched by EDF and NUWARD¹ to get a wider international view and to embed international expectations into the NUWARD SMR design development.

This summary report presents the NUWARD team experience of the JER. As such, it should be read in conjunction with the combined JER Regulators Group summary report, issued at the same time. The two reports are complementary as they present the two sides of the same JER experience, and in such they offer insights to the whole nuclear community of what was done, how it was done and what was collectively learnt.

2. CONTEXT OF JER

The main objectives of the JER were to:

- Foster exchanges with several European regulators on the NUWARD SMR design and its safety approach.
- Identify key enablers and conditions to meet licensing expectations in these countries.
- Enable all participants to increase their respective knowledge of each other's regulatory practices.

The interest on the regulators side was additionally fueled by the fact that at least one energy utility in each of the represented countries (France, Finland and Czech Republic) had shown interest in SMR reactors and confirmed their wish to have their respective regulator participate to the NUWARD SMR JER initiative.

The practical approach undertaken, including the selection of topics for engagement and the evolution of the menu for discussion, is fully detailed in the JER Regulators Group summary report. In brief the main topics discussed during the JER were:

- Topic 1. The general safety objectives.
- Topic 2. The list of design basis conditions and design extension conditions.
- Topic 3. The use of passive cooling systems.
- Topic 4. The development plan for computer codes.
- Topic 5. The integration of two reactor units in a single facility.
- Topic 6. The Probabilistic Safety Assessment (PSA) approach.

¹ Early in 2023, EDF Group has launched its subsidiary, NUWARD, a venture dedicated to the development of its Small Modular Reactor (SMR) technology.

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The review was conducted based on NUWARD SMR information provided in support of the considered topics. This review was performed in the context of the current set of national regulations from each of the involved countries, following WENRA's safety objectives and reference levels, and in light of the up-to-date knowledge and best practices. For each of the selected topics, NUWARD provided the Regulators Group with a document in advance of the technical meeting(s) where the respective topic was presented and explored. After each session the Regulators Group produced a joint synthesis report to summarise their findings and views. These joint synthesis reports reflect the views of the Regulators Group on the proposed NUWARD SMR design in terms of technical and legal regulatory expectations and highlight the main areas of convergence and the differences between the approaches and requirements of each country. The JER Regulators Group summary report, issued publicly, is a shared consolidation of their overall experience and feedback.

3. SUMMARY OF NUWARD VIEWS, LEARNINGS AND OUTCOMES

The JER initiative provided a unique environment for useful and encouraging exchanges, outside of and prior to any formal licensing process, in which the use of a real SMR case study added a substantial vehicle to enable views to be expressed and explored.

This facilitated exchanges on practical applications and interpretations of high-level safety objectives and legal requirements. It also revealed areas of differences in the interpretation or further development into national regulation of common international nuclear safety related requirements. These exchanges are viewed as pivotal for the learning curve of the NUWARD SMR Project, to improve the ability of the design engineers to anticipate the challenges of international licensing and design a SMR meeting future market needs.

The JER has been an opportunity for regulators to raise questions on the design and safety approach and receive answers from the NUWARD team at an early design stage. It also allowed for the NUWARD team to get clarifications from the Regulators Group on their expectations, enabling discussions to share a common understanding at point of source. The range, depth of discussion, and insights achieved in a relatively short time has been significant for international discussions, mixing three different contexts of regulation, nuclear history, and culture.

Some highlights of the JER are that:

- It has been an excellent opportunity to gain real understanding of each Regulator's approach, and to progressively learn how to facilitate discussion and generate feedback that is of tangible use for all involved.
- The insights for the NUWARD team have been numerous, relevant and useful for the NUWARD SMR development. They will feed the rationale for decisions on some topics as part of the on-going Basic Design phase of the project, in order to see if a more holistic and centralised approach to certain aspects can be built into the NUWARD SMR model. Examples of topics include dose limits and radiological consequences limitation objectives with respect to severe accident, DEC-A definition and selection, consideration of DBC in combination with loss of offsite power, and the classification approach for systems/structures/components.
- The timing of this JER was well chosen. It was carried out at a sufficiently advanced stage of NUWARD SMR design process, ensuring that options are already defined on some key aspects, but still early enough to allow the insights to guide the detailed design choices going forward.
- The structure used to facilitate the JER has supported clear and focused feedback in the exchanges. It allowed for an efficient way of working, involving sufficient preparation before the meetings and debriefing after to complete and clarify some points.

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- The process and its output have challenged the ways of thinking and working within the NUWARD team. It has encouraged increased agility and a growth mindset in anticipating how some of its design approach and assumptions may be viewed in different regulatory contexts.

Added value of the JER includes:

- Written up and formalised exchanges from both sides (both the designer and the Regulators), while not committing the parties to any positions taken for future official licensing exchanges.
- Clear and structured overview of common approaches as well as some differences, highlighting the underlying rationale when available.
- Practical recommendations complementing high level ones, focused on the NUWARD SMR specific design and safety features or choices.

Key success factors include:

- Having a highly skilled, motivated, and committed Regulators Group with a “core team” involved in all meetings, providing continuity and direction, as well as taking additional advice and information from experts where necessary.
- Efforts being made by all participants involved to agree and formalise the written records at each stage within appropriate timeline, complemented by regular meetings with feedback loops to ensure mutual understanding.
- Focused efforts on a selected and limited range of high priority topics, in a pre-defined timeline.

Some process challenges and key learnings are that:

- There was a need to agree on standard terms and definitions, and some explanation on exact meaning was frequently required throughout the process. The IAEA safety glossary was generally acknowledged as a shared basis.
- Engaging early in the design process is an opportunity but also implies that further exchanges may be needed at a later stage and that different statements may then be expressed as the design evolves.
- Referencing and explaining the underlying rationale of safety approaches was acknowledged as good practice.
- It was relevant to have the participation of experienced staff or experts for each subject, in support of the “core team”:
 - To enable an easier understanding and explanation of the given information.
 - To get detailed and relevant insights for a better understanding of the intents and implications on a particular topic or area of discussion raised in advance of the meeting.

4. CONCLUSION AND NEXT STEPS

Within the NUWARD SMR Joint Early Review, the use of a real SMR case study enabled views to be expressed and explored by the Regulators. This facilitated exchanges on practical applications and interpretations of high-level safety objectives and also revealed some areas of difference in such interpretations. The Joint Early Review is a unique “bottom-up” collective consideration of a real SMR design prior to any (pre)-licensing process in various countries, which supports the nuclear community with a tangible SMR concept experience.

It should be acknowledged that the very fruitful insights offered by the JER are the product of a significant collective investment of time and resources of all those involved. NUWARD and EDF are thankful to all participants for their significant contribution to this successful initiative.

On the designer side, this has been a uniquely valuable learning experience and has improved the ways of thinking and working within the NUWARD project team. The intent of the NUWARD team is to develop a standardised design, suitable and licensable in multiple contexts. The JER exchanges

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further convinced NUWARD and EDF that it would not be desirable, or even possible in some cases, to consider inclusion of all the highlighted specific requirements in such design. The NUWARD team believes that opportunities for collaboration as well as increased mutual understanding and appreciation of different country contexts have been achieved by the JER.

The next key steps identified for the NUWARD team, now rich with the experience feedback from the JER, include:

- Further identifying and referencing the foundation of our safety approach and licensing with an increased international view. Clarifying the links to common international guidance (IAEA and WENRA for example).
- Further explaining the design choices, and underlying safety rationale, so that they can be communicated in a straightforward and accessible manner, beyond a single national context.
- Fostering increased mutual understanding of each other's regulatory practices for all participants.
- Further considering the outputs of the JER to inform the NUWARD SMR design choices and safety approach, in order to better cope with expectations from key European countries in the detailed design.

The NUWARD team looks forward to continuing the JER, further enriching both our own learning and that of the Regulators Group, from key European countries for the NUWARD SMR future development. Topics to be addressed as part of such continuation could encompass:

- New technical topics, to be defined in accordance with all participants, to enrich the lessons learned.
- Further exchanges on how NUWARD can develop and offer a safety approach likely to be internationally accepted. In doing so, each Regulator could express their views on the compliance and challenges with their own national expectations and, where applicable, the steps that may have to be further considered to facilitate a successful licensing process.

The NUWARD team believes that the JER initiative is a key step to help designers and regulators move towards a wide harmonised set of expectations in the future, identified as a success factor for the emergence of the SMR market. The NUWARD team is also committed to further sharing insights and experience feedback with the international nuclear community.

Through a better understanding of the variety of expectations and sharing the designer's set of constraints, NUWARD wishes to provide the market with an SMR solution that will ensure a very high level of safety while maintaining design simplicity and cost-efficiency.

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About NUWARD

Launched in March 2023, NUWARD is EDF Group's subsidiary dedicated to the development of its Small Modular Reactor (SMR). The NUWARD SMR is targeted to replace old high CO₂-emitting coal, fuel, oil and gas power plants around the world, as well as offering the capability of supporting other usages such as heat and electricity cogeneration, hydrogen production, district heating or water desalination. Based on proven PWR technology, it is a 340 MWe plant with two reactors of 170 MWe each. The project relies on the skilled and valued contributions of EDF, CEA, Naval Group, TechnicAtome, Framatome and Tractebel. More information on www.nuward.com