



## **Terms of Reference**

### **Small Modular Reactor (SMR) Regulators' Forum**

**March 2021**

#### **Purpose**

To identify, enhance understanding of and address key regulatory challenges that may emerge in future SMR regulatory discussions. This will help enhance safety, security, efficiency in SMR regulation, including licensing, and enable regulators to inform changes, if necessary, to their requirements and regulatory practices.

#### **Background**

The idea of establishing an international forum for regulators to discuss issues associated with regulation of SMRs was first raised in mid-2012 after bilateral discussions between the U.S. and Canada. At the INPRO Dialogue Forum on Licensing and Safety Issues for Small and Medium-sized Reactors (SMRs), held in Vienna in July/August 2013, there was explicit interest expressed by a number of the International Atomic Energy Agency (IAEA) Member States to evaluate and discuss the benefits of forming a regulators' forum which would specifically address regulatory issues in safety and licensing of SMRs.

The IAEA was considered to provide a long term vision to maximize Member State participation and to provide an efficient means to apply lessons learned from discussion into the IAEA global safety framework. The intent was to work cooperatively with other regulatory forums investigating the impacts of new reactor technologies on regulation.

As a result, consultancy meetings, facilitated by the IAEA, were held in Vienna 18-20 February 2014, and 22-24 July 2014. The outcome of these consultancy meetings was an agreement to organize a Small Modular Reactor Regulators' Forum on a 2 year pilot basis. A draft Terms of Reference (ToR) and draft Pilot Project Plan, including the scope of the working groups, were also produced and were subsequently accepted by the members of the forum at the initial meeting.

A pilot phase of the forum was conducted from March 2015 to May 2017, with the objectives of addressing different issues for both light-water and non-light-water SMR designs described in Annex A.

The second phase of the forum was conducted from May 2017 to December 2020, with the objectives of addressing new issues described in Annex A.

The third phase of the forum is to be conducted from January 2021 to December 2023, with the objectives of addressing new issues described in Annex A.

### **Scope / Definitions**

The scope of the forum is to identify, enhance understanding and address key regulatory challenges that may emerge in future SMR regulatory and licensing discussions to inform changes, if necessary, to their requirements and regulatory practices. The forum will distinguish itself from existing fora/organizations such as OECD/NEA (e.g. MDEP, GIF, WGSAR, CNRA) and WNA/CORDEL, whose focus lies more on specific technical issues or particular designs. Issues covered by the working groups of this forum would be cross-cutting in nature, covering common issues of SMRs.

For the purposes of this forum, Small Modular Reactors are Nuclear Power Plants that typically have several of these features:

- Nuclear reactors typically <300 MWe or <1000 MWt per reactor;
- Designed for commercial use (include prototypes or demonstration plants), i.e., electricity, production, desalination, process heat (as opposed to research and test reactors);
- Designed to allow addition of multiple reactors in close proximity to the same infrastructure (modular reactors);
- May be light or non-light water cooled;
- Use novel designs that have not been widely analysed or licensed by regulators.

The IAEA publications serve as references for the discussion and as a benchmark for making common positions.

## Objectives and Outcomes

### *Objectives*

Share SMR regulatory knowledge and experience among the members and other stakeholders to:

- Facilitate efficient, robust and thorough regulatory decisions;
- Encourage enhanced nuclear safety and security;
- Facilitate international cooperation among regulators performing SMR-related assessments;
- Identify and discuss common safety issues that may challenge regulatory reviews associated with SMRs and, if possible, recommend common approaches for resolution;
- Advise IAEA on the need for revision or development of new IAEA publications on Safety of SMR.

### *Outcomes*

- Position<sup>1</sup> statements on regulatory (policy and technical) issues;
- Suggestions for revisions of or drafting of IAEA documents and especially on potential enhancements to the IAEA Safety Standards with regard to SMRs;
- Generation and sharing of information that regulators may use to enhance their regulatory framework and regulatory activities;
- Description of regulatory challenges and discussion on paths forward;
- Suggestions for high level issues to be raised to international codes and standards organizations for dispositioning.

## Guiding Principles

The outcomes of this forum shall not replace national regulators' responsibility for making regulatory decisions and the following guiding principles will apply:

- The forum is a regulator-to-regulator<sup>2</sup> forum driven by its members;
- Each member shall supply the appropriate expertise to contribute effectively to forum activities and ensure that the views of the regulatory body are represented;
- Each member will make best endeavours to share its regulatory experiences and lessons learned within the scope of the forum;
- Within the scope of confidentiality agreements, information can be shared;
- The forum will appropriately control proprietary information;
- Members may, for the purposes of completing research, seek assistance from other members;
- The forum activities shall be periodically assessed for continuous improvement according to the project plan;
- The issues to be addressed in the forum may be proposed by any member;
- The forum will strive to maintain awareness of other organizations' work and align its own tasks accordingly;

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<sup>1</sup> They can take the form of reports or formal position statements as necessary and do not necessarily represent the position of the IAEA

<sup>2</sup> The regulator may choose to be represented by a TSO

- The forum will attempt to develop consensus-based documents on technical and regulatory issues of interest to forum members;
- The forum will take into account IAEA Safety Standards and safety objectives from other organizations such as WENRA for new reactor designs;
- The forum will strive to avoid duplication of work done by other organizations and fora;
- The forum will seek to draw information from existing sources where possible, including specific information discovered during design reviews by Member States and international organizations;
- This forum will establish and maintain relationships with other organizations working on relevant topics for the forum. The forum may, on occasion, invite selected representatives of these organizations to participate in forum activities.

## Membership

Membership to the forum was originally limited to the IAEA Member States who participated in the initial sessions of this forum: Canada, China, Finland, France, Republic of Korea, Russian Federation and United States. The United Kingdom joined during the second year of the pilot project. South Africa joined in March 2021.

Following the pilot phase, membership to the forum is now open to all IAEA Member States who are able to contribute in a meaningful manner to the work of the forum working groups. The work being conducted is generally of a complex nuclear safety nature with a focus on SMRs that requires experience in:

- Multidisciplinary technical assessment across multiple areas of safety;
- Application of defence in depth in design and safety analysis;
- Use of risk informed methodologies in regulatory decision making.

In particular, if a Member State is a SMR technology holder or developer, has operating experience or already has commitments<sup>3</sup> for new build or firm plans to have commitments for licensing in the near future, it may apply for membership with the forum, which will then be subject to an approval process.

Membership presupposes a commitment to devote adequate resources, with appropriate experience and knowledge base, to ensure that the forum's purpose and objectives can be fully accomplished.

International and regional organizations which expressed an interest may be granted the status of observer by decision of the Steering Committee. Observers participate in the forum working groups and are granted a read-only access to the restricted forum web site, however, their participation in Steering Committee activities is limited to observation only. Member States can request the status of observer to a single combined meeting of the Steering Committee and working groups prior submitting a request to participate.

The list of forum members and observers shall be made publicly available.

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<sup>3</sup> Commitments should be considered to be pre-licensing discussions between the regulator and the vendor.

## Structure

This forum is composed of:

- A Steering Committee
  - A chairperson and vice-chairperson will be selected from the Steering Committee membership;
  - As Scientific Secretariat, the IAEA will be part of the Steering Committee;
  - Every member should provide a representative to the Steering Committee who is capable of fully representing their regulatory body's position in technical matters and decision making.
- Task-specific technical working groups (one working group per issue)
  - The Steering Committee will appoint a group chair and co-chair, who will coordinate the group's activities;
  - Any member may participate in the forum working groups; however, they should be capable of fully representing their regulatory body's position in technical matters.
  - Issues covered by the working groups will be cross-cutting in nature, covering common issues of selected technologies.
  - With the approval of the Steering Committee, IAEA staff may contribute expertise to support in the WGs in accomplishing their aims.. Their role in the WG is twofold:
    - to support the working group experts by bringing to their attention information either existing in IAEA publications or being developed by other IAEA programs that may be useful to the discussions at hand; and
    - to learn from the members of the WG of their needs and the gaps they identify in the IAEA standards and guidance. This will be an input to the IAEA planning of future activities.
- A Scientific Secretariat
  - The International Atomic Energy Agency, will serve as Scientific Secretariat, appointed by the Regulatory Activities Section of the Division of Nuclear Installation Safety of the Department of Nuclear Safety and Security.

## Roles and Responsibilities

The Steering Committee will:

- Manage and approve the detailed programme of work including defining topics and working methods, establishment and closure of working groups and appointment of the group chair and co-chair;
- Approve reports and position statements developed by the working groups;
- Establish interfaces with other international organizations to benefit from available work and avoid duplication;
- Review progress on a periodic basis to ensure that working groups and the forum as a whole are achieving their goals according to the programme plan;
- Decide upon the working topics for each phase after consultation with all Members and the Secretariat;

- Based on suggestions from the working groups, make recommendations to the Secretariat, such as, for example revisions to IAEA documents or drafting of new IAEA documents;
- Approve membership and observer applications.

The working groups will:

- Implement their specific portion of the project plan depending of the Phase;
- Report progress to the Steering Committee;
- Draft a report on their dedicated portion of the project plan;
- Document suggestion and recommendations for consideration to the IAEA such as specific areas of work to pursue, revisions to IAEA documents or drafting new IAEA documents.

Subject to the availability of extra-budgetary resources, the Scientific Secretary will:

- Promote and facilitate the forum;
- Provide general and professional support staff to facilitate open collaborative meetings;
- Develop and maintain a communication platform;
- Provide advice on the IAEA Safety Standards;
- Ensure timely distribution of the recommendations of the Forum concerning IAEA documents and Safety Standards to the relevant IAEA departments;
- Support the Steering Committee in establishing interfaces with other international organizations to benefit from available work and avoid duplication;
- Support the Steering Committee in reviewing progress by the working groups on a periodic basis, to ensure that the forum, as a whole, is achieving their goals according to the programme plan;
- Perform any other activities related to the forum requested by the Steering Committee.

## **Meetings and Phases**

The quorum for Steering Committee Meetings shall be half of its members, including the Chair or the Vice Chair. Decisions of the Steering Committee shall be adopted by consensus of the members present at the meeting.

Each forum's Phase should last between two and three years. New working topics for each working groups might be defined when a new phase starts. Each Phase is concluded by the publication of a comprehensive report including the work of all working groups.

Steering Committee and working groups meet twice a year during combined meetings.

Working groups are encouraged to meet in-between combined meetings, using online virtual meeting or telephone calls.

Minutes of combined meetings and list of actions shall be prepared and kept by the Scientific Secretariat.

## **Finances**

This extra-budgetary effort will be financed by required annual contributions of approximately 30,000 – 40,000 euros/year from each forum member. The annual contributions should be received by the Secretariat by 31 December of each year and the Steering Committee will follow up on those contributions.

Overdue contributions should be subject to a further decision of the Steering Committee.

The IAEA will use these funds to provide the following support services:

- IAEA staff member costs, both salary and travel needed to participate in forum (both general and professional staff) and promote the forum activities.
- Support for specific activities as necessary such as consultants from academia to support working group research.
- Support for communications including web site support required to maintain and update the forum's web site.
- Support the organisation of workshops to promote the work of the forum.

Forum members will finance their own participation in the forum meetings.

Every three years, an evaluation should take place to assess the forum's performance and to determine its further financial support.

### **Communications (Internal / External)**

A structured web space within the Global Nuclear Safety and Security Network (GNSSN) (maintained by the IAEA) will be used and shall include a restricted, password protected part to share information among the Steering Committee members or working group participants.

Dissemination of relevant information important to other stakeholders and the public will be handled through the public IAEA web portal.

Representation of the forum at relevant international conferences and meetings will be handled as needed.

Organizations the forum expects to interface with, include:

#### Regulator forums

- Organisation for Economic Co-operation and Development (OECD)/ Nuclear Energy Agency (NEA) – Multinational Design Evaluation Programme (MDEP), Group on the Safety of Advanced Reactors (GSAR), Committee on Nuclear Regulatory Activities (CNRA)
- Regulatory Cooperation Forum (RCF)
- European Nuclear Safety Regulators Group (ENSREG)
- Western European Nuclear Regulators Association (WENRA)

#### Industry forums

- Generation IV International Forum (GIF)
- World Nuclear Association (WNA) - Cooperation in Reactor Design Evaluation and Licensing (CORDEL)

- International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)

The forum may, on occasion, invite selected representatives of these organizations or any relevant ones to participate in forum activities.

### **Amendment**

Any member of the forum, as well as the Scientific Secretariat, may propose an amendment to these Terms or Reference. Proposed amendments shall be considered and agreed upon by consensus within the Steering Committee.



## **Annex A: Description of the working topics for each working groups for the different Phases of the forum.**

### Phase 1

From March 2015 to May 2017, a pilot Phase of the forum was conducted, with the objectives of addressing the following issues for both light-water and non-light-water SMR designs:

- *Emergency Planning Zone*

Examination of existing practices and strategies for understanding how flexible (i.e., risk informed) EPZs are established in Member States and discussion on the implications that SMR characteristics bring to these existing practices and strategies

- *Defence-in-depth*

Discussions on applicability of DiD principles to SMRs.

- *Graded approach*

Examination of existing practices employed by regulators for application of graded approach. Discussion on the implications that SMR characteristics bring to these existing practices. Recommendations on approaches to clarify the use of the Graded approach for SMRs

### Phase 2

During Phase 2 (second Phase) from May 2017 to December 2020, the working groups focused on the following topics:

#### *Licensing Issues Working Group*

Explore the implications on the application of the graded approach in technical assessment and the overall regulatory inspection programme

Examine the nature of evidence available and impacts on the use of a graded approach when supporting safety claims in decision making

Discuss the impacts on licensing and regulatory approaches to address uncertainties associated with outsourcing of activities considering the modular design approach and the fact that significant decentralization of design and safety analysis activities is being seen in SMR development,

#### *Human Factors Engineering (HFE) Subgroup (works under Licensing Issues Working Group)*

Compare the state of requirements against other industry HFE best practices (aerospace, chemical industry etc) and recommend enhancements to existing IAEA documents recognizing that operation and control of the plant can be different for SMRs

Explore human factors impacts of intense I&C implementation, advanced displays and multiple module operation and maintenance on safety analysis

Improve understanding of error-likely conditions (HF and organizational effectiveness) created by outsourcing of many design and development activities and their impacts on the determination of adequate plant staffing (i.e. minimum plant complement):

#### *Design and Safety Analysis Issues Working Group*

Execute recommended follow up actions from the two-year pilot phase reports of the defence-in-depth WG

Support forum input into drafting a new IAEA Safety Guide on use of the graded approach for nuclear power plants

Provide graded approach expertise to the other working groups

Discuss and document regulatory views around the concept of what “relevant good practices” are and mean when applied to SMRs.

#### *Manufacturing, Commissioning and Operation Working Group*

This WG will build on already existing body of knowledge being generated from new build power plant OPEX by further examining the implications that SMR characteristics present to manufacturing, construction, commissioning and operation

*Construction:* Document regulatory views of SMR specific construction issues and implications in licensee oversight and regulatory inspection programs

*Commissioning:* Document regulatory views of expected SMR commissioning issues and implications in licensee oversight and regulatory inspections programs

*Operation:* Document the implications on in service inspection programs from, for example, compact system design, sealed vessels or inaccessible systems

## Phase 3

During Phase 3 (Third Phase) from January 2021 to December 2023, the working groups will consider the following topics:

### **Licensing WG**

- Framework for mutual recognition of regulators’ assessment/Joint assessments/ Collaboration
  - The high-level enablers or challenges to development of framework
  - Fundamental and technical expectations and their timeframe
  - How a regulator could utilize assessment performed by a regulator of another state
  - What kind of joint assessments could be carried out
  - How the IAEA can help. (for example, SSG 16 enabling infrastructure for newcomers)
- Legal constraints between member states considering mutual recognition. Possible areas for discussion:
  - What is not covered in international/local frameworks for international deployment?
  - Any legal implications of international supply chain

- Are legal issues with sharing information or technologies covered?
- What elements of collaboration could be identified for further work under the legal framework umbrella? Do the recommendations that the licensing groups come up with have any legal implications to them.
- Lessons learned from MDEP efforts
  - Design specific working group
- Licensing process<sup>4</sup> - Impact of the licensee's core safety capabilities to oversee the construction and operation of SMR facilities. SMR supply chain impacts on organizational capabilities of new build stakeholders with respect to stakeholders' capabilities. The difference for SMRs is that many of the potential licensees are smaller than more traditional plant licensees and may not have the depth and breadth of knowledge. With this in mind, what additional issues should a regulator consider
  - Work with MCCO WG, but focus on technical assessment of licensee capabilities (compare practices based on experience)
  - What requirements should there be for knowledge transfer from the vendor to the licensee for things like maintenance, future design changes, aging management, and operation limitations
    - What is the 'company' that is going to oversee the construction: core competencies of the licensee to oversee the construction and operation of the reactor: How is this measured during a licensing evaluation?
  - Also consider smaller deployments with outsourced monitoring and maintenance
  - Consider whether regulators should come up with some pre-licensing engagement guidelines in order that a proponent would be better prepared to enter a licensing process

### **Design and Safety Assessment WG**

- Integrate Security by Design considerations into design and safety analysis considerations (speak to interface with safety)
  - Determine what documents and guidelines exist and find if gaps exist related to SMRs and current expectations for integration of safety and security considerations in design assessments
  - Identify common features of SMRs that may be the focus of attention for the integrating safety and security considerations (e.g. underground siting, sealed cores, unmanned operation, transport of factory fuelled modules etc.)
  - Identify the barriers to integrating regulatory considerations of security and safety for SMRs, including any trade-offs specific to SMRs. Are there limits to the level of integration that can be achieved or is desirable?
  - Consider whether design optimisation across both security and safety functions is a realistic goal?
  - Is the adoption of common non-prescriptive/outcome-based regulatory regimes for both safety and security a pre-requisite to the effective integration of these functions?
  - Share practical experience on judging how security by design may be achieved (Sharing of practical examples of effective integration of security considerations during early stage plant design for SMRs)
  - What additional staff training might be needed to support integration of safety and security regulatory functions?
  - How the integration of security by design considerations into design and safety analysis is different for SMRs than NPPs? For example, consider application of the Graded Approach or defence-in-depth (DiD).
- Containment/confinement – New-design-for-containment approaches and impacts on DiD. Report common positions for topics such as:

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<sup>4</sup> Similar topical area being looked at by MCCO WG but from a different perspective of conducting authorized activities.

- The current expectations for delivery of the confinement function, and approaches to physical containment (e.g. expectations for leak tightness)
- Identified gaps in regulatory guidance with respects to SMRs including Gen IV SMRs and proposed ways forward from which common positions can be established.
- Sharing of regulatory approaches to ensuring the achievement of an appropriate balance between safety features at levels 1-3 and level 4 of DiD for SMRs
- The identification of postulated 'limiting' scenarios informing containment design for SMRs
- Regulators' expectations on multiple independent, physical barriers to the release of radioactive material
- "Low leakage" vs leak tight concepts
- Difference between containment means and containment SSCs
- Address FOAK uncertainties
- How can the IAEA help? Can the IAEA Safety Reports on applicability of the IAEA selected Safety Guides for Design be useful?
- Can the IAEA Report on Safety Assessment of SMR be useful?
- Safeguards by design (may only include input presented by Safeguards Department) – This area of work of the WG is assigned lower priority than the two previous items. The Secretariat will promote interactions with the IAEA Safeguards Department on its initiatives on safeguards by design..
  - Practical examples of safeguards-by-design in the context of SMRs including GenIV types.
  - What are the barriers to integrating safeguards considerations at the design stage for SMRs?
  - The role of international regulators in supporting safeguards by design (IAEA, Euratom, Brazilian-Argentine Agency for Accounting and Control of Nuclear Material)
  - Identification of SMR specific considerations. Identification of SMR features that may be the focus of attention for safeguards considerations (e.g. sealed cores, liquid fuels)
  - Proposed verification activities for accountancy, physical inventory and facility design for SMRs
  - Novel or specific safeguards containment/surveillance/remote monitoring equipment/measures for SMRs
  - Can the IAEA publication on "Safety, Security and Safeguards by Design" (planned by NS, NE and SG Departments) be useful?

## MCCO WG

- OPEX paper. This is a topic brought forward from Phase 2. (Report #4 OPEX).
  - Use of experience
- Implications of SMRs in long lead SSC procurement. This topic may include:
  - Differences in the meaning of "long-lead" for SMR with respect to large nuclear power plants. Just-in-time manufacturing for SMRs.
  - How the different regulators regulate long-lead procurement;
  - Degree of involvement by the regulator and where the risks lie to the future licensee;
  - The impact of time passing on the code that was used for the long lead item ("code effective" dates and reconciliations with later versions of the codes used);
  - What does the "off the shelf manufacturing" business model for SMRs mean for Regulators?
  - What are the implications from the use of innovative processes, such as additive manufacturing, for SMR components?
  - If one regulator accepts an approach, what is the basis for another regulator to do so as well? (*this is part of the Licensing WG scope*)
  - Fleetwide considerations for long lead items

- Conduct of authorized activities impact on organizational stakeholders' capabilities (Designers, Vendors, Manufacturers, Supply chains, Operators). This topic may include:
  - Licensee will likely be a smaller organisation for an SMR (than an NPP), and therefore more reliant on supply chain organisations and contractors;
  - Vendors are smaller organisations and more reliant on their suppliers;
  - Licensees and vendors may be new to nuclear, with implications for capability.
  - Experience of people in any organisation in nuclear likely to be spread thinly;
  - Likely to be more businesses involved in any function ("fragmentation") and possibility of lack of control by Licensee due to more interfaces between organisations for the Licensee to manage;
  - Likely globalisation of SMR supply chain leading to misunderstandings due to cultural differences between countries and legislation differences;
  - Tools to measure capability will be more important for SMRs than for NPPs. How to measure a Licensee's ability to measure organisational capabilities in their suppliers?
  - Learning from experience on capability.
- Configuration management. This is a topic brought forward from Phase 2. (Report #3 - Configuration management). This topic may include :
  - Implications of configuration management;
  - ANSI/EIA-649-1998;
  - Engineering changes control – different tools to apply a graded approach to maintaining the configuration within the safety case;
  - Time between the implementation of modifications for one plant, ie several modules may impact the operability of the plant or shared systems.
- Design of SMRs to allow straightforward de-commissioning and waste management. (low priority)