

Agency-wide Platform on SMRs and their Applications

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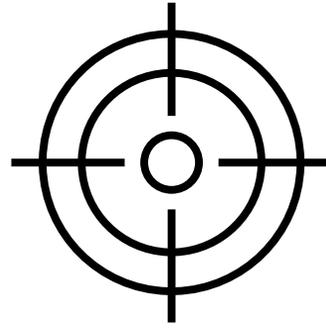
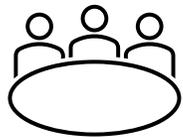
Agency-wide Platform on SMRs and their Applications



Objective: Provide national governments, experts and regulators with integrated Agency-wide support on all aspects of SMR development, deployment and oversight

What?

IAEA's internal governance to coordinate activities consistently with MSs needs and requests
Single access point for MSs and stakeholders



How?



- Develop medium-term strategy on SMR and its applications
- Create enabling environment and a portal to enhance internal as well as external communication

Why?

- Member States request for consistent, coordinated and optimized Agency support
- Effective and efficient support to Member States, International Organizations and stakeholders willing to cooperate with the IAEA



Agency-wide Platform on Small Modular Reactors and their Applications

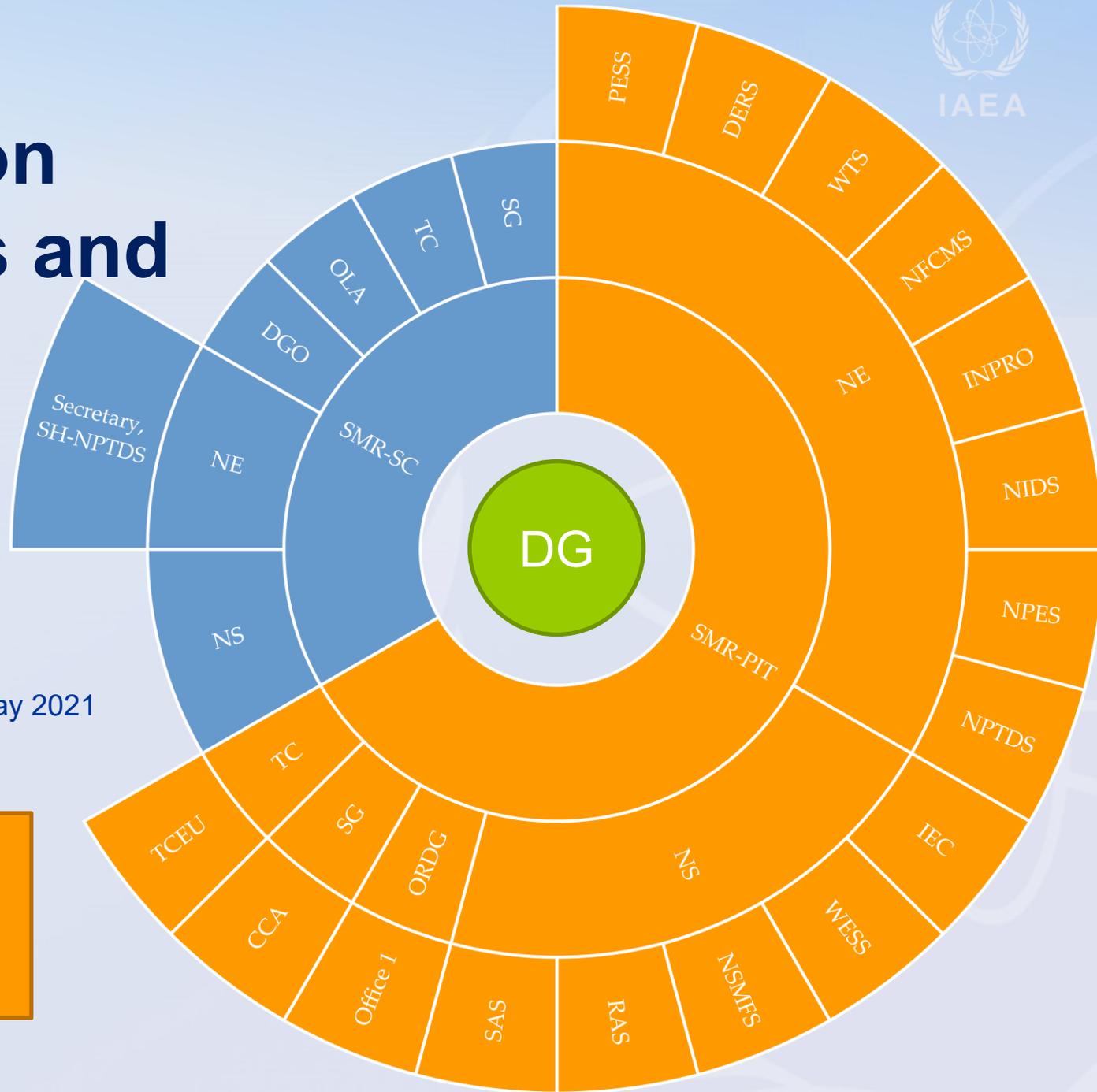
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SMR Steering Committee (SMR-SC)

+

Kick-off meeting held on 27 May 2021

SMR Platform Implementation Team (SMR-PIT)



- Kick-off meeting held on 2 July 2021
- Second Meeting held on 12 August 2021
- Third Meeting scheduled for 28 Sep 2021

Led & coordinated by NE Department

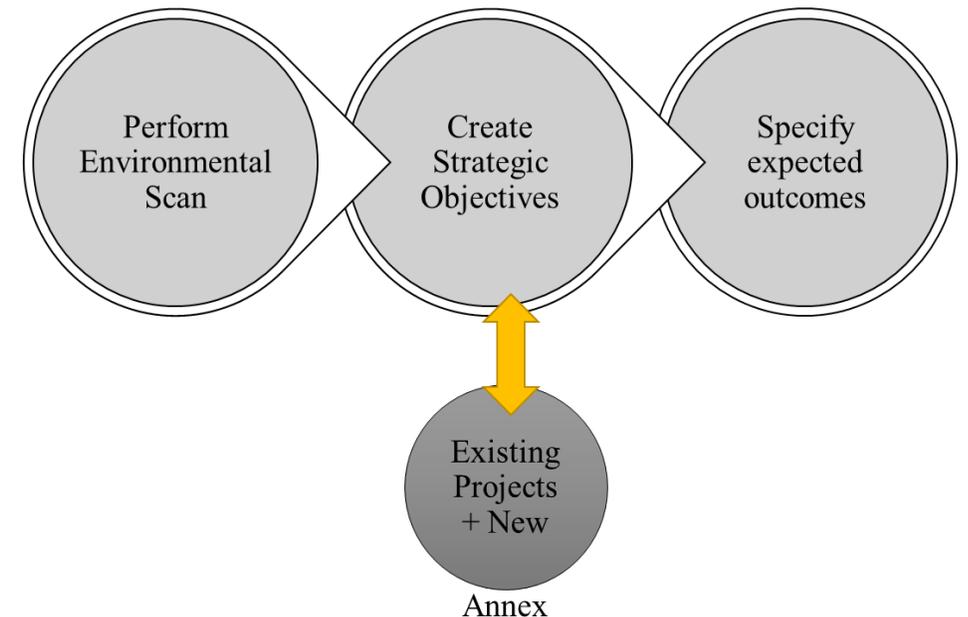
Medium Term Strategy (2022-2027)

Methodology

- i. First an environmental scan should be performed to identify MSs needs and gaps in IAEA programme
- ii. Based on the environmental scan the IAEA strategic objectives in the medium-term should be established and defined
- iii. Describe the expected outcomes in member states if strategic objectives will be met, along with the associated risk analysis

Draft Structure

- I. Introduction - strategic enablers
- II. Outcomes of the environmental Scanning
- III. Strategic Objectives
- IV. Expected Outcomes in Member States



Information Collection and Proposed Path

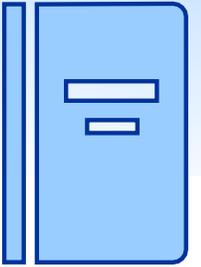
II. Environmental Scanning



High Level SMR Booklet



SMRs: A new nuclear energy paradigm



1. Understanding SMRs
2. Success – what will it take?
3. Next steps - Future: what's next for SMRs – from a decade to perspective for the century
4. The IAEA

An internal Task Force has been established
Kick-off meeting: 15 Sep 2021



SCORPION:

SMR Coordination and Resource Portal for Information Exchange, Outreach and Networking

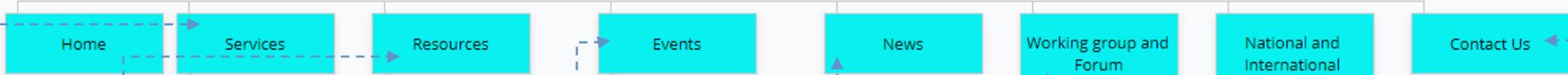
*Develop and maintain an 'SMR Portal' which will serve as a controlled **internal collaboration tool** as well as a means of **sharing information and data with internal stakeholders**. The portal will also serve as a **centralized source of information for external stakeholders** with a mechanism for registration as well as different level of data/info access authorization.*

- The Task (as per point 26(g) of the ToR)



Proposed Design (first major version)

SMR Portal



IAEA services to Member states

Resources like publications, toolkits, databases etc. + curated list of non-IAEA publications



- CRPs
- TC
- E&T
- Professional Networks
- Collaborating Centers

- Publications
 - IAEA
 - Non-IAEA
- Toolkits
 - RTA
 - Simulator

- Databases
- e-learning
- ONCORE
- Wiki

- IAEA Events
 - TM
 - CM
 - RCM
 - Webinar
- Non-IAEA Events

IAEA Events: upcoming and archive (list of last 5 year is ready to be verified by departments) + non-IAEA

- IAEA News
- Non-IAEA News

IAEA news + curated list of external news

- Working group and Forum
 - TWG-SMR
 - TWG-GCR
 - SMR - Regulator's Forum

Official working groups and forums

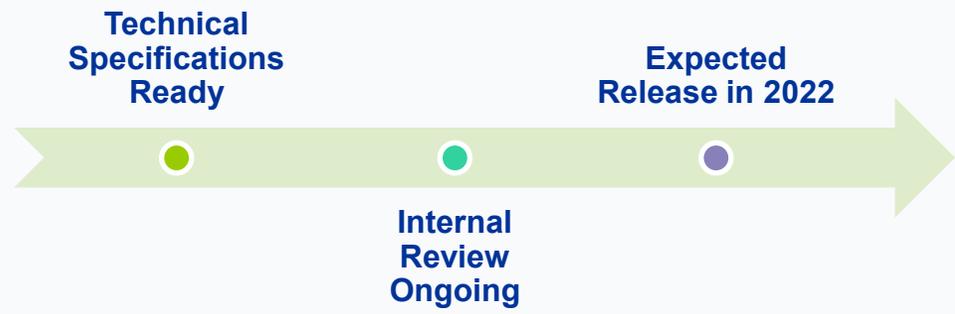
National and International Projects

- International cooperation and agreements
- Programme and Projects in MSs

Brief information about national and international projects (non-IAEA)

Contact Us

General contact point + forms to address request to SMR - SC



New TC Interregional Project



Supporting Member States' Capacity Building on Small Modular Reactors and Microreactors and their Technology and Applications – A Contribution of Nuclear Power to the Mitigation of Climate Change

Period: 2022 – 2025

Field of Activity (#6 Nuclear Power Reactors)

Objective

To improve technical knowledge, capacity building and safety review capability in developing countries addressing the fundamental aspects of SMRs/MRs and their electric and non-electric applications.

Outcome

Awareness raised on SMRs/MRs technology and their applications to enhance nuclear energy contribution in social-economic development in Member States

Currently under approval by BoG

Thank you!



SMR@iaea.org

Member States' Perspectives on SMR Developments for Near Term Deployment

Marco RICOTTI

Chair of IAEA Technical Working Group for
Small and Medium sized or Modular Reactors (TWG SMR)

Politecnico di Milano, ITALY

TWG-SMR established in Q1/2018

	Argentina Comisión Nacional de Energía Atómica (CNEA)		Australia Australian Nuclear Science and Technology Organisation (ANSTO)		Canada Canada's National Nuclear Laboratory (CNL)		China Tsinghua University
	Finland VTT Technical Research Centre		France Commissariat à l'énergie atomique et aux énergies alternatives (CEA)		India Bhabha Atomic Research Centre (BARC)		Indonesia National Nuclear Energy Agency (BATAN)
	Iran Atomic Energy Organization of Iran AEOI		Italy <u>Politecnico di Milano</u> POLIMI (The Chair for 2018 – 2021)		Japan Japan Atomic Energy Agency (JAEA)		Jordan Jordan Atomic Energy Commission (JAEC)
	Kenya Kenya Nuclear Energy Board (KNEB)		Republic of Korea Korea Atomic Energy Research Institute (KAERI)		Pakistan Pakistan Atomic Energy Commission (PAEC)		Russian Federation <u>OKBM Afrikantov</u>
	Saudi Arabia King Abdullah City of Atomic and Renewable Energy (K.A.CARE)		South Africa Department of Energy		Ukraine <u>Energoatom</u>		United Kingdom Department for Business, Energy and Industrial Strategy (BEIS)
	United States of America , Department of Energy (DOE)		Morocco Office National de l'Electricité et de l'Eau Potable (ONEE) - Observer		EC-JRC Observer		OECD-NEA Observer

Members: 21 countries = 15 countries with nuclear power + 6 countries without nuclear power including embarking countries;
 Observers: 1 country (Morocco), 2 international organizations (EC-JRC, OECD-NEA)

The functions of the TWG



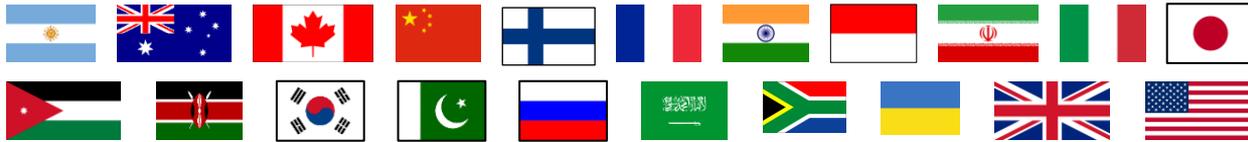
- To provide advice to DDG-NE on specific topics of relevance to the IAEA's programmatic activities;
- To share information and knowledge on national and international programmes;
- To contribute to the development of selected IAEA publications, assess existing gaps and advise on the preparation of new publications;
- Upon request, to present to the Standing Advisory Group on Nuclear Energy (SAGNE) the key findings of the TWG meeting; and
- To share experience and advice on increasing the participation of young professionals and improving the gender balance in the nuclear sector.

DDG-NE appoints *Members* in their individual capacity following their endorsement by their respective Member State(s).

International Technical Working Group on SMR (2018 – 2021 Cycle)



- **Chairperson: Mr. Marco RICOTTI, Politecnico di Milano, Italy**
- To advice and support IAEA programmatic planning and implementation in areas related to technology development, design, deployment and economics of SMRs
- Now 21 Member States and two International Organizations: European Commission and OECD-NEA as invited observers:



- Three technical subgroups established:
 - **SG-1:** Development of Generic Users Requirements and Criteria (GURC)
 - **SG-2:** Research, Technology Development and Innovation; Codes and Standards
 - **SG-3:** Industrialization, design engineering, testing, manufacturing, supply chain, and construction technology
- Three General Meetings conducted : 2018, 2019, 2020 (virtual), the last TWG-SMR Meeting was in September 2021
- Information at:

<https://nucleus.iaea.org/sites/htgr-kb/twg-smr/SitePages/Home.aspx>

SG-1: Development of Generic Users Requirements and Criteria (GURC)



IAEA GURC for SMR Technology

- **Definition:** a comprehensive statement that reflects key policy of a Member State on the expectations of its user/owner/operator on SMR technology for their nuclear power plant(s)
- **Rationale:** User organizations in developing countries embarking on NPP with SMRs do not necessarily have access to the established utility requirements from advanced countries aforementioned;
- **Nature:** Complementary to Reactor Technology Assessment and Technology Roadmap for SMR Deployment;
- **Interdisciplinary subjects, cross-cutting** between Reactor Technology with: Engineering, Infrastructure, Nuclear Energy System Sustainability, Economics & Financing, Fuel Cycle & Waste Management, Safety Assessment, Security, Safeguards, Regulatory Oversight & Licensing, Siting, Environment, and so forth.
- **Key Benefit for Member States:**
 - Facilitate embarking countries in conducting reactor technology assessment and eventually developing a tender document;
 - Provide a basis for SMR designers and technology developers to offer a licensed SMR product that addresses/incorporates specific needs of embarking countries;
 - Provide a basis for strong investor confidence that risks associated with the initial investment to complete and operate the first SMR can be minimized.

SG-1: Development of Generic Users Requirements and Criteria (GURC)



Meetings Conducted and Planned

Outputs

Kick Off Consultancy on Development of Generic User Requirements and Criteria (GURC) on Small Modular Reactor (SMR) Technology

11 -13 November 2020

GNE Advisory, Tractebel-Engie, Ontario Power Generation, Fermi Energia, EDF, BATAN, Politecnico di Milano, JAIF-ICC, Rosatom, K.A.CARE, Ultra Safe Nuclear Corporation, SAF-DEMR, STEG, Idaho National Laboratory

- First online survey
- Top 15 GURC elements for SMR technology

Technical Meeting on GURC of SMR for Near Term Deployment

24 – 27 May 2021

Brazil, Canada, China, Egypt, Estonia, France, Germany, India, Indonesia, Iran, Italy, Republic of Korea, Mexico, Morocco, Pakistan, Romania, Russian Federation, Singapore, Switzerland, United States of America, and Uzbekistan

- First online Exercise Module on GURC-SMR
- Presentation and discussion on responses result of selected questions

2nd Consultancy on Development of Generic User Requirements and Criteria (GURC) on Small Modular Reactor (SMR) Technology

30 August – 1 Sept 2021

GNE Advisory, Tractebel-Engie, Ontario Power Generation, EDF, Politecnico di Milano, JAIF-ICC, KHNP, STEG, Idaho National Laboratory

- A comprehensive review of Technical Evaluation Module (Short version) of GURC-SMR, ready for the 2nd TM
- A preliminary review of the Nuclear Energy Series Report outline, a Guidance Document on GURC-SMR

2nd Technical Meeting on GURC of SMR for Near Term Deployment
August 2022 – expecting nomination of 30 participating Member States and International Organizations

SG-2: Research, Technology Development and Innovation; Codes and Standards



Passive Engineered Safety Features in IPWRs

Completed

- Develop an approach for
 - Designing passive engineered safety features for water cooled SMRs and
 - Offering good practices for assessing their performance and reliability
 - Verification & validation methodologies

Development of Approaches, Methodologies and Criteria for Determining the Technical Basis for Emergency Planning Zone for Small Modular Reactor Deployment

Completed

- Definition of consistent approaches, methodologies, criteria to determine need for off site EPR, including EPZ/D size, for SMR deployment
- Includes identification of technology specific factors for different SMRs that may influence source term and timing of release possible sequences to be considered for emergency classification system

Technologies to enhance the competitiveness and early deployment of SMRs and HTRs

New

- Provides a forum for R&D with the objective to facilitate MS with the formulation of innovative solutions to make SMRs / HTRs more attractive viable option to diverse markets
- The Coordinated Research Project will study technologies related to reactor design and innovative power conversion of SMRs and HTRs to enhance the competitiveness and possibilities for deployment

SG-2: Research, Technology Development and Innovation; Codes and Standards



- Consider **risk-based approach** for codes and standards. Alternative methods should be considered
- **Country dependent.** IAEA can help facilitate information exchange and promote common approaches.
- **High temperature Materials for Advanced Reactors** included in Codes
- Requirements for in-service (and commissioning) **testing and surveillance** for SMRs may be different
- **Functional requirements safety design criteria** may be different between SMRs and large nuclear reactors. Identify differences in functional and operational requirements, so that S&C can be modified or exceptions are identified accordingly
- Embarking countries will benefit substantially from the availability of **OPEN SOURCE software to be able to calculate SMR design, operational and safety performance:** IAEA could facilitate access to these codes and also a conduct workshop or training to introduce users to this software

SG-2 Codes & Standards – Applicability to SMRs



Key Advantage #1: Enabling Design Simplification

- Minimized number of systems and components without compromising safety;
- Simplification to improve economics, maintainability and availability of components – without compromising safety.

Key Advantage #2: Confirm a robust supply chain:

- Assure 'diverse' supply for replacement by manufacturers other than the original manufacturers;
- Improve the assurance of sustainable operation of the nuclear power plant.

Findings on Standardization:

- Standardization alone will not solve all issues in advanced reactor product development;
- *Excellence* in applying *advanced manufacturing* and *NDE techniques* are often proprietary; not readily shareable or standardized because it would benefit competitors
- The biggest challenge to quality product is to having the capability of designing, manufacturing and delivering, within time and budget, products that meet the requirements

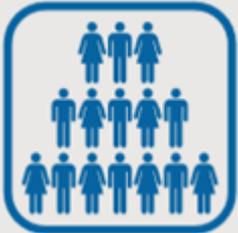
SMR Development should increasingly apply codification and standardization of Advanced Manufacturing Techniques to realize high degree of Modularity

SG-3: Industrialization, design engineering, testing, manufacturing, supply chain, and construction technology

• Support to Achieving Excellence in NPP Operation



- Power uprate and plant upgrade
- Design Change
- Configuration management
- Asset Management
- Corrective action programme
- Construction/Commissioning/Operation
- Instrumentation and Control
- Outage and maintenance management
- Ageing/Plant Life Management
- Supply Chain



- Human resource management
- Training and qualification
- Leadership
- Stakeholder involvement
- Organizational culture and management of safety and performance

Consultancy on QA and Advanced Manufacturing

- Challenges faced by the industry, manufacturers and operating nuclear power plants to implement advanced manufacturing processes while meeting industry quality assurance standards for nuclear power plants. Advanced manufacturing processes that can be discussed, but not limited to, are the following:
 - **Structure manufacturing:** powder metallurgy, metal additive manufacturing, spark plasma sintering, cryogenic machining, in-process control and qualification
 - **Welding technology:** electron beam welding, solid state friction stir welding, laser welding, in-situ welding control and real-time monitoring, irradiated material welding.
 - **Advanced cladding:** cold spray, diode laser cladding, friction stir additive manufacturing
 - **Reactor construction:** self-consolidating concrete, high strength rebar, modular construction

Agency-wide Supports to TWG-SMR



Department of Nuclear Energy

- Economic Appraisal of SMR Project
- Operation, Maintenance and Engineering
- HR Development Strategy for Deployment
- Milestone Approach: its Application to Deployment of SMR
- Fuel Cycles / Spent Fuel
- Non-Electric Applications
- Technology Assessment
- Design for Decommissioning
- Legal and Institutional Issues of Factory-fuelled, Tested and Transportable NPP

Department of Nuclear Safety and Security

- Licensing and Regulatory Frameworks
- Applicability of IAEA Safety Standards to Novel Advanced Reactors
- Seismic Design Aspects and External Safety Events considerations in SMR Deployment
- Instrumentation and Control and Computer Security for Microreactors

Department of Safeguards

- Safeguards by Design for SMR
- Proliferation Resistance characteristics of SMR

Department of Technical Cooperation

- **TC Interregional Project** on supporting Member States' Capacity Building on SMRs and their Applications – A Contribution of Nuclear Power to Climate Change Mitigation

Member States' updates



Member States	Key National Activities, Issues and/or Achievements on SMR since 2019
Argentina	CNEA participates in “High-Performance Advanced Methods and Experimental Investigations for the Safety Evaluation of Generic Small Modular Reactors
Australia	National team participates in IAEA CRP on Economic Appraisals of SMR Project
Canada	12 SMR designs in CNSC Vendor Design Review; First SMR a micro in Chalk River
China	Criticality of HTR-PM #1; ACP100 started construction, DHR-400 to start construction
Finland	Techno-Economy Evaluation of SMRs for District Heating; Studies on EPZ sizing
France	NUWARD project launched, conceptual design defined, pre-licensing with IRSN – ASN
India	longest continuous operation of KAIGA NPP-1; advanced R&Ds on Molten Salt Reactors
Indonesia	National priority to complete Feasibility Study on SMR for West Kalimantan (2020-2024)
Iran	Completed national’s users technical requirements document for selecting SMRs
Japan	HTTR-30 test reactor received license to re-operate; GTHTTR300 design development

Member States' updates



Member States	Key National Activities, Issues and/or Achievements on SMR since 2019
Jordan	Evaluation of SMRs since 2017; concerns with techno-maturity & cost competitiveness
Kenya	Capacity Building through Reactor Technology Assessment for SMR designs
Republic of Korea	Compliance evaluation of SMART Std Design Approval review started by NSSC
Pakistan	Viability of SMRs for district-heating for country's northern region in severe winter
Russian Federation	Akademik Lomonosov FNPP in operation; RITM-200N to start construction, SHELF-M for remote
Saudi Arabia	Joint R&D projects with KAERI on energy planning and SMR for Desalination
South Africa	Nuclear Knowledge Management on HTGR-type SMRs, including PBMR-400
Ukraine	Energoatom active in international for a on SMRs (INPRO, EUR, IFNEC, WNA)
United Kingdom	Rolls Royce's UK-SMR will undertake ONR's Generic Design Assessment in 2021
United States of America	NuScale received NRC's SDA in 9/2020, first module to operate by 2020 in Idaho

MS Recommendations to IAEA



- Agency-wide Platform on SMR and Applications address coordination issues
- IAEA's support to Member States in supply chain is needed
- Priority assessment of requirements and clearly defined aspects to be proven
- Applying state-of-the-art approaches to help promote the deployment of SMRs
- Embarking countries expect more information on financial scheme and economics from vendors
- Involvement of all stakeholders and interaction among them at an early stage is needed
- Expect opportunities to learn from designers' experience at more advanced stage
- National participation and localization are important for newcomer countries
- Considering market, including utility/end-user requirements and the applications
- Synchronizing cooperation with other organizations in related subjects
- Business models based on standardization and streamlined production help promote the deployment

Summary of TWG-SMR's Chairperson



- The Agency-wide Platform on SMRs and their applications – implements «holistic» approach for consistent and coordinated support to Member States
- Focusing on what is differential for SMRs when compared with current reactor technologies
- Embarking Countries: increase of awareness and knowledge on SMRs and supporting their capacity building
- Topics for medium-long term activities on SMRs:
 - Supply chain development; development of industrial codes and standards, and suitable deployment strategies
 - SMR Regulators and stakeholders interaction
 - Involvement of experts from non-nuclear communities (e.g., H2, cogen., grid TSO-Transmission System Operators); potential key role of SMRs as «green solution»
 - HR development (non-standard SMR solutions, supply chain development/ qualification/ organisation, economics/ business models, cogen. systems & processes)
 - Understanding the requirements and criteria of the users of SMRs

Thank you!





Value and Results
from Collaboration

Update on the Small Modular Reactor Regulators' Forum

Side Event GC65 – Discussion on Agency Wide
IAEA Platform on SMRs and their Applications,
Wednesday, 22 September 2021,
12:30 – 14:00 CEST

Marcel de Vos, Senior Project Officer
New Major Facilities Licensing Division
Canadian Nuclear Safety Commission

What is the SMR Regulators' Forum?

Self-funded Regulator-to-Regulator group for collaboration on SMR Issues (water-cooled and advanced concepts)

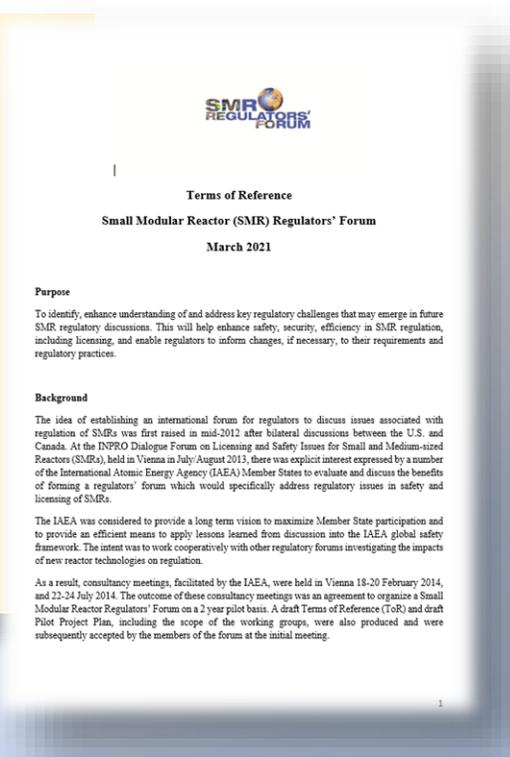
Members

- Canada
- China
- Finland
- France
- Korea
- Russian Federation
- Saudi Arabia
- South Africa
- United Kingdom
- United States

IAEA - Scientific Secretariat +
on Forum Steering Committee

Observers:

- Joint Research Centre (EC)
- OECD Nuclear Energy Agency
- WNA-CORDEL



Objectives and work driven by its members



Objectives of the Forum

- Share regulatory experience amongst Forum members preparing 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 SMRs

Emphasis is placed on supporting near-term regulatory needs but long term objectives are part of discussions



Examples of near-term versus long term regulatory areas of interest

Near-term – First of a Kind

- Leveraging information between regulators based on experience
- Implications of modular design and modular construction
- Key areas of regulatory interest in licensing process/conduct of regulated activities
- Factors in risk informed assessment of safety claims and evidence (use of Graded Approach)

Long-term – “Nth” of a Kind

- Mutual recognition of regulators’ assessment/ Joint assessments/ Collaboration
- Serial manufacturing/construction
- Transportable factory fueled reactors
- Improving sharing of experience on regulatory oversight
- Enhancing and aligning requirements and guidance using case studies and experience



Outcomes of the Forum

- Common position statements on regulatory (policy and technical) issues
 - ✓ IAEA safety framework is the benchmark but member frameworks and experience inform development of common positions
- Suggestions for revisions of, or drafting of, IAEA documents, especially on potential enhancements to the IAEA Safety Standards and Guides with respect to SMRs
- Generation and sharing of information that regulators may use to enhance their regulatory framework
- Descriptions of regulatory challenges and discussions on paths forward
- Suggestions for high level issues to be raised to international organizations for dispositioning (e.g. WANO, Standards Developers etc)

Stress the importance of a Member State's effective & independent regulatory function



Completed work of the Forum (2015-2020)

Phase 1 (2015 - 2017)

- Graded Approach
- Defence-in-Depth
- Emergency Planning Zone Size



Phase 2 (2018 - 2020)

- Licensing Issues
- Design and Safety Analysis
- Manufacturing, Commissioning and Operation

Completed reports for Phases 1 and 2 are posted on the Forum's web-page at:
<https://www.iaea.org/topics/small-modular-reactors/smr-regulators-forum>



Graded Approach Working Group (Phase 1)

- Clarified what the term Graded Approach means
 - Exists in the IAEA safety framework as well as frameworks of all regulators
 - Tools and processes for risk-informed decision making are integral to a Graded Approach
 - Confidence in supporting evidence for proposed safety provisions plays an important role
- Recommended: “...IAEA... to lead the development of a technical document that further explains what the Graded Approach is and how it is used to ensure safety”

Lessons learned inform the work of current Forum activities.

**The IAEA leveraged this work in developing a new 2021 TECDOC:
*Application of a Graded Approach in Regulating Nuclear Installations***



Defence in Depth Working Group (Phase 1)



- Defence in Depth (DiD) is a technology-neutral fundamental principle for ensuring nuclear safety and is a fundamental basis for the design and safety demonstration of SMRs
- Use of fault-tolerant fuels, innovative coolants, and inherent and passive characteristics influence how provisions are put in place for the different levels of DiD
 - Seeing increased emphasis on robust design for Levels 1-3 to seek need for less provisions at Levels 4 and 5
 - Some design features cover more than one level. Raises question: How are levels of DiD independent to the extent practicable?
- All five levels of DiD need to be addressed in a safety demonstration
 - Safety and control provisions for each level need to be commensurate with confidence in the performance of provisions for previous levels
 - Need confidence in characterization and analysis of events and progression
 - Multiple unit facilities need to consider common cause events or failures of shared features.

Work continued in Design and Safety Analysis Working Group 2018-2020



Emergency Planning Zone (EPZ) Working Group (Phase 1)

- Reviewed existing practices of member regulators
- Documented key factors and considerations underpinning the determination of EPZ boundaries
- EPZs can be scaled for facilities depending on:
 - the results of a site-specific hazard assessment,
 - implementation of '*practical elimination of large releases*' in design activities; and,
 - confidence in the effectiveness of safety and control provisions for the facility
- Siting of SMRs/advanced reactors in remote regions, near industrial facilities or in higher population regions require special consideration in EPZ determination
 - New types of challenging events? Available infrastructure for emergency response? Response times? New sensitive environments?

IAEA rolled these results into the Coordinated Research Project on EPZ for SMRs



Licensing Issues Working Group (Phase 2 & 3)

Phase 2 – Published work in 3 major areas – provided Common Positions and recommendations to IAEA for areas that should receive follow-up attention:

- **Key Regulatory Interventions (KRI)** – areas of strategic regulatory interest in the licensing process (assessment and compliance) emerging in new deployment models for reactor facilities
- **First of a Kind versus Nth-of-a-Kind** - How the safety case and licensing for a facility can differ – includes discussion on consideration of new entrants into licensing and use of serial manufacturing
- **Licensing of Multiple Unit Facilities** – Includes discussions on combined construction/commissioning/operation, sharing of structures, systems and staff

In Progress Now (Phase 3)

- **Framework for mutual recognition of regulators' assessment/joint assessments/ collaboration** – Practical and legal considerations in executing collaborative work
- **Implications of SMR supply chain on licensee's core safety capabilities** to oversee the conduct of licensed activities



Design and Safety Analysis Issues Working Group (Phase 2 & 3)



Phase 2 – Published work in 3 major areas – provided Common Positions and recommendations to IAEA for areas that should receive follow-up attention:

- **Multi-unit, multi-module aspects of SMRs** – Design and safety analysis considerations
- **Considerations in the use of passive and inherent safety features in SMR designs** - Expectations and regulatory assessment of passive and inherent safety features
- **Aspects of beyond design basis analysis relevant to SMRs** – Consideration of safety features at Level 4 defence-in-depth including design extension conditions, severe accidents and the concept of ‘practical elimination’ as introduced in Specific Safety Requirements SSR 2/1

In Progress Now (Phase 3)

- **Integration of Security, Safeguards and Safety-by-Design principles** – Focus on SMR characteristics and features (e.g. underground siting, sealed cores, autonomous and remote operation technologies, transport of factory fuelled modules etc.)
- **Clarifying requirements for confinement and design provisions for containment** – Exploring safety functions and how they interface with safety features in consideration of appropriate barriers to releases



Manufacturing, Construction, Commissioning, Operations Working Group (Phase 2 & 3)

Phase 2 – Published work in 4 major areas – provided Common Positions and recommendations to IAEA for areas that should receive follow-up attention:

- **Manufacturability, supply chain management and commissioning of SMRs** – discusses the concept of modularity and presents common regulatory positions on manufacturing, construction, and First of a Kind commissioning
- **Collection and Use of Experience in the Lifecycle of Small Modular Reactor facilities** – In many cases Operating Experience with SMRs is limited and therefore needs to be adapted or collected and sufficiently justified to support activities related to the entire lifecycle
- **Conduct of Maintenance in an SMR** – Discussions need to address the conduct of maintenance as early as possible in design taking into account Human Performance
- **Conduct of Co-activities and Combined Activities on a Multiple Unit Small Modular Reactor Facility Site** - discusses safety considerations that need to be considered up front in the design

In Progress Now (Phase 3)

- **Regulatory Considerations in Long Lead Items** – Implications of SMRs and advanced reactors to long lead item (services and goods) engagement with regulators prior to the licensing process for a specific facility
- **Capabilities of the supply chain when supporting licensees** – implications of new ownership models, new and more internationally dispersed suppliers joining the industry
- **Implications of SMR deployment on Configuration Management** – managing configurations across a fleet of facilities, including implementing engineering changes as designs are optimized over time



Supporting ongoing IAEA work on SMRs and Advanced Reactors



- Forum members with expertise in specific areas also contribute to IAEA technical meetings and consultancies
 - ✓ outputs of the Forum are promoted for use in drafting of IAEA documents
- Significant contribution to *Consultancy on Applicability of IAEA Standards and Guides to Advanced Reactors*
 - ✓ Consultancy attendees from regulators, industry and academia performed a detailed review of specific standards and guides to identify potential gaps or areas that require additional clarification
 - ✓ Many recommendations made point to specific analysis outputs of the Forum to be considered



Supporting harmonization of regulatory practices

- The Forum showcases agreement between regulators on specific nuclear safety issues
- Outputs of the Forum can be promoted and leveraged to clarify/improve IAEA safety standards and guides
 - In many cases, outputs show that information already contained in the IAEA Safety Framework can be used – with intelligent interpretation
 - Many recommendations are for supplemental guidance in specific technical areas
 - Recommendation made to consider the Forum's reports in the work of the IAEA *Consultancies on Applicability of Safety Standards to Advanced reactors*
- Outputs being used in other bilateral cooperation arrangements between regulators (e.g. joint engagements with technology developers)

In consideration of the needs of Member States embarking in Nuclear Power programmes



Promotion of the Forum's Work to Other Member States

- Organized as Regional Workshops (WS)
- Target audience: Member States Regulatory Body staff
- Divided into 2 components:
 - IAEA presents progress made on all fronts of SMRs (technology, safety, legal)
 - Forum members to present the Forum's outputs
- 1 WS planned in Jordan for December 2021 – For region: West Asia/Africa)
- 4 WS planned in 2022
 - AMSSNUR-Morocco March 2022
 - ARN-Argentina, June 2022
 - East Asia, Central-East Europe
- Funded through Forum members' contributions



Agency-wide Platform: General comments

- Greater coordination between departments across the agency will be useful
 - How it is structured and communicated out to the public will be very important
 - Structure and work under the platform must clearly show that regulatory independence is maintained
 - Demonstration of safety, security, safeguards performance of SMRs and advanced reactor technologies must remain a clear priority
- Mechanisms to enable improved and timely access to technical information will be welcomed
- Clarity is needed on how the SMR Steering Committee will work with Member States to prioritize work. Program will be highly complex.



Enabling improvements in use of IAEA Safety Framework

- Not realistic in the near-term to develop detailed guidance for every technology and SMR permutation
 - need to work with what we have and make calculated improvements as experience is gained
- Regulators increasingly being requested to document consensus on interpretation of requirements and guidance
- Interpretation of IAEA objective-focused requirements and guidance is a skill that must be learned
 - Application of risk-informed decision making (Graded Approach) in consideration of credible evidence
 - Work of SMR Regulators' Forum and recent IAEA *Consultancy on Applicability of Safety Standards to Advanced Reactors* showed how complex this can be



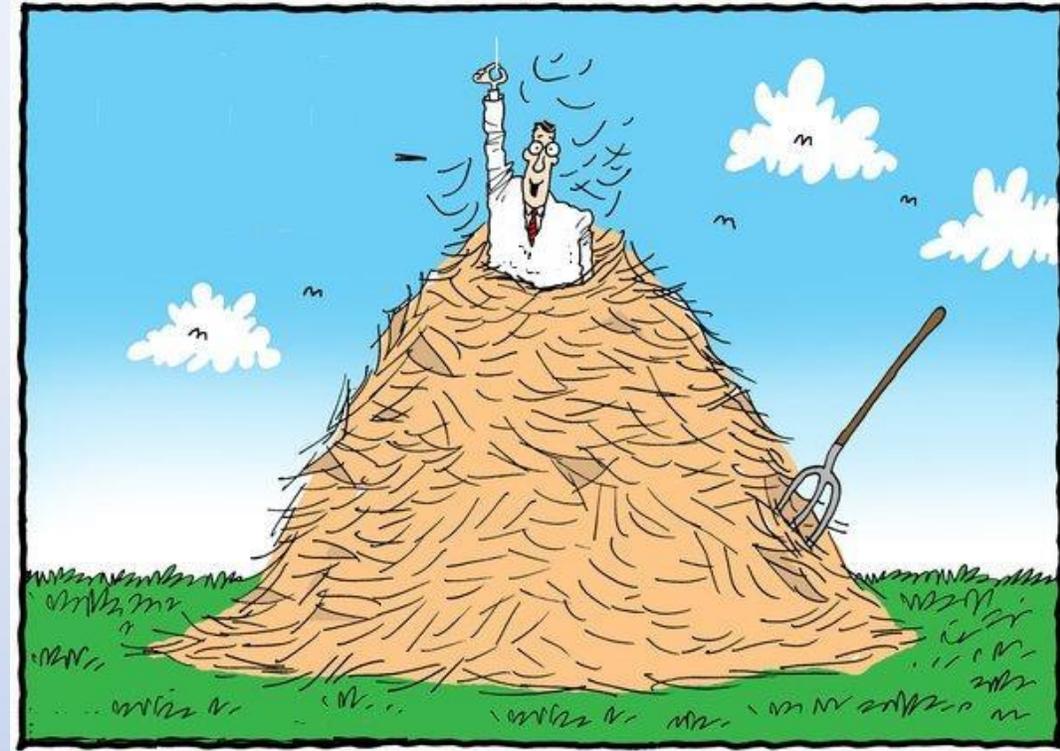
Recommendation for the Platform: Use of the Safety Framework (2)

- Improved mechanisms needed to guide regulators on which areas of safety framework interpretation should receive priority
- Expedite development of Graded Approach TECDOC covering all regulatory functions that can be applied to SMRs
- Implement programmatic elements for more detailed training in the use of the safety framework documents at a working level:
 - revisit the fundamental safety objectives underpinning requirements
 - explain the importance of systematic approaches to risk-informed decision-making as part of application of a Graded Approach
 - show how guidance can be used in a flexible and effective way when presented with innovative and novel approaches
 - highlight the role of suitable evidence to demonstrate requirements have been met
 - explain the role of proven practices (codes and standards) in using the framework



Information to enable regulatory cooperation

- Having a well organized library of common technical information will facilitate more efficient cooperative activities
- Regulators need to be confident in the quality and pedigree of information, particularly if it is to be used for decision-making
- Process will be needed to agree on regulatory information needs and how to vet such information for use



Thank you!

Please Visit the SMR Regulator's Forum Web Page

<https://www.iaea.org/topics/small-modular-reactors/smr-regulators-forum>



Small Modular Reactor (SMR) Regulators' Forum

Small modular reactors

- Small Modular Reactor (SMR) Regulators' Forum
- News
- Events
- Publications

Small Modular Reactors (SMRs) are advanced reactors that produce electricity of up to 300 MW(e) per module, which is less than current power generation reactors. Many SMRs can be made in factories and transported by truck or rail.

The establishment of regulatory controls for this relatively new type of reactor requires focused and consistent attention. The SMR Regulators' Forum, created in March 2015, provides support by enabling discussions among Member States and other stakeholders to share SMR regulatory knowledge and experience.

The Forum enhances nuclear safety by identifying and resolving common safety issues that may challenge regulatory reviews associated with SMRs and by facilitating robust and thorough regulatory decisions.

Related resources

- SMR Regulator's Forum Terms of Reference
- SMR Regulator's Forum (Restricted Site)
- Meeting Materials
- SMR Database
- Regulatory Activities Section

