Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

Information Session on Regulatory Readiness: Enhancing Efficiency and Effectiveness

in the Regulation of Small Modular Reactor Projects

CNSC Staff Presentation
To the Commission
January 21, 2021

CMD 21-M5

e-Doc 6369171 (PPTX)
e-Doc 6460689 (PDF)

Canada

Previous Information Presentations to the Commission on SMRs

CMD 14-M8, *The Evolution of Nuclear Reactor Technologies - 2014*	Introduction of SMRs as a concept
CMD 16-M71, *Development, Deployment and Regulation - 2016*	• Vendor Design Reviews (VDRs) began • Consultation comments from SMR Discussion Paper (DIS 16-04) • Start of SMR Regulators' Forum (IAEA)
CMD 18-M31, *Small Modular Reactor Update – Development, Deployment and Regulation - 2018*	• Report on the CNSC Regulatory Readiness Strategy • Increasing international cooperation

Gradually increasing SMR activities in Canada

Outline for Today's Presentation

- Canadian environmental scan
- Readiness of the regulatory framework
- How pre-licensing engagement enables efficient and effective conduct of regulatory activities
- Supporting regulatory decision making
- Conducting international engagement to support efficient and effective regulatory activities
- Readiness for effective engagement with the public and Indigenous groups

FOCUS ON NEAR-TERM REACTOR FACILITY PROJECTS IN CANADA

In many ways, SMRs are not new


Image source: Canadian Nuclear Society

- Douglas Point Generating Station (1967-1984)
- 220 MWe CANDU design
- Factory manufactured reactor assemblies and major systems transported to site for assembly


Image source: Swiss Federal Nuclear Safety Inspectorate ENSI www.ensi.ch

- Beznau Units 1 and 2 Switzerland (1969- still operating)
- 2 x 300 MWe Pressurized Water Reactors
- Also supplies district heating for the local region

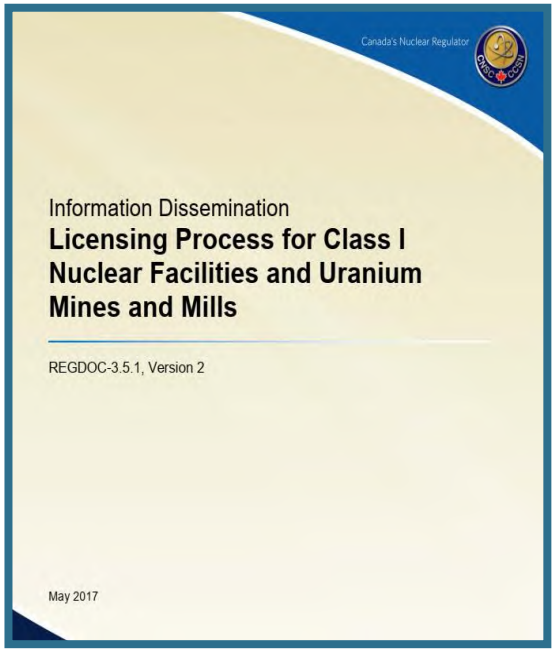
Example of Grid-Scale SMR Project

- **HTR-PM**:
  High Temperature Reactor-Pebble-bed-Module Demonstration Shidaowan, China
- 211 electrical MW, using 2 reactors, 1 turbine
- Commissioning in Progress

Image source: World Nuclear News

Licensing process for SMR Facilities

- Subject to *Class I Nuclear Facilities Regulations*
- Licensing decisions will be made by the Commission
- All 14 Safety and Control Areas to be addressed commensurate with a Graded Approach
- CNSC staff regulatory activities governed by the CNSC's risk policy



Historic Major Impacts on Project Timelines

- Completeness of licence applications
- State of completeness of design
- Novel features or approaches - Supporting information, state of Research & Development
- Outstanding safety issues
- Quality and timeliness of Construction and Commissioning
- Stakeholder engagement

CNSC REGULATORY FRAMEWORK INCORPORATES GLOBAL NEW BUILD EXPERIENCE

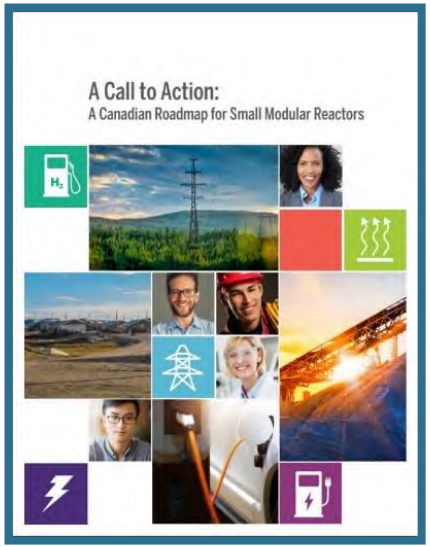
The CNSC's Role in SMR Readiness

BUILDING TRUST WITH CANADIANS

Canadian Environmental Scan

Industry efforts underway

- **SMR Road Map** developed by taking a collaborative pan-Canadian approach (Nov. 2018)
- **SMR Action Plan** issued by NRCan Minister (Dec. 2020)
- **$2.5 billion** to support pan-Canadian clean electricity transmission
  (Canada Infrastructure Bank $10 Billion, 3-year Growth Plan, Oct. 2020)
- **Canadian Nuclear Laboratories** supporting governments, industry and inviting demonstration projects
- **Various industry SMR Task Forces formed –** to address standardization, harmonization and various other technical topics



Inter-provincial Co-operation

- Memorandum of Understanding (MoU) between Ontario, Saskatchewan, New Brunswick provincial governments on deployment of advanced reactors (Nov. 2019)
- Premier Moe requested support for SMRs in Saskatchewan in the Speech from the Throne
- Alberta has signaled interest in signing onto the MoU

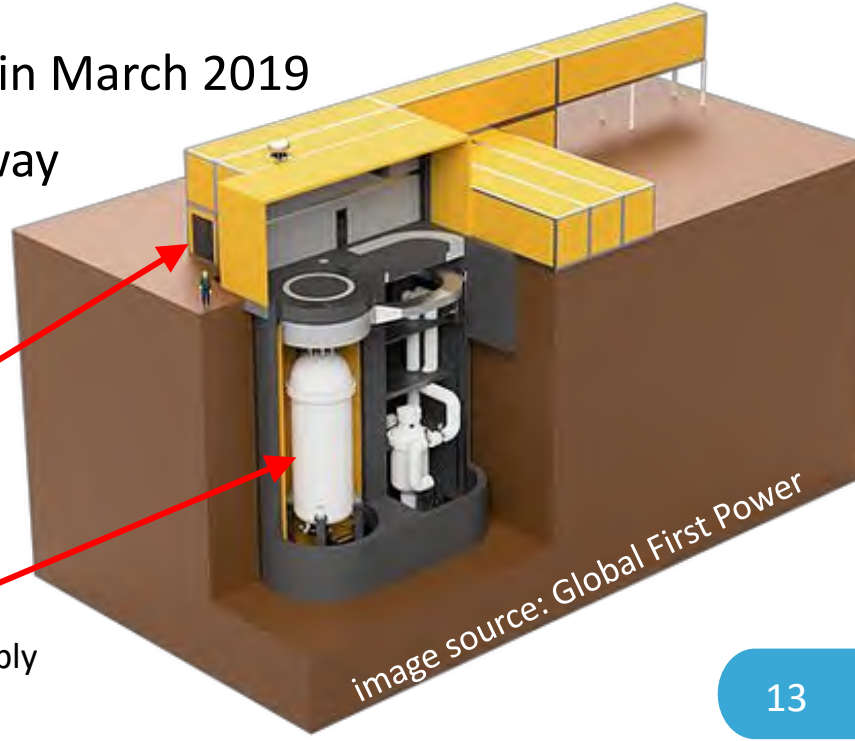
PROVINCES DECIDE WHAT TECHNOLOGIES TO ADOPT

Darlington New Nuclear Project - Ontario Power Generation, (OPG)

- Holds *Licence to Prepare Site* for new site in Clarington, Ontario
- Renewal hearing, June 2021
- In October OPG announced technology studies were in progress focusing on 3 reactor technologies
- On December 2nd, OPG notified the CNSC of its intent to apply for a licence to construct by end of March 2022

Global First Power – Chalk River, ON

- Licence to Prepare Site application received in March 2019
- CNSC-led environmental assessment underway
- 15 thermal MW facility to provide "*high quality heat tailored to end-user needs*" - up to 5 MW electrical generation
- High temperature gas-cooled
- Demonstrate commercial operation / maintenance



New Brunswick

- Supporting two SMR vendors - ARC Nuclear Canada; Moltex Energy
- Supporting analysis of using processed CANDU fuel in technologies being designed

Canadian Research and Development (R&D) Activities

Canadian laboratories and academic institutions doing R&D work on SMRs and advanced reactor concepts

- Complementing international work

Canadian Nuclear Laboratories (CNL) providing science and technology services

What the CNSC is Seeing

Many companies new to Canadian regulatory environment

- May have experience from other countries or may be new to the commercial nuclear sector

New organizational models being considered in deployment

- New / smaller proposed licensee organizations with greater reliance on support from service providers and sub-contractors
- How will they demonstrate they are qualified to conduct their proposed activities?

PRE-LICENSING ENGAGEMENT REINFORCES CANADIAN REGULATORY FRAMEWORK

Readiness of the Regulatory Framework

Enabling Infrastructure

The Canadian Regulatory Approach

The Canadian regulatory approach enables applicants/licensees to:

Be innovative in the activities they are proposing to do

Establish safety and control provisions that are in accordance with a Graded Approach

Demonstrate how they are proposing to meet fundamental nuclear safety objectives

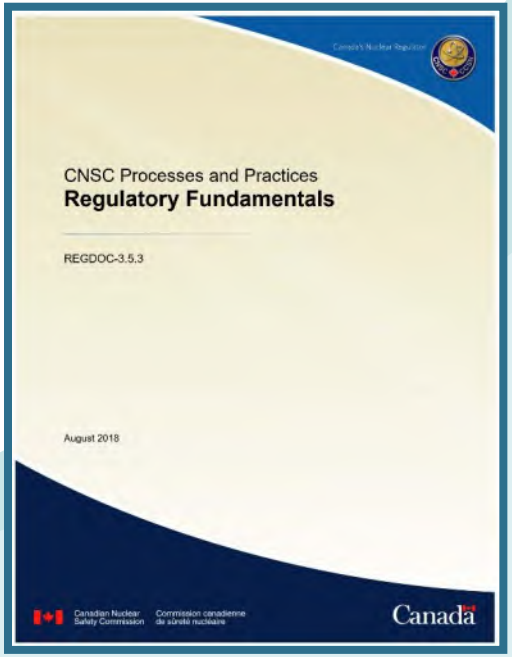
The licensee has primary responsibility for safety

FIT FOR APPLICATION TO SMR PROJECTS
UPDATED AS EXPERIENCE EVOLVES

Promoting Understanding of the Canadian Regulatory Framework

Information is available to develop a working understanding in advance of triggering decision-making processes

- Specific regulatory documents located in the “Other regulatory areas” on the CNSC’s regulatory document web-page.
- Pre-Licensing Engagement with CNSC staff



Promoting understanding of the Regulatory Framework (2018 to 2020)

- **12 presentations** at nuclear regulatory events (e.g. IAEA, Finland, U.K.)
- **8 events** hosted by industry organizations (e.g. World Nuclear Association)
- **5 events** with other industries (e.g. Canadian Mining Association)
- **7 presentations** to research & development related meetings, academia (e.g. Generation 4 & SMR Conference, Canadian Nuclear Society, University of Ontario, University of Calgary)

ENGAGEMENT ANTICIPATED TO INCREASE IN COMING YEARS

Licence Application Guides (LAGs)

- Provides guidance to applicants developing submissions in support of *Licence to Prepare Site* (LTPS), *Licence to Construct* (LTC), *Licence to Operate* (LTO)
- Can be used for any size project commensurate with novelty, complexity in accordance with a Graded Approach
- **REGDOC-1.1.5**, *Supplemental Information for Small Modular Reactor Proponents* was published in 2019

COMPLETE APPLICATIONS ENABLE EFFECTIVE AND EFFICIENT REGULATORY ASSESSMENTS

Safety and Control Areas

Regulatory Documents published for all Safety and Control Areas:

- Applicable to SMR projects
- Used in conjunction with LAGs to develop a project specific licensing basis
- Contain safety principles & objectives, requirements and guidance

Enables the use of alternative approaches to meet safety objectives underpinning requirements.

REGDOCs REVISED BASED ON ACCUMULATED EXPERIENCE

Robust Framework for Environmental Reviews

SMR projects may be subject to an impact assessment under the *Impact Assessment Act* (IAA) in accordance with the *Physical Activities Regulations.*

If not subject to the IAA, future SMR projects will be assessed under at least one
of the following processes:

- Federal lands review
- CNSC licensing process and environmental protection review under the *Nuclear Safety and Control Act* (NSCA)
- Provincial/territorial/land claim environmental assessment

PROJECTS MUST MEET ENVIRONMENTAL PROTECTION REQUIREMENTS OF NSCA

Nuclear Security Regulations: Amendments underway

- Amendments proposed to establish high level principles similar to other regulations and remove prescriptive requirements
  - ✓ Enables engineered Security-by-Design provisions in facilities
  - ✓ REGDOCs will be proposed to address requirements and guidance.
- Consultation will begin in 2021
- Expectations of Canada Gazette I in late 2021 or early 2022

SECURITY WILL NOT BE COMPROMISED

Regulatory Document Enhancements Underway

REGDOC 1.1.2 - V2, Licence Application Guide: Licence to Construct a Nuclear Power Plant

REGDOC 2.4.1 - V2 – Deterministic Safety Analysis

REGDOC 2.4.2 - V2 – Probabilistic Safety Assessment for Nuclear Power Plants

REGDOC-2.5.2 - V2 - Design of Reactor Facilities: Nuclear Power Plants

REGDOC-3.5.3 - V3 - Regulatory Fundamentals

AMENDMENTS INCORPORATING MOST RECENT EXPERIENCES

Efficient and Effective Conduct of Regulatory Activities

Optional CNSC Pre-Licensing Processes

Role of a Vendor

A vendor is part of the licensee's Procurement process.
They supply services and products to applicants.

Potential Applicant for a Project

Licensing involves an **applicant** for a **licence** who is proposing to build and operate a vendor's design. Usually an owner/operator of a plant, responsible for the safe conduct of the activities being licensed.

Vendor Design Review (VDR)

Application Assessment Strategy

SECTION 4 OF REGDOC-1.1.5, *SUPPLEMENTAL INFORMATION FOR SMALL MODULAR REACTOR PROPONENTS*

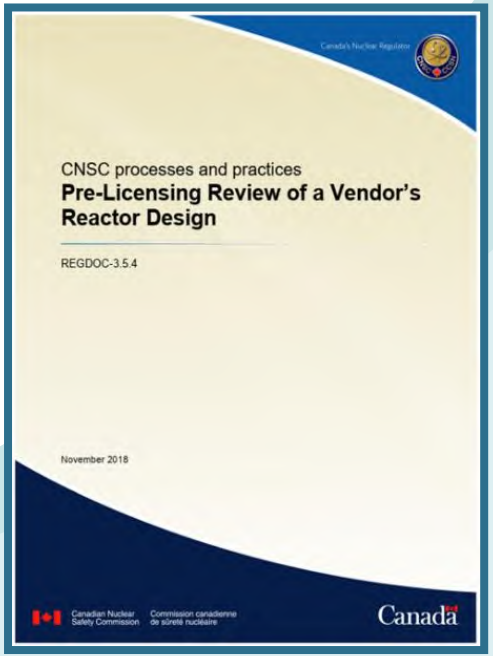
The Vendor Design Review Process

An opportunity for the Vendor to:

- Verify its understanding of Canadian requirements
- Obtain early feedback from CNSC staff on how:
  - Canadian requirements are being addressed in design and safety analysis
  - New design features and approaches are being addressed

An opportunity for CNSC staff to:

- Develop an understanding of both the vendor's organization and its design concept
- Anticipate regulatory challenges before a licensing process is triggered



Completed VDRs

Terrestrial Energy

Phase 1
Molten salt
200 MWe

UltraSafe Nuclear

Phase 1
High Temperature Gas
5 MWe

Advanced Reactor Concepts (ARC)

Phase 1
Sodium pool fast spectrum
100 MWe

SMR LLC (Holtec)

Phase 1
Pressurized Water
160 MWe

Current VDRs

Terrestrial Energy

Phase 2
Molten salt
200 MWe

Nuscale

Combined Phase 1 & 2
Integral pressurized water
50 Mwe per unit

Moltex Energy

Phase 1
Molten salt
300 MWe

GE Hitachi

Combined Phase 1 & 2
Boiling Water
300 MWe

X-Energy

Combined Phase 1 & 2
High temperature gas pebble bed
75 MWe

How Vendors can Gain Efficiencies through the VDR Process (1)

- The vendor is expected to:
  - explain how their approach meets Canadian requirements
  - choose and justify the codes standards or methods they will follow
  - identify areas that require additional research and development and explains links between the knowns and the unknowns

How Vendors can Gain Efficiencies through the VDR Process (2)

Well established management systems are important early in the design process:

- Programs and processes are logically and systematically implemented & risk-informed
- Quality management is an integral part of each process
- Basis for decisions are documented for traceability

How VDRs inform CNSC Workforce Readiness

Extensive knowledge and skills exist in the CNSC.

- Expert skills grounded in scientific and engineering fundamentals gained through education and experience
- Can generally be applied to any technology

Technology Reviews under the CNSC VDR Program:

- Expose staff to cutting edge technological issues and
- Exercise the use of our regulatory requirements and guidance

VDRs ALSO ALLOW FOR EARLY ENGAGEMENT WITH OTHER REGULATORS LOOKING AT THE SAME DESIGNS

Supporting Regulatory Decision Making

Containment/Confinement (1)

CNSC Expectation:

State that an NPP shall install a containment structure that must be:

- Designed to be leak tight
- Classified as a safety system
- Protect against external hazards
- Provide radiation shielding

Vendors Propose:

To use alternatives to fulfill the same safety objectives, such as:

- Engineering fuels with superior performance
- Improving retention of radionuclides such that failures will not result in a large release
- The use of protective civil structures

Containment (2)

Example of fuel technology that impacts traditional approach to containment

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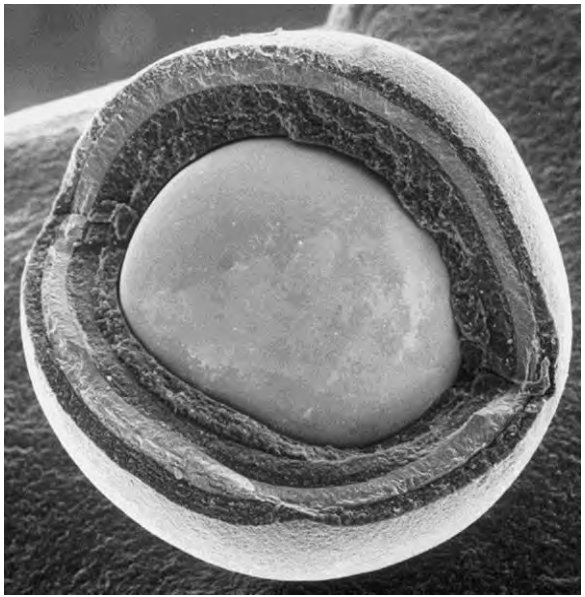
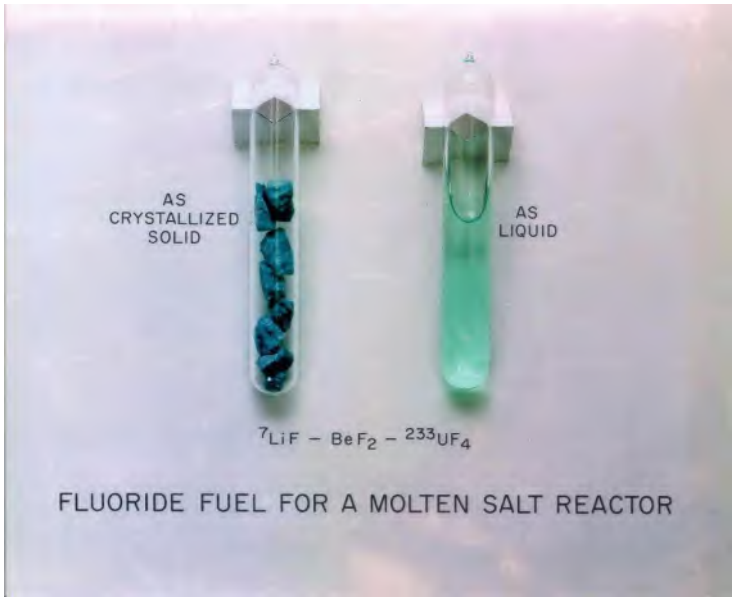


Source: *energy.gov.com*



Credit: ORNL/US DOE

Containment/Confinement (3)

CNSC Staff Expect the Vendor/applicant:

- To comply with all fundamental safety objectives including an appropriate application of defense in depth
- To provide evidence of fission product retention within the fuel particles through its fuel qualification program
- To address impacts of the generation of radionuclides outside the fuel particles through its safety analysis

Containment/Confinement (4)

Other Activities:

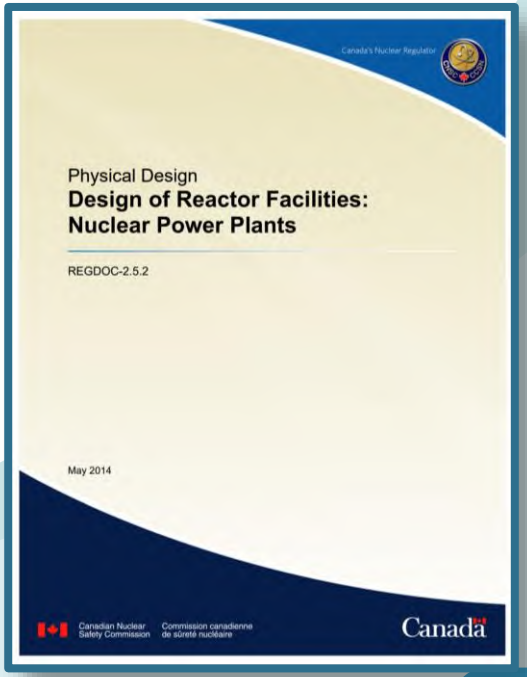
- Systematically evaluating the existing requirements to document the underlying intent
  - Information will inform further development of requirements and guidance where appropriate
- Collaborating with other Regulators (e.g, U.K. ONR)
  - Gathering historical data and perspectives

Key Principles used by CNSC staff to Address Novel Approaches

- Novel techniques/features may present challenges but also an opportunity for improvements in safety and security performance
- Regulate in a science-based and risk-informed manner
- Proposals, performance claims and the evidence supporting those claims must be provided and appropriately justified, taking into account operating experience

Key Principles used by CNSC staff to Address Novel Approaches

- Fundamental safety objectives in REGDOC 2.5.2 must be met
- Safety margins must be identified and maintained
- Credible scientific information should be leveraged to the extent practicable



Leveraging International Cooperation

To Ensure Efficient and Effective Regulatory Activities

Benefits of International Cooperation

- Enables exchange of lessons learned and ability to leverage reviews, research, and development data to support regulatory reviews
- Enables conditions for increased mutual recognition of regulators' assessment activities and the ability to conduct joint assessments where circumstances warrant

INCREASES ABILITY TO CONVERGE AND HARMONIZE REGULATORY PRACTICES

CNSC Global Influence

Multilateral collaboration

- Share and document good practices and lessons learned in IAEA's regional workshops and meetings
- Participate in working groups under the NEA
- Lead and participate in international peer reviews

Canadian Chairmanship for IAEA's Commission on Safety Standards

- Provide strategic advice on the overall IAEA's safety standards programs
- Promote worldwide application of standards

INFLUENCING INTERNATIONAL CONVERSATIONS ON READINESS FOR REGULATION OF NEW BUILD PROJECTS

SMR Regulators Forum

Self standing forum with IAEA as Scientific Secretariat aiming to:

- Understand and document regulatory implications being presented by design and deployment of SMR technologies
- Develop guidance on establishing processes for increased mutual recognition and use of regulatory information
- Provide recommendations on improvements to IAEA standards and guides

RESULTS BEING USED IN CURRENT CNSC SMR ACTIVITIES

Leveraging Bilateral Engagements (Canada-U.S.A)

Memorandum of Cooperation (MoC) between US NRC and CNSC

- Signed August 2019 to guide and expand cooperation
  on advanced reactor technologies (ART) and SMR
- ART-SMR Sub Committee established
- Terms of Reference (TOR) developed
- Collaboration on technical reviews

Leveraging Bilateral Engagements (Canada-U.K.)

Memorandum of Cooperation (MoC) between UK ONR and CNSC

- Signed October 2020 to enhance bilateral cooperation in the reviews of small modular reactors.
- Strengthening existing relationship, increasing regulatory effectiveness and supporting innovation.
- Sharing lessons learned and experience on regulatory assessment of selected topical areas
- Sharing training programs and development activities

Leading International Harmonization of Safety Requirements

The IAEA safety framework is a proven platform

- Canada is demonstrating leadership through bilateral and multilateral regulatory cooperation

CNSC is developing a process for mutual recognition and use of regulatory information

- To leverage information from another regulator that is scientific based and reviewed by a rigorous process
- To seek efficiencies in respective national reviews

DOCUMENTING COMMONALITIES WHILE UNDERSTANDING DIFFERENCES

Effective Engagement with the Public and Indigenous Groups

Engagement and Consultation

is about building and maintaining trust

- Trust in regulators is key to acceptance of decision making
- The industry, who is responsible for safety, has a key role in building trust with the public and policy makers
- Both need to establish their own long-term relationships based on cooperation, information-sharing, and robust communication amongst **the public and Indigenous groups**

A NUCLEAR POWER PROJECT LIFECYCLE EXTENDS ACROSS MULTIPLE GENERATIONS

Raising Awareness of the CNSC in Other Parts of Canada

The nuclear power sector has been traditionally concentrated in specific parts of Canada.

As other parts of the country begin to explore the potential of SMRs, the CNSC needs to, **as early as possible**:

- Introduce ourselves, explain our role and be ready to listen, meaningfully engage and consult
- Answer questions that people have about nuclear energy and how regulators ensure that licensees conduct their activities safely
- Enable participation in decision making processes

The CNSC is committed to early and ongoing engagement and information sharing with Indigenous groups and the public regarding SMRs in Canada

Enabling Participation in Decision-making Processes

The CNSC welcomes, encourages and supports participation in its decision-making processes.

- CNSC offers participant funding support to eligible applicants
- Offers multiple opportunities for the public and Indigenous groups to participate in the regulatory process for nuclear projects, including the review of CMDs and participation in Commission hearings
- Ongoing engagement and information sharing with Indigenous groups, the public and Civil Society Organizations

Diverse Engagement Approaches

- Workshops and conferences
- Presentations to municipalities and the public
- Webinars and videoconferences
- Info sheets and web content
- One-on-one meetings with Indigenous groups

ENGAGEMENT APPROACH MUST FULFILL THE NEEDS OF THE STAKEHOLDERS

Communications Initiatives

- New and continuously updated webpages, including short informative videos and feature articles
- Active social media presence to inform and join the conversation
- Timely responses to public and media requests
- Communications support in promoting participation in workshops, webinars and videoconferences

COMMUNICATIONS STRATEGY TAILORED TO THE NEEDS OF ALL STAKEHOLDERS

Conclusions (1)

- New SMR plans are accelerating - new ways to deploy and operate facilities
- The regulatory framework is ready - improvements incorporated as experience is gained
- Pre-licensing engagement enables the CNSC and proponents to ready the workforce and understand, plan and resolve potential regulatory challenges early

> "The CNSC management system is well established, documented and implemented based on a process approach which integrates all functions and activities."
>
> *- 2019 IRRS*

Conclusions (2)

- International engagement between regulators promotes leveraging of information and convergence on common safety principles and approaches
  – **this is a path to long term harmonization**
- Early and effective engagement and consultation with the public and Indigenous groups builds trust

Our state of readiness enhances efficiency and effectiveness in regulation of small modular reactor projects

THANK YOU

Questions?

Connect With Us

Join the conversation

nuclearsafety.gc.ca

Terminologies Used in This Presentation

- **Novel feature**– a technical characteristic and/or specific set of structures systems or components with highly limited practical experience relevant to nuclear applications
- **Novel approach** – a process or methodology with highly limited practical experience relevant to nuclear applications
- **Graded Approach** – A framework enabling the use of risk informing tools in a systematic manner to make decisions commensurate with novelty, complexity and potential for harm
- **Alternative Approach** – described in REGDOC 2.5.2 § 11: A proposal made to achieve underpinning safety objectives in requirements in a non-traditional manner

Additional Useful CNSC Web-Links

- Small Modular Reactors (overview)
- Strategy for Readiness to Regulate Advanced Reactor Technologies
- New reactor facility projects (overview)
- New Reactor Facility FAQs
- CNSC and US-NRC MOC and FAQs