



Small Modular Reactors (SMRs) Regulatory Approach in Canada

CNSC Presentation to
Johnson-Shoyama Graduate School
of Public Policy
University of Saskatchewan

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Canadian Nuclear Safety Commission

nuclearsafety.gc.ca



Canadian Nuclear Safety Commission

- Established May 2000, under the *Nuclear Safety and Control Act*
- Replaced the *AECB*, established in 1946, under the *Atomic Energy Control Act*
- The CNSC regulates all nuclear-related facilities and activities



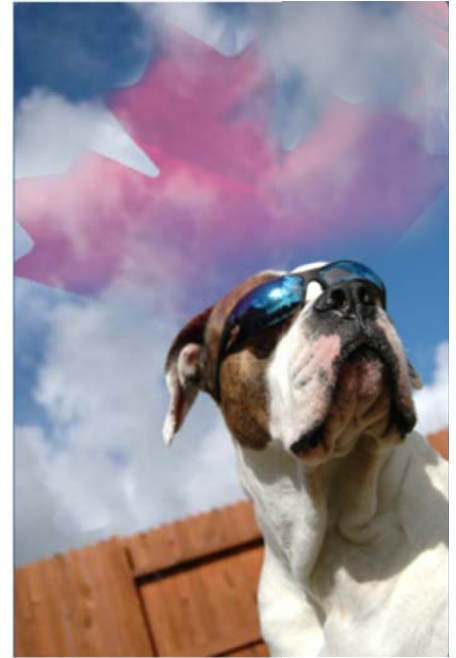
Over 69 years of experience



Our Mandate

- Regulate the use of nuclear energy and materials to protect the *health, safety* and *security* of Canadians and the *environment*
- Implement Canada's *international commitments* on the peaceful use of nuclear energy
- Disseminate *objective scientific, technical* and *regulatory information* to the public

We are Canada's nuclear watchdog!



We Will Never Compromise Safety



Protecting Workers

- Control of radioactive materials
- Control of workers' radiation doses
- Measurement of radiation
- Conventional health and safety



Protecting the public

- Measure key parameters in the environment
- Estimate potential dose to the public



Protecting the Environment

- Control releases to the air, to surface water and to ground water
- Measure releases: effects
- Take action, when required



International Commitments

- CNSC participates in a range of international undertakings including
 - Regulatory cooperation arrangements and MOUs with foreign counterparts
 - IAEA initiatives and conventions, for example Canada's nuclear non-proliferation policy
 - International Commission on Radiation Protection (ICRP)



5



Disseminating Information

Research

- Research on a wide range of topics, from health studies to the long-term management of nuclear waste in geological repositories

Publications

- Publishes and shares regulatory documents, discussion papers, informational videos, news articles, third-party health studies, research papers, and presentations



6



CNSC Regulates All Nuclear-Related Facilities and Activities

The Fuel Cycle

- Uranium mines and mills
- Uranium fuel fabrication Nuclear power plants
- Waste management facilities

Other Facilities and Activities

- Nuclear substance processing
- Industrial and medical applications
- Nuclear research and educational facilities
- Export/import of controlled nuclear substances



From Cradle to Grave

7



Our Mission

To protect the **health, safety** and **security** of persons and the **environment**; and to implement Canada's **international commitments** on the peaceful use of nuclear energy

To disseminate **objective scientific, technical and regulatory information** to the public concerning the activities of the Commission and the effects on the environment and on the health and safety of persons

8

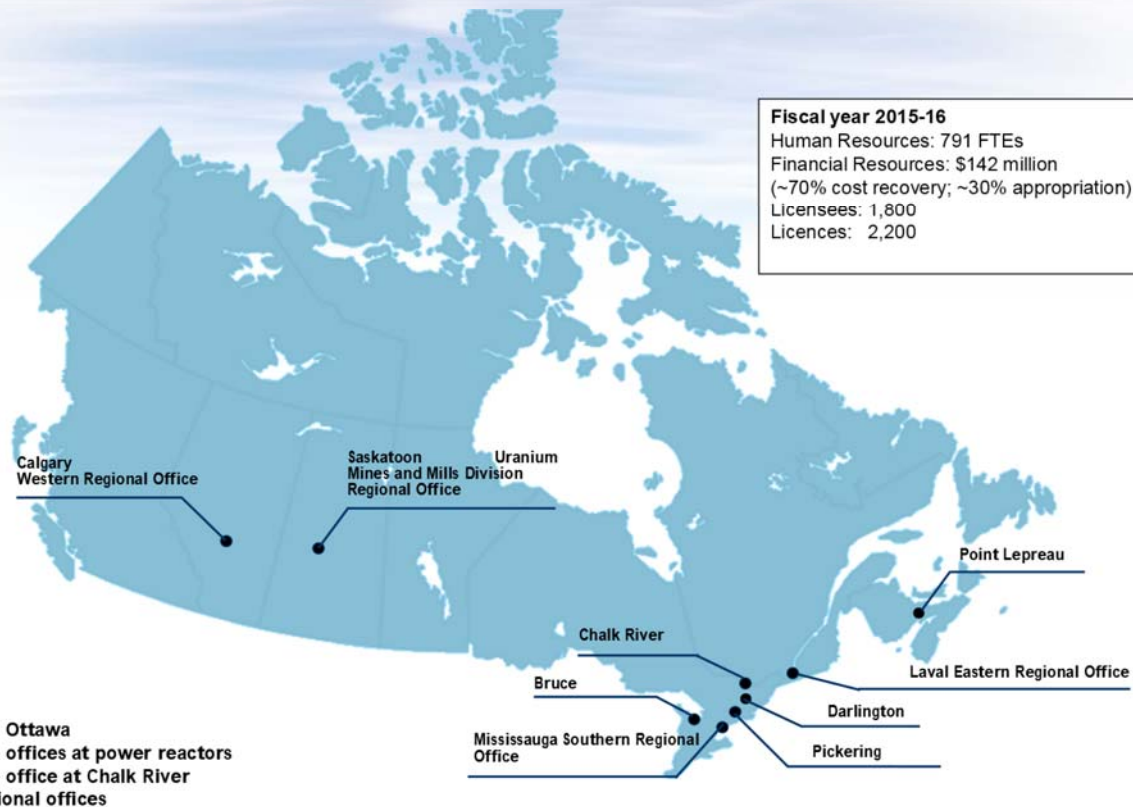


Independent Commission

- Quasi-judicial administrative tribunal
- Independent Commission members
- Public hearings
- Supported by Secretariat and independent legal services
- Decision can only be reviewed by Federal Court



Transparent, science-based decision-making



How the CNSC Reports to the Government

- The CNSC reports to Parliament through the Minister of Natural Resources



The Honourable James Carr

Constitution Act 1982
Parliament
Governor in Council

Minister of Natural Resources



11

The Commission

- Independent, quasi-judicial tribunal and court of record
- Consists of up to seven members appointed under the authority of the NSCA
- One member is designated as President of the Commission and Chief Executive Officer of the CNSC
- Supported by scientific, technical and professional staff



12



The Commission and Staff

President



Dr. Michael Binder

Permanent Commission Members



Dr. Sandy McEwan



Dr. J. Moyra J. McDill



Dr. Ronald J. Barriault



Ms. Rumina Velshi



Mr. Dan D. Tolgyesi



Mr. André Harvey

CNSC Staff

- Commission Secretariat
- Legal Service
- Regulatory Operations Branch
- Technical Support Branch
- Corporate Services Branch
- Regulatory Affairs Branch

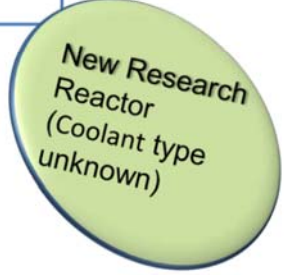
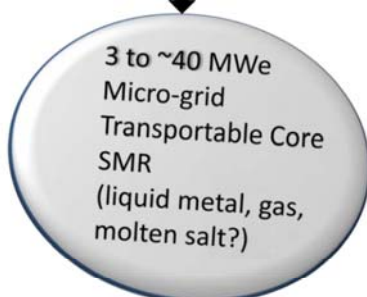
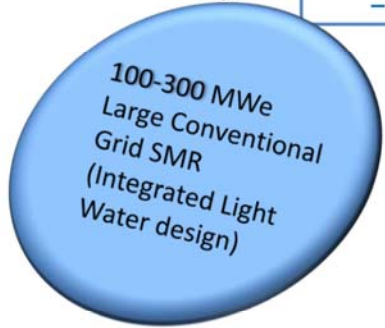


13



Meaning of “SMR” in Canada is very broad

- All share common attributes such as:
 - A controlled fission chain-reaction (with a source-term)
 - Modularity and use of factory-manufacturing
 - Proposed greater use of automation in operation
 - Proposed use of more passive and inherent safety features
 - Multiple end-uses
 - Different & possibly more challenging siting scenarios



Different safety approaches need to be supported by R&D and proven design methodologies

14

Larger SMRs – For Conventional Electrical Grids Examples

Generation mPower (USA)

Integrated Pressurized Water Reactor
~200 MWe per reactor



KAERI-SMART (Korea)

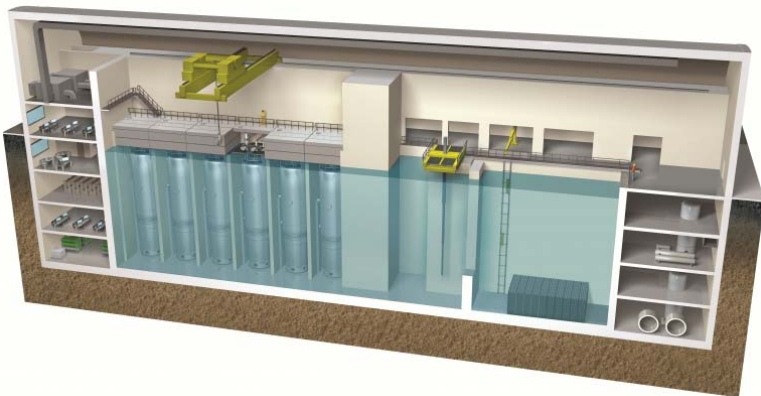
Integrated Pressurized Water Reactor ~100 MWe per
reactor



Larger SMRs – For Conventional Electrical Grids Examples (continued)

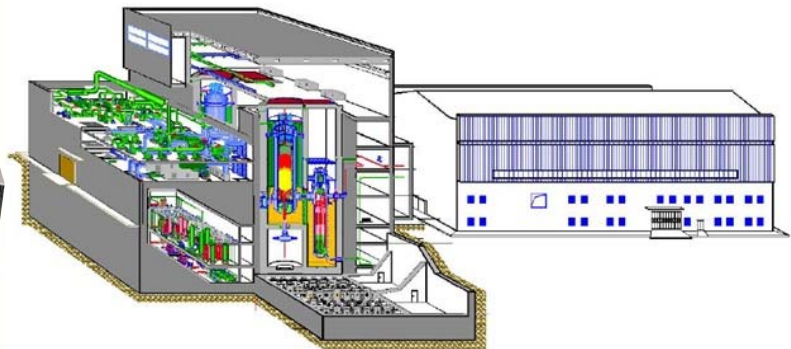
NuScale Power (USA)

Integrated Pressurized Water Reactor
~45 MWe per reactor, up to 12 reactors per facility



HTR-PM (China)

High Temperature Gas Reactor
~105 MWe per reactor





Conventional Grids – Larger SMRs / Advanced Reactors

Water Cooled

- 2 integrated Light Water Reactor companies
- 1 Boiling Water Reactor company

Non-Water Cooled (i.e. Advanced Reactors)

- 3 Molten Salt Reactor companies
- 1 Sodium Fast Reactor company
- 1 Lead Cooled Reactor company
- 1 High Temperature Gas Cooled Reactor company

As deployed multiple unit facilities, all could produce energies
(and potential source terms) equivalent to a single unit NPP

17



Smaller SMRs for Edge-of-Grid/Off-Grid

Example at right:

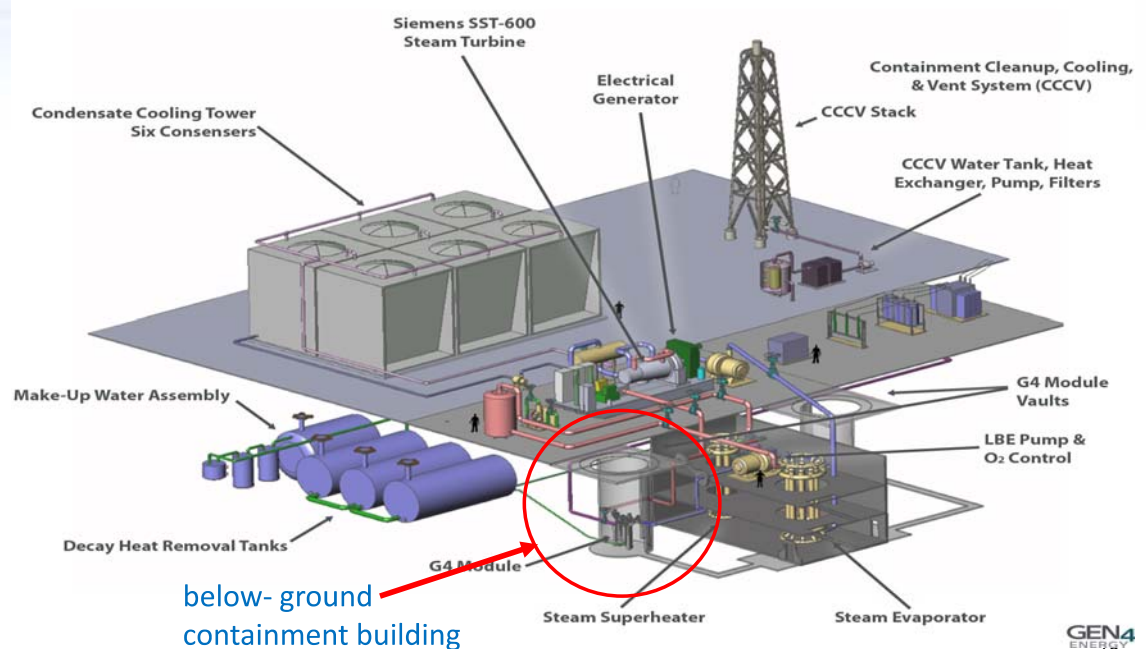
G4M Module

(Gen4 Energy - USA)

Lead Bismuth Fast
Reactor ~25 Mwe

- This type of reactor is designed for longer intervals between refueling
- Reactor core will be compact for transportability

Conceptual Drawing of Gen4 Module (G4M)-based 25MWe Electric Power Plant





Off-Grid, Edge-of-Grid – Smaller SMRs / Advanced Reactors

Non-Water Cooled (i.e. Advanced Reactors)

- 1 Molten Salt reactor company
- 1 Sodium Fast reactor company
- 2 Lead / Lead Bismuth reactor companies
- 2 High Temperature Gas Cooled reactor companies

**Transportable cores /fuel cartridges? New types of utilization?
Potential source terms / hazards are still significant**

19



What makes SMRs different

- At the root of the discussion is: **Novel approaches**
 - Need to clarify how existing requirements and guidance address these
 - Understanding where clarifications need to be made
- New technologies used within a facility
- Activities that challenge existing licensing and operational models/approaches
- Approaches that present policy questions

20

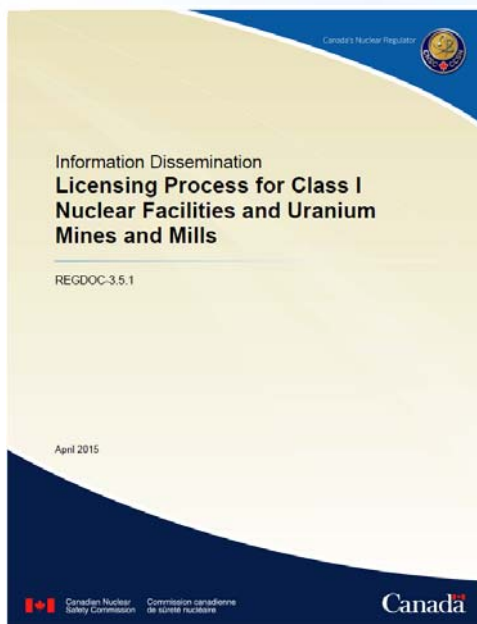
Understanding what a “SMR” represents has shaped our readiness preparations

- We recognize that:
 - Requirements must be based on well-understood nuclear safety principles that are technology neutral
 - Guidance should speak to a graded application of those requirements under different circumstances and risk scenarios (i.e., use of risk-informed insights)
 - Supporting evidence needs to be based on sound science and engineering practices

Canadian regulatory framework is risk-informed and independent of reactor size or technology

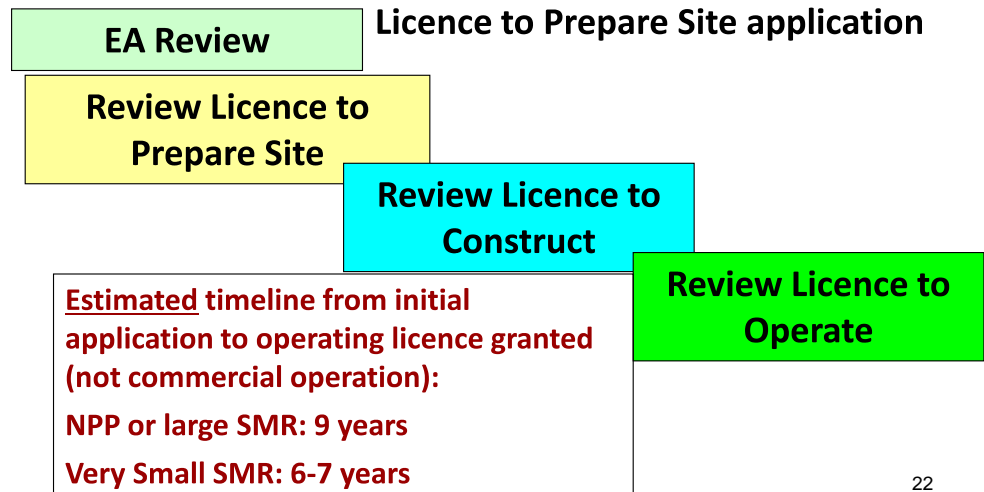
21

Licensing process is risk-informed and independent of reactor size or technology



Example: For a First of a Kind (FOAK) concept

With parallel Environmental Assessment (EA) and



22



Licence Application Guides (LAGs)

- Suggest application format and submission information



23



Things That Affect Licensing Timelines

- Completeness of licence application
- Stakeholder support (Communities, Aboriginal and public consultations, provincial/territorial agencies)
- State of completeness of design
- Outstanding safety issues
- Novel features or approaches
- Supporting R&D
- Quality and timeliness of Construction and Commissioning

CNSC is committed to meeting timelines but the applicant has to be well prepared

24



Graded Approach

- Methods used to establish stringency of the following commensurate with the level of risk posed by the reactor facility:

Design Measures

Safety Analyses

Provisions for Operation

- Factors to be considered include:
 - reactor power, reactor safety characteristics, fuel design, source term
 - amount and enrichment of fissile and fissionable material
 - what the reactor is being utilized for
 - presence of high-energy sources and other radioactive and hazardous sources
 - safety design features
 - siting, proximity to populated areas

Requirements are not relaxed: Safety will not be compromised

25



Examples of CNSC Requirements that can already be applied to SMRs

- REGDOC 2.4.1, *Deterministic Safety Analysis*
- REGDOC 2.5.2, *Design Requirements for Nuclear Power Plants (for larger SMRs)*
- RD-367, *Design of Small Reactor Facilities (For smaller SMRs)*
- REGDOC 2.3.2, *Accident Management, version 2*
- REGDOC 2.10.1, *Nuclear Emergency Preparedness and Response*

All address the use of the Graded Approach

26



SMR Discussion Paper DIS-16-01

- Expected to be released for public consultation in next few months
- Different audiences being considered to maximize feedback:
 - Public at large – to explain SMR concepts and approaches to regulation
 - Existing licensees
 - Vendors and (Build Own Operate) utilities originating from outside Canada but exploring Canadian deployment (i.e., no Canadian regulatory experience)
 - Government agencies (provincial, territorial and federal)
 - Educational and S&T Institutions
 - Foreign nuclear regulators are interested

27



SMR Discussion Paper DIS-16-01 (continued)

- Will speak to how we would address licensing (incl. technical assessment) should an application be submitted now
- Will discuss key international issues and:
 - show how the issue is currently addressed in Canadian regulatory requirements
 - identify challenges in a Canadian context
 - ask for feedback (thoughts, concerns, proposals)

28



Regulatory / licensing issues appear to fall into 3 broad groups:

First Group - Issue not likely a problem	Existing requirements and guidance already address the issue
Second Group - Issue requires some clarification (Short to medium lead time to resolve)	Clarification may be needed around application of the graded approach or the basis of the requirements needs to be more clearly expressed For now, can be addressed in pre-licensing engagement discussions (e.g. Vendor Design Reviews)
Third Group - Issue requires significant regulatory analysis to understand potential risks and mitigation approaches Long lead time to resolve Challenges: <ul style="list-style-type: none"> • We are not sure if or when the issue might be proposed in an application • May be technology dependent 	CNSC staff will consider proposals in developing regulatory positions based on science and engineering practices Public consultations, through processes such as CNSC Discussion Papers, will help to further establish regulatory positions prior to developing or modifying requirements and guidance Issues may also benefit from international discussion through regulatory cooperative arrangements

29



What will feedback on the SMR discussion paper be used for?

- Commission meeting being planned for 2016
 - Update being provided on SMR activities
- Inputs to be considered in regulatory framework
 - Impacts on regulatory requirements and guidance
 - Development work on standards
- Inputs into regulatory research program

30



In Conclusion...

- CNSC's regulatory framework is robust, flexible and technology neutral:
 - We are committed to setting the right level of requirements and guidance to enable flexibility without compromising safety
 - Positions are informed by engineering judgement and scientific data
- Applicant / licensee needs to be prepared to demonstrate their proposals will meet or exceed requirements

31



We Will Never
Compromise Safety...

... It's In Our DNA!

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