



Canadian Nuclear
Safety Commission

Commission canadienne
de sûreté nucléaire

CNSC's Regulatory Approach to Small Modular Reactors and Other Advanced Technologies – Presentation to UK Nuclear Graduates

Stephanie Herstead
Project Officer
New Major Facilities Licensing Division



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nuclearsafety.gc.ca

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Outline



- Background
- National Highlights and Challenges
- Pre-Licensing Engagement
- Regulatory Framework Considerations
- Conclusions

Small Modular Reactors (SMRs)



- There are a wide range of technologies and power levels under consideration
- Many developers propose to use novel and integrated technological approaches for design, construction and operation
 - proposing alternative approaches to meeting requirements
 - extensive use of factory-built modules

Technology Evolution



Regulatory approach

Objective-based
with few prescriptive
requirements

More prescriptive
More regulatory
certainty

New safety claims
and no operational
experience – return
to objective-based?

National Highlights



- New Canada-wide roadmap for SMRs under development
- Canadian Nuclear Laboratories' Request for Expression of Interest on SMR Strategy
- Established nuclear utilities
 - are interested in becoming SMR operators for companies seeking to deploy SMRs in Canada
 - have introduced a new forum to discuss SMR issues



Deployment-Related Challenges



Deployment strategies include:

- security by design
- unattended / remote operation
- transportable / relocatable cores
- extensive use of factory-constructed facility / reactor modules

Safety claims can be validated by supporting evidence and a “first-of-a-kind” facility

Design-Related Challenges



- New engineered safety features have limitations and uncertainties that must be understood and addressed
 - passive safety features require proof of concept
- In-service inspection for sealed components and fitness-for-service
- Lack of operational experience
- Understanding how safety margins are being established

Pre-licensing vendor design reviews allow some challenges to be addressed early

Pre-Licensing Engagement



- Stakeholders are encouraged to engage with the CNSC early
- Formal pre-licensing activities:
 - *GD-385, Pre-licensing Review of a Vendor's Reactor Design*
 - *Determining Appropriate Licensing Strategies for Novel Nuclear Technologies*

Vendor Design Review Highlights



A vendor design review:

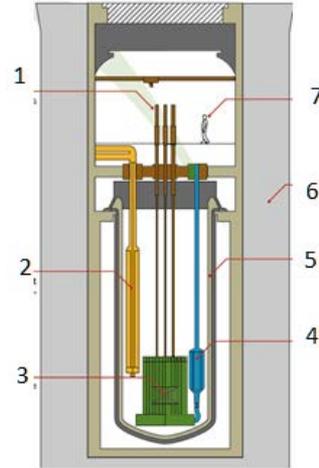
- considers areas of design related to reactor safety, security and safeguards
- provides feedback on the vendor's efforts to address Canadian requirements in their design and safety analysis
- provides early feedback on the use of new design features and approaches
- promotes early identification of key issues and fundamental barriers
- identifies research activities that will support the design review and future licensing

The Commission retains the final licensing decision

Currently Engaged Vendors



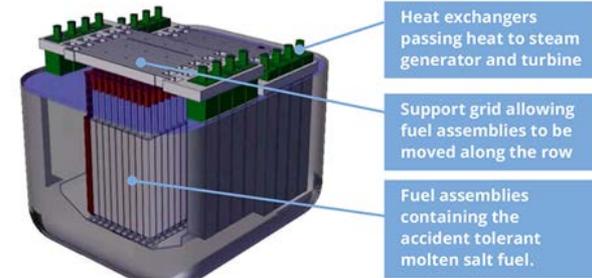
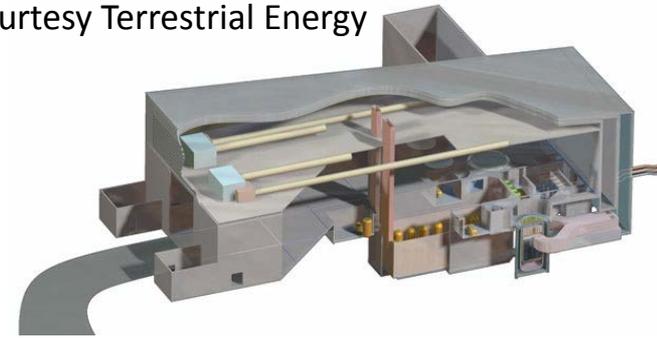
- **Terrestrial Energy**
- **Ultra Safe Nuclear Corporation**
- **Advanced Reactor Concepts**
- **Moltex Energy**
- **SMR LLC (Holtec)**
- **NuScale Power**
- **Westinghouse eVinci**
- **LeadCold**
- **URENCO**
- **StarCore Nuclear**



- 1) Control rods 2) Heat exchanger
3) Reactor core 4) Pump 5) Reactor vessel
6) Concrete 7) Human scale

Cross section of core module –
courtesy ARC Nuclear

IMSR-400 facility cross section –
courtesy Terrestrial Energy



Moltex design – courtesy Moltex 10

Determining Appropriate Licensing Strategies



for Novel Nuclear Technologies

Ensures a systematic and consistent risk-informed approach

Prepare for and establish a preliminary description of hazards

Conduct risk assessment and document proposed licensing strategy

Operations management decides on licensing strategy

Licensing strategy decision is communicated to the proponent

Proposal is evaluated on potential hazards, complexity and novelty

Licensing strategy recommends most appropriate regulations, licence application guide, REGDOCs and scope/depth of licensing review for each safety and control area

Proponent is informed of licence application expectations

Regulatory Framework Considerations

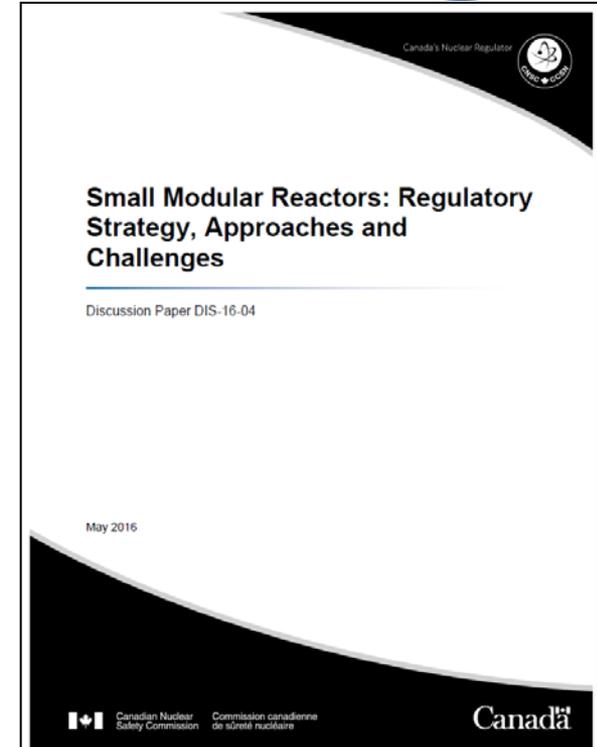


- *Nuclear Safety and Control Act*, regulations and complete suite of regulatory documents ensure safety requirements in all aspects of design, construction, operation, etc.
 - based on 60 years of operating experience of both heavy and light water reactors
 - alternative approaches are allowed, provided safety objectives are met (being used successfully in vendor design reviews for advanced reactors)

Key SMR Regulatory Framework Activities



- SMR Discussion Paper (DIS-16-04)
 - written to inform and validate readiness activities
 - *What We Heard Report*
- Graded approach workshop



What Is a Graded Approach?



- A graded approach is used by regulators and proponents/licensees
- A graded approach is fundamentally good engineering judgment, supported by a framework of decision-making tools, and rules that rest upon an organization's management system
 - documents the analyses supporting decision making
- Proponents need to demonstrate their proposal meets requirements

A graded approach is the way in which risk-informed decisions are made to arrive at a response that is proportional to the hazards

Graded Approach Workshop



The CNSC committed to providing greater clarity on the application of a graded approach for SMRs. The workshop examined:

- the application of the graded approach in regulating SMRs
- feedback from participants on the material presented, with a focus on fundamental safety principles

A synopsis of the workshop will be published shortly.

Conclusions



- Our regulatory framework is robust, flexible and based on decades of operating experience and can be applied to advanced reactor technologies.
- Our regulatory framework and internal processes are risk-informed and can be used to license advanced reactors; they allow for proposing alternatives and the use of grading.
- Vendor design reviews are a key element in establishing readiness.

A hand holding a sign that says 'Safety First'.

**Safety
First**

The CNSC is ready and able to license SMRs

For More Information on the CNSC...



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Thank You!



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