



# CNSC Review of Vendor Designs for Generation IV and Small Modular Reactors

## 1st International Conference on Generation IV and Small Reactors: G4SR-1

Ottawa, Canada  
November 7, 2018

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Canadian Nuclear Safety Commission

[nuclearsafety.gc.ca](http://nuclearsafety.gc.ca)

eDOCS #5641711

# Our Mandate

- Regulate the use of nuclear energy and materials to protect **health, safety**, and **security** 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



# Independent Commission

- Quasi-judicial administrative tribunal
- Agent of the Crown (duty to consult)
- Reports to Parliament through Minister of Natural Resources
- Commission members are independent and part-time
- Commission hearings are public and webcast
- Public presentations by staff
- Decisions are reviewable by Federal Court

**Transparent,  
science-based  
decision  
making**

# Role of VP, Technical Support Branch

- Chief Science Officer
- Provides technical support, as the technical support organization, to the Regulatory Operations Branch and, ultimately, to the Commission
- Supports licensing decisions by assessing and providing judgment on safety cases submitted by applicants
- Responsible for all vendor design reviews (VDRs)
  - technical lead for the review of the different safety focus areas
  - integrates and signs off on the final technical report



# Regulatory Approach



# Safety

## The Cornerstone of the CNSC Mandate

### **Section 24(4) of the *Nuclear Safety and Control Act (NSCA)***

No licence shall be issued, renewed, amended or replaced ... unless, in the opinion of the Commission, the applicant ...

- (a)** is qualified to carry on the activity that the licence will authorize the licensee to carry on; and
- (b)** will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

# Regulatory Approach

## The CNSC establishes safety requirements

- CNSC regulatory philosophy is flexible in that it allows a proponent to propose how the design will meet the intent of a requirement without compromising safety

## Graded approach

- safety commensurate with risk
- not a relaxation of requirements
- higher levels of uncertainty lead to increased safety and control measures

## Combination of management, performance-based and prescriptive approaches

**Alternative approaches can be used to meet the intent of many regulatory requirements**

**The current regulatory framework is fit for reviewing advanced reactors**



# Small Modular Reactor Designs



# New Innovative Reactor Designs

**The CNSC is currently reviewing small modular reactor (SMR) designs with:**

- non-traditional fuel
- operation in the fast neutron spectrum
- gas, light water, or liquid metal cooling
- longer fuel cycles
- non-traditional deployment models
- modular construction
- transportable reactors
- security by design
- higher operating temperatures

**New designs  
bring new  
innovation**



# Vendor Design Review



# Purpose of Vendor Design Reviews

- The CNSC's vendor design review (VDR) process evaluates if:
  - the vendor understands Canadian regulatory requirements and expectations
  - the design, as it is evolving, complies with, as applicable, [REGDOC 2.5.2, Design of Reactor Facilities: Nuclear Power Plants](#), and/or [RD-367, Design of Small Reactor Facilities](#), and related regulatory documents and national standards
  - a resolution plan exists for any design issues identified in the review
- A VDR does not consider deployment issues, such as:
  - cost-benefit analysis
  - social acceptability
  - site-specific issues

**A completed VDR does not constitute an approval of a design!**

# Vendor Design Reviews and Licensing Process

## Optional pre-licensing

Vendor design review

- Reactor vendor
- GD-385, *Pre-licensing Review of a Vendor's Reactor Design*

Determining appropriate licensing strategy

- Potential applicant

Environmental assessment

## Licensing

Site preparation

Construction

Operation

Decommissioning

- Under licence to prepare site
- Licence application guide (REGDOC-1.1.1)

- Under licence to construct
- Licence application guide (RD/GD-369 – under revision)

- Under licence to operate
- Licence application guide (REGDOC-1.1.3)

- Under licence to decommission

**Draft REGDOC-1.1.5, *Licence Application Guide: Small Modular Reactor Facilities***  
**For all licensing stages of SMR facilities**

# How Is a Licensee Different From a Vendor?

- **Licensees** hold a licence, issued under section 24(4) of the NSCA
  - they are *qualified* and have made *adequate provisions* for the activities they are licensed to carry out
- **Vendors** develop technologies based on design requirements solicited from potential licensees
- **Proponents** are entities interested in carrying out a project, but that have not yet submitted a licence application

# VDR Assessment Phases



- Conceptual design largely completed
- Vendor demonstrates understanding of CNSC design requirements and shows how their design, as it is evolving, would be able to meet CNSC requirements

- Basic engineering program is either well
- underway or completed. Vendor demonstrates:
  - through design processes and system level design information that the design is capable of meeting CNSC requirements
  - how sufficient evidence is being generated to support safety claims
- The CNSC identifies where potential fundamental barriers to licensing may exist or are emerging in the design

- Vendor seeks more information or clarification from the CNSC about a Phase 2 topic, and/or
- Vendor asks the CNSC to review activities undertaken towards design readiness, following the completion of Phase 2
- Phase 3 VDR activity and scope is vendor-driven, based on need

# VDR Process Management

- VDRs are conducted using a managed process:
  - CNSC subject matter experts use procedures and work instructions to review vendor design submissions
  - internal committees are available to examine and resolve challenges stemming from novel approaches to design
  - lessons learned are documented after a VDR is completed and used to further improve the CNSC's capability

# Benefits of a VDR

Vendor	Potential applicant	CNSC
<ul style="list-style-type: none"><li>• Gains a better understanding of the regulatory requirements and process</li><li>• Understands which aspects of their proposal may trigger additional regulatory scrutiny and can consider whether scaling their proposal is desirable</li><li>• Provides the vendor with information that can be used when holding discussions with a potential applicant</li></ul>	<ul style="list-style-type: none"><li>• Helps ensure an efficient and effective licensing process</li><li>• Identify and address regulatory issues early enough so that delays in licensing and facility construction can be minimized</li></ul>	<ul style="list-style-type: none"><li>• Leads to higher- quality licence applications</li><li>• Aids CNSC staff with readiness for licence applications</li></ul>



# Technical Considerations



# Evidence to Support Safety Claims for Novel Designs

- For novel approaches, safety claims must be supported by validated and quality-assured scientific and engineering processes:
  - adequate and relevant experimental or field-derived data
  - relevant operating experience
  - existing codes and standards
  - qualification program
  - computer modelling
  - uncertainties characterized and demonstratively accounted for
  - critical in areas where engineering codes are not available, or not fully applicable
- **Research and development is critical** in support of safety claims
  - demonstrates completeness and adequacy
  - incorporates reactor lifecycle considerations
  - supplements safety case when existing codes, standards and proven technologies are not available

**Final quality of design must be commensurate with the necessary safety function**

# Additional Design Considerations

- A first-of-a-kind reactor, without the benefit of operating experience, will have to account for potential unknowns that may challenge the safety case
- Vendors are encouraged to perform a critical self-review of their design:
  - use conservative estimates and consider potential unknowns
  - consider the holistic effect on the reactor whenever design changes are made
- Mitigation methods may include:
  - additional margins
  - additional facility monitoring
  - compensatory systems
  - conservatism in design
  - restrictive operating parameters
  - enhanced commissioning activities to demonstrate safety claims

# Conclusions

- The CNSC is an independent regulator that continues to support government initiatives in the area of SMRs
- There is a regulatory framework in place that can be applied to new designs
- Reactor designs may be innovative, but must be based on solid nuclear safety and engineering practices
- The CNSC encourages early engagement through VDRs
- A VDR is beneficial for all stakeholders
- VDR submissions should be comprehensive and supported by appropriate evidence



Thank You





Canadian Nuclear  
Safety Commission

Commission canadienne  
de sûreté nucléaire

Canada

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# Appendix

## Current Vendor Designs Under Review

No.	Country of origin	Company (design)	Reactor type	Elec. output per unit	Status
1	Canada– U.S.	Terrestrial Energy (IMSR-400)	Molten salt (graphite moderated)	200 MWe	Phase 1 – Completed Phase 2 – Service agreement signed
2	U.S.– Korea– China	Ultra Safe Nuclear (MMR-5)	High-temperature gas cooled (graphite moderated)	5 MWe	Phase 1 – Near completion Phase 2 – Service agreement signed
3	Sweden– Canada	LeadCold (SEALER)	Liquid metal cooled - Lead (no moderator - fast spectrum)	3 to 10 MWe	Phase 1 – On hold at vendor’s request
4	U.S.	Advanced Reactor Concepts (ARC-100)	Liquid metal cooled - Sodium (no moderator - fast spectrum)	100 MWe	Phase 1 – In progress
5	UK	Urenco (U-Battery)	High-temperature gas cooled (graphite moderated)	4 MWe	Phase 1 – Service agreement under development
6	UK	Moltex Energy (SSR-W300)	Molten salt (no moderator - fast spectrum)	300 MWe	Phase 1 – In progress
7	Canada – U.S.	StarCore Nuclear	High-temperature gas cooled (graphite moderated)	20 MWe	Phase 1 & 2 – Service agreement under development
8	U.S.	SMR LLC – a Holtec International Company (SMR-160)	Pressurized water (light-water moderated - PWR)	160 MWe	Phase 1 – On hold
9	U.S.	NuScale Power (NuScale)	Pressurized water (light-water moderated - PWR)	50 MWe	Phase 2*– Service agreement under development
10	U.S.	Westinghouse Electric (eVinci)	Heat pipe / Nuclear battery (yttrium hydride moderated)	< 25 MWe	Phase 2*– Service agreement under development

