CNSC Regulatory Approach for Fusion Related Activities

DOE/NRC/FIA Public Forum on Regulations for Fusion
Discussion Session 1: Regulator Perspectives
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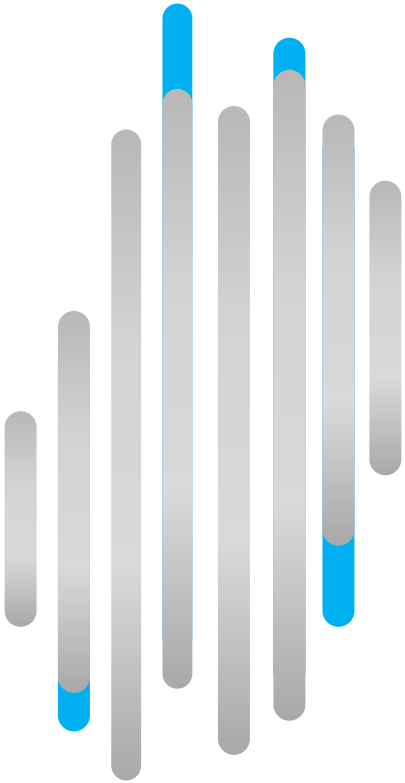


The Basics:

- Who we are
- The Regulatory Framework and Fusion Activities

Canadian Nuclear Safety Commission Mandate

REGULATE
the use of nuclear energy and materials to protect health, safety, and security and the environment

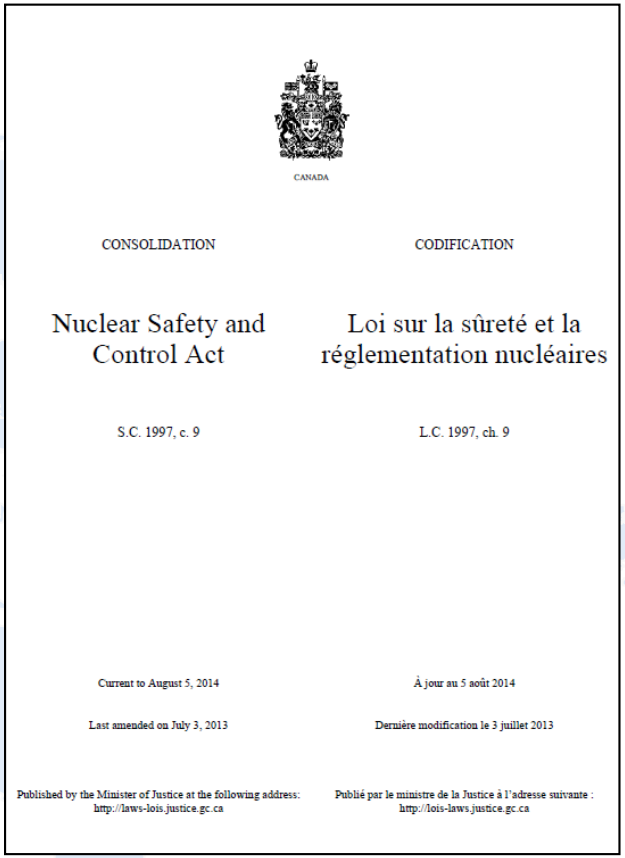
IMPLEMENT
Canada's international commitments on the peaceful use of nuclear energy

DISSEMINATE
objective scientific, technical and regulatory information to the public

Legal Basis for Risk-informed Regulation

§ 3. *The purpose of this Act is to provide for*
(a) the limitation, to a reasonable level and in a manner that is consistent with Canada's international obligations, of the risks to national security, the health and safety of persons and the environment that are associated with the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information…

CNSC mandate covers both radiological and non-radiological risks in the conduct of regulated activities



CANADA

CONSOLIDATION

CODIFICATION

Nuclear Safety and Control Act

Loi sur la sûreté et la réglementation nucléaires

S.C. 1997, c. 9

L.C. 1997, ch. 9

Current to August 5, 2014

À jour au 5 août 2014

Last amended on July 3, 2013

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Section 26 of the *Nuclear Safety and Control Act*

26 Subject to the regulations, no person shall, except in accordance with a licence,

(a) possess, transfer, import, export, use or abandon a nuclear substance, prescribed equipment or prescribed information;

(b) mine, produce, refine, convert, enrich, process, reprocess, package, transport, manage, store or dispose of a nuclear substance;

(c) produce or service prescribed equipment;

(d) operate a dosimetry service for the purposes of this Act;

(e) prepare a site for, construct, operate, modify, decommission or abandon a nuclear facility; or

(f) construct, operate, decommission or abandon a nuclear-powered vehicle or bring a nuclear-powered vehicle into Canada.

Regulation is associated with the conduct of the above activities

Basis for a Licensing Decision (technology independent)

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

No licence may 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

Licensee is responsible for the safe conduct of the activities being licensed

Applicant's safety case must be supported by evidence

CNSC Discussion Paper DIS 16-04, *Small Modular Reactors: Regulatory Strategy, Approaches and Challenges*

Section 3 included an opportunity for the Fusion industry to present their perspectives in a number of regulatory areas of interest in the Canadian Regulatory framework. Key points from the "What We Heard Report":

- There are a number of different technology approaches being evaluated.
- "*A single regulatory framework could be applicable to both fusion and fission reactors and any combination of them*."
- "*If the risk of operating a fusion reactor is quantifiable, then it should be regulated similarly to a fission reactor with the same quantifiable risk*."
- "*…although the hazards are different, the mechanisms for quantifying and managing those risks are the same*"

CNSC position: "*The regulatory framework is intended to take into consideration the level of risk posed by a proposal. Application of this framework would be adapted to the specific options considered by a proponent*"

Examples of Regulations that may apply to specific fusion related activities (case-by-case)

Existing Regulations	Applies to
General Nuclear Safety and Control Regulations	All nuclear facilities and CNSC licensees and applicants
Radiation Protection Regulations	All nuclear facilities and CNSC licensees and applicants
Nuclear Substances and Radiation Devices Regulations	All nuclear substances, sealed sources, radiation devices, licensees and applicants
Class I Nuclear Facilities Regulations	Class 1 Nuclear Facilities (includes fusion reactors)
Nuclear Non-proliferation Import and Export Control Regulations	Any CNSC licensee and applicant with respect to import and export activities

Licences for Fusion Related Activities

Existing CNSC licensing processes and licence formats can be used.

Licensing process will be commensurate with the proposed activities and the regulations that apply.

Safety and Control Areas (SCA)

Safety and Control Areas (SCAs)
Management System
Human Performance Management
Operating Performance
Safety Analysis
Physical Design
Fitness for Service
Radiation Protection
Conventional Health and Safety
Environmental Protection
Emergency Management and Fire Protection
Waste Management
Security
Safeguards and Non-Proliferation
Packaging and Transport
Other
Informing the public
Siting and EA

- Technical topics used by the CNSC to assess, review, verify and report on regulatory requirements and performance across all regulated facilities and activities
- Regulatory framework documents exist for each Safety and Control Area (SCA)
- Scope and depth considerations for each SCA are applied commensurate with novelty, complexity and potential for harm.
- Application comprises the safety case, and is part of the licensing basis for the regulated activity

The design of the facility is not the only consideration in licensing

Regulatory Documents

- × currently do not have expectations specifically addressing Fusion activities

BUT Regulatory Documents…

- ✓ take into account international best practices and align with IAEA Safety Fundamentals and Safety Requirements
- ✓ are not embedded in regulations, and,
- ✓ contain fundamental safety principles and objectives that can be applied to fusion activities commensurate with importance to safety

This provides for a measure of flexibility and enables CNSC staff to apply professional judgement

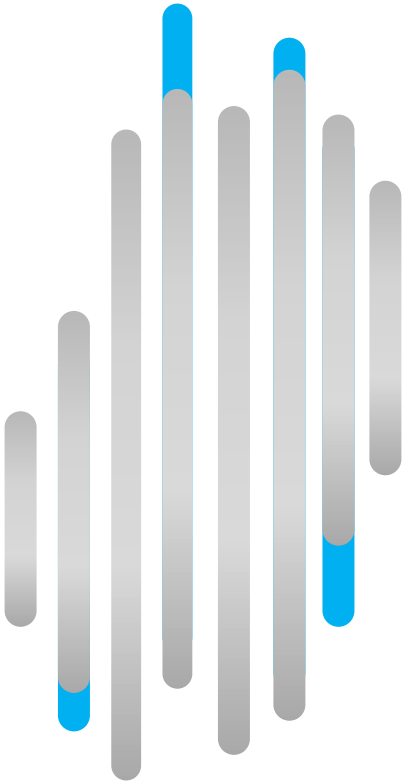
The applicant is expected to support safety claims with evidence

More about this later….

CNSC staff are continually assessing how proposed activities would be regulated in Canada

- CNSC staff currently using its existing technology neutral framework to engage with proponents proposing fusion facilities, using graded and risk informed approaches
- CNSC staff engaging an external expert party to:
  - review the CNSC's Regulatory Framework through the lens of a user considering fusion related activities
  - focus on requirements and guidance that may need additional clarity
  - recommend areas that need attention for consideration in the CNSC's regulatory framework work plan
  - recommend areas that require additional preparations with respect to compliance verification
- Projected project completion by Fall 2021

Will provide independent third party validation of CNSC's Regulatory Framework's "technology neutral" nature



Pre-Licensing Engagement with a potential applicant for a licence:

- Enabling proponents to prepare to enter the licensing process for their proposed activities
- Enabling CNSC to regulate in a Risk-informed and efficient manner

Pre-Licensing Engagement Triggers

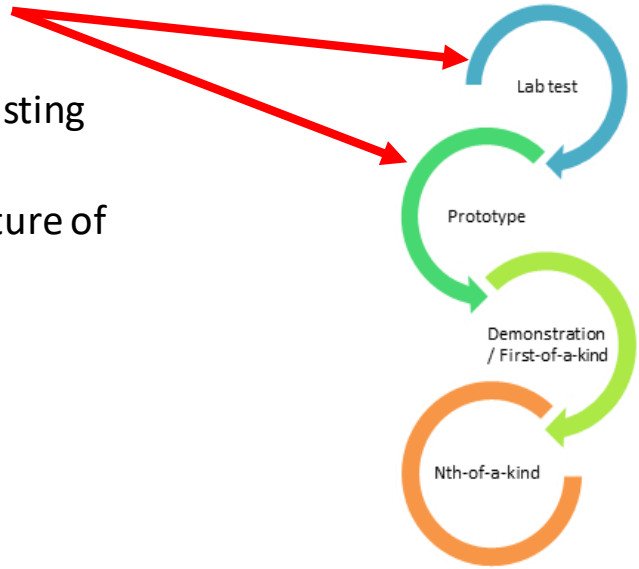
Pre-licensing engagement is productive when considering:

- New types of activities being proposed with little or no past experience
  - Understanding the state of proven practices and levels of uncertainties that may need to be considered in regulatory decision-making
- New technological approaches that require extensive interpretation of requirements
- New organizational models for conducting a project
- New ways to conduct activities (e.g. construction approaches)

What are the right tools and processes necessary to regulate the conduct of activities (if needed) in a Risk-informed and efficient manner?

Fusion related activities happening now in Canada

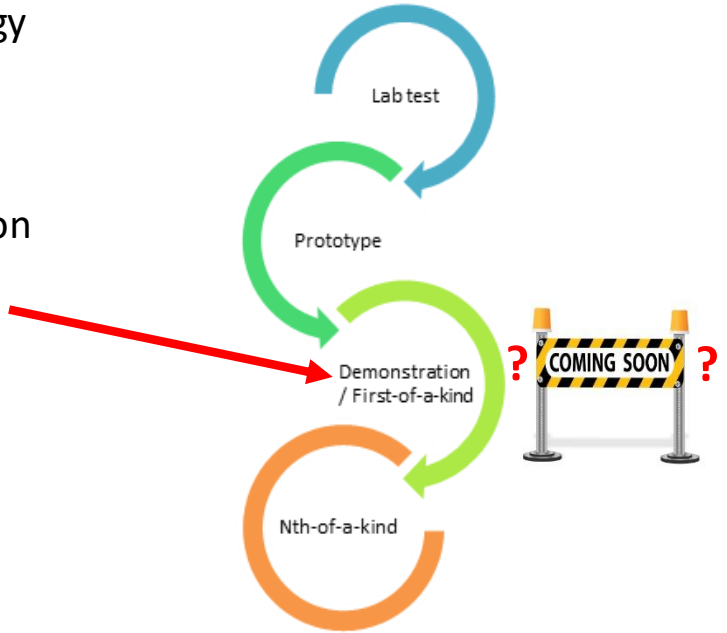
- Individual lab-test and prototypical experiments being performed to investigate physics phenomena or develop specific components
- These activities can be regulated using appropriate existing processes and requirements taking into account:
  - Scale and complexity of experiments and the nature of energies involved
  - Use of nuclear substances
  - Use of hazardous substances
  - Need to manage waste appropriately



Pre-licensing engagement does not result in regulatory decision-making

CNSC Preparing for Proposals for Integrated Demonstration and First of a Kind Facilities

- Recognition that there is a need to remain technology neutral
  - There are different concepts being developed
  - Availability of operating experience will vary
- CNSC will use existing tools for Risk-informed Decision Making
  - Many existing time-proven fundamental safety principles and practices remain valid
  - Proposals must be supported by appropriate evidence commensurate with importance to safety
  - Uncertainties need to be characterized and addressed in a systematic manner by the applicant



Risks different from fission reactors but understanding and addressing hazards remains central to demonstration of limitation of risk to a reasonable level

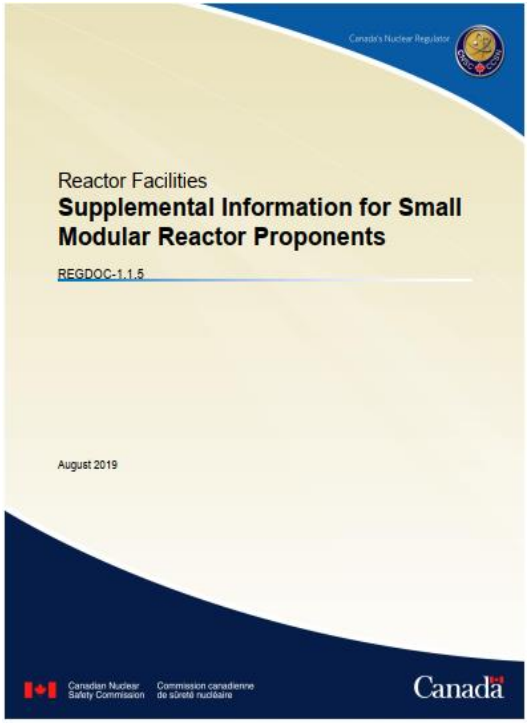
Current pre-licensing activities

- General Fusion holds a class II development and testing licence, originally issued in 2012 and renewed in 2017 (expiry 2022)
  - Has publicly announced plans to pursue a Fusion Energy Demonstration Plant project
  - Given the novelty of the project, CNSC has discussed the pre-licensing engagement process with General Fusion

These discussions do not evaluate the technology against regulatory requirements, but they do consider technological implications on the safe conduct of regulated activities

Leveraging REGDOC-1.1.5 as a regulatory guide for fusion proponents

- Section 4.2.2, *Supplemental Information for Small Modular Reactor Proponents*
  - Can be applied beyond fission reactors
  - Describes a useful case-by-case Risk-informed process to establish an appropriate application assessment strategy for novel activities
  - Includes criteria for proponents to use to describe the conceptual project's activities and hazards
  - Contains Safety and Control Area (SCA)-specific information that a proponent should consider when determining the extent on the emphasis to give each SCA



CNSC's case-by-case Risk-informed process to establish an appropriate application assessment strategy

4 steps for effective pre-licensing communications between a proponent and CNSC staff

Step 1

A written preliminary description of the proposed activity or facility is developed and submitted by a proponent

- Who is the proponent?
- Nature of activities?
- Potential hazards?
- Safety and control measures to be implemented for each Safety and Control Area?
- How are uncertainties being addressed?

Step 2

The submission is assessed by CNSC staff, with conclusions and recommendations documented in a draft report

- Identify applicable regulatory requirements that can be leveraged
- Recommend an application assessment strategy for use in a licensing process
- Identify possible regulatory approaches to address unresolved uncertainties

Step 3

The draft report is reviewed and the strategy is decided on by CNSC management and technical experts

- Verifies the strategy is appropriate given the information provided

Step 4

The CNSC lead licensing director formally responds with a supplemental guidance letter

Consideration of hazards that may exist when conducting fusion related activities

Non-radiological risks	Radiological risks
• chemistry of materials • hydrogen explosion • lithium and other fire hazards • hot metals • dust related to molten metal circulation (explosion, toxicity) • active magnetic fields (effect on humans and consequences of failure) • electric hazards • electronic control systems and external effect on them (plasma, high currents and magnetic fields)	• tritium handling (e.g., remote handling requirements) • tritium releases (operational and accidental) • fast neutrons (fusion releases high energy neutrons) • ionizing radiation other than neutrons resulting from fusion reactions • mobilization of activated materials; neutron activation of material • erosion of the molten metal transport systems (metal to metal friction) and transport of radioactive particles in it • plasma containment failure

Dependent on the nature of proposed activities

Identifying applicable regulatory requirements that can be leveraged

- CNSC staff use the information provided to look for precedents that have been established in similar cases, e.g.
  - Activities being regulated with a similar hazard profile
  - What is different between the current proposal and what has been done in the past?
  - What are the implications of the differences (including uncertainties) on effectiveness of safety and control measures?
  - What were the lessons learned and how should they be addressed in this case?
- CNSC staff then recommend the appropriate set of regulations that apply and which regulatory framework tools (e.g. regulatory documents) that can be leveraged using a graded approach
- Fundamental safety principles remain central to the analysis, such as:
  - The licensee must have appropriate and effective management systems (including quality assurance) for safety, security and environmental protection
  - A defence-in-depth approach is used in the design of safety provisions
  - Radiation Exposures kept As Low as Reasonably Achievable (ALARA)
  - Information used to support safety claims is appropriately quality assured commensurate with safety importance

Requirements for use of "*Proven Engineering Practices*"

REGDOC 2.5.2: *Design of Reactor Facilities: Nuclear Power Plants*

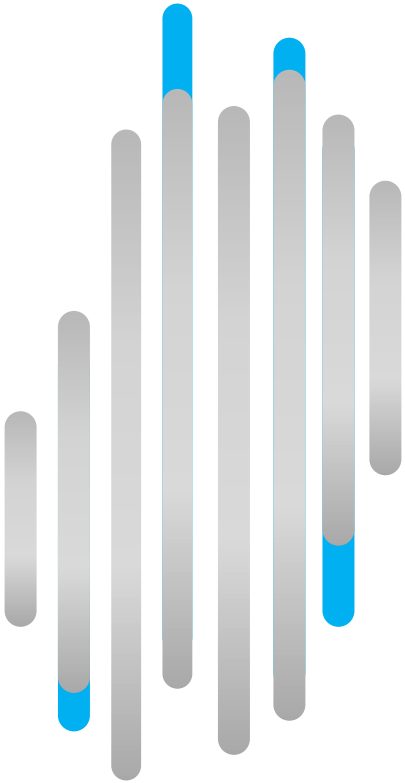
Section 5.4: *Proven Engineering Practices*

"When a new Structure System and Component (SSC) design, feature or engineering practice is introduced, adequate safety shall be demonstrated by a combination of supporting research and development programs and by examination of relevant experience from similar applications.

An adequate qualification program shall be established to verify that the new design meets all applicable safety requirements.

New designs shall be tested before being brought into service and shall be monitored while in service so as to verify that the expected behaviour is achieved."

Although technology developers are proposing design solutions, the applicant/licensee must ultimately decide how they will accept and use them.



And finally...

How can regulators work together?

There is Great Potential for International Cooperation and Harmonization of regulatory requirements for fusion

- The sharing of scientific information between countries can improve regulatory efficiency in the licensing process
  - Industry has a role to enable regulators to access and share quality credible information
  - Regulators can leverage information used by other regulators as long as it is applicable to the specific proposal – It is up to the applicant to demonstrate this.

- Fusion represents a "*from-the-ground-up*" opportunity for regulators to come to an agreement on harmonized regulatory requirements at the international level.
  - International Atomic Energy Agency (IAEA) safety standards and guides contain many time-proven safety objectives that can be used as a starting point to establish specific requirements and guidance applicable to fusion

- CNSC is open to engaging with the U.S. NRC and U.K. ONR to further advance cooperation in these areas.

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