The Canadian Nuclear Safety Commission – Thoughts on Regulating Fusion

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CNSC Mandate

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

Not Part Of Our Mandate…

- Promoting the use of nuclear energy
  - But we will have an informed opinion on its safe-use
- Indigenous rights and treaty determination
- Provincial and Federal Government energy policy such as what mix or types of energy to use
- Provincial and Federal Government waste policies
- Selecting sites or technologies to be used in licensed activities

Regulatory Responsibilities

CNSC responsibilities

- Set safety requirements, inform licensees, verify compliance
- Base regulatory action on the level of risk – graded approach
- Assure Parliament that licensee responsibilities are properly discharged
- Make **independent**, **objective** and **risk informed decisions**

Licensee responsibilities

- Licensee has the **first responsibility for safety**
- Manage regulated activities in a manner that protects the **health, safety, security** and the **environment** while respecting Canada's **international obligations** (consistent with the licence application)

This aligns with International Atomic Energy Agency (IAEA) Safety Fundamentals

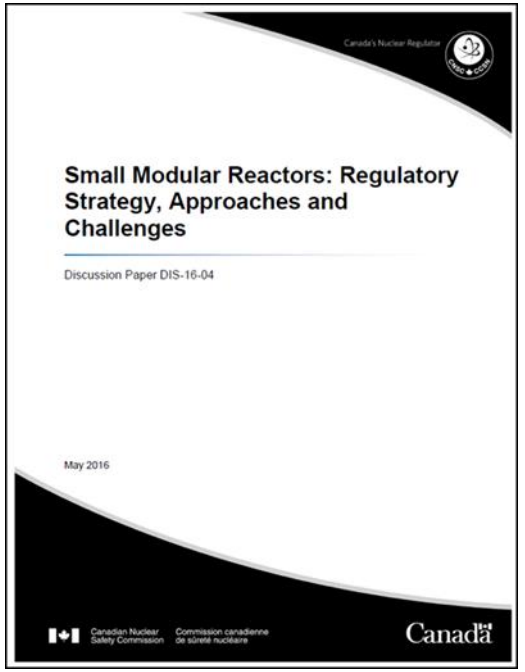
The CNSC Current Regulatory Framework for Fusion

Currently, should a proponent come forth with a fusion technology and seek to construct and operate it in Canada, the Class I facilities regulations would apply. The definition of a Class IA facility, as currently stated in section 1 of the regulations, is as follows:

- "Class IA nuclear facility means any of the following nuclear facilities:
  - a) nuclear fission or fusion reactor or subcritical nuclear assembly; and
  - b) a vehicle that is equipped with a nuclear reactor"

DIS 16-04 - Background

1. Address growing public interest in new reactor technologies, in particular SMR technologies (including Fusion technologies)
2. Prepare the CNSC to evaluate an SMR or Fusion application
3. Further the CNSC's knowledge in areas where SMRs or Fusion technologies may present licensing challenges based on their unique characteristics
4. Clarify where and how to augment the Regulatory Framework



Feedback on Fusion

- Some respondents told the CNSC that fusion and fission technologies are not necessarily discrete as most practicable fusion interactions release free neutrons.
  - Novel reactor concept could incorporate both fusion and fission as a source of energy.
  - Single regulatory framework could be applicable to both fusion and fission reactors and any combination thereof.
  - 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.
- Others indicated risks associated with fusion technologies can be significantly different from fission technologies.
- Agreement that although hazards are different, the mechanisms for quantifying and regulating those risks are the same.

Feedback on Fusion (2)

- Respondents also indicated that a waste stream still exists as components become activated over the course of operations. Fusion facilities, both research and development stage, and future commercial power producing systems, will have radiation hazards driven by three factors:
  - Inventory of volatile radioactive substances, primarily tritium
  - Prompt exposure to neutron or high energy photon flux from a fusion reaction
  - Radioactivity from decay of materials activated by fusion neutron flux
- Magnitudes of these radiation hazards will depend on the specific fusion technology and the nature of the system.
- Large volume magnetic fusion systems, for example, may have higher tritium inventories than pulsed approaches.
  - Similarly, neutron and photon energy flux will depend on the design of blanket and shielding systems that may be technology specific.

Fast Forward to October 2021

- CNSC completed with the help of a third-party nuclear consulting company a review of Fusion and its impact on the CNSC
  - Deliverable 1: Three hypothetical preliminary descriptions of the hazards and activities of nuclear fusion technology facilities
  - Deliverable 2: International benchmarking
  - Deliverable 3: Baseline Report on the status of the CNSC's Regulatory Framework
  - Deliverable 4: Initial Assessment Report including initial observations with respect to regulatory readiness, potential licence and implementation challenges with fusion technology and guidance on potential solutions
  - Deliverable 5: CNSC's Readiness to review a fusion application
  - Deliverable 6: Final Overview Report on readiness, which will include specific regulatory issues (e.g., restrictive guidance or requirements) and implementation issues (e.g., the clarity of the Framework with respect to compliance and inspection of novel technology)

Areas Requiring Focus

- Radiological: primary neutrons, secondary emissions, tritium, activated components, activated products in dust, gases and liquids
- Chemical: beryllium, SF6, liquid lithium or lithium/lead eutectics
- Thermal: plasma, pressurized coolants, steam, cryogenics, liquid lithium or lithium/lead eutectics
- Physical: rotating equipment, electrical/magnetic forces, high velocity projectiles, pistons
- Electrical: high voltage, high current
- Other: radio frequencies, neutral beams, flammable materials, hydrogen

CNSC Early Thinking

1. We are still evolving how to regulate fusion technology.
2. Fusion is not fission.
3. Fusion technologies are different and have different risks.
4. Be educated and understand fusion technology.
5. Avoid Fission reactor mentality.
6. Set high level objectives.
7. Apply a Graded-approach.
8. Build guidance/requirements for fusion from simple to complex not complex to simple
   (e.g., a bottom-up approach not just simplifying fission regulation).
9. Working towards harmonizing regulation internationally may be beneficial
   - Possibly through IAEA

QUESTIONS?

Thank You!

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