FUEL CYCLE OPERATING EXPERIENCE IN CANADA

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Executive Vice-President and Chief Regulatory Operations Officer

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Bethesda, MD - United States of America
March 13, 2019
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.

OVER 70 YEARS OF REGULATORY EXPERIENCE
INDEPENDENT COMMISSION

TRANSPARENT, SCIENCE-BASED DECISION MAKING

- 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
- Staff presentations in public
- Decisions are reviewable by Federal Court
COMMISSION MEMBERS

MS. RUMINA VELSHI
(President and CEO)

Appointed March 12, 2018
Five-year term

DR. SANDOR DEMETER

Appointed March 12, 2018
Five-year term

MR. TIMOTHY BERUBE

Appointed March 12, 2018
Four-year term

MS. KATHY PENNEY

Appointed March 12, 2018
Four-year term

DR. MARCEL LACROIX

Appointed March 12, 2018
Four-year term

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THE CNSC REGULATES ALL NUCLEAR FACILITIES AND ACTIVITIES IN CANADA

- Uranium mines and mills
- Uranium fuel fabrication and processing
- Nuclear power plants
- Nuclear substance processing
- Industrial and medical applications
- Nuclear research and educational activities
- Transportation of nuclear substances
- Nuclear security and safeguards
- Import and export controls
- Waste management facilities
CNSC REGULATORY FRAMEWORK

Fourteen Safety and Control Areas

- 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

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URANIUM PROCESSING IN CANADA

Front end nuclear fuel cycle

Operating mines / mills

- Key Lake Mill (Cameco)
- McArthur River Mine (Cameco)
- Rabbit Lake Mine/Mill (Cameco)
- Cigar Lake Mine (Cameco)
- McClean Lake Mine/Mill (Orano)

Uranium processing facilities

- Blind River Refinery (Cameco)
- Port Hope Conversion Facility (Cameco)
- BWXT Nuclear Energy Canada Inc.
- Cameco Fuel Manufacturing Inc.
CNSC STAFF LOCATED ACROSS CANADA

- Headquarters (HQ) in Ottawa, ON
- Four regional offices
- Fuel cycle facilities

Uranium Processing Facilities

Uranium Mines and Mills

Calgary

Saskatoon

Laval

Mississauga

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FUEL CYCLE FACILITIES IN CANADA

Mines & Mills
Major producer of Yellow cake with several Mines and Mills located in Northern Saskatchewan

Refining
Cameco operates only commercial Refinery facility that makes Uranium trioxide (UO$_3$) powder at Blind River, Ontario

Conversion
UO$_3$ from refinery is used at Port Hope Conversion Facility to make UF$_6$ that is exported to other countries for further processing into fuel for light water reactors

Conversion
UO$_3$ from refinery is also used to make ceramic UO$_2$ product for further processing into fuel for CANDU reactors

Fuel Fabrication
Two facilities make CANDU fuel bundles for Canadian reactors.

Interim spent fuel storage
On site storage at the NPPs with three dedicated dry storage sites (Darlington, Pickering & Western Waste Management)

Research Facilities
Chalk River Laboratories with capability to process enriched uranium fuel rods and isotope processing

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## OPERATIONAL EXPERIENCE FEEDBACK (OPEX) FRAMEWORK

### INTERNATIONAL LEVEL
- **FINAS**
  Fuel Incident Notification and Analysis Systems
- **RRIN**
  Research Reactor Information Network
- **IRS**
  Incident Reporting System

### CNSC
- **CERTS**
  Central Event Reporting and Tracking System (NPPs)
- **RIB**
  Regulatory Information Bank
  - Fuel Cycle Facilities
  - Research Reactors
  - Transport events & nuclear substance licences
- **OAG/internal audits**

### OPERATOR LEVEL
- **Local event/incident reporting and recording**
  - Reporting requirements in regulations and REGDOCs
  - OPEX required by CSA N286-12 standard

Three-tiered framework benchmarked with best practices

[IAEA Safety Standards](https://nuclearsafety.gc.ca)
OPEX arises from reporting by licensees as established by regulatory requirements

- **REGDOC-3.1.2** - Reporting requirements for nuclear facilities (2018)
  - CNSC reviews and initiates regulatory action based on event significance
- CNSC Event Initial Reports (EIR) presented to the Commission in a public hearing
- CSA standard N286-12 as per licence conditions handbook

**Peer review**

- Office of the Auditor General of Canada
- CNSC - Internal audit functions
- International Atomic Energy Agency (IAEA) peer reviews
  - Integrated Regulatory Review Service (IRRS)
  - Emergency Preparedness Review Service (EPREV)
  - International Physical Protection Advisory Service (IPPAS)
  - Operational Safety Review Team (OSART)

**Industry / Licensee OPEX**

- CANDU Owners Group (COG)
Lessons learned from non-nuclear incidents
- Mount Polley mine disaster
- Lac-Mégantic rail tragedy

CNSC internal staff forums to provide multidisciplinary OPEX
- Inspectors forum
- Designated officers forums
- Peer review of inspection findings within CNSC divisions

Lessons learned from international forums and incidents
- UN conventions as administered by the IAEA
- Bilateral and multilateral conferences
  - Working Group for Fuel Cycle Safety (WGFCs)
  - Regulatory Information Conference (RIC)
- OPEX from IAEA/NEA database – Fuel Incident Analysis and Notification System (FINAS)

Continuous enhancement to safety is driven by operational experience
INTERNATIONAL OPEX – CANADIAN EXPERIENCE WITH FINAS

- Canada was an observer in IAEA-FINAS national coordinators meetings until 2014
- Attended first meeting as a member in September 2016
- Contributed to development of draft TECDOC on OPEX from events reported to FINAS
- Initiated reporting of Canadian events to FINAS in 2018
- Direct database access to licensees in 2019

Need for more international participation

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*until September 2018
FINAS – VALUE IN INFORMATION EXCHANGE

**CANADA GAINS**

Several lessons learned for compliance oversight
- Procedural adherence / preventative maintenance
- Maintenance of uranium ventilation systems
- Zirconium swarf storage and handling
- Repetitive failures and safety culture

Licensing
- Chemical hazards in fuel cycle facilities (FCFs)
- Fire protection and emergency response
- Safety reassessment during licence renewal

Regulatory Framework
- Several regulatory documents and regulations updated post-Fukushima

**INTERNATIONAL PARTICIPANT GAINS**

Handling yellow cake and associated hazards
- Blind River Drum pressurization event

OPEX on handling of UF6 and UF6 cylinders
- Lessons learned from past events at Port Hope

Canadian OPEX and regulation of Uranium Mines, Mills, Refining and Conversion
- Unique facilities

Canadian experience with enforcement tools
- Recent experience with “Administrative Monetary Penalties”

Value in international OPEX
CONCLUSION

Need better participation / commitment from other member states

• Event reporting is voluntary
  – Only 8 out of 33 members reported to FINAS in last three years
• Transparent OPEX and event reporting improves safety
  – Not reporting events should not be influenced by political pressure
  – Reporting of events is not an indication of loss of regulatory control

Canada is committed to improving transparency through better public reporting of events and lessons learned

OPEX and information sharing among industry and regulators is an important aspect of continuous improvement
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ADDITIONAL INFORMATION
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FUEL CYCLE FACILITIES IN CANADA

URANIUM PROCESSING CYCLE

LEGEND

Front end of Uranium Processing Cycle (Natural Uranium Fuel)
Front end of Uranium Processing Cycle (Enriched Uranium Fuel)
Back end of Uranium Processing Cycle

U = Uranium; U₃O₈ = Uranium Oxide Concentrate; UO₂ = Uranium Trioxide
UO₂ = Uranium Dioxide Concentrate; UF₆ = Uranium Hexafluoride

URANIUM MINING → URANIUM MILLING → URANIUM REFINING → URANIUM CONVERSION → UO₂ (NATURAL) → CANDU POWER REACTORS

UO₂ (SPENT FUEL)

UF₆ (NATURAL) → URANIUM CONVERSION → UO₂ (ENRICHED) → UO₂ (ENRICHED FUEL)
Port Hope Conversion Facility (PHCF) operated by Cameco Corporation converts UO$_3$ powder produced by Cameco’s Blind River Refinery into uranium hexafluoride (UF$_6$) and uranium dioxide (UO$_2$)

- **UO$_3$**: Dissolution in nitric acid
- **UO$_2$**: Reduce with hydrogen
- **Uranyl nitrate**: React with aqueous ammonia
- **UF$_4$**: React with fluorine
- **Ammonium diuranate**: Reduce with hydrogen
- **UF$_6$**: Hydro-fluorination with hydrofluoric acid
- **UO$_2$**: React with aqueous ammonia
• Instrumentation technician was calibrating a gauge connected to a tank containing hydrofluoric acid (HF)
• When technician removed the impulse line to the gauge, HF gas was released
• Technician left the area, contacted the Emergency Response Team and received first-aid
• Emergency Response Team stopped the leak by closing the line

The worker was not injured and there was no impact on the environment
Cause

• Maintenance work performed without proper work clearances, permits or supervision

Licensee corrective actions

• Evaluate work clearances and permits ensuring they provide clear direction
• Improve maintenance work process for improve visibility and accountability
• Audit program assessment to determine how to improve program monitoring especially during shift work

Regulatory actions

• CNSC issued Administrative Monetary Penalty (AMP) in September 2017 for $17,830
  – Violation: failure to comply with licence condition to implement and maintain a management system
  – Cameco requested a review of the penalty, which was conducted in March 2018
  – Commission determined that Cameco committed the violation. AMP stands as written
• Follow-up inspections by CNSC to ensure effectiveness of corrective actions
RECENT OPEX – BERYLLIUM EXPOSURE EVENT – (1/3)

- Toronto facility produces natural and UO₂ pellets for nuclear fuel bundles
- Peterborough facility produces and tests nuclear fuel bundles, and is authorized to receive, repair, modify and return contaminated equipment from offsite nuclear facilities
• Incorrect respirator cartridges were used for maintenance work
• Personal air sampling results for beryllium particulates:
  – Average air concentration: 0.39 μg/m³
  – Maximum: 4.63 μg/m³
  – Limit: 0.05 μg/m³
• Two workers affected and referred for follow-up tests and increased monitoring for potential long-term effects
• Both workers returned to normal duties with no noted health effects
RECENT OPEX – BERYLLIUM EXPOSURE EVENT – (3/3)

Cause

• Inadequate verification of procured filters as purchase orders lacked adequate descriptions and staff did not recognize incorrect filters

Licensee corrective actions

• Update critical to safety list to include respirator filters by part number
• Implement approval process to ensure staff are trained and received items are properly verified
• Provide additional training to identify correct filter type when working with respirators

Regulatory actions

• CNSC staff issued a request for a report with information about the measures taken to minimize beryllium air concentrations in the future
• Follow-up inspections by CNSC to ensure effectiveness of corrective actions
Key Lake Mill processes uranium yellowcake from uranium ore mined from McArthur River mine.
On February 16, 2015, calcine was found on the floor of the building below the calciner exhaust duct

- The source of the calcine was a broken weld in the calciner exhaust duct
- Further investigation identified a total of 12 weld failures of various sizes ranging up to a complete weld failure
- As a result of this, workers in the area were potentially exposed to airborne calcine dust

Three nuclear energy workers who were working in the area were tested for uranium intake

- Two workers had no evidence of an intake
- One worker was assigned a weekly total effective dose of 1.16 mSv
- Kidney toxicity: The uranium kidney deposition was about 0.3% of the recommended uranium chemical toxicity limit

Workers were removed from the area and the mill was safely shutdown
RECENT OPEX – CALCINE RELEASE EVENT – (3/3)

Cause:
• Broken welds caused by physical impact to duct along with inadequate structural support

Corrective actions:
• The 40 foot long, 18 inch diameter stainless steel calciner exhaust duct was thickness tested and showed negligible change to its nominal 1/8 inch thickness (thickness wear on the duct does not appear to be a factor)
• Welds, expansion joints and the existing support were inspected and repaired
• Welds were dye-penetrant tested (to test for cavities and holes)
• The calcine exhaust duct was previously supported by one central underside base support. Two new duct support hangers were installed
• An “inspection port” was installed to allow for future duct integrity monitoring

Regulatory action:
CNSC staff issued a request under subsection 12(2) of the General Nuclear Safety Control Regulations to all UMMs requiring to review
• The design and operational features that help prevent an unplanned release of yellowcake into the work environment, the equipment, processes and procedures that help in monitoring and identifying any weakening of containment systems that might lead to the unplanned release of yellowcake into the work environment
• The radiation monitoring equipment and procedures that will quickly identify any unplanned releases of yellowcake into the work environment