



Canadian Nuclear
Safety Commission

Commission canadienne
de sûreté nucléaire

Canada



FUEL CYCLE OPERATING EXPERIENCE IN CANADA

Mr. Ramzi Jammal

Executive Vice-President and Chief Regulatory Operations Officer

U.S. Nuclear Regulatory Commission's 31st Annual Regulatory Information Conference
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



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



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

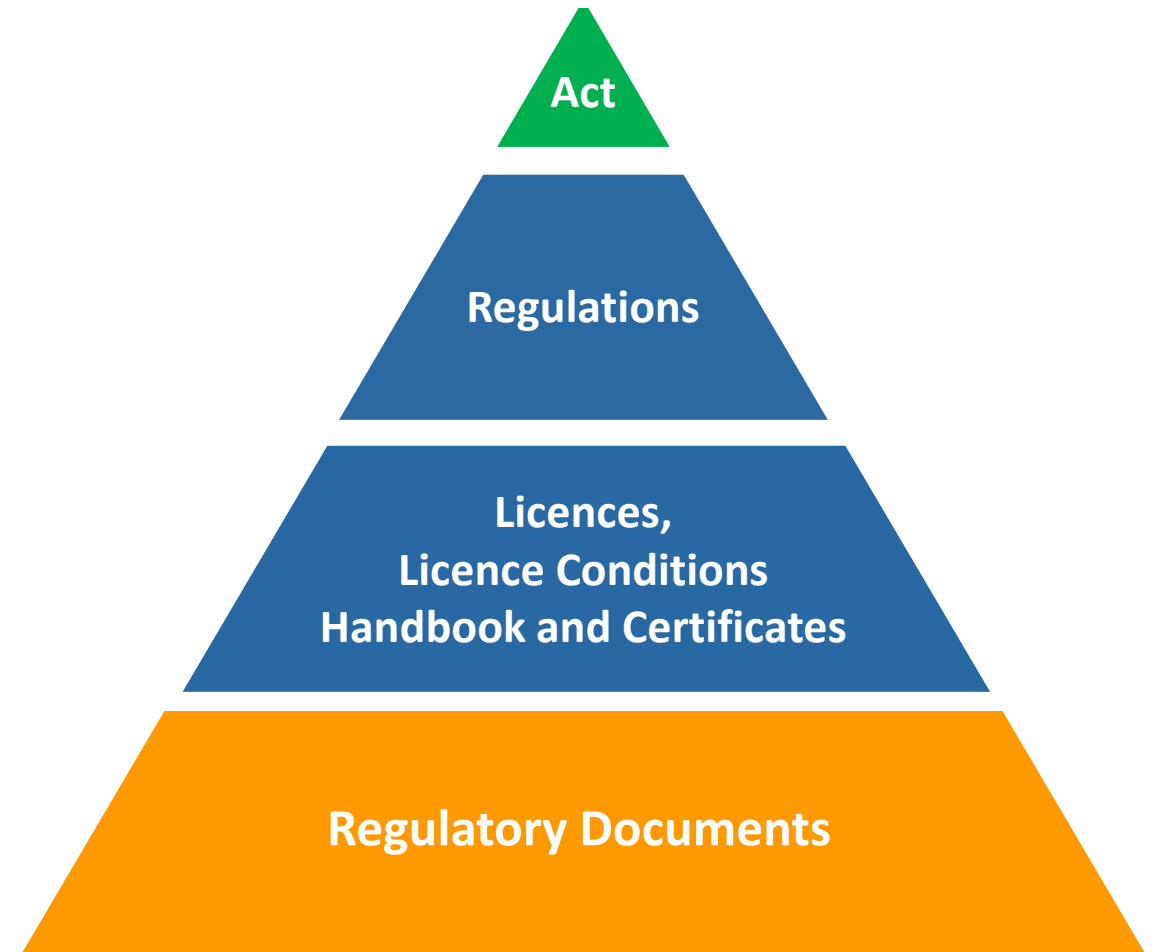


CNSC REGULATORY FRAMEWORK



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





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.



Key Lake mine site



McArthur River mine site



Blind River Refinery



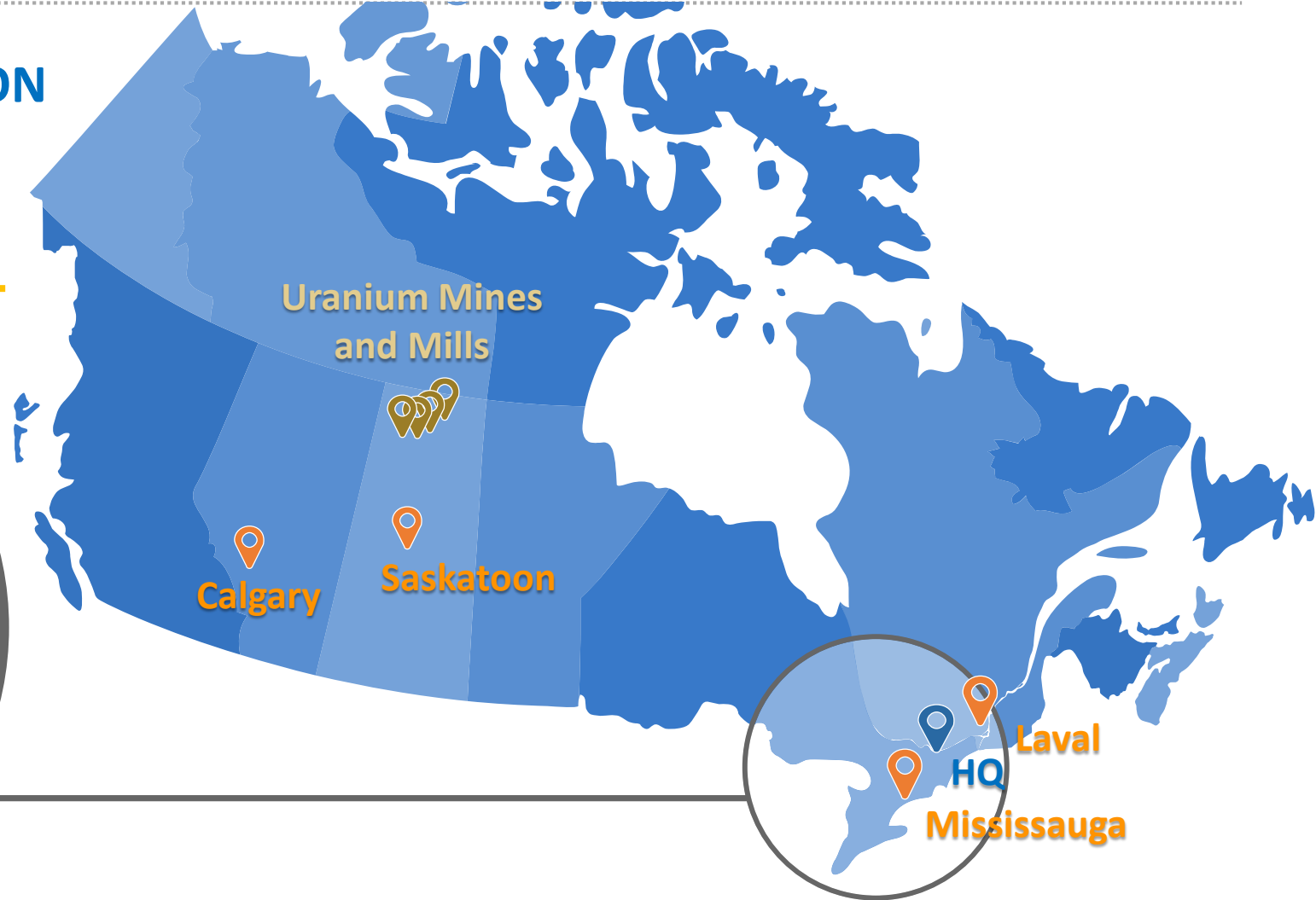
Port Hope Conversion Facility



CNSC STAFF LOCATED ACROSS CANADA



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





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



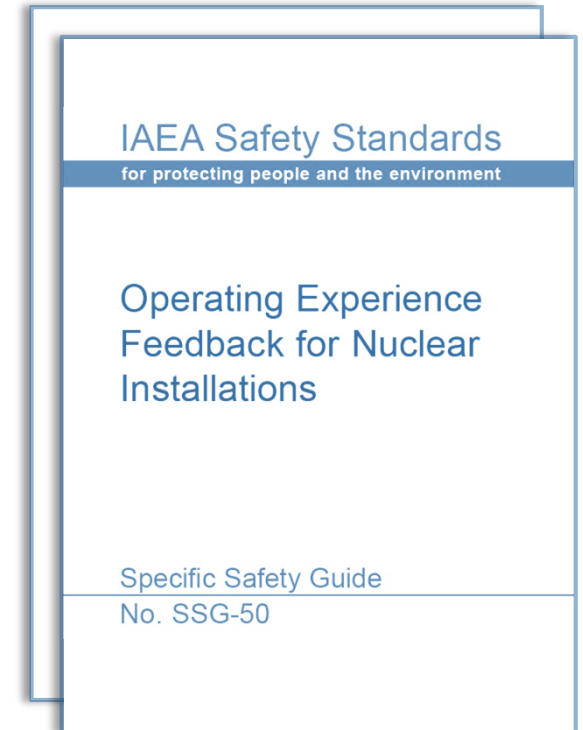
OPERATIONAL EXPERIENCE FEEDBACK



OPERATIONAL EXPERIENCE FEEDBACK (OPEX) FRAMEWORK



INTERNATIONAL LEVEL	CNSC	OPERATOR LEVEL
<p>FINAS Fuel Incident Notification and Analysis Systems</p> <p>RRIN Research Reactor Information Network</p> <p>IRS Incident Reporting System</p>	<p>CERTS Central Event Reporting and Tracking System (NPPs)</p> <p>RIB Regulatory Information Bank</p> <ul style="list-style-type: none"> Fuel Cycle Facilities Research Reactors Transport events & nuclear substance licences <p>OAG/internal audits</p>	<p>Local event/incident reporting and recording</p> <ul style="list-style-type: none"> Reporting requirements in regulations and REGDOCs OPEX required by CSA N286-12 standard



Three-tiered framework benchmarked with best practices



REGULATORY OPEX IN CANADA



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
 - Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
- Bilateral and multilateral conferences
 - Working Group for Fuel Cycle Safety (**WGFC**)
 - 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



Aerial photo of the Mount Polley mine site



Lac-Mégantic rail disaster

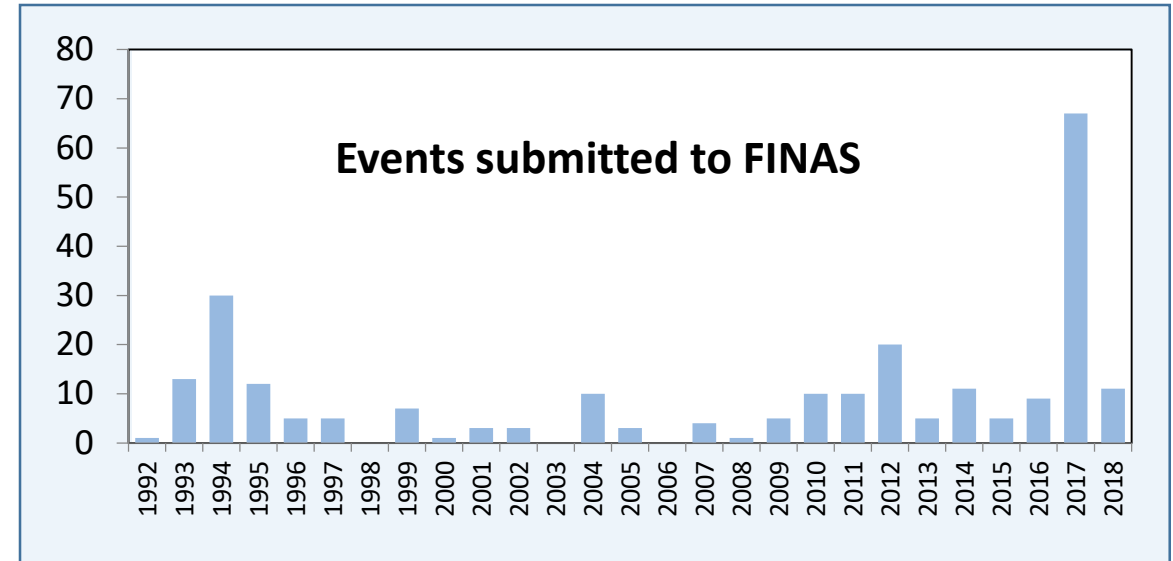


INTERNATIONAL OPEX – CANADIAN EXPERIENCE WITH FINAS



- 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



Country	2016	2017	2018*
Belgium	-	1	-
Canada	-	-	2
China	3	1	-
France	1	3	-
Japan	1	-	2
Sweden	-	1	1
United Kingdom	3	3	3
United States	1	58	3
Total	9	67	11



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

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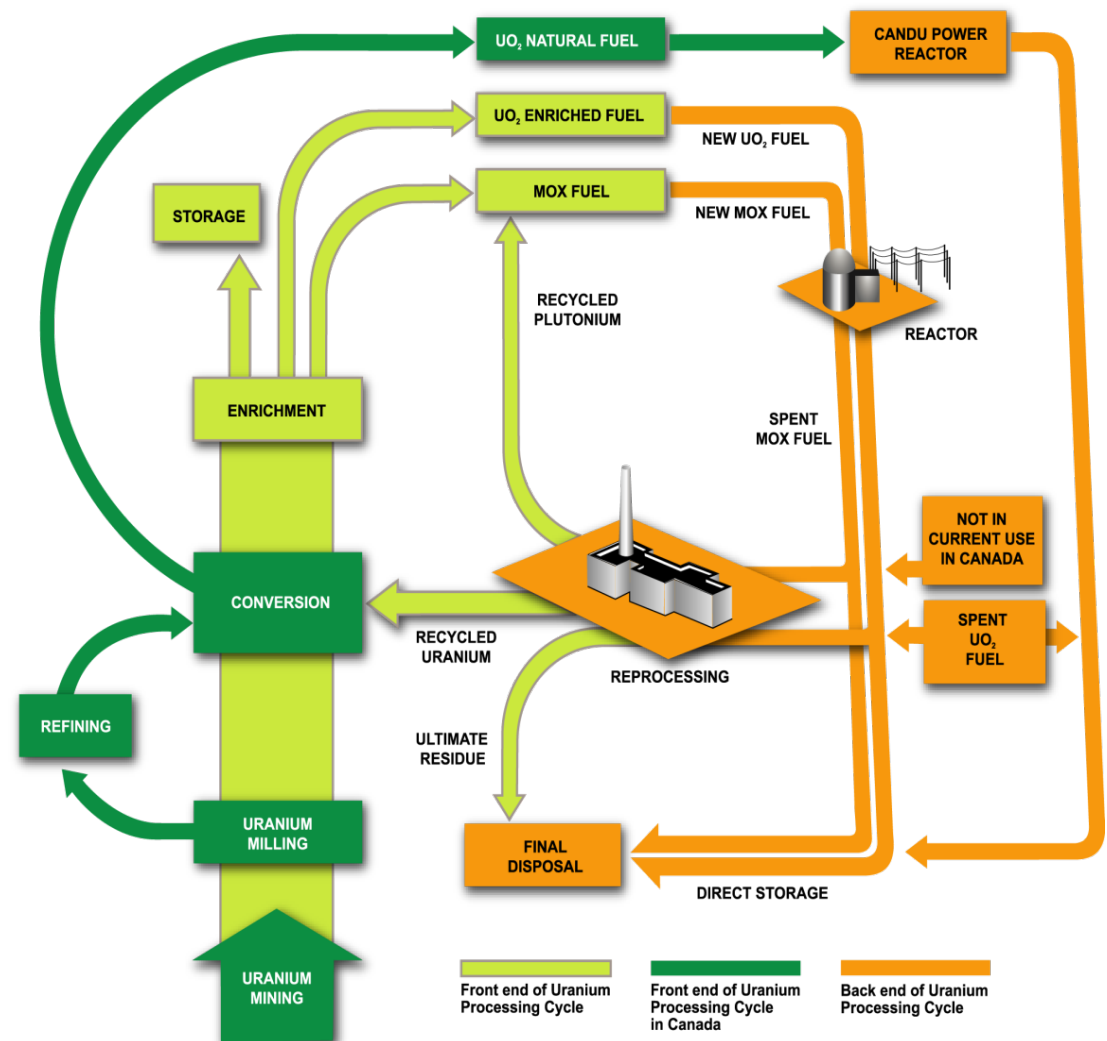
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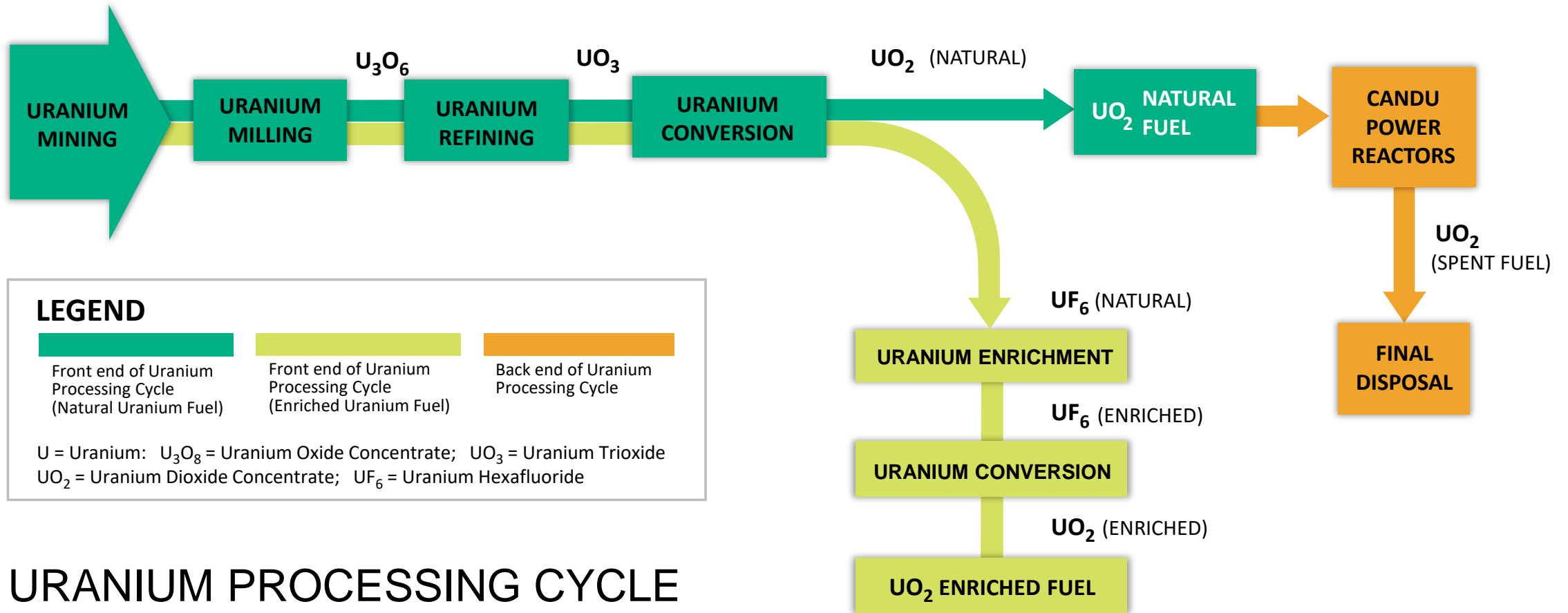
Chalk River Laboratories with capability to process enriched uranium fuel rods and isotope processing

URANIUM PROCESSING CYCLE





FUEL CYCLE FACILITIES IN CANADA





RECENT OPEX – HYDROFLUORIC ACID RELEASE EVENT (PHCF) – (1/3)



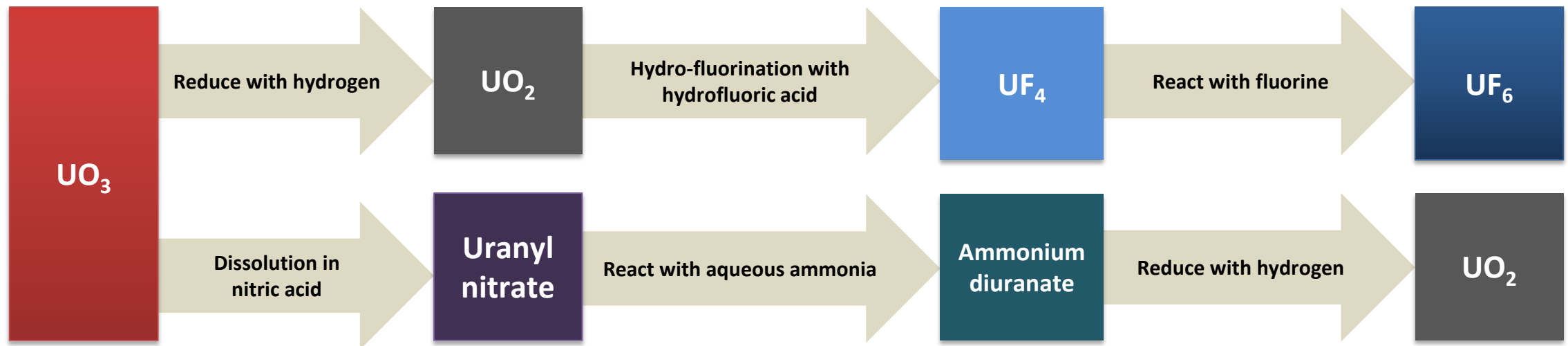
Port Hope Conversion Facility (PHCF) operated by Cameco Corporation converts UO_3 powder produced by Cameco's Blind River Refinery into uranium hexafluoride (UF_6) and uranium dioxide (UO_2)



Port Hope Conversion Facility



Blind River Refinery



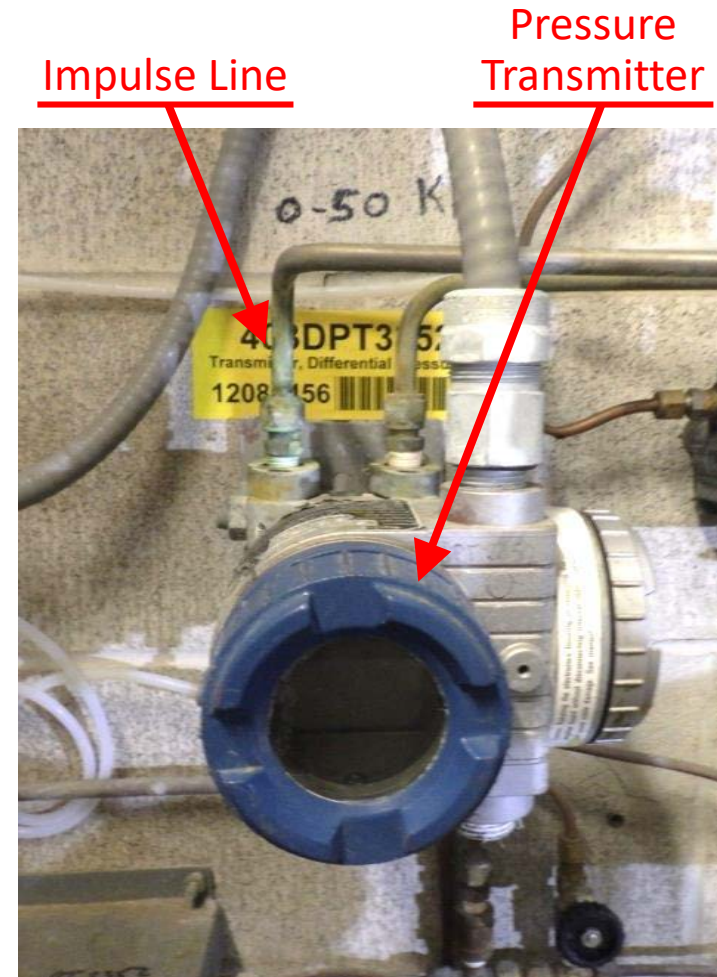


RECENT OPEX – HYDROFLUORIC ACID RELEASE EVENT (PHCF) – (2/3)



- 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**



Close-up of a tank containing hydrofluoric acid (HF)



RECENT OPEX – HYDROFLUORIC ACID RELEASE EVENT (PHCF) – (3/3)



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

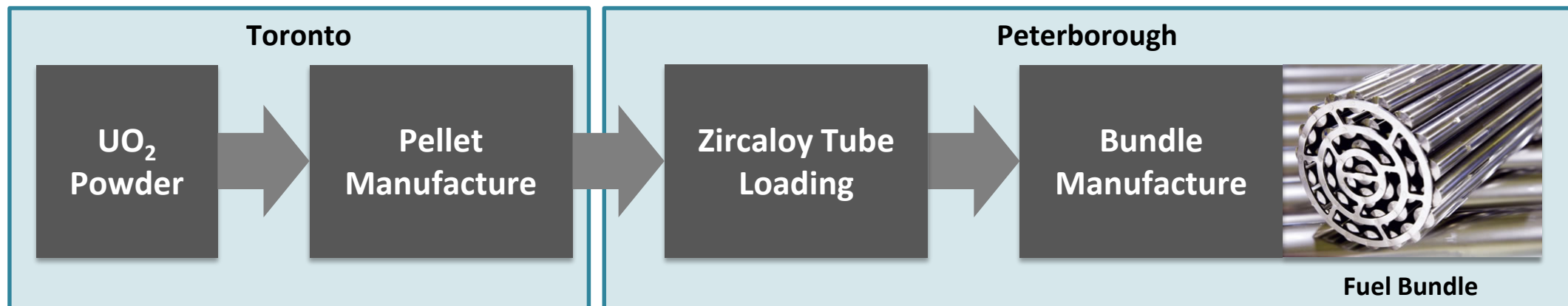
- CNSC issued Administrative Monetary Penalty (AMP) in September 2017 for \$17,830
 - Violation: failure to comply with licence condition to implement and maintain a management system
 - Cameco requested a review of the penalty, which was conducted in March 2018
 - Commission determined that Cameco committed 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 UO_2 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



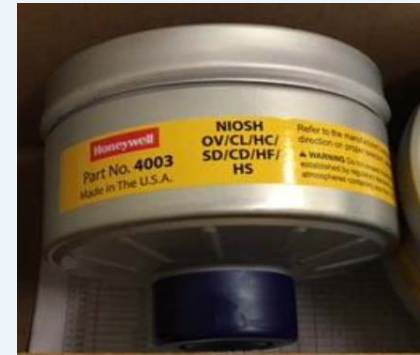
BWXT facility in Toronto



RECENT OPEX – BERYLLIUM EXPOSURE EVENT – (2/3)

- Incorrect respirator cartridges were used for maintenance work
- Personal air sampling results for beryllium particulates:
 - Average air concentration: $0.39 \mu\text{g}/\text{m}^3$
 - Maximum: $4.63 \mu\text{g}/\text{m}^3$
 - Limit: $0.05 \mu\text{g}/\text{m}^3$
- 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

INCORRECT FILTER



Honeywell North 4003 Filter
Organic Vapor, Acid Gas (Chlorine, Hydrogen Chloride, Sulfur Dioxide, Hydrogen Yellow, Fluoride, Chlorine Dioxide, Hydrogen Sulfide) and Formaldehyde Cartridge

CORRECT FILTER



Honeywell North 4003 HE Filter
Organic Vapor, Acid Gas (Chlorine, Hydrogen Chloride, Sulfur Dioxide, Hydrogen Yellow, Fluoride, Chlorine Dioxide, Hydrogen Sulfide) and Formaldehyde Cartridge **with HEPA (High Efficiency Particulate Air-purifying) filter, (99.97% minimum filter efficiency) for all particulates**



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



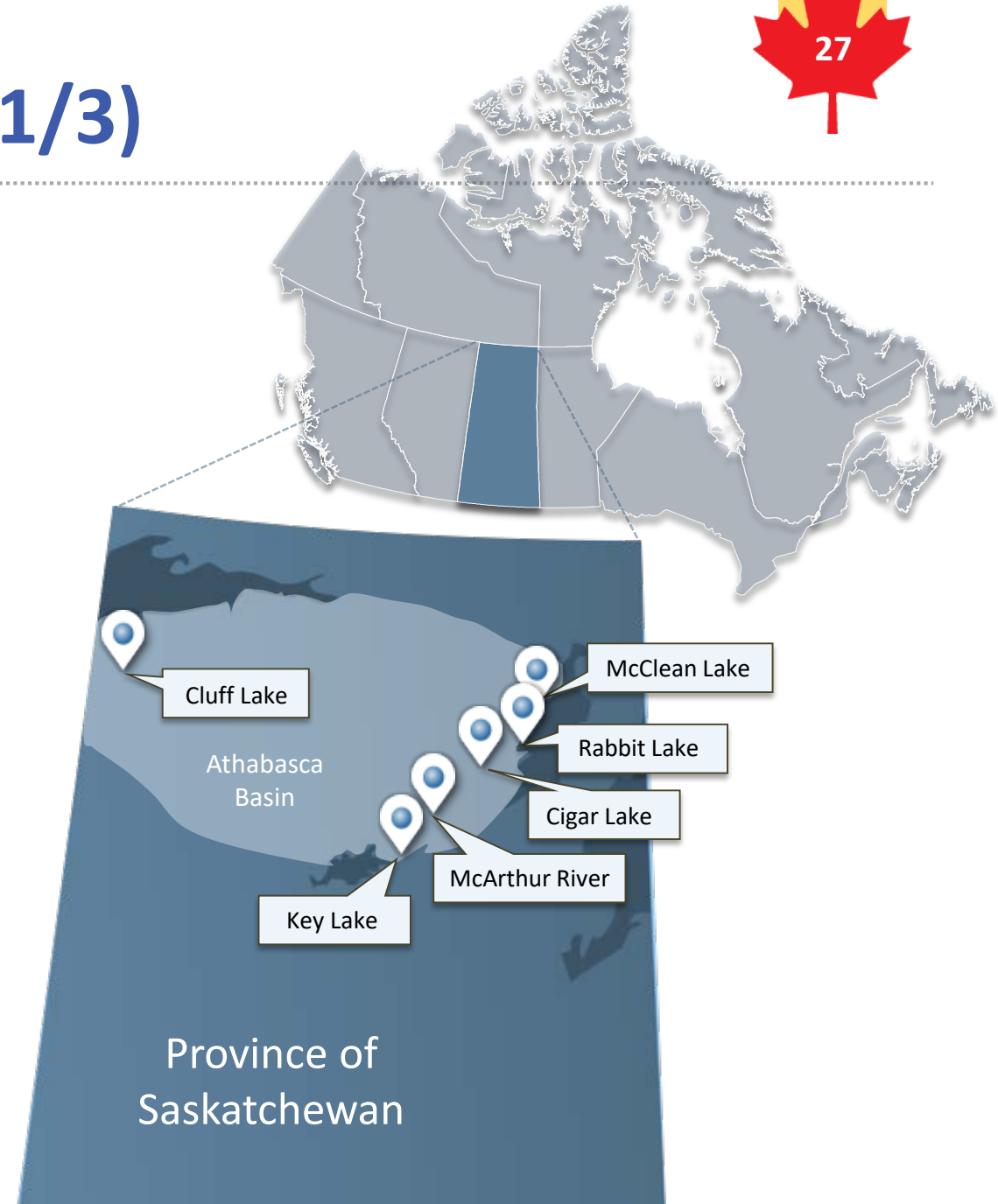
RECENT OPEX – CALCINE RELEASE EVENT – (1/3)



Key Lake Mill processes uranium yellowcake from uranium ore mined from McArthur River mine.



McArthur River mine site



RECENT OPEX – CALCINE RELEASE EVENT – (2/3)

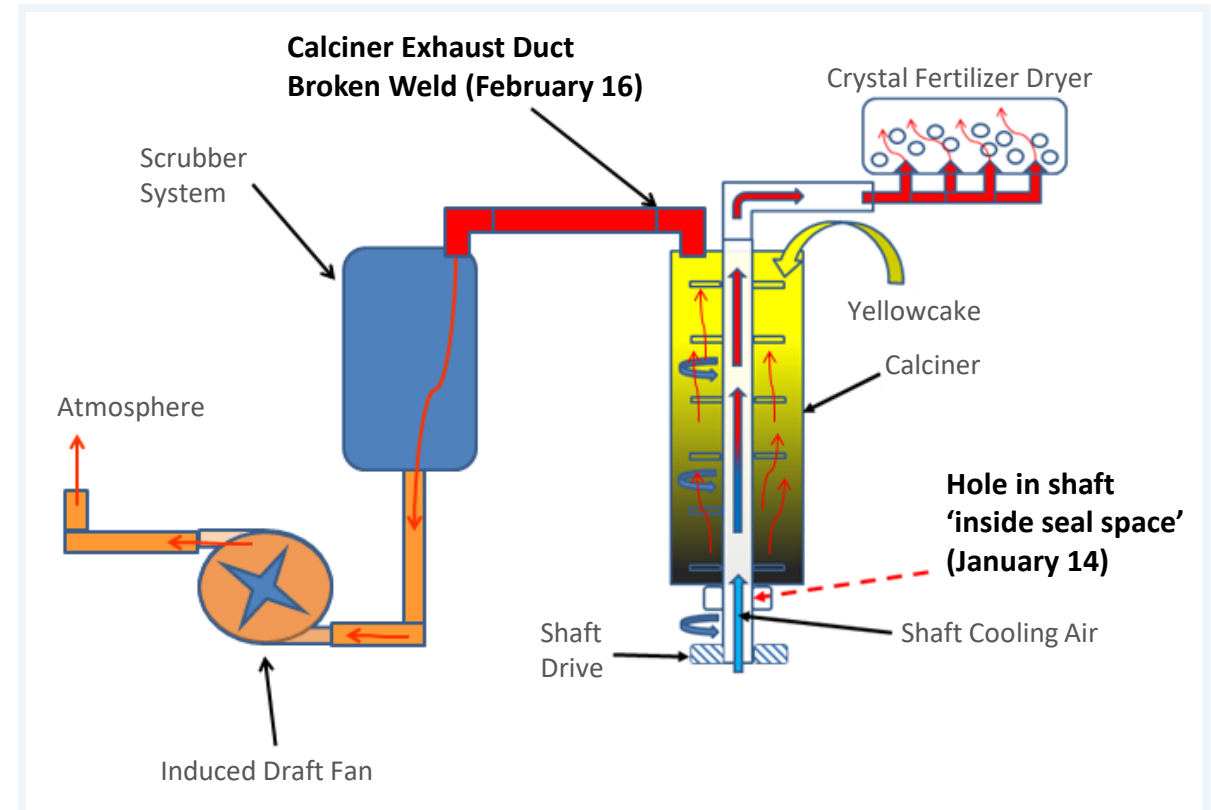
On February 16, 2015, calcine was found on the floor of the building below the calciner exhaust duct

- 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



Calcine system showing exhaust duct and scrubber system

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



Inspection ports



Broken weld



Extra structural support