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Canada

Evaluating Structures, Systems and Components From Decommissioned/Decommissioning Nuclear Facilities in Canada

Nuclear Regulatory Commission Harvesting Workshop

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Daniel Tello – Senior Research Officer, CNSC
Désiré Ndomba – Technical Specialist, CNSC
Karen Huynh – Federal S&T Manager, AECL

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Outline

- Who we are
  - Canadian Nuclear Safety Commission (CNSC)
  - Atomic Energy of Canada Limited (AECL)
- Canadian Harvesting Projects & Sources
  - Nuclear power plants and research reactors
    - ✓ Nuclear Power Demonstration (NPD) Generating Station
    - ✓ Gentilly-2 Nuclear Generating Station
    - ✓ Nuclear Research Universal (NRU) reactor
- Summary

Canadian Nuclear Safety Commission

Canada's nuclear regulator for over 70 years

- The Canadian Nuclear Safety Commission (CNSC):
  - established in May 2000 under the *Nuclear Safety Control Act* (NSCA)
  - replaced the Atomic Energy Control Board, which was established in 1946 under the *Atomic Energy Control Act*

- The CNSC's mission is to:
  - 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

Atomic Energy of Canada Limited

AECL
EACL

- AECL is a federal Crown corporation responsible for managing Canada's radioactive waste liabilities and enabling nuclear science and technology
- AECL delivers its mandate through a contractual arrangement with Canadian National Energy Alliance (CNEA) for the management and operation of Canadian Nuclear Laboratories (CNL) under a Government-owned, Contractor-operated (GoCo) model
- AECL oversees the delivery of the Federal Nuclear Science and Technology Work Plan to support the Government's priorities and core responsibilities in areas such as nuclear safety, security, energy, health and the environment
- CNL is responsible for the management and operation of the laboratories, and is the licensee with access rights to AECL's assets and intellectual property (IP)

Harvesting Materials in Canada

Why is harvesting important?

- The nuclear power plants (NPPs) that are currently in operation were generally designed and built with conservative principles, and in many cases have significant remaining safety margins. Typically, NPPs were designed with the intent to operate for up to 30 years. This is now changing to approximately 60 years.
- Harvesting materials from decommissioned or decommissioning facilities is intended to assess the remaining safety margins for the physical condition of structures, systems and components (SSCs) in NPPs through testing to verify and/or validate the technical feasibility of long-term operation (LTO).

Canadian harvesting projects

- Canada currently has harvesting projects in two areas from different facilities:
  - Analysis of Degradation Mechanisms of Cables
  - Understanding Degradation of Concrete

Nuclear Power Demonstration (NPD) Plant

- The 20 MW Nuclear Power Demonstration (NPD) plant was Canada's first nuclear power reactor to supply electricity to Ontario Hydro's electrical distribution grid
- The reactor permanently shut down in 1988 after 25 years of service
  - the CNSC sponsored a research project with Ontario Hydro in 1991 on "Cable insulation degradation of the 20 MW Nuclear Power Demonstration plant"
  - AECL currently has a research project to analyze concrete samples from NPD

Understanding the Degradation of Concrete

Background

- This project will address gaps in the domestic knowledge of concrete degradation in nuclear power plants and will support regulatory decisions for long-term reactor operations of domestic utilities and new reactor technologies, such as small modular reactors (SMRs).

Project objective

- To assess concrete core samples for degradation

Status

- Year one of a three-year project
- Received seven concrete cores from Nuclear Power Demonstration (NPD) reactor
- Identified test techniques to assess for degradation

Other opportunities

- Concrete from other decommissioned reactors in Canada such as Gentilly-2, Douglas Point and AECL's Whiteshell Reactor in Pinawa, Manitoba

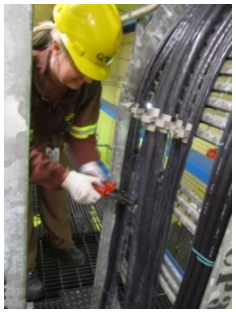
Gentilly-2 Nuclear Facility

- Gentilly-2 (G2) Nuclear Facility is a CANDU-6 675 Mwe nuclear reactor which was permanently shut down in 2012 after 29 years of service
  - CNSC and AECL/CNL are currently conducting a research project on the analysis of degradation mechanisms of cable insulation due to aging in a decommissioned nuclear power plant

Cable Harvesting Project From G2

Background

- Material properties of cables aged in real time and real operating conditions can be significantly different from the properties received by studying samples aged in a laboratory and assumed in codes and standards



Project objective

- Assess current cable degradation resulting from thermal and radiation aging
- Validate environmental qualification work

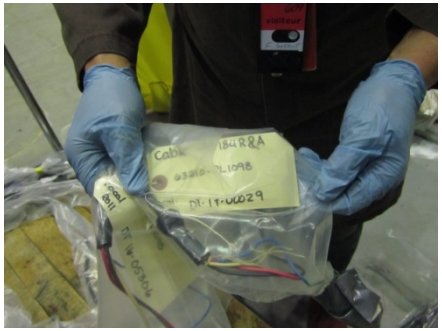
Status

- Reviewed environmental conditions and selected cables to be harvested from Hydro-Québec/Gentilly-2 reactor
- CNSC and AECL/CNL staff have recently witnessed the removal of cable samples from the G2 facility
- Samples will be retrieved and tested to improve cable aging test parameters used to assess cable condition

Cable Harvesting Project From G2 (cont'd)

Challenges

- There were several challenges associated with the cable harvesting project at G2:
  - removal of material samples from a decommissioned NPP is neither a compliance nor licensing activity for licensees
  - accessibility of analysis and testing records (data, samples, etc.)
  - inaccessibility or contamination of materials to be removed
  - cost related to carrying out research activity on these materials



National Research Universal (NRU) Reactor

- NRU is a 135MWt nuclear research reactor built at Chalk River Laboratories, Ontario, with first criticality achieved on November 3, 1957.
- The NRU reactor has three purposes:
  - Supplier of industrial and medical radioisotopes used for the diagnosis and treatment of life-threatening diseases
  - A major Canadian facility for neutron physics research
  - Research and development support for CANDU power reactors
- After five decades of service, the NRU reactor will shut down permanently in March 2018, after ~270k hours of operation
- The NRU reactor contains a vast array of materials and components including
  - structural materials (such as steels and other nickel bearing alloys, zirconium alloys, aluminum, concrete) and welded joints
  - a thermal graphite column
  - equipment (including pumps)
  - graphite seals
  - electrical cables
  - thermocouples

304 SS, ~1.6 dpa, 35 ^{o}C, ~3.4x10^{26} n/m^{2} (E<0.625 eV)

Harvest Material From National Research Universal (NRU) Reactor

Project objective

- Create an inventory of irradiated materials which can be harvested from the decommissioned NRU reactor
- The inventory will be used to assess irradiation damage on the performance of in-core materials and components

Advantages of harvesting materials from NRU

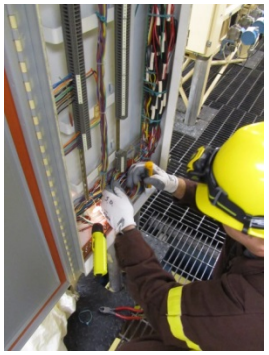
- Assess the effects of irradiation on the performance and degradation of a variety of materials:
  - wide range of temperature, flux and neutron spectrum
  - irradiation times on the order of power reactor lifetimes
  - the combination of operating conditions and exposure is not always easily or economically obtainable in test programs
- Collaborate with various partners throughout the international nuclear industry who also wish to characterize the effects of irradiation on materials
- Provide information to decommissioning groups interested in the radionuclide inventory of the decommissioned reactor

Status

- One year project that will start on April 1, 2017

Summary

- Understanding aging degradation is an important aspect to ensure nuclear safety as NPPs age
- R&D behind SSC material life management is needed to ensure the safe and reliable operation of NPPs
- Several nuclear facilities in Canada exist for potential harvesting of SSCs. Examples include:
  - Nuclear Power Demonstration (NPD) Facility
  - Gentilly-2 (G2)
  - National Research Universal Reactor (NRU)
  - Douglas Point
  - AECL's Whiteshell Reactor



Contacts

Daniel Tello
Senior Research Officer
Email: daniel.tello@canada.ca

Désiré Ndomba
Technical Specialist
Email: desire.ndomba@canada.ca

Karen Huynh
Federal S&T Manager
Email: khuynh@aecl.ca

Gina Strati
Director – Energy
Email: gina.strati@cnl.ca

Lori Walters
Sr Mechanical R&D
Email: lori.walters@cnl.ca

Questions

Thank you!