BWXT Nuclear Energy Canada Inc.

Peterborough Operations Fuel and Fuel Handling & Engineered Solutions Safety Analysis Report Summary

BWXT Nuclear Energy Canada Inc.'s (BWXT NEC) Peterborough operation assembles natural uranium fuel pellets into fuel bundles. The Peterborough operation is licensed to process a maximum of 150 Megagrams (150 tonnes) of uranium monthly under Nuclear Fuel Facility Operating Licence FFOL-3620.01/2020.

The facility can handle both natural and depleted ceramic uranium dioxide (UO_2) fuel pellets for use in CANDU® (Canadian Deuterium Uranium) reactor fuel bundles.

The Facility

Sintered fuel pellets are received from the BWXT NEC Nuclear Fuel Pellet Operation located in Toronto. The fuel bundle manufacturing operations involve the loading of these fuel pellets into zirconium tubes, sealing, welding and machining of the tubes to produce fuel elements and the assembly of the fuel elements into fuel bundles. Details of fuel bundle design vary by reactor. However, fuel bundles currently manufactured at BWXT NEC in Peterborough generally consist of 28 or 37 fuel elements.

The Peterborough operations are located at 1160 Monaghan Road, Peterborough, Ontario. BWXT NEC operations occur within four buildings on the western side of the plant complex located between Monaghan Road and Park Street North.

Safety at the Peterborough Operations

The President, management team and employees of BWXT NEC are committed to ensuring that a strong, positive nuclear safety and security culture is established, fostered, and actively monitored for our nuclear facilities and activities. A nuclear safety and security culture is defined as the core values and behaviors resulting from a collective commitment which is instilled in organizations by leaders and individuals that emphasize nuclear safety and security over competing goals to ensure protection of people and the environment.

BWXT NEC EHS Mission Statement:

It is a business priority to continuously improve our EHS systems to protect fellow employees, the environment, and our communities against environmental, health and safety hazards.

Defence in Depth

The defence in depth concept is applied to all safety related activities, whether organizational, behavioural, design and operational related, particularly those dealing with chemical/ radiological hazards.

The concept of defence in depth involves the implementation of a number of consecutive and independent levels of protection that would have to fail before harmful effects could be caused to people or to the environment. In other words, the idea is that if one level of protection or barrier were to fail, the subsequent level or barrier would be available. In brief, the idea of multiple levels of protection is the central feature of defence in depth.

At BWXT NEC, the defence in depth approach combines the following:

- An effective management system with a strong management commitment to safety and a strong safety culture. The BWXT NEC Environmental, Health and Safety (EHS) Mission Statement notes that the President, management team and employees of BWXT NEC are committed to ensuring that a strong, positive nuclear safety and security culture is established, fostered, and actively monitored for our nuclear facilities and activities.
- The incorporation of strong design and engineering features providing safety margins, diversity and redundancy, mainly using:
  - Design, technology and materials of high quality and reliability, particularly through developing procedures for Critical to Safety Systems, Structures, and Components;
  - Control, limiting and protection systems (particularly fire safety) and surveillance features; and
- Comprehensive operational procedures and practices as well as accident management procedures including emergency preparedness and response plans (see next section).

The Safety Analysis

Our Safety Analysis Report (SAR) was completed in compliance with safety analysis requirements specified in the Canadian Nuclear Safety Commission's Class I Nuclear Facilities Regulations.

The SAR is an important part of the licensing basis for the Peterborough operations. The fundamental objective of the safety assessment is to protect the people and the environment from any potential harm arising from the licensed activity. More specifically, the conduct of safety analysis demonstrates that the Peterborough operations are operated:

- To ensure control over exposure to people and the environment from hazards arising from the licensed activity through any postulated initiating event;
- To ensure control over safety for a broad range of facility states or operating conditions and restrict the likelihood of such events that might lead to a loss of control over the safety of the licensed facility and its activities; and
- To mitigate the consequences of such events if they were to occur through defence in depth.

The SAR is a high-level summary of the Peterborough operations' safety analysis program and associated controls and safeguards. In brief, the SAR:

- Summarizes the key characteristics of the Peterborough operations;
- Summarizes the results of the Facility Safety Analysis (FSA), identified hazards, selection and classification of events to be analyzed, acceptance criteria, methods and associated documentation; and
- Documents the results of the Safety Assessment.

The focus of the FSA is on offsite consequences to the public and the environment. Worker safety hazards are identified, and worker safety is primarily addressed through the Peterborough Operations' *Health & Safety Manual* and *Radiation Protection Manual*.

The FSA was completed in two steps. The first step involved the completion of a What-if Analysis or a HAZOP (Hazard and Operability Study) of licensed activities. The What-if Analysis was the primary tool used.

The What-if Analysis consisted of structured brainstorming sessions to determine what could go wrong in a given operation. Deviations were then qualitatively screened based on a qualitative assessment of likelihood and consequences to determine their level of risk as High, Intermediate or Low.

A full range of potential hazards was considered for all relevant hazardous materials and activities. In assessing potential risks both internal to the operations and external, initiating events (potential causes of accidents) were considered in the identification and performance of the FSA.

Among the sources of hazards considered were:

- Radioactive material;
  - UO_2 pellets and powder;
  - Contaminated equipment from reactor sites;
- Beryllium;
- Hydrochloric Acid;
- Isopropyl Alcohol;
- Zirconium;
- Compressed gas cylinders;
- High pressure hot water;
- Fire.

External events that were considered included, the effects due to earthquakes, flooding, tornados and external fires.

The FSA did not identify the need for a second step involving quantitative risk assessment (QRA), a more quantitative assessment of risks based on accident data and numerical modelling to predict the consequences of events. However, some quantitative calculations were undertaken in support of the What-if Analysis.

For the What-if Analysis the frequency, or likelihood, of an accident or malfunction was estimated. In the quantitative support calculations, the frequency, or likelihood estimations were more robust and were

based on industry accident statistics and, as appropriate, fault tree analysis to determine the likelihood of multiple events occurring concurrently or consecutively.

Consequences were assessed against emergency exposure guidelines for exposure to airborne uranium and beryllium.

The What-if Analysis did not identify any risk greater than Low. Quantitative calculations completed in support of the What-if Analysis confirmed the What-if Analysis modelled scenarios presented a Low or Very Low risk.

Conclusions of the Facility Safety Assessment

The FSA demonstrated that engineering and administrative controls and safeguards implemented by the BXWT NEC Peterborough operations provide an adequate level of protection over a broad range of operating conditions:

- To restrict the likelihood of events that might lead to a loss of control over the safety of the licensed facility; and
- To adequately protect the public and the environment from any potential harm arising from the licensed activity.

Specifically, the FSA (What-if Analysis and supporting calculations) determined that with existing safeguards, that facility risks are all Low or Very Low.

From consequence modelling, there were no radiological release events that exceeded the Provincial Nuclear Emergency Response Plan for public intervention (sheltering or evacuation[1]). Similarly, beryllium levels are below those requiring shelter or evacuation.

The results of the FSA were used to confirm the adequacy of the Peterborough operations' safety program, which is summarized in the SAR.

Peterborough operations' safety program is based on the defence in depth concept. The implementation of defence in depth is the primary means of preventing accidents and mitigating the consequences of accidents if they do occur. The strategy for defence in depth is twofold: first, to prevent accidents, and second, if prevention fails, to minimize the potential radiological and chemical consequences and to prevent evolution to more serious conditions. The Peterborough operations apply the defence in depth concept to all safety related activities, whether organizational, behavioural, design related, or operational related, particularly those dealing with chemical/radiological hazards.

Our Safety Analysis Report and supporting documentation will be periodically updated throughout the lifecycle of the facility as required by the Licence Condition Handbook, and, at a minimum, not less than every five years. The SAR will also be updated if a significant event impacts the safety of the facility and/or ongoing site evaluation identifies new information indicating an update is warranted.

Contact Us

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[1] Generic Criteria – 10 mSv Sheltering, 100 mSv Evacuation
https://www.emergencymanagementontario.ca/sites/default/files/content/emo/docs/PNERP%20Master%20Plan%202017.pdf