Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

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Event Initial Report

Ontario Power Generation and Bruce Power

Potential neutron exposure of workers

Commission Meeting

September 12, 2024

Rapport initial d'événement

Ontario Power Generation et Bruce Power

Exposition potentielle des travailleurs aux neutrons

Réunion de la Commission

Le 12 septembre 2024

Canada

EVENT INITIAL REPORT (EIR)

e-Doc 7326622

EIR: Potential Neutron Exposure of Workers	
Prepared by: Directorate of Power Reactor Regulation (DPRR) and Directorate of Nuclear Cycle and Facilities Regulation (DNCFR)	
Licensee: Ontario Power Generation Bruce Power	**Location:** Retube Waste Storage Building (RWSB) at Darlington Waste Management Facility (DWMF) and Retube Component Storage Building (RCSB) at Western Waste Management Facility (WWMF)
Date Event was Discovered: 2024-06-03	**Have Regulatory Reporting Requirements been met?** Yes ☒ No ☐ **Proactive Disclosure:** Licensee: Yes ☒ No ☐ CNSC: Yes ☒ No ☐

Overview

Reporting Criteria:

From Event Initial Reporting (EIR) Process document:

15) Issues, events, occurrences that the Directors-General (DGs) or their designates judge to have potential for repercussions outside the CNSC and for which the DGs or their designates believe the Commission should be informed.

Description:

On June 3, 2024, an International Atomic Energy Agency (IAEA) safeguards inspector performed a complementary access inspection at the Retube Waste Storage Building (RWSB) located at the Ontario Power Generation (OPG) Darlington Waste Management Facility (DWMF). As part of the routine radiation survey activities, the IAEA inspector measured very low-level, but detectable, neutron radiation counts. The IAEA did not raise concerns for worker safety based on the measured radiation levels.

On June 5, 2024, OPG conducted independent neutron surveys at the RWSB, and found that neutron readings were present inside the building, and not outside the RWSB. The maximum neutron dose rate found in the RWSB was below 0.002 mSv/hr.

On June 5, 2024, as part of their extent of condition assessment, OPG completed neutron surveys of waste containers located in the Retube Component Storage Building (RCSB) at the Western Waste Management Facility (WWMF), which is an OPG waste management facility located on the Bruce Power site. OPG informed Bruce Power that the surveys of the RCSB confirmed the waste containers stored there had neutron fields. The maximum dose rate found in the RCSB was below 0.14 mSv/hr.

Cause(s):

OPG and Bruce Power's verification surveys determined that the neutron source was emanating from the refurbishment waste containers stored at the RWSB and RCSB. The RWSB stores waste containers that contain internal reactor components from the Darlington Refurbishment Project, whereas the waste containers in the RCSB contain internal reactor components from Bruce Power's Major Component Replacement (MCR) project. Measurable levels of neutron radiation were detected at/near the exterior surface of the waste containers storing specifically pressure tube (PT) and calandria tube (CT) waste.

Neutron hazards at the Canadian nuclear power plants (NPPs) are normally associated with fission reactions and fission products, and with some high-energy photoneutron reactions, which require the presence of irradiated nuclear fuel. Since fuel is removed from the reactor at the beginning of refurbishment, it is not anticipated that neutron radiation would be a significant hazard in the work required to retube the reactors, nor from managing the resulting waste.

Further investigation and analysis are being undertaken by OPG and Bruce Power to characterize and determine the cause of the neutron source term associated with refurbishment waste. This investigation will also evaluate to what extent neutrons should have been considered as a potential occupational hazard to workers. These findings are expected to be available by January 31, 2025, with an update provided to CNSC staff by NPP licensees.

Impact of the Event

On People:

How many workers have been (or may be) affected?

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The number of workers potentially affected is currently being investigated. OPG and Bruce Power have committed to provide CNSC staff with an update by January 31, 2025.

How many members of the public have been (or may be) affected by the event?

No members of the public were affected or are affected.

How were they affected?

In the interim, conservative assumptions have been made and the licensees have concluded that the addition of the unaccounted neutron exposures will not cause any worker to exceed the effective dose limit for any one-year dosimetry period, or the current five-year dosimetry period. Currently, licensees are developing methods, models, and modeling assumptions to ascertain worker neutron doses more accurately.

All workers involved in handling of the relevant waste were Nuclear Energy Workers (NEWs). The annual dose limit for NEWs per the Radiation Protection Regulations is 50 mSv per one-year dosimetry period and 100 mSv per five-year dosimetry period. The maximum conservative estimate for an individual's unaccounted neutron dose at Bruce Power is 3 mSv (over the five-year dosimetry periods). The regulatory limits would not be exceeded if this is added to other radiation exposure. Similarly, for OPG, the maximum conservative estimate for an individual's unaccounted neutron dose is 0.80 mSv per calendar year, which combined with other radiation exposure, is also less than the regulatory limits. Note that these estimates are expected to be made more accurate in the future as the licensee neutron dose models are further refined.

On the Environment: None

Other Implications: None

Licensee Actions

Taken or in Progress:

Upon discovery of neutron radiation fields at the RWSB (DWMF) and RCSB (WWMF), refurbishment work on Darlington Unit 4 and MCR work on the Bruce Unit 3 was temporarily stopped until neutron hazard controls were established. After implementing controls to ensure worker protection, refurbishment work resumed at both facilities.

Immediate corrective actions taken by OPG and Bruce Power included conducting surveys of impacted areas, updating Radiation Exposure Permits and hazard boards, and deploying barriers and signage to the affected areas. In addition, OPG and Bruce Power proactively communicated in-field conditions to workers and event details to all nuclear staff. Some of the communication means included face-to-face town halls, a global communication email, release of a podcast providing details on the event, and discussions at Joint Committees for Radiation Protection with union leaders.

OPG and Bruce Power currently have provisions in their RP programs for ascertaining doses, including neutron exposure using licensed dosimetry methods. OPG and Bruce Power have now implemented this neutron dosimetry where it is required by their program. Actions are also in place to analyze historical neutron dose assignments of affected workers and adjust if required. Dose increases will be communicated to individual staff when they are finalized and this information is expected to be completed by January 31, 2025, with an update to the CNSC.

Furthermore, for Darlington NGS which performs volume reduction of PT and CT and the filling of waste containers in a separate building, called the Retube Waste Processing Building (RWPB), all flasks used to transfer the PT/CT from the reactor vault to the RWPB were monitored for neutron radiation to ensure sufficient worker protection is in place. OPG has confirmed that all observed neutron dose rates from the transfer flasks and in worker-accessible areas of the RWPB are less than 0.0025 mSv/hr.

In addition, OPG assessed whether the safety analyses of the RWPB, RWSB, and RCSB are impacted as a result of PT/CT waste having neutron radiation hazards. Their assessment concluded that there were no significant impacts to the safety analyses due to the presence of low levels of neutron radiation.

Extent of condition surveys were also conducted at OPG's Retube Component Storage Area located at the Pickering Waste Management Facility on June 11, 2024. The neutron surveys completed near the exterior surface of the waste containers identified very low levels of neutron dose rates (near the detection limit of the instrument, 0.0001 mSv/h). Given the low neutron dose rates measured to date, there is no current concern with neutron exposures at this facility.

On June 14, 2024, both OPG and Bruce Power submitted a preliminary event report (D-2024-09596, B-2024-377562) to CNSC staff as per the required REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*, Version 2, reporting process. However, with the event investigation ongoing and more information to be obtained, detailed event reports (DERs) are required and will be submitted once sufficient information becomes available. Corrective actions to prevent recurrence will be determined and documented in the DERs. For the OPG Waste Management Facilities (WMF), OPG submitted a notification to CNSC staff as per REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear*

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Once informed about detectable neutron dose rates around the waste containers housing refurbishment waste, New Brunswick (NB) Power took actions to assess dose rates from the waste containers holding refurbishment waste at the Point Lepreau Nuclear Generating Station (PLNGS). NB Power's refurbishment waste (pressure tubes, calandria tubes and calandria tube inserts) is stored at the PLNGS Solid Radioactive Waste Management Facility (SRWMF) in concrete structures. While only a portion of the SRWMF is used to store refurbishment waste, neutron surveys were completed by NB Power on all concrete structures located at the SRWMF. No neutron dose rates were detected during the surveys completed on June 6, 2024.

In addition, NB Power completed a review of the refurbishment work activities with the potential for neutron exposures. At PLNGS, all workers are issued a dosimeter capable of indicating exposure to neutrons; therefore, NB Power reviewed the dosimetry results for the refurbishment period for all workers involved in activities with possible neutron exposures. Out of the 3,749 workers, NB Power assessed that two NEWs who participated in the refurbishment activities in 2009 had each received about 0.15 mSv of neutron dose. Both NEWs were informed of the situation. It was also confirmed that the amount of unaccounted neutron dose for the two NEWs did not cause them to exceed the regulatory effective dose limit for the annual or five-year dosimetry periods.

Planned:

OPG and Bruce Power are performing further evaluations for all remaining refurbishment/MCR activities involving the removal of irradiated core components to determine any hazard mitigation and neutron dosimetry requirements. In addition, the investigations on the root cause of the neutron source are still ongoing, with the assessments expected to be completed by January 31, 2025. OPG and Bruce Power have each committed to providing CNSC staff with formal updates on their findings.

CNSC Actions

Taken or in Progress:

On June 7, 2024, CNSC staff initiated reactive compliance oversight activities, including deploying CNSC site inspectors to conduct reactive inspections that focused on verifying whether adequate protective measures have been implemented for workers. CNSC staff also confirmed that surveys of the neutron hazards were being performed, that Radiation Exposure Permits updated, neutron doses ascertained and assigned, and hazards posted in accordance with the licensees' Radiation Protection Programs.

As this hazard had the potential to exist for any units that have undergone refurbishment, CNSC staff issued a request pursuant to subsection 12(2) of the *General Nuclear Safety and Control Regulations* to all the Canadian NPPs [1-3] to conduct and submit the following:

- A summary of the work activities with the most potential for unaccounted dose and an associated conservative estimate of the magnitude of that dose.
- Assessment of whether the unaccounted dose has caused any worker to exceed the effective dose limit for the current one-year dosimetry period, as well as the current and previous five-year dosimetry periods.
- Methods, models, and modeling assumptions used to ascertain worker neutron doses.
- A characterization of the neutron source term.
- Confirmation whether licensees included a neutron source term in their original source term characterization of reactor component waste.
- Additional work controls implemented to mitigate future exposures; and
- Confirmation that affected parties have been informed.

CNSC's staff review of the information provided by the licensees to date, conclude that this event is expected to have no adverse impacts or appreciable increased risks on the health and safety of persons or the environment. CNSC staff based their conclusion on:

- The measured neutron dose rates from the waste containers at OPG and Bruce Power being low.
- No neutron dose rates being detected on all waste structures holding refurbishment waste at the PLNGS.
- Conservative historical dose estimates from the neutron hazard indicating that no worker exceeded the regulatory effective dose limits.
- The affected waste containers being stored in areas that are not regularly accessed by workers and access to which is restricted for the members of the public.

In addition, CNSC staff confirmed past regulatory approvals for the waste containers in question. OPG requested authorization to construct and operate the RWSB in the 2013 licence renewal for DWMF and the RCSB in the 2006 licence amendment for WWMF. During review of the licence applications, CNSC staff assessed the Safety Analysis Reports that included the design of the waste containers and were satisfied with the information provided [4, 5]. As per the DWMF and WWMF licence conditions handbooks [6, 7], OPG shall submit a revised safety analysis report for the facilities every five

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years. CNSC staff review the safety reports to verify that the waste containers continue to be stored safely.

CNSC staff confirmed that the licensees have met reporting requirements for these recent discoveries. CNSC staff reviewed the REGDOC-3.1.1 Preliminary Event Reports and REGDOC-3.1.2 notifications received on June 14, 2024, and continue to monitor licensees' follow-up corrective actions through review of station records, discussions with licensee staff, and on-site inspections. Overall, CNSC staff are satisfied with licensee actions taken thus far in response to the event.

CNSC staff published the event information and links to the associated 12(2) letters sent to each licensee on the CNSC website. The event was also communicated to the public through CNSC's X (formerly known as Twitter) social media platform. Furthermore, CNSC staff proactively engaged with interested Indigenous Nations and communities to provide information about the event.

Planned:

CNSC staff will assess licensee's responses to the request pursuant to subsection 12 (2) of the GNSCR and will continue evaluating information as it becomes available. Staff will also update the Commission and the public, as may be necessary.

Additional reporting to the Commission Members anticipated:

☒ Yes

☐ No

If Yes, provide method of reporting: The response to the request pursuant to subsection 12(2) of the GNSCR will be provided to the Commission. Updates to the Commission will be provided by way of memos and/or future NPP status reports.

Name and Title	Signature
A. Viktorov Directorate of Power Reactor Regulation	2024-08-23 X A. Viktorov Alexandre Viktorov Director General Signed by: Viktorov, Alexandre
L. Sigouin Directorate of Nuclear Cycle and Facilities Regulation	2024-08-23 X  Luc Sigouin Director General Signed by: Sigouin, Luc

References:

1. CNSC letter, A. Viktorov to A. Grace, R. Geofroy, and K. Aggarwal, "Request pursuant to Subsection 12(2) of the General Nuclear Safety and Control Regulations: Potential Neutron Exposure of Workers", June 13, 2024, e-Doc 7299458

2. CNSC letter, A. Viktorov to M. Burton, "Request pursuant to Subsection 12(2) of the General Nuclear Safety and Control Regulations: Potential Neutron Exposure of Workers", June 13, 2024, e-Doc 7297758

3. CNSC letter, A. Viktorov to S. Bagshaw, "Request pursuant to Subsection 12(2) of the General Nuclear Safety and Control Regulations: Potential Neutron Exposure of Workers", June 13, 2024, e-Doc 7298234

4. CMD 12-H14, Ontario Power Generation's Darlington Waste Management Facility Licence Renewal, e-Doc 4003693

5. CMD 06-H106, Applications by Ontario Power Generation Inc. for licence amendments to permit the construction of Two Refurbishment Storage Buildings and Low-Level Storage Building #10 at the Western Waste Management Facility at the Bruce Nuclear Site in the Municipality of Kincardine, e-Doc 3010183

6. DWMF Licence Conditions Handbook: WFOL-W4-355.00/2033, e-Doc 6896065

7. WWMF Licence Condition Handbook: WFOL-W4-314.00/2027 e-Doc 6353887