Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

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Written submission from
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Mémoire de
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Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2018

Rapport de surveillance réglementaire des sites de centrales nucléaires au Canada : 2018

Commission Meeting

Réunion de la Commission

November 6, 2019

Le 6 novembre 2019

Canada

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Participant Funding Agreement Reference Number: PFP 2019 NPGS ROR CA Poulet	Participant Funding Recipient: Benoit Robert Poulet

September 17, 2019

Participant Funding Program Administrator

Canadian Nuclear Safety Commission

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Subject: Review of CMD 19-M30 - Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2018 (e-Doc 5977745).

The Recipient agreed to participate in the CNSC public meeting scheduled for November 6, 2019 by completing the following tasks:

1. Review the Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2018 and comment on the report from the perspective gained from the recipient's professional experience and expertise.
2. Summarize the findings and recommendations in a written report to be submitted to the Commission by no later than October 7, 2019.

The Recipient has completed these tasks and documented the findings, comments, questions, and recommendations for consideration by the Commission in this report. Some of these items, for consideration by the Commission, are general in nature while others are specific to sections or topics covered by the Regulatory Oversight Report (ROR) prepared by CNSC staff. All specific items are linked back to a specific ROR page and/or section number (e-Doc 5977745) to provide the context and facilitate understanding of the item.

The Recipient general comments are as follows:

1. The ROR is a very comprehensive and voluminous report which clearly required the written technical contributions of many CNSC staff members. These technical contributions have to be assembled, reviewed, edited, and included in the ROR in a balanced manner over an extended period of time. It is clear a lot of effort went into assembling the 2018 ROR to produce what is a generally a very good and balanced report. Only minor discrepancies and inaccuracies were identified during the review are these are documented later in this report.

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2. As stated in Section 1.2 of the ROR (page 13), the information provided in this regulatory oversight report is pertinent to 2018, and the status that is described is valid as of December 2018. The word "UPDATE" is used in the report to identify topics where more recent information (up to June 1, 2019) is included (e.g., descriptions of significant events or updates that were specifically requested by the Commission). The inclusion of these "UPDATES" within the relevant sections of the 2018 ROR is very helpful in improving reader understanding and consideration should be given to maintaining that practice in future years. This practice is particularly important when the presentation of the ROR is done later in the following year.

The Recipient specific comments, questions, and recommendations are as follows:

1 - References to the International Atomic Energy Agency (IAEA) reporting.

CMD19-M30 Sections:

- Summary (page ii)
- Executive Summary (page 6)
- Section 1.4.3 – Reporting (page 19)
- Summary and Conclusions (page 247)

Review comment:

The ROR states the following on four occasions: "No events above INES Level 0 were reported to the IAEA." This statement is not clear and potentially misleading.

Rating and reporting events using the IAEA INES system is not routinely done by many IAEA Member States including Canada. The fact that no event above Level 0 was reported to the IAEA INES system does not necessarily mean there were no events in Canada above that level during 2018.

The Bruce Unit 4 event involving the failure of PHT pumps seals (Table 25 on page 159) which resulted in a PHT system radioactive leak outside of containment and a forced outage should likely have been rated above INES Level 0.

There are 5 barriers between the radioactive fission products within the reactor and the surrounding population: the ceramic fuel itself, the fuel cladding, the PHT system which contains the fuel coolant, containment, and the exclusion zone around the NPP site. While the PHT system is located inside containment, the containment boundary has some areas where it is more vulnerable, including the PHT pump seals.

The PHT pump motor is located outside containment in an accessible area of the Bruce plant, the rotating pump shaft penetrates through the containment boundary through a mechanical seal

arrangement and turns the pump impeller which is located within the PHT system to circulate the reactor coolant. The PHT pump mechanical seal is thus not only a part of the HTS but it is also a part of the containment boundary. The PHT pump mechanical seal is located inside of an enclosed pump stool with a liquid collection system in place to collect smaller leaks. A larger leak such as the one that occurred with Unit 4 at power was likely beyond the capacity of the collection system and resulted in the spreading of radioactive contamination in certain accessible areas of the plant as described in the event report. The seal failure in the Unit 4 event thus resulted in a small PHT system radioactive heavy water leak outside of containment meaning two of the 5 barriers mentioned above were compromised at once.

The IAEA INES system rates events according to three main categories as follows:

- Impact on People and the Environment
- Impact on Radiological Barriers and Controls at Facilities
- Impact on Defence-in-Depth.

The Bruce Unit 4 event had a negligible impact (if any) on People and the Environment so this INES category is not applicable.

Although the Bruce Unit 4 event resulted in the leakage of approximately 1 metric ton of contaminated heavy water to an accessible area of the plant, there is insufficient information (i.e. radiological survey data) provided in the ROR to rate the event using this INES category.

The remaining Category, Impact on Defence-in-Depth, can however be used to rate the Bruce Unit 4 event using INES.

As stated in the IAEA INES User's Manual, the approach for rating an event of this type is based on consideration of initiators, safety functions, and safety systems. An "initiator" is an occurrence that leads to a deviation from the normal operating state and challenges one or more safety functions (e.g. an event with an actual PHT leak while at power). For events with an "initiator", the event rating depends principally on the extent to which the operability of the safety function is degraded as well as on the anticipated frequency of the particular initiator that has occurred.

The three basic safety functions for reactor operation are:

- controlling the reactivity
- cooling the fuel
- confining the radioactive material

These basic safety functions can be achieved using several systems including safety systems and process systems. It is important to evaluate the operability of the safety function when events are rated, not the operability of an individual system. A system or component is considered operable when it is capable of performing its required function in the required manner.

The operability of a safety function for a particular initiator can range from a state where all the components of the safety systems provided to fulfil that function are fully operable to a state where the operability is insufficient for the safety function to be achieved. To provide a framework for rating events, four categories of operability are considered when using INES as follows:

- Full: This is when all the safety systems and components that are provided by the design to cope with the particular initiator in order to limit its consequences are fully operable (i.e. redundancy/diversity is available).
- Minimum required by operational limits and conditions: This is when the operability of each of the safety systems required to provide the safety function meets the minimum level for which operation at power can be continued (possibly for a limited time), as specified in the Operational Limits and Conditions.
- Adequate: This is when the operability of at least one of the safety systems required to provide the safety function is sufficient to achieve the safety function challenged by the initiator being considered. It is also possible that the safety function may be adequate due to the operability of non-safety systems.
- Inadequate: This is when the operability of the safety systems is such that none of them is capable of achieving the safety function challenged by the initiator being considered.

Using the INES approach and guidance provided in the INES User's Manual, an event involving "Reactor coolant system leakage that would not prevent a controlled reactor shutdown and cooldown", such as the one which occurred in Unit 4, is first classified as an "event with an initiator". The anticipated frequency of this particular initiator for Pressurized Heavy Water Reactors is considered "*Expected"* meaning it is expected to occur once or several times during the operating life of the plant (i.e. $> 10^{-2}$ per year).

The first of the three safety functions, controlling reactivity, was not challenged as the Reactor Regulating System, and both Shutdown Systems were fully available throughout the event.

The second safety function, cooling the fuel, was only moderately challenged as the PHT system inventory escaping outside of containment through the failed sealed was being replenished by the PHT pressure and inventory control system and the Emergency Core Cooling system remained fully available throughout the event. The available reserve of PHT heavy water inventory would have continued to slowly decrease had the seal leak not abated when the HTS pressure was lowered from 9 MPa to 3 MPa following shutdown of the reactor; however, the impact of this small loss of PHT inventory on the fuel cooling function is not significant for the purposes of the INES rating.

The third safety function, confining the radioactive material, was more severely challenged by the Unit 4 event since the PHT pump seal failure compromised two of the 5 barriers mentioned above allowing the release of radioactive steam and water to accessible areas of the plant.

Using the guidance provided in the IAEA INES User's Manual, the operability of this third safety function can be evaluated as being lower than both "Full" and the "Minimum required by operational limits and conditions" since the Unit 4 Containment was no longer fully effective and continued safe operation of the Unit 4 reactor at power was no longer possible.

The table below provides the INES ratings for events with real initiators that being considered under the category Impact on Defence-in-Depth.

Safety Function Operability	Initiator Frequency		
	Expected	Possible	Unlikely
Full	0	1	2
Minimum required by OL & Cs	1 or 2*	2 or 3*	2 or 3*
Adequate	2 or 3*	2 or 3*	2 or 3*
Inadequate	3 (or higher)**	3(or higher)**	3 (3 or higher)**

*The INES User's Manual provides additional guidance on the selection of the proper INES rating within this range.
** Any event involving a real initiator and Inadequate Safety Function Operability likely resulted in an actual accident with potentially more severe consequences and should be rated using the criteria provided under "Impact on People and the Environment" or "Impact on Radiological Barriers and Controls at Facilities".

Based on the nature of the failure, the impact it had on reactor operation, the release of radioactive steam, water, and contamination within accessible areas of the plant located outside of containment, and the resulting radiological conditions created by this event; the safety function operability relating to confining the radioactive material cannot be considered to have been fully available for this event. The resulting INES rating using the Impact on Defence-in-Depth would thus have been higher than Level 0, had it been rated using INES and reported to the IAEA INES system.

The ROR statement "No events above INES Level 0 were reported to the IAEA" which appears in no less than four instances within the report is potentially misleading and requires clarification.

Items for consideration by the Commission:

Question #1 for CNSC staff:

How many of the 246 events reported to the CNSC in the year 2018 by Canadian NPP Licensees as per Regulatory Document 3.1.1 – Reporting Requirements for NPPs were rated using INES and reported to the IAEA INES system?

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Question #2 for CNSC staff:

For any event that is rated by CNSC staff using INES, is the licensee from the impacted NPP consulted during the rating and are they required to concur with the rating before it is submitted to the IAEA INES system?

Question #3 for CNSC staff:

Can CNSC staff explain how the INES rating criteria were applied to the Bruce Unit 4 event described above to obtain an INES rating of Level 0?

Question #1 for Bruce Power:

The PHT water/steam leak collects in the PHT pump stool and is then directed to a collection tank located in a lower elevation of the plant. The ROR states the water was directed to an area equipped with a dyke and later collected. Could you please clarify which areas of the plant were impacted by the seal failure; e.g. immediate vicinity of the PHT pump only or other areas located at lower elevations?

Recommendation #1 for the Commission:

The IAEA INES system is voluntary and intended to facilitate the transfer of relevant nuclear event information such as safety significance between nuclear organizations, the media, and the public at national and international levels. The INES system is not intended to be used as a means of assessing the safety performance of nuclear operators or regulators. Use of the statement "No events above INES Level 0 were reported to the IAEA" in the ROR to demonstrate the safety performance of the Canadian Nuclear Power Industry (and the effectiveness of the Regulatory Oversight) represent a misuse of the INES system which can be misleading. This is particularly true when, as demonstrated above for the Bruce event, not all of the 2018 events reported to the CNSC should have been rated at INES Level 0.

The Commission should review whether including statements about INES Levels in the ROR is appropriate when the use of INES is not fully integrated in the routine activities of its staff.

Recommendation #2 for the Commission:

Each IAEA member, is responsible for designating one or more INES National Officer(s). The CNSC is responsible for designating the INES National Officer(s) for Canada.

The designated INES National Officer for Canada should develop a clear and complete procedural framework to cover the use of INES in Canada including, criteria for reporting to the

IAEA, the review and approval of event reports sent to the IAEA, posting of routine reports for events with low INES ratings, posting of reports during actual accidents, and updating posted reports for serious events which are still evolving. The duties of the INES National Officer should also be clearly defined, supported, and integrated in the CNSC emergency response plans. This framework should be reviewed, approved, and supported by CNSC management.

2 – Radiation Protection – Darlington

CMD19-M30 Section:

- 3.1.7 Radiation Protection Program Performance (pages 109 and 110)

Review comment:

In June 2018, CNSC staff requested information from OPG under subsection 12(2) of the *General Nuclear Safety and Control Regulations*. The request was complied with in early 2019; however, CNSC staff requested OPG to assess the implementation of its alpha monitoring program.

In 2018, OPG submitted 14 event reports to CNSC staff, from both online operations and the refurbishment project, related to radiation protection that identified poor work practices as a contributing factor. Event involving RP issues made up more than one quarter of the 49 event reports submitted to the CNSC during 2018. CNSC staff concluded that the frequency and nature of the events was indicative of an overall downward trend in performance of the radiation protection program.

Items for consideration by the Commission:

Question for OPG:

The high number (14) of RP related occurrences and event reports in 2018 should have been enough to show a potential decline in the performance of the Radiation Protection Program performance. Why did OPG wait for the CNSC staff request to review the Radiation Protection Program performance?

Question for CNSC staff:

Could CNSC staff provide an update on the status of the regulatory follow-up being conducted on the OPG RP Program?

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3 – CNSC Staff Inspections - Pickering

CMD19-M30 Section:

- 3.2.0 - Introduction List of CNSC staff Inspections at Pickering Site (Table 22 on pages 109 and 110).

Review comment:

CNSC conducted a Reactive Inspection involving on the Fuel Handling Conveyor Tunnel (Report Number: PRPD-2018-003). The nature of the event which prompted this reactive inspection is not stated in the report and the findings are not discussed in the report.

Item for consideration by the Commission:

Question for CNSC Staff:

Could staff explain the technical basis which prompted the conduct of this reactive inspection and describe the inspection findings and regulatory actions which may have been taken as a result of this inspection?

4 – CNSC Staff Informal Comments - Pickering

CMD19-M30 Section:

- 3.2.4 – Safety Analysis (page 138).

Review comment:

The ROR includes the following UPDATE: "CNSC staff completed a detailed review of the severe accident analysis and provided OPG with informal comments". It is not clear whether the severe accident analysis was accepted by CNSC staff and the expression "informal comments" is also unclear.

Items for consideration by the Commission:

Question #1 for CNSC staff:

Could CNSC staff confirm whether the OPG severe accident analysis was found acceptable by CNSC staff?

Question #2 for CNSC staff:

Could CNSC staff explain what is meant by "informal comments", whether these comments require action by the licensee, and how these "informal comments" were provided to OPG?

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5 – Standby Generator Testing – Bruce

CMD19-M30 Section:

- 3.3.5– Physical Design (page 170).

Review comment:

The ROR states: "When Bruce Power is at the minimum number of SGs, it is prudent to test the remaining SGs to confirm that they are functional and that safe operation is still supported. The requirements in the OP&Ps do not allow testing when there is a minimum number of SG's available (resulting in a reportable event). CNSC staff agreed to Bruce Power's proposal to revise the OP&Ps to allow testing under those circumstances".

The former OP & P requirement was in place because the type of turbine driven standby generators installed at the Bruce Site became automatically unavailable for a short period of time following a test run because some of the SG subsystems had to go through a shutdown cycle before they could be ready to start again. Testing an SG meant that the same SG would unavailable for a short period of time at the conclusion of the test run leaving the station with one SG less than the minimum required for a short period of time. It was thus deemed preferable to not conduct testing of the SGs when down to the minimum required by OP & Ps because the testing would cause the number of available SGs to be below the minimum required for a short period of time.

The basis for amending the OP & P requirement as per the Bruce Power request is not clearly explained in the ROR.

Item for consideration by the Commission:

Question for CNSC staff:

Could CNSC staff confirm the basis for the original OP & P requirement and describe the compensatory measures Bruce Power would have to take in the event an SG fails the test run when the station is already at the minimum number of required SGs for continued safe operation.

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6 – Negative Pressure Containment (NPC) – Bruce

CMD19-M30 Section:

- 3.3.6– Fitness for Service (page 172).

Review comment:

The ROR states: "The NPC system for Unit 4 exceeded the unavailability target because of the removal of airlock dykes during installation of equipment during a planned outage".

It is not clear where the subject airlock is located within Unit 4, particularly as to its elevation within Unit 4. It is also not clear whether removal of the dyke was part of the work package prepared for the Unit 4 planned outage.

Items for consideration by the Commission:

Questions #1 for Bruce Power (BP):

Could BP clarify the location of the airlock within the plant and explain the potential safety impact of the Airlock Dyke removal on the Containment System?

Question #2 for Bruce Power (BP):

Was the potential safety impact of the Airlock Dyke removal on A/L availability considered during the work planning/ preparation phase? If so, what approvals were sought or obtained to allow the Airlock Dyke removal to proceed and the resulting A/L unavailability target to be exceeded?

7 – Emergency response capability – Bruce

CMD19-M30 Section:

- 3.3.10 – Emergency Management and Fire Protection (page 181).

Review comment:

The ROR states: "Bruce Power implemented the disaster LAN (DLAN) electronic data management system in 2018. In response to a CNSC staff request in 2017, per sub-section 12(2) of the *General Nuclear Safety and Control Regulations*, Bruce Power committed to investigate options for automatic connectivity between plant data systems and the electronic data transfer system. In 2019, Bruce Power was preparing to submit its feasibility assessment of DLAN or Non-DLAN options for automatic electronic data transfer to the CNSC".

The reviewer notes NB Power appears to have a similar system in place for the Point Lepreau NPP (refer to page 224 of the ROR).

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Items for consideration by the Commission:

Question for Bruce Power (BP):

Could BP describe the purpose and type of data that would be processed by the DLAN system?

Question #1 for CNSC staff:

Could CNSC staff confirm whether systems similar to the one being developed and implemented at the Bruce site are being developed or already in place at all other Canadian NPP sites?

Question #2 for CNSC staff:

Could CNSC staff confirm whether there is connectivity in place between Canadian NPP sites and the CNSC for the automatic transfer of data to the CNSC?

8 –Stockage d'eau lourde – Gentilly-2

CMD19-M30 Section:

- Section 3.6.10 – Gestions des Urgences et Protection-incendie (page 242)

Review comment:

The ROR states : « L'eau lourde provenant du système caloporteur a été valorisée chez un autre titulaire de permis et l'eau lourde provenant du système modérateur est entreposée de façon sécuritaire dans les quatre (4) réservoirs du système d'alimentation de D2O (38110) à l'intérieur du bâtiment des services ».

Item for consideration by the Commission:

Question for CNSC staff or Hydro-Québec:

Pour combien de temps l'eau lourde du système modérateur sera-t-elle entreposée sur le site de Gentilly-2? [How long is the Moderator Heavy Water going to remain stored on the Gentilly-2 site?].

9 – Minor discrepancies and inaccuracies presented in the ROR tables and figures.

Review comment:

As stated earlier in this report, the ROR is a very comprehensive and voluminous report which requires the written technical contributions of many CNSC staff members. The inadvertent introduction of minor discrepancies and inaccuracies is understandable and should be acceptable only to the extent where the trust of the information presented to the Canadian public by the Canadian nuclear regulator is not compromised.

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The items listed below are only some of the discrepancies and inaccuracies found during my review of the ROR. There remain several other minor typos and formatting issues which could distract the reader away from the importance and validity of the ROR.

CMD19-M30 Sections:

- Section 1.4.4 Tables 5 and 6 (pages 19 and 20). The numbers on the tables are not accompanied by the unit "person-hours". The reader has to continue reading past the tables to determine the intended unit. It would be preferable to specify the unit either in the title of the tables or within the tables themselves to improve readability.
- Section 2.3 – Operating Performance – Table 8 and Figure 2 (page 32). The 2018 data shown in Table 8 does not match the 2018 data on Figure 2. Figure 2 shows an industry total of 22 while Table 8 shows an industry total of 27. Also, Table 8 shows a total of 4 for DNGS in 2018 while Figure 2 shows a total of 7 for DNGS in 2018. The numbers should be confirmed.
- Section 2.7 – Radiation Protection – Table 13 (page 60). Although the unit (mSv) is introduced in the preceding ROR text, the numbers on the table are not accompanied by the unit (mSv). It would be preferable to specify the unit either in the title of the tables or within the tables themselves to improve readability.
- Section 3.1 – Darlington Site – Table 15 (page 88). The Conventional Health and Safety rating for the DWMS (SA^2) has an undefined note. A correction is required.
- Section 3.3.3 -Operating Performance (page 166). The ROR text refers the reader to Table 22 when the correct table number is 25.
- Section 3.6.8 – Santé et Sécurité Classiques – Pratiques (page 238). The section number of the two reports is incorrectly specified as "XX".

<u>Item for consideration by the Commission:</u>

The process used to produce the annual ROR should be reviewed and improved as appropriate to ensure the introduction of minor discrepancies and inaccuracies is minimized to the extent possible.