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Mémoire de Helmy Ragheb

In the Matter of the

New Brunswick Power Corporation, Point Lepreau Nuclear Generating Station

Application for the renewal of NB Power's licence for the Point Lepreau Nuclear Generating Station

Commission Public Hearing
Part 2

May 11 and 12, 2022

À l'égard de la

Société d'Énergie du Nouveau-Brunswick, centrale nucléaire de Point Lepreau

Demande de renouvellement du permis d'Énergie NB pour la centrale nucléaire de Point Lepreau

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Comments on
Licence Application for the renewal of NB Power's licence for the Point Lepreau Nuclear Generating Station

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Executive Summary

The Canadian Nuclear Safety Commission (CNSC) agreed to my participation in the CNSC's proceedings and review New Brunswick Power Corporation's (NB Power) licence renewal application and related documentation, including NB Power and CNSC Commission Member Documents. My review provides comments on the licence application through the lens of my professional background and experience. I wish to thank the CNSC for the opportunity to conduct this review and to share my observations and findings.

The review focused on the safety control areas, and made recommendations in specific areas, including the Operating Performance, Safety Analysis and Operating Experience (OPEX).

In the Operating Performance area, my review focussed on the Safe Operating Envelope (SOE) within which operation of the nuclear facility must meet the regulatory requirements and public risk limits. The review identified apparent deficiencies in the SOE maintenance process and highlighted the risks associated with these deficiencies. Recommendations were made to assign the SOE maintenance process the highest significance rating, consistent with major reduction in the margin of safety to the public or station personnel. It is also recommended that the Licence Conditions Handbook (LCH) should include a condition that NB Power conduct a rigorous review, system by system, of all safety analysis-based limits imposed on safety systems, and implement the required changes in the SOE documents on a high priority basis.

In May 2019, the Shutdown System at Point Lepreau station was found to operate within limits not aligned with the safety analysis-based limits. The discovery highlighted the significance of the Safe Operating Envelope SOE) maintenance.

In the Safety Analysis area, I reviewed the compliance of the deterministic safety analysis with REGDOC 2.4.1. I found that NB Power's current safety analysis may not meet the regulatory requirements and does not demonstrate that the Point Lepreau NGS has sufficient safety margins in the event the station is subject to an earthquake. It is recommended that NB Power be required – as a licence condition – to perform deterministic safety analysis for the design-basis earthquake event and other external hazards in compliance with the current REGDOC 2.4.1.

Safe Operating Envelope (SOE) Limits Alignment with the Safety Analysis

What is Safe Operating Envelope (SOE)?

The Safe Operating Envelope refers to those safety analyses limits or operational requirements for parameters or system conditions within which operation of the nuclear facility has been shown to meet the regulatory requirements and public risk limits, and which can be directly observed and/or controlled by the operator.

The safety limits are used to define the hardware functional requirements and limiting system parameter values in the hardware subsystems. They are also used to ensure there is sufficient margin to the nominal actuation setpoints to account for instrument error and uncertainty.

Requirements imposed by the safety limits on Nuclear Power Plant (NPP) systems must be routinely verified throughout the life of the plant. Verification that the requirements are met is usually demonstrated by hardware surveillance requirements.

How is the SOE Aligned with the Safety Analysis results?

When a new safety analysis is completed or an existing safety analysis is update, the impact of the change in the analysis on the affected systems is identified and all the relevant documents (such as the plant training and operational documents) must be updated based on the results of the new or updated analysis, to reflect the newly imposed limits or requirements. NPPs use certain processes to ensure the SOE is aligned all the time with safety analysis results. Among these processes is the Engineering Change Control (ECC).

Documenting the SOE, involves transposing the derived limits from the safety analysis to several of documents. This process must be done routinely and in a timely manner without delay. This represents a challenge to maintaining the validity of the SOE, as it requires update of several documents, each time a safety limit is revised in the safety analysis.

To address this challenge, NPPs usually consolidate all requirements and limits derived from the safety analysis in one controlled document called Operational Safety Requirement (OSR). CSA standard, section A.4.8.4.2 (b) describes one of the SOE implementation objectives: “Safe *operating limits, conditions of operability, actions and action times should be consolidated for each system in the applicable impairment manual or equivalent (e.g., operating manuals*) “. NB Power’s Ref. [1] does not provide information on how the SOE document consolidation is achieved.

Risks of Operation Outside the SOE

Safety systems, for example, are required to automatically initiate reactor shutdown before the safety limit associated with any trip parameter is exceeded. If these limits are not aligned with the limits determined by the safety analysis, shutdown systems may not have sufficient negative reactivity depth inserted within the required timing as assumed in the safety analysis. If this deficiency is discovered, the safety system is declared unavailable, otherwise the deficiency may remain in the safety system as a "dormant failure"

Point Lepreau plant, throughout its operational life, must have undergone many engineering changes, several updates to its safety analyses and lately plant upgrades as part of the refurbishment project. The accumulation over the years of plant changes, if combined with less-than-adequate processes to implement the impact of the changes, may have resulted in a situation where the SOE is not aligned with the safety analysis results. In this case, its likely that some of the safety systems may not be effective in performing there intended function when called upon.

What are NB Power's Actions to Ensure the Validity and Integrity of the SOE?

NB Power submission CMD 22-H2.1 of January 26, 2022 [1], explains in Section 4.5 that "*SOE parameters are documented within various station documents including Basis documents, Implementation reports, Impairments Manuals, Operating Manual Tests, Routines and Surveillance activities*". No additional information was found in NB Power's submission regarding status and method of validation of SOE. But the CNSC staff submission CMD 22-H2 shed some light on the current challenges with the SOE at Point Lepreau station.

CMD 22-H2 indicated in Section 2.6 that NB Power prepared an integrated implementation plan (IIP) with actions to address aggregate findings from the Periodic Safety Review (PSR). These actions, which were reported in section 3.2 of Ref. [2], include implementation of the findings of the Periodic Safety Review (PSR), among them findings related to the SOE administration. The SOE findings and plans for resolution were described in the Aggregate Finding Resolution Plan (AFRP-16). The description of plan states: "*This plan strengthens how PLNGS maintains its SOE, analysis supporting the identification of safe operating margins and limits and supporting operational safety requirements including SOE parameters*". The implementation status indicates: "COMPLETED". It says also: "It *is now a matter of process for staff and vendors to refer to SOE documentation for the correct values to be used in safety analysis to ensure alignment*"

With the limited information on how PLNGS manages the resolution SOE findings, it is difficult to assess the status of the safety systems effectiveness and their availability at Point Lepreau NGS.

Is it Possible that Point Lepreau Station Unknowingly Operate Outside the SOE?

The answer is yes.

On May 13, 2019 at Point Lepreau station, a surveillance test was conducted to check the correct functioning of the complete Liquid Injection Shutdown System (SDS2) [3]. The test was to verify that the Liquid Injection process functions better than credited in the safety analysis. This requires verification that poison is injected at an acceptable rate, and reactor power is reduced as fast or faster than assumed in the safety analysis for shutdown by SDS2. If these requirements are not met, then the Liquid Injection Shutdown System (LISS) is unavailable.

Assessment of the test results found that previous analysis and subsequent design changes had credited a total time of 280 milliseconds from the time that the trip signal is received, as a maximum safety limit to fully stroke the quick opening injection valves. It was also found that the timing gates for the SDS2 LISS were originally established with acceptance gates derived from the average LISS performance over four physical system firings from years 1987-1997. As well, the SOE limits related to helium tank pressure run-down during the LISS firing, did not align with the run-down curve applied in the safety analysis and the safety margin was underestimated.

In response to the assessment findings, NB Power determined the following actions:

- Change the SDS2 timing gates in the Test. One of the gates was changed to a more restrictive value.
- SDS2 SOE basis report was revised and the revised limits to be implemented into operational documentation.
- The SDS2 timing gates were analyzed, and new timing gates were specified to align with safety analysis limits and to correct for initial tank pressure.

The Event Report of Ref. [3] stated at that time that the SOE implementation improvement project was underway and was approximately 75% complete. Any similar issue would be caught through this process

Conclusion

The Safe Operating Envelope (SOE) represents the safety analyses limits or operational requirements for system conditions within which operation of the nuclear facility must meet the regulatory requirements and public risk limits. If any safety system was found, through routine testing or fortuitus reasons, to operate outside the SOE, the safety system is declared unavailable, otherwise the deficiency may remain in the safety system as a “dormant failure”. Maintenance of the SOE, therefore, should be taken seriously and should be assigned the highest significance ratings among other findings in the Periodic Safety Reviews (PSRs). I am surprised that the existing maintenance program for the SOE at Point Lepreau station is treated as an “improvement” plan that

is implemented over several years rather than an “urgent” and an immediate action to ensure no “dormant” failures” remaining in the safety systems. I am particularly concerned about the apparent weakness reported by NB Power in managing the safety analysis. The Aggregate Finding Resolution Plan (AFRP-16) erroneously describes the SOE maintenance process in reverse: It calls on the staff and vendors to use the correct values from the SOE documentation as input to the safety analysis, instead of using the safety analysis results as input to SOE documentation. The discovery, in the September 2020 reported event, of the safety limits of the Shutdown System 2 (SDS2) not in alignment with the safety analysis limits, does not provide assurance of the effectiveness of the SOE maintenance program at Point Lepreau station.

It is suggested that CNSC, while reviewing the NB Power’s application for Licence renewal, request NB Power to assign the Safe Operating Envelope (SOE) maintenance process the highest significance rating, consistent with major reduction in the margin of safety to the public or station personnel. The Licence Conditions Handbook (LCH) should include a condition that NB Power conduct a rigorous review, system by system, of all safety analysis-based limits imposed on safety systems and implement the required changes in the SOE documents on a high priority basis.

Deterministic Safety Analysis for Hazards is not in Compliance with REGDOC 2.4.1

Regulatory Requirements for the Safety Analysis of Earthquake Event

REGDOC 2.4.1 “Deterministic Safety Analysis” requires that deterministic safety analysis should be performed for events caused by natural common-cause events (section 4.2.1 “Identification of events”). The frequency of these events should be identified iteratively by the Probabilistic Safety Assessment (PSA).

Section 4.2.2.4 of REGDOC 2.4.1 further specifies that earthquakes is among the externally initiated common-cause events that is required to have deterministic safety analysis.

Section 4.2.3 of REGDOC 2.4.1 stipulates that credible common-cause events shall also be classified within the AOO, DBA and BDBA classes.

Appendix A Table in REGDOC 2.4.1 lists the “Design-basis earthquake” with Design-basis (DBA) class.

Design-basis Earthquake (DBE) Deterministic Analysis Appears to be Missing

The NB Power application [1] states in section 5.2 “Hazard Analysis” that the hazard screening was updated in 2016 including additional analyses performed on seismic, high wind and tsunami hazards. The screening led to incorporating the earthquake events within the PSA version finalized in 2016. There was no mention of performing any deterministic safety analysis for the Design-basis Earthquake (DBE) as required by REGDOC 2.4.1

CNSC Staff Assessment did not Comment on the Missing DBE Analysis

Despite the apparent absence of the deterministic safety analysis for the DBE event, CNSC staff confirmed in section 3.4.2 of CMD 22-H2 that NB Power performs deterministic safety analysis to evaluate the plant response to events in accordance with CNSC requirements REGDOC-2.4.1 (Deterministic Safety Analysis published in 2014.) In February 2021, CNSC staff also reviewed the most recent revision of the Point Lepreau NGS REGDOC-2.4.1 implementation plan and determined that it is acceptable.

Why is DBE Analysis Necessary?

The Lepreau station response to a seismic event should be taken into consideration in the station design. A conservative assessment of the station's response and the public dose following a DBE provide assurance that the public dose limits, are not exceeded.

Typically, such analysis when performed, credits those systems and structures that are seismically qualified with fulfilling their design intent and conservatively assumes the failure of all systems that have not been seismically qualified. Some consequential failures may subject systems to harsh conditions or result in flooding and prevent mitigating operator actions in these areas.

Safety analysis methods for the DBE should be the same as those used in performing all other design basis events, as prescribed in REGDOC 2.4.1. The method of analysis should be distinguished from the “Seismic hazard assessment “method and seismic PSA.

Conclusion

It is concluded that NB Power’s current safety analysis may not meet the regulatory requirements and does not demonstrate that the Point Lepreau NGS has sufficient safety margins in the event the station is subject to an earthquake”

It is recommended that NB Power be required – in a licence condition – to perform deterministic safety analysis for the design-basis earthquake event and for other external hazards in compliance with the current REGDOC 2.4.1.

References

[1] CMD 22-H2.1 “Application for the renewal of NB Power’s licence for the Point Lepreau Nuclear Generating Station”, 2021-12-22 Edocs 6706600.

[2] PLNGS Information Report IR-03612-23 Rev.1, Periodic Safety Review 2 (PSR2) Integrated Implementation Plan

[3] Event Report No. ER-03500-2009-003-A-00: “Revised Safety Analysis Limits”, 2020-09-03