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December 13, 2013
L-13-373

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject:
Davis-Besse Nuclear Power Station
Docket No. 50-346, License No. NPF-3
Reply to Request for Additional Information Related to Steam Generator Inventory Change (TAC No. MF0536)

By letter dated January 18, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13018A350), FirstEnergy Nuclear Operating Company (FENOC) submitted an application for amendment of Operating License NPF-3 for the Davis-Besse Nuclear Power Station (DBNPS). The proposed amendment would revise Technical Specifications in support of the steam generator replacement scheduled for the DBNPS spring 2014 refueling outage.

By letter dated November 14, 2013 (ADAMS Accession No. ML13311B193), the Nuclear Regulatory Commission (NRC) staff requested additional information in order to complete its review of the application. The FENOC response to this request is attached.

There are no regulatory commitments contained in this letter. If there are any questions, or if additional information is required, please contact Mr. Thomas A. Lentz, Manager - Fleet Licensing, at 330-315-6810.

I declare under penalty of perjury that the foregoing is true and correct. Executed on December 13, 2013.

Sincerely,

Raymond A. Lieb

Attachment: Reply to NRC Request for Additional Information Dated November 14, 2013

cc: NRC Region III Administrator
NRC Project Manager
NRC Resident Inspector
Executive Director, Ohio Emergency Management Agency,
State of Ohio (NRC Liaison)
Utility Radiological Safety Board

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1. **The NRC staff is concerned that the steam generator (SG) inventory characteristics may change as a result of the proposed changes or the related modifications. The concerned is based on the proposed revision to Technical Specification (TS) Figure 3.7.18-1, which would require the operating range to remain lower than the existing limit, even though the revised TS BASES included with the January 18, 2013, submittal, states that the initial inventory in the SG will remain the same. The TS BASES included for information in Attachment 3 to the submittal, the licensee indicates that the requirements contained in TS limiting condition for operations (LCO) 3.7.18, "Steam Generator [SG] Level," are based**

    ...*primarily* [emphasis added] on preserving the initial condition assumptions for the steam generator inventory used in the main steam line break (MSLB) accident analysis."

    Similarly, the Applicable Safety Analyses from the submittal section states,

    [t]he *most limiting* [emphasis added] Design Basis Accident [DBA] that would be affected by steam generator operating level is a main steam line failure.

    The proposed revision to TS Figure 3.7.18 would modify TS LCO 3.7.18.a to specify the SG operate range level as a revised function of main steam superheat.

    Since the emphasized language in the TS BASES suggests that the LCO requirements may not be exclusively related to the MSLB analyses, address whether the process variables, design features, and/or operating restrictions controlled by TS LCO 3.7.18.a are initial conditions for other design basis accident or transient analyses that either assume the failure of or present a challenge to the integrity of a fission product barrier.

a. **In particular, state whether operation at the limit prescribed by TS LCO 3.7.18.a is assumed in any of the feedwater line break, SG tube rupture, or emergency core cooling system evaluation/loss-of-coolant-accident analyses.**

b. **If the operation at the limit prescribed by LCO 3.7.18.a is assumed in the DBA listed above, explain whether the proposed LCO would ensure that plant operation remains bounded by the existing safety analyses.**

c. **If it is not, provide a brief summary of, and the basis for, the selected secondary side initial conditions.**

FENOC Response

The above-referenced statements in the BACKGROUND and APPLICABLE SAFETY ANALYSES sections of the BASES for TS 3.7.18, as provided in the subject application for amendment, are consistent with corresponding statements in "Standard Technical Specifications – Babcock and Wilcox Plants: Bases" (NUREG-1430, Revision 4). Although technically correct, inclusion of the emphasized words in these statements provides the unintended implication that other design basis accident analyses may assume maximum steam generator secondary side inventory as an initial condition for the respective events.

The change proposed to LCO 3.7.18 ensures that the maximum steam generator inventory allowed during plant operation remains bounded by the inventory that was used as an initial condition in analyzing the main steam line break. Ensuring operation within the limits of this analysis does not alter the relationship of the main steam line break event to other analyzed events. The proposed change to LCO 3.7.18 will not have any impact on the plant response to, or the analyses of, any other events identified.

The maximum inventory limitation provided by LCO 3.7.18 is only considered in the main steam line break analysis. In response to NRC Question 1.a operation at the limit prescribed by TS LCO 3.7.18.a is not assumed in the feedwater line break, SG tube rupture, or emergency core cooling system evaluation/loss-of-coolant-accident analysis. Accordingly, question 1.b is not applicable. In response to question 1.c, a summary of and the basis for the selected steam generator secondary side initial conditions is provided for each of these accident analyses.

Main Feedwater Line Break (MFWLB)

MFWLB Mass and Energy Release

DBNPS Updated Safety Analysis Report section 15.2.8, "Loss of Normal Feedwater," in subsection 15.2.8.2.3, states:

> The environmental consequences resulting from the loss of normal feedwater due to a feedwater line break between the first feedwater line upstream check valve and the steam generator produce results no worse than the steam line break accident presented in Subsection 15.4.4.

There is no explicit analysis of the mass and energy release from a MFWLB presented in the USAR. The conclusion stated above is the result of the physical differences in the mechanics of the release to containment for a MFWLB compared to a MSLB. Specifically, in a MFWLB, much more of the mass being released is liquid from the downcomer region of the steam generator and from the feedwater piping. This liquid inventory does not pass through the tube region of the steam generator to absorb energy from the reactor coolant system prior to its release, as it would for a break in the main steam line. This results in a reduced energy content for the same mass released to the containment. As a result, the mass and energy release of a MFWLB will be inherently bounded by the mass and energy release resulting from the main steam line break analysis, regardless of the secondary side inventory assumed in the MSLB analysis. The proposed modifications to the DBNPS steam generators do not affect the accuracy of the statement in USAR subsection 15.2.8.2.3. In conclusion, the MFWLB is inherently bounded by the MSLB analysis, and no specific value for steam generator secondary inventory was considered for analysis of the mass and energy release resulting from a MFWLB.

<u>MFWLB Core Response</u>
The summary of the analysis for the reactor core response to a MFWLB is presented in USAR subsection 15.2.8.2.3, and includes the following statement.

> Assumptions (2) and (6) are conservative assumptions which result in the highest power level with the minimum full power inventory. This clean generator inventory results in less water initially available for cooling in this overheating event...

Assumptions (2) and (6) establish 100 percent reactor power and an unfouled (low) steam generator inventory as initial conditions for the MFWLB core response analysis. Because the concern regarding this event is the inability to remove heat from the reactor core, high reactor power and low steam generator inventory support a conservative analysis. USAR figures 15.2.8-2 and 15.2.8-3 show that the steam generator inventory used in this analysis was approximately 38,000 pounds mass.

<u>Steam Generator Tube Rupture (SGTR)</u>

USAR section 15.4.2, Steam Generator Tube Rupture, in subsection 15.4.2.2.4, states:

> During the venting time of the affected steam generator, it is conservatively assumed that all fission products leaking from the reactor coolant system go directly to the atmosphere. Prior to the tube rupture, the unit is assumed to have been operated with a 1 gallon per minute tube leak and 1 percent defective fuel

rods. Volatile activity that reaches the condenser is released to the atmosphere after passing through the condenser air removal system.

The analysis presented in the USAR for the SGTR event addresses only environmental dose consequences. As presented above, those analyses assumed a complete release to atmosphere of volatile fission products that are introduced to the steam generator secondary side through the ruptured tube. Because of this conservative assumption, the secondary side of the steam generator is simply a flowpath to the release point, and steam generator secondary inventory is not a specific consideration for the SGTR analysis.

Emergency Core Cooling System Evaluation/Loss-of-Coolant Accident

No specific value for steam generator secondary inventory is assumed as an input for either the large break or small break loss-of-coolant accident (LOCA) analyses. The analyses are performed by initializing the model to establish a steady-state primary-to-secondary heat balance with the target values for feedwater temperature and reactor coolant system flow and the specified amount of steam generator tube plugging. Based on these inputs, the steam generator secondary inventory values used to establish the required primary-to-secondary heat removal are internally calculated in the analytical model.

The large and small break LOCA analyses are dominated by factors other than the initial steam generator inventory. For the large break LOCA, linear heat rate limits, fuel stored energy, reactor coolant pump trip, decay heat, core power peaking, heat transfer restrictions, core flood tank initial conditions, and reactor vessel vent valve flow bypass dominate the peak clad temperature predictions. The main turbine trip timing, main feedwater isolation, and auxiliary feedwater actuation and flowrate dominate the small break LOCA analysis. Changes in the initial steam generator inventory will not detectably affect the results of these analyses.

2. **Regarding the MSLB analyses, the TS BASES for TS LCO 3.7.18 indicate that Figure 3.7.18-1 is based on maintaining inventory <56,000 pounds-mass (lbm), which ensures that the MSLB analysis is bounding "considering all plant effects (e.g., steam superheat and downcomer voiding)."**

   Explain how limiting the mass present in the SG ensures that the MSLB analysis remains bounding in consideration of other secondary side thermal-hydraulic phenomena, including not only steam superheat and downcomer voiding, but also the axial void profile on the secondary side of the tube bundle region. These phenomena contribute to the predicted performance of the plant during a postulated transient. For example, explain why an MSLB inside containment would not discharge more energy to the containment if initiated with a higher superheat level, despite that more steam and less

mass may have initially been present in the steam generator (i.e., at a condition to the right of, and below, the proposed limit line).

FENOC Response

The RELAP5/MOD2-B&W modeling of the once-through steam generator (OTSG) thermal-hydraulic phenomena, as well as complete system performance, has been benchmarked to test facilities, plant transient data, and other computer codes in BAW-10193-PA. Those benchmarks demonstrated agreement with the data, demonstrating acceptability of RELAP5/MOD2-B&W for performing safety analyses of non-LOCA events for the B&W-designed pressurized water reactorss. No new phenomena are introduced by the replacement once-through steam generators (ROTSG); therefore, the conclusions drawn from those benchmarks remain valid for the ROTSG.

AREVA Topical Report BAW-10193-PA provides guidance on initial steam generator mass inventory. The guidance specifies that the main steam line break (MSLB) analysis is run using a conservatively high, initial SG inventory. Operation at any lower inventory will produce a lower total energy release.

Due to the large density differences for steam and liquid on the secondary side of the SGs, higher volume of superheated steam implies less total mass. This is due to the steam space (volume occupied by steam associated with superheating) holding less mass than the equivalent liquid or two-phase volume. Maximizing the secondary total mass minimizes the steam region (superheat region) and maximizes the liquid region. This maximizes the potential heat removal capability of the steam generator during a steam line break. Therefore, the largest initial mass will maximize the integrated energy released during the event.

Also, the initial steam volume present in the steam generator represents a relatively small portion of the overall energy release for the event. As noted above, increasing the volume of superheated steam (more steam mass) will reduce the overall mass/energy release as less total mass will be discharged through the break during the event. For containment analyses, limiting reactor building pressure and temperature responses are predicted when modeling the maximum initial SG inventory, which occurs at full power.

High secondary inventory would result in decreased steam temperatures (superheat); conversely, high steam temperatures can exist only if the inventory is lower. Athough they could not actually exist at the same time during plant operation, high SG inventory and high steam temperature are conservatively assumed as initial conditions in the MSLB analysis. This analytical approach ensures that the MSLB analysis conservatively bounds any combination of initial mass and steam temperature that can actually exist during plant operation.