UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 29, 2015

Mr. Dennis L. Koehl
President and CEO/CNO
STP Nuclear Operating Company
South Texas Project
P.O. Box 289
Wadsworth, TX 77483

SUBJECT: SOUTH TEXAS PROJECT, UNITS 1 AND 2 – STAFF AUDIT SUMMARY RELATED TO REQUEST FOR EXEMPTIONS AND LICENSE AMENDMENT FOR USE OF A RISK-INFORMED APPROACH TO RESOLVE THE POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN-BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS (TAC NOS. MF2400, MF2401, MF2402, MF2403, MF2404, MF2405, MF2406, MF2407, MF2408, AND MF2409)

Dear Mr. Koehl:

By letter dated June 19, 2013, as supplemented by letters dated October 3, October 31, November 13, November 21, and December 23, 2013 (two letters); and January 9, February 13, February 27, March 17, March 18, May 15 (two letters), May 22, June 25, and July 15, 2014; and March 10 and March 25, 2015, STP Nuclear Operating Company (STPNOC, the licensee) submitted exemption requests accompanied by a license amendment request for a risk-informed approach to resolve Generic Safety Issue 191 regarding the issue of potential impact of debris blockage on emergency recirculation during design-basis accidents for South Texas Project (STP), Units 1 and 2. The proposed amendment request would implement a risk-informed approach for resolving GSI-191 for STP, Units 1 and 2, as the pilot plants for other licensees pursuing a similar approach.

The U.S. Nuclear Regulatory Commission (NRC) staff conducted a regulatory audit at University of New Mexico in Albuquerque, New Mexico, on May 12 and 13, 2015, in order to gain a better understanding of the licensee's approach to implement a risk-informed evaluation of the effects of debris on emergency core cooling system and the containment spray system operation following a loss-of-coolant accident. A specific goal was to evaluate the licensee's technical approaches implemented in support of the methodology for its risk-informed approach and to identify related verification and validation activities.

The enclosure to this letter describes the results of the NRC staff's audit and some of the key technical issues highlighted by the staff during the audit. The NRC staff and the licensee will continue discussions for resolution of the technical issues during the future interactions.

If you have any questions, please contact me at 301-415-1906 or via e-mail at Lisa.Regner@nrc.gov.

Sincerely,

ASBerg for

Lisa M. Regner, Senior Project Manager
Plant Licensing Branch IV-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-498 and 50-499

Enclosure:
Staff Audit Summary

cc w/encl: Distribution via Listserv

STAFF AUDIT SUMMARY

RISK-INFORMED APPROACH TO RESOLUTION OF

GENERIC SAFETY ISSUE (GSI) 191, "ASSESSMENT OF ACCUMULATION

ON PRESSURIZED-WATER REACTOR SUMP PERFORMANCE"

STP NUCLEAR OPERATING COMPANY

SOUTH TEXAS PROJECT, UNITS 1 AND 2

DOCKET NOS. 50-498 AND 50-499

1.0 Background

By letter dated June 19, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML131750250), as supplemented by letters dated October 3 and 31, 2013 (ADAMS Accession Nos. ML13295A222 and ML13323A673, respectively), STP Nuclear Operating Company (STPNOC, the licensee) submitted exemption requests accompanied by a license amendment request (LAR) for a risk-informed approach to resolve the potential impact of debris blockage on emergency recirculation during design-basis accidents for South Texas Project (STP), Units 1 and 2. This initial submittal was superseded in its entirety by a revised LAR provided by letter dated November 13, 2013 (ADAMS Accession No. ML13323A128). In addition, the licensee provided additional information by letters dated November 21 and December 23, 2013 (two letters); and January 9, February 13, February 27, March 17, March 18, May 15 (two letters), May 22, June 25, July 15, 2014; and March 10, March 25, 2015 (ADAMS Accession Nos. ML13338A165, ML14015A312, ML14015A311, ML14029A533, ML14052A053, ML14072A076, ML14086A383, ML14087A126, ML14149A353, ML14149A354, ML14149A434, ML14178A481, and ML14202A045, ML15072A092, and ML15091A440, respectively). The U.S. Nuclear Regulatory Commission (NRC) staff issued a request for additional information (RAI) by letter dated March 3, 2015 (ADAMS Accession No. ML14357A171). The licensee provided responses to the RAIs by letter dated March 25 and an updated methodology description by e-mail dated April 29, 2015 (ADAMS Accession No. ML15119A327).

The NRC staff conducted a regulatory audit at the University of New Mexico in Albuquerque, New Mexico, on May 12 and 13, 2015, to gain a better understanding of the licensee's approach to implement a risk-informed evaluation of the effects of debris on the emergency core cooling system and containment spray system operation following a loss-of-coolant accident (LOCA).

Enclosure

The following NRC staff members participated in the audit:

- Margaret Watford – Audit lead, Project Manager
- Christopher Fong – Technical lead, Probabilistic Risk Assessment (PRA) technical reviewer
- Ashley Guzetta – Debris generation/transport technical reviewer
- Steven Laur – PRA technical reviewer
- Osvaldo Pensado – Contractor from Southwest Research Institute (SwRI)
- Stephen Smith – Debris generation/transport technical reviewer
- Stuart Stothoff – Contractor from SwRI

STPNOC was represented by the following personnel:

- Steve Blossom – STPNOC
- Wayne Harrison - STPNOC
- Ernie Kee – STPNOC
- Drew Richards - STPNOC
- Wes Schulz – STPNOC
- Don Wakefield - ABS Consulting
- Benjamin Bridges - Alion Science & Technology
- Bruce Letellier - Alion Science & Technology
- Janet Leavitt - Alion Science & Technology
- Dominic Muñoz - Alion Science & Technology
- Megan Stachowiak - Alion Science & Technology
- Rodolfo Vaghetto - Texas A&M University
- Zarah Mohaghegh - University Indiana, Urbana-Champaign
- Seyed Rehani - University Indiana, Urbana-Champaign
- Dan LeBrier – University of New Mexico
- John Hasenbein – University of Texas, Austin
- Jeremy Tejada – University of Texas, Austin

2.0 Audit Report

During the review of the LAR, the NRC staff identified several technical issues and generated RAIs. The RAIs were transmitted to the licensee by letter dated March 3, 2015. The licensee provided responses to the RAIs by letter dated March 25, 2015, and an updated methodology description by e-mail dated April 29, 2015 (ADAMS Accession No. ML15119A327). To facilitate an expedited review and to develop a clear understanding of the information provided by the licensee, a regulatory audit, consistent with the audit plan dated April 17, 2015 (ADAMS Accession No. ML15110A463), was conducted on May 12 and 13, 2015.

2.1 Technical Issues Discussed During the Audit

The audit team focused on the following items:

1. Comparison of Computer-Assisted Design (CAD) Model to CASA Grande

    The audit team observed the licensee's explanations of the in-depth calculations related to four welds locations: three that were identified in the audit plan and an additional location of interest identified during the audit. This sample included both critical and non-critical break locations.[1] The audit team compared supporting documentation (e.g., piping isometrics, insulation specifications, and lithographs) to the CAD model and CASA Grande[2] to confirm that the models used by the licensee were consistent with the as-built and as-operated plant configurations.

    The audit team reviewed the overall process used to construct the CAD model, and observed agreement between the zones-of-influence (ZOIs) used by the CAD model, which were developed manually, and those used by CASA Grande, which were developed using an automated process. During this review, the audit team questioned the licensee about changes made to the upgraded CASA Grande platform that led to a reduction in the amount of debris generated by certain break locations. The licensee explained that this reduction was caused by a more accurate and higher resolution representation of the insulation adjacent to large components such as reactor coolant pumps.

2. Consistency with Nuclear Energy Institute (NEI) 04-07, "Pressurized Water Reactor Sump Performance Evaluation Methodology," December 2004[3]

    The licensee stated that the fibrous debris size distributions were developed based on a methodology that subdivides the ZOI into concentric volumes surrounding the break. The licensee stated that the debris size distributions for each sub-ZOI were determined based on jet impact testing of fibrous insulation. The methodology was stated to be equivalent to that accepted by the NRC staff for other licensee applications. Specifically, the licensee stated that the methodology was used by Indian Point Nuclear Generating Unit Nos. 2 and 3 (Indian Point) and reviewed by NRC staff as part of a GSI-191 regulatory audit for Indian Point. The size distributions used for each sub-ZOI are listed in the Indian Point audit report dated July 29, 2008 (ADAMS Accession No. ML082050433), in Table 3.2-3, "Licensee-Assumed LOCA-Generation Insulation Debris Size Distributions."

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[1] In this context, "critical" means a weld location that could produce debris in excess of 191 lbs of fine fibrous debris.

[2] CASA Grande is the licensee's evaluation tool used to analyze the probabilities and associated uncertainties of specific accident sequences possibly leading to a debris-related failure of containment.

[3] Publicly available in ADAMS at Accession No. ML050550138.

3. Inorganic Zinc ZOI

Discussions regarding the ZOI for inorganic zinc coatings took place between the licensee and NRC. The licensee conducted strainer head loss testing in 2009, which is being used to calculate deterministic fiber limits used in the STP evaluation. At the time the test was conducted, NRC staff guidance, "NRC Staff Review Guidance Regarding Generic Letter 2004-02 Closure in the Area of Coatings Evaluation," dated March 2008 (ADAMS Accession No. ML080230462), allowed licensees to assume a factor of five times the break diameter (denoted as 5D) to define the ZOI for inorganic zinc. In 2010, the NRC staff found that the industry testing used to justify the 5D ZOI contained non-conservatisms, and the NRC staff determined that a 10D ZOI was more appropriate for inorganic zinc coatings. NRC guidance titled "Revised Guidance Regarding Coatings Zone of Influence for Review of Final Licensee Responses to Generic Letter 2004-02," dated April 6, 2010 (ADAMS Accession No. ML100960495), calls for evaluation of inorganic zinc coatings debris generation assuming a 10D ZOI. The licensee stated it is evaluating how to address the potential that the 2009 testing may not have included adequate inorganic zinc quantities to meet current NRC staff guidance.

4. Transport Fractions

The licensee explained the assumptions used for the transport fractions and erosion percentages in their evaluation. The licensee stated that constant factors are used to compute proportions of transported and retained debris, and proportions of retained small and large fiber that erode into fiber fines. A fraction of particulates is assumed to form sediments in the bottom of the pool. No sediments are assumed to form for inorganic zinc coatings.

The NRC expressed concern with some of the assumptions used in the transport evaluation, specifically, that the assumptions could underestimate the amount of small debris that washes down to the pool, and the amount of debris that erodes from the fibrous debris in the pool. The NRC staff stated that these assumptions require additional justification since they differ from NRC-approved guidance documents. For example, NEI 04-07 states that any debris smaller than the grating should not be considered to be held up during the washdown phase of transport. In addition, the NRC staff noted that the 7-percent erosion fraction for debris in the sump pool credited by STP is lower than the value approved by the NRC staff in a letter dated June 30, 2010 (ADAMS Accession No. ML101540221).

5. Calculation of Break Sizes Exceeding Threshold Values of Fiber Fines

The licensee explained its methodology for determining the critical welds and corresponding break sizes at the critical weld locations that could produce more than 192 pound-mass (lbm) of fiber fines for two or more sumps in operation or more than 96 lbm for one sump in operation. The licensee presented plant drawings, demonstrated how the CAD model was constructed, and showed how the debris source term for a double-ended guillotine break (DEGB) of any selected weld could manually be produced from the CAD model. The NRC staff selected non-critical welds, similar to the critical ones in location and pipe dimension, and the licensee described the debris source-term computation process to confirm the welds were non-critical based on the amount of fiber fines generated. The CAD model provided a graphical demonstration as to why these similar welds were non-critical (i.e., since these welds are farther from larger debris sources).

The licensee explained that the CASA Grande program samples the direction of the hemisphere (representing a break jet) as perpendicular to the pipe axis, centered at the break location on the pipe surface. The licensee stated that its approach systematically varies this hemisphere direction to find the largest amount of debris that could be generated for a specific break size at a given weld location. The licensee presented contour plots of fiber fines amounts as function of the break size and the vertical orientation angle for one example weld.

The licensee described the approach to compute the smallest break at a weld location that would produce fiber fines exceeding 192 lbm (two-train case) or 96 lbm (single-train case). First, the licensee determined the mass of fiber produced by DEGB breaks and identified the welds that were incapable of producing enough fiber fines to reach the identified thresholds. For the remaining welds, the licensee stated that the CASA Grande platform uses Monte Carlo sampling and decreases the break size at a given weld, finds the maximum fiber generated as a function of the orientation angle, then compares that amount of fiber to the 192-lbm or 96-lbm thresholds. To address the Monte Carlo sample size resolution, the licensee explored convergence tests, and provided data to the NRC staff to demonstrate that the exceedance breaks (i.e., minimal breaks causing fiber fines to exceed the 192-lbm or 96-lbm thresholds) did not significantly change after the Monte Carlo sample size exceeded a given number of realizations.

6. Calculation of Core Damage Frequency

The licensee demonstrated how the final core damage frequency (CDF) attributable to debris was calculated. As stated previously, for each critical weld, the smallest size break was determined that would produce a mass of fiber fines greater than the debris thresholds. Loss of coolant accident (LOCA) frequencies for each critical weld were determined by dividing the plant-wide LOCA frequencies from NUREG-1829 by the number of welds in each size category. LOCAs expected to produce fiber fines in excess of threshold values were assigned a conditional core damage probability of one.

The audit team identified a discrepancy between Attachment 7 of the March 25, 2015, response to RAIs and independent calculations performed by NRC staff. During the audit, the licensee stated that these discrepancies were due, in part, to revisions to CASA Grande. The NRC staff suggested that these changes should be reflected in the revised LAR and other future docketed correspondence.

7. Verification of the Mass-Balance Computations Implemented in Python

The licensee discussed verification activities for the Python[4] code. The licensee described its efforts to derive mass-balance equations and to check line-by-line coding. The licensee stated that special cases will be analyzed in the future which would be compared to analytical or expected solutions. The licensee discussed sensitivity analyses performed using the Python code to show a response to a range of conditions, including low flow rates. In all of the cases, the computed fiber buildup was well below 15 grams per fuel assembly (this threshold was developed by the licensee during deterministic testing).

The NRC staff asked whether long-term shedding from the strainer fiber load would significantly contribute to buildup in the reactor core. The licensee explained that the implementation of the filtration model accounts for shedding as detected in tests. The NRC staff noted that, to date, the only available description of a filtration/shedding model is in the license amendment submittal dated November 2013, Enclosure 4-3, *Risk-Informed Closure of GSI-191 Volume 3, Engineering (CASA Grande) Analysis*, (ADAMS Accession Nos. ML13323A190 and ML13323A191). This enclosure distinguishes a filtration component (empirical equation with 4 parameters) from a long-term shedding component (differential equation with 2 parameters). To address this observation, the licensee stated it would provide in a future submittal existing internal reports analyzing data from filtration tests and deriving filtration equations.

8. Calculation of Large Early Release Frequency

The licensee described the types of scenarios in its PRA model that lead to large early release and described which ones would apply when calculating the large early release frequency (LERF) attributable to debris. For example, the licensee stated that there would be no "high pressure melt" scenarios because all of the critical weld break sizes are large LOCAs – which contribute to LERF in the STP PRA model. The description provided by the licensee is considered more complete than the LERF to CDF ratio approach provided in response to RAIs. The licensee stated that a more detailed description will be provided to properly justify the ratio approach and LERF values.

<u>Other Items:</u>

The licensee stated that CASA Grande was now under a software quality assurance (SQA) program. An overview of the SQA program was presented to the NRC staff including documents to define software requirements, the development plan, verification of implementation against requirements, the user guide, and software verification. Software for version and revision control (TortoiseSVN) is used to control the CASA Grande source code. The licensee stated that upcoming submittals will describe the work completed to control CASA Grande under an SQA program.

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[4] The Python code was developed by the licensee to implement fiber mass-balance computations to compute the amount of fiber buildup as a function of the filtration efficiency of the strainers (which is a function of the fiber mass-load on the strainers).

2.1 Exit Meeting

During the exit meeting on May 13, 2015, the NRC staff stated that the audit helped to better understand areas of the licensee's submittal, and advanced resolution of several NRC staff concerns. There was open communication throughout the audit and it was conducted in accordance with the audit plan with no known deviations.

The NRC staff summarized the following areas that, if not addressed by future docketed correspondence, would likely be the topic of future RAIs, including:

- An evaluation of critical welds where a small break size would exceed the inorganic zinc amounts used in the tests.
- A detailed description to justify the LERF methodology.
- A description of work completed to control CASA Grande under an SQA program.
- An explanation of which information in the upcoming submittal supersedes information and results already on the docket from previous submittals and supplements.
- A more detailed explanation of the conclusion that an appropriate number of trials were performed to adequately define the exceedance break size for each location.
- A 7 percent versus 10 percent factor for erosion in light of related NRC guidance on appropriate erosion factors.
- A description of washdown calculations for small and medium debris.
- A strainer penetration test report describing filtration and shedding equations.
- A discussion of whether small fiber trapped on strainers could later erode or be shed from the fiber bed in the form of fines, thus contributing to more fines in the system than initially determined.
- A numerical result using the code for in-vessel fiber buildup computations comparing to a special case that can be analytically computed, or to an alternative implementation (e.g., in MATLAB) to provide assurance that the mass-balance code is properly implemented and that results are convergent.

If you have any questions, please contact me at 301-415-1906 or via e-mail at Lisa.Regner@nrc.gov.

Sincerely,

/Andrea George for/

Lisa M. Regner, Senior Project Manager
Plant Licensing Branch IV-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-498 and 50-499

Enclosure:
Staff Audit Summary

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NAME	MWatford	LRegner	JBurkhardt	SRosenberg*
DATE	6/24/2015	6/29/2015	6/24/15	7/27/15
OFFICE	NRR/DSS/SSIB/BC	NRR/DORL/LPL4-1/BC	NRR/DORL/LPL4-1/PM	
NAME	VCusumano*	MMarkley	LRegner (AGeorge for)	
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