



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

May 31, 2016

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 – AUDIT SUMMARY RELATED TO APRIL 12-13, 2016, REGULATORY AUDIT FOR THE REVIEW OF THE RISK-INFORMED SOLUTION TO GENERIC SAFETY ISSUE 191 AND DRAFT REQUEST FOR ADDITIONAL INFORMATION (CAC NOS. MF2400 THROUGH MF2409)

Dear Mr. Koehl:

By letter dated June 19, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML131750250), as supplemented by letters dated October 3, October 31, November 13, November 21 and December 23, 2013 (two letters); January 9, February 13, February 27, March 17, March 18, May 15 (two letters), May 22, June 25, and July 15, 2014; March 10, March 25, and August 20, 2015; and April 13, 2016 (ADAMS Accession Nos. ML13295A222, ML13323A673, ML13323A128, ML13338A165, ML14015A312, ML14015A311, ML14029A533, ML14052A110, ML14072A075, ML14086A383, ML14087A126, ML14149A353, ML14149A354, ML14149A439, ML14178A467, ML14202A045, ML15072A092, ML15091A440, ML15246A125, and ML16111B204, 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 Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on PWR [Pressurized-Water Reactor] Sump Performance," at South Texas Project, Units 1 and 2.

The U.S. Nuclear Regulatory Commission (NRC) staff conducted a regulatory audit at the University of Texas in Austin, Texas, on April 12-13, 2016, to review remaining open items associated with the licensee's risk-informed analysis of debris as provided in the LAR. Enclosure 1 of this letter describes the results of the NRC staff's audit and some of the key technical issues highlighted by the NRC staff during the audit. The draft request for additional information questions¹ are included in Enclosure 2.

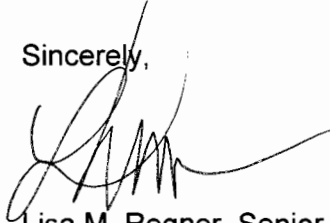
¹ Draft requests for additional information were sent by e-mail to the licensee on March 22 and May 4, 2016 (ADAMS Accession Nos. ML16082A484 and ML16125A239, respectively). The May document updated the March document and added one question (question APLA-4-6).

D. Koehl

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

Sincerely,

A handwritten signature in black ink, appearing to read 'L. Regner', with a long horizontal flourish extending to the right.

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

Enclosures:

1. Audit Summary
2. Draft Request for Additional Information

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AUDIT SUMMARY – APRIL 12-13, 2016
REVIEW OF PROBABILISTIC RISK ASSESSMENT ASSOCIATED
WITH THE RISK-INFORMED SOLUTION TO GENERIC SAFETY ISSUE 191
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, October 31, November 13, November 21 and December 23, 2013 (two letters); January 9, February 13, February 27, March 17, March 18, May 15 (two letters), May 22, June 25, and July 15, 2014; March 10, March 25, and August 20, 2015; and April 13, 2016 (ADAMS Accession Nos. ML13295A222, ML13323A673, ML13323A128, ML13338A165, ML14015A312, ML14015A311, ML14029A533, ML14052A110, ML14072A075, ML14086A383, ML14087A126, ML14149A353, ML14149A354, ML14149A439, ML14178A467, ML14202A045, ML15072A092, ML15091A440, ML15246A125, and ML16111B204, 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 Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on PWR [Pressurized-Water Reactor] Sump Performance," at South Texas Project, Units 1 and 2 (STP).

In order to complete its review, the NRC staff needed a better understanding of the licensee's probabilistic risk assessment (PRA) of the effects of debris on core cooling following a design-basis loss-of-coolant accident (LOCA). The NRC staff provided requests for additional information (RAIs) in draft documents dated March 22 and May 4, 2016 (ADAMS Accession Nos. ML16125A239 and ML16082A484, respectively). Due to the complexity of this analysis, to more efficiently complete its review of this subject, the NRC staff determined that a regulatory audit was necessary.

2.0 SCOPE AND PURPOSE

The NRC staff audited STPNOC's PRA for GSI-191 at the University of Texas in Austin on April 12-13, 2016. The purpose of the audit was to determine the remaining open items for the risk review of the submittals, and ensure that the RAI included questions to close these open items. The NRC staff conducted the audit in accordance with the draft audit plan e-mailed to STPNOC staff on March 29, 2016 (ADAMS Accession No. ML16090A132). The final draft questions are included in this document as Enclosure 2. These questions will be issued as a formal RAI.

The following NRC staff and contractors participated in the audit:

- CJ Fong, Team Leader, Risk-Informed Licensing Initiatives
- Steve Laur, Senior Reliability and Risk Analyst
- Osvaldo Pensado, NRC contractor

The following STPNOC staff and contractors participated in the audit:

- Drew Richards, STPNOC
- Wayne Harrison, STPNOC
- Steve Blossom, STPNOC
- Ernie Kee, STPNOC
- Zahra Mohaghegn, STPNOC contractor
- Seyed Reihani, STPNOC contractor
- David Johnson, STPNOC contractor
- Alex Zolan, STPNOC contractor
- Jeremy Tejada, STPNOC contractor
- Bruce Letellier, STPNOC contractor
- John Hasenbein, STPNOC contractor

3.0 AUDIT REPORT

The audit plan outlined a series of technical areas for the NRC staff and licensee to discuss. The audit team met the objective of the audit plan and obtained the following insights:

- With respect to monitoring and corrective action, the licensee suggested a change to its Updated Final Safety Analysis Report rather than a license condition to provide the regulatory control the NRC staff is seeking. The licensee stated that this approach was used to implement its risk-informed Quality Assurance Program.
- The licensee stated that it would provide additional information to resolve a discrepancy between the double-ended guillotine break-only core damage frequency value (reported in the August 20, 2015, submittal) and the independent calculation performed by the NRC's Southwest Research Institute contractors.
- The licensee provided information on its current programs (e.g., design control) and how these would be used to prevent future introduction of problematic debris sources.

- The licensee clarified the basis for screening certain sequences from the analysis.
- The NRC staff and licensee discussed reasonable approaches to quantify the risk from a seismically induced LOCA (both direct and indirect).
- The licensee provided information on how the risk from water hammer has been addressed.
- The NRC staff and licensee discussed which LOCA break sizes (for breaks in the reactor cavity) could be treated using risk and which would be treated deterministically through RELAP5-3D analysis.

Open and positive communications occurred throughout the audit, and there were no deviations from the draft audit plan. Consistent with the NRR guidance on audits (LIC-111, ADAMS Accession No. ML082900195), the audit team reminded participants that no regulatory decisions are made during audits.

At the conclusion, the audit team stated that answers to open items in other disciplines (e.g., deterministic analysis for long-term core cooling and treatment of epoxy debris in the reactor cavity) could change the PRA results. The NRC staff stated that this needs to be factored into the RAI responses.

4.0 CONCLUSION

The NRC staff found that the audit provided a better understanding of the licensee's PRA activities associated with the resolution of GSI-191. These audit activities helped to clarify for the audit team members the licensee's expected responses to the remaining NRC open items associated with the risk analysis.

DRAFT REQUEST FOR ADDITIONAL INFORMATION
EXEMPTION REQUESTS AND LICENSE AMENDMENT REQUEST
RISK-INFORMED APPROACH TO RESOLVE THE ISSUE OF POTENTIAL
IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING
DESIGN-BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS
STP NUCLEAR OPERATING COMPANY
SOUTH TEXAS PROJECT, UNITS 1 AND 2
DOCKET NOS. 50-498 AND 50-499

By letter dated June 19, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML131750250), as supplemented by letters dated October 3, October 31, November 13, November 21 and December 23, 2013 (two letters); January 9, February 13, February 27, March 17, March 18, May 15 (two letters), May 22, June 25, and July 15, 2014; March 10, March 25, and August 20, 2015; and April 13, 2016 (ADAMS Accession Nos. ML13295A222, ML13323A673, ML13323A128, ML13338A165, ML14015A312, ML14015A311, ML14029A533, ML14052A110, ML14072A075, ML14086A383, ML14087A126, ML14149A353, ML14149A354, ML14149A439, ML14178A467, ML14202A045, ML15072A092, ML15091A440, ML15246A125, and ML16111B204, respectively), STP Nuclear Operating Company (STPNOC) submitted exemption requests accompanied by a license amendment request (LAR) for a risk-informed approach to resolve Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on PWR [Pressurized-Water Reactor] Sump Performance," at South Texas Project, Units 1 and 2.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the information provided in your application and your responses to NRC staff requests for additional information (RAI) related specifically to the probabilistic risk analysis portions of these documents, and determined that the following additional information is required to complete its review.

REQUEST FOR ADDITIONAL INFORMATION

Note: The questions below use the numbering system established in the RAI issued to STPNOC on April 11, 2016 (ADAMS Accession No. ML16082A507). The system consists of the Office of Nuclear Reactor Regulation (NRR) Branch acronym (i.e., Probabilistic Risk Assessment Licensing Branch or APLA), the NRC RAI Round No., then a sequential number starting with 1.

APLA-4-1: NRC Regulatory Guide (RG) 1.174, Revision 2, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," May 2011 (ADAMS Accession No. ML100900006), states, in part, that, "the [probabilistic risk assessment (PRA)] should realistically reflect the actual design, construction,

operational practices, and operational experience of the plant.” Therefore, whether a particular accident sequence (e.g., secondary side break followed by sump recirculation) is part of a plant’s licensing basis is immaterial when performing a risk analysis. For example, accident sequences involving common cause failures are not part of a plant’s licensing basis since the Updated Final Safety Analysis Report (UFSAR) Chapter 15 accident analyses require consideration of only a single active failure. Yet operational experience shows that these types of accidents can occur and they therefore must be modeled by the plant’s PRA. Consistent with this guidance, the risk assessment of debris should consider all hazards, initiating events, and plant operating modes. It should not be limited to design-basis accidents, licensing basis events, specific plant operating modes, or specific initiating events such as a loss-of-coolant accident (LOCA).

In the licensee’s submittal dated October 13, 2013, Enclosure 4-2, “South Texas Project Risk-Informed Closure of GSI-191, Volume 2, Probabilistic Risk Analysis” (Reference 1), provides the screening rationale and concluded in Section 12.3 that “Medium and large LOCAs from internal events only are retained for further consideration with respect to core damage resulting from GSI-191 phenomena.” The Volume 2 document also stated that the full-power analysis bounds consequences of other plant states.

A supplemental analysis (Risk-Over-Deterministic or RoverD) was submitted in STPNOC’s letter dated August 20, 2015 (Attachment 1-3; Reference 2), which did not supersede previous submittals but purported to be “stand-alone.” This raises the question regarding the applicability of the earlier information.

Please confirm that the conclusion in Section 12.3 in the earlier submittal (Reference 1) applies to the RoverD supplemental analysis (Reference 3); that is, confirm that all hazards, initiating events, and plant operating modes were screened out of consideration except medium and large LOCAs and that full-power operation is the only operating mode that merits consideration in the detailed RoverD analyses.

APLA-4-2: NUREG-1829, “Estimating Loss-of-Coolant Accident (LOCA) Frequencies Through the Elicitation Process,” April 2008 (ADAMS Accession No. ML082250436), includes only breaks caused by long-term material degradation. Other potential contributors to LOCA frequency such as seismically induced LOCA (both direct and indirect) should be evaluated separately. A “direct” seismically induced LOCA involves rupture of a piping or non-piping component caused by the seismic event itself. An “indirect” seismically induced LOCA is caused by, for example, failure of piping or component supports that leads to the consequential failure of the piping or non-piping component.

In its May 22, 2014, response to an NRC RAI dated April 14, 2014 (ADAMS Accession No. ML14087A075), STP provided an estimate of the frequency of seismically induced LOCA (Attachment 1, p. 24/86; Reference 4). However, the response did not appear to consider indirect seismically induced LOCAs. One acceptable approach for evaluating indirect seismically induced LOCAs is for the analyst to use the method described by NUREG-1903, “Seismic Considerations for the Transition Break Size,” Section 4.6, “Indirectly Induced Piping Failures,” February 2008 (ADAMS Accession No. ML080880140). “Representative” values in the NUREG could be replaced with site-specific fragility and hazard information that, as appropriate, accounts for any effects of material degradation or aging. Alternatively, it may

demonstrated that the representative values are bounding for the site with consideration of effects due to material degradation or aging.

Please clarify whether the analysis documented in the RAI response considered indirect seismic LOCAs. If not, provide an analysis accounting for indirect damage mechanics eventually leading to rupture of piping and non-piping systems and LOCA events. For both direct and indirect seismically induced LOCAs, estimate, bound or screen any increase in seismic risk due to debris.

APLA-4-3: NUREG-1829 LOCA frequencies include only breaks caused by long-term material degradation. Other potential contributors to LOCA frequency, such as water hammer, should be evaluated separately.

One acceptable approach for evaluating water hammer is to verify that the potential for water hammer is not likely to cause pipe rupture in the break locations that can produce and transport problematic debris. Water hammer includes various unanticipated high-frequency hydrodynamic events, such as steam hammer and water slugging. To demonstrate that component failure risk due to water hammer is acceptably low, the analyst could take the following actions:

- Assess historical frequencies of water hammer events affecting break locations (piping and non-piping) that could generate and transport debris.
- Evaluate operating procedures and conditions and demonstrate that they are effective in precluding water hammer.
- Alternatively, the analyst can demonstrate the following:
 - Plant changes, such as the use of J-tubes, vacuum breakers, and jockey pumps, coupled with improved operating procedures, have been used to successfully mitigate water hammer events.
 - Measures used to abate water hammer frequency and magnitude have been effective over the licensing period of the plant.

Please evaluate the relevance of water hammer events in the context of GSI-191 and estimate, bound, or screen any increase in risk due to water hammer events.

APLA-4-4: Please provide values of total risk estimates (also including water hammer and seismically induced LOCA) for the plant expressed as core damage frequency (CDF) and large early release frequency (LERF). Those values are not available in the recent RoverD analysis (Reference 2). This information is needed to compare pairs {CDF, Δ CDF} and {LERF, Δ LERF} to risk acceptance guidelines in RG 1.174.

APLA-4-5: Title 10 to the *Code of Federal Regulations* (10 CFR), Subsection 50.46(b)(5), *Long-term cooling*, and Appendix A to 10 CFR Part 50, General Design Criterion 35, *Emergency core cooling*, state, in part, that the emergency core cooling system (ECCS) must provide core cooling for extended periods following postulated LOCAs. Licensing basis analyses used to

demonstrate compliance with these regulations have historically analyzed the effects of debris in a deterministic manner. STPNOC has submitted a pilot LAR and a series of exemptions that, if approved, would change its licensing basis by using a risk-informed treatment of debris (Reference 3). RG 1.174 contains five key principles for performing risk-informed changes to a plant's licensing basis. Principle 5 states that an implementation and monitoring program should be utilized to ensure that the conclusions reached by the staff (e.g., that the increase in risk is small) remain valid after the change is implemented.

The NRC staff has determined that it does not yet have adequate assurance that principle 5 of RG 1.174 is met and that there are sufficient regulatory controls of the key elements of the STP risk-informed assessment of debris.

Specifically, the NRC requires regulatory assurance of the continued applicability of the results of the risk-informed approach for consideration of debris in order to issue the requested license amendments and grant the associated exemptions. In order to obtain this regulatory assurance, certain aspects of the risk-informed approach must (1) be subject to an ongoing monitoring program consistent with principle 5 of RG 1.174; (2) be periodically updated; (3) continue to use methods acceptable to the NRC; and (4) be subject to reporting and corrective action when the risk-informed acceptance criteria are not met. The NRC also requires regulatory assurance that the risk-informed approach will not be employed for plant design changes that would increase the problematic debris source term without prior NRC review and approval.

Please provide assurance of appropriate regulatory considerations:

- a. Prior to changing the key methods, approaches, and data of the risk-informed analysis set forth in (reference).
- b. Prior to using the risk-informed approach to justify future plant design changes that would increase the problematic debris source term compared to the level that existed as of (date).
- c. STPNOC will implement and maintain a program to monitor key assumptions and data used in the risk assessment and the evaluation of defense-in-depth and safety margins. The monitoring program must assess the effects of design or plant modifications, procedure changes, as-found conditions, identified changes or errors in the analysis, industry operating experience, and any other information that could result in increased risk, or decreased defense-in-depth or safety margins, under the alternative risk-informed approach. The results of the monitoring program should be retained onsite for inspection.
- d. STPNOC will update the risk-informed evaluation no later than 48 months after initial NRC approval or the latest update and compare the risk results, CDF, LERF, Δ CDF, and Δ LERF, to the acceptance criteria in the safety evaluation that accompanies the requested LAR (reference).

- e. In the event that the acceptance criteria for the risk-informed analysis are not met:
 - 1. STPNOC will notify the NRC in accordance with 10 CFR § 50.72 or 50.73 to notify the NRC that the acceptance criteria has been exceeded; and,
 - 2. STPNOC will take timely action to ensure that the acceptance criteria are met.

These requirements are in addition to (and separate from) the reporting requirements in 10 CFR 50.46(a).

APLA-4-6: Please confirm the accuracy of the computation of the Δ CDF for the double-ended guillotine break (DEGB)-only model that was provided (References 2 and 3). It appears that the current approach assumes, for example, that a 12.8-in DEGB could occur in larger diameter pipes (e.g., 27.5-in, 29-in, and 31-in diameter pipes). Include arithmetic and geometric mean approaches.

REFERENCES:

- 1. STP Nuclear Operating Company, "Enclosure 4-2, 'South Texas Project Risk-Informed Closure of GSI-191, Volume 2, Probabilistic Risk Analysis,'" Revision 2, dated October 22, 2013 (ADAMS Accession No. ML13323A189).
- 2. Powell, G. T., STP Nuclear Operating Company, letter to U.S. Nuclear Regulatory Commission, "South Texas Project Units 1 and 2 – Supplement 2 to STP Pilot Submittal and Requests for Exemptions and License Amendment for a Risk-Informed Approach to Address Generic Safety Issue (GSI)-191 and Respond to Generic Letter (GL) 2004-02," dated August 20, 2015 (ADAMS Accession No. ML15246A126).
- 3. Powell, G. T., STP Nuclear Operating Company, letter to U.S. Nuclear Regulatory Commission, "Description of Revised Risk-Informed Methodology and Responses to Round 2 Requests for Additional Information Regarding STP Risk-Informed GSI-191 Licensing Application," dated March 25, 2015 (ADAMS Accession No. ML15091A440).
- 4. Powell, G. T., STP Nuclear Operating Company, letter to U.S. Nuclear Regulatory Commission, "South Texas Project Units 1 and 2 —First Set of Responses to April, 2014, Requests for Additional Information Regarding STP Risk-Informed GSI-191 Licensing Application Revised," dated May 22, 2014 (ADAMS Accession No. ML14149A434).

D. Koehl

- 2 -

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

Sincerely,

/RA/

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

Enclosures:

1. Audit Summary
2. Draft Request for Additional Information

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