



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

April 26, 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 – STAFF AUDIT SUMMARY RELATED TO REQUEST FOR EXEMPTIONS AND LICENSE AMENDMENT FOR USE OF A RISK-INFORMED APPROACH TO RESOLVE THE ISSUE OF POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN-BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS (CAC NOS. MF2400, MF2401, MF2402, MF2403, MF2404, MF2405, MF2406, MF2407, MF2408, AND MF2409)**

Dear Mr. Koehl:

By letter dated June 19, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML 131750250), 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, March 25, and August 20, 2015 (ADAMS Accession Nos. ML13295A222, ML13323A673, ML13323A128, ML13338A165, ML14015A312, ML14015A311, ML14029A533, ML14052A110, ML14072A075, ML14086A383, ML14087A126, ML14149A353, ML14149A354, ML14149A439, ML14178A467, ML14202A045, ML15072A092, ML15091A440, and ML15246A125, respectively), 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 (GSI)-191, the impact of debris blockage on emergency recirculation during design-basis accidents for South Texas Project, Units 1 and 2 (STP). The proposed amendment request would implement a risk-informed approach for resolving GSI-191 for STP as the pilot plant for other licensees pursuing a similar approach.

The U.S. Nuclear Regulatory Commission (NRC) staff conducted a regulatory audit at the offices of Alion Science and Technology in Albuquerque, New Mexico, on February 24 and 25, 2016, in order to gain a better understanding of the licensee's approach to analyze the effects of debris on the emergency core cooling system and the containment spray system operation following a loss-of-coolant accident. Specifically, the NRC staff audited STPNOC's analyses related to debris transport, strainer performance, and pump net positive suction head.

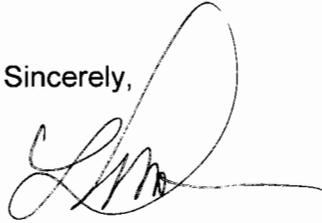
The enclosure to this letter describes the results of the NRC staff's audit and some of the key technical issues highlighted by the NRC staff during the audit.

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](mailto:Lisa.Regner@nrc.gov).

Sincerely,

A handwritten signature in black ink, appearing to read 'L M Regner', with a large, sweeping 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

Enclosure:  
Staff Audit Report

cc w/encl: Distribution via Listserv

STAFF AUDIT SUMMARY – FEBRUARY 24-25, 2016

REVIEW OF DEBRIS TRANSPORT AND COATINGS CALCULATIONS

ASSOCIATED WITH THE RISK-INFORMED APPROACH

TO RESOLUTION OF 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. ML 131750250), 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, March 25, and August 20, 2015 (ADAMS Accession Nos. ML13295A222, ML13323A673, ML13323A128, ML13338A165, ML14015A312, ML14015A311, ML14029A533, ML14052A110, ML14072A075, ML14086A383, ML14087A126, ML14149A353, ML14149A354, ML14149A439, ML14178A467, ML14202A045, ML15072A092, ML15091A440, and ML15246A125, 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, the impact of debris blockage on emergency recirculation during design-basis accidents for South Texas Project, Units 1 and 2 (STP).

The U.S. Nuclear Regulatory Commission (NRC) staff conducted a regulatory audit at the offices of Alion Science and Technology in Albuquerque, New Mexico, on February 24 and 25, 2016, in order 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 (ECCS) the containment spray system (CSS) operation following a loss-of-coolant accident (LOCA).

2.0 SCOPE AND PURPOSE

On February 24-25, 2016, the NRC staff audited STPNOC's analyses related to debris transport, strainer performance, and pump net positive suction head (NPSH). The purpose of the audit was for the NRC staff to gain a better understanding of the methodologies used by the licensee associated with:

- the treatment of unqualified coatings and epoxy debris in containment
- the transport of coatings and fiber, erosion of fiber, holdup of debris, and uncertainty
- degasification of sump fluid and its effect on pump NPSH

### 3.0 AUDIT TEAM

The following NRC staff members participated in the audit:

- Vic Cusumano – Branch Chief, Safety Issues Resolution Branch
- Matt Yoder – Coatings technical reviewer
- Ashley Smith – Debris generation/transport technical reviewer
- Steve Smith – Debris generation/transport technical reviewer
- Osvaldo Pensado – Contractor from Southwest Research Institute (SwRI)
- Stuart Stothoff – Contractor from SwRI

STPNOC was represented by the following personnel:

- Mike Murray – STPNOC
- Wes Schulz – STPNOC
- Benjamin Bridges – Alion Science and Technology
- Bruce Letellier – Alion Science and Technology
- Dominic Muñoz – Alion Science and Technology
- Megan Stachowiak – Alion Science and Technology
- Mac Cook – Alion Science and Technology
- Jeremy Tejada – SimCon
- Matt Ballan – SimCon

### 4.0 AUDIT REPORT

During the NRC staff's review of the LAR, several technical issues were identified and a request for additional information (RAI) was prepared. The RAI was transmitted to the licensee by letter dated March 3, 2015 (ADAMS Accession No. ML14357A171). The licensee provided responses to the RAI questions by letter dated March 25, 2015, and an updated methodology description by letter dated August 20, 2015. Several existing questions remained and several new questions developed due to the change in methodology. To facilitate the NRC staff's review and develop a clear understanding of the information provided by the licensee, a regulatory audit was conducted on February 24 and 25, 2016, consistent with the draft audit plan e-mailed on January 25, 2016 (ADAMS Accession No. ML16085A008).

#### 4.1 Technical Issues Discussed During the Audit

##### Debris Transport

The licensee discussed its treatment of small fiber pieces the licensee predicted would reach the strainer, but which, in fact, were observed to settle in the pool during strainer testing. The licensee also discussed the transport of large fiber pieces and the erosion of small and large pieces of fibrous debris. The transport discussion covered the holdup of debris in locations such that small and large fibrous debris would not reach the pool. These topics are related such that a change in the treatment of one area results in changes in debris amounts throughout the transport analysis and estimated amounts of fiber fines loading the strainers.

The STPNOC transport analysis minimizes capture fractions during blowdown for structures, gratings, and 90-degree bends by using minimum drywell debris transport study (DDTS) values. Additionally, STPNOC did not credit more than a single debris capture location for the debris capture analysis. For example, if there is more than one grating in the transport path, only one grating is credited for capturing a portion of the arriving debris. The DDTS (NUREG/CR-6369, "Drywell Debris Transport Study, Final Report," published September 1999; ADAMS Accession No. ML003728226) has been accepted by the NRC as providing values that can be used by licensees in their transport evaluations.

In its August 20, 2015, submittal, STPNOC referenced a proprietary test report that justified an erosion fraction of 10 percent for fibrous insulation in the sump pool if it is shown that the test conditions are applicable to the plant. STPNOC concluded that an erosion fraction of 7 percent was justified for use in its transport analysis. The NRC staff identified that 10 percent was the NRC staff-approved value for use of those test results and that it was not aware of any justification allowing reduction of this value. The NRC developed a draft RAI question on this issue (dated January 14, 2016, available in ADAMS at Accession No. ML16022A008). STPNOC stated that because of plant and test specific factors, the use of 7 percent was justified. Based on the information discussed during the audit, the staff concluded that STPNOC may be able to justify using a value less than 10 percent. The NRC staff will review information provided by STPNOC during the RAI resolution process and determine whether a reduction in erosion fraction is justified.

The audit team also discussed the licensee's treatment of small fibrous debris predicted to reach the strainer, but which was observed not to transport to the strainer during head loss testing. The NRC staff concluded that this either needs to be treated as fiber settled in the pool (which increases the amount of fine fiber reaching the strainer due to erosion) or as fiber reaching the strainer during head loss testing. The NRC staff position is based on the concept that the fiber must be accounted for in some way in the evaluation. STPNOC proposed to treat small fiber as settled in the pool (if not already captured by structures) and then eroded. STPNOC performed alternative transport computations assuming that the small fibers settle in the pool (if not held in structures) and erode, similarly to other fibrous debris in the pool.

STPNOC performed several sensitivity studies to determine the effects of the two issues discussed above (i.e., erosion fraction and transport of small fiber to the strainer). The sensitivity study case used the one of the following sets of assumptions:<sup>1</sup>

- Small fibrous debris not captured by structures settles in pool, 7 percent erosion
- Small fibrous debris not captured by structures settles in pool, 10 percent erosion
- Twenty-five percent of the small fibrous debris that was predicted to reach the strainer in the original transport calculation reaches strainer as fines, 7 percent erosion of remainder (the remainder is all small fiber not captured by structures minus the 25 percent predicted to reach the strainer)

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<sup>1</sup> The sensitivities described only deal with erosion of fibrous debris in the pool and the small fibrous debris that was originally predicted to reach the strainer.

- Twenty-five percent of small fibrous debris that was predicted to reach the strainer in the original transport calculation reaches strainer as fines, 10 percent erosion of remainder
- All of small fibrous debris originally predicted to reach the strainer reaches strainer as fines, 7 percent erosion of remainder

STPNOC provided the results of these sensitivities using both geometric and arithmetic mean LOCA frequencies from NUREG-1829, "Estimating Loss-of-Coolant Accident (LOCA) Frequencies Through the Elicitation Process," dated April 2008 (ADAMS Accession No. ML080630013), and using double-ended guillotine break models, as well as continuum break size models. These sensitivities identified that increases in the change in core damage frequency ( $\Delta$ CDF) would occur. For sensitivity cases in the first two bullets, the changes were small (i.e., the  $\Delta$ CDF values were very similar to baseline values in the STPNOC submittals). The other three sensitivity cases resulted in increasing  $\Delta$ CDF values, but none beyond the acceptance guidelines of 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," dated May 2011 (ADAMS Accession No. ML100910006). STPNOC stated that it will determine the appropriate assumptions to include in the final RAI responses. The licensee will also include changes in the  $\Delta$ CDF value reported in its LAR.

#### Treatment of Coatings

The most critical unresolved part of this topic is the treatment of coatings in the reactor cavity. STPNOC stated it has not finalized how the reactor cavity coatings will be addressed in the evaluation. The licensee stated that it may be able to show that these coatings are qualified or physically robust by a review of documentation and physical testing.

Another unresolved NRC staff concern regards the coatings' radiation resistance. If the coatings cannot be shown to be qualified or physically robust, the coatings should be assumed to fail after a LOCA event; however, the characteristics and the ability of the failed coatings to transport out of the reactor cavity have not been established. STPNOC stated that the transport of these coatings would be reduced or non-existent for breaks outside the reactor cavity since the reactor cavity volume would be stagnant and have no large water source. Also, if some of the coatings fail as chips, the chips may not transport to the strainer even for breaks within the reactor cavity. STPNOC may also attempt to perform an analysis that shows that breaks in the reactor cavity cannot fully offset, so that the zone of influence from the breaks would be significantly reduced and very little fiber would be damaged by a break. If the fiber amount is low enough, a fiber bed would not form (formation of a fiber bed is a condition required for coatings and other particulates to have a large impact on strainer head loss). STPNOC continues to assess this issue and will provide more information in its response to an RAI.

#### Degasification of Sump Fluid

STPNOC stated that the ECCS and CSS pumps' NPSH evaluation accounts for the degasification of fluid as it passes through the debris bed. However, STPNOC assumed that the gas would be reabsorbed by the fluid by the time it reached the ECCS and CSS pumps because of the head caused by the elevation difference between the strainers and pump suctions. The NRC staff stated that credit is allowed for bubble collapse due to the increased

head, but it had not allowed the assumption of complete reabsorption because of the unknowns associated with the kinetics and timing of reabsorption. STPNOC stated that it would consider the NRC position and look for information that may justify that any gas liberated due to head loss across the debris bed would be completely reabsorbed prior to reaching the pump suctions. The licensee's position will be provided in response to an RAI.

#### Comparison of Plant-Specific Debris and Test Debris Surrogates

After reviewing the most recent LAR submittal from STPNOC, the NRC staff concluded that each potential debris source in the plant was not clearly linked to a surrogate material in the head loss testing in the RoverD analyses. The NRC drafted an RAI to ensure that each potential debris source was either included in the head loss testing or otherwise accounted for in the RoverD analyses. The question mainly concerned the particulate debris sources of Microtherm and coatings. Microporous debris like Microtherm is known to have a significant effect on head loss when included in a debris bed. As previously discussed, the treatment of the coatings within the reactor cavity will be separately assessed by STPNOC. A full evaluation of STPNOC's treatment of debris cannot be completed until the licensee defines how it will evaluate reactor cavity coatings.

STPNOC performed additional analysis of the amount of Microtherm that would be generated by various breaks in the reactor coolant system. The licensee determined that only one break would generate more Microtherm than was included in the test. This break was previously categorized into the risk-informed breaks, assumed to fail, and considered to lead to core damage and contribute to the change in core damage frequency ( $\Delta$ CDF) calculation. All other breaks are bounded by the amount of Microtherm included in the test. This finding will greatly simplify the evaluation of Microtherm.

STPNOC noted that it used about 180 pounds of Marinite in the test, but all of the Marinite material was subsequently removed from the STP containments. Marinite is another material that results in significant head loss increases when included in a debris bed. The NRC and STPNOC discussed how the excess Marinite included in the test could be credited against other less problematic materials that may not have had adequate representation in the test and RoverD analyses. The NRC stated that it is acceptable to substitute Marinite for less problematic materials on a one-to-one mass-equivalent basis. Other substitutions will require added justification.

STPNOC also noted that it included excess inorganic zinc (IOZ) in the head loss test. This material may also be credited for other materials that may have been underrepresented in the test. STPNOC and the NRC staff also discussed the idea of correcting coating surrogates with density equivalences. The qualified epoxy coatings included in the STP testing appear to bound the amount that can be generated for all breaks except those that are already assumed to fail and contribute to  $\Delta$ CDF. STPNOC will provide in its RAI responses a comprehensive comparison and analysis of the debris that could reach the plant strainers, to debris included in the head loss tests.

## Draft RAI Discussion

STPNOC and the NRC discussed applicable draft RAI questions that had previously been transmitted to the licensee.<sup>2</sup> The discussion was limited to ensuring that the licensee understood the technical issues presented in the RAIs so that its responses would address the proper aspects of the issues.

### 4.2 Exit Meeting

During the exit meeting on February 25, 2016, the NRC staff stated that the audit was very helpful in clarifying topics of the licensee's submittal and in moving toward resolution of the NRC staff concerns. The audit was conducted in accordance with the audit plan.

The NRC staff summarized the following open issues in the areas of debris generation and transport, and coatings that will need to be resolved in order for the NRC staff to complete its review:

- Treatment of reactor cavity coatings: Another public meeting may be needed to discuss the issue once STPNOC has decided how to treat these coatings.
- Treatment of small fibrous debris: The NRC staff noted that STPNOC may have a justifiable assumption that no small debris in the pool reaches the strainer and a fraction is considered to erode.
- Fiber erosion value: The NRC noted that STPNOC may be able to justify the use of an erosion value below 10 percent based on the plant specific testing and plant specific conditions that were discussed during the audit.
- Evaluation of test margins: The NRC staff stated that it understands how the concept of test margins for particulate debris will be used in the analyses and that appropriate treatment of debris density equivalences will be included. The treatment of the coatings within the reactor cavity will need to be resolved prior to completing the evaluation of test margins. The NRC staff stated that the substitution of Marinite for coatings on a 1 to 1 mass basis appears to be a conservative approach. Crediting a ratio less than this would require justification.

## 5.0 CONCLUSION

The NRC staff found that the audit provided a better understanding of the licensee's methodologies especially in the area of debris transport and the treatment of coatings. The NRC staff stated that it was advantageous to clarify the staff's questions that had been transmitted in the form of draft RAIs so that STPNOC understands what the NRC expectations are for addressing these areas. There was open communication throughout the audit and the draft RAI questions discussed during the audit will be transmitted formally to the licensee for response prior to a staff decision on the LAR.

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<sup>2</sup> The draft RAI questions were transmitted to the licensee by emailed dated January 14, 2016, and are available at ADAMS Accession No. ML16022A008. The applicable questions are prefixed SSIB and ESGB.

D. Koehl

- 2 -

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

Enclosure:  
Staff Audit Report

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**ADAMS Accession No.: ML16103A344**

\* per email

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