NRR-PMDAPEm Resource

From: Regner, Lisa
Sent: Friday, March 13, 2015 4:02 PM
To: Wayne Harrison; Sterling, Lance (lsterling@STPEGS.COM)
Cc: Dean, Jeremy; Guzzetta, Ashley; Lent, Susan
Subject: DRAFT STP GSI 191 Boric Acid Precipitation Audit Plan
Attachments: DRAFT STP GSI 191 BAP Audit Plan - to licensee.docx

Wayne, Lance,
Here is the DRAFT Boric Acid Precipitation Audit Plan for Thursday, March 19.
Let me know if you have any questions.
I doubt all 4 of the people listed will be coming, but I included them just in case. It is likely to be just me and Len Ward.
Thanks and have a good weekend.
Lisa

Hearing Identifier: NRR_PMDA
Email Number: 2178

Mail Envelope Properties (Lisa.Regner@nrc.gov20150313160100)

Subject: DRAFT STP GSI 191 Boric Acid Precipitation Audit Plan
Sent Date: 3/13/2015 4:01:44 PM
Received Date: 3/13/2015 4:01:00 PM
From: Regner, Lisa

Created By: Lisa.Regner@nrc.gov

Recipients:
"Dean, Jeremy" <Jeremy.Dean@nrc.gov>
Tracking Status: None
"Guzzetta, Ashley" <Ashley.Guzzetta@nrc.gov>
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"Wayne Harrison" <awharrison@STPEGS.COM>
Tracking Status: None
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Tracking Status: None

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DRAFT STP GSI 191 BAP Audit Plan - to licensee.docx	42481	

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AUDIT PLAN

REQUEST FOR RISK-INFORMED SOLUTION TO GSI-191

SOUTH TEXAS PROJECT NUCLEAR OPERATING COMPANY

SOUTH TEXAS PROJECT, UNITS 1 AND 2

Purpose and Scope

By letter dated June 19, 2013 (Agencywide Document Access and Management System (ADAMS) Accession No. ML13175A211) as supplemented by letters dated November 13, 2013 (ADAMS Accession No. ML13323A183), May 16, 2013 (ADAMS Accession No.ML14149A434), June 25, 2013 (ADAMS Accession No.ML14178A481), and July 15, 2013 (ADAMS Accession No. ML14202A045), South Texas Project Nuclear Operating Company submitted a pilot license amendment request for a risk-informed solution to generic safety issue. 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. During review of the amendment, the NRC staffidentified an open item requiring further evaluation associated with boric acid precipitation. Efficient resolution of this item warrantsa regulatory audit by NRC staff. The purpose of the audit is to review calculations performed by Westinghouse to improve NRC staff understanding and efficiency during the safety review and development of the safety evaluation report.

Audit Agenda

The auditwill take place on the afternoon of March 19, 2015, and will include an opening meeting and exit meeting, as necessary. The audit will take place at the Westinghouse Electric facility in Rockville, Maryland.

The agenda will include:

1) Review of documents on Westinghouse boric acid precipitation calculation for the South Texas Project
2) Discuss the assumptions employed in performing the calculation of precipitation timing
3) Present the boric acid concentration in the mixing volume vs time using the geometric data and initial conditions provided in the STP RAI responses.
4) Address the issues identified with the STP in-house analyses and their resolution given in the attachment.
5) Present any sensitivity studies to show impact of viscosity increase on drift velocity in core,
6) Present the entrainment mode and results of the entrainment model calculation to show the time post-LOCA beyond which entrainment of potential hot side injection ceases

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7) Discuss how the potential for the boric acid storage tank (BAST) discharge is handled and its potential impact on precipitation timing. What are the consequences if BAST discharge is operating during a LOCA?

Details of these discuss topics are included in the Enclosure to this document.

Audit Team

The audit team will consist of:

- **Lisa Regner**, Team Lead, Senior Project Manager, Division of Operating Reactor Licensing, NRR
- **Len Ward**, Technical Lead, Senior Reactor Engineer, Nuclear Performance and Code Review Branch, NRR
- **Ashley Guzzetta**, Safety Issues Resolution Branch Technical Reviewer, NRR
- **Jeremy Dean**, Chief, Nuclear Performance and Code Review Branch, NRR

The following support personnel are requested:

- STP personnel familiar with the Westinghouse boric acid precipitation calculation for the South Texas Project.

Documents Requested for Staff Examination

A copy of the write-up presenting a list of the assumptions and discussion of the precipitation calculation results typical of the submittal contents provided by Westinghouse in their power uprate submittalsis requested. Documents associated with the Westinghouse boric acid precipitation calculation for the South Texas Project.

Logistical Considerations

The NRC staff requests a conference room with desks for staff to review documents.

Documentation of Audit

Following the audit, the NRC staff will prepare an audit report documenting the information reviewed during the audit, and any open items identified as a result of the audit. The NRC staff will also document its understanding of the proposed resolution of any identified open items. The audit report may be provided to the licensee in draft form for proprietary markup.

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South Texas Project Boric Acid Precipitation Audit Discussion Topics

A review of the STP calculation to justify the 6.18 hour precipitation time reveals the following questions by the staff. Note that the staff audit calculations show a precipitation time of about 3.6 hrs at the 27.5% limit. This is based on the data provided in the RAI response that includes the mixing volume composed of only the upper plenum below the bottom elevation of the hot leg, the core, and half of the lower plenum volume. This mixing volume constitutes the accepted staff model for predicting precipitation. As such, the STP calculation may include these components.

1. The power level in NC-7136 by STP is given as 3853Mwt. As such, the standard 1.02% uncertainty applied to core power gives 3930.06 Mwt. The STP calculations assumed 3876 Mwt, which is 1.02% of 3800 Mwt or the previous licensed power level. Please explain the uncertainty applied and the thermal power level.

2. The staff calculated average void fraction in the core at 3 hrs is 0.68; the U. Plenum void fraction is 0.69, based on a drift-flux model with 20 cells in the core and 9 in the upper plenum. Applying the ave core void fraction to the upper plenum is incorrect as the upper plenum void is feed by the exit void fraction to the core adjusted by the increase area of the upper plenum.

STP assumed the mixing volume void fraction was 0.55 and included the upper plenum. The upper plenum will not be at the core average void fraction. The surface void fraction in the core at 3 hrs is 0.77 with an upper plenum void fraction of 0.69. The void fraction entering the upper plenum will reflect the void at the core exit which is much higher than the STP void of 0.55.

This void fraction was extracted from the Beaver Valley void fraction (the Beaver Valley axial power shape is top peaked; a bottom peak is more limiting and will increase the average void fraction further). However, the staff verified the Beaver Valley precipitation time where the average core void was found to be 0.61 and an upper plenum void of 0.71 at 3 hrs.

Using the Beaver Valley void data is not appropriate since the axial shape differs. And, since voiding is a strong function of the flow area in the core (bubbles rising upward will congregate based on the cross-sectional area which established the volumetric flux density in this region), so power to core area flow area ratio scaling is a more appropriate factor to scale.

Instead of attempting to justify the void distribution from another plant, it is prudent to perform a specific drift-flux calculation (or other suitable model that can properly predict the non-linear void distribution in the core) to determine the axial void distribution in the core and upper plenum, since this behavior is very plant specific.

<u>Summary at 3 hrs</u>:

	Core ave. void	core exit void	Upper plenum void
BV	0.61	0.75	0.70
STP	0.68	0.77	0.69

ENCLOSURE

The 3hrs information was chosen since this is close to the expected precipitation time. Also note that the decrease in void from the core exit to the upper plenum is due to the increased upper plenum flow area.

3. The mixing volume changes with time as the void fraction slowly decreases with time due to the decreasing decay heat. The loop resistance impacts the mixing volume and hence precipitation time that was ignored in the STP calculation.

4. The STP source concentration used to compute the boron content in the core decreases with time from the very start of the calculation at 100 sec. The RWST discharge for the first 45 – to one hr with the capacity of about 500,000 gals (the maximum volume during operation should be used if it exceeds the TS limit where the max vol is 550,000 gals). It is not understood why the source concentration decreases from the beginning of the LOCA. It appears that the sump concentration was used for the entire calculation.

5. The basis for the sump liquid mass and concentration during recirculation is needed.

6. Boric acid concentration is defined as the lbs boron divided by the lbs boron plus water mass. So the concentration can be easily calculated as the initial born mass plus accumulation of boron divided by the initial boron mass plus accumulated boron plus water mass in the mixing volume. Using the volume data provided in the RAIs and the 1971 standard with a 1.2 multiplier, a core ave void of 0.68 and U plenum void of 0.69 produces a precipitation time of about 3.5 hrs (@27.5% limit).

7. Since Millstone Unit 3 is of the same design as STP, except the core height is 2 ft higher (14 vs 12 ft), it is not clear why this plant was not used as the example plant to scale power and source conc. from. It has a lower power but the same or similar RCS geometry and initial conditions. Precipitation Is predicted at about 3.5 hrs for this plant. MP3 has a lower power (3650 Mwt) and lower RWST concentration (2900ppm), but could have been more appropriately scaled to STP.

8. The calculations do not appear to include the effects of boric acid density and viscosity increase during the boiling period. Increases in fluid viscosity will decrease the vapor drift velocity. This decrease will increase the void fraction beyond that for the case with no viscosity effects included and reduce the amount of liquid in the mixing volume. The analyses should include the impact of viscosity on liquid content in the mixing volume.

9. The break should be located in the discharge leg at the top elevation. As such the loop seals will fill with ECC liquid and increase the loop resistance and the upper plenum pressure needed to drive vapor around the loop. This should be included in the time varying mixing volume in the vessel. The void fraction in the loop seals then needs to be computed appropriately.

10. The time needed for the operators to perform the switch to simultaneous injection needs to be identified where initiation of hot side injection can then be performed one hr prior to precipitation. What is the timing if the operators make an error and need additional time to correct such an error?

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