

October 6, 2010

Mr. Mark McBurnett, Vice President
Regulatory Affairs
South Texas Project Nuclear Operating Company
P.O. Box 289
Wadsworth, TX 77483

SUBJECT: REGULATORY AUDIT SUMMARY OF SOUTH TEXAS PROJECT,
UNITS 3 AND 4 COMBINED LICENSE APPLICATION REVISION 3 –
FLOW-INDUCED VIBRATION PROGRAM

Dear Mr. McBurnett:

By letter dated September 20, 2007, STP Nuclear Operating Company (STPNOC) submitted to the U.S. Nuclear Regulatory Commission (NRC) a Combined License (COL) application to construct and operate two reactor units (Units 3 and 4) based on the U.S. Advanced Boiling Water Reactor (ABWR) Design Certification at the South Texas Project Nuclear Power Plant. The NRC Office of New Reactors (NRO) is reviewing the South Texas Project (STP) COL application that incorporates by reference the ABWR Design Control Document (DCD). As part of this review, the NRO Engineering Mechanics Branch 2 (EMB2) conducted an audit of the documentation supporting the STP COL application to develop the reactor internals comprehensive vibration assessment program (CVAP) in Chapter 3.9.2. The audit was conducted at the Westinghouse office in Cranberry Township, Pennsylvania, from August 23, 2010 to August 25, 2010. The NRC staff followed the guidance in NRO Office Instruction NRO-REG-108, "Regulatory Audits," in performing this audit. Enclosure 1 is a list of the NRC and STPNOC team participating in the audit. Enclosure 2 is the detailed results of the audit.

Please contact Tom Tai at (301) 415-8484 or Tom.Tai@nrc.gov if you have any questions related to the audit.

Sincerely,

/RA/

Mark Tonacci, Chief
BWR Projects Branch
Division of New Reactor Licensing
Office of New Reactors

Docket Nos.: 52-012
52-013

cc: See next page

October 6, 2010

Mr. Mark McBurnett, Vice President
Regulatory Affairs
South Texas Project Nuclear Operating Company
P.O. Box 289
Wadsworth, TX 77483

SUBJECT: REGULATORY AUDIT SUMMARY OF SOUTH TEXAS PROJECT,
UNITS 3 AND 4 COMBINED LICENSE APPLICATION REVISION 3 –
FLOW-INDUCED VIBRATION PROGRAM

Dear Mr. McBurnett:

By letter dated September 20, 2007, STP Nuclear Operating Company (STPNOC) submitted to the U.S. Nuclear Regulatory Commission (NRC) a Combined License (COL) application to construct and operate two reactor units (Units 3 and 4) based on the U.S. Advanced Boiling Water Reactor (ABWR) Design Certification at the South Texas Project Nuclear Power Plant. The NRC Office of New Reactors (NRO) is reviewing the South Texas Project (STP) COL application that incorporates by reference the ABWR Design Control Document (DCD). As part of this review, the NRO Engineering Mechanics Branch 2 (EMB2) conducted an audit of the documentation supporting the STP COL application to develop the reactor internals comprehensive vibration assessment program (CVAP) in Chapter 3.9.2. The audit was conducted at the Westinghouse office in Cranberry Township, Pennsylvania, from August 23, 2010 to August 25, 2010. The NRC staff followed the guidance in NRO Office Instruction NRO-REG-108, "Regulatory Audits," in performing this audit. Enclosure 1 is a list of the NRC and STPNOC team participating in the audit. Enclosure 2 is the detailed results of the audit.

Please contact Tom Tai at (301) 415-8484 or Tom.Tai@nrc.gov if you have any questions related to the audit.

Sincerely,
/RA/
Mark Tonacci, Chief
BWR Projects Branch
Division of New Reactor Licensing
Office of New Reactors

Docket Nos.: 52-012
52-013

DISTRIBUTION:

PUBLIC
RidsNroDnrlNge2
JDHerrity, NRO
AHsia, NRO
YWong, NRO

RidsNroDeEmb2
SKirkwood, OGC
RidsOgcMailCenter
MTonacci, NRO
TTai, NRO

BAbeywickrama, NRO
Gwunder, NRO
RidsNroDnrl
RidsRgnMailCenter

ACCESSION NO. ML102560535

NRO-002

OFFICE	NRO/DNRL/BWR	NRO/DNRL/BWR	NRO/DE/EMB2	NRO/DE/EMB2	NRO/DNRL/NGE2
NAME	TTai	BAbeywickrama	YWong	JDHerrity	MTonacci
DATE	9/16/10	9/16/10	9/20/10	10/6/10	10/6/10

OFFICIAL RECORD COPY

Audit Participants
AUGUST 23 - 25, 2010

Name	Organization
Brad Maurer	Westinghouse
Jianfeng Yang	Westinghouse
Subhash Chandra	Westinghouse
Ryan McGuinness	Westinghouse
Younus Munsie	Westinghouse
Robert Thevret	Westinghouse
Gianluca Longoni	Westinghouse
Richard Schwirian	Westinghouse
Jeff Bibby	Westinghouse
Bob Letendre (Note 1)	Westinghouse
Karen Fujikawa	Westinghouse
David Forsyth	Westinghouse
Berndt Gustaffsson (Note 1)	Westinghouse – Sweden
John E. Price	STPNOC – Licensing
Tom Daly	STPNOC Engineering
Ken Uchida	Toshiba
Keiji Matsunaga	Toshiba
Yukihiko Okuda	Toshiba
Dale Wuokko	TANE – Licensing
Sam Ranganath (Note 1)	XGEN
Mahadeo Patel (Note 1)	XGEN
Tom Tai	NRC
Yuken Wong	NRC
Samir Ziada	McMaster University/Argonne
Omesh Chopra	Argonne National Laboratory
David Ma	Argonne National Laboratory

Notes:

1. Participated by telephone

DETAILED AUDIT RESULTS FOR FLOW-INDUCED VIBRATION ANALYSES

AUGUST 23 - 25, 2010

1. Introduction

On September 20, 2007, STP Nuclear Operating Company (STPNOC) submitted to the U.S. Nuclear Regulatory Commission (NRC) a Combined License (COL) application to construct and operate two reactor units (Units 3 and 4) based on the U.S. Advanced Boiling Water Reactor (ABWR) Design Certification at the South Texas Project Nuclear Power Plant. The NRC Office of New Reactors (NRO) is reviewing the South Texas Project COL application that incorporates by reference the ABWR Design Control Document (DCD). As part of this review, the NRO Engineering Mechanics Branch 2 (EMB2) conducted an audit of the documentation supporting the STP COL application to develop the reactor internals comprehensive vibration assessment program (CVAP) in referenced Chapter 3.9.2. The audit was conducted at the Westinghouse office in Cranberry Township, Pennsylvania, from August 23, 2010 to August 25, 2010. The NRC staff followed the guidance in NRO Office Instruction NRO-REG-108, "Regulatory Audits," in performing this audit. Enclosure 1 is a list of the NRC and STPNOC team participating in the audit.

2. Objectives and Approach

In early 2010, STPNOC decided that STP Unit-3 reactor internals will be the ABWR prototype, and Unit-4 will be non-prototype, Category 1 in accordance with the guidance in Regulatory Guide 1.20. The proposed FSAR changes to reflect this new licensing position were provided in a letter to the NRC on May 19, 2010 (U7-C-STP-NRC-100114). This is a significant change in licensing position in that Revision 3 of the FSAR specified STP Units 3 & 4 reactor internals as non-prototype, Category I. This resulted in not only a requirement for a different (reactor internal vibration assessment) program for each unit, it also required an extensive amount of analytical work to develop such programs. The review and acceptance of the CVAP is part of the scope of Chapter 3.9.2 of the STP Units 3 & 4 COL FSAR. The main objective of this audit is to provide the NRC staff an opportunity to review the approach, methodologies, and assumptions in the calculations that form the basis of the STP Units 3 & 4 CVAP. The proposed schedule to issue the CVAP for NRC's review and approval is December 15, 2010. It is the intent of STPNOC that the CVAP will be based on these calculations. Consequently, the predictive analysis of the CVAP that is within the scope of these calculations will not involve additional detailed review, instead, the final review and approval of the CVAP will be confirmatory based on the findings and observations in this audit and future audits of additional planned supporting calculations and analyses.

Enclosure 2

3. Technical Review

To address the pertinent reactor internal components that could be affected by flow-induced vibration (FIV), STPNOC and its engineering team divided the analytical program into four (4) categories for the various responsible organizations to perform the analyses:

- A. Steam dryer (Westinghouse-U.S);
- B. Lower plenum components (Toshiba);
- C. Reactor internal components that have experienced the effects of FIV (Westinghouse – Sweden);
- D. Reactor internal components that have not experienced the effects of FIV (XGEN).

The analyses completed under each category, including the respective peer review packages which ensured the methodologies were acceptable to a panel of experts in various organizations, were made available in the audit. The following is a list of calculations provided for this audit:

Document Nos.	Rev.	Document Title	Preparers
CN-SEE-II-15-10	0	STP 3 Flow Induced Vibration Analysis	WEC
LTR-AEO-10-4 (Reference 1)	2	Peer Review Package – FIV Analysis for STP 3/4 RIN Components	WEC
SES-10-160	0	South Texas Plant 3/4 RG 1.20 Assessment Physical properties for Materials	WSE
SES-10-161	0	South Texas Plant 3/4 RG 1.20 Assessment Natural Frequencies and mode Shapes for CP and RIP DP Lines	WSE
SES-10-162	0	South Texas Plant 3/4 RG 1.20 Assessment Natural Frequencies and mode Shapes for FW and LPCF Spargers	WSE
SES-10-163	0	South Texas Plant 3/4 RG 1.20 Assessment Natural Frequencies and mode Shapes for Reactor Internal Pump Guide Rails	WSE
SES-10-164	0	South Texas Plant 3/4 RG 1.20 Assessment Natural Frequencies and mode Shapes for Guide Rods	WSE
SES-10-165	0	South Texas Plant 3/4 RG 1.20 Assessment Natural Frequencies and mode	WSE

Document Nos.	Rev.	Document Title	Preparers
		Shapes for Shroud Head and Steam Separators	
LTR-AEO-10-4 (Reference 2)	2	Peer Review Package – Analysis for STP 3/4 FIV Assessment WSE Scope	WEC
XGEN-2010-03	0	FIV Evaluation of Option 1 Components for STP Unit 3	XGEN
LTR-AEO-10-4 (Reference 3)	2	Peer Review Package – Option 1 Components	WEC
7B11-D001-3809-01	0	CFD Analysis Report for Lower Plenum	Toshiba
7B11-D001-3809-02	0	Forcing Function Analysis Report for Lower Plenum	Toshiba
7B11-D001-3809-03	0	Structural Analysis report – Modal Analysis (CE Guide Tube and CRD Housing)	Toshiba
7B11-D001-3809-04	0	Structural Analysis report – Modal Analysis (ICM Guide Tube and ICM Housing)	Toshiba
7B11-D001-3809-05	0	Structural Analysis report – Modal Analysis (HPCF Sparger and Coupling)	Toshiba
7B11-D001-3809-06	0	Structural Analysis report – Modal Analysis (Shroud)	Toshiba
VCD-2010-000521	0	Outline of FIV Analysis for Lower Plenum	Toshiba
TP-A&SA-10-01	2	South Texas Project Unit 3 Four-Line Subscale Model Acoustic Test Plan	WEC
WCAP-17287-P	0	South Texas Project 3 ABWR Pump-Induced Pulsation Analysis	WEC

The Staff's approach to conducting the audit is to review the calculations in each of the four categories to ensure the assumptions, input, and methodologies are reasonable. Any issues or questions identified during the audit was shared with the STPNOC engineering team and documented in this audit report. For significant issues that need additional actions by STPNOC, RAIs will be issued. The peer review packages were acknowledged but not reviewed because analytical results discussed in the peer review packages were potentially not final. The final analyses being referenced in the CVAP will incorporate the comments from the expert panel and the analytical results reported in the peer review may be moot. Finally, the staff did not question or review the computer codes referenced in these calculations. The validation of these computer codes will be discussed in a future audit.

Thirteen (13) calculations were originally scheduled for the audit. WCAP 17287-P was added to the audit. Due to the amount of information requiring attention, the depth of review for each calculation varies. In general, the staff found that the calculations audited were of good quality, and the STPNOC team was supportive of staff's requests and responsive to staff's feedback provided during the audit. The following are generic comments that apply to all calculations:

1. These calculations were developed by various engineering organizations throughout the world, and each has its own procedures and conventions to prepare calculations. Some of the calculations have multiple but different document identifiers. For future references, STPNOC needs to decide what calculation number and revision number to use in the CVAP. This is administratively important because if these calculations are referenced in the SER and the CVAP, the staff's SER reference needs to be consistent with the STP approach.
2. When assumptions are used in these calculations, more details are needed to justify their appropriateness or conservatism. A discussion on how these assumptions are being validated is also necessary.
3. These calculations have a section named "Open Item". The staff noted that when preliminary design and/or calculations were used as input to the calculation, the use of this preliminary information should be considered an open item.
4. There is very little discussion on bias errors and uncertainties in these calculations. The guidance in Regulatory Guide 1.20 is clear that this is important for all reactor internal components, including those that may be affected by flow-excited acoustic resonances and flow-induced vibrations. STPNOC needs to address this in each of these calculations, or in the final vibration assessment report.

The following is a summary of the findings and observations for the calculations:

A. Document CN-SEE-II-10-15

This calculation was prepared for the dryer and the steam separator. There were no major issues but the staff identified some typographic errors that Westinghouse acknowledged and will correct. Staff also raised questions on the approach and the level of details in justifying assumptions. In addition, the calculation referenced the use of JSME (Japanese Society of Mechanical Engineers), a foreign code that the staff does not use in licensing U.S. applications. This is a generic concern and the calculations and the CVAP report must address any difference between JSME and U.S. codes and standards.

B. Documents 7B11-D001-3809-01 to 7B11-D001-3809-06

These calculations were prepared for the lower plenum components. The staff found that these calculations did not have any "significant assumptions". This is not consistent with the remaining calculations which mentioned various assumptions. In addition, there were questions on the modeling which require justifications and

sensitivity studies. RAIs will be issued to request STPNOC to address these concerns.

C. Documents SES-10-161 to SES-10-165

These calculations were prepared for reactor internal components that have experienced the effects of FIV. The staff found that some of the assumptions need more detailed discussion and justifications. RAIs will be issued to request STPNOC to address these concerns.

D. Document XGEN-2010-03

This calculation was prepared for reactor internal components that have not experienced the effects of FIV. The purpose of this calculation is to evaluate these components to ensure that they can be excluded from the FIV program, or can be included in the test plan. The staff did not find any major issues but there were several confirmatory actions that will be captured in RAIs.

E. Document WCAP-17287-P

As a result of this audit, RAIs will be issued requesting validation of the computer code and detailed information on the assumptions and methodology.

During the exit meeting, future deliverables, audit plans, and schedules were discussed. After the subscale model test visit on July 27, 2010, and according to the plan and schedule proposed by STP in the April 2010 meeting, the subscale test report will be ready in September, 2010, and the predictive analyses and the measurement, test, and inspection plans are scheduled to be completed by November 2010. To facilitate communication and to avoid the burden of frequent meetings, it was agreed that for planning purposes, the following are proposed:

- a. The steam dryer stress calculation for high cycle fatigue will be available in early November 2010.
- b. On September 28, 2010, a telephone conference will be arranged to discuss the peer review of the steam dryer analysis. STPNOC will send the peer review package on September 21.
- c. On October 18-19, 2010, a meeting will be held to present the results of the acoustic circuit methodology and the peer review finding on the dryer.
- d. On November 18 and 19, 2010, a meeting at Windsor, CT (tentative) will be held to present the stress reports for all components.

STPNOC also advised that these calculations will be revised and approved prior to the submittal of the CVAP in December 2010. The revised calculations will consider feedback from their respective peer reviews, comments from the NRC in this audit and future reviews, and RAIs resulting from the NRC reviews. In addition, all open items described in the calculations will be closed. Instead of issuing multiple revisions to the same calculation, STPNOC plans to prepare an assessment package for each calculation detailing how the above affect the calculation and the extent of the changes to the calculation. These assessments will be available for NRC review to determine what future interactions are necessary and how the review and schedule are affected.

4. Conclusion

The August 23-25, 2010, audit provided the NRC staff an opportunity to review the design analyses that will be used to support the STP Units 3 and 4 reactor internals comprehensive vibration assessment programs. There were no findings, but several RAIs will be issued and there were several observations listed below:

- a. None of the calculations provide a satisfactory evaluation on uncertainties and bias errors to validate any analytical results. Regulatory Guide 1.20 places emphasis on this issue for all reactor internal components, the issue it is not limited to the steam dryer.
- b. Although some calculations document their assumptions, few provide sufficient justification on why these assumptions are conservative and/or plans to validate these assumptions.
- c. Foreign codes and standards were occasionally referenced in these calculations. The preparers of these calculations need to provide a detailed reconciliation on how these foreign codes and standards are being applied to U.S. licensees.
- d. The practices for naming and numbering calculation packages are not consistent and several calculations have multiple identifiers. STPNOC needs to have a consistent identification system to avoid future confusion.
- e. When preliminary design information is used as input to these calculations, it should be noted as an "open item" in the calculation package to ensure appropriate closure once the design information is finalized.