April 12, 2011

Mark A. McBurnett, Vice-President
Oversight and Regulatory Affairs
South Texas Project Units 3 and 4
P.O. Box 289
Wadsworth, TX 77483

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION RE: SOUTH TEXAS PROJECT NUCLEAR OPERATING COMPANY TOPICAL REPORT (TR) WCAP-17202-P, "SUPPLEMENT 4 TO BISON TOPICAL REPORT RPA 90-90 P-A" (TAC NO. RG0026)

Dear Mr. McBurnett:

By letter dated June 30, 2010 (Agencywide Documents Access and Management System Accession No. ML101830265) the South Texas Project (STP) Units 3 and 4, submitted for U.S. Nuclear Regulatory Commission (NRC) staff review Topical Report WCAP-17202-P "Supplement 4 to BISON topical Report RPA 90-90-P-A."

The NRC staff has identified that additional information is needed to continue portions of the review. The staff's request for additional information (RAI) is contained in the enclosure to this letter. The STP staff has requested the following response times for these RAIs:

| **60 days** | **90 days** | **180 days** |
|---|---|---|
| 15.00.02-3 | 15.00.02-1 | 15.00.02-5 |
| 15.00.02-4 | 15.00.02-2 | 15.00.02-6 |
| 15.00.02-23 | 15.00.02-21 | 15.00.02-22 |
| 15.00.02-27 | 15.00.02-29 | 15.00.02-24 |
| 15.00.02-28 | 15.00.02-30 | 15.00.02-31 |
| | | 15.00.02-32 |
| | | 15.00.02-33 |
| | | 15.00.02-34 |
| | | 15.00.02-35 |
| | | 15.00.02-36 |
| | | 15.00.02-37 |
| | | 15.00.02-38 |

If you have any questions or comments concerning this matter, I can be reached at 301-415-6197 or by e-mail at Tekia.Govan@nrc.gov.

Sincerely,

***/RA/***

Tekia V. Govan, Project Manager
ABWR Projects Branch
Division of New Reactor Licensing
Office of New Reactors

Docket Nos. PROJ0772

eRAI Tracking No. 5538, 5559, 5579, 5580, 5581, 5583,

Enclosure:
Request for Additional Information

cc: See next page

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| OFFICE | DSRA/SRSB/TR | DSRA/SRSB/TR | DNRL/NGE2/PM |
|---|---|---|---|
| NAME | MHayes | JDonoghue | TGovan |
| DATE | 3/1/2011 | 3/16/2011 | 4/8/2011 |

*Approval captured electronically in the electronic RAI system.
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Request for Additional Information No. 5538 Revision 0

ABWR South Texas Topical Reports
South Texas Project Nuclear Operating Co
Docket No. PROJ0772
SRP Section: 15.00.02 - Review of Transient and Accident Analysis Methods 01/2006
Application Section: Topical Report WCAP-17202, Section 1, Introduction

QUESTIONS for Reactor System, Nuclear Performance and Code Review (SRSB)

15.00.02-1

Section 1.1 of WCAP-17202 states that the BISON code is applicable to BWR/2-6 and ABWR. However, the NRC approved BISON Topical Report,RPA-90-90-P-A, is only applicable to BWR/2-6 transient analysis. Please provide the qualification basis describing how BISON is applicable to ABWR transient analysis.

15.00.02-2

Section 1.1 of WCAP-17202 states that Westinghouse intends to expand the scope of BISON to include all limiting and non-limiting transients required for a first time transient analysis application. Section 11 of RPA-90-90-P-A provides a list of BWR reload transients for which BISON is approved.

a. Identify the additional transients that will be evaluated using the new methods and models described in WCAP-17202, separately for BWR/2-6 and ABWR. Identify which new models and methods from WCAP-17202 will be used for each transient.

b. List any existing BWR/2-6 or ABWR transients that will not incorporate the new methods and models described in WCAP-17202.

15.00.02-3

The “Nomenclature for Equations” is found on pages vi-viii of WCAP-17202.

a. Please add $\xi_{wind}$ and $\xi_{stat}$ (from Equations 2-2 and 2-3) and C, CONDR, $k_0$, $k_1$, $k_2$, $\Delta T_{surf}$, CA and $A_{eff}$ (from Equations 3-49 and 3-50) to this list.

b. Because the units associated with the nomenclature are not always identified in the text, please add the units to each item in this tabulation.

15.00.02-4

Provide the specific programs and procedures that are in place to train the future users of the BISON code both at Westinghouse and potential licensees (e.g., STP).

Request for Additional Information No. 5559 Revision 0

ABWR South Texas Topical Reports
South Texas Project Nuclear Operating Co
Docket No. PROJ0772
SRP Section: 15.00.02 - Review of Transient and Accident Analysis Methods 01/2006
Application Section: Topical Report WCAP-17202, Section 2, Resolution of SER Restriction

QUESTIONS for Reactor System, Nuclear Performance and Code Review (SRSB)

15.00.02-5

Per Section 2.2 of WCAP-17202, the ability of the recirculation pump model to adequately represent the reverse flow appears to be determined by the user inputs for the speed below which the pump is “stopped” and the mass flow rate at which a “stopped” pump goes from behaving as a “windmill” type to a “stationary” type and vice versa

a. Discuss the physical basis that the pump hydraulic behavior can change from “windmilling” to “stationary” at two unique values of the mass flow rate.

b. Explain the basis for these inputs, including any plant-specific pump test data, to be applied to ABWR analyses. Explain how these parameters were selected for the Hamaoka 5 integral validation studies.

15.00.02-6

Section 2.3 of WCAP-17202 describes the validation of the recirculation pump model performed against data from the Hamaoka 5 plant.

a. Consistent with the SRP Section 15.0.2.III.2.D guidance, please indicate if the recirculation pump model has been compared against manufacturer’s curves or curves for pumps with similar specific speeds over the entire range of pump operation (including the energy dissipation regime where speed > 0 and flow < 0).

b. Consistent with the SRP guidelines in Section 15.0.2.III.2.E related to the use of plant data for model validation, provide the uncertainty associated with the plant test data.

c. Discuss whether the pumps (tripped and running) in each of the validations were modeled individually or as a group and provide the rationale for the selected approach.

Request for Additional Information No. 5579 Revision 0

ABWR South Texas Topical Reports
South Texas Project Nuclear Operating Co
Docket No. PROJ0772
SRP Section: 15.00.02 - Review of Transient and Accident Analysis Methods 01/2006
Application Section: Topical Report WCAP-17202, Section 3.2, Improved Method for Cross-Section Collapsing

QUESTIONS for Reactor System, Nuclear Performance and Code Review (SRSB)

15.00.02-21

Section 3.2.2 of WCAP-17202 provides a description of an improved method for collapsing the cross-sections.

a. Please describe all parameters input to the axial power shape fitting procedure.

b. Please describe all parameters used to characterize the cross-sections, along with its level of granularity (e.g., burnup step spacing, temperature steps employed, void percentages used, coolant density steps employed).

c. Please provide information that demonstrates the validation of this technique for the broad range of conditions that it will need to cover to support analysis of first core and limiting transients.

15.00.02-22

The results provided in Figures 3-4 through 3-8 of WCAP-17202 demonstrate reasonable agreement, but there are some discrepancies. Please explain how the biases and uncertainties indicated in Figures 3-4 through 3-8 are considered when utilizing BISON results from AOO transients or ATWS in determining whether the acceptance criteria for safety parameters have been satisfied.

15.00.02-23

Section 3.2 of WCAP-17202 plots the reactivity change associated with a specified perturbation in recirculation flow, but does not report the nominal flow value.

a. Please indicate what change in steady state power is equivalent to this change in flow.

b. Please comment on whether this level of perturbation is intended to establish any limits on the applicability of the method.

c. Please explain how this level of perturbation qualifies the improved Method B for use on limiting transients where the changes to reactivity and power distribution would seem to be larger than what was plotted.

15.00.02-24

(Related to Section 3.2 of WCAP-17202) CENPD-390-P-A, “The Advanced PHOENIX and POLCA Codes for Nuclear Design of Boiling Water Reactors,” provides comparisons of results demonstrating the degree of agreement between POLCA calculations and plant measurements. This is relevant to BISON because of the reliance upon POLCA for 3D information. Figures 5.33 through 5.38 of CENPD-390-P-A shows some deviations from measured power distributions, and Figures 5.30 through 5.32 of CENPD-390-P-A indicate a bias in core reactivity.

a. Please describe whether, and if so how, uncertainties and biases in power distribution and reactivity originating in POLCA are propagated into the BISON model via the axial power shape fitting procedure and cross-sections.

b. Please describe how uncertainties and biases in analytical models determined from comparisons to measurements are considered when BISON results are used to confirm the acceptability of selected plant setpoints.

Request for Additional Information No. 5581 Revision 0

ABWR South Texas Topical Reports
South Texas Project Nuclear Operating Co
Docket No. PROJ0772
SRP Section: 15.00.02 - Review of Transient and Accident Analysis Methods 01/2006
Application Section: Topical Report WCAP-17202, Section 3.4, BISON/SAFIR Interface for Level Measurement

QUESTIONS for Reactor System, Nuclear Performance and Code Review (SRSB)

15.00.02-27

Section 3.4 of WCAP-17202 describes the BISON/SAFIR interface for level measurement and states that it uses the BISON nozzle-component. However, the description of a BISON nozzle-component is neither provided in WCAP-17202 nor in RPA-90-90-P-A. If a new component is being introduced into the BISON code, provide an explanation of the new component and its integration into the BISON code, using the same level of detail as other BISON components described Section 3.8 of RPA-90-90-P-A. If the BISON nozzle-component already exists, provide a reference to its description.

15.00.02-28
With respect to the equations in Section 3.4 of WCAP-17202

a. Does the non-modified BISON level, $Z_0$, represent the two-phase (mixture) level or the collapsed water level (void fraction = 0)?

b. Is the density used in these equations a single phase density or a mixture density?

15.00.02-29

Equation 3-48 of WCAP-17202 presents the final equation used to calculate the pressures at the nozzle. It is stated that these pressures can be used as input to model the RPV water level measurement. Later it is also stated that the RPV water level system is usually modeled using SAFIR. It is not clear which parts of the model are implemented using BISON and which ones are simulated using SAFIR. Please briefly discuss the BISON/SAFIR implementation of the complete model.

15.00.02-30

Section 1.3 of WCAP-17202 the applicant requests NRC approval of the BISON/SAFIR interface for level measurement. However, Section 3.4.3 defers presentation of validation data, stating that “the SAFIR model is validated for the first time application in connection with a License Amendment Request by comparing to plant data”. Based on the Standard Review Plan guidelines in Section 15.0.2.III.2.D, this is inadequate for the NRC review and approval process. Please demonstrate the adequacy of the BISON/SAFIR level measurement model for general

application by comparing its performance to separate effects experimental data and provide the uncertainties for this data.

15.00.02-31

Per Equation 3-44 of WCAP-17202, pressure at a nozzle is assumed to vary linearly with elevation between adjacent BISON nodes. When pressure drops occur due to flow obstructions such as the steam dryers, this is not necessarily an accurate assumption. Figure 3-17 appears to show that nozzle "x+1" is located at or within the steam dryer region. Clarify the elevation used for this nozzle relative to the dryer top and bottom elevation and demonstrate that the model's pressure drop $\Delta p_{sd} = kW_{steam}^2$, referenced by Equation 3-45, correctly accounts for the actual pressure drop relative to the steam dryer.

Request for Additional Information No. 5583 Revision 0

ABWR South Texas Topical Reports
South Texas Project Nuclear Operating Co
Docket No. PROJ0772
SRP Section: 15.00.02 - Review of Transient and Accident Analysis Methods 01/2006
Application Section: Topical Report WCAP-17202, Section 3.5, Steam Dome Water Surface Condensation Model

QUESTIONS for Reactor System, Nuclear Performance and Code Review (SRSB)

15.00.02-32

Section 3.5.1 of WCAP-17202 summarizes observations of the current BISON simulation of the Hamaoka-5 start-up tests, but does not reference the supporting documentation.

a. In order to appreciate the overall improvements in the BISON model predictions after incorporation of the new steam dome water surface condensation model, provide the reference where the BISON calculations of Hamaoka-5 start-up tests are documented or provide the results of comparison of the original BISON code for the Hamaoka-5 start-up tests (pressure in dome, water level, and water subcooling).

b. Explain whether the third bullet is an experimental observation or a BISON prediction.

15.00.02-33

The last paragraph of Section 3.5.1 of WCAP-17202 implies the new model is incorporated in Reference 1. Because Reference 1, RPA-90-90-P-A, was issued in 1989, it is not expected to include the improved model presented in this WCAP. Please explain.

15.00.02-34

Section 3.5.2 of WCAP-17202 states that “the applied model is a second degree polynomial versus surface subcooling ($\Delta T_{surf}$),” which is presented in proprietary Equation 3-49.

a. Please provide the physical basis for the selection of the polynomial dependence used in the model. Comment on the generality of the purely empirical model for steam dome water surface condensation when applied to all possible ABWR related transient scenarios.

b. Discuss the physical significance of each model parameter in Equation 3-49.

c. Address the implications of having a finite amount of condensation for zero subcooling.

d. Surface condensation is due to transfer of heat from vapors to subcooled liquid surface and the condensation rate is equivalent to the heat transfer rate divided by latent heat. Since the latent heat is function of pressure, the surface condensation rate is also pressure dependent. Discuss the pressure dependence of each model parameter in Equation 3-49.

e. The interfacial condensation heat transfer coefficient between vapor space and the subcooled liquid surface is affected by the flow conditions (e.g., laminar, turbulent, natural convection, forced convection) in vapor and liquid phases. These flow conditions can vary during the transient, and can be very different for different type of transients. Discuss how the model captures dependence on flow conditions or the implications of not including it.

15.00.02-35

Proprietary Figure 3-18 of WCAP-17202 presents a verification of the fitting of the condensation model. The following information is required related to this figure:

a. Please provide the values of all model parameters from Equation 3-49 used to generate the "Model" curve.

b. Provide the experimental conditions (e.g., pressure, flow conditions, test section geometry etc.) for the experimental data presented in the figure. Is this separate effect test data, integral effects data or plant data? Please explain the method used to measure the rate of condensation in the experiment and the uncertainty in the measurement.

c. Address the discrepancy in units reported for condensation C in Equation 3-49 versus Figure 3-18, and reconcile it to the units on the right hand side of Equation 3-49.

d. The value used for CONDR in Figure 3-18 differs from the value used for CONDR in Section 3.5.5. Please add to Figure 3-18 the model prediction using the CONDR value from Section 3.5.5, which is stated to be the BISON default

15.00.02-36

Section 3.5.4 of WCAP-17202 presents validation of the steam dome water surface condensation model. Proprietary Figure 3-19 and Figure 4 in Appendix 1 show the predictions of the model for the Load Rejection with Bypass (LRWBP) transient. Similarly, Proprietary Figure 3-20 and Figure 8 in Appendix 1 show the predictions of the model for the Main Steam Isolation Valve Closure (MSIVC) transient.

a. Please provide the values of all model parameters from Equation 3-49 used for the comparisons presented in each of these figures.

b. Consistent with the SRP guidelines in Section 15.0.2.III.2.E related to the use of plant data for model validation, provide the uncertainty in the plant test data, and comparisons of predicted and measured water subcooling ($\Delta T_{surf}$).

15.00.02-37

Proprietary Equation 3-50 of WCAP-17202 contains the final correlation of the steam dome water surface condensation model. Please describe how this equation was derived from Equation 3-49, as it appears some parameters were deleted.

15.00.02-38

In the comparison shown in Figure 4 in Appendix A of WCAP-17202, the BISON prediction using the surface condensation model levels off after 90 seconds, whereas the data shows a continuous decrease in the pressure. Furthermore, the water level is consistently over-predicted between 40 to 80 seconds. Please explain these apparent discrepancies in behavior.