April 18, 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**
15.00.02-7	15.00.02-1	15.00.02-5
15.00.02-8	15.00.02-2	15.00.02-6
15.00.02-11	15.00.02-9	15.00.02-16
15.00.02-12	15.00.02-10	15.00.02-19
15.00.02-17	15.00.02-13	15.00.02-26
15.00.02-25	15.00.02-14	15.00.02-39
15.00.02-41	15.00.02-15	15.00.02-40
	15.00.02-18	
	15.00.02-20	
	15.00.02-42	

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. 5564, 5580, 5584

Enclosure:
Request for Additional Information

Distribution:
PUBLIC
NGE 1/2 R/F
JDonoghue, NRO
GThomas, NRO
MHayes, NRO
GWunder, NRO
RidsNroDnrlNge2

ADAMS Accession No. ML111050109 NRO-002

OFFICE	DSRA/SRSB/TR	DSRA/SRSB/TR	DNRL/NGE2/PM
NAME	MHayes	JDonoghue	TGovan
DATE	3/1/2011	3/16/2011	4/14/2011

***Approval captured electronically in the electronic RAI system.**

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Request for Additional Information No. 5564 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 3.1, Advanced Control Rod Hydraulic Insertion Model

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

15.00.02-7

In proprietary Equation 3-3 of WCAP-17202, the form loss for the valve appears to be given by the expression in parenthesis. Provide justification for using this expression as the form loss.

15.00.02-8

Per Section 3.1.2.3 of WCAP-17202, the VALVE factor is zero for a fully opened valve. Depending on the type of valve, a fully open valve can also have a finite form loss. Provide justification for not including the form loss for a fully open scram valve in the general formulation of the model.

15.00.02-9

Equations 3-6 and 3-18 of WCAP-17202 are used to calculate the heat transfer from surroundings to the gas inside the gas and water tanks.

a. The temperatures of the tank inside wall surfaces are assumed constant at their initial values, implying the inside surfaces are in thermal equilibrium with the atmosphere surrounding the tanks. This assumption would be non-conservative if the tanks are insulated or the tank wall thermal resistance is high due to either low thermal conductivity and/or large wall thickness. Justify the assumption of constant initial temperature for the gas and water tank walls.

b. Provide the constitutive equations or empirical relations used to determine the values for the effective thermal exchange constants, a_1 and a_2.

15.00.02-10

Proprietary Equation 3-9 of WCAP-17202 is used to relate the gas flow between the gas tank and the water tank to the pressure difference between the two tanks

a. Justify the use of the expression containing ξ_1.
b. Explain the impact of the extra linear term on pressure drop calculations when the flow is critical (choked).
c. Discuss the entrance and exit losses.

d. Please justify the assumption regarding the density of the gas from the gas tank.

15.00.02-11

Equation 3-11 of WCAP-17202 provides an energy balance for the gas space in the water tank. Please explain why the heat transfer from the gas tank wall, q_1, is used in the energy balance for the water tank.

15.00.02-12

Section 3.1.2.7 of WCAP-17202 describes the water flow from the water tank to the rotary actuator using level descriptors (HP3, HP4, HP5) from Figure 3-1. If the levels are calculated dynamically, provide the relevant equations. If not, justify the use of constant values.

15.00.02-13

Section 3.1.2.11 states that "If there is a hydraulic brake in the scram system the actuator velocity is reduced during a set braking distance." Explain how the effect of the hydraulic break is calculated or determined for any plant.

15.00.02-14

Please reconcile the presence of the term VALVE in Equations 3-36 and 3-37 as it relates to proprietary Equations 3-24 and 3-27.

15.00.02-15

Equations 3-36 and 3-37 represent the flow from the water tank to the actuators already inserted (extracted) from the available group and to the non-extracted actuators. It is expected that the expressions for these equations will be the same as Equation 3-27 except for the number of actuators in each group. However, Equations 3-36 and 3-37 have different terms in their expressions. Please explain the reason for these differences. Also explain the significance of the last two terms in Equation 3-37. Note that the units for these terms do not seem to be consistent with the remainder of the equation.

15.00.02-16

The following items refer to Sections 3.1.3 and 3.1.4 of WCAP-17202, which discusses the verification and validation procedures for the control rod insertion model.

a. Since the scram valve in the reactor discussed in Section 3.1.3.1 was located between the gas and liquid tanks, it seems the expression for dp_{12} should include a term similar to the VALVE factor from Equation 3-3. Please clarify if any changes were made to the documented model to simulate the control rod insertion of this particular reactor. If no changes were made, please explain the reasons for leaving the model unchanged.

b. Discuss the control rod data used for comparison in proprietary Figure 3-3. Is it representative of a group with two control rods or the group with a single control rod? Does this figure include all data from the tests described in Section 3.1.3.2?

c. Discuss if there was any variation in reactor pressure during the testing.

15.00.02-17

In proprietary Figure 3-3, the model shows good agreement for the third and fourth data points. In Figure 3-2, please explain the BISON data with regard to validation of the model corresponding to the same x-values.

15.00.02-18

Section 3.1.3 and 3.1.4 of WCAP-17202 compare the control rod insertion model to data from 3 reactors. Consistent with the guidelines provided in SRP Section 15.0.2.III.2.E, please provide the uncertainty in the test data from these three plants. Explain how this uncertainty has been incorporated into the BISON predictions using the control rod insertion model.

15.00.02-19

In order to determine the adequacy of the model presented in Section 3.1 of WCAP-17202, please provide the following geometric information of the ABWR advanced control rod insertion system:

a. Diameters and volumes of gas and water tanks.
b. Lengths and diameters of the pipes connecting the gas tank to the water tank and water tank to the rotary actuator.
c. Diameter and volume of rotary actuator.

15.00.02-20

In order to examine the behavior of the model presented in Section 3.1 of WCAP-17202, please provide following <u>time dependant</u> information for a typical ABWR control rod insertion calculation:
a. Pressures in gas tank (P1), water tank (P2), rotary actuator (P4), and reactor pressure (P5).
b. Flow rates G1, G2, G3, and G41.
c. Water levels HP3, HP4, and HP5.

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 3.3, Asynchronous Pump Motor

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

15.00.02-25

The BISON asynchronous pump model presented in Section 3.3.2.1 of WCAP-17202 includes a slip parameter k_{s}, defined as the relative difference between the stator and rotor angular speeds. Stator speed in this model is a time-dependent control input from SAFIR, while the rotor speed is described as a time-dependent output.

a. Please clarify the procedure by which the slip parameter is calculated in BISON (e.g., using old timestep values of the angular speeds to calculate slip used in obtaining the new timestep rotor speed).

b. Discuss how impedance Z_2 was derived.

15.00.02-26

The validation of the asynchronous pump motor model is discussed in Section 3.3.3 of WCAP-17202 where comparisons of model predictions to measure data, such as the total core flow rate, from the Hamaoka 5 plant are presented. Consistent with the guidance in SRP Section 15.0.2.III.2.E, please indicate if any comparisons of the asynchronous pump motor model against the pump manufacturer data or data for pumps with similar motor and pump characteristics have been is made.

Request for Additional Information No. 5584 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, Questions on Section 3.6, Post Dryout and Rewet Model

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

15.00.02-39

Proprietary Equation 3-55 of WCAP-17202 gives the final heat transfer correlation developed to calculate the post dryout heat transfer between the cladding and the coolant. Please address the following:

a. This equation includes the selection criteria for using either the Groeneveld or the Bromely heat transfer coefficients. Provide justification for this criteria, as it seems to be non-conservative for the Peak Clad Temperature (PCT) calculation.

b. This equation uses the Groeneveld heat transfer correlation, which was developed for the high pressure (P>23.8 bar) liquid deficient (dispersed flow) regime and does not distinguish between radiation and convection modes of heat transfer. Please comment as to whether this leads to a non-conservative estimation of the total heat transfer coefficient for the flow region in which Groeneveld correlation calculated heat transfer coefficient is selected. Discuss the relative magnitudes of the heat transfer coefficients due to radiation and the Dittus-Boelter correlation as compared to that using the Groeneveld correlation during transition boiling.

c. WCAP-17202 states that the Dittus-Boelter heat transfer coefficient is added to account for the heat transfer contribution from the cladding to the water drops in transition boiling. However, the Dittus-Boelter correlation was developed for single-phase fully developed turbulent flow in a smooth circular tube. Transition boiling is characterized by the intermittent rewetting of the heated surface by the liquid in the flow stream. Such conditions do not appear to be similar to those encountered during turbulent single-phase flow. It appears that the Reynolds number in Equation 3-54 assumes that the liquid phase is flowing in the entire pipe which does not reflect the conditions during partial film boiling in a pipe. Please provide justification for the application of the Dittus-Boelter correlation in the form presented in Equation 3-54 to the partial (intermittent) film boiling regime.

d. Please explain the rationale for the multiplier in Equation 3-55.

15.00.02-40

Proprietary Equation 3-56 of WCAP-17202 gives the correlation for the calculation of rewet quench velocity, which is plotted in proprietary Figure 3-21.

a. This equation indicates that there is a step change in rewet velocity at the ΔT transition boundaries while Figure 3-21 shows a continuous trend along ΔT. Please explain this discrepancy.

b. Upon incorporation in the BISON code, the above described model discontinuities may cause numerical convergence problem for the code. Please comment on this. Provide the results of the BISON predicted rewet velocity (using the new correlations) against data from integral tests.

c. Please explain the physical basis for each correlation included in the equation and how the transition points were selected. Discuss how each correlation is compared to experimental data, as it appears there is no data supporting the last transition.

d. Quantify the uncertainty in the prediction of the rewet velocity and explain how it will be accounted for in the BISON application.

e. What value is the rewet model based on?

15.00.02-41

Proprietary Figure 3-22 of WCAP-17202 shows the comparisons of predicted and measured temperature increases for one fuel type and proprietary Figures 3-24 to 3-26 show similar comparisons for a second fuel type. The figures show a relatively large scatter in the data points (data points consisting of a measurement and prediction pair) for the first fuel type compared to the scatter in data points for the second fuel type. Moreover, in Figure 3-22 a large fraction of the data points are below the ideal line indicating a general tendency for the correlation to under predict PCT. Please describe the reasons for the differences in the scatter illustrated in Figure 3-22 and the significant non-conservatism for some of the predictions. Also discuss any differences in how the two experiments were conducted.

15.00.02-42

Proprietary Figure 3-23 of WCAP-17202 shows the comparison of predicted and measured temperature data points using what the figure description calls a “conservative method” for PCT calculations.

a. Please describe how the predicted PCTs are calculated for Figure 3-23 and how it is different from the calculations supporting Figure 3-22.

b. Please explain whether this "conservative method" will be used only for limiting transients as mentioned in Section 3.6.3, or is it to be more generally applied. If the conservative approach is not uniformly used, how will the uncertainties in PCT prediction be considered.