Nuclear Operating Company

South Texas Project Electric Generating Station P.O. Box 289 Wadsworth, Texas 77483

April 13, 2010
U7-C-STP-NRC-100078

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

South Texas Project
Units 3 and 4
Docket No. PROJ0772
Response to Request for Additional Information

References:

1. Letter from Tekia Govan to Mark McBurnett, "Request for Additional Information Re: South Texas Project Nuclear Operating Company Topical Report (TR) WCAP-17079-P Revision 0, Supplement 3 to Bison Topical Report RPA 90-90-P-A SAFIR Control System Simulator" (TAC No. RG0012), March 12, 2010.

2. Letter from Tekia Govan to Mark McBurnett, "Request for Additional Information Re: South Texas Project Nuclear Operating Company Topical Report (TR) WCAP-17116-P Revision 0, Supplement 5 – Application to the Advanced Boiling Water Reactor (TAC No. RG00007), March 12, 2010.

Attached are responses to NRC staff questions included the referenced letters. Attachments 1 thru 11 address the RAIs shown below:

RAI 10
RAI 12
RAI 13
RAI 14
RAI 23
RAI 24
RAI 28
RAI 31
RAI 33
RAI 34
RAI 15.06.05-1

Responses to RAIs 1, 2, 4, 5, 6, 7, 8, 9, 11, 16, 17, 21, 25, 26, 27, 29, 30, 32, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, and 45 will be provided on April 30, 2010.

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There are no commitments in this letter.

If you have any questions, please contact me at (361) 972-7136, or Bill Mookhoek at (361) 972-7274.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 4/13/10

Scott Head
Manager, Regulatory Affairs
South Texas Project Units 3 & 4

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Attachments:

1. RAI 10
2. RAI 12
3. RAI 13
4. RAI 14
5. RAI 23
6. RAI 24
7. RAI 28
8. RAI 31
9. RAI 33
10. RAI 34
11. RAI 15.06.05-1

cc: w/o attachment except*
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RAI 10

QUESTION:

Section 3.11 states that all instances of a component must have a unique name within a model. How many characters are allotted to name a component within a model? If such a character limit exists, does it pose a challenge in terms of simulating a sufficient number of components within a detailed transient analysis model?

RESPONSE:

A component may be named using any combination of characters; the current limit is 72 characters and doesn't pose any limitations in terms of simulating a sufficient number of components. Therefore there is no challenge to simulating the number of components within a detailed transient analysis model.

RAI 12

QUESTION:

When new components are developed, must the transfer functions have analytical solutions? Section 4.1 of Supplement 3 states that any components added to SAFIR in the future must consist of a simple transfer function. Please describe more specifically what is meant by the term "simple."

RESPONSE:

Westinghouse will, if needed, incorporate new components that can be verified based on an analytical solution. New components that perform a mathematical operation can also be added to SAFIR based on mathematical functions provided by the code compiler. An example is the logarithmic function.

Transfer functions are not required to have analytical solutions. A simple function is a function that can be described by an equation with either an analytical solution or a standard mathematical function (for example the logarithmic or exponential functions).

The process by which a new component will be verified is governed by the Westinghouse Quality Management System (QMS).

RAI 13

QUESTION:

Section 4 of Supplement 3 refers to "empirical" component models that are essentially tuned to plant data. When such models are developed for inclusion in SAFIR, please describe how the addition is consistent with the requirement that the transfer function be "simple."

Additionally, when empirical models are developed, it is likely that such models would be tuned to plant data over a specific range of plant or control system conditions. Please specify how the assumptions, validation range, and limitations of an empirical component model are documented. Additionally, please describe how these aspects of the empirical component model are tracked in the Westinghouse safety analysis process to ensure that the model is implemented appropriately for the transient analyses.

RESPONSE:

Westinghouse will, if needed, incorporate new components that can be classified as simple according to the answer to RAI-12. New components that can not be classified as simple will be treated as a complex component. Examples are a fuzzy controller or an empirical component. The assumptions, validation range, and limitations of such a component depend on the nature of the function. The verification and validation process including documentation for such component is identical to the process to verify and validate a SAFIR model as described in Section 5 of Supplement 3.

RAI 14

QUESTION:

On a plant-specific basis, when new component models are employed in the safety analysis, please confirm that the Westinghouse Reload Safety Evaluation provides sufficient information, either directly or by reference, for the licensee to independently verify that the new component model was developed and implemented consistent with the process described in the LTR and quality assurance procedures that comply with the requirements of 10 CFR 50 Appendix B. Please provide a statement in the –A version of Supplement 3 to this effect.

RESPONSE:

The Westinghouse Reload Safety Evaluation is presented in WCAP-9272-P-A, and is applicable to pressurized water reactors. For boiling water reactors the reload specific safety methodology is described in CENPD-300-P-A. In CENPD-300-P-A there is an example of a reload safety analysis for a plant specific basis called the Reload Safety Analysis Summary Report. The Reload Safety Analysis Summary Report does not address the addition of new control system components as this is below the level of detail that is described. The addition of new components is internally reviewed and approved in accordance with the Westinghouse Quality Management System.

The Westinghouse Quality Management System (QMS) has been reviewed and approved by the USNRC (WCAP-12308). The Westinghouse QMS meets all requirements of 10 CFR 50 Appendix B as well as ISO-9001. All analysis and internal calculations, or in this case the addition of a new component, must be done in accordance with the Westinghouse QMS.

RAI 23

QUESTION:

The existing recirculation pump model in the BISON code has been approved with the following SER limitations as stated in RPA-90-90-P-A:

- *We require justification for use of the recirculation pump model when transients are in other than the first quadrants of the Karman-Knapp diagram.*

- *We require justification for use of the recirculation pump model when two-phase flow conditions are calculated.*

Section 3.8 Table 3-1 of WCAP-17079-P indicates that the recirculation pump speeds are output by SAFIR as well as by BISON (i.e., it is listed as both an input to and an output from BISON).

a) Explain how ABWR reactor internal recirculation pumps are modeled in BISON-SAFIR, including how the pump speeds can be both an input to and an output from BISON, as described in Table 3-1 of WCAP-17079-P.

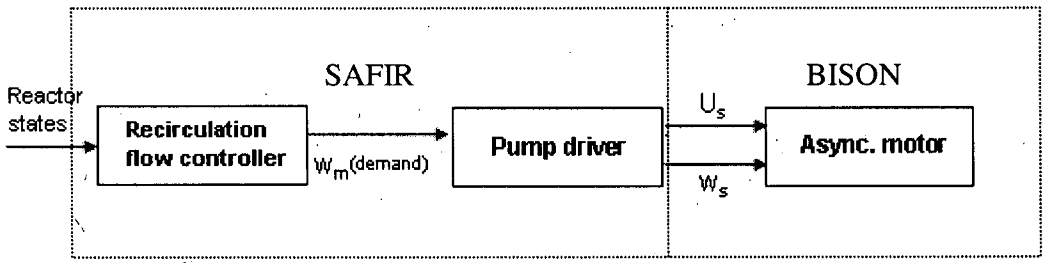
b) Provide a qualification analysis, uncertainty analysis, and range of validity demonstrating applicability of the BISON-SAFIR model of the ABWR reactor internal recirculation pumps.

RESPONSE:

a) The use of SAFIR for controlling the recirculation pumps does not change the BISON recirculation pump model approved by the NRC and described in RPA 90-90-P-A. The SAFIR code determines the pump speed demand (W_m) by using various plant parameters, which is then transferred to a pump driver that feeds the BISON asynchronous motor model with a frequency (U_s) and a voltage (W_s) as shown in Figure 1 below. The asynchronous motor uses this information to calculate a pump speed which is the input to the BISON recirculation pump model. The BISON code calculates the pump head and pump torque given the pump speed, in accordance with methods as described in RPA 90-90-P-A. Since SAFIR can be used to control the recirculation pumps, the pump speed can be both an input and an output to the model if the pumps are in speed control mode. If the pumps are in speed control mode, the pump controller uses the current pump speed to calculate the error in pump speed (pump demand minus the current pump speed) to determine the means to maintain a constant pump speed.

Moreover, the recirculation core flow is one of the user inputs to BISON to solve the BISON steady state. When the steady state is solved, BISON determines a pump speed that matches the recirculation core flow and the pump head in accordance to the methods as described in RPA 90-90-P-A. Hence, the BISON determined pump speed can be transferred to SAFIR to initialize models such as Recirculation Flow Controller to a state that corresponds to the calculated steady state pump speed.

b) The usage of SAFIR for controlling the recirculation pumps does not pose any changes to the BISON recirculation pump model licensed by the NRC as described in RPA 90-90-P-A since the recirculation pumps are not modeled with SAFIR. Therefore SAFIR does not introduce any further uncertainties in the recirculation pump model.



RAI 23, Figure 1 Block schedule of the SAFIR-BISON interface for the pump model

RAI 24

QUESTION:

The previously approved steam line model (described in RPA-90-90-P-A) or PARA steam line model (described in CENPD-292-P-A) calculates the mass flow and pressure for each of the modeled steam line assuming isentropic behavior of the steam. Furthermore, the PARA steam line model includes models for flow control valves (Main steam line isolation valve (MSIV), turbine bypass valve, and turbine stop valve), safety/relief valves, and the turbine assembly. The valves are modeled using user-specified tables representing changes in valve stem position, valve flow area, or valve flow rate with time. The SER limitation on this model as documented in CENPD-292-P-A states that:

> *With use of the PARA steamline model, the user has flexibility of modeling valves and control system functions through the use of user supplied table and control systems. Modeling of these systems greatly affects the amount of conservatism in the transient outcome in certain event analysis. Therefore as required in the original SER for BISON, ABB/CE is required to provide justification for these user controlled items, which include valve performance, to assure conservatism in licensing applications.*

Table 3-1 in Section 3.8 and Sections 5 and 6 of WCAP-17079-P indicate that SAFIR is used for modeling MSIV, turbine bypass valve, turbine stop valve, and safety/relief valves.

a) Confirm that SAFIR models for these components are in compliance with above noted SER limitation.

b) Explain how the flow rates in flow controlled steam line valves can be both an input to and an output from BISON, as described in Table 3-1 of WCAP-17079-P.

RESPONSE:

a) The above SER limitation is based on the original SER for BISON. This limitation will be removed with the approval of WCAP-17079-P. The SAFIR models approved by WCAP-17079-P will also meet the requirements for the above SER limitation as documented in CENPD-292-P-A.

b) Output signals from the steam line model are pressure and flow from each junction within the steamline model. The flow from the steamline is controlled by one or several valves and the valve position may be altered by signals where the signals describe the relative change of flow compared to the stationary solution.

RAI 28

QUESTION:

The SAFIR general model description and limitations in WCAP-17079 appear to permit feedback in an input model (i.e., it is possible to construct a closed circular path from an input signal back to itself entirely within SAFIR). Does the SAFIR model used for ABWR contain any such closed loops? If so, describe how a SAFIR solution is obtained for a sampling time interval, given the existence of such feedback loops, and justify its correctness. (For example, consider the hypothetical situation where output from SAFIR component "A" is an input to component "B", and the output from "B" feeds back into "A". If this were simply evaluated once in either order, the outputs of "A" and "B" may be inconsistent since one output changes after the other has been evaluated.) (e.g., does SAFIR iterate within one sampling time interval until a stable solution is obtained for all components? Does it simply evaluate each component once in some fixed order regardless of the existence of feedback loops, resulting in a possibly inconsistent solution?)

RESPONSE:

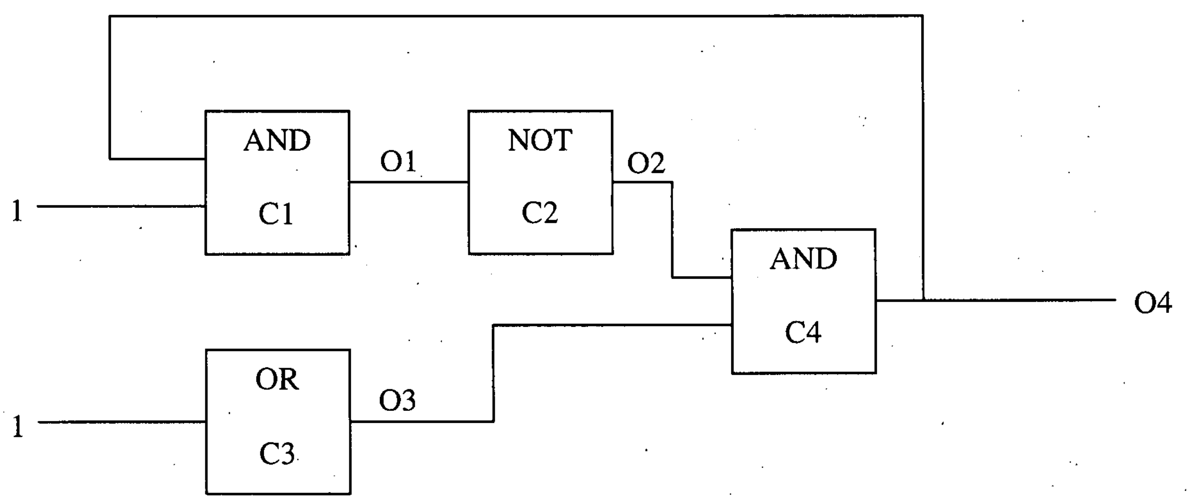
SAFIR permits feedback such as constructing a closed circular loop from an input signal back to itself. This feature can be used in many applications such as in controllers to feed back the output signal to the input signal. Figure 6-90 in Supplement 3 is an example on a model where such feedback is used in the SAFIR model for the ABWR.

SAFIR uses an explicit calculation scheme and does not iterate to get a stable solution except for the steady state iteration. Instead, the user supplied order of the components matters. The component that is first in order is evaluated first and then the second component and so on. Note that the component will only be updated if its sample time permits it.

An illustrative example is provided in Figure 1 below for a feedback loop. The components are supplied in the order of C1, C2, C3 and C4 and the outputs are named O1, O2, O3 and O4. The output (O4) from component C4 is feed back to component C1 and is assumed to be initialized to 1 for the steady state iteration. Furthermore, the components are assumed to have the same sampling time. The output signal O4 for each time step is shown in Table 1. As can be seen in the table, the output signal is assigned the values 0 and 1 every second time step. Note that if an iterative solution technique is used, the output signal would never converge despite the fact that the model as shown below is a valid one.

RAI 28, Table 1 Output signals from the feedback model

Sampling time #	O1	O2	O3	O4
1	0	1	1	1
2	1	0	1	0
3	0	1	1	1
4	1	0	1	0
5	0	1	1	1



RAI 28, Figure 2 Example of a feedback model

RAI 31

QUESTION:

One element commonly found in computational models of control systems is the ability to latch an output signal (i.e., to fix an output signal once certain conditions are met, such as activation of scram, irrespective of later changes to the input signals). Is any such capability necessary in modeling ABWR systems using SAFIR? If so, how will the "latched" outputs be modeled (e.g., through use of GVB component)?

RESPONSE:

Latched output signals can be modeled using various components and techniques. An example is to use the Set and Reset switch where the Reset input is kept to zero. Hence, the output can never be changed, as the reset is set to zero, after the Set input has been set. Reactor protection systems and ATWS logics are two typical examples where latched output signals are used where the output signals are irrespective of later changes to the input signals.

RAI 33

QUESTION:

SAFIR provides several components for modeling random numbers (UNI, NORM, PRBS), as described in Table 3-2 of WCAP-17079-P. Are any of these random number components used in the SAFIR model of ABWR? If so, then:

a) Are the random numbers generated by these components pseudo-random, such that they are reproducible from one calculation to another (given the same input random number seed)?

b) Suppose a SAFIR input model includes one or more random number components, and the calculation yields a certain time-dependent random number vector for each. If this input model were to be later augmented with an additional random number component, and the same random number seed used, would the previous random number components generate the same random vectors as before (i.e., previously present random elements remain reproducible and independent of new random elements)?

RESPONSE:

The random number generators have been found to be unnecessary for modeling of the ABWR plant as of today. The random number generators are pseudo-random numbers and the results are therefore re-producible. Each pseudo-random number generator works independent of one another and thus, adding more random number components does not affect the number sequences generated by the previous ones.

RAI 34

QUESTION:

The list of SAFIR components described in WCAP-17079 Section 3.10 does not include ones to facilitate calculation of a number of basic mathematical functions, such as logarithms (OUT(t) = LOG(IN(t))) or exponentiation (OUT(t) = IN(t) ** C1, for C1 not equal to 0.5 (SQRT)). Are any such mathematical functions necessary for modeling of ABWR systems in SAFIR? If so, describe how these would be modeled (e.g., user-input table lookup).

RESPONSE:

None of these functions are needed in the current ABWR modeling as today. If new functionality is required in SAFIR to model a certain system Westinghouse can either follow the processes as described in the answers to RAI-12 and RAI-13, or model an equivalent functionality by usage of the existing basic components within SAFIR. Two examples of the latter could be a piece-wise linear function or a Taylor expansion.

RAI 15.06.05-1

QUESTION

Please submit documents RPB 90-93-P-A ("Boiling Water Reactor Emergency Core Cooling System Evaluation Model: Code Description and Qualification", October 1991) and RPB 90-94-P-A ("Boiling Water Reactor Emergency Core Cooling System Evaluation Model: Code Sensitivity,"October 1991.). These documents are necessary to complete the review of WCAP-17116.

RESPONSE:

Document RPB 90-93-P-A ("Boiling Water Reactor Emergency Core Cooling System Evaluation Model: Code Description and Qualification") is renumbered from and identical to WCAP-11284-P-A with the same title, which was previously approved by the NRC in August, 1989. Document RPB 90-94-P-A ("Boiling Water Reactor Emergency Core Cooling System Evaluation Model: Code Sensitivity") is also renumbered from and identical to WCAP-11427-P-A with the same title, which was also approved by the NRC in August, 1989. Consequently, submittal of these documents is not required. An explanation for the change in document numbering is provided below.

The licensing of the Westinghouse Boiling Water Reactor (BWR) fuel safety analysis methodology for U.S. applications was commenced by the Westinghouse Electric Corporation in 1982, with the submittal of various licensing topical reports. These reports described codes and methodology developed by Westinghouse Atom AB, formerly known as ABB Atom (and ASEA Atom) of Sweden.

In 1988, ABB Atom continued the licensing of the BWR reload methodology, started by Westinghouse, directly with the Nuclear Regulatory Commission (NRC). The transfer of the licensing effort was facilitated by ABB Atom's formal re-submittal of NRC-approved licensing topical reports under ABB Atom ownership. The NRC acknowledged the transfer of these licensing topical report approvals in 1992 (Reference Letter from A. C. Thadani (NRC) to J. Lindner (ABB Atom), "Designation of ABB Atom Topical Reports Related to Licensing of ABB Atom Reload Fuel," June 18, 1992). The report numbers of the resubmitted reports reflected the "RPB" numbering scheme.

There are no changes to WCAP-17116 required as a result of this response.