Babcock & Wilcox
a McDermott company

Nuclear Power Generation Division
3315 Old Forest Road
P.O. Box 1260
Lynchburg, Virginia 24505-1260
(804) 385-2000

December 1, 1981

Mr. James R. Miller
Standardization and Special Projects Branch
Division of Project Management
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Miller:

Enclosed are 35 copies of B&W Topical Report BAW-10149 Rev. 1, "POWER TRAIN - Hybrid Computer Simulation of a Babcock & Wilcox Nuclear Power Plant."

This report describes the version of the POWER TRAIN code in present use today at B&W. This code is used to provide results and inputs for accident analyses for FSAR Chapter 15 for all 205 FA and 145 FA plants.

POWER TRAIN is a real-time, on line hybrid computer simulation of a typical Babcock & Wilcox nuclear power plant. POWER TRAIN is used to predict the performance and behavior of the major components in the NSS for a wide range of plant conditions and operation.

This report describes an improved version of the code described in an earlier Topical Report, BAW-10070 presently under review by your office. The earlier version of this code was used to provide Chapter 15 results and inputs for the 177 FA plants.

The original submittal of BAW 10149, 8/17/81, contained descriptions of the scope of the simulation, the modeling assumptions, and the modeling equations. Revision 1 enlarges Section 4's (Applications) detailed description of its application to accident analysis and provides benchmarking of this version against the one described in BAW 10070.

T010
S1/35 Cys on Shelf

The original submittal provided a detailed description of the steam generator model requested as one of a series of NRC questions submitted 4/4/79 on BAW 10070. Rev. 1 is being referenced to provide the information requested in the remainder of those questions. A copy of the cross reference of questions and the related Section of BAW 10149 that provides the answers is attached.

A separate submittal is being made to Mr. Walton L. Jensen, Reactor Systems Branch of the Office of Nuclear Reactor Regulation through Mr. Darl Hood, NRC Project Manager for Consumers Power Company, Midland project for this purpose.

Very truly yours,

THE BABCOCK & WILCOX COMPANY

James H. Taylor

James H. Taylor
Manager, Licensing

Enclosure

JHT/efc

cc: R. B. Borsum - Bethesda Office (B&W)
W. L. Jensen - NRC Reactor Systems Branch, NRR
Darl Hood - NRC Project Manager Consumers Power Co., Midland Project

Cross-Reference Between NRC Questions (4/4/79)
on BAW 10070 and the Recent Topical Report
on POWER TRAIN, BAW 10149.

The questions submitted to B&W (Steven A. Varga to James H. Taylor, "Review of Topical Report BAW-10070, April 4, 1979) pertaining to Power Train are answered by referencing portions of Topical Report BAW-10149, POWER TRAIN. Specifically, the response to each question is referenced in BAW-10149 as follows.

"Information on Prior Responses"

Question 1.

Question 1 has been divided into three parts for clarity of the responses.

Q.1.1. "The requested description of the plant protective system modeled in POWER TRAIN is limited to identification of the trip parameters used. Information concerning the manner of considering protective instrumentation response, protective system logic and response, and controlled component response characteristics have not been presented. Provide a block diagram type schematic of the protective system modeled in POWER TRAIN including all input instrumentation, output control signals, and output controllers."

Response

See Subsection 4.3.1-4.3.6

Figures 4.3, 4.4 and 4.5

Q.1.2. "In addition, describe the modeling of the plant control system action that may take place before protective action is initiated. A discussion of the manner in which such action is considered in the slower accident transients should also be provided in connection with the description of the protective system function for these transients."

Response

See Subsection 4.4.

Q.1.3. "In the response to Question 4, reference is made to an ICS system concerning feedwater controls. This system, which evidently is part of or interacts with the plant protective system is not described in the report. Provide a description of this system, the normal system functions, and where the system is modeled in connection with POWER-TRAIN analyses."

Response

The feedwater system (flowrate, valve ΔP) does not interact directly with the plant protection system (see Section 4.3.4 and 4.3.5). The feedwater system modeled in Power Train is shown on Figure 4.3.

Question 2. "Response to Question 4"

Q.2. "The information provided in this response does not respond to the request made concerning Twi. Identify the limit information against which a judgment is reached with respect to Twi for the turbine trip transient. This information was requested in the original request for additional information. It is also requested that the dependence on mass flow rate of the Twi limit be furnished.

In connection with the sample results shown on Figure B-1, provide the following additional information:

a) Discuss and justify the apparent lack of cold leg transport delay at the reactor inlet.

b) Discuss the apparent transport delay occurring in the core resulting from the use of a single node core coolant mixing model such as would be obtained from equations 3.3-2 and 3.3-3 in the report."

Response

See Section 2.7 for discussion of modeling of reactor coolant temperatures and flow dependent transport delays.

Figures 4-2, 4-7, 4-18 and 4-19 show the expected and actual transport delays in selected temperatures. Judgement about the adequacy of the transport delays is based on comparison of model performance against actual plant data.

Question 3. "Response to Question 7"

Q.3. "Describe the valve vendor supplied data used as a basis for determining spray, relief, and pilot valve flow rates, and describe the method used for quantitatively determining these parameters for POWER-TRAIN calculations."

Response

Section 4.3.1 discusses valves represented in Power Train.

"General Information"

Question 1. "Identify the accidents analysed for plant licensing applications that are performed with the POWER TRAIN code. Also identify all other codes used, if any, to provide input data to POWER TRAIN for these analyses in addition to the COMANCHE and PUMP codes, and describe all data transfer between codes."

Response

See Section 4.1.

Question 2. "Because of the limited core noding detail used in POWER-TRAIN, limiting DNBR, and limiting clad and fuel temperatures during accident transients can only be roughly estimated. Describe the manner by which these and other limiting parameters are determined for SAR analyses on the basis of POWER-TRAIN results."

Response

See Subsection 4.1.

Question 3. "The course of accident transients can be appreciably influenced by various plant control systems in addition to the protective system. These controls are not described in the report, but some of their actions may be included in POWER-TRAIN analyses as indicated in some responses to questions. As a result, it is not certain if their normal response is considered to be completely included in accident analyses using POWER-TRAIN. Provide a discussion of how the reactor, pressurizer, feedwater, steam generator and turbine controls response is considered in SAR analyses."

Response

See Subsections 4.3 and 4.4.

Question 4. "The steam generator is described in generality with respect to the finite difference equations used to compute the unit thermodynamics. The model detail used in accident analyses, the heat transfer regimes and correlations modeled, and the unit hydrodynamics are not presented. Provide descriptions for each of these aspects of the steam generator model to enable a more adequate understanding of the OTSG model."

Response

See Section 2.16.

Question 5. "A sample application of the POWER-TRAIN code to an accident transient as submitted in an SAR is required. The computed results should be graphically presented for the primary system parameters, and all controls and protective system action should be described or identified in a discussion or on output graphics used to present results of the sample calculation."

Response

A POWER TRAIN application is discussed in Appendix A.

Question 6. "Sensitivity of results to uncertainties in primary controlling parameters in the plant design, such as flow rate, power level, system pressure, coolant volumes, reactivity coefficients, etc., should also be determined from analytical studies using the computer program for off-design conditions."

Response

See Subsection 4.5.

Question 7. "Verification studies using POWER-TRAIN to simulate plant or experimental system transients including protective and control action are also required to provide a degree of assurance that the computer program provides reasonably accurate predictions of accident transients for the SARs. Previous verification studies conducted by B&W with POWER TRAIN on plant startup transients, load swings, load rejections, etc., would be applicable for this purpose, and should be furnished in response to this information request. The comparisons between experimental measurements and POWER TRAIN results presented in the response to Question 4 in the first round request for additional information, and in the response to Question 2 of the second round request are inadequate for this purpose as the comparisons concern only minor perturbations to the steam generator portion of a plant simulation. POWER TRAIN verification should be based on comparisons with several plant parameters, such as, primary and secondary flow rates, temperature and pressure profiles along flow paths, pressurizer inventories, protective, and reactor, steam generator, and pressurizer control systems response, secondary steam conditions, etc., to be considered adequate.

Response

See Section 4.6.