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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO TOPICAL REPORT WPPSS-FTS-131

"APPLICATIONS TOPICAL REPORT FOR BWR DESIGN AND ANALYSIS"

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

WASHINGTON NUCLEAR PROJECT NO.2 (WNP-2)

DOCKET NO. 50-397

1.0 INTRODUCTION

By letter dated September 24, 1990, the Washington Public Power Supply System (WPPSS) submitted Topical Report WPPSS-FTS-129, "BWR Transient Analysis Model," describing and qualifying the RETRAN-02-based plant model for the WNP-2 plant as a best-estimate systems analysis tool. This report was supplemented with submittals dated July 15, 1991, March 5, 1992, and September 11, 1992, and with Topical Report WPPSS-FTS-131, "Applications Topical Report for BWR Design and Analysis," dated September 19, 1991. This topical report describes the WPPSS uses of its core physics and transient methods for licensing applications. The staff review of WPPSS-FTS-129 was discussed in a safety evaluation (SE) dated March 27, 1993. This SE addresses the staff review of WPPSS-FTS-131.

2.0 SUMMARY

The staff reviewed the methodology reported in WPPSS-FTS-129 (Rev. 01) with the technical assistance of International Technical Services, Inc. (ITS). The evaluation and findings are described in the above-mentioned SE. As identified in the SE, certain items were not included in the review of WPPSS-FTS-129 and were to be addressed and reviewed when the staff reviewed WPPSS-FTS-131 (the applications topical report). These open items include the following: demonstration that the algebraic slip model provides conservative results; more information on the use of statistical uncertainty analysis in the methodology used in licensing calculations; justification of the licensee's use of its licensing conditions and safety margins; comparative analysis of the NRC standard problem (a turbine trip without bypass (TTWOBP) transient); justification of the use of the jet pump flow-reversal model proposed; and the treatment of mixed fuels, from different vendors and with different geometric configurations, in the licensing calculations.

3.0 EVALUATION

The licensee supplemented the information in WPPSS-FTS-131 with submittals dated March 14, 1994, and August 12, 1994. This was in response to a request for additional information prepared by the staff and its contractor (ITS) to provide assurance that the licensee's use of the information in these two

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topical reports will yield conservative results for the licensing basis transient analysis for WNP-2. The contractor evaluation and findings are described in the attached ITS technical evaluation report (TER). As stated in the TER, certain items must be addressed and properly utilized as described in the two topical reports to provide an acceptable transient analysis licensing basis for WNP-2. These items are discussed below.

The licensee addressed all the open items that were spelled out in the SE and ITS TER for WPPSS-FTS-129, and the staff finds the methodology and analysis model described in WPPSS-FTS-129 to be acceptable for use as a systems analysis tool for WNP-2. The limitations were addressed in the applications report WPPSS-FTS-131 and the additional information provided on March 14, 1994, and August 12, 1994. The review findings are restricted to the base plant model and do not apply the individual models for which the licensee was required to provide quantification in the WPPSS-FTS-129 TER and RETRAN SER. The licensee has adequately demonstrated the conservative nature of its WNP-2 RETRAN model using RETRAN-02, subject to the limitations and restrictions listed below and discussed on pages 8 and 9 of the attached TER.

(1) The base plant model is to be used for WNP-2 only.

(2) The use of the jet pump model is reasonable as part of the base model, although the model in the reverse-flow regime was not qualified. The licensee must qualify its adequacy for each case in which reverse flow is predicted if the transient is the limiting transient or if the transient challenges core operating limits. NRC approval is required prior to use of the jet pump model for any case meeting these conditions.

(3) The algebraic slip model was not qualified. However, the plant model, including the slip model, was demonstrated to yield conservative results when compared against the vendor's analysis. This does not mean the algebraic slip model is qualified since the conservative nature of the RETRAN transient predictions is due to differences in transient assumptions. Nevertheless, as long as the Supply System uses the base model unchanged, it is acceptable to use the algebraic model in licensing type applications. However, if any changes are made in transient assumptions, models, or application, the licensee must demonstrate to the NRC prior to its use that the model yields conservative results.

(4) The hot channel methodology utilized by the Supply System for WNP-2 is based on the use of the VIPRE-01 computer code with the ANFB critical power correlation for the delta-CPR calculations. The WNP-2 VIPRE model included use of the drift flux model. The Supply System elected not to qualify the model for the WNP-2 application directly but as part of the WNP-2 model in combination with other correlations and models. This is adequate as long as the transient assumptions and scenarios remain unchanged. NRC approval is required prior to use of the VIPRE-01 with the drift flux model for any case for which any of these parameters are changed.

(5) The statistical combination of uncertainties (SCU) methodology developed by the Supply System is used in the analysis of the generator load rejection without bypass event with respect to scram times as an independent variable. This was justified by a large database of measurements of scram times.

Therefore, the approval recommended is for use with scram time only. Should the Supply System wish to extend this methodology to other plant parameters, a separate evaluation with a description and documentation of the database must be submitted to and approved by the NRC prior to its use.

(6) The mixture level prediction in the WNP-2 analysis is calculated through the use of a RETRAN control block. The Supply System formulated an algorithm by which it estimates, based upon the liquid mass in the core, what the level should be. The algorithm was not qualified for use in any transient in which a large variation (more than 10%) in the mixture level is expected. The level trip is relied upon in only one transient, the feedwater controller failure event. In this instance, the change in the feedwater flowrate assumption resulted in more conservative predictions of the system parameters than the vendor's results. Therefore, its use is only reasonable in this scenario. If any of the transient assumptions or models are changed in the future, the licensee must demonstrate to the NRC prior to its use that the model yields conservative results.

(7) The WNP-2 RETRAN plant model is approved with the limitations and restrictions noted above for licensing basis applications. However, the licensee must adhere to the restrictions and limitations of the governing SERs of the relevant computer codes and models that comprise the RETRAN plant model for WNP-2.

The staff does not adopt the statement in Section 2.7 of the attached TER about not analyzing the stability event for reloads. The boundaries of regions of possible instability on the power/flow map are subject to potential reanalysis, in keeping with the "actions requested" section of NRC Bulletin 88-07, Supplement 1, under Section (2) of "Operating Reactors." It is expected that such calculations will be done for WNP-2 with a staff-approved code.

The combined use of the two topical reports represents a conservative transient model for WNP-2 licensing basis calculations with the limitations and restrictions noted above and in the TER. The staff, therefore, finds the models presented in the two topical reports acceptable for licensing basis transient applications for WNP-2 provided the restrictions and limitations described above and in the attached TER are adhered to.

Principal Contributor: R. Frahm

Attachment: Technical Evaluation Report

Date: October 12, 1994

Attachment

Applications Topical Report for
BWR Design and Analysis
WPPSS-FTS-131
Washington Public Power Supply System WNP-2

1.0 INTRODUCTION

In the topical report, WPPSS-FTS-131 (Rev. 01) entitled "Applications Topical Report for BWR Design and System" (Ref. 1), the Washington Public Power Supply System (Supply System) submitted a description of the reload analysis methodology developed by the Supply System for the WNP-2 plant. Additional information was provided in References 2 and 3. The methodology is based upon use of the RETRAN-02 MOD-4 computer code (Refs. 4 and 5). The description and qualification of the use of RETRAN for BWR analysis for WNP-2 was documented in the topical report WPPSS-FTS-129 (Ref. 6), which has been approved with restrictions (Ref. 7). Specifically, the Supply System was to provide analysis of the NRC Sample Problem which has been required to be performed by all BWR owners as part of demonstration of their ability to perform safety transient analysis using RETRAN by comparison of results against the GE and BNL analyses.

Toward these objectives, the Supply System presented descriptions of computer codes and analysis techniques used in the reload analysis.

2.0 Assessment

2.1 Outstanding Issues from Review of WPPSS-FTS-129

In the SER for WPPSS-FTS-129, on which the methodology described in WPPSS-FTS-131 is based, a certain set of conditions/restrictions were cited which the Supply System addressed during this review. These are:

1. To demonstrate that use of the algebraic slip model in the WNP-2 plant model provides adequate assurances of conservative results in licensing analysis.

2. To discuss and justify the use of the jet pump model with flow reversal, to be provided in the context of existence of a core safety limit margin.

3. To submit (i) statistical analysis; (ii) justification of its licensing conditions and safety margins; and (iii) comparative analysis of the standard NRC problem (a Turbine Trip Without Bypass (TTWOBP) transient).

4. To address the mixed core effect in the review as part of the reload methodology.

2.1.1 Use of the Algebraic Slip Model

The Supply System stated that it elected not to qualify the algebraic slip model as required by the RETRAN SER but rather to qualify, as adequate for licensing analysis, the overall plant model which includes the algebraic model. This was accomplished through benchmark analysis against a limited set of test data and some vendor's analysis results. On that basis, the Supply System was able to obtain reasonably conservative predictions. It should be emphasized, however, that the use of the algebraic model in general has not been qualified and that in the event that the Supply System changes transient assumptions, input or plant models, the licensee is required to qualify either (1) the use of the algebraic model for WNP-2 generic licensing analysis or (2) the use of the modified plant model including the algebraic model, demonstrating results to be conservative.

2.1.2 Jet Pump Model

The Supply System stated in References 2 and 3 that the events in which reverse jet pump flow is expected are mild and do not result in limiting operating conditions with respect to either the MCPR or other plant operating condition.

As a whole plant model, the Supply System was able to obtain reasonable plant parameter predictions in spite of reverse flow prediction. Therefore, we recommend that the use of the jet pump model in the reverse flow regime is acceptable for transient analysis provided that the core operating limits remain insensitive to the prediction of reverse jet flow pump flow.

2.1.3 Other Aspect of Licensing Analysis Methodology

In the WPPSS-FTS-129 SER, it was recommended that the licensee submit for NRC review (i) statistical analysis; (ii) justification of its licensing conditions and safety margins; and (iii) comparative analysis of the standard NRC problem (a Turbine Trip Without Bypass (TTWOBP) transient).

2.1.3.1 Statistical Uncertainty Analysis

The Supply System provided a description of its Statistical Combination Uncertainty Analysis (SCU) and the review findings are presented in Section 2.4 of this report.

2.1.3.2 Justification of Licensing Conditions and Safety Margins

The Supply System provided justification of its licensing conditions and safety margins through comparison against the vendor's analysis to show that the WNP-2 analysis using RETRAN is as or more conservative than those analyzed by the vendor. More details and review findings are presented in Section 2.2 of this report.

2.1.3.3 Analysis of Standard NRC Problem

All BWR licensees have been required to submit a comparative analysis of the standard NRC problem (a Turbine Trip Without Bypass (TTWOBP) transient at Peach Bottom Atomic Power Station Unit 2) to demonstrate their ability to perform transient analysis and by comparison of their analysis to the results obtained by General Electric Company using ODYN and Brookhaven National Laboratory using RELAP-3B with BNL-TWIGL as documented in EPRI NP-564 (Ref. 8) and BNL-NUREG-26684 (Ref. 9), respectively.

The Supply System provided results of comparative analysis which showed that its RETRAN model was able to predict the global trends of the transient. Since the computer codes used by other organizations are different, this is all that can be expected.

2.1.4 Mixed Core Effects

The WNP-2 core contains fuels of different geometrical configurations which are manufactured by different vendors. Therefore, during this review, the Supply System was asked to address the mixed core effect in the licensing analysis.

The methodologies for the systems transient and core thermal hydraulic analysis remain unchanged. The input to these computer codes will change due to the type of fuel in the core. The changes for RETRAN, SIMULATE-E and VIPRE-01 input are presented in References 2 and 3 for transient reload analysis and MCPR analysis.

2.2 Computer Codes, Analysis Techniques, Design and Safety Analysis Approaches

For physics related analysis, the Supply System uses SIMULATE-E, CASMO-2E, MICBURN-E and ESCORE. Delta CPR is computed by TLIM if SIMULATE-E is used to generate core conditions and by VIPRE-01 if RETRAN is used for transient results.

Transient events which must be analyzed at reload were identified and summarized in Table 5.2-1 of the topical report.

As part of the event analysis procedures, sensitivity studies will be performed to address transient dependant uncertainties.

2.3 Generation of Kinetics Data

Generation of kinetics data for use in RETRAN is carried out using a standard series of codes (SIMULATE-E, SIMTRAN-E, STRODE, CASMO-2E, NORGE-B) all of which were developed under sponsorship of the Electric Power Research Institute. Details of these code applications were not reviewed, as it was outside the scope of this review. However, based upon the descriptions provided in the submitted materials, use of these code for the stated applications appear to be reasonable. Qualification of the Supply System's core physics methodology is documented in its topical report WPPSS-FTS-127. The Supply System demonstrated adequacy of its core physics methodology through benchmark against measured results documented in WPPSS-FTS-129 and benchmark analysis against a limited set of vendor analysis.

2.4 Gap Conductance

The fuel-cladding gap conductance is computed by the vendor using an NRC approved methodology.

2.5 Hot Channel Methodology

The hot channel methodology utilized by the Supply System for WNP-2 is based on the use of the VIPRE-01 computer code with the ANFB critical power correlation for delta-CPR calculations.

The ANFB correlation has been reviewed and approved by the NRC with restrictions (Ref. 5). The Supply System stated in References 2 and 3 that the manner in which the correlation is used does not violate the restrictions cited in the ANFB SER.

Description of the WNP-2 VIPRE model and selections of VIPRE internal thermal-hydraulic models are provided in References 2 and 3. The Supply System provided results from benchmark analysis against transient CHF tests and comparisons to reload analysis performed using XCOBRA-T by Siemens Power Corporation (SPC).

Benchmark of the VIPRE model against the CHF test data resulted in reasonable agreement with measured data. Comparisons to SPC reload analysis results produced favorable agreement, with VIPRE-01 being slightly more conservative than XCOBRA-T. The WNP-2 VIPRE model included the use of the Drift Flux Model. The Supply System elected not to directly qualify the model for the WNP-2 application but rather as part of the WNP-2 model in combination with other correlations and models. This is adequate as long as the transient assumptions, input and scenarios remain unchanged.

2.6 Statistical Combination of Uncertainties Methodology Application

Statistical uncertainty methodology was developed to statistically combine uncertainties associated with certain parameters and phenomenological factors which affect the outcome of calculations of the delta-CPR. The objective was to reduce the excess conservatism built into the traditional deterministic approach. In the safety analysis, the SCU methodology is applied to compute the operating limit minimum core power ratio (MCPR).

In order to eliminate the use of limiting conditions as initial conditions in performance of transient events, the Supply System developed the SCU methodology using scram time as the only independent variable in the development of the response surface (RS). Five different scram times were used for each fuel type in determination of the RS coefficients. Over 4800 measurements of scram times were gathered for statistical basis. These times were used in computing sensitivity of delta-CPR to scram time.

Uncertainties of other model parameters were tabulated and sensitivities were added by means of the square root of the sum of the squares and incorporated by convolution of the response surface and the model uncertainties. The resulting probability distribution was used to establish the core operating limit MCPR.

The ranges of uncertainties assumed in the statistical analysis are chosen to ensure that they generally bound the uncertainty ranges expected in the WNP-2 plant. Detailed description and justification of selection criteria is provided in Reference 2.

The Supply System used the technical specification scram time in generation of model uncertainties. Thus when the SCU methodology is applied, delta-CPR would always be less than the base value.

The Supply System intends to use the SCU methodology for the limiting system transient event. For the Cycle 8 analysis presented in the Topical Report, the limiting transient is Generator Load Rejection without Bypass and this is the event for which SCU methodology is used. As the Supply System stated, the SCU methodology is applicable to the other potential limiting pressurization transients and the overall model uncertainties are applicable to other potentially limiting pressurization transients, provided that the ranges of uncertainties used remain bounding. Similarly, so long as no additional uncertainties are introduced by a particular mixed core configuration, the model uncertainty and SCU analysis presented during this review will be applicable to the mixed core configuration in WNP-2.

The Supply System, stated in Reference 2, will evaluate future plant and fuel design changes and their impact on the applicability of the overall model uncertainty. If a determination is made that the impacts are not negligible, revised analysis of the model uncertainty will be performed and the resulting values will be used in the calculation of the operating limit MCPR.

2.7 Reload Analysis

The Supply System presented procedures of identifying the limiting scenarios, necessary sensitivity studies and methods of event consequence evaluation for each of the transient analysis which will be performed at reload. Typical results were compared with those of ANF's using the comparable cases to demonstrate the conservative nature of the Supply System's methodology.

The following thirteen transient events are either considered or analyzed at reload. The Supply System described procedures to identify limiting scenarios, relevant sensitivity studies and limiting assumptions in order to meet analysis objectives.

(1) Loss of Feedwater Heating Event
(2) Generator Load Rejection without Bypass
(3) Control Rod Withdrawal Error
(4) Feedwater Controller Failure - Maximum Demand
(5) Recirculation Flow Controller Failure

(6) Control Rod Drop Accident
(7) Loss of Coolant Accident
(8) Fuel Loading Error - Mislocated Fuel Assembly
(9) Fuel Loading Error - Rotated Fuel Assembly
(10) Shutdown Margin
(11) Standby Liquid Control System Capability
(12) Code Overpressure Protection Analysis (MSIVC)
(13) Stability

The stability event is normally analyzed using the fuel vendor's NRC approved analysis methods. However with each reload this is not analyzed since protection is provided through the power/flow operating map in the Technical Specification. The Supply System stated that for LOCA analysis it will use the fuel supplier's approved LOCA methodology.

RETRAN-02 is used for only three of eleven remaining transient events. These events are (i) Generator Load Rejection without Bypass, (ii) Code Overpressure Protection Analysis and (iii) Feedwater Controller Failure at Maximum Demand. VIPRE-01 is used for Recirculation Flow Controller Failure. For the remaining seven transients, the Supply System stated that the progression of the transient is slow enough that a steady-state or quasi-steady-state assumption is adequate enough for analysis. The Supply System further stated that this approach to transient analysis is consistent with the vendor's approved analysis approach. Therefore either SIMULATE-E and/or CASMO-2E are used for analysis. Transient consideration was included in the sensitivity studies for these cases to assure that the steady-state assumption is adequate.

As discussed in Section 2.6, the Supply System intends to use the SCU method for analysis of Generator Load Rejection without Bypass with respect to scram time as an independent variable.

2.7.1 Water Level Prediction

A licensee developed RETRAN control block is used to compute the water level in the core. For the feedwater control failure event, a water level trip actuates scram. The Supply System model computes the collapsed water level in the core. This methodology was benchmarked, in WPPSS-FTS-129, against a set of test data. In that benchmark analysis, the Supply System showed that the computed level was conservative, however, the variation in the water level in the test was too small to be applicable for the Feedwater Control Failure analysis in which the system is expected to experience significant changes in water levels.

In support of its model, the Supply System compared the transient analysis results with those of the vendor's. In the comparative analysis, the Supply System's results were more conservative than those obtained by the vendor. However, the conservative nature of the transient results was largely due to a change in feedwater flowrate modeling. Therefore, the Supply System has not adequately demonstrated that its method of computing the water level in the core is conservative. Nevertheless, if used in the combination with the modified feedwater flowrate the submitted RETRAN plant model is a package

results in conservative predictions. Should any transient assumptions, input or thermal/hydraulic models be changed, the Supply System must demonstrate that the as modified plant model still yields conservative transient predictions.

2.7.2 RETRAN transient analysis

System response calculations for the three primary transients (i) Load Rejection without Bypass (LRNB), (ii) Feedwater Controller Failure (FWCF) and (iii) Main Steam Isolation Valves Closure (MSIVC) were provided in Reference 2. The calculated results were compared reasonably to the vendor's results.

LRNB

The RETRAN/VIPRE predictions were compared to SPC's predictions for WNP-2 Cycle 8. The differences were attributed to the combined effects of modeling difference in the separator and upper downcomer region and the equilibrium assumptions. The Supply System's calculated RCPRs are consistently more conservative than those of the vendor.

FWCF

In addition to the above mentioned differences in the modeling, for this transient analysis, the Supply System modified the feedwater flow and feedwater pump trip assumptions.

The water level trip is relied upon in this transient analysis. The governing case for the FWCF transient is computed at full power. For this case, the water level predicted by RETRAN matched that by the vendor's prediction and the delta-CPRs computed by the Supply System for both 8x8 and 9x9 fuel types were more conservative than those obtained by the vendor.

However, for the lower power case , the RETRAN predicted water level was higher at the point of turbine trip and similarly, the delta-CPR predictions were slightly less conservative. The Supply System stated the lower power case is not the limiting case.

MSIVC

More conservative predictions in peak neutron flux, peak heat flux and peak reactor vessel pressure were obtained at earlier times in the transient using RETRAN. The Supply System stated that the differences in the timing of the peaks and in the height of the peaks is due to the use of the more limiting MSIV closure characteristics by the licensee.

3.0 CONCLUSION

The Supply System's topical report "Applications Topical Report for BWR Design and Analysis," WPPSS-FTS-131, Rev. 1 dated December 1992 and supplemental information provided by the Supply System in support of its submittal were reviewed. Review was also performed to assure that the limitations and restrictions cited in the WPPSS-FTS-129 SER are adequately addressed.

We have reviewed the Supply System reload type licensing analysis for WNP-2 using its RETRAN base plant model. Our review focus was upon its adequacy for licensing type applications. Since the licensee chose not to qualify certain individual thermal/hydraulic model, our evaluation is based upon the performance of the base model as a package for licensing applications. Therefore review findings are restricted to the base plant model and not the individual models. If the individual models are to be used for any other application, the licensee must provide their qualification as required in the WPPSS-FTS-129 SER and RETRAN SER.

We find that the licensee has adequately demonstrated reasonably conservative nature of its WNP-2 RETRAN plant model using RETRAN-02 subject to the limitations and restrictions described below:

1. The base plant model is to be used for analysis of WNP-2 only;

2. The use of the jet pump model is reasonable as part of the base model, although the model in the reverse flow regime was not qualified. The licensee must qualify its adequacy for each case in which reverse flow is predicted if the transient challenges the core operating limits.

3. The algebraic slip model was not qualified. However, the plant model including the algebraic slip model was demonstrated to yield conservative results when compared against the vendor's analysis. This does not mean that the algebraic slip model is qualified since the conservative nature of the RETRAN transient predictions is largely due to difference in transient assumptions. Nevertheless, as long as the Supply System uses the base model unchanged, it is recommended that the licensee be allowed to use the algebraic model in licensing type applications. However, if any changes are made in transient assumptions, input, models or application, the model must be re-qualified.

4. The mixture level prediction in the WNP-2 analysis is calculated through the use of RETRAN control block. The Supply System formulated an algorithm by which it estimates, based upon the liquid mass in the core where the mixture level would be. The algorithm was not qualified for use in any transient in which a large variation (more than 10%) in the mixture level is expected. The mixture level trip is relied upon in only one event, the Feedwater Controller Failure event. In this instance, the change in the feedwater flowrate assumption resulted in more conservative predictions of the system parameters when compared with the vendor's results. Therefore, its use is reasonable only in this transient scenario. If any of the transient assumptions, input or models are to be changed in the future, the licensee must provide further qualification of the model and justification of planned changes.

5. The Supply System developed SCU methodology is used in the analysis of generator load rejection without bypass event with respect to scram time as an independent variable. This was justified by a large database of measurements for scram times. Therefore the approval recommended is for use with scram time only. Should the Supply System wish to extend this methodology to other plant parameter, it must submit a separate topical report with description and documentation of database.

6. Finally, although we recommend approval of the WNP-2 RETRAN plant model for use, with the aforesaid restrictions, in licensing applications by the Supply System; the licensee remains subject to the restrictions and limitations of all other governing SERs of relevant computer codes and models.

4.0 REFERENCES

1. "Applications Topical Report for BWR Design and Analysis," WPPSS-FTS-131, Rev. 1, December 1992.

2 Letter from J.V. Parrish (WPPSS) to USNRC, "Nuclear Plant No.2, Operating License NPF-21 Revised Response to Request for Additional Information Regarding Topical Report WPPSS-FTS-131, "Applications Topical Report for BWR Design and Analysis" (TAC Nos. M77048 and 81723), August 12, 1994.

3. Letter from J.V. Parrish (WPPSS) to USNRC, "Nuclear Plant No.2, Operating License NPF-21 Response to Request for Additional Information Regarding Topical Report WPPSS-FTS-131, "Applications Topical Report for BWR Design and Analysis" (TAC Nos. M77048 and 81723), March 14, 1994.

4. "RETRAN-02 - A Program for Transient Thermal-Hydraulic Analysis of Complex Fluid Flow Systems," EPRI NP-1850-CCM-A, Revision 4 (MOD004) and Revision 5 (MOD005.0), Volumes I-III, November 1988.

5. Letter to R. Furia (GPU) from A.C. Thadani (NRC), "Acceptance for Referencing Topical Report EPRI-NP-1850 CCM-A, Revisions 2 and 3 Regarding RETRAN02/MOD003 and MOD004," October 19, 1988.

6. "BWR Transient Analysis Model," WPPSS-FTS-129, Rev. 1, September 1990.

7. Letter from R.C. Jones (USNRC) to T.R. Quay (WPPSS), "Safety Evaluation - Washington Public Power Supply System Topical Report, WPPSS-FTS-129 (Rev. 01), BWR Transient Analysis Model (TAC NO. M77048)," March 27, 1993.

8. "Transient and Stability Tests at Peach Bottom Atomic Power Station Unit 2 at End of Cycle 2", EPRI NP-564, June 1978.

9. "Analysis of Licensing Basis Transients for a BWR/4" BNL-NUREG-26684, September 1979.