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TECHNICAL EVALUATION REPORT: "BWR TRANSIENT ANALYSIS MODEL" WPPSS-FTS-129, REV.1 FOR WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-2

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Technical Evaluation:
"BWR Transient Analysis Model"
WPPSS-FTS-129 Rev.1
Washington Public Power Supply System WNP-2

1.0 INTRODUCTION

In the topical report, WPPSS-FTS-129 (Rev. 01) entitled "BWR Transient Analysis Model," (Ref. 1), Washington Public Power Supply System (the Supply System) submitted descriptions and qualification of its RETRAN-02 based plant model for its WNP-2 plant as a best-estimate, general purpose and system analysis tool.

Toward these objectives, Supply System presented in the topical report and its supplemental materials (Refs. 2, 3, 4), RETRAN-02 analyses of WNP-2 Power Ascension Tests, Peach Bottom 2 Cycle 2 Turbine Trip Tests to benchmark control system and component performance and responses, and selected WNP-2 licensing basis analyses. However, the NRC specified "standard" problem (which is a Turbine Trip Without Bypass (TTWOBP) transient), which the NRC has required BWR licensees to analyze and compare against analysis performed by General Electric (GE) using ODYN and Brookhaven National Laboratory (BNL) using RELAP-3B with BNL-TWIDL, was not part of this topical report and is to be reviewed with the Supply System Applications Topical Report (Ref. 5). Similarly neither a statistical uncertainty analysis to determine the minimum core power ratio (MCPR) nor any discussion of conservatism was contained in this subject topical. These are also intended to be presented in the separate applications topical report.

This review, therefore, evaluated the licensee's analyses performed with the Supply System's version of the RETRAN-02/MOD005.0 computer code (Refs. 2, 6) for eventual use in licensing analysis.

2.0 SUMMARY

The topical report contains the descriptions of the models and procedures used by the Supply System to perform safety analysis using the RETRAN-02 computer code. WNP-2 Power Ascension tests results and Peach Bottom Unit 2 Cycle 2 Turbine Trip Tests data were used for qualification (in a best-estimate sense) of the RETRAN-02 plant model developed by the Supply System. The Supply System also provided a method by which the best-estimate plant model is to be converted, by the introduction of conservatism in the input, for licensing type analyses. A limited discussion of two reload type analyses was presented.

The Supply System used the mini-computer version (IBM RISC6000) which is a modified version of officially approved version of RETRAN-02 instead of the mainframe version of RETRAN-02. Since this version contains coding changes, the Supply System submitted, with the topical report, results from the qualification runs to show acceptability of the use of the mini-computer version of the code in licensing applications.

Thus, the topical report was reviewed with respect to the acceptability of the use of the RISC6000 version of RETRAN-02 and of the use, for reload safety analysis, of the Supply System developed WNP-2 plant model.

3.0 EVALUATION

3.1 Supply System Versions of RETRAN-02

The Supply System used two versions of the NRC approved RETRAN computer code: a mainframe based RETRAN-02/MOD004 and the mini-computer based RETRAN-02/MOD005.0 version. Both of these versions, when installed on a mainframe, have been approved by the NRC with qualifications (Ref. 6).

The RETRAN-02/MOD004 computer code was compiled and maintained by the Power Computing Co. at Dallas, Texas for the Electric Power Research Institute (EPRI) which funded the development of the code. The version used in preparation of this topical report and supplemental materials, designated MOD4BIG in most of the submittal, differed from the officially released version of MOD004 only in its slightly larger computer core memory; therefore it can reasonably be expected that the differences will not affect the performance of the code for transient analysis.

The Supply System also used RETRAN MOD5UEM, a version installed on a DOS-based PC with a UNIX-based workstation. Descriptions related to this version and its qualification were provided in References 3 and 4. A major difference between this version and the mainframe version is that FORTRAN-77 subroutines replaced the environmental library, making this version more machine-independent. Qualification of the code and results of comparative analyses using the mainframe and mini-computer versions were provided and reviewed.

Ten sample problems in the standard RETRAN-02 distribution package were rerun using the MOD5UEM version on the IBM RISC6000 (R6000) workstation for comparison with those run using the MOD005.0 mainframe version. These sample problems are provided in a RETRAN-02 package to assure proper installation of the code at a code licensee computer and not necessarily to check performance of individual subroutines or particular code models.

A selection of certain key parameters for each problem was suggested by the code developer for result comparison to ascertain the degree of accuracy in the code performance and predictions. In six of the ten sample problems which are considered to be simple (Nos. 1-4, 7 & 8) there were no differences predicted in the parameters when compared to six significant figures. In the more complex sample problems (Nos. 5 and 6) and the remaining problems which are more typical cases for analysis (No. 9 - turbine trip without bypass with space-time kinetics and No. 10 - PWR ATWS), only negligeable differences were detected (Ref. 5).

In addition to the standard sample problems, the Supply System analyzed the most limiting transient identified in the topical report, the WNP-2 Licensing Basis Model Load Rejection without Bypass, to further verify the MOD5UEM

(R6000) version. In order to isolate the source of differences for this transient, the Supply System performed additional calculations. The comparison was made with the results obtained using the MOD004 (mainframe) version and MOD5UEM (mainframe) (Refs. 5, 6).

Between MOD5UEM R6000 and MOD004, the largest difference predicted was -0.51% in the total reactivity and 0.27% difference in the normalized core power at 2.0 seconds, the end of the calculation time. However, over the 2 seconds of power history, the deviation in the normalized core power at the time of the peak power prediction, at approximately 1.0 second, was -0.48%. The version MOD5UEM was consistently under-predicting the peak core power when compared with that computed by MOD004, although the magnitude of the differences is small.

Between MOD5UEM R6000 and MOD5UEM, no difference in the normalized core power was observable until 0.8 second into the transient calculation. At 1.0 second, 0.069% (instead of -0.51%) deviation was computed and a difference in the normalized core power of 0.17%, instead of -0.27%, was observed at 2.0 seconds. The MOD5UEM R6000 version was consistently over-predicting the peak core power when compared with that by MOD5UEM, the magnitude of such difference is negligible. Therefore, it was concluded that the cause of these differences reported in Reference 4 was error corrections made to the MOD004 rather than the models added to the code for MOD005.0 or due to the use of the mini-computer version.

We note that no review was conducted of the coding, and the Supply System has certified to the NRC that MOD5UEM R6000 is substantially identical to MOD005.0 except for the "environmental library." Since the test problem produced nearly identical results on both versions, we have reasonable assurances that the modified environmental library is adequate.

Therefore, MOD5UEM R6000 was found to be acceptable for use in licensing analysis in place of the mainframe version.

3.2 Model Description

WNP-2 start-up tests (power ascension tests) were used to benchmark the nodalization, code model options and control systems, and to demonstrate the adequacy of calculational procedures and the WNP-2 base model.

3.2.1 Plant Nodalization

The WNP-2 RETRAN base model was developed as a best-estimate model to represent WNP-2 at a rated operational conditions in a steady state mode.

Base Plant Nodalization

The Supply System developed a base model for WNP-2 containing, among other volumes, 12 hydraulic volumes and 25 neutronic regions in the active core, one seven-volume steam line representing four steam lines, a steam separator and a non-equilibrium volume representing the upper downcomer. The algebraic slip option and subcooled void model with one-dimensional or point kinetics options were selected in the core volumes. A non-equilibrium pressurizer model simulated the upper downcomer region where a steam-water interface exists. The base model also contains two separate recirculation loops; each containing volumes representing the recirculation pump, loop piping and jet pumps. The centrifugal pump model was used in the recirculation pump volumes, and the characteristics of the jet pump model selected were based upon vendor's data. Safety valves were modeled as banks of valves, each bank representing a multiple of valves at a common setpoint using the Moody critical flow option. Contraction coefficients of the relief valve junctions are adjusted to yield the rated flow at the reference pressure.

Vessel Nodalization

Core

The Supply System's nodalization of the reactor core is comparable to some of the BWR core nodalizations used by other licensees. The Supply System performed a sensitivity study to assess the impact of finer nodalization on the predicted results. The study indicated for the transient analyzed (Power Ascension Test 027 simulating the load rejection) both nodalizations predicted virtually the same power level. On that basis we find the core nodalization acceptable for best estimate analyses; however, it is recommended that the licensee retain the option to use finer core noding for cases where fine structures of core parameters are necessary.

Two nodalizations (12 and 24 nodes in the active core) studied using the PAT 027 test (Generator Load Rejection with Bypass) showed that the nodalization was converged; however, not to the plant data when selected systems parameters were compared. The power comparison showed, not surprisingly since it was mostly decay power, good agreement. The reference case for some flow related parameters, which was initialized to rated conditions which are higher than the actual plant conditions, agreed with plant transient data better than a case initialized to actual plant conditions. This indicates that the best-estimate nodalization is not able to track the plant data well. Therefore care needs to be taken when performing licensing type calculations to assure conservative predictions. The Supply System should identify the transients for which tracking of the voids in the core and reactivity are important and justify the use of the coarse nodalization for those cases.

Kinetics Option

The Supply System stated that generation and qualification of the 1-D kinetics input will be described in detail in the Applications Topical Report (Ref. 4). Selection of one or the other kinetics option depends upon a given transient. Point kinetics is used for analysis in which little change in the axial power shape is expected during the transient. For transients in which simulation of effects from control rod movements and reactivity feedback from the void collapse is important, the 1-D kinetics option is used.

Separator Model

In the separator volume the bubble rise model was selected for a mechanism to represent the functioning of the 225 individual steam separators.

The Supply System stated that the pressure drop distribution at the rated operating conditions agreed well with the vendor's calculation. The vendor's data were used to determine the separator inertia, while the separator inlet and exit loss coefficients were determined by RETRAN during the steady state initialization.

The Supply System's use of the bubble rise model permitting the carryunder fraction of 0.0037 at steady-state to compare well with the nominal value at full power and flow conditions, and (according to the Supply System) this value is consistent with that used by the vendor.

Use of Non-Equilibrium Pressurizer in Downcomer Region

The Supply System's nodalization of the downcomer as a three volume representation consists of a single volume for each of upper, middle and lower downcomer regions and is consistent with the need for non-equilibrium modeling in the two-phase region in the upper downcomer and equilibrium modeling in the lower downcomer regions. This approach is consistent with the approach generally used by the industry, and we find this nodalization acceptable.

The Supply System's use of the non-equilibrium model in the upper downcomer region is acceptable since the use of non-equilibrium modeling is necessary in that region to represent the steam flowing in from the separator and the cooler liquid present in the lower portion of that volume. However, as restricted in the RETRAN-02 SER (Ref. 7), the licensee should provide additional justification for conditions with single-phase fluid in the upper downcomer, if such conditions occur.

The Supply System provided results from a sensitivity study using the Peach Bottom TT1 test. In one calculation, thermodynamic equilibrium between phases was assumed for the upper downcomer control volume, while the other calculation used a non-equilibrium model for the same volume. When the steam dome pressure and core neutron power were compared with the data, the use of non-equilibrium modeling resulted in better agreement and was more conservative and is therefore acceptable.

Jet Pump Model

Use of the jet pump model is restricted by the RETRAN-02 SER to the normal quadrant of forward flows, although, in the Supply System's analysis of the one pump trip test (PAT 30A), a reverse flow was computed to occur. The fact that the plant data also indicated negative flow does not qualify the use of the model in that regime. The licensee is required by the RETRAN-02 SER (Ref. 7) to provide justification of its use for flow prediction in transients for which a negative flow is expected, quantify and justify its impact on the predicted transient MCPR and the determination of conservative plant operating limits. We, therefore, recommend that this be checked during the review of the Applications Topical Report.

3.2.2 Control Systems

Control systems developed by the Supply System are: the feedwater control system, pressure control system, recirculation flow control system, and the direct bypass heating system. Some of these control systems perform multiple functions. A water level control system and a feedwater flow delivery system are part of the feedwater control system. Similarly, the pressure control system consists of a reactor pressure regulation system, a turbine control valve system and a steam bypass valve system.

Qualification of these control systems was presented in the topical report using start-up test data, and is discussed in detail in Section 3.3 of this evaluation report.

3.3 Model Qualification

The base model described in the previous sections was compared to test data for four sets of WNP-Power Ascension Tests. In addition, the Supply System submitted results from the Peach Bottom Turbine Trip Tests.

3.3.1 WNP-2 Power Ascension Tests

The Supply System selected four series of start-up tests to qualify the base RETRAN plant model: water level setpoint change, pressure regulator setpoint change, one recirculation pump trip and generator load rejection with bypass tests.

In the original submittal, the Supply System initiated the base WNP-2 RETRAN model at nominal plant conditions and not at the test conditions. Two test analyses, PAT 30A and 27, were re-initialized, in response to an NRC request, at the actual test conditions to ascertain bias due to the modeling.

RETRAN analysis of the Pressure Regulator Setpoint Change test (Test PAT 22) was performed to demonstrate adequacy of the pressure control system. Generally, after accounting for a minor difference in initial conditions, RETRAN calculations captured the global trends of measured system parameters presented in the topical report.

The Water Level Setpoint Change (Test PAT 23A) test was selected to qualify the feedwater control system and vessel water level models. A general function table in the RETRAN base model was modified to introduce a step change of the level setpoint. The analysis was performed from nominal conditions instead of the test conditions; however, the differences in water level convergence by the end of the test period were greater than the small difference in the initial conditions. The RETRAN predicted water level equilibrated at 5 inches higher than the initial condition while roughly 8 inches of increase was measured in the test. The Supply System concluded that the results "may indicate an inconsistency between the step change" introduced in the RETRAN analysis and the test. Since the power response is much slower during periods of changing feedwater flow during the test, RETRAN predicted the trend well. The Supply System stated that in the feedwater controller failure event analysis, the prediction of lower water level is more conservative since it would delay tripping of the main turbine resulting in higher peak power peak heat flux. The Supply System should identify the transients for which the feedwater controller is relied upon and faster acting response is necessary, and that information should be examined during the review of the Applications Topical to assure that low prediction of water level is conservative in terms of licensing applications.

In order to verify the pump coastdown characteristics and system response to asymmetric flow conditions, analysis of the One Recirculation Pump Trip (Test PAT 30A) test was performed by tripping one recirculation pump.

The point kinetics and one dimensional kinetics models were used to measure the impact on the transient simulation of the use of one versus the other. Results were very similar (although the 1-D model yielded slightly better results) and showed, as the Supply System concluded, that for a mild transient in which there is little axial reactivity feedback, point kinetics is adequate. Jet pump coastdown was demonstrated to match the measured data well.

The analysis objective of the Generator Load Rejection with Bypass (Test PAT 27) test was to qualify the steam line modeling and overall system modeling to rapid pressurization.

The one dimensional kinetics model was used. The recirculation pump coastdown characteristics did not match well until four seconds into the transient. The Supply System attributed the difference to the pump inertia uncertainty which, based upon this study, lead to inclusion of the bounding value in the licensing basis model. The predicted dome pressures compared well with the data increasing slightly higher than the data at its peak.

3.3.2 Peach Bottom Turbine Trip Tests

To examine the adequacy of the base model under design basis conditions, three pressurization transient tests (TT1, TT2, TT3) conducted at Peach Bottom Unit 2 were analyzed.

Good agreement was obtained for all three tests. Computed pressures compared favorably to the measured pressures at three locations (turbine inlet, upper plenum and steam dome). Where there were minor differences, they differed in the conservative direction which would insert more reactivity. RETRAN predicted power and reactivity matched the measured data well in predicting the timing of the peaks. The magnitude of the peaks were predicted to be either about the same or higher, which is conservative.

3.4 Licensing Basis Analyses

In order to demonstrate the adequacy of the WNP-2 model for licensing analysis, the Supply System presented the results of two most limiting events which are generally required to be reanalyzed with each reload: (1) Load Rejection without Bypass (LRNB) and (2) Feedwater Controller Failure to Maximum Demand (FWCF). These analyses were presented to describe the method by which the Supply System modified the RETRAN models to perform licensing type analyses.

A full spectrum of the reload analysis methodology, sensitivity analysis and the hot channel analysis are provided in a separate applications topical report and review of them is beyond the scope of this review. Similarly, the NRC Standard Problem is to be provided as part of the Supply System Applications Topical (Ref. 5) and therefore was not reviewed. Therefore, more detailed review of the Supply System's licensing analysis methodology will be conducted during the review of Reference 5.

This review is focused, instead, upon adequacy of the modifications of the best-estimate RETRAN WNP-2 model for licensing type analysis to yield conservative results.

3.4.1 Licensing Basis Model Description

A generic model, based upon the Cycle 4 core configuration consisting mostly of the Advanced Nuclear Fuels (ANF) fuels, was used for analyses presented in this section. Therefore, the GE fuel design data used in the best-estimate model were changed to reflect the ANF design data. Inherent in this modeling assumption is that there are no mixed core effects from housing fuels of different geometrical configurations. It is recommended that mixed core effect analysis be addressed during the review of the applications topical report.

The licensing calculations were initialized at power level of 104.36% of the nominal power level using reactivity data reflecting the end of cycle core.

The parameters requiring modifications for the purpose of the licensing calculations, summarized in Table 4.1 in the topical report, were found to be modified in the conservative direction when compared to the nominal values. Since this review covers only the methodology, their accuracy or validity were not reviewed. However, the Supply System stated that conservative equipment design specifications and technical specification limits were used in the RETRAN model input. It is recommended that the adequacy of plant key parameters for analysis be determined during the review of the applications topical report.

3.4.2 Licensing Basis Analyses

To show the similarity of results (and not necessarily to demonstrate analytical accuracy), the Supply System presented comparison of RETRAN results for the Load Rejection Without Bypass (LRNB) transient with the ANF's COTRANSA1 analysis results. Differences were observed between the Supply System and ANF analyses in prediction of dome pressure, core power and core average heat flux. The Supply System attributed these differences to the fact that a higher dome pressure was computed by RETRAN and to the different neutronics data used by two organizations.

The Supply System analyzed the Feedwater Controller Failure to Maximum Demand (FWCF) event (which is considered to be most severe for WNP-2). However, no comparison to the ANF analysis results were provided for this event since different initial power levels were used by two organizations.

These transient analyses and other licensing analyses will be reviewed in depth during review of the Supply System Applications Topical Report.

4.0 CONCLUSIONS

The Supply System's topical report "BWR Transient Analysis Model," and supplemental information provided by the Supply System in support of its submittal were reviewed.

We find that the licensee has adequately qualified its WNP-2 RETRAN base model using RETRAN-02 MOD004 and its mini-computer version of the code, RETRAN MOD5UEM, subject to the limitations and restrictions described below. Differences between the mainframe and mini-computer versions were examined and found to have negligeable impact on the analysis results for the range of qualification analyses provided. Therefore, use of RETRAN MOD5UEM (R6000) was found to be acceptable for licensing, subject to the same conditions delineated in all relevant SERs on the RETRAN computer code and its various versions.

We have reviewed the Supply System base model and the special purpose models used therein, and we conclude that the Supply System's nodalization and use of non-equilibrium and separator models in its base model is acceptable. The base model which includes the algebraic slip model as a best-estimate analysis tool is acceptable. However, this does not imply that the algebraic slip model is qualified for use by the Supply System for WNP-2 in licensing analysis. Notwithstanding a requirement regarding the slip model contained in the RETRAN-02 SER, we recommend that its reviews be done in context of licensing analysis; i.e., the licensee should be required to demonstrate that use of the algebraic slip model provides adequate assurances of conservative results. Therefore, adequacy of its use should be reviewed during the review of the Application Topical Report.

We recommend, further, that before any licensing analysis is accepted, the licensee 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).

In addition, detailed discussion and justification of the use of the jet pump model with flow reversal should be provided in the context of existence of a core safety limit margin. Its acceptability in licensing applications has not been assessed and should be performed during the later review.

Finally, in addition to the foregoing, since the WNP-2 core contains fuels of different geometrical configurations and manufactured by different vendors, it is recommended that the mixed core effect analysis be reviewed as part of the reload methodology during the review of the applications topical report.

5.0 REFERENCES

1. "BWR Transient Analysis Model," WPPSS-FTS-129 (Rev. 01), September 1990.
2. Letter from G.C. Sorensen (WPPSS) to USNRC, "Response to Request for Additional Information Regarding Topical Report WPPSS FTS-129, "BWR Transient Analysis Model" (TAC No. 77048)," July, 15, 1991.
3. Letter from G.C. Sorensen (WPPSS) to USNRC, "Response to Second Request for Additional Information Regarding Topical Report WPPSS FTS-129, "BWR Transient Analysis Model" (TAC No. 77048)," March 5, 1992.
4. Letter from G.C. Sorensen (WPPSS) to USNRC, "Supplement to Response to Second Request for Additional Information Regarding Topical Report WPPSS FTS-129, "BWR Transient Analysis Model" (TAC No. 77048)," September 11, 1992.
5. "Applications Topical Report for BWR Design and Analysis," WPPSS-FTS-131, September 1991.
6. "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.
7. 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.

Enclosure 2

Attachment

1. Computer Codes

Q.1 Generic use of VIPRE-01 for BWR applications was approved with restrictions. As was done for PWR applications of VIPRE, the SER requires each user to submit to the NRC for review and approve a report documenting and qualifying its use with full detailed description. Therefore, the Supply System must submit a separate topical report (or detailed write-up) documenting its intended use of the code and model qualifications to meet the requirements of the VIPRE SER. Use of CHF correlations other than GEXL must be separately submitted for review and approval (which was done and will be under review) describing use for WNP-2 analysis. Demonstration of their applicability for analysis of mixed cores must also be addressed.

Q.2 Besides VIPRE and RETRAN, WPPSS uses EPRI developed linked physics codes (CASMO-2E, NORGE-B, SIMULATE-E, SIMTRAN and STRODE) and a set of special purpose codes (ESCORE, FICE, RODDK, TLIM, CALTIP, RBLOCK, and STARS). Since these codes are being used in licensing applications, please identify which of these codes have been reviewed and approved by the NRC and describe ANY local adaptations/modifications (regardless of their impact) implemented in the released versions of these codes. Provide detailed discussion of the impact of changes on the analytical prediction.

Q.3 Provide a thorough description of the STARS computer code used in connection with the Statistical Core Uncertainty (SCU) methodology.

2. Statistical Uncertainty Analysis

Q.4 Please identify the transients for which the statistical uncertainty methodology will be used. In addition, please provide the following: (1) identification of the range of parameters used in the model development (not just for the generator load rejection event), (2) justification that the applicable ranges encompass the conditions expected to be encountered in all relevant transient analyses and (3) justification of the uncertainty distribution function assumed for each.

Q.5 Provide ar NRC approved reference to support the position that no more that four parameters are necessary for development of a response surface.

Q.6 For the parameters which are not directly measurable (there are the parameters which are analytically determined (therefore code dependant) such as the nuclear parameters), describe the method by which the "nominal" values are determined and justify the uncertainty ranges considered.

Q.7 Since the overall uncertainty due to the individual model and input uncertainties was determined by taking the square root of the sum of the squares of the ΔCPR, their statistically independence is inherently assumed. This assumption is justifiable only if coefficients were determined by perturbation analysis. Explain in depth and justify the methodology for determination of those coefficients.

Q.8 Explain in depth and provide thorough justification for the statement that "the contribution of drift flux parameter uncertainty to overall model uncertainty is small (p.A-4)." Provide references for the NRC recommended values for parameters.

Q.9 One key parameter missing from parameters considered in the SCU method is an uncertainty associated with the use of the RETRAN code. Considering difficulties experienced with plant data benchmark calculations, justify not including this factor in the overall uncertainty (or include it).

Similarly there is considerable flexibility in the core nodalization used with the VIPRE code. Justify the impact of core nodalization on the overall uncertainty and provide a separate uncertainty associated with it.

Q.10 The Supply System extrapolated the findings obtained by GE for its GESSAR plant using its own code with respect to the degree of sensitivity exhibited by certain parameters to the expected values when RETRAN and VIPRE are used in the similar analyses. Justify in depth the assumption of applicability of GE results to the WNP-2 RETRAN/VIPRE analysis. Discussion should include identification of the similarities and differences of code models used to model relevant components between the codes. If the Supply System is unable to do the foregoing, it must otherwise justify using the same values for the ranges of uncertainties and variations in the analysis and identify biases due to these codes.

Q.11 The Supply System has elected to use algebraic slip for modeling of the phases present in the vessel with RETRAN and it is also using the drift flux model with VIPRE. Neither of these models has been qualified. As per SER on WPPSS-FTS-129, Rev. 1, qualify both of these models for use with WNP-2 analysis. Discussion should include applicability and scalability of qualification provided by the Supply System (based upon the one small scale experiment which it used) to the full-scale plant.

Q.12 Explain how the physics, systems and modeling uncertainties are statistically treated as part of the overall Response Surface Method (RSM).

Q.13 Identify the impact to its hot channel methodology in the mixed core environment.

Q.14 The ANFB critical power correlation developed by Advanced Nuclear Fuels

Corporation (ANF) was implemented in the VIPRE-01 code for the thermal margin evaluation. Thorough justification of use of this correlation in the mixed core environment must also be provided.

3. NRC Specified Licensing Analysis

Q.15 Justify the use of the steam line length of 400 ft in the NRC specified problem as a benchmark analysis. The Supply System acknowledged the significance of this value in the computed results but did not state whether the value used was consistent with that used by GE and BNL or an accurate indication of the real plant data.

4. Reload Analysis

Q.16 Although the Supply System mentioned in the cover letter that some changes were made to incorporate the mixed core effects, no details of such incorporation were given. Please provide a thorough discussion of how these effects are being incorporated in the transient reload analysis, input parameters, MCPR analysis or applicable CPR correlations.

Q.17 Identify and justify any changes to the input (initial conditions, transient assumptions, trip setpoints and delays) for these transient from those assumed in the current FSAR transients.

Q.18 On the basis of DCPR comparison with the vendor's results the Supply System predictions appear to be conservative. However, in order to ensure that the comparison is valid, provide comparative system parameter plots for representative parameters for each transient. Where there are significant differences between the results of those two sets of calculations, provide detailed discussion and explanation of the source(s) of differences.

Q.19 When performing sensitivity studies, the Supply System used a range of values for parameters considered to be important for each transient. Identify the source(s) of the ranges used in such studies.

Q.20 Identify any transients for which system actuation on low reactor water level is relied upon. If there are any, justify the ability of the RETRAN model to compute a conservative water level for this purpose.

Q.21 The Supply System, where applicable, compared its results against those of ANF. Please identify the version of COTRANSA used, and if it is COTRANSA and not COTRANSA1, identify the bias in COTRANSA vs. the plant data.

Q.22 Although the Supply System stated that the ANF approved LOCA methodology is incorporated into the Supply System LOCA methodology, it does not explain how the two methodologies are integrated and used. Provide a detailed discussion of how this is accomplished.

Q.23 Identify any transients for which reverse jet pump flow is predicted.

For those transients qualify the jet pump model in that regime.

Q.24 Describe the "licensing" model for the loss of FW heating event including the power distribution used.

Q.25 Some reload analyses were performed as steady state events using SIMULATE-E, a reactor physics code. The stated justification is based on the fact that these events take place "very slowly" therefore the core remains in a quasi-steady-state condition. Provide and justify determination criteria for slowness of events to be analyzed as steady state. Furthermore, qualify SIMULATE-E for this type of applications and justify not using a T/H code.

Q.26 For the Generator Load Rejection transient, the Supply System reduced a number of independent variables in the response surface equation to one, the control rod scram time. This may be an over-simplification of the response surface method. Justify not considering other variables in the equation.

Q.27 For the Feedwater Controller Failure event, there are dramatic differences between the results presented in Rev. 0 and Rev. 1. Explain thoroughly these differences (shown on Tables 5.3.7-3 and 4 in Rev. 0 and Tables 5.3.7-4 and 5 in Rev. 1), and provide a complete set of plots comparing these two sets of analyses.

Q.28 Although the event limits for the ASME Overpressure Protection Failure event (Table 5.3.13-2) compare well between the Supply System and ANF results, provide and thoroughly explain further the following comparative information: time of these peaks, transient assumptions and comparative figures for key parameters presented in the submittal.