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U.S. Nuclear Regulatory Commission
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Gentlemen:

Re: Response to Request for Additional Information Related to Topical Report NTH-TR-01, RETRAN Model Qualification - St. Lucie Plant Unit Nos. 1 and 2 and Turkey Point Plant Unit Nos. 3 and 4 (TAC Nos. 75082, 75083, 75084 and 75085)

By letter dated September 19, 1990, the Nuclear Regulatory Commission requested additional information concerning Florida Power & Light Company's (FPL) report, NTH-TR-01, "RETRAN Model Qualification - Decrease in Heat Removal by the Secondary System" (J.H. Goldberg to U.S. NRC, dated October 2, 1989, L-89-326). The purpose of this letter is to provide FPL's response to this request for additional information (attached). Please note that FPL's submittal of October 2, 1989, is referred to throughout the attachment as "Reference Submittal".

If additional information is required on this topic, please contact us.

Very truly yours,

W.H. Bohlke
Vice President
Nuclear Engineering and Licensing

WHB/vmg

Attachment

cc: Stewart D. Ebneter, Regional Administrator, Region II, USNRC
Senior Resident Inspector, Turkey Point Plant, USNRC
Senior Resident Inspector, St. Lucie Plant, USNRC

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ANSWER TO GENERAL APPROACH QUESTION # 1

QUESTION: Demonstrate, by steam generator nodalization parametric studies, that the chosen nodalization for each vendor's plant produces conservative results compared to other nodalizations.

1. Introduction

Based on NRC accepted topical reports, referenced published papers, and industry accepted licensing analysis practice, precedence has been established that the single node steam generator secondary side modelling technique produces acceptable licensing transient calculations for the category of licensing transients denoted as "Decrease In Heat Removal by the Secondary System". The notable exception is transients which involve loss of feedwater and an associated reactor scram on steam generator low level signal. These transients require a multinode steam generator secondary side nodalization to adequately predict steam generator water level, inventory, and heat transfer based on first principles. This is illustrated in the overlay plots provided in the Appendix, where the results of the Turkey Point Loss of AC RETRAN licensing analysis with the single and multinode steam generator models, are compared.

2. Single Node Versus Multinode Steam Generator Models

As stated in the Reference Submittal (Chapters 4 and 5), in the Category of Decrease in Heat Removal by the Secondary System Events for the Turkey Point and St. Lucie Units, the only licensing event where a multinode steam generator secondary side model has been necessary, is the Turkey Point Loss of AC transient. The other licensing transients in the category do not involve reactor scram

on low-low steam generator water level and, therefore, can be adequately and efficiently modelled with a single volume steam generator secondary side.

For this Loss of AC transient, it is assumed that main feedwater ends immediately upon loss of AC power and that auxiliary feedwater is not activated until three minutes after reactor scram, consistent with plant Technical Specifications. Reactor scram and reactor coolant pump trip are assumed to occur after the low-low steam generator level trip. These assumptions are made to minimize the steam generator water inventory and heat transfer capability and, hence, to maximize the primary system heatup.

The parameters of concern from a licensing viewpoint in the Loss of AC transient are maximum pressurizer pressure and maximum pressurizer liquid level. As evidenced in Figures 2 and 3 of the Appendix, the transient results from the single node steam generator secondary side model do not predict a limiting peak pressure during the time period up to approximately 700 seconds after the Loss of AC occurs. The multinode steam generator secondary side model does predict the most limiting peak in pressurizer pressure and pressurizer liquid level in the 700 second time frame. This late, limiting peak pressure is in agreement with the vendor calculations for the Loss of AC transient as documented in the Turkey Point FSAR, Figure 14.1.12-1.

Since the RETRAN computer code is based on a homogeneous volume assumption, the single node steam generator secondary side model cannot adequately calculate the steam generator tube bundle region secondary side heat transfer. This is due to recirculation not being modelled and the regional liquid distribution not being accounted for as the steam generator approaches dryout. The multinode steam generator model can account for the regional liquid distribution and heat transfer degradation during this transient.

In the single node steam generator secondary side model, the incoming auxiliary feedwater is homogeneously mixed with the remaining steam generator water and the total water mass is available for removing decay heat from the primary side via the steam generator tube bundle. Once auxiliary feedwater is available, the steam generator secondary side volume has enough heat capacity as a pool boiling volume to remove the decay heat. As shown in the overlay plots, once auxiliary feedwater is initiated at 232 seconds; the primary side is adequately cooled with pressurizer pressure and level steadily decreasing.

In the multinode steam generator secondary side model, recirculation is modelled and the steam generator liquid inventory is distributed through the tube bundle, downcomer,and separator volumes. Only the water within the tube bundle volumes is available for heat transfer from the primary side. As evidenced by the primary system heat up (Figures 2 through 4 in the Appendix), the initial minimum auxiliary feedwater flow provided from a time of 232 seconds until the operator re-aligns auxiliary feedwater at 652 seconds does not provide enough heat capacity in the tube bundle region to completely remove the decay heat. The re-aligned higher auxiliary feedwater flow eventually provides enough heat removal capacity and the primary system heatup is terminated; thereby defining the late and most limiting primary side heatup peak parameters.

3. FPL's Methodology

FPL has reviewed a variety of references concerning steam generator secondary side nodalization studies. These references are listed in Section 4 and, in general, they support the following three conclusions: 1) The single node steam generator secondary side model is the acceptable RETRAN methodology for calculating

licensing transients of the category known as "Decrease in Heat Removal by the Secondary System". 2) The single node steam generator secondary side nodalization cannot adequately model steam generator recirculation and downcomer water level which greatly affects heat transfer in transients involving loss of feedwater. Therefore, the analysis of these type of transients requires a multinode steam generator secondary side model. 3) Any multinode steam generator secondary side nodalization with at least three volumes (tube bundle, downcomer, steam dome) gives a realistic calculation of heat transfer phenomena important to predicting the limiting primary side parameters and that all nodalizations beyond three nodes give basically the same answers. The FPL Turkey Point and St. Lucie multinode steam generator RETRAN models consist of ten nodes and are shown in Figures 1.2-4 and 1.2-5 of the Reference Submittal.

Based on the results shown in the Appendix and the supporting evidence provided by the literature search, FPL's position with respect to the issue of steam generator secondary side nodalization is that the RETRAN multinode steam generator models will be used in licensing analyses, involving loss of secondary heat removal capability that require accurate steam generator level prediction.

4. <u>References Concerning Steam Generator Nodalization</u>

a. SINGLE NODE STEAM GENERATOR SECONDARY SIDE MODEL

a.1 VEP-FRD-41, "Reactor System Transient Analyses Using The RETRAN Computer Code," Virginia Electric and Power Company, March 1981.

a.2 NUSCO 140-1, "NUSCO Thermal Hydraulic Model Qualification, Volume 1, (RETRAN)," Northeast Utilities, August 1984.

a.3 A-85-11A, "RETRAN Computer Code Reactor System Transient Analysis Model Qualification," Baltimore Gas and Electric Company, January 1986, page 13, 167, 212.

a.4 Kinnersly, Stephen R., "Winfrith Experience of RETRAN for PWR Pressurized Transients With Particular Emphasis on ATWS," United Kingdom Atomic Energy Authority, Conference Proceedings: First International RETRAN Conference, EPRI WS-80-150, April 1981, page 11-7.

a.5 Kinnersly, Stephen R., "Assessment of RETRAN for a PWR Loss of 11kV ATWS," United Kingdom Atomic Energy Authority, Proceedings: Third International RETRAN Conference, EPRI NP-3803-SR, February 1985, page 29-13.

a.6 Garrett, Terry J., "The Development and Application of System Analysis at Kansas Gas and Electric Company", Kansas Gas and Electric Company, Proceedings: Fourth International RETRAN Conference, EPRI NP-4558-SR, May 1986, page 7-7.

a.7 Sorrell,S., "RETRAN-02 SGTR Analysis: A Comparison Between A Six Volumed Steam Generator Secondary and a Single Volume Secondary", Kansas Gas and Electric Company, Proceedings: Fourth International RETRAN Conference, EPRI NP-4558-SR, May 1986, page 14-6.

a.8 Riniker, Lance G., and Ramsden, Kevin B., "RETRAN Modeling of the Westinghouse Model D Steam Generator", Commonwealth Edison Company, Proceedings: Fourth International RETRAN Conference, EPRI NP-4558-SR, May 1986, page 16-3.

b. MULTINODE STEAM GENERATOR FOR LOSS OF FEEDWATER ANALYSES

b.1 Naser, J.A., Sehgal, B.R., and Agee, L.J, "Analysis of PWR ATWS Transients With RETRAN-02", Conference Proceedings: First International RETRAN Conference, EPRI WS-80-150, April 1981, page 6-7.

b.2 Bamdad, "Thermal-Hydraulic Analysis of a Steam Generator During Loss of Feedwater Transient," Boston Edison Company, Conference Proceedings: First International RETRAN Conf., EPRI WS-80-150, April 1981, page 14-7.

b.3 Griggs, D.P. and Honan, T.J., "RETRAN Calculation of Loss of Feedwater Transients at Connecticut Yankee," Northeast Utilities Service Company, Conference Proceedings: First International RETRAN Conference, EPRI WS-80-150, April 1981, page 26-10.

b.4 Kinnersly, S., "Winfrith Studies of Severe PWR Pressurized Faults," United Kingdom Atomic Energy Authority, Conference Proceedings: Second International RETRAN Conf., EPRI NP-2494-SR, July 1982, page 7-13.

b.5 Choe,W.G. and Matsui,Y., "RETRAN Analysis of PWR Small Break LOCA," Nippon Energy Incorporated, Conference Proceedings: Second International RETRAN Conference, EPRI NP-2494-SR, July 1982, page 13-2.

b.6 Choe, Layman, and Vine, "Reducing Scram Frequency by Modifying Reactor Setpoints for a Westinghouse 4-Loop Plant", Nuclear Safety Analysis Center, EPRI, Proceedings: Fourth International RETRAN Conference, EPRI NP-4558-SR, May 1986, page 9-15.

b.7 Garrett, Terry J. and Hseu, Jin-Shou, "RETRAN Benchmark Analysis of Wolf Creek Large Load Reduction Test", Wolf Creek Nuclear Operating Corporation, Proceedings: Sixth International RETRAN Conference, EPRI NP-6949, August 1990, page 9-3.

c. MULTINODE STEAM GENERATOR NODALIZATION STUDIES

c.1 Kinnersly, S., "Winfrith Studies of Severe PWR Pressurized Faults," United Kingdom Atomic Energy Authority, Conference Proceedings: Second International RETRAN Conf., EPRI NP-2494-SR, July 1982, page 7-13.

c.2 Ramsden,K.B. and Munshi,P., "Analysis of Steam Generator Transients with RETRAN-02," Commonwealth Edison Company, Conference Proceedings: Second International RETRAN Conference, EPRI NP-2494-SR, July 1982, page 16-3.

c.3 Choe,W.G., Richert,K.D., Chao,J. and Naser,J.A., "RETRAN-02 Loss of Feedwater ATWS Analysis for Combustion Engineering and Westinghouse PWRs," Energy Incorporated and EPRI, Proceedings: Third International RETRAN Conf., EPRI NP-3803-SR, February 1985, page 16-20.

c.4 Jensen,P.J., Richert,K.D., and Chao,J., "A Parametric Study of an Anticipated Transient Without Scram in a Westinghouse Four-Loop Plant", Energy Incorporated and Nuclear Safety Analysis Center, EPRI, Proceedings: Fourth International RETRAN Conference, EPRI NP-4558-SR, May 1986, page 13-10.

c.5 Montgomery,R., Alvis,J., Peddicord,K., Boyer,R., and Albury,C., "Nodalization Study of the Westinghouse Model E Steam Generator Secondary Side", Texas A&M University and Houston Lighting & Power, Proceedings: Fourth International RETRAN Conference, EPRI NP-4558-SR, May 1986, page 15-2.

c.6 Riniker, Lance G., and Ramsden,Kevin B., "RETRAN Modeling of the Westinghouse Model D Steam Generator", Commonwealth Edison Company, Proceedings: Fourth International RETRAN Conference, EPRI NP-4558-SR, May 1986, page 16-3.

c.7 Coen,E.D., "RETRAN Prediction of Test Data at Kewaunee", Wisconsin Public Service Corporation, Proceedings: Sixth International RETRAN Conference, EPRI NP-6949, August 1990, page 32-1.

APPENDIX

COMPARISON OF MULTINODE AND SINGLE-NODE STEAM GENERATOR RESULTS FOR THE TURKEY POINT LOSS OF AC POWER TRANSIENT

The attached plots compare the RETRAN results of the Turkey Point Loss of AC Power Transient with single-node and multinode steam generator models. The multinode steam generator analysis is the one reported in the Reference Submittal (Section 4.2.3.6). The single-node analysis is based on a model in which the initial steam generator inventory has been adjusted to match the time of the low level trip in the multinode analysis. The time of low level trip in the single-node analysis had to be approximated with a vendor provided trip-equivalent steam generator inventory.

The fluctuating responses of both analyses after 200 seconds (Figure 3) has been investigated. They are caused by the cycling of the Main Steam Safety Valves (MSSVs). The opening and closing of these valves produces drastic changes in the steam generator flow, which in turn affect the heat transfer between primary and secondary. Since, in the scenario considered here, primary forced circulation has been lost, the effects of the heat transfer changes in the steam generator tube bundle result in small primary pressure fluctuations. The pressurizer surge line discharge flow varies accordingly, producing the T_{hot} fluctuations in the loop with the pressurizer (Figures 4 and 5). The fluctuations in the multinode response are less pronounced than those in the single-node because the presence of continuous recirculating flow within the steam generator tends to lessen the heat transfer changes produced by the cycling of the MSSVs.

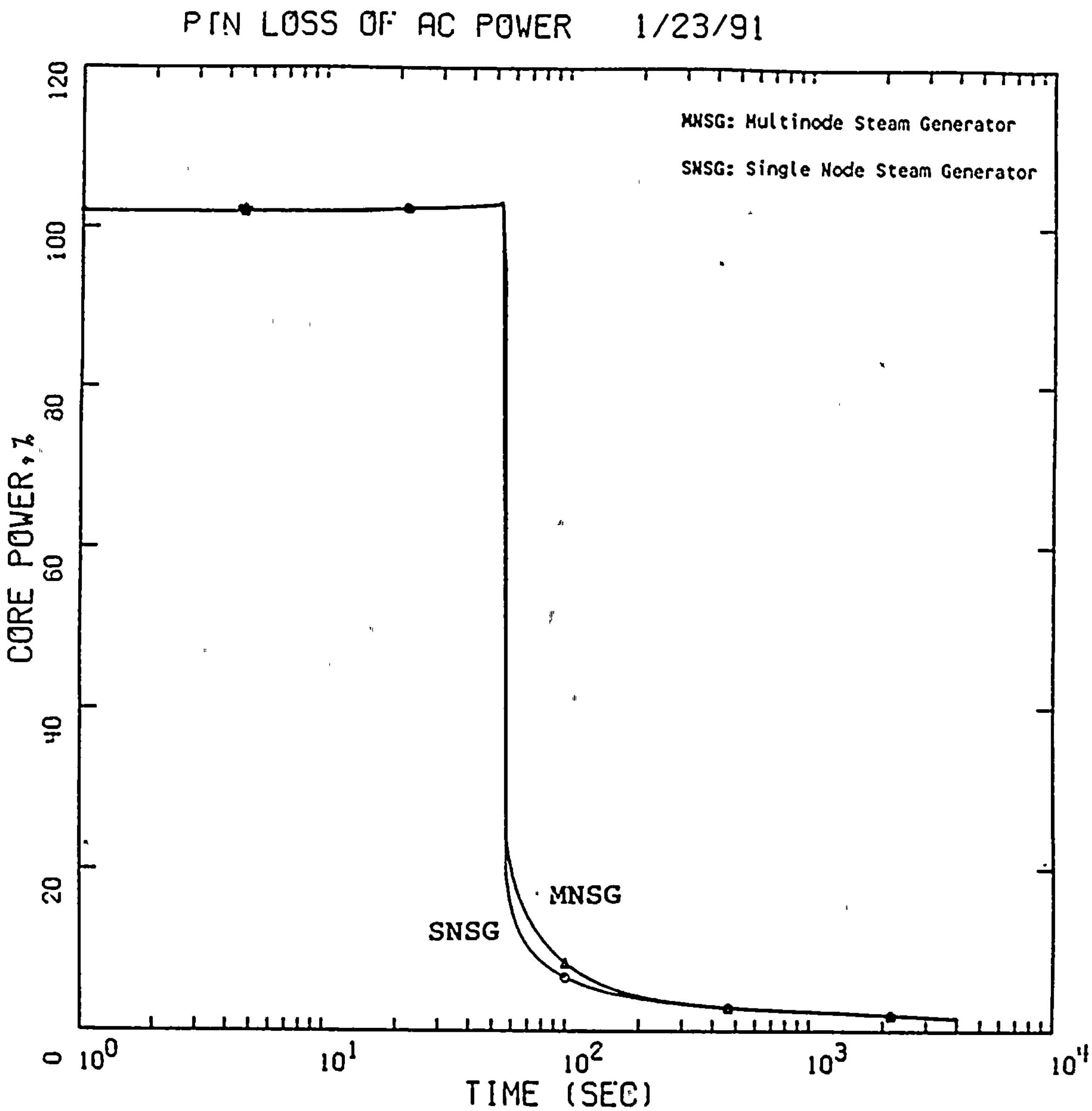

FIGURE 1. CORE POWER

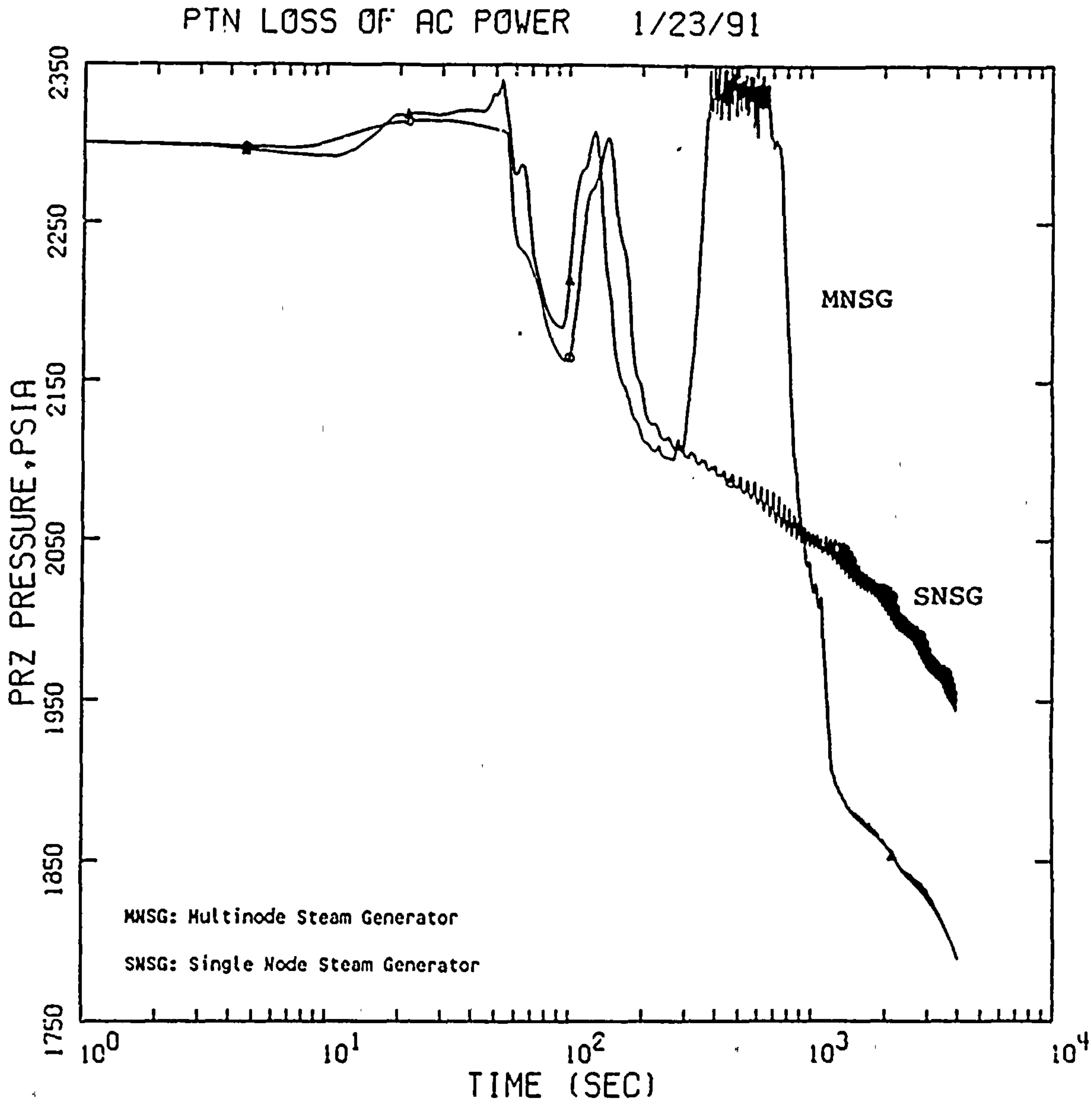

FIGURE 2. PRESSURIZER PRESSURE

PTN LOSS OF AC POWER 1/23/91

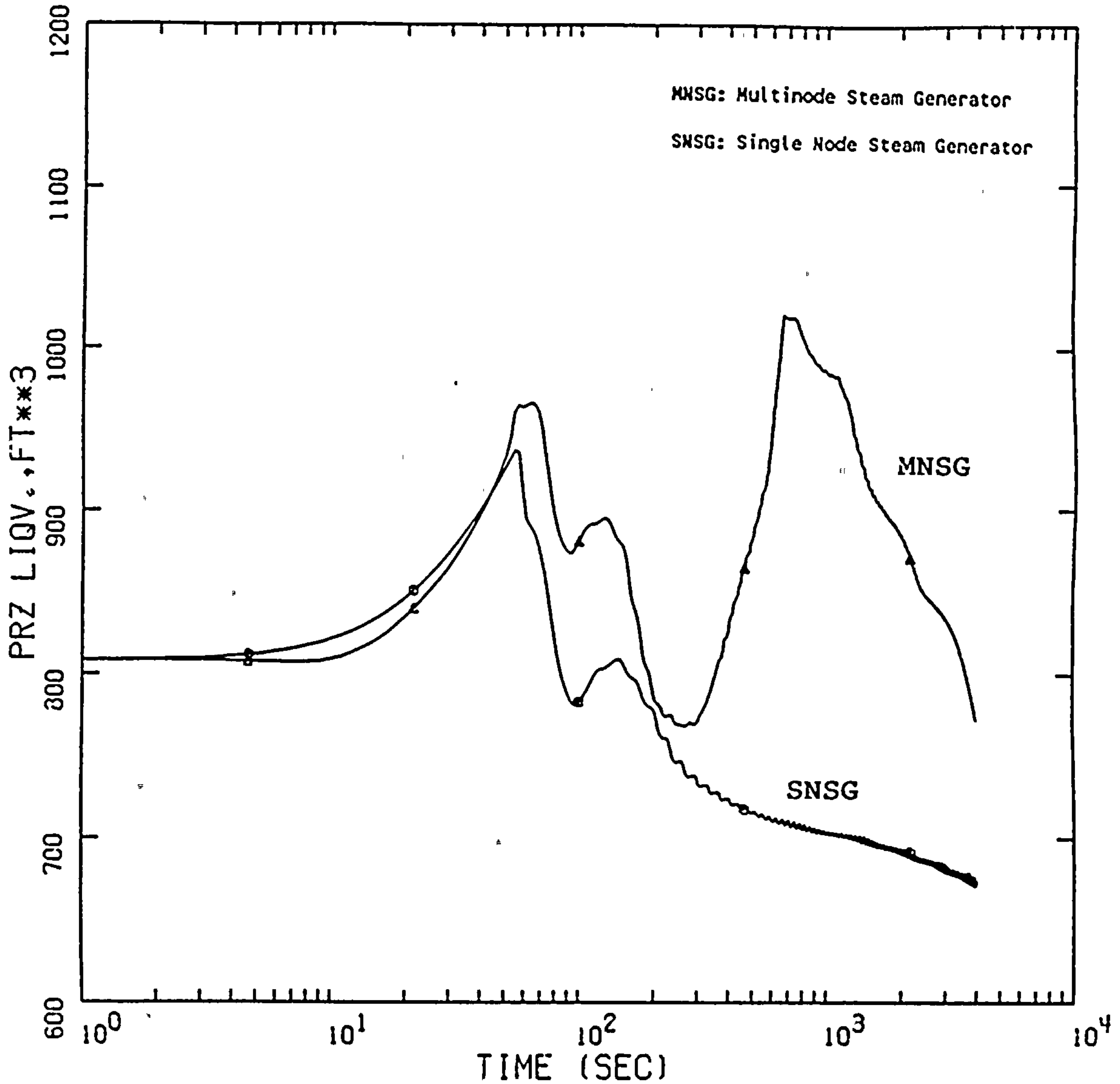

FIGURE 3. PRESSURIZER LIQUID VOLUME

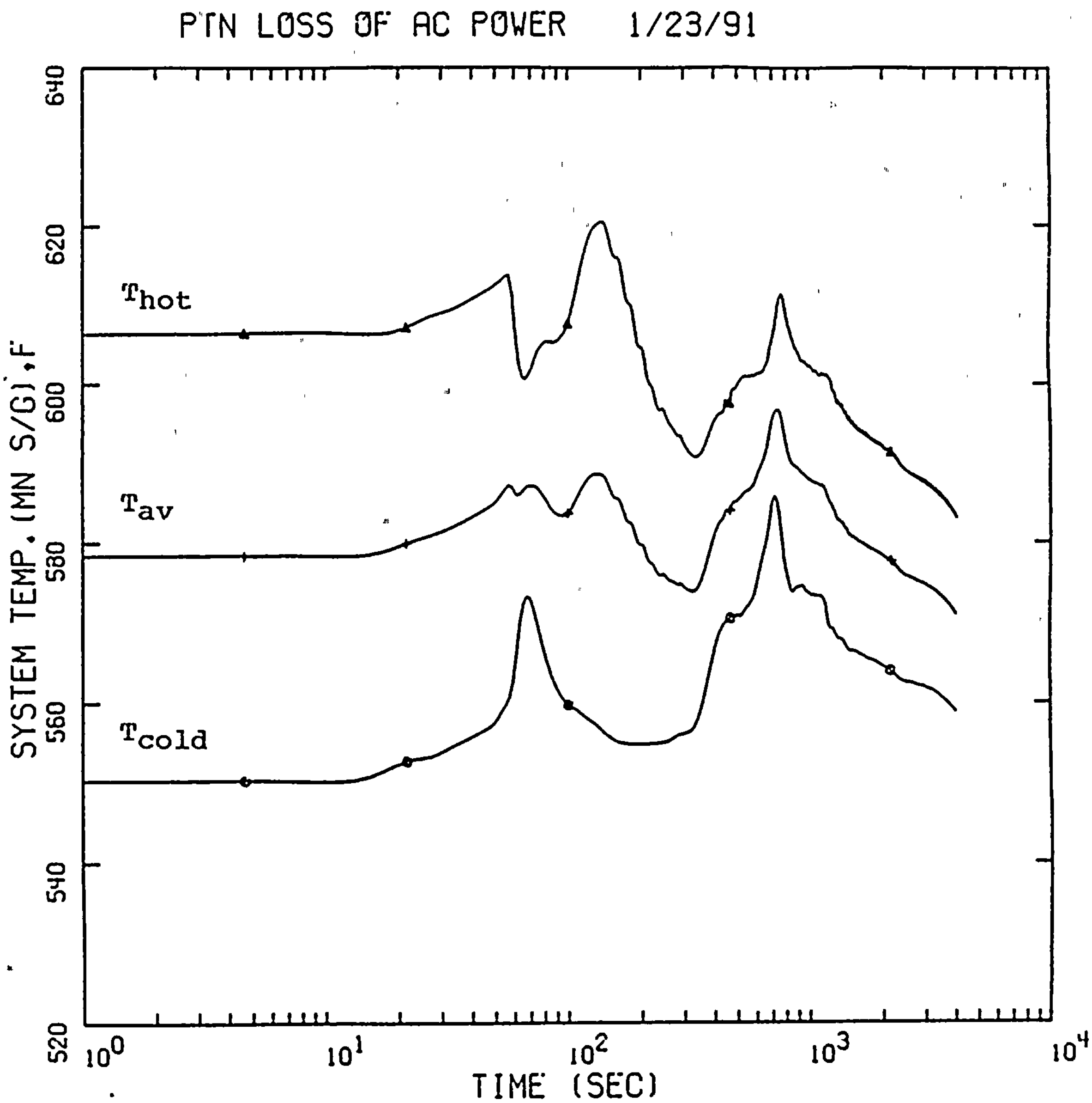

FIGURE 4. RCS TEMPERATURES
WITH MULTINODE STEAM GENERATOR MODEL

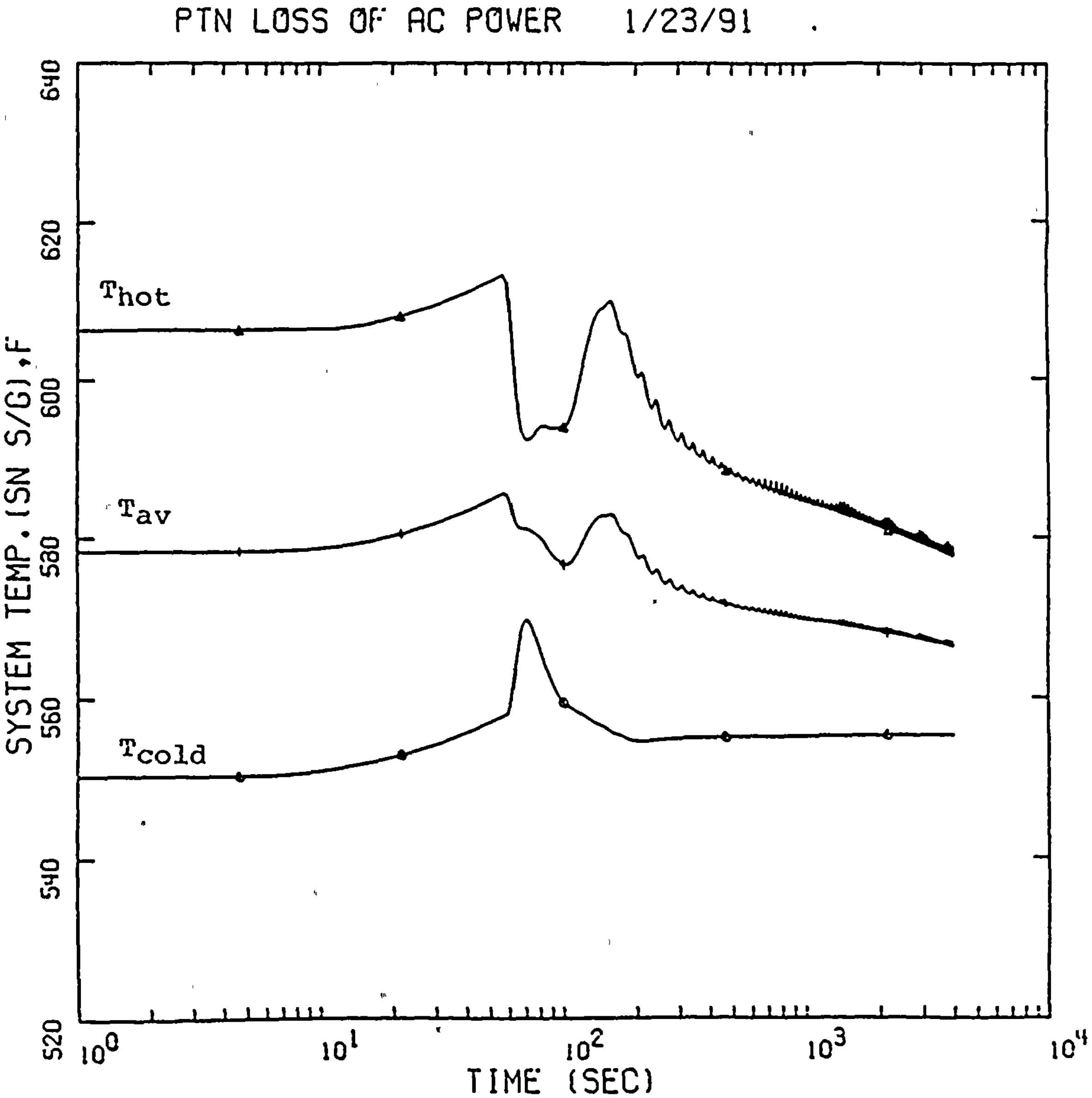

FIGURE 5. RCS TEMPERATURES
WITH SINGLE NODE STEAM GENERATOR MODEL

ANSWER TO GENERAL APPROACH QUESTION # 2

QUESTION: Demonstrate, by parametric studies for each user specified mode, that the selected model produces conservative results. Such studies should include, but not be limited to, the choices of (i) 0.08 and 3.0 ft/sec for the gradient and initial bubble velocity, (ii) 5 ft/sec for the rainout velocity, (iii) a single-node pressurizer (PRZ) model, and (iv) user defined control system models such as feedwater and steam bypass controls.

1. Introduction

The FPL RETRAN base decks and the modeling approaches on which they are based are described in Section 1.2 of the Reference Submittal. Section 4.1, in the same reference, documents how the above models have been applied or modified in the proposed methodology to analyze Loss of Secondary Heat Sink transients.

The sensitivity studies presented here, and summarized in Table 1, have been performed to evaluate the adequacy of the parameters and options used in the proposed methodology. The FPL Answer to the General Approach Question # 3 provides the criteria used in the selection of the sensitivity studies.

All the sensitivities have been performed with the St. Lucie Unit 2 Loss of Condenser Vacuum RETRAN model used in the proposed methodology in Chapter 4 of the Reference Submittal. The results of the studies are compared to the peak primary and secondary pressures predicted in the Reference Submittal (Case 0 or Reference Case in Table 1).

In addition to the sensitivities summarized in Table 1, an investigation of the effects of further increasing the steam generator tube plugging level used in the Turkey Point Loss of Condenser Vacuum RETRAN analysis has been performed.

The results of the parametric studies confirm that the options selected in the proposed methodology, to analyze Loss of Secondary Heat Sink transients, are adequate and tend to maximize the primary and secondary pressures.

2. Results of the Sensitivity Studies

2.1 Heat Transfer Between Primary and Secondary

The heat transfer between primary and secondary for the events of interest here, loss of secondary heat sink type, is largely dependent on the correlation that the RETRAN code selects for the secondary side heat transfer coefficient. The code selects the appropriate correlation from a heat transfer map based on the thermal-hydraulic conditions during the transient. There are two heat transfer map options in RETRAN [1]. The first option (IHTMAP=0) has the same heat transfer correlations as RETRAN-01, which basically are all forced convection models. The second heat transfer option, (IHTMAP=1), includes both natural and forced convection models. The use of the IHTMAP=0 option has been investigated here.

The Loss of Condenser Vacuum event, and all the other events in the Loss of Secondary Heat Removal Category in Chapter 4 of the Reference Submittal, are characterized by early isolation of the steam generators. When this occurs, in a single node steam generator model, flow stops and the heat transfer degrades into a natural convection regime. The IHTMAP=0 option artificially keeps the forced convection heat transfer and, hence, results in a lower RCS peak pressure (Case 1 in Table 1). Therefore, the IHTMAP=1 used in the Reference Submittal is appropriate.

Because the code selection of the appropriate heat transfer correlations is based on the thermal-hydraulic conditions during the transient, sensitivities on the user selected inputs for the steam generator secondary side bubble gradient and bubble velocity have been considered. However, the studies have not been performed because they are expected to show the same results shown for the pressurizer (see Section 2.2 below). The events in the Loss of Secondary Heat Removal Category are all characterized by an early pressurization of both the primary and secondary sides. As happens in the pressurizer, the bubbles in the steam generator collapse when the turbine trips at the beginning of the transient and, therefore, the impact of having different initial bubble distributions or velocities is not important. In addition, the heat transfer modes selected by the code during the transient (Nucleate Boiling in either Natural Convection or Forced Convection regimes) are not directly impacted by the bubble distribution or velocity [1].

2.2 Pressurizer Modeling

<u>Nodalization</u> For the events of interest here, the RCS peak pressure occurs as a result of an insurge of hot leg fluid into the pressurizer and compression of the vapor space. In a reactor system, the incoming fluid entering the pressurizer is generally subcooled relative to the pressurizer pressure. As the vapor is compressed, the region becomes superheated and a temperature difference between the vapor and the liquid regions is established. The higher the temperature difference, the higher will be the heat transfer between the two regions for a given inter-region heat transfer coefficient. The magnitude of this heat transfer is a source of uncertainty in modelling pressurizer behavior. The overall uncertainty is a

combination of the following factors:

- Value of the Inter-region Heat Transfer Coefficient
- Heat transfer to the pressurizer wall material
- Liquid region interface temperature

Given that in the proposed methodology the inter-region heat transfer coefficient has been fixed to minimize the heat transfer (see sensitivity study below) and that heat transfer to the wall has been ignored (see Section 1.2.3.1 in the Reference Submittal), the liquid region interface temperature is the only factor that needs to be evaluated in terms of its impact on peak pressure.

The RETRAN code treats the liquid region as a single homogeneous volume and uses its average temperature as the liquid temperature for the inter-region heat transfer calculation. During an insurge it may be argued that, if the incoming fluid is subcooled, there will be a temperature gradient in the fluid region. Furthermore, this consideration will affect the calculated value of the heat transfer rate and thus, affect the pressure calculation.

Compared with a stratified fluid assumption with no mixing, the homogeneous or mixed fluid assumption produces a lower liquid temperature for the heat transfer calculation. This produces comparatively more heat transfer to the liquid from the vapor and, therefore, a lower pressure (which is controlled by the state of the vapor). This behavior provides a theoretical basis for disputing the accuracy of the single node pressurizer representation. It can be argued that a single node pressurizer will tend to predict

lower peak pressures than a multinode model where stratification is allowed for insurge type of events. This argument has a valid justification in situations where the inter-region heat transfer coefficient is such that heat transfer between the two regions is allowed. However, the argument has no basis in situations like that in the proposed methodology where the coefficient has been selected to prevent heat transfer between the vapor and liquid regions (see sensitivity study below). Therefore, it can be concluded that the single node pressurizer model, when combined with the low inter-region heat transfer coefficient selected in the Reference Submittal, is sufficiently conservative.

Rainout Velocity Section 1.2.3.1 in the Reference Submittal discusses that this parameter is of no significance for the events in the Loss of Secondary Heat Removal Category.

Inter-region Heat Transfer Coefficient As discussed in Sections 1.2.3.1 and 4.1.1.2 of the Reference Submittal, the heat transfer coefficient between the pressurizer liquid and vapor phases, for the proposed methodology, has been kept arbitrarily low (50 Btu/hr-ft^2-$^\circ$F) to enhance the non-equilibrium effects between the two regions and maximize the predicted pressurizer pressure. To try to further increase the non-equilibrium effects, a value of 0 Btu/hr-ft^2-$^\circ$F has been investigated. The results shown as Case 2 in Table 1 confirm that the value of 50 Btu/hr-ft^2-$^\circ$F already results in the maximum degree of non-equilibrium that can be achieved in the model. The non-equilibrium effects and hence, the RCS peak pressures could be reduced by increasing the inter-region heat transfer coefficient by several orders of magnitude and/or by simply removing the non-equilibrium option in the pressurizer. This, however, is not the

approach selected in the proposed methodology of the Reference Submittal.

Bubble Rise Parameters Sections 1.2.3.1 and 4.1.1.2 in the Reference Submittal discuss the FPL approach in the selection of the bubble rise parameters in the liquid region of the pressurizer. To evaluate the impact of changes of these parameters on RCS peak pressure, combinations of extreme values for the bubble gradient and velocity parameters have been investigated. Case 3 in Table 1 shows that the peak pressure is not affected by changes in these parameters. This is to be expected because for the Loss of Condenser Vacuum event analyzed here, and in general for all the events in the Loss of Secondary Heat Removal Category, the RCS peak pressure occurs during a period where no bubbles are present in the liquid region of the pressurizer. As the liquid region is compressed against the vapor region in the top of the pressurizer any bubbles that may have been present collapse and therefore, the bubble gradient and velocity parameters are of no significance. The values for these parameters used in the proposed methodology are 0.8 and 3.0 ft/sec, respectively.

2.3 Fuel Stored Energy

The impact of variations in the initial fuel stored energy on RCS peak pressure has been investigated by varying the UO_2 volumetric heat capacity without changing the gap thermal conductivity. Increases in stored energy result in more fuel energy being released to the RCS and therefore, higher peak pressures. However, as shown in Table 1 (Case 4) the effects of this change on the RCS peak pressure are not significant enough to justify a change in the physical

properties of the fuel used in the FPL RETRAN models. These properties are industry standard and are considered adequate for the analysis of events in the Loss of Secondary Heat Removal Category.

2.4 Steam Generator Tube Plugging

The main consequence of Steam Generator Tube Plugging (SGTP) is a decrease in the primary to secondary heat transfer area in the tube bundle region of the steam generators. At a given primary to secondary temperature difference, the allowed heat generation must proportionally decrease with an increase in the level of SGTP since the heat transfer rate is approximately proportional to the heat transfer area. In order to compensate for a decrease in heat transfer area, due to plugging, the primary to secondary temperature difference must increase in proportion to the inverse of the fraction of remaining active steam generator tubes, if the heat generation rate is to be preserved. A way to accommodate increases in plugging levels, if the RCS average temperature is to be maintained, is by decreasing the secondary pressure and, consequently, temperature.

Table 2 shows the actual levels of SGTP at the St. Lucie and Turkey Point Units and the corresponding levels used in the analyses of the Reference Submittal. The analyses for the St. Lucie Units have been performed at the highest level allowed by the current Technical Specifications. A study of the impact of further increasing the 5% level of SGTP used in the analysis of the Turkey Point Loss of Condenser Vacuum event has been performed. The study shows that the results of the analysis are not affected by SGTP. This is

because: 1) The reduced tube heat transfer area is compensated by an increase in the temperature differential between primary and secondary as a result of unchanged RCS temperature and lower secondary pressure. 2) The lower initial secondary pressure, although it delays the time of the Main Steam Safety Valves (MSSV) opening, does not impact the RCS peak pressure because the MSSVs open after the primary peak is reached for Turkey Point Loss of Condenser Vacuum Event. Therefore, it can be concluded that SGTP does not play an important role in terms of primary or secondary overpressurization and that the level of 5% included in the proposed methodology for Turkey Point is adequate.

3. Control Systems in the FPL RETRAN Models

The RETRAN models in the proposed methodology for analyzing Loss of Secondary Heat Removal transients do not include action of any control system. Consistent with accepted licensing methodologies, the RETRAN licensing analyses for this category of events are performed without taking credit for the operation of control systems such as the feedwater, steam dump bypass, pressurizer pressure and level, etc.

4. References

1. RETRAN-02- A Program for Transient Thermal-Hydraulic Analysis of Complex Fluid Flow Systems. EPRI NP-1850-CCM-A, Volume 1, Revision 4, November 1988. Chapter III, Section 3.0.

TABLE 1

RETRAN SENSITIVITY STUDIES

ST. LUCIE UNIT 2, LOSS OF CONDENSER VACUUM EVENT

CASE NO.	DESCRIPTION	REACTOR TRIP TIME (sec)	PEAK PRIMARY PRESSURE (psia)	TIME (sec)	PEAK SECONDARY PRESSURE (psia)	TIME (sec)
0	Base Case	8.3	2674.4*	10.9	1040.0	16.1
1	Heat Transfer Map as in RETRAN-01	8.2	2666.9	10.7	1040.4	16.0
2	Pressurizer Inter-Region Heat Transfer Coefficient = 0.0	8.3	2674.4	10.9	1040.0	16.1
3	Pressurizer Bubble Rise Model Parameters:					
3a	v = 0. g = 0.0	8.3	2674.1	10.9	1040.0	16.1
3b	g = 1.	8.3	2674.1	10.9	1040.0	16.1
3c	v = 1E+6 g = 0.	8.3	2673.9	10.9	1040.0	16.1
3d	g = 1.	8.3	2673.9	10.9	1040.0	16.1
4	Fuel Stored Energy:					
4a	Increased by 10%	8.3	2675.1	11.0	1040.2	16.1
4b	Decreased by 10%	8.3	2673.9	10.8	1039.8	16.1

* The peak RCS pressure reported in the Reference Submittal (page 83), for the same analysis, is 2675.0. The reason for the discrepancy is because the value in the Reference Submittal was rounded up in a conservative manner.

TABLE 2

STEAM GENERATOR STATUS AS OF 01-01-91

Steam Generator	Tubes Installed	Tubes Plugged	% Tubes Plugged	FPL Analyzed SGTP (%)*
St. Lucie 1, 1A	8519	729	8.6	15
St. Lucie 1, 1B	8519	523	6.2	15
St. Lucie 2, 2A	8411	242	2.8	15
St. Lucie 2, 2B	8411	180	2.1	15
Turkey Point 3, 3A	3214	15	0.5	5
Turkey Point 3, 3B	3214	14	0.4	5
Turkey Point 3, 3C	3214	26	0.8	5
Turkey Point 4, 4A	3214	16	0.5	5
Turkey Point 4, 4B	3214	7	0.2	5
Turkey Point 4, 4C	3214	9	0.3	5

* Steam Generator Tube Plugging used in the FPL proposed methodology to analyze Loss of Secondary Heat Removal transients.

ANSWER TO GENERAL APPROACH QUESTION # 3

QUESTION: Demonstrate that the parameters selected for sensitivity studies are the only ones which might significantly impact the overall result by examining sensitivity to those user-selectable input parameters not selected.

A review of the appropriate Standard Review Plan (SRP), Reactor Analysis Support Package (RASP) documentation and the RETRAN Modeling Guidelines has been performed to identify the areas of importance in the modeling and analysis of the events in the Loss of Secondary Heat Removal Category. The following are the identified areas:

- Primary to Secondary Heat Transfer
- Pressurizer Modeling
- Fuel Stored Energy

Within each of the above areas, a variety of parameters, options, modeling approaches and assumptions can be identified as being of importance. Most of them, however, have already been addressed either in the Reference Submittal or in the answers to other questions and will not be repeated here. Examples of these are: Multinode Steam Generator, Pressurizer Spray, Initial Power Level Uncertainty, etc. Those not addressed elsewhere have been evaluated, in terms of their impact on primary and secondary peak pressures, in the Answer to General Approach Question # 2 and are listed below.

Parameters/ Options Affecting Primary to Secondary Heat Transfer*

- Heat Transfer Map
- Steam Generator Bubble Rise Parameters
- Steam Generator Tube Plugging

Parameters/ Options Affecting Pressurizer Response*

- Pressurizer Nodalization
- Rainout Velocity
- Inter-region Heat Transfer Coefficient
- Non-equilibrium Option
- Bubble Rise Parameters

Parameters/ Options Affecting Fuel Stored Energy*

- Fuel Thermal Conductivity
- Fuel Volumetric Heat Capacity

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* See the Answer to General Approach Question # 1 for a discussion of the effect of these parameters.

ANSWER TO GENERAL APPROACH QUESTION # 4

QUESTION: Compare each of the computed RETRAN initial conditions with all available measured plant data for each of the two plant transients analyzed in the submittal. Discuss and justify any differences.

The RETRAN base decks for Turkey Point and St. Lucie Unit 1 were utilized for the two plant benchmark analyses included in the Reference Submittal. Since the philosophy in the construction of these decks was to include as much plant data as possible, it is reasonable to expect good agreement between plant and RETRAN initial conditions for the two benchmark analyses. In addition, an effort was made to incorporate available plant specific initial conditions into the respective RETRAN models so that they would be representative of the particular plant conditions at the time of initiation of the two events analyzed. Tables 1 and 2 compare the plant and RETRAN initial conditions for the two benchmark analyses.

REFERENCES

1. Letter, FPL-85-599, from D.J. Richards, Westinghouse Manager NSID Projects to S.G. Brain of FPL, Subject: FPL Turkey Point Units 3 & 4 Steam Generator Repair Program Thermal Hydraulic Report, dated April 2, 1985.

2. Internal Memo from K. Nordmeyer to J.Arpa, " Turkey Point Unit 4 RCS Flow Calculation" , NF-91-141, April 1, 1991.

3. Combustion Engineering Memo to R.W. Winnard of FPL from A.S. Jameson, F-CE-6841, August 14, 1979.

4. Internal Memo from L.A. Martin to J.E Moaba, "Removal of Allowance for Variations in Flow Between Flow Measurements", FRNT-87-044, February 11, 1987.

TABLE 1

PLANT AND RETRAN INITIAL CONDITIONS FOR THE TURKEY POINT LOSS OF INVERTER EVENT

PARAMETER	PLANT	RETRAN	
Time in Cycle	MOC	MOC	
Thermal Power (%)	100	100	
Pressurizer Pressure (psia)	2254.7	2254.7	
Pressurizer Level (%)	51.7	51.7	
RCS Average Temperature (°F)	572.3	572.4	
Steam Generator Pressure (psia)	825.3	825.3	
Steam Generator Recirculation Ratio	3.8	4	(1)
Charging Flow (gpm)	72	72	
RCS Flow Rate (gpm)	308550	280900	(2)
Main Feedwater Flow (lbm/s/SG)	873.1	878.8	(3)
Feedwater Enthalpy (Btu/lbm)	405.3	405.8	(3)

FOOTNOTES

(1) The plant value is from a steam generator design document [1]. In the Single Node Steam Generator RETRAN model, the secondary flow area is adjusted as the actual tube bundle flow area divided by the recirculation ratio of 4. This is an approximate way to preserve a close to the actual full power fluid velocity in the tube bundle region.

(2) The plant flow, at the time of the event, was estimated based on operator logs [2]. The RETRAN flow was adjusted to yield the measured plant RCS average temperature. The discrepancy between the two flows is not expected to significantly affect the results of the benchmark analysis.

(3) Plant data show the feedwater temperature at 427.0 °F and 1100 psia. Since in the RETRAN model for this transient the feedwater flow is modeled as a Fill Junction, the enthalpy of the fluid, instead of the temperature needs to be entered. At the above conditions an enthalpy of 405.3 Btu/lbm can be calculated using Steam Tables. Following the standard RETRAN initialization procedure, this value was input as the initial feedwater enthalpy and the feedwater flow was adjusted until a reasonably close RETRAN iterated feedwater enthalpy was obtained. The final values used in RETRAN for the feedwater flow and enthalpy are 878.8 lbm/s and 405.8 Btu/lbm, respectively. The discrepancies between the RETRAN and plant values are not considered significant in terms of their potential impact in the results of the benchmark analyses.

TABLE 2

PLANT AND RETRAN INITIAL CONDITIONS FOR THE ST. LUCIE UNIT 1 LOSS OF FEEDWATER EVENT

PARAMETER	PLANT	RETRAN	
Time in Cycle	BOC	BOC	
Thermal Power (%)	100	100	
Pressurizer Pressure (psia)	2250	2250	
Pressurizer Level (%)	66.9	66.9	
RCS Average Temperature (^{o}F)	574.5	574.5	
Steam Generator Pressure (psia)	888	888	
Steam Generator A, N.R. Level (%)	65.9	65.9	
Steam Generator B, N.R. Level (%)	69.9	69.9	
Steam Generator Recirculation Ratio	3.95	3.95	(1)
Charging Flow (gpm)	44	44	
RCS Flow Rate (gpm)	397600	373840	(2)
Feedwater Enthalpy (Btu/lbm)	---	412	(3)
Initial Feedw. Flow to "A" SG	1679	1641	(3)
Initial Feedw. Flow to "B" SG	1729	1641	(3)

FOOTNOTES

(1) The RETRAN Multinode Steam Generator uses a Recirculation Ratio of 3.95 in accordance with steam generator design documentation [3].

(2) The plant flow, at the time of the event, was estimated based on historical data [4]. The RETRAN RCS flow was adjusted to yield the measured plant RCS average temperature. The discrepancy between the two flows is not expected to significantly affect the results of the benchmark analysis.

FOOTNOTES FOR TABLE 2 (Continuation)

(3) No plant data for the feedwater temperature was recorded for this event. An enthalpy value of 412 Btu/lbm, from a steam generator design manual, was used in RETRAN in combination with a feedwater flow of 1641.2 lbm/s. This flow was assumed the same for both steam generators and was adjusted to yield a minimum, code calculated, feedwater enthalpy bias of 0.06 Btu/lb. The plant feedwater flow transient data for each steam generator was normalized to the respective steam generator initial flow values for use in RETRAN as boundary conditions. Since the actual plant initial steam generator conditions were preserved in RETRAN, the discrepancy between the plant and RETRAN initial feedwater flows is not expected to significantly affect the results of the benchmark analysis.

ANSWER TO BENCHMARK ANALYSES QUESTION # 1

TURKEY POINT LOSS OF INVERTER EVENT

QUESTION: Explain why FPL chose to use a longer rod insertion time than the plant data indicated (2.4 sec vs. 1.9 sec). Explain why lower predicted RCS temperature and PZR level would result in a higher predicted PZR pressure than the measured data.

1. Rod Insertion Time

The FPL Turkey Point RETRAN input model uses a scram reactivity insertion time of 2.4 seconds based on the scram curve documented in the Turkey Point FSAR Figure 14-1. This scram reactivity insertion time was established by Technical Specifications based on experimental tests and is the scram reactivity insertion time used by the vendor in analyzing the FSAR Chapter 14 Safety Analysis transients. FPL has chosen this same scram reactivity insertion time for use in the FPL Turkey Point RETRAN model as a bounding scram time.

FPL did not modify the scram reactivity insertion time for modelling the Turkey Point Loss of Inverter transient, as revising the scram insertion time from 2.4 seconds to 1.9 seconds would not have a significant impact on the calculated results. Also, most of the reactor coolant system transient recorded data was only available at a 10 second frequency, which negates any benefit gained by trying to fine tune the timing of scram.

The actual recorded plant data from the Turkey Point Loss of Inverter transient was obtained from the datalogger alarm printout covering the time of the transient. The datalogger printout shows

reactor trip breaker opening alarms at a time of 15:18:09.48 and the rod bottom alarm occurring at a time of 15:18:11.40. Subtracting the two alarm times results in an actual scram insertion time of 1.92 seconds. Clearly, the RETRAN model scram insertion time of 2.4 seconds is bounding for the Turkey Point Unit 4 and is applicable for analyzing the Loss of Inverter event.

2. Pressurizer Response

There are several issues involved concerning the RETRAN calculated pressurizer response in comparison to the recorded plant data for the Turkey Point Loss of Inverter Transient. These issues are presented and discussed below.

2.1 Expected Pressurizer Behavior

The Loss of Inverter transient involves a failure induced turbine runback with no corresponding reduction in reactor power. The immediate reactor system behavior is a perceived reduction in secondary side heat removal capacity and a resulting primary side heatup and increase in Tavg. The increasing primary system Tavg causes the pressurizer to experience a rapid insurge and level increase. Therefore, the expected pressurizer behavior is characterized by increasing pressurizer pressure and pressurizer level. This particular transient pressurizer response was complicated by the loss of inverter causing the pressurizer spray valves to fail "as-is" and the pressurizer heaters to fail "off". The pressurizer pressure continues to increase until the high pressurizer pressure trip setpoint is reached, which initiates a reactor scram.

2.2 RETRAN Predicted Responses

<u>RCS Average Temperature</u> The reactor coolant system Tavg is the primary indicator used to monitor the primary side response to a decrease in secondary side heat transfer capacity. As shown in the Reference Submittal, Figure 2.3-3, the RETRAN predicted RCS average temperature begins increasing at approximately 8 seconds after the Loss of Inverter occurs. RETRAN predicts a peak Tavg of 577.5 ^{o}F at 23.0 seconds after Loss of Inverter occurs. The plant measured data for Tavg during the Loss of Inverter transient was only available at a 10 second frequency. The plant recorded data is shown in the Figure 2.3-3 as "+" at each known data point with a maximum value of 577.2 ^{o}F at 17.7 seconds after Loss of Inverter occurs. The RETRAN predicted peak Tavg value is in excellent agreement with the known plant data. However, as plant data was recorded only at 10 second intervals, the exact peak Tavg value and time of peak experienced by the plant following the Loss of Inverter can not be precisely determined.

The RETRAN predicted shape of the Tavg response curve agrees very well with the measured plant data but appears to be translated approximately 4.3 seconds later than the plant data. The RETRAN predicted Tavg curve shown plotted in Figure 2.3-3 has been processed by a RETRAN control system calculation to simulate the best estimate plant indicated loop Tavg signal from the RTD temperature instrumentation. The Turkey Point RETRAN model passes the calculated instantaneous hot and cold leg temperatures through DELAY and LAG control blocks to simulate the actual plant indicated Tavg. The RETRAN model uses a delay time of 1.0 second and a lag time constant of 2.0 seconds for calculating indicated hot leg temperature. A delay time of

0.5 second and a lag time constant of 2.0 seconds is used for calculating indicated cold leg temperature. These delay and lag time constants are based on best estimate information from similar RETRAN models and are certainly bounding as evidenced by the data comparison of Figure 2.3-3. The time constants used to calculate indicated Tavg from RETRAN have not been fine tuned to agree with plant indicated Tavg data.

Pressurizer Pressure As shown in the Reference Submittal Figure 2.3-5, the RETRAN calculated pressurizer pressure response is in good agreement in comparison to the plant measured data. RETRAN predicts a peak pressurizer pressure of 2427.6 psia at 20.6 seconds after Loss of Inverter occurs. The plant measured data for pressurizer pressure during the Loss of Inverter transient was available at a 5 second frequency. The plant recorded data is shown in the Figure 2.3-5 as "+" at each known data point with a maximum value of 2386.7 psia at 20.0 seconds after Loss of Inverter occurs. The RETRAN predicted peak pressurizer pressure value is less than 2% greater than the known plant data and the predicted time of peak pressure is 0.5 second later than the known plant data. Plant data for pressurizer pressure was available at a 5 second recording frequency, so there is not much uncertainty in the exact timing and peak pressure value of the plant data from the Loss of Inverter transient.

The RETRAN non-equilibrium pressurizer option is used in the Turkey Point input model. The non-equilibrium option uses a conservatively low inter-region heat transfer coefficient value of 50 Btu/hr-ft^2-°F which has been chosen by FPL in their base RETRAN deck to maximize the peak pressure response in the pressurizer during insurges caused by heatup

transients. There was an attempt by FPL to optimize the inter-region heat transfer coefficient to match the pressurizer peak pressure which occurs during the Loss of Inverter transient. As documented in the Reference Submittal, Section 2.4, FPL ran sensitivity studies with the pressurizer inter-region heat transfer coefficient increased to 20,000 Btu/hr-ft^2-°F. The RETRAN predicted pressurizer pressure response was not very sensitive to changes of inter-region heat transfer coefficient in this range.

As discussed in Reference 1, an inter-region heat transfer coefficient of approximately 30,000 to 50,000 Btu/hr-ft^2-°F is required for best estimate analysis of pressurizer transients with large insurges. This magnitude of inter-region heat transfer coefficient is physically unrealistic, but is used to compensate for the lack of RETRAN modelling effects of steam condensation on the pressurizer walls.

Upon further examination of the RETRAN calculated results for the Loss of Inverter transient, it is observed that the pressurizer exhibits non-equilibrium behavior during the 5 to 23 second transient time period. The maximum amount of non-equilibrium in the pressurizer is predicted by RETRAN to be about 10 °F.

The possibility of using the RETRAN equilibrium option instead of the non-equilibrium option was evaluated. However the equilibrium pressurizer is expected to result in a non-realistic lower peak pressure for this mild insurge transient.

In summary, the RETRAN calculated peak pressurizer pressure for the Loss of Inverter benchmark transient is 40 psi above

the plant recorded value. By using a higher value of approximately 50,000 Btu/hr-ft^2-^{o}F for the inter-region heat transfer coefficient, the RETRAN calculated peak pressurizer pressure could be reduced by approximately 20 psi. Due to the uncertainty of available plant data concerning spray flow rate and the inability of the model to account for pressurizer heat loss to the environment, FPL did not pursue further fine tuning of the pressurizer model for this benchmark transient.

Pressurizer Level As shown in the Reference Submittal Figure 2.3-6, the RETRAN calculated pressurizer level response is in good agreement in comparison with the plant measured data. RETRAN predicts a peak pressurizer level of 55.6 % at 20.5 seconds after Loss of Inverter occurs. The plant measured data for pressurizer pressure during the Loss of Inverter transient was available at a 10 second frequency. The plant recorded data is shown in Figure 2.3-6 as "+" at each known data point with a maximum value of 57.3 % at 17.5 seconds after Loss of Inverter occurs. The RETRAN predicted peak pressurizer level value is less than 2% lower than the known plant data and the predicted time of peak level is 3.0 seconds later than the known plant data. Since plant data was available at a 10 second recording frequency, there remains some uncertainty in the exact timing and peak level value of the plant data from the Loss of Inverter transient.

As discussed above, the pressurizer inter-region heat transfer coefficient used in all the FPL RETRAN models is selected to conservatively maximize the calculated peak

pressurizer pressure in response to rapid pressurizer insurges. This also has the effect of decreasing the peak pressurizer level response, which is the behavior evidenced in the RETRAN prediction of peak pressurizer level as compared to the indicated plant data from the Loss of Inverter transient. FPL did not optimize the pressurizer inter-region heat transfer coefficient in an attempt to obtain a best estimate value with regards to better agreement with the indicated plant pressurizer level data. Since most of the available plant data was recorded at a frequency of 10 seconds or more, there was no justification for further fine tuning of the RETRAN model due to the uncertainty of plant recorded peak values and actual timing of peak values.

A further examination of the RETRAN calculated pressurizer response during the Loss of Inverter transient showed that the pressurizer liquid region developed a small amount of steam bubbles (approximate quality of 0.003) during the depressurization phase of the transient. Since the RETRAN pressurizer level algorithm is based on the pressurizer volume mixture level parameter, there will be an over prediction of indicated level in comparison to the plant data any time steam bubbles are present in the RETRAN pressurizer liquid region. However, with such a low quality being predicted, the magnitude of the level overprediction would be minor. The FPL model was not revised to calculate pressurizer indicated level based only on liquid level, instead of mixture level.

2.3 Sensitivity Studies

During the investigation of the Loss of Inverter benchmark transient, FPL ran a total of 27 transient cases in an effort to explain and/or reduce the uncertainty associated with the available plant recorded data. The calculated results of all the cases clearly demonstrated that the Turkey Point RETRAN model calculated peak pressurizer pressure and level response for the Loss of Inverter transient was not sensitive to realistic variations in RETRAN options or user inputs. The timing of peak pressurizer pressure and level could be directly influenced by varying the reactor trip and turbine trip delay times, but the magnitude of peak pressurizer pressure and level was insensitive to the other parameters evaluated.

2.4 Instrument Accuracy

From Reference 2, the following plant instrument accuracies were obtained.

PRZ pressure	+/- 10 psi
PRZ level	+/- 1.5% of full range (0-100%)
Tavg	+/- 1 degree F

Based on these instrument accuracy values, the RETRAN predicted Tavg peak value falls within the plant indicated peak value accuracy range. The RETRAN calculated pressurizer pressure peak value is greater than the plant data accuracy band by 30.9 psi. The RETRAN calculated pressurizer level peak value is less than the plant data accuracy band by 0.2% level.

2.5 Conclusions

FPL has provided additional information concerning the RETRAN calculated peak pressurizer response for the Turkey Point Loss of Inverter benchmark transient. It is concluded that the RETRAN calculated peak pressurizer response is in good agreement with the limited available plant recorded data and the calculated data trends agree with expected physical plant behavior. The timing of peak pressurizer pressure, peak pressurizer level, and peak Tavg differ from plant indicated data by approximately 0.5 to 5.0 seconds. FPL acknowledges that a better best-estimate comparison could be obtained by further fine tuning of the trip delay times and pressurizer inter-region heat transfer coefficient as well as accounting for wall heat transfer. However, the uncertainty in plant recorded data due to the recording frequency make any further comparison or fine tuning of the RETRAN calculated response an exercise with no technical basis for meaningful improvement.

3. References

1. BG&E Topical Report on RETRAN Model, A-85-11A, January 31,1986, page 27.

2. Reactor Protection System, DBD Vol. #8, Rev 0, Document # 5610-049-DB--001.

ANSWER TO BENCHMARK ANALYSES QUESTION # 2

ST. LUCIE PARTIAL LOSS OF FEEDWATER FLOW EVENT

QUESTION: Explain how the MSSV component input was determined. Provide any physical basis for the assumptions made in the sensitivity study with respect to the flowrate and the number of valves operating. Did FPL change nodalization as a result of observing that separately modeling the MSSV's lead to better comparison with measured data? Provide comparisons of other computed parameters on the primary side with measured data after the change in MSSV modeling. Explain the differences between predicted and measured steam generator pressure and level trends after 40 seconds.

1. Main Steam Safety Valve (MSSV) Model in the RETRAN Analysis

The Partial Loss of Feedwater RETRAN Analysis benchmark was performed with the St. Lucie 1 RETRAN Base Deck which uses the MSSV model summarized in Section 1.2.3.3 of the Reference Submittal. The plant has a total of sixteen MSSVs, eight on each of the two steamlines. The valves on each steamline are grouped into two banks with four valves per bank. In the RETRAN base model the four valves on each bank are lumped and represented by a single valve with an equivalent total capacity. The following are the MSSV bank capacities, from Technical Specifications, in the RETRAN model:

BANK 1 Capacity: 827 lbm/s @ Setp. Press. + 3% Accum. (1030 psia)
BANK 2 Capacity: 860 lbm/s @ Setp. Press. + 3% Accum. (1071 psia)

Fill tables of flow versus pressure values, calculated with the Moody Critical Flow Model, are used to represent each of four lumped MSSVs. Based on these tables, the lumped valves in the first bank discharge a flow of 801.5 lbm/s when they open at the setpoint pressure of 1000 psia and 733.6 lbm/s when they close at 920 psia. The lumped valves are assumed to open and close

instantaneously when the respective setpoint pressures are reached.

The following are the only two changes to the MSSV model in the St. Lucie Unit 1 RETRAN Base Deck to analyze the Partial Loss of Feedwater Flow event:

- Based on available plant data for the event, the pressure reset setpoint was changed from 960 psia to 920 psia.

- As part of a sensitivity study, only three out of the four MSSVs, on each loop, in the first bank were assumed to open.

2. Basis for Assumptions in Sensitivity Study

In an effort to try to improve the results of the RETRAN benchmark analysis, a sensitivity analysis was performed, in the Reference Submittal, in which the total MSSV flow was reduced by 25% to simulate that only six of the eight available MSSVs in Bank 1 opened after the pressure setpoint was reached. This is based on:

- Conversations with plant staff regarding similar type of events for which the indications are that not all the MSSVs open every time the high pressure setpoint is reached.

- Observation of the RETRAN prediction for the event shows that the steamline pressure excursion was slow and barely exceeded the high pressure setpoint. Small drifts on the valves set pressures may have prevented some of the MSSVs from opening at the plant.

The assumption, in the Reference Submittal, that one MSSV on each loop failed to open is arbitrary but, in view of the above arguments, is believed to be realistic.

3. Nodalization Changes

It is recognized that individual, instead of lumped, representation of the MSSVs along with allowance for pressure setpoints drifting in the RETRAN model would provide a more realistic prediction of the plant's response. However, the effort was not pursued for this benchmark analysis mainly because of the lack of plant data on the performance of the individual valves during the event.

4. Additional Comparisons

Figures 1 through 4 show the requested comparisons between plant data and the RETRAN predictions for primary side parameters.

5. Differences Between Measured and RETRAN Predicted Secondary Data

As evidenced by the Figures 3.3-2 and 3.3-3 of the Reference Submittal, the RETRAN calculated steam generator pressures show a faster depressurization than the plant during the first 45 seconds. Between 45 and 100 seconds, the RETRAN steam generator pressures tend to respond faster than those at the plant.

The above discrepancy was documented and discussed in the Reference Submittal, page 43. At that time, sensitivity studies were performed to investigate the effect of varying the number of main steam safety valves that may or may not have actually opened during the plant event. The best agreement with plant data was obtained

when only three out of the four MSSVs in Bank 1 of each steam generator were modelled to open in RETRAN. This sensitivity study documented in the Reference Submittal (Figures 3.3-9 and 3.3-10) yields better agreement in the secondary pressure until the time of MSSV closure. After that time, however, the RETRAN analysis still overpredicts the plant steam generator repressurization in the 45 to 60 second interval and the depressurization in the 60 to 100 second interval.

Recorded plant data for the steam flow out of the A Steam Generator is compared to that predicted by the RETRAN sensitivity study in Table 1. Unfortunately, no similar plant data for the B Steam Generator is available. Closer investigation of the available plant data and RETRAN results has produced the following additional thoughts:

- Up until the time of the MSSV closure, both the MSSVs and the steam dump system should operate to reduce steam generator pressure and RCS temperature. After MSSV closure, only the steam dump should operate. One of the steam dump valves is designed to control the turbine header pressure to 910 psia while the other four valves are designed to control RCS temperature.

- Based on Table 1 data, during the time of MSSV action, RETRAN overpredicts the plant flow out of the A steam generator. This supports the hypothesis that only a few of the plant MSSVs in Bank 1 must have opened as opposed to all of them opening simultaneously as in the RETRAN prediction.

- Based on Table 1 data, the steam flow out of the A generator when the MSSVs close decreases by about 60% in RETRAN while only about 20% at the plant. This larger reduction of the flow in RETRAN may explain the higher rebounding of the RETRAN steam generator pressure after MSSV closure. The comparison of the respective pressure rebounds for the original RETRAN prediction and its sensitivity study (see Figures 3.3-2, 3.3-3 and 3.3-9, 3.3-10 in the Reference Submittal) confirms that fewer MMSVs opening during the event result in smaller pressure rebounds after they close. This trend has also been observed in other sensitivity studies in which the number of MSSVs assumed to open has been further reduced.

- Towards the end of the prediction, both RETRAN and the plant steam generator depressurize at about the same rate (see Figures 3.3-9 and 3.3-10 in the Reference Submittal). The RETRAN steam generator pressure starts decreasing earlier than that at the plant probably because the higher pressure rebound after the MSSV closure produces higher demand on the steam dump pressure controller.

- Clearly in this event, the secondary response is dominated by a complex interaction of the MSSVs and the steam dump bypass system. Without plant recorded data on the flow out of the B Steam Generator or steam dump flow, it is difficult to draw conclusions concerning the plant operability of the MSSVs and steam dump during the event.

Without detailed information on the plant MSSV and steam dump flows, additional efforts to fine tune both flows in RETRAN to replicate the plant response has no discernible benefit.

It is important to note that the purpose of the Partial Loss of Feedwater benchmark analysis is to demonstrate the ability of the FPL RETRAN models to predict the magnitude and timing of plant peak pressures during heatup events. Based on the results of the analysis, it can be concluded that the RETRAN predicted timing and magnitude of the peak pressures are in good agreement with plant data and that therefore, the model should be applicable for licensing analyses of similar type of events.

TABLE 1

STEAM GENERATOR A, OUTLET FLOWS* (lbm/sec)

Time(s)	Plant	RETRAN**
0	1679	1641
20	1643	1552
23	1657	1285
24	1657	820
25	352	591
30	851	940
35	710	718
40	695	1279
45	672	1367
50	516	1196
51	516	1166
52	516	493
53	412	431
54	412	336
55	412	372
56	408	409
57	408	415
58	408	392
60	408	342
70	371	301
100	371	234

* The plant steam flow out of the B Steam Generator is not available for this event.

** The RETRAN results are from the sensitivity study with 25% less MSSV capacity reported in the Reference Submittal.

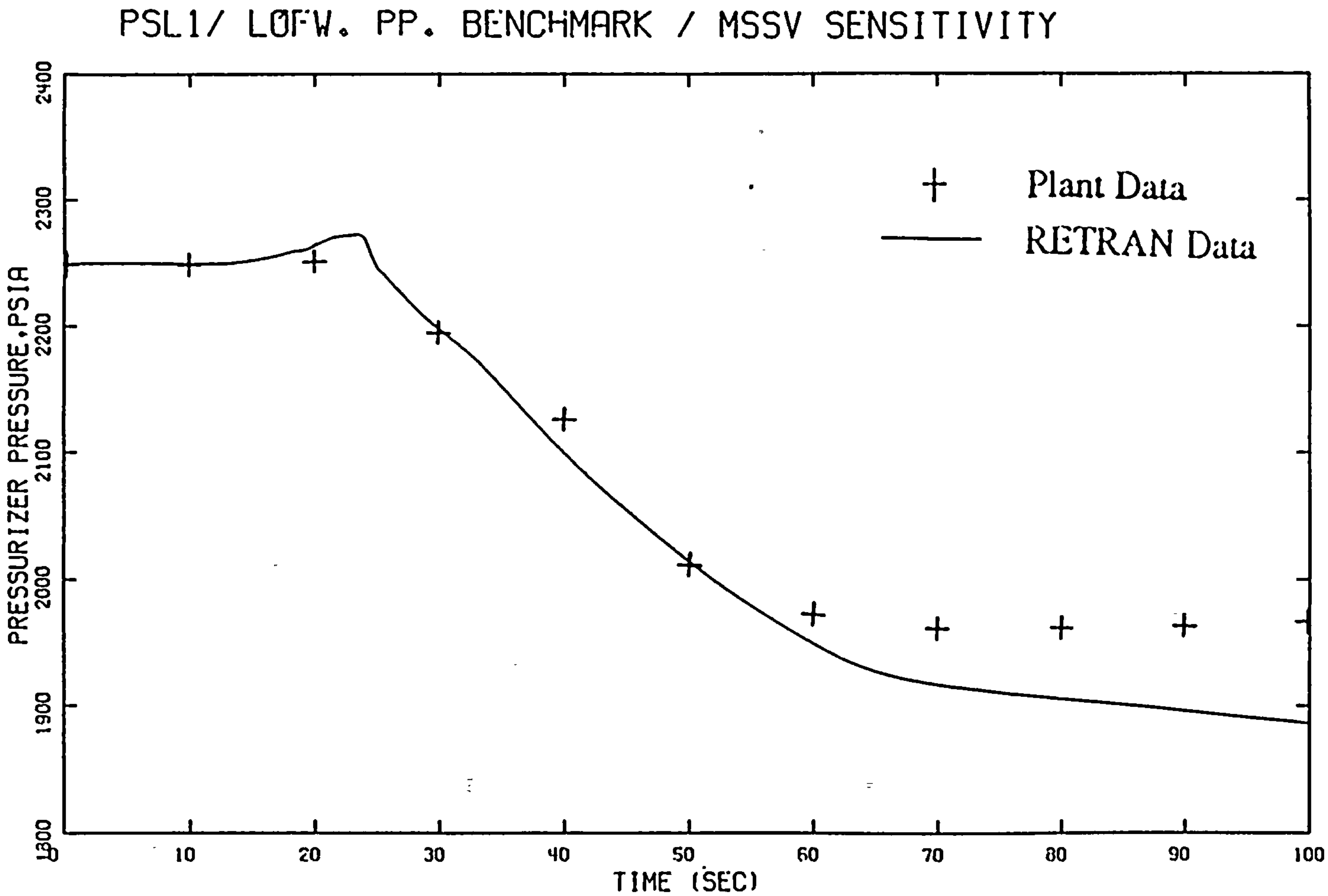

FIGURE 1. PRESSURIZER PRESSURE
MSSV SENSITIVITY

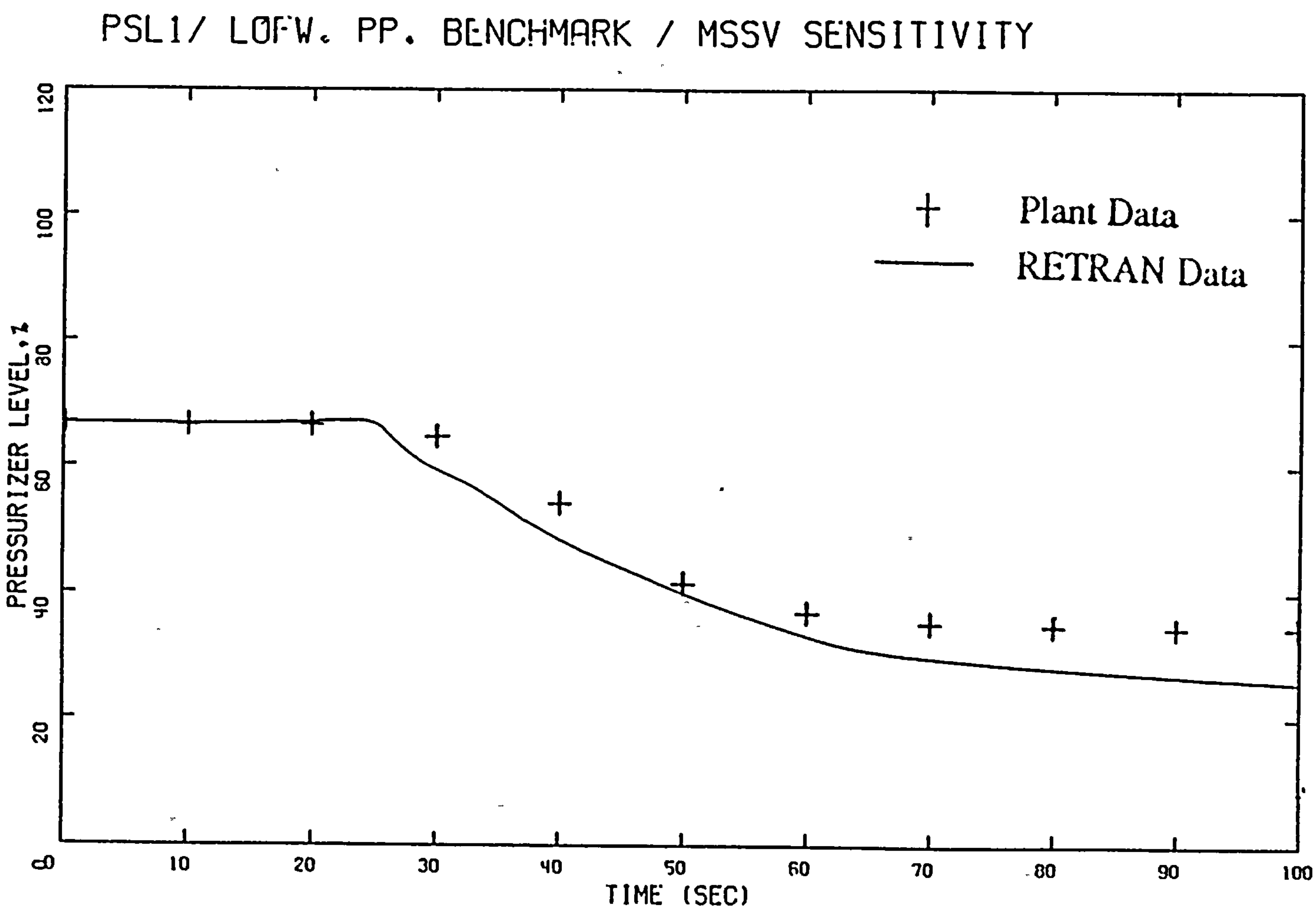

FIGURE 2. PRESSURIZER LEVEL
MSSV SENSITIVITY

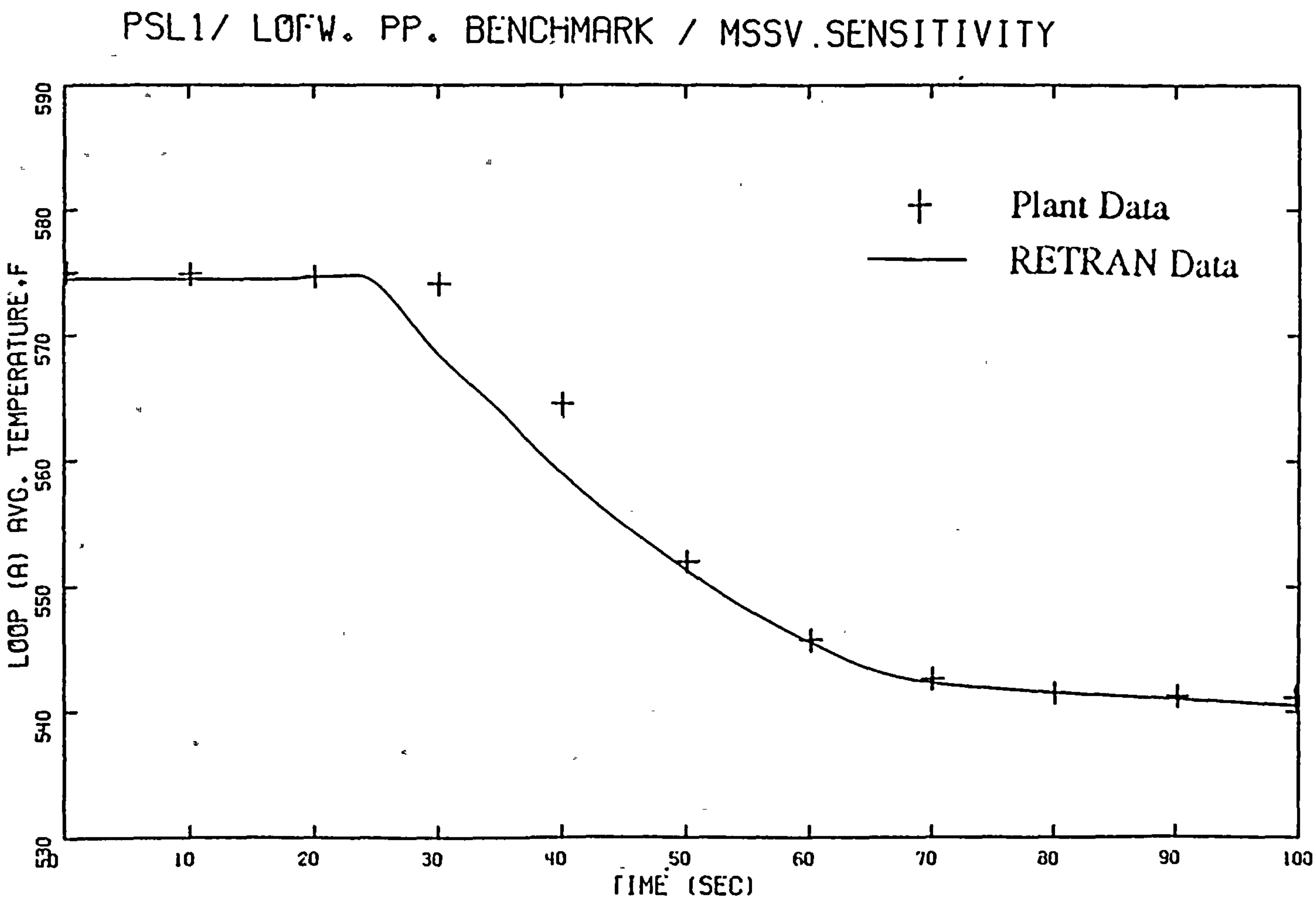

FIGURE 3. LOOP A AVERAGE TEMPERATURE
MSSV SENSITIVITY

PSL1/ LOFW. PP. BENCHMARK / MSSV SENSITIVITY

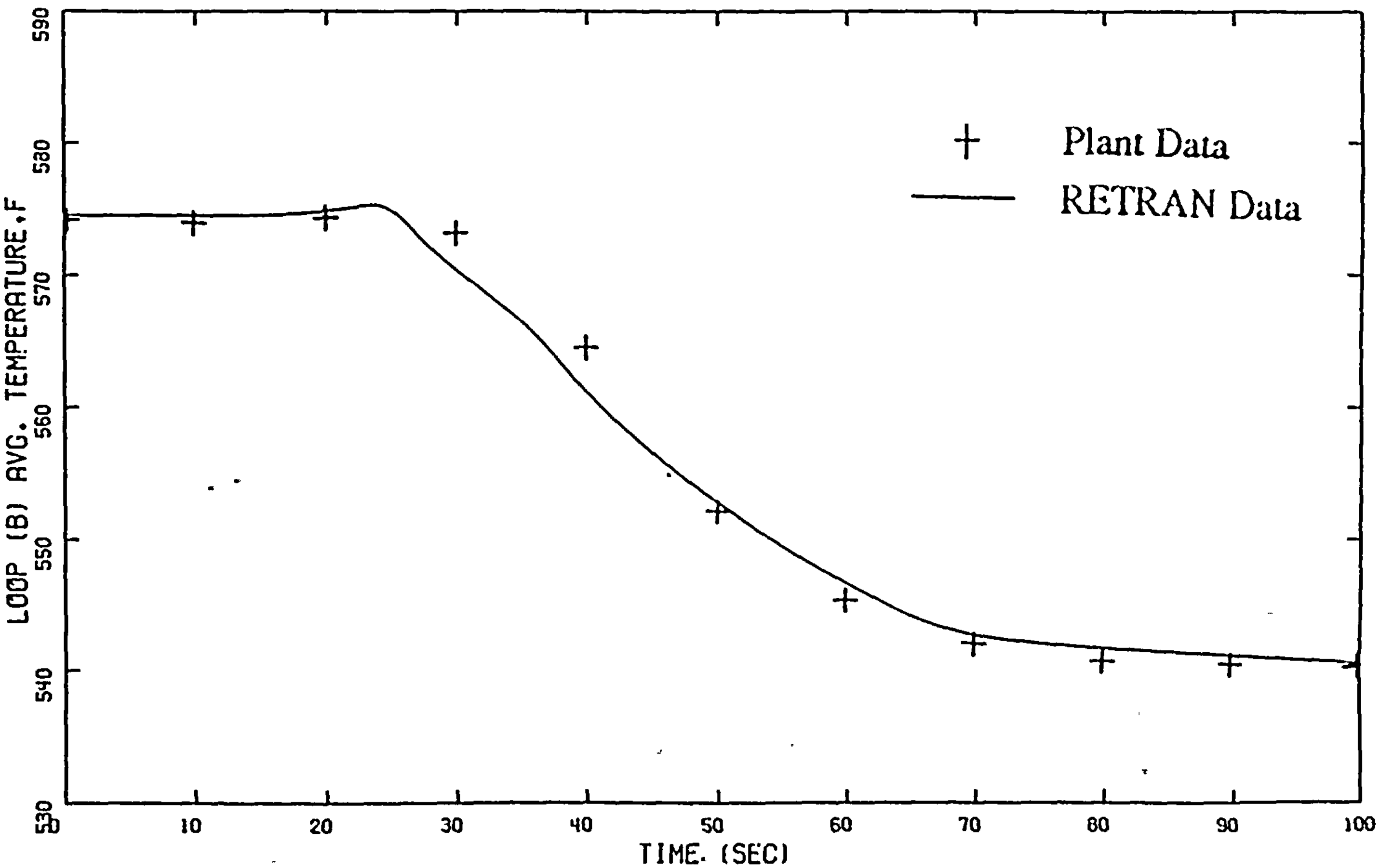

FIGURE 4. LOOP B AVERAGE TEMPERATURE

MSSV SENSITIVITY

ANSWERS TO QUESTIONS ON

SAFETY ANALYSIS METHODS AND LIMITING TRANSIENTS

SAFETY ANALYSIS QUESTIONS

QUESTION 1: List each specific purpose for which the RETRAN plant models presented in the submittal will be used (i.e., licensee FSAR update, reload analysis, tech spec revision), and explain and justify each difference between each selected initial condition and those presented in the FSAR.

QUESTION 2: Justify the use of the nodalization, user specified models and correlations, control systems and response and delay times presented in Chapters 2 and 3 of the submittal in FSAR-type analyses. Identify and justify each modification to any of the foregoing which will be made for FSAR-type analyses.

LIMITING TRANSIENT QUESTIONS

QUESTION 1: Discuss, in depth, the method by which FPL selected the limiting event and the limiting set of input parameters for each transient in this category. Demonstrate that any changes from those used in the FSAR would produce results which are at least as conservative as those in the FSAR.

QUESTION 2: For transient analysis in this category, provide comparison of each input parameter, assumption and initial condition with the existing FSAR assumptions and conditions and demonstrate that any changes from those used in the FSAR would produce results which are at least as conservative as those in the FSAR.

1. Introduction

Review of the above four questions has identified the following major areas or topics that need to be addressed with respect to the proposed FPL Methodology in the Reference Submittal.

- Purpose of the Reference Submittal.

- Justification of the Selected Events in the Proposed Methodology.

- Role of the Benchmark Analyses in the Reference Submittal.

- Justification of Analysis Inputs in the Proposed Methodology.

Since some of the above topics are referenced in more than one place, it has been decided to address them individually rather than in the context of each question.

2. <u>Purpose of the Reference Submittal</u>

As specified in Section 1.1 of the Reference Submittal, the purpose of the submittal is "to provide the additional information required by the NRC in one specific class of transient events, Decrease in Heat Removal by the Secondary System, and obtain NRC approval for the use of RETRAN in licensing actions associated with transients within this category".

The type of contemplated licensing actions, for which the Reference Submittal is intended, are in support of:

- Plant changes:

  Trip Reduction Efforts or

  Increased Operational Margins

- Fuel Reload Analyses

To further support the Fuel Reload Analyses licensing action, FPL is planning to develop a full scope RETRAN Topical to be submitted to the NRC within the next 24 months. The Loss of Secondary Heat Removal Methodology Topical defended here is to be considered as a component of the full scope Topical. It is anticipated that in that Topical, the methodology for analyzing the events in the Loss of Secondary Heat Removal category will not again be addressed but instead it will be included by reference.

3. Justification of the Selected Events in the Proposed Methodology

The basis for the selection of the limiting transients in the Loss of Secondary Heat Removal Category of events is provided in Sections 4.1 and 4.2 of the Reference Submittal and is summarized below.

For each of the FPL's nuclear units, the limiting transient in the category of Decrease in Heat Removal from the Secondary System was determined after detailed review of the respective FSARs and the Standard Review Plan (SRP), Section 15.2, which addresses this category of events. Each of the events in the category was evaluated, as it applies to each of the FPL's units, and the limiting one was selected.

Although the events in this category are evaluated primarily against the potential to exceed the 110% design pressure limits on the primary and secondary sides, other safety design criteria such as Departure from Nucleate Boiling behavior were also considered in the evaluation of the limiting transient for each Unit.

The selected limiting transients in the category of Decreases in Heat Removal from the Secondary Side will be used to evaluate licensing actions that have the potential for affecting the

overpressurization safety margins. If transient input values change, other currently non-limiting events in this category will be evaluated to ensure that transient acceptance criteria continue to be met.

4. Role of the Benchmark Analyses in the Reference Submittal

The two plant benchmark RETRAN analyses presented in Chapters 2 and 3 of the Reference Submittal were included for two purposes: 1) to demonstrate FPL's ability to successfully predict plant responses to events related to decreases in secondary heat removal; and 2) to demonstrate the applicability of the FPL's RETRAN base models to analyze this type of events. The FPL RETRAN base models are generally built with plant initial conditions (see Answer to General Approach Question # 4) for use in the analysis of plant operational transients and in support of Simulator Certification.

The above RETRAN best estimate base models have been modified for the analysis of the limiting transients in the Loss of Secondary Heat Removal Methodology presented in the Reference Submittal. The modifications to the base models include the deactivation of all the non-safety grade control systems, the modeling of limiting initial conditions to maximize the severity of the transients and the inclusion of a more versatile and conservative model for the safety valves (see Section 4.1.1 in the Reference Submittal).

Some of the modeling approaches and code options used in the proposed Methodology were evaluated, via sensitivity studies, during the benchmark analyses (see Reference Submittal Section 4.1.1). In general, as the additional sensitivity studies presented in the Answer to General Approach Question # 2 confirm, it can be concluded that the selection of modeling approaches and code options in the proposed Methodology is acceptable.

5. Justification of Analysis Inputs in the Proposed Methodology

As it can be seen in Tables 1, 3, 5 and 7 the inputs, initial conditions and assumptions for the limiting transients in the FPL methodology either match or are more conservative than those used by the respective vendors in their licensing analyses. There are a few exceptions in which the vendor is more conservative than FPL but there is no justification for the additional conservatism used. In these situations the inputs used by FPL are based on current Technical Specification values to which the appropriate uncertainties have been added.

The results of the FPL analyzed limiting transients are compared with those presented in the respective FSARs in Tables 2, 4, 6 and 8. These comparisons are summarized below for each transient:

St. Lucie Unit 1 Loss of Condenser Vacuum (Table 2)

The FSAR predicted peak pressures are higher than those predicted in the Reference Submittal. This is attributed to the higher MTC and pressurizer safety valve opening setpoint tolerance used in the vendor's calculation. The values for these two parameters in the FPL proposed Methodology are consistent with current St. Lucie Unit 1 Technical Specifications.

St. Lucie Unit 2 Loss of Condenser Vacuum (Table 4)

The FSAR predicted pressures appear to be higher than those predicted in the Reference Submittal. Given the fact that the FPL inputs tend to be more conservative than those in the FSAR, the reason for the more limiting FSAR results can probably be attributed to differences between the vendor code CESEC and RETRAN.

Turkey Point Loss of Condenser Vacuum (Table 6)

The analysis in the Reference Submittal yields more conservative results than the FSAR because some key input parameters, such as setpoints and initial conditions, are more conservative than those used in the FSAR.

Turkey Point Loss of AC Power (Table 8)

The results of the FPL's analysis are more benign than those predicted in the FSAR. Since the FPL inputs tend to be more conservative, the fact that the FSAR results are more limiting can probably be attributed to differences between the vendor code LOFTRAN and RETRAN. In addition, the vendor inputs a special heat transfer coefficient in the steam generator that is used during natural circulation while in the methodology of the Reference Submittal, RETRAN automatically calculates the heat transfer coefficient in natural circulation conditions. In the RETRAN prediction, the more realistic heat transfer between primary and secondary results in the RCS heatup being turned around shortly after the operator increases the auxiliary feedwater flow from 110 to 230 gpm at 652 seconds (see Table 8).

The proposed FPL's methodology in the Reference Submittal is based on the straight use of the RETRAN-02 MOD 004 code [4]. The methodologies used by the respective vendors differ with that proposed by FPL at least in the computer codes used. In addition, other differences may exist if the vendor specially modifies its code to either circumvent code limitations or to artificially increase the conservatism of the calculation. The FPL's position on this is that the RETRAN code already has been reviewed and approved by the NRC for the types of scenarios analyzed in the Reference Submittal and that conservatisms, other than those in the

Standard Review Plan, are not necessary. With respect to the inputs for the safety analyses, FPL's is committed to verify them, for each application, to make sure that they:

- are conservative
- yield results that fall within acceptance criteria.
- are still representative of current:
    - plant conditions
    - Technical Specifications
    - FSAR

6. References

1. "St. Lucie Unit 1, Cycle 9, Plant Parameters for LOCA and Plant Transient Analysis", Report ANF-87-103(P), Rev.1, November 1987.

2. CESEC - Digital Simulation of a Combustion Engineering Nuclear Steam Supply System, CENPD-107, April 1974.

3. Updated Final Safety Analysis Report, Turkey Point Plant, Units 3 & 4, Volume 5, page 14-2, Rev 8 7/90.

4. "RETRAN-02, A Program for Transient Thermal-Hydraulic Analysis of Complex Fluid Flow Systems", EPRI NP-1850-CCM-A, November 1988.

5. Turkey Point Units 3 & 4 Evaluation of Increased Pressurizer Pressure Uncertainty, Westinghouse Document, SECL NO. 89-651, April 26, 1989.

6. Letter from D.J. Richards (Westinghouse) to S,T. Hale (FPL), "SECL for Containment Temperature Increase to 130 °F for Protection System Setpoints", FPL-88-831, September 14, 1988, page 5. This SECL (No. 88-434) is contained in an internal FPL letter from S.T. Hale to F.H. Southworth, "Turkey Point Units 3 & 4 Safety Evaluation for Containment Temperature REA-86-62, REA-88-198 FILE: TPN-86-62-2", JPN-PTP-88-1707, Sept. 28, 1988.

TABLE 1

ST. LUCIE UNIT 1 LOSS OF CONDENSER VACUUM ANALYSIS INITIAL CONDITIONS AND ASSUMPTIONS USED IN THE REFERENCE SUBMITTAL AND IN THE FSAR

PARAMETER / ASSUMPTION	REF. SUBMITTAL	FSAR	
Core Power (%)	102	102	
Pressurizer Pressure (psia)	2203	2203	
Pressurizer Level (% NR)	65.6	65.6	
RX. Trip on HI PRZR Pres. Setp. (psia)	2422	2422	
PRZR. Safety Valve Setpoint (psia)	2525	2575	(1)
Core Inlet Temperature (°F)	547	540	(2)
RCS Flow (gpm)	370000	370000	
Steam Generator Tube Plugging (%)	15	15	
Steam Generator Pressure (psia)	813	772.5	(3)
MSSV 1st. Bank Setpoint (psia)	1010	1010	
MSSV 2nd. Bank Setpoint (psia)	1050.4	1050.4	
MTC (pcm/°F)	+2	+7	(4)
Doppler Coefficient (pcm/°F)	-0.8	-1	(5)
Beta Effective (* 1.E-5)	710	710	
Scram Reactivity Curve	Bottom Peaked	Bottom Peaked	
Scram Reactivity (% Delta Rho)	-5.3	-5.3	
Feedwater Isolation	Instantaneous	Instantaneous	
Steam Dump Bypass Control System	Unavailable	Unavailable	
Pressurizer Pressure Control Syst.	Unavailable	Unavailable	
PORVs	Unavailable	Unavailable	

Footnotes for Table 1

(1) The FSAR analysis, performed by ANF, assumes a maximum valve tolerance of 3%. The value of 1% in the Reference Submittal is based on current St. Lucie Unit 1 Technical Specifications.

(2) The T_{cold} value of 547 °F in the Reference Submittal is based on the full power value of 549 °F minus 2 °F uncertainty [1].

(3) The steam generator pressure of 813 psia in the Reference Submittal has been calculated based on a 15% Steam Generator Tube Plugging level.

(4) The FPL's MTC value has been conservatively assumed from current St. Lucie Unit 1 Technical Specifications which stipulate that the MTC has to be less than +2 pcm/°F whenever the power level is above 70%. The +7 pcm/°F value used by the vendor corresponds to the Technical Specification limit at Hot Full Power Conditions.

(5) The FPL Doppler Coefficient is more conservative than that used in the FSAR.

TABLE 2

ST. LUCIE UNIT 1 LOSS OF CONDENSER VACUUM ANALYSIS RESULTS IN THE REFERENCE SUBMITTAL AND IN THE FSAR

EVENT	REFERENCE SUBMITTAL VALUE	REFERENCE SUBMITTAL TIME (S)	FSAR VALUE	FSAR TIME (S)
Peak RCS Press.(psia)	2603	9.6	2713	5.9
Peak SG Press. (psia)	1054	9.7	1034	8.0

TABLE 3

ST. LUCIE UNIT 2 LOSS OF CONDENSER VACUUM ANALYSIS
INITIAL CONDITIONS AND ASSUMPTIONS
USED IN THE REFERENCE SUBMITTAL AND IN THE FSAR

PARAMETER / ASSUMPTION	REF. SUBMITTAL	FSAR	
Core Power (%)	102	102	
Pressurizer Pressure (psia)	2167	2170	(1)
Pressurizer Liquid Volume (ft^3)	906	980	(2)
RX. Trip on HI PRZR Pres. Setp. (psia)	2428	2428	
PRZR. Safety Valve Setpoint (psia)	2525	2525	
Core Inlet Temperature (^{o}F)	532	535	(3)
RCS Flow (gpm)	363000	363000	
Steam Generator Tube Plugging (%)	15	17.8	(4)
Steam Generator Pressure (psia)	720.8	790	(5)
MSSV 1st. Bank Setpoint (psia)	1010	1010	
MTC (pcm/^{o}F)	+3	+3	
Doppler Coefficient (pcm/^{o}F)	-0.8	0.85*BOC	(6)
Beta Effective (* 1.E-5)	700	700	
Scram Reactivity Curve	Bottom Peaked	Bottom Peaked	
Scram Reactivity (% Delta Rho)	-5.5	-5.5	
Holding Coil Delay (sec)	0.74	0.74	
Feedwater Isolation	Instantaneous	Instantaneous	
Low Flow Trip (RCPs Off)	Simultaneous w/ React.Trip	Simultaneous w/ React.Trip	
Steam Dump Bypass Control System	Unavailable	Unavailable	
Pressurizer Pressure Control Syst.	Unavailable	Unavailable	
PORVs	Unavailable	Unavailable	

Footnotes for Table 3

(1) The initial value for the pressurizer pressure in the Reference Submittal is more conservative than that used in the current FSAR. The value in RETRAN is calculated by subtracting an uncertainty of 58 psia from the nominal pressure of 2250 psia. This uncertainty has been computed by subtracting the setpoint values, for the High Pressurizer Pressure Trip, used in the FSAR (2428 psia) and in the current Technical Specifications (2370 psia).

(2) The liquid volume in the Reference Submittal corresponds to the nominal full power level setpoint of 63% and is more conservative than that used in the FSAR. The lower the initial liquid level the longer will it take for the pressure to reach the setpoint for reactor trip on high pressure and more energy will be stored in the coolant. This results in a higher RCS peak pressure after the trip.

(3) The initial value for T_{cold} in the Reference Submittal is more conservative than that used in the current FSAR. The RETRAN value corresponds to the lowest temperature allowed by current Technical Specifications at full power (535 $^{\circ}$F) minus an uncertainty of 3 $^{\circ}$F.

(4) The current FSAR analysis has been done with 1500 tubes plugged in each steam generator which corresponds to a 17.8% Steam Generator Tube Plugging (SGTP) level. The SGTP level in the Reference Submittal corresponds to the minimum allowed RCS flow of 363,000 gpm. Table 2 in the Answer to General Approach Question # 2 shows that the actual level of SGTP at St. Lucie Unit 2 is still below 3%. The FPL's methodology in the Reference Submittal will be revised when the SGTP level approaches 15%. At that time the minimum allowed RCS flow in RETRAN and in the FSAR will have to be revised too.

(5) The initial steam generator pressure in the Reference Submittal is more conservative than that used in the current FSAR. The RETRAN value of 720.8 psia has been calculated based on a 15% Steam Generator Tube Plugging level.

(6) The Doppler reactivity feedback is calculated, in the FSAR, as a function of fuel temperature via a polynomial expression [2]. The Doppler reactivity feedback in the Reference Submittal is a temperature independent constant value. The fuel reactivity feedback is not a primary parameter in this event and therefore any small discrepancy in the Doppler Coefficients used in the FSAR and in the Reference Submittal is not expected to significantly affect the comparison between the two calculations.

TABLE 4

ST. LUCIE UNIT 2 LOSS OF CONDENSER VACUUM ANALYSIS RESULTS

IN THE REFERENCE SUBMITTAL AND IN THE FSAR

EVENT	REFERENCE SUBMITTAL VALUE	REFERENCE SUBMITTAL TIME (S)	FSAR VALUE	FSAR TIME (S)
Peak RCS Press.(psia)	2675	.11	< 2750	10
Peak SG Press. (psia)	1041	16	< 1100	17

TABLE 5

TURKEY POINT LOSS OF CONDENSER VACUUM ANALYSIS
INITIAL CONDITIONS AND ASSUMPTIONS
USED IN THE REFERENCE SUBMITTAL AND IN THE FSAR

PARAMETER / ASSUMPTION	REF. SUBMITTAL	FSAR	
Core Power (%)	102	102	
Pressurizer Pressure (psia)	2200	2220	(1)
Pressurizer Liquid Volume (ft^3)	808	808	
RX. Trip on HI PRZR Pres. Setp. (psia)	2455	2425	(2)
PRZR. Safety Valve Setpoint (psia)	2525	2525	
Core Inlet Temperature (°F)	542.2	550.2	(3)
RCS Flow (gpm)	268500	268500	
Steam Generator Tube Plugging (%)	5	5	
Steam Generator Pressure (psia)	834	850	(4)
MSSV 1st. Bank Setpoint (psia)	1111	1111	
MTC (pcm/°F)	+2	+5	(5)
Doppler Coefficient (pcm/°F)	-1	-1	
Scram Reactivity Curve	Bottom Peaked	Bottom Peaked	
Scram Reactivity (% Delta Rho)	-4	-4	
Feedwater Isolation	Instantaneous	Instantaneous	
Steam Dump Bypass Control System	Unavailable	Unavailable	
Pressurizer Pressure Control Syst.	Unavailable	Unavailable	
PORVs & Second. Atm. Relief Valves	Unavailable	Unavailable	

<u>Footnotes for Table 5</u>

(1) The FSAR uses a pressurizer pressure uncertainty of 30 psia which was recently revised to 50 psia [3]. According to Reference 5 the FSAR results are still valid with the new uncertainty of 50 psia. This new pressure uncertainty, which is more conservative than the old one, has been used in the Reference Submittal.

(2) The setpoint for the Reactor Trip on High Pressurizer Pressure used in the Reference Submittal is more conservative than the 2425 psia setpoint used in the current FSAR [6]. The value in RETRAN has been calculated by adding an uncertainty of 55 psia [6] to the Technical Specifications setpoint.

(3) The value of T_{cold} in the Reference Submittal is more conservative than that used in the current FSAR. The RETRAN value of 542.2 ^{o}F has been calculated by subtracting 4 ^{o}F uncertainty [3] from the nominal T_{cold} of 546.2 ^{o}F. In accordance with the other analyses in the Reference Submittal, the temperature uncertainty is subtracted from the nominal temperature to lower the initial steam generator pressure and to increase the delay in the opening of the secondary safety valves. This increases the severity of the transient.

(4) The initial steam generator pressure in the Reference Submittal is more conservative than that used in the current FSAR. The RETRAN value of 834 psia has been calculated based on a 5% Steam Generator Tube Plugging level.

(5) The MTC used in the Reference Submittal has been derived from Technical Specifications which allow a rampdown, as a function of power, from +5 pcm/^{o}F at 70% power to 0 pcm/^{o}F at 100% power. The value of +2pcm/^{o}F has been chosen for conservative reasons.

TABLE 6

TURKEY POINT LOSS OF CONDENSER VACUUM ANALYSIS RESULTS

IN THE REFERENCE SUBMITTAL AND IN THE FSAR

EVENT	REFERENCE SUBMITTAL VALUE	REFERENCE SUBMITTAL TIME (S)	FSAR VALUE	FSAR TIME (S)
Peak RCS Press.(psia)	2601	8.3	2554	10.0
Peak SG Press. (psia)	1151	15.7	1133	11.0

TABLE 7

TURKEY POINT LOSS OF NON-EMERGENCY AC POWER ANALYSIS INITIAL CONDITIONS AND ASSUMPTIONS USED IN THE REFERENCE SUBMITTAL AND IN THE FSAR

PARAMETER / ASSUMPTION	REF. SUBMITTAL	FSAR	
Core Power (%)	102	102	
Pressurizer Pressure (psia)	2300	2280	(1)
Pressurizer Liquid Volume (ft^3)	808	808	
RX. Trip on LO SG Level (% NR)	10	10	
Core Inlet Temperature (^oF)	550.2	550.2	
RCS Flow (gpm)	268500	268500	
Steam Generator Tube Plugging (%)	5	5	
Steam Generator Pressure (psia)	831	850	(2)
MSSV 1st. Bank Setpoint (psia)	1111	1111	
MTC (pcm/^oF)	+2	0	(3)
Doppler Coefficient (pcm/^oF)	-1	-1	
Beta Effective (* 1.E-5)	750	750	
Scram Reactivity Curve	Bottom Peaked	Bottom Peaked	
Scram Reactivity (% Delta Rho)	-4	-4	
Loss of Power to RC Pumps	4 sec. After Reactor Trip	4 sec. After Reactor Trip	
Feedwater Isolation	Instantaneous	Instantaneous	
Steam Dump Bypass Control System	Unavailable	Unavailable	
Pressurizer Spray	Available	Available	
PORVs	Available	Available	
Total Available Aux.Feedw. (gpm)	110 After 3min 230 After 10min	125 After 3min 230 After 10min	

Footnotes for Table 7

(1) The FSAR uses a pressurizer pressure uncertainty of 30 psia which was recently revised to 50 psia [3]. According to Reference 5 the FSAR results are still valid with the new uncertainty of 50 psia. This new pressure uncertainty, which is more conservative than the old one, has been used in the Reference Submittal.

(2) The lower initial steam generator pressure in the Reference Submittal tends to delay the opening of the secondary safety valves and therefore is more conservative than that used in the FSAR.

(3) The MTC used in the Reference Submittal is more conservative than that used in the FSAR. The FPL's value in the Reference Submittal has been derived from Technical Specifications which allow a rampdown, as a function of power, from +5 pcm/^{o}F at 70% power to 0 pcm/^{o}F at 100% power.

TABLE 8

TURKEY POINT LOSS OF NON-EMERGENCY AC POWER ANALYSIS RESULTS

IN THE REFERENCE SUBMITTAL AND IN THE FSAR

EVENT	REFERENCE SUBMITTAL		FSAR	
	VALUE	TIME (S)	VALUE	TIME (S)
Peak Water Volume in Pressurizer (ft^3)	1020	720	1300	3720
Cold Auxiliary Feedw. Delivered to SGs After Hot Fluid Volume in Piping is Purged	see note	1095	see note	1080

note
Both calculations use the same 110 ft^3 volume of warmer stagnant fluid that has to be swept out of the piping before the colder auxiliary feedwater can enter the steam generators.