Florida Power
CORPORATION
Crystal River Unit 3
Docket No. 50-302

December 4, 1997
3F1297-12

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: Additional Information Regarding the Post-LOCA Boron Precipitation Prevention Plan for CR-3

References: 1. FPC to NRC letter dated October 31, 1997, "License Amendment Request #223, Revision 0 - Post-LOCA Boron Precipitation Prevention" [3F1097-32]

2. NRC to B&WOG letter dated March 9, 1993, "Post-LOCA Reactor Vessel Recirculation to Avoid Boron Precipitation" [3N0393-18]

Dear Sir:

Florida Power Corporation (FPC) hereby provides additional information regarding the post loss of coolant accident (LOCA) boron precipitation prevention plan that was submitted with License Amendment Request (LAR) #223 (Reference 1) for Crystal River Unit 3 (CR-3). This information includes the results of recent calculations and additional details as discussed with Mr. Warren Lyon of your staff during the week of November 3, 1997, and on November 20, 1997.

In LAR #223, FPC stated that for some low probability LOCA scenarios, the passive hot leg nozzle gap method of post-LOCA boron precipitation prevention would be relied upon as a primary method until the active methods would be effective. In support of FPC, Framatome Technologies Incorporated (FTI) has performed calculations to show that the active methods of post-LOCA boron dilution will be effective for all postulated break sizes. Therefore, the hot leg nozzle gaps will not be relied upon as a primary method for post-LOCA boron precipitation prevention.

The results of the calculations are discussed below along with the additional requested information.

Auxiliary Pressurizer Spray and Drop Line to RB Sump

FTI has performed detailed analyses and evaluations to confirm the performance of the active methods of post-LOCA boron precipitation prevention for CR-3. The active methods being used are the drop line to the reactor building (RB) sump [DL-RB Sump] A001/1

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and hot leg injection with auxiliary pressurizer spray [APS]. These methods were described in LAR #223. Use of these methods consists of steps to initiate an active method and steps to confirm that the method has been initiated and is effective. The steps are summarized below.

Initiation of active methods

The APS method using the A train of the low pressure injection (LPI) system is initiated by the following steps.

1. "A" train LPI system flow is throttled to 1100 to 1300 gpm to ensure the maximum head available for APS flow to the pressurizer while still ensuring abundant core cooling.

2. Valves DHV-91 and RCV-53 are opened - verified by position indications.

If the A train LPI pump is not operating, APS is initiated using the B train of LPI by the following steps.

1. "B" train LPI system flow is throttled to 1100 to 1300 gpm to ensure the maximum head available for APS flow to the pressurizer while still ensuring abundant core cooling.

2. The A train of the reactor building spray is stopped.

3. DC knife switches in the 4160V Switchgear Room located on the second floor of the Control Complex (108' elevation) are opened for the Engineered Safeguards (ES) pumps in the affected train. This action is performed to protect against inadvertent start of the pumps.

4. Cross connect LPI trains by opening DHV-7 and DHB-8 - verified by position indications.

5. Valves DHV-91 and RCV-53 are opened - verified by position indications.

The DL-RB Sump method is initiated by securing one LPI train and preparing the train for flow from the hot leg to the RB sump using the drop line. The actions required by the DL-RB Sump method are discussed below.

1. DC knife switches in the 4160V Switchgear Room located on the second floor of the Control Complex (108' elevation) are opened for the ES pumps in the affected train. This action is performed to protect against inadvertent start of the pumps.

2. Valves DHV-4, DHV-41, DHV-39 (or DHV-40) are fully opened - verified by position indications.

3. The seal-in for the sump suction valve (DHV-42 or DHV-43) is defeated in order to allow the valve to be opened to a mid-position. Defeating the seal-in prevents energizing relays which would normally ensure that the valve would travel to the full

open or full closed position when the main control board control switch is released to the normal position.

4. The RB sump suction valve DHV-42 (or DHV-43) is stroked for 6 seconds. A flow path to the RB sump will not exist until DHV-3 is opened in the following step. This will ensure that DHV-42 (or DHV-43) can be adequately positioned before the flow path to the RB sump is established. Training on the Emergency Operating Procedures (EOP) has addressed the technique to be utilized to obtain consistent and accurate valve stroking. Analyses have established an acceptable stroke time of 5.5 to 6.5 seconds for these valves.

   Note: One failure mode, that was evaluated with respect to this action, is the failure of the switch to return to its normal position. This would result in the valve traveling to the full open position even though the seal-in is bypassed. Another failure mode would be the possibility of lifting the wrong lead for the seal-in. If the valve is full open, and the final isolation valve is opened (step 5 below), the sump screens may fail as a result. Operators are aware of this potential failure mode and will ensure the valve is properly positioned prior to opening the final isolation valve. This ensures the two identified failure modes can be managed.

5. DHV-3 will then be fully opened aligning the drop line to the RB sump - verified by position indication.

<u>Confirmation of method effectiveness</u>

Following initiation of either active method, the following indications will be used to confirm that the selected boron dilution flow path is effective.

1. Verify increase in temperature in the flow path (this confirms that flow has commenced in the affected line).

   This step will be performed using thermocouples that are being installed on the drop line and auxiliary pressurizer spray line. Remote readout of these thermocouples will be provided in the main control room. These thermocouples will be installed prior to entering Mode 2 from the current outage.

2. For APS method only - verify an increase in pressurizer level.

3. Verify that the sump boron concentration begins an increasing trend as measured by the post accident sampling system (PASS).

FTI Analyses

The results of the FTI analyses show that reliance on alternative means (e.g., hot leg nozzle gaps) is not needed for any scenario absent a single failure. Figures 1 and 2 provide the results of these analyses in graphical form.

As shown in Figure 1, at least one of the active methods will be effective in any LOCA break scenario prior to the core boron concentration reaching the solubility limit. This figure represents conservative calculations that were performed assuming 1.2 times the ANS 1971 values for core decay heat to show compliance with 10 CFR 50.46 criteria for long term core cooling. This graph shows the areas where DL-RB Sump and APS would be effective. Additionally, the area where boron solubility limits would be reached is shown. As shown on the figure, one of the active methods would be effective prior to pressure decreasing to where the boron solubility limit could be reached.

In the case of a large break LOCA (LBLOCA) where pressure decreases rapidly, approximately 15 hours would be available to implement an active method of post-LOCA boron precipitation prevention. No credit is taken for hot leg nozzle gap flow.

Additional calculations were performed based on more realistic (yet conservative) core decay heat values (1.0 times the ANS 1971 values of core decay heat). The results of these calculations are shown in Figure 2. Using these values of core decay heat, both the DL-RB Sump and APS methods would each be effective for a greater range of LOCA break sizes. The results of these calculations will be used in the Technical Support Center (TSC) guidance describing actions that will be taken in post-accident conditions to control boron precipitation. This will reflect a more realistic representation of expected plant response.

RB Sump Sampling

The methodology of sampling RB sump boron concentration was described in LAR #223. Boron concentration in the RB sump will be used as an indication of boron concentration in the core region and, therefore, as a measurement for initiating an active method and confirming the effectiveness of boron dilution.

In addition to using the PASS boronometer as described in LAR #223, other means of RB Sump sampling would be available if post-accident dose rates were not prohibitive. Excessively high dose rates are not anticipated since fuel failure would not be expected. Normal sample points on the decay heat system could be used as an alternative or to validate the accuracy of the PASS boronometer.

Sump sampling is effective for determining adequate core boron concentration decrease for both APS and DL-RB Sump methods. The amount of time required to obtain feedback regarding the effectiveness of the boron dilution method will be a function of the boron dilution method used as discussed below.

As shown in Figure 2 using realistic decay heat values, the APS method will become effective approximately 24 hours post-LOCA. Following initiation of APS as directed by the TSC, there will be a delay of 1.5 to four hours while the pressurizer is being filled prior to APS flow entering the reactor vessel. The time required to fill the pressurizer is a function of reactor coolant system (RCS) pressure. The upper limit of four hours is based upon the APS flow rate at an RCS pressure of 135 psia and is acceptable since core solubility limits cannot be reached for RCS pressures above approximately 72 psia. For RCS pressures where APS would be required, a two to three hour pressurizer fill time is more representative. Additionally, it should be noted that actual APS flow will be higher than calculated values based on RCS pressure since the pressure in the pressurizer will be lower than RCS pressure due to condensation of the steam space by the spray.

An increase in pressurizer level as indicated on the pressurizer level instrumentation will confirm that APS flow is occurring prior to when flow to the hot leg begins. Once flow to the hot leg begins, concentrating of the boron in the core will cease due to the internal mixing in the core and the additional flow of APS above core boil off. After APS flow reaches the core, the decrease in RB sump boron concentration associated with the increase of boron concentration in the core will stop as break flow reaches the RB sump. The minimum expected flow during operation from the sump will be approximately 3000 gpm (assumes one LPI pump , one HPI pump, and one reactor building spray pump are operating). Based on an RB flood volume of approximately 300,000 gallons, one turnover of the RB volume will occur every 100 minutes. Adequate mixing in the RB sump should occur in about three to four hours after the RB flood volume has turned over a few times. The total time for the response of the boronometer to the APS flow (two to three hours for pressurizer fill and three to four hours for adequate mixing) is acceptable for the use of APS because during this period of time it is expected that APS will at least begin the reduction in core region boron concentration. If this is not the case, then sufficient time exists following indication from the boronometer to take other actions (or verify that the actions taken were implemented properly) since any boric acid coming out of solution would only be that associated with the concentration at or above the solubility limit.

The DL-RB Sump method drains the hot leg to the RB sump by opening the drop line valves and having concentrated boron in the core region flow down the drop line to the sump. Flow to the core region is replaced by less borated water from the downcomer. Once the DL-RB Sump method is initiated, the lowest flow velocity in the drop line (based on minimum expected valve opening) will be approximately 0.1 ft/sec. Approximately 300 feet of drop line piping is involved in the flow path to the sump. Thus, it could take as long as one hour for the RCS to drain to the sump. The thermocouple response to higher drop line temperatures will be expected sooner. The lag time between the hot leg discharge into the sump and the sump concentration sample to the boronometer will vary based upon the flow rate which occurs through the drop line. The sump concentration will increase as a result of mixing in the sump due to drop line flow directly reaching the sample point and flow to the sump from the break as discussed in the APS method above. Flow rates well in excess of the minimum 0.1 ft/sec. will be experienced for the majority of breaks for which there will be a pressure differential between the RCS and RB. Considering the minimum of 15 hours for reaching the solubility limit for a LBLOCA, there is sufficient time to confirm the effectiveness of the DL-RB Sump method prior to reaching the core solubility limit.

Hot Leg Injection via Reverse Flow through Portions of Low Pressure Injection

FPC is developing an additional active method that will provide defense in depth for the current active methods of post-LOCA boron dilution. This method, which provides hot leg injection via reverse flow through a non-operating low pressure injection (LPI) pump [HLI-RF], will require NRC approval prior to implementation. Reliance on this method of boron dilution is not required prior to the restart of CR-3 and is not credited in this submittal. The following information is provided as a preliminary summary of the topical report to be submitted and is included here to provide a more complete understanding of the boron dilution methods available.

FPC, with support from FTI, has evaluated the use of this method of post-LOCA boron precipitation control for CR-3 and has found it acceptable. The FTI evaluation of this method is documented in FTI document 51-5000519-03 which was included as Attachment D of LAR #223. As part of the ongoing calculations described in this submittal, the analyses for HLI-RF are being revised.

In FTI Document 51-5000519-03, FTI recommends that the HLI-RF alignment provide flow for one high pressure injection (HPI) system pump (600 gpm), a minimum hot leg injection flow of at least 500 gpm for boron dilution, and approximately 1000 gpm into one core flood tank (CFT) nozzle. A minimum HLI-RF flow of 500 gpm will provide sufficient reverse flow to dilute the core boron concentration and prevent boron precipitation.

FPC has performed a hydraulic analysis of the LPI system to demonstrate that the HLI-RF flow requirements determined by FTI will be met. This analysis also evaluated the impact of reverse flow through the affected LPI components, including the LPI pump. Hydraulic modelling of the LPI system concluded that the operating LPI pump is capable of supplying 500 to 1000 gpm of reverse flow through the drop line throughout the range of RCS pressures for which reverse flow would be required. The hydraulic model included each of the flow paths for the operating LPI pump and ensured adequate flow rates were available. Net positive suction head (NPSH) required and available for the LPI pump in this configuration was also evaluated to ensure cavitation within the pump would not occur.

Additionally, components within the flow path for this method were evaluated for the effects of reverse flow. Components evaluated for reverse flow include the pump, pump seals, and pump motors for the LPI pumps, the control valve, and the heat exchanger. This review of LPI components subjected to reverse flow conditions indicates that all components will perform acceptably under flow rates of 500 to 1000 gpm.

FTI evaluated the potential effects of reverse core flow on the fuel and reactor vessel internal components. For the expected flow rates, FTI concluded that no adverse effects would occur. These results are documented in FTI document 51-5000519-03.

Guidance for the use of the HLI-RF method will be proceduralized in Emergency Plan Implementing Procedure EM-225B, "Post-Accident Boron Concentration Management," prior to plant restart. This post-LOCA boron dilution method will only be implemented at the direction of the TSC. Procedures will be available for stopping HLI-RF and re-establishing normal emergency core cooling system (ECCS) flow through the idle LPI pump as dictated by plant conditions.

Decision Matrix

Utilization of post-LOCA boron dilution methods at CR-3 will be coordinated in the TSC using the decision matrix provided in LAR #223. The decision matrix shows the logic for determining the actions to be taken if subcooled conditions cannot be achieved following a LOCA. Prior to initiating an active method, operators have RCS temperature, pressure, subcooling margin, and RB sump boron concentration as a means to track system conditions. As long as adequate subcooling margin exists, there will be no need to initiate an active method of boron dilution since the boron concentrating mechanism does not exist.

After swap over of the ECCS suction to the RB sump, sump boron sampling will be initiated. Post-LOCA boron precipitation prevention controls will be initiated using a symptom based approach. RB sump boron concentration will be used as an indication of approaching core boron solubility limits. If core boron solubility limits are being approached, the decision matrix would direct the establishment of an active method of post-LOCA boron dilution. The TSC will determine when the active dilution method should be initiated as well as which method should be initiated. The TSC guidance will contain a discussion of necessary analyses associated with post-LOCA boron precipitation including lag time for boronometer response as well as expected plant response to initiation of the active method chosen. The determination of which active method should be initiated, as well as the determination of when an active method of post-LOCA boron dilution will be initiated, will be based upon realistic values rather than conservative analytical values. Based on actual plant conditions and core decay heat values, APS will realistically be effective much earlier than analyzed with conservative core decay heat assumptions. Decision making based on actual plant values could allow the use of APS instead of other boron dilution methods that would require securing one train of ECCS.

Single Failure

Single failure was addressed in LAR #223. As described in this letter, calculations show that active methods of post-LOCA boron dilution will be effective for all postulated break sizes. Also, as discussed in LAR #223, the failure of ES motor control center (MCC) 3AB can render the DL-RB Sump and APS active methods inoperable because valves DHV-41, DHV-53, and RCV-91 are powered from ES MCC 3AB. A procedure will be developed to provide actions that will be taken to repower affected valves on the drop line and auxiliary pressurizer spray flow paths upon the failure of ES MCC 3AB. For this failure, sufficient time will be available to repower necessary valves from available power sources to initiate the necessary flow path. If this failure occurs following the initiation of a method, the affected valves will fail as-is and will not affect the boron dilution flow path.

If the DL-RB Sump and APS method are not available, reliance on hot leg nozzle gap flow as a backup method will adequately prevent boron precipitation. This is consistent with the conclusions in Reference 2.

As stated above, calculations have been performed that show the active methods of post-LOCA boron dilution will be effective for all postulated break sizes. Therefore, the hot leg nozzle gaps will be relied upon only as a backup method for post-LOCA boron precipitation prevention consistent with Reference 2. Based on the results of the calculations as provided in this letter along with the evaluations provided as part of LAR #223, FPC considers that CR-3 is operable with regards to post-LOCA boron precipitation prevention, and operation of the plant is justified. This conclusion is based upon the methods and procedures that CR-3 will have in place to adequately control post-LOCA boron precipitation. Therefore, approval of LAR #223 is not required prior to restart of CR-3.

The technical results of the FTI calculations have been verified by FTI. FPC will complete the review of these calculations by December 12, 1997 and promptly incorporate them into FPC's records in order to support the review and approval of LAR #223. FPC will submit the formal FTI summary reports that document the results of these calculations by February 27, 1998. Accordingly, FPC requests approval of LAR #223 by March 31, 1998.

The additional information provided in this letter does not affect the previous conclusions of the 'No Significant Hazards Consideration' provided for LAR #223 in accordance with 10CFR50.92(c), and FPC does not consider that an additional public notice in accordance with 10CFR50.91(a)(2) is necessary. If you have any questions regarding this submittal, please contact Mr. David Kunsemiller, Manager, Nuclear Licensing at (352) 563-4566.

Sincerely,

J. J. Holden

John J. Holden
Director
Site Nuclear Operations

JJH/dah
Enclosures

cc: Regional Administrator, Region II
NRR Project Manager
Senior Resident Inspector

Figure 1. Matchup Times and Time to Solubility 1.2 ANS 1971
Without Gap Flow or Active Boron Dilution

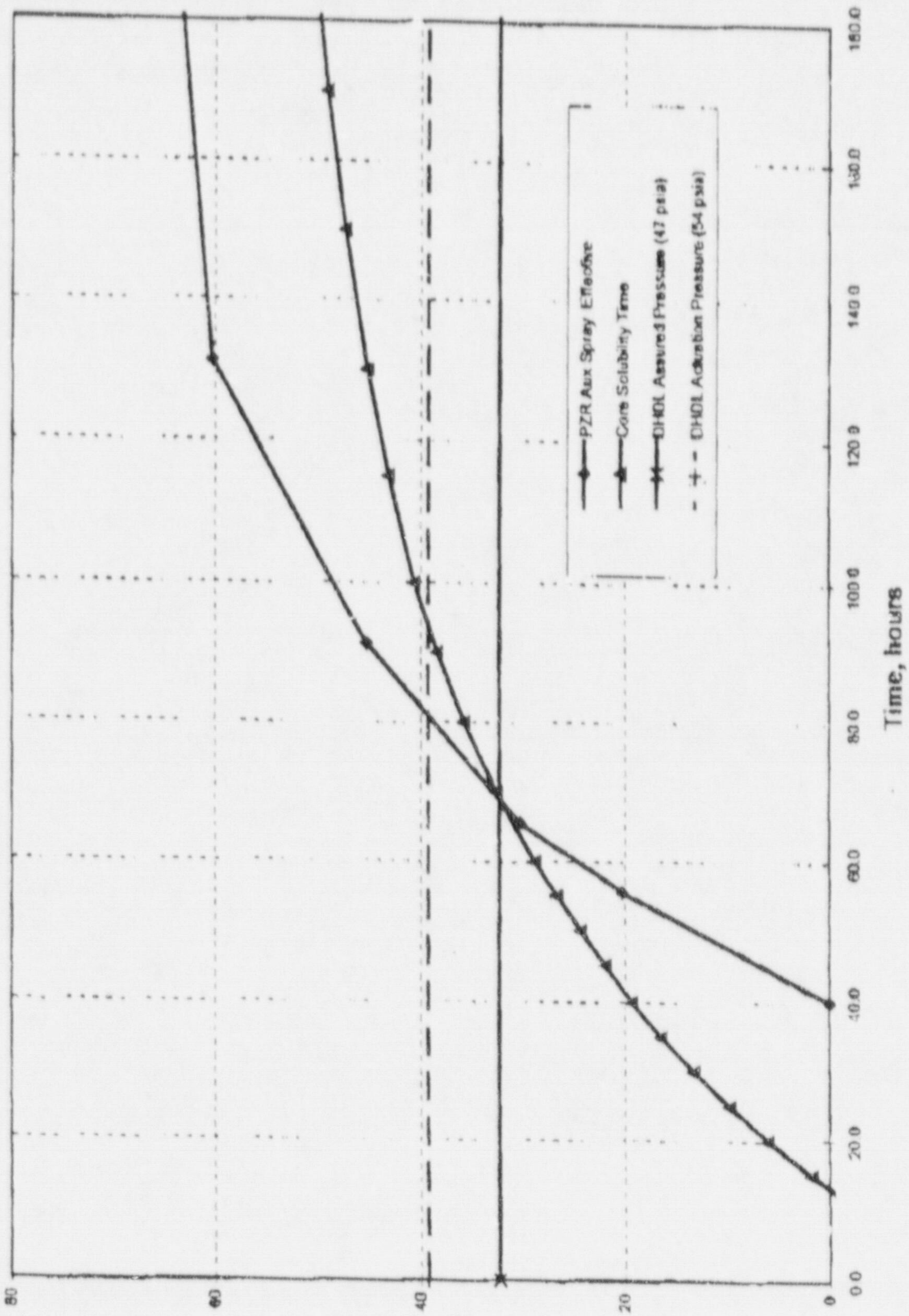
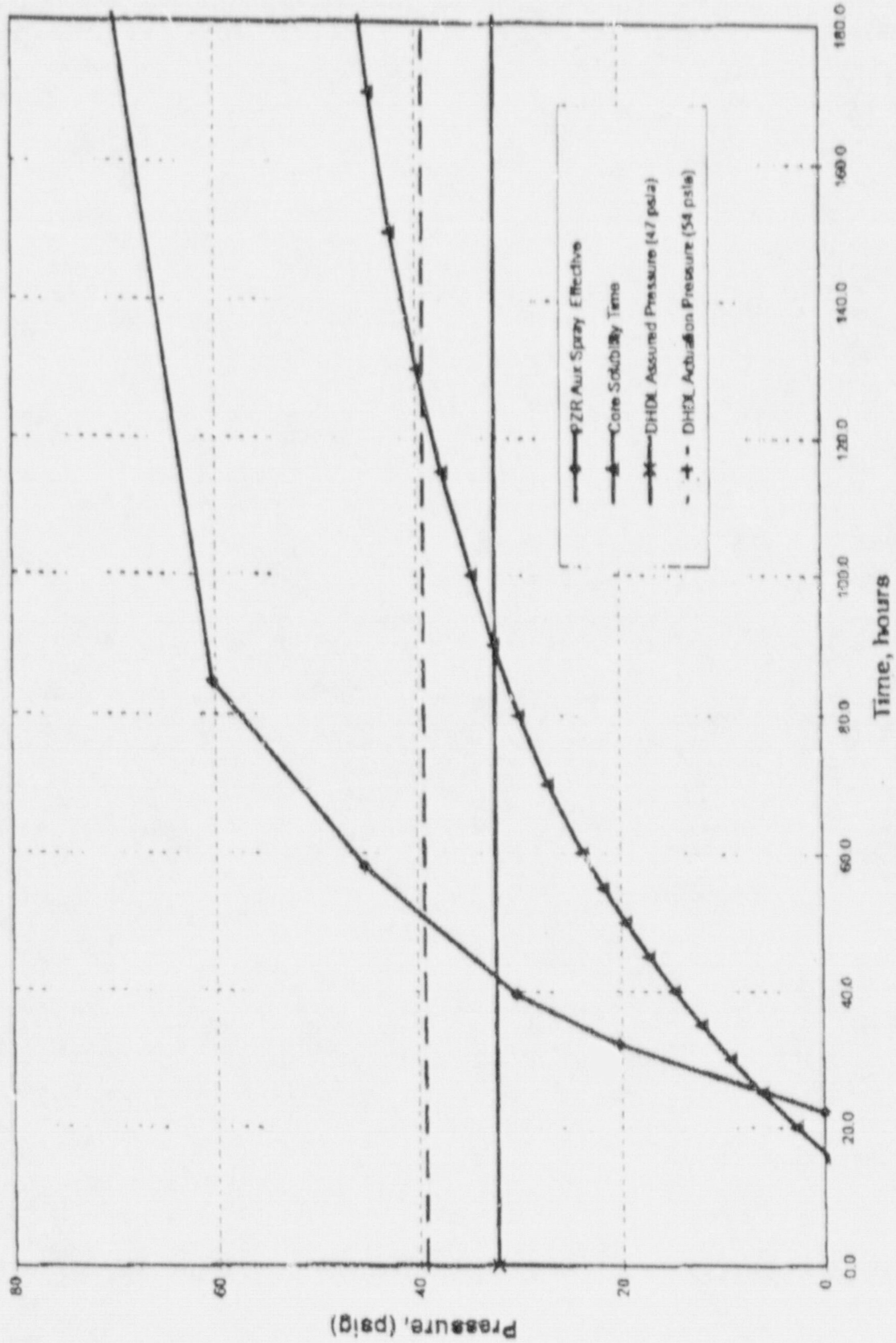


**Figure 2. Matchup Times and Time to Solubility 1.0 ANS 1971
Without Gap Flow or Active Boron Dilution**



LIST OF COMMITMENTS

The following table identifies those actions committed to by Florida Power Corporation in this document. Any other actions discussed in the submittal represent intended or planned actions by Florida Power Corporation. They are described to the NRC for the NRC's information and are not regulatory commitments. Please notify the Manager, Nuclear Licensing of any questions regarding this document or any associated regulatory commitments.

Letter Reference	Commitment	Due Date
Page 3	This step will be performed using thermocouples that are being installed on the drop line and auxiliary pressurizer spray line. Remote readout of these thermocouples will be provided in the main control room. These thermocouples will be installed prior to entering Mode 2 from the current outage.	Prior to Mode 2
Page 7	A procedure will be developed to provide actions that will be taken to repower affected valves on the drop line and auxiliary pressurizer spray flow paths upon the failure of ES MCC 3AB.	Prior to Mode 2
Page 8	The technical results of the FTI calculations have been verified by FTI. FPC will complete the review of these calculations by December 12, 1997 and promptly incorporate them into FPC's records in order to support the review and approval of LAR #223.	December 12, 1997
Page 8	FPC will submit the formal FTI summary reports that document the results of these calculations by February 27, 1998.	February 27, 1998

ENCLOSURES

Enclosure 1 — FPC Calculation M97-0097, "Low Pressure Auxiliary Spray Flow Rate for Boron Precipitation"

Enclosure 2 — Simulator Exercise Number ROT-9-200, "Boron Precipitation Control"

Enclosure 3 — CH-632D, "Post Accident Sampling and Analysis of Reactor Building Sump"

Enclosure 4 — Boron Precipitation Risk Analysis