Florida Power
CORPORATION
Crystal River Unit 3
Docket No. 50-302
Operating License No. DPR-72

October 22, 1998
3F1098-05

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

Subject: Low Pressure Injection Engineering Study

Reference: FPC to NRC letter, 3F0298-11, dated February 6, 1998, "Low Pressure Injection Crossover During Long-Term Cooling"

Dear Sir:

The purpose of this letter is to provide the results of the Low Pressure Injection (LPI) Engineering Study, conducted by Florida Power Corporation (FPC) to fulfill the commitment made to the NRC in the referenced letter. This commitment was the result of several questions raised during the recent NRC Emergency Operating Procedures (EOP) Inspections (50-302/97-12 and 50-302/98-02).

FPC committed to analyze system configuration and consider possible engineering solutions to enhance system performance. This analysis was to include further review of the normal standby positions of the LPI injection valves (DHV-5 and DHV-6) and the LPI suction valves from the borated water storage tank (DHV-34 and DHV-35). In addition, the analysis was to evaluate the continued use of DHV-5 and DHV-6 for throttling flow during LPI/high pressure injection (HPI) piggyback injection and LPI crossover injection.

FPC previously committed to submit documentation to resolve an Unreviewed Safety Question (USQ) related to maintaining valves DHV-34 and DHV-35 normally closed. This documentation was submitted under separate correspondence as License Amendment Request (LAR) #229.

FPC has completed the evaluation phase of the LPI Engineering Study and has determined that modifications to the LPI system would be beneficial to improving LPI system performance and reducing operator burden during emergency LPI system operation. A description of the design issues involving LPI that were addressed by the LPI Engineering Study is contained in Attachment A (LPI Engineering Issues). A description of the proposed modification to the LPI system is contained in Attachment B (Proposed LPI Modification).

Attachment C (List of Commitments) provides details of the commitment to modify the LPI system made in this submittal.

If you have any questions regarding this submittal, please contact Ms. Sherry Bernhoft, Manager, Nuclear Licensing at (352) 563-4566.

Sincerely,

J.J. Holden
Director
Site Nuclear Operations

JJH/gew

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

Attachments

A. LPI Engineering Issues
B. Proposed LPI Modification
   Figure 1: Current LPI Configuration
   Figure 2: Proposed LPI Configuration
C. List of Commitments

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302/LICENSE NUMBER DPR-72

ATTACHMENT A

LOW PRESSURE INJECTION ENGINEERING STUDY

LPI Engineering Issues

ATTACHMENT A

LPI ENGINEERING ISSUES

BACKGROUND

As a result of design issues related to the low pressure injection (LPI) system, Florida Power Corporation (FPC) committed to analyze LPI system configuration and consider possible engineering solutions to enhance LPI system performance. The evaluation phase of the LPI Engineering Study has been completed, and FPC has determined that modifications to the LPI system would be beneficial to improve LPI system performance and reduce operator burden during emergency LPI system operation.

DESCRIPTION OF LPI EMERGENCY OPERATING MODES

For reference, the normal standby configuration of LPI is described in Attachment B, and the major components of the system are schematically shown in Figure 1 of Attachment B. The LPI system is capable of being operated in three distinct emergency operating modes for the mitigation of loss-of-coolant accidents (LOCAs). These emergency operating modes are implemented by the Emergency Operating Procedures (EOPs) and other procedures, and include LPI injection, LPI/high pressure injection (HPI) piggyback injection, and LPI crossover injection.

LPI Injection

Following an engineered safeguards actuation system (ESAS) safety injection signal, the normally closed valves in the LPI emergency core cooling system (ECCS) flow path from the borated water storage tank (BWST) to the reactor coolant system (RCS) open automatically. These include the LPI and building spray (BS) suction valves from the BWST (DHV-34 and DHV-35) and the LPI injection valves (DHV-5 and DHV-6). The LPI pumps receive a start signal during sequential electrical loading of the emergency power busses.

Once the LPI pumps start, automatic LPI flow control valves (DHV-110 and DHV-111) become enabled to control flow at the established setpoint of 3000 gpm.

At some point in time, the BWST will near depletion. At that time, the EOPs contain instructions for the operator to establish ECCS recirculation by opening the LPI and BS suction valves from the reactor building (RB) sump (DHV-42 and DHV-43). Once valves DHV-42 and DHV-43 are open, the operator closes valves DHV-34 and DHV-35.

LPI/HPI Piggyback Injection

After initial establishment of LPI injection, the EOPs contain instructions for aligning the LPI and HPI systems for LPI/HPI piggyback injection. This alignment is implemented during ECCS injection prior to establishing ECCS recirculation. LPI/HPI piggyback operation may also be used to establish certain configurations required for boron precipitation control during ECCS recirculation.

To implement LPI/HPI piggyback injection, the operator first manually throttles LPI injection flow for the affected LPI train using DHV-5 or DHV-6. The associated LPI flow control valve (DHV-110 or DHV-111) will fully open because of the throttling of DHV-5 or DHV-6 to less than 3000 gpm. The operator then opens the LPI to HPI suction valve (DHV-11 or DHV-12) for the associated HPI pump. If not already running, the operator starts the HPI pump and establishes desired HPI injection flow using the HPI control valves (MUV-23, MUV-24, MUV-25, and MUV-26).

Once LPI/HPI piggyback injection is established, the operator is instructed to monitor LPI flow and manually adjust DHV-5 or DHV-6 as necessary to ensure adequate LPI pump net positive suction head (NPSH) is maintained.

LPI Crossover Injection

Maintenance activities may be required during long-term cooling following an accident. In this instance, procedures exist to provide instructions for the use of one LPI pump to provide LPI injection through both LPI injection lines. This configuration is known as LPI crossover injection. In order to maintain adequate core cooling, LPI crossover injection may only be used based on specific criteria detailed in procedures.

To implement LPI crossover injection, the operator must first verify the selected train LPI pump is operating in the LPI/HPI piggyback injection mode of operation. The operator then stops the opposite LPI pump, and isolates the opposite LPI train from the BWST, RB sump, RCS and associated HPI pump. The operator then further reduces LPI injection flow in the selected LPI train by manually throttling DHV-5 or DHV-6. The associated LPI flow control valve (DHV-110 or DHV-111) remains fully open because of the throttling of DHV-5 or DHV-6 to less than 3000 gpm. The operator opens the LPI crossover valves (DHV-7 and DHV-8), and establishes balanced flows to both LPI injection flow paths by further manual adjustments of DHV-5 and DHV-6.

Once LPI crossover injection is established, the operator is instructed to monitor LPI flow and manually adjust DHV-5 and/or DHV-6 as necessary to ensure adequate LPI pump NPSH is maintained, and ensure the proper split of LPI injection flows.

LPI ISSUES

Normal Standby Position of Valves DHV-34 and DHV-35

In 1997, the NRC conducted a Safety System Functional Inspection of the makeup and purification (MU) and decay heat removal (DH) systems. Based on this inspection, the NRC issued Notice of Violation (NOV) 50-302/97-14-13, "Failure to Take Adequate Corrective Actions to Identify and Correct the Design Weaknesses Associated with Adequacy of the Past 10 CFR 50.59 Review for Positioning of DHV-34 and DHV-35 During Normal Operation." This NOV was the result of an Unreviewed Safety Question (USQ) that was created in 1985 by changing the normal standby position of valves DHV-34 and DHV-35 from normally open to normally closed.

FPC has completed evaluation of this NOV, and has determined that a change to the Crystal River Unit 3 (CR-3) licensing basis is required to resolve this USQ. The LPI Engineering Study confirmed that maintaining the normal standby position for valves DHV-34 and DHV-35 normally closed is acceptable and has no adverse impact on the LPI system. Justification for the acceptability of this change was provided under separate correspondence as License Amendment Request (LAR) #229. This issue will be resolved upon approval of LAR #229.

Normal Standby Position of Valves DHV-5 and DHV-6

In 1997, the NRC conducted an inspection of the recently revised EOPs. In the final inspection report, Unresolved Item (URI) 50-302/97-12-09, "Failure to Normally Position LPI Injection Valves Open," was opened. The issues addressed by this URI include the possible impact of a failure of either valve to open on LPI injection, and the requirement to throttle LPI flow during LPI/HPI piggyback injection and LPI crossover injection (Reference NRC TAC No. MA2125).

Based on the NRC concerns expressed during this EOP inspection, FPC issued a letter to the NRC on February 6, 1998. In this submittal, FPC described the justification for maintaining valves DHV-5 and DHV-6 normally closed, and concluded that maintaining these valves normally closed is consistent with the CR-3 licensing and design basis. The LPI Engineering Study has confirmed this conclusion, and has found no adverse impact on the LPI system. Statements in the CR-3 Final Safety Analysis Report (FSAR) and the Improved Technical Specification (ITS) Bases are consistent with these valves being maintained normally closed.

Maintaining these valves normally closed does not affect the assumptions or the results of the CR-3 accident analyses as described in the CR-3 FSAR, and no revisions to CR-3 licensing documents are required. No single, active failure can result in the failure of both of these valves to automatically open upon receipt of an engineered safeguards actuation system (ESAS) safety injection signal. Only one train of LPI is required to mitigate the analyzed design basis accidents.

The current CR-3 probabilistic safety assessment (PSA) models the LPI system with valves DHV-5 and DHV-6 normally closed. Based on use of the PSA model, and assuming valves DHV-5 and DHV-6 are left normally open, the impact on the core-damage frequency (CDF) was estimated and determined to slightly decrease by 0.3%. This decrease in overall CDF is not considered risk significant as discussed in Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Current Licensing Basis," dated July 1998.

Use of LPI Crossover Injection

As a result of the 1997 EOP inspection, the NRC opened URI 97-12-06, "Previous LPI Crosstie Safety Evaluations," and URI 97-12-07, "Current LPI Crosstie Safety Evaluation."

The issue addressed by URI 97-12-06 included previous safety evaluations performed to support procedure changes in 1979 and 1996 that removed the use of LPI crossover injection from operating procedures. URI 97-12-07 addressed a 1998 safety evaluation performed to support a CR-3 FSAR change. The CR-3 FSAR change appeared inconsistent with the NRC-approved topical reports that formed the basis for approval of the ECCS design at CR-3.

FPC resolved these issues by implementing procedures that describe the use of LPI crossover injection as a defense-in-depth method of long-term core cooling. The required LPI emergency modes of operation to ensure compliance with 10 CFR 50.46 are LPI injection and LPI/HPI piggyback injection. LPI crossover injection may be used to provide additional defense-in-depth if certain multiple failures of ECCS equipment occur, or if certain maintenance activities are required, during long-term cooling following an accident. In order to maintain adequate core cooling, LPI crossover injection may only be used based on specific criteria detailed in these procedures.

In 1998, the NRC conducted a follow-up inspection of the recently revised EOPs. In the final inspection report, URI 50-302/98-02-08, "LPI Crossover Cooling Non-Single Failure Proof," was opened. The issue addressed by this URI included the fact that there were several single failures that would prevent the establishment of LPI crossover injection.

FPC has evaluated several alternatives that would eliminate the specific single failures that would prevent LPI crossover injection. The CR-3 PSA was examined for event sequences that may benefit from these enhancements of LPI crossover injection. If LPI crossover injection is enhanced to eliminate single failures, the reduction in the overall CDF would be no greater than 0.6%. This decrease in CDF is not considered risk significant as discussed in Regulatory Guide 1.174.

The current LPI configuration requires manual flow control by remote throttling of LPI injection valves DHV-5 and DHV-6 during LPI crossover injection. These valves are motor-operated gate valves not specifically designed for the throttling required. and multiple manual operator actions are required to establish required flows to both LPI injection lines. The proposed LPI modifications described in Attachment B will significantly improve implementing LPI crossover injection by use of the new, automatic flow control valves as described in Attachment B.

LPI/HPI Piggyback Injection Testing

In 1998, the NRC conducted a follow-up inspection of the recently revised EOPs. In the final inspection report, NOV 50-302/98-02-09, "Inadequate Piggyback Testing," was issued. The issue addressed by this NOV included the fact that there had not been an acceptable preoperational testing program to demonstrate the flow stability of LPI/HPI piggyback injection, and specifically discussed the lack of testing LPI/HPI piggyback injection at the maximum possible flow rates.

FPC responded to this NOV in a letter dated April 15, 1998, which included a commitment to develop a testing program to demonstrate the capability of LPI during LPI/HPI piggyback injection. The resultant testing was committed to be implemented prior to restart from the next scheduled refueling outage (Refueling Outage 11).

As described in NOV 50-302/98-02-09, preoperational testing of LPI/HPI piggyback injection was performed with valves DHV-5 and DHV-6 maintained closed and with HPI flow throttled to ~300 gpm. The operation of LPI/HPI piggyback injection in the most limiting configuration described in the EOPs has not been tested. This configuration includes each LPI pump injecting at ~2200 gpm while supplying ~600 gpm to the associated HPI pump. At these flows, DHV-5 and DHV-6 would be throttled to at least 95% closed. These valves are motor-operated gate valves not specifically designed for the throttling required.

The proposed LPI modifications described in Attachment B will significantly improve implementing LPI/HPI piggyback injection by use of the new, automatic flow control valves as described in Attachment B. Following modification, DHV-5 and DHV-6 will not require throttling for LPI/HPI piggyback injection. These modifications are to be implemented during Refueling Outage 11, and subsequent post-modification testing will be conducted prior to restart from the outage. This issue will be resolved upon implementation of the proposed modification and satisfactory completion of post-modification functional testing.

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ATTACHMENT B

LOW PRESSURE INJECTION ENGINEERING STUDY

Proposed LPI Modification

ATTACHMENT B

PROPOSED LPI MODIFICATION

REASON FOR MODIFICATION

Figure 1 provides a simplified schematic of the LPI system in the normal, standby condition. As shown, the LPI and BS suction valves from the BWST (DHV-34 and DHV-35), and the LPI and BS suction valves from the RB sump (DHV-42 and DHV-43), are maintained normally closed on the suction side of the LPI pumps. The LPI flow control valves (DHV-110 and DHV-111) are maintained throttled at a predetermined position that will ensure adequate, initial LPI injection flow, and the automatic flow controller left in automatic with a selected setpoint of 3000 gpm. The LPI injection valves (DHV-5 and DHV-6), and LPI crossover valves (DHV-7 and DHV-8), are maintained normally closed in the LPI injection flow path. In addition, the LPI to HPI suction valves (DHV-11 and DHV-12), and the auxiliary pressurizer spray (APS) valve (DHV-91) located on train "A" of the LPI system, are maintained normally closed.

Valves DHV-5 and DHV-6 must be manually throttled during LPI/HPI piggyback injection, LPI crossover injection, and transitions between the three emergency operating modes for the LPI system. The throttling service ranges from 500 to 3000 gpm, with a maximum pressure drop across the valve of approximately 180 psi. Valves DHV-5 and DHV-6 are gate valves, and are not specifically designed for throttling service.

Manual throttling of valves DHV-5 and DHV-6 to achieve the desired LPI injection flows is not desirable due to the hydraulic characteristics of the valves. Further, due to the lack of automatic flow control while throttling with DHV-5 and DHV-6, the valves may require continued monitoring and manipulation by the operator as RCS pressure changes.

DESCRIPTION OF MODIFICATION

Figure 2 provides a simplified schematic of the proposed configuration of the LPI system in the normal, standby condition. As shown, two new flow control valves will be added downstream of the LPI crossover line and upstream of valves DHV-5 and DHV-6. The existing flow controls for valves DHV-110 and DHV-111 will be provided to the new LPI flow control valves. The new valves will be normally maintained in a predetermined throttled position that will ensure adequate initial injection flow, with the flow controller set for 3000 gpm and left in automatic.

The existing valves DHV-110 and DHV-111 will be retained, and will normally be left in their full open position. Retaining valves DHV-110 and DHV-111 in the LPI system provides adequate LPI flow control for required surveillance testing and for other normal operations, and provides for isolation of the LPI pumps for conducting maintenance activities.

EVALUATION OF MODIFICATION

As discussed in Attachment A, the proposed LPI system modifications will greatly improve LPI system performance, and will significantly reduce operator burden during emergency operations.

Following implementation of the proposed modifications, normal operations involving the LPI system will not be adversely affected. The proposed modification will fully support the required surveillance testing of the LPI pumps and valves. Normal decay heat removal operations, operations involving transfer of borated water between the BWST and the RCS or refueling transfer canal during refueling operations, and recirculation and cleanup of borated water sources, will be fully supported by the new design.

The proposed modifications will fully resolve the issues described in Attachment A involving throttling of valves DHV-5 and DHV-6 for LPI/HPI piggyback injection and LPI crossover injection. Also, throttling of valves DHV-5 and DHV-6 will no longer be required for implementing both active strategies for boron precipitation prevention, including the auxiliary pressurizer spray and the hot leg injection methods. In addition, operator burden will be significantly reduced for these emergency modes of operation. As RCS pressures and other parameters change during emergency operations, the new automatic flow control valves will ensure proper LPI injection flows are maintained without operator intervention. As a result, the possibility of operator error will be significantly reduced.

FIGURE 1
CURRENT LPI CONFIGURATION

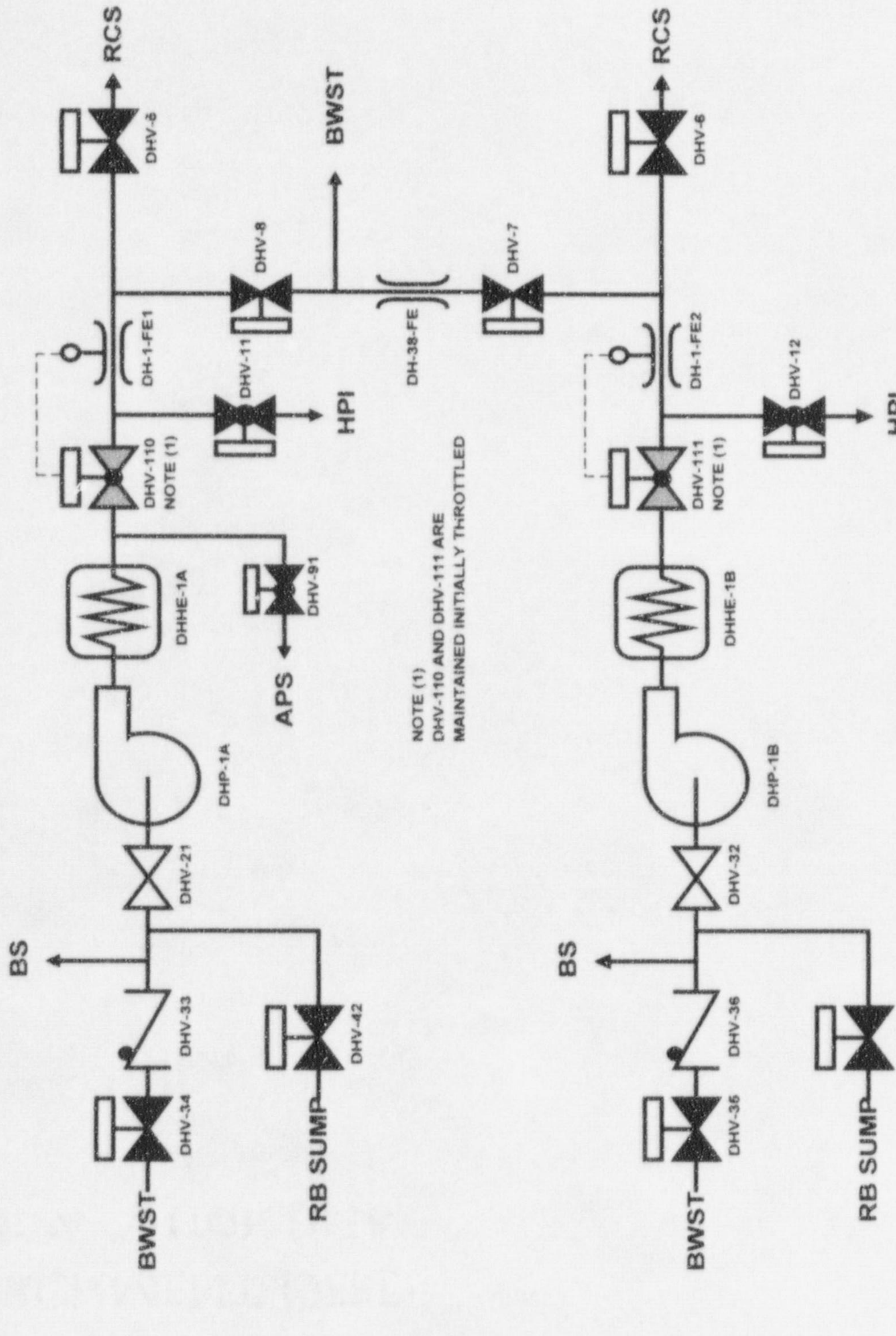
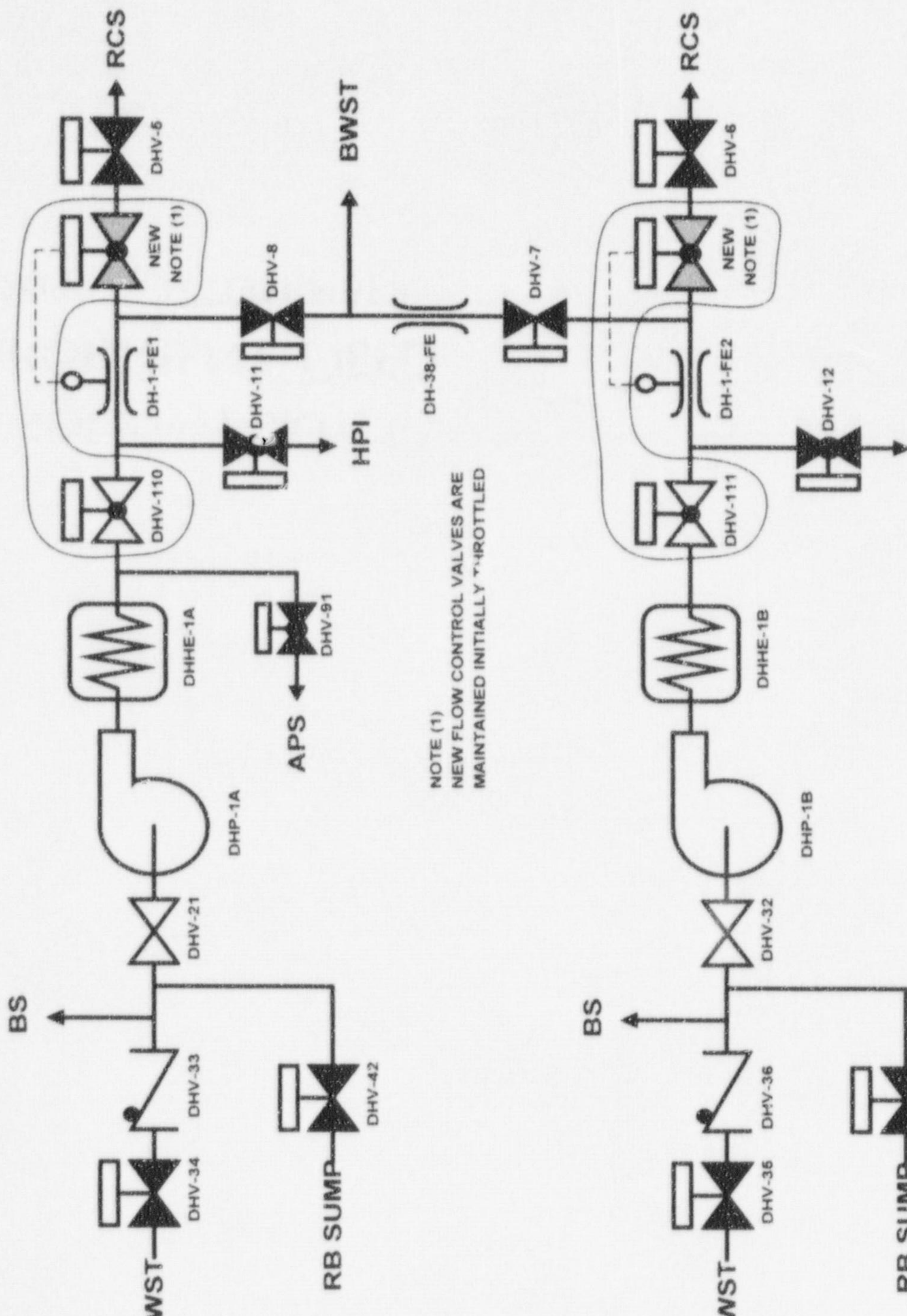


FIGURE 2
PROPOSED LPI CONFIGURATION



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ATTACHMENT C

LOW PRESSURE INJECTION ENGINEERING STUDY

List of Commitments

ATTACHMENT C

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.

Commitment	Due Date
A modification will be implemented to install new flow control valves in each of the low pressure injection (LPI) lines downstream of the LPI crossover line and upstream of the LPI injection valves (DHV-5 and DHV-6), and post-modification testing will be performed.	Prior to Restart from Refueling Outage 11