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

January 29, 1999
3F0199-01

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

Subject: Requested Information: Post-Modification Testing of the High Pressure Injection and Emergency Feedwater Systems

References:
1. FPC to NRC letter, 3F1198-01, dated November 24, 1998, "Addition of Safety-Related Diesel Driven Emergency Feedwater Pump"
2. FPC to NRC letter, 3F1198-03, dated November 23, 1998, "High Pressure Injection System Modifications"

Dear Sir:

Florida Power Corporation (FPC) submitted License Amendment Requests (LARs) #240 and #241 in References 1 and 2. This letter provides information regarding the post-modification test plans for the plant changes associated with the proposed LARs.

FPC presented an overview of the proposed modifications to the NRC Staff on September 21, 1998. At that time, the Staff requested information concerning the post-modification testing of the proposed changes. FPC committed to send the subject information by January 29, 1999. This submittal meets that commitment. FPC is providing the attached test plans for information only, and no NRC action is requested. Some of the details of these plans may change as the specifics of the test procedures are developed.

In addition to the modification test plan information, the NRC Project Manager for Crystal River Unit 3 (CR-3) requested clarification on the scope of License Amendment Request #241 (Reference 2). FPC is requesting NRC approval of the proposed Improved Technical Specification (ITS) changes and the relevant portions of the modifications only (i.e., setpoint changes and valves throttled in the high pressure injection (HPI) flow path associated with the revised surveillance requirements). The description of the remaining HPI modifications (discharge piping, maintenance, isolation and crosstie valves, etc.) and related components were provided in Reference 2 as supporting information to aid in reviewing the ITS changes. FPC is evaluating these modifications in accordance with 10 CFR 50.59, and has preliminarily determined that these changes do not represent an unreviewed safety question (USQ). Therefore, FPC is not requesting NRC approval of the HPI modifications. If upon further

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review FPC determines that these modifications do represent a USQ, then FPC will request NRC approval for the modifications as well. Numerous components are described in the attached test plans. For more information on these components, please refer to the drawings submitted in References 1 and 2.

This letter establishes no new regulatory commitments.

If you have any questions regarding this submittal, please contact Mr. Sid Powell, Manager, Nuclear Licensing at (352) 563-4883.

Sincerely,

JJHolden

J.J. Holden
Director
Site Nuclear Operations

JJH/pei

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

Attachments:

A. High Pressure Injection System Test Plan
B. Emergency Feedwater System Test Plan

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302/LICENSE NUMBER DPR-72

ATTACHMENT A

HIGH PRESSURE INJECTION SYSTEM TEST PLAN

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HIGH PRESSURE INJECTION SYSTEM TEST PLAN

Purpose

The high pressure injection (HPI) system modifications include adding crosstie connections between the "A" train and "B" train injection lines to increase HPI flow to the core under conditions where only one train of injection isolation valves open. In addition to the crosstie lines, manual throttle valves will be installed downstream of the crosstie lines. These valves balance flow among the HPI lines and would limit flow out of a broken HPI line. A hydraulic calculation has been completed that models the new system configuration. This calculation (Reference 1 of this attachment) establishes system hydraulic resistances necessary to meet the system design requirements and required HPI system flow rates to the reactor coolant system for various plant and system configurations and conditions. The loss-of-coolant accident (LOCA) analysis (Reference 2 of this attachment) shows that the flow rates determined in the hydraulic evaluation were sufficient to maintain adequate core cooling for the new system configuration. The various system and injection line settings established during the HPI system testing described below will verify system and individual injection line flow resistances match those established in the hydraulic model.

Basis for Test Plan

The HPI test plan will replace performance test PT-444 (HPI Flow Verification Test), which was previously used to set pump discharge valve throttle positions in order to establish adequate HPI flow balances at 600 psig reactor coolant system (RCS) pressure. The PT-444 test conditions were based on verifying the original HPI system design point, which was to inject 500 gpm at an RCS pressure of 600 psig. The original accident analyses used this design point as a basis for demonstrating adequate HPI flow for LOCAs. The HPI modifications, including the new hydraulic model and accident analysis, establish revised design flow rate requirements for the HPI system. The post-modification testing flow balancing of the HPI system will be performed with the RCS depressurized. The hydraulic evaluation (Reference 1) has established new flow rates for the proposed HPI system configuration. The revised accident analysis (Reference 2) has demonstrated that the flow rates established in this hydraulic evaluation (in conjunction with the associated reactor protection system (RPS) and engineered safeguards (ES) setpoint changes) provide adequate core cooling and meet the appropriate 10 CFR 50.46 criteria for emergency core cooling systems (ECCS).

Framatome Technologies, Incorporated (FTI) has prepared a hydraulic model for the HPI system that represents the new configuration. This model will be used to predict the flow rates observed for the system in the Mode 6 testing configuration. The manual throttle valves (MUV-590, 591, 592, and 593) will be positioned to balance flows through each of the four injection lines as determined by the analytical model. A number of pump and system lineup tests will be performed. The results of the flow balancing will be compared to the analytical values. This comparison will confirm the analytical modeling of system resistances. These new design flow rates will be tested in Mode 6 to confirm the hydraulic model. By confirming the hydraulic model, using the flow rates established during the testing, flow rates at other RCS pressures can be accurately determined. The Mode 6 flow testing outlined in this test plan will ensure that system resistances have been adequately modeled. The existing surveillance procedures that monitor pump head capacity will provide adequate assurance that the pump head capacity has not degraded below an acceptable value. These two items ensure that the analytical model provides an accurate representation of the HPI system. If any future changes to the HPI system that affect the system flow characteristics are made (such as replacing a pump rotating element), this analytical hydraulic model can be used to accurately predict the resultant impact on system flow rates at any RCS pressure.

This new configuration requires setup testing to demonstrate that the HPI system will deliver adequate ECCS flow and to assure the operability of various system components. This setup testing consists of establishing various flow resistances and subsequent individual injection line flow rates to meet the system design requirements. In order to establish the various system resistances for the new system configuration, the HPI pump characteristics must be established. This will be done for each pump by taking flow measurement readings with the pump discharge stop check valves at various positions. After establishing the pump characteristics, the stop check valves (MUV-2, MUV-6 and MUV-10) on the discharge lines of the HPI pumps will be throttled, if necessary, to balance pump flow. It is expected that the stop check valves on the two weaker pumps will be full open. The stop check valve for the strongest pump will remain secured in a throttled position.

The HPI system flow testing and system hydraulic setup will assure that the following criteria are met:

1. The construction meets design requirements as identified by the ECCS accident analyses and supporting hydraulic analyses.

2. The weakest pump delivers the minimum required flow rate through all four injection lines as established by the hydraulic analysis.

3. The HPI system provides the required flow rates while in the "piggyback" mode of operation (i.e., HPI pump suction lined up to the low pressure injection (LPI) pump discharge).

4. The system resistance is adequate to prevent exceeding pump maximum flow rates.

5. Normal makeup line hydraulic resistance setup (stop check valve MUV-595 throttled) assures that the assumptions for low temperature overpressurization protection (LTOP) remain bounding with no additional operator actions required to limit normal makeup line flow during LTOP conditions.

6. Maintain a 10% pump degradation margin while demonstrating system flow capacities.

It should be noted that the piggyback configuration identified in item 3 above is a modified version of what would actually exist during an accident. The difference between the test configuration and post-accident conditions is the location from which the LPI pump will be drawing suction. During an accident, the LPI pump suction would be initially aligned to the borated water storage tank (BWST) and later to the reactor building sump once the BWST volume was depleted. During the modified piggyback testing, the LPI pump will maintain suction from the decay heat removal dropline ("B" hotleg), operating in the decay heat removal mode. To support this test, the operating LPI pump flow will be throttled to the Emergency Operating Procedure based value of approximately 2000 gpm, which will be more than adequate to remove decay heat. The HPI pump will be aligned to take suction from the discharge of the operating LPI pump. The total LPI and HPI pump flows will not exceed the normal operating value of approximately 3000 gpm. The analysis of the test results will account for the difference in suction sources between the test and accident conditions. This test is far more extensive than typical post modification testing and will provide a significant level of assurance that the interconnecting systems will perform as required.

Description of Testing

The testing described within this document will be performed with the HPI pump suction lined up to either the BWST or to the LPI pumps in the modified piggyback mode. During this testing, the pump characteristics for each pump will be determined by manipulating the pump discharge stop check valves, thereby establishing several points on the head-capacity curve. From this test data, it will be determined which HPI pump provides the greatest flow for the expected range of system resistance. This pump will be designated as the "strong pump." The remaining two HPI pumps will be referred to as the weaker pumps. The stop check valves on the weaker pumps will be full open for the remainder of the system flow testing. The stop check valve on the strong pump will be adjusted to equalize the flow to approximately that from the weaker HPI pumps.

The throttle valves (MUV-590, 591, 592 and 593) and the makeup line stop check valve (MUV-595) will be initially set based on valve position versus valve coefficient (C_v). The motor operated HPI injection valves (MUV-23, 24, 25, and 26) currently open to a pre-set throttled position on receipt of an engineered safeguards actuation system (ESAS) signal. This pre-set throttled position is no longer required for the new system configuration and, therefore, these valves will be full open for this system flow testing (the same as the new ESAS position).

The pump that provides the lowest flow rates for the given system configuration will be used to determine the proper position for the manual throttle valves (MUV-590, 591, 592, and 593). This test will be performed to demonstrate that minimum HPI flows assumed in the analysis can be achieved. The other two HPI pumps will also be tested to ensure validity of the hydraulic model. This testing will be conducted with no pump recirculation and with the normal makeup and seal injection lines isolated, as would be expected after an ES actuation. These tests will be performed with the HPI pump taking suction from the BWST. Drawing from the BWST is conservative since the BWST provides a lower suction pressure, and therefore lower flows, than piggyback mode.

The makeup injection line stop check valve (MUV-595) throttle position will be established using the strongest HPI pump with normal pump recirculation flow and seal injection isolated. This test will ensure maximum flow through MUV-595 is measured and limited below LTOP analysis limits. This test will be performed with suction from the BWST, which will provide comparable suction pressure as the makeup tank (the normal makeup source) for LTOP concerns. The normal makeup line is isolated on an ESAS signal; therefore, the flow will not be measured in piggyback mode.

To assure that the system design is adequately verified, the following testing will be conducted prior to declaring the Makeup/HPI system operable:

A. Adjust the HPI Manual Throttle Valves Using the Weakest Pump (expected to be the "C" HPI pump)

1. Pre-position the manual throttle valves to a C_v based on the testing conditions, the pump head capacity curve and the vendor supplied C_v versus position curve.

2. Establish system valve lineup and pump suction configuration. All four injection flow paths open and pump suction from the BWST. Seal injection and normal makeup lines shall be isolated. Crosstie valves shall also be initially closed.

3. Manipulate the discharge stop check valve to obtain several head-capacity points for the pump. The pump recirculation will be open for this testing. After this portion of the testing is complete, the stop check valve will be restored to the full open position and the recirculation flow path will be isolated.

4. With the system configuration and pump characteristics (2 and 3 above), determine the correct throttle valve positions (MUV-590, 591, 592 and 593) and associated indicated flow rates for each of the four HPI injection lines using the HPI system hydraulic model. Set the injection line throttle valve (MUV-590, 591, 592 and 593) positions to provide the pre-determined indicated flow in each line. The flow in each line will be based on a hydraulic evaluation considering the previously documented pump head capacity information and the other system conditions. Flow indication will be provided using temporary, high-accuracy flow instrumentation on each injection line.

5. Open the crosstie lines and close one train of isolation valves (MUV-25 and MUV-26) to determine the impact on indicated flow rates in each line.

6. Maintain the crosstie lines open. Open MUV-25 and MUV-26 and close the opposite train isolation valves (MUV-23 and MUV-24) to determine any impact on flow rates in each line.

B. Confirm Flow Rates Using the Other Weak Pump (expected to be the "A" HPI pump)

1. Establish system valve lineup and pump suction configuration. All four injection flow paths shall be open and pump suction either from the BWST or from the LPI pump discharge (i.e., piggyback). Seal injection and normal makeup lines will be isolated and the crosstie isolation valves will be closed.

2. As in 'A' above, establish several head-capacity points for the HPI pump by manipulating the pump discharge stop check valve.

3. With the pump discharge stop check valve full open, identify individual HPI line flow rates to assure that the hydraulic model accurately predicts the indicated flows for this configuration. No cycling of the individual injection line motor-operated valves (MUV-23, 24, 25 and 26) is required for this test.

C. Confirm Strongest Pump Flow (expected to be the "B" HPI pump)

1. Establish system valve lineup and pump suction configuration. All four injection paths shall be open and pump suction either from the BWST or from the LPI pump discharge (i.e., piggyback). Seal injection, normal makeup line and pump bypass line should be isolated to limit flow.

2. As in 'A' and 'B' above, establish several head-capacity points for the HPI pump by manipulating the pump discharge stop check valve. This valve shall be manipulated carefully so as not to exceed pump maximum flow limits.

3. Using the hydraulic evaluation and knowledge of valve C_v versus valve position, set the stop check valve to a C_v that provides the required line flow resistance. Secure the valve in position.

D. Establish an LTOP Pre-Set Limit for MUV-595

1. This test uses the strongest HPI pump with suction from the BWST. The HPI lines will be isolated so that flow will be delivered through the normal makeup flow path. All four HPI isolation valves (MUV-23, 24, 25 and 26) and the seal injection flow path will be closed. The pump recirculation line will be open.

2. Open the normal makeup flow control valve (MUV-31) to the full open position and assure that the makeup control valve bypass flow path (MUV-30) is open.

3. Set MUV-595 to the throttled position required to provide a pre-determined flow rate (using the Reference 1 hydraulic model) based on the system configuration, pump suction pressure, pump bypass flow rate, etc.

E. Additional Testing Not Specifically Related to Flow Testing

In addition to the flow setup testing that establishes the required HPI flow rates and pump operability limits, other testing will be performed either separately or in conjunction with the flow testing to establish system and component operability requirements. This additional testing will include:

1. Initial MOV setup/testing of MUV-18, MUV-27, and MUV-596.
2. Setup/stroke/operability testing of air operated valves MUV-586 and MUV-587.
3. Stroke/operability and differential pressure testing of MUV-18, MUV-27 and MUV-596.
4. Testing ES functions for MUV-18, MUV-27, MUV-586, MUV-587 and MUV-596.

References

1. FTI Document No. 32-5002731-00, "CR-3 Hydraulics Analysis," dated 12/10/98.

2. FTI Document No. 86-5001942-01, "CR-3 RELAP5/MOD2 SBLOCA Summary-HPI Upgrade," dated 11/23/98.

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302/LICENSE NUMBER DPR-72

ATTACHMENT B

EMERGENCY FEEDWATER SYSTEM TEST PLAN

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EMERGENCY FEEDWATER SYSTEM TEST PLAN

Purpose

The Emergency Feedwater (EFW) system will be modified as described in License Amendment Request #240, "Addition of Safety-Related Diesel-Driven Emergency Feedwater Pump (EFP-3)," dated November 24, 1998. Testing of the new equipment and systems will be performed in three phases. Initial testing of components will be performed at the vendor/manufacturer's facilities. The new building, EFW pump/diesel, and most of the piping and electrical systems will be installed prior to the refueling outage, and will be tested while Crystal River Unit 3 (CR-3) is operating at power. Final testing will be performed prior to start-up after final connections are made during the refueling outage.

Basis for Test Plan

The test plan requirements will demonstrate that:

1. EFP-3 will be capable of delivering 550 gpm to either or both steam generators, with steam generator pressure at 1050 psig. This will be accomplished by taking head/capacity data in the full flow recirculation mode to demonstrate that the values are equal to or greater than minimum acceptance criteria developed via system hydraulic modeling.
2. Ensure the flow through the cavitating venturi is within analyzed limits with control valves full open and minimal backpressure.
3. Airflow through the building due to the shaft-driven fan is sufficient to maintain diesel water and lube oil temperatures within manufacturer's specifications and maintain the ambient temperature inside the building less than 120°F under design basis conditions.
4. The capacity of the air start system will allow six consecutive diesel engine starts without compressor operation.
5. EFP-3 will start and achieve rated flow within 25 seconds.
6. After starting, EFP-3 will continue to operate following a loss of all DC and AC power.
7. All emergency feedwater initiation and control (EFIC) and manual controls (start, stop, open, etc.) perform as required.
8. Steam generator EFW isolation valves (EFV-14, EFV-33, EFV-57 and EFV-58) can close against expected differential pressure.

Description of Testing

The new equipment and systems will require testing to demonstrate that the EFW system is capable of meeting its design requirements. This includes testing individual components as well as integrated systems. The following is an overview of the three phases of testing:

Phase 1: Vendor/Manufacturer's Facility:

1. Certified pump performance testing (head, capacity, brake horsepower, efficiency, and net positive suction head) will be conducted at the Ingersoll-Dresser Pump (IDP) test facility utilizing a shop motor and coupling. Testing will be in accordance with the American Society of Mechanical Engineers (ASME) Power Test Code - Centrifugal Pump (Type A test). IDP will perform all tests, inspections, and non-destructive examinations required by ASME Section III, subsection ND and the equipment specification prepared by Framatome Technologies, Incorporated (FTI). Impeller/rotor balancing will be performed per the requirements of the American Petroleum Institute (API) standard API-610.

2. Airflow testing for the radiator/fan assembly will be performed at the radiator/fan manufacturing plant. This testing will demonstrate the flow/head/horsepower performance characteristics of the fan.

3. For the diesel engine drive unit, Engine Systems, Incorporated (ESI) will demonstrate the load carrying capability of the diesel by running tests coupled to a dynamometer and verifying the diesel performance characteristics. These tests will also assure that water and oil temperatures are within manufacturer's specified limits. In addition, ESI will provide documentation to demonstrate that the diesel engine driver is capable of 99 successful sequences (start/run/load/stop) out of 100 consecutive attempts based on previous testing of similar diesel engines.

4. The pump, diesel engine drive unit, coupling, and radiator will then be assembled and tested as an integrated unit. Testing will include a mechanical run test to demonstrate integrated operation, a 25-second start capability, and a loss of DC and AC power test to assure adequate operation during simulated station blackout conditions.

Phase 2: On Site, Pre-Outage Testing:

Pre-outage testing will be performed at the CR-3 site to assure functionality. To accomplish this, the suction piping from the condensate storage tank (CDT-1) to EFP-3 will be installed prior to the outage. The EFP-3 discharge piping will be connected to the emergency feedwater tank (EFT-2) at the condensate fill line. Testing of EFP-3 through a flow path from CDT-1 to EFT-2 will permit verification of critical design parameters. To maximize the testing duration, EFT-2 will be drained to a level just above the EFW Improved Technical Specification (ITS) Limiting Condition for Operation (LCO) requirements in order to provide the largest storage volume for testing. The available volume will allow approximately 20 minutes of full-flow testing. Inventory removed from EFT-2 will be directed to the condenser hotwell and/or CDT-1. Therefore, this inventory is not lost to the EFW system since both existing EFW pumps can draw from these sources.

The volume available for testing in EFT-2 is limited by the physical size and LCO minimum level requirements of the tank. Certain tests may require pump run times longer than 20 minutes. FPC is evaluating the option to drain EFT-2 below the ITS LCO limit in order to permit an extended test of EFP-3. If this option is pursued, limitations and precautions will be developed to ensure actual EFW inventory from all sources is maintained above analyzed limits.

Testing during the pre-outage phase will include:

1. Full-flow pump testing.

2. Flow testing to demonstrate the cavitating venturi will perform as designed.

3. Flow testing to set the continuous recirculation flow rate.

4. Differential pressure measurements to confirm the accuracy of the hydraulic model.

5. Vibration testing.

6. Air start testing to demonstrate starting system performance, including air compressor capacity and air tank recharge time.

7. Building auxiliaries testing to demonstrate performance requirements for non-safety-related power, fire protection, ventilation, and other support equipment.

Phase 3: On Site, Post Installation (Outage) Testing:

Final functional testing will be performed after all system tie-ins are complete. Outage testing will include:

1. EFP-3 pump flow with suction from EFT-2 and discharge back to EFT-2 through the full-flow recirculation test line. This will demonstrate EFW system functional performance.

2. EFIC testing to demonstrate that EFP-3 receives a start signal upon EFIC actuation, including verification that EFP-1 does not start, and ASV-204 does not open.

3. EFP-1 and EFP-3 start/trip interlock testing to ensure that EFP-1 will not start or operate if EFP-3 is in operation.

4. Instrumentation and control testing, including control room, remote shutdown panel, and local control panel functions.

5. Building ventilation testing to ensure design ventilation parameters are achieved.

6. Valve differential pressure testing to assure that steam generator isolation valves (EFV-14, EFV-33, EFV-57 and EFV-58) can adequately close against the maximum expected differential pressure.

7. Flow path verification testing from EFP-3 to OTSGs by full flow test under EFIC control.