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Mr. John A. Hancock
Vice President, Nuclear
Florida Power Corporation
ATTN: Manager, Nuclear Licensing
P. O. Box 14042, M.A.C. H92
St. Petersburg, Florida 33733

Dear Mr. Hancock:

SUBJECT: CRYSTAL RIVER UNIT 3 (CR-3) - STATUS OF EMERGENCY FEEDWATER SYSTEM (EFS) UPGRADE REVIEW AND THE RESULTANT REQUEST FOR ADDITIONAL INFORMATION (NUREG-0737 ITEM II.E.1.1)

We have completed our review of the information you provided on proposed upgrade of the CR-3 EFS. A status report which provides our evaluation and identifies items for which our review is not complete is enclosed as Enclosure 2. The information we require to complete our review is outlined in Enclosure 1. Please note that the review did not include seismic design and the upgrade reliability analysis.

Please provide the requested information within 30 days of receipt of this letter. If the information cannot be provided within the 30 days, please provide within 7 days of receipt of this letter a schedule for submission of the information. Within 60 days of receipt of this letter please propose an amendment to your Technical Specifications to include the requirement outlined in Part II.A.2 (Recommendation GS-2) and Part II.A.6 (Recommendation GS-6).

This request for information was approved by the Office of Management and Budget under clearance number 3150-0065 which expires May 31, 1983. Comments on burden and duplication may be directed to the Office of Management and Budget, Reports Management Room 3208, New Executive Office Building, Washington, D. C. 20503.

Sincerely,

"ORIGINAL SIGNED BY
JOHN F. STOLZ"

John F. Stolz, Chief
Operating Reactors Branch #4
Division of Licensing

Enclosures:
1. Request for Add. Info.
2. Status Rept.

cc w/enclosures: See next pg.

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

August 19, 1982

Docket No. 50-302

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Vice President, Nuclear
Florida Power Corporation
ATTN: Manager, Nuclear Licensing
P. O. Box 14042, M.A.C. H-2
St. Petersburg, Florida 33733

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Enclosure 1

CRYSTAL RIVER UNIT 3

50-302

REQUEST FOR ADDITIONAL INFORMATION

1. Provide the quality group classification of all the components and piping for the Emergency Feedwater System (EFS) shown in Figure 3.1.1 of the proposed upgrade design submittal (Part I.B.1.C).

2. Identify all EFS components which are not protected from tornadoes, floods, external missiles and internally generated missiles (Part I.B.2.b).

3. Verify that all essential components of the EFS are protected against the effects of high and moderate energy lines. These include the effects of pipe whip, jet impingement, and internal flooding (Part I.B.2.c).

4. Provide a means of eliminating the single failure potential in the recirculation lines of the EFS pumps (Part I.B.2.e).

5. Propose Technical Specifications which require a monthly inspection to verify that the locked open valves in the EFS flow path are locked and in the proper position (Part II.A.2 - Recommendation GS-2).

6. Propose Technical Specifications which requires that the normal flow path from the primary EFS water source to the steam generators be verified following a refueling shutdown or any cold shutdown of longer than 30 days duration (Part II.A.6 - Recommendation GS-6).

7. Commit to providing prior to start up from the next refueling outage redundant level indication and alarms for the condensate storage tank.

8. Revise your design to provide one of the two alternatives outlined in Recommendation GL-2 (Part II.C.2 - Recommendation GL-2).

9. Evaluate the design of the EFS water supply to determine if automatic protection of the pump is necessary following a tornado as stated in Recommendation GL-4 (Part II.C.4 - Recommendation GL-4).

10. Provide the information requested in Enclosure 3 to our letter of January 28, 1981, concerning the EFS flow requirements (Part II.D).

STATUS REPORT
CRYSTAL RIVER, UNIT 3 - EMERGENCY FEEDWATER SYSTEM

In accordance with the requirements of Item II.E.1.1 of NUREG-0660 "NRC Action Plan Developed as a Result of the TMI-2 Accident," and NUREG-0737 "Clarification of TMI Action Plan Requirements," the licensee was requested to:

(1) Perform a simplified AFW system reliability analysis that uses event-tree and fault-tree logic techniques to determine the potential for AFW system failure under various loss-of-main feedwater-transient conditions. Particular emphasis is given to determine potential failures that could result from human errors, common causes, single-point vulnerabilities and test and maintenance outages.

(2) Perform a deterministic review of the AFW system using the acceptance criteria of Standard Review Plan Section 10.4.9 and associated Branch Technical Position ASB 10-1 as principal guidance; and

(3) Reevaluate the AFW system flow rate design bases and criteria

Our evaluation of the Crystal River Unit 3 (CR3) emergency feedwater system (EFS) against the requirement of Item II.E.1.1 is present in two parts. Part I is our evaluation of the EFS upgrade design against the criteria of the Standard Review Plan. Part II

is our evaluation of the (1) EFS against the criteria developed after the Three Mile Island Unit 2 accident and enumerated in NUREG-0611 and NUREG-0635, (2) the licensee's reliability analyses, and (3) the licensee's reevaluation of the design basis for the EFS flow requirements.

PART I

A. We have reviewed the emergency feedwater system against the Acceptance Criteria of the Standard Review Plan (SRP) Section 10.4.9. These criteria are as follows:

1. General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena" as related to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criteiron 4, "Environmental and Missile Design Bases" with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associate with pipe breaks.

3. General Design Criterion 5, "Sharing of Structures, Systems and Components" as related to the capability of shared systems and components important to safety to perform required safety functions.

4. General Design Criterion 19, "Control Room," as related to the design capability of system instrumentation and controls

for prompt hot shutdown of the reactor and potential capability for subsequent cold shutdown.

5. General Design Criterion 44, "Cooling Water," to assure:

   a. The capability to transfer heat loads from the reactor system to a heat sink under both normal operating and accident conditions.

   b. Redundancy of components so that under accident conditions the safety function can be performed assuming a single active component failure. (This may be coincident with the loss of offsite power for certain events.)

   c. The capability to isolate components, subsystems, or piping if required so that the system safety function will be maintained.

6. General Design Criterion 45, "Inspection of Cooling Water System," as related to design provisions made to permit periodic inservice inspection of system components and equipment.

7. General Design Criterion 46, "Testing of Cooling Water System," as related to design provisions made to permit appropriate functional testing of the system and components to assure structural integrity and leak-tightness, operability and performance of active components, and capability of the integrated system to function as intended during normal, shutdown, and accident conditions.

8. Regulatory Guide 1.26, "Quality Group Classification and Standards for Water-, Steam- and Radioactive Waste Containing Components for Nuclear Power Plants," as related to the quality group classification of system components.

9. Regulatory Guide 1.29, "Seismic Design Classification," as related to the seismic design classification of system components.

10. Regulatory Guide 1.62, "Manual Initiation of Protective Actions," as related to design provisions made for manual initiation of each protective action.

11. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants," as related to the protection of structures, systems, and components important to safety from the effects of flooding.

12. Regulatory Guide 1.117, "Tornado Design Classification," as related to the protection of structures, systems, and components important to safety from the effects of tornado missiles.

13. Branch Technical Position (BTP) ASB 3-1, "Protection Against Postulated Piping Failure in Fluid Systems Outside Containment," as related to breaks in high and moderate energy piping systems outside containment.

14. Branch Technical Position (BTP) ASB 10-1, "Auxiliary Feedwater System Pump Drive and Power Supply Diversity for Pressurized Water Reactor Plants," as related to auxiliary feedwater pump drive and power supply diversity.

B. The following evaluation discusses the implementation of the acceptance criteria identified in SRP Section 10.4.9 and follows the format of the Review Procedures identified in SRP Section 10.4.9.

By letter dated August 11, 1981, the licensee submitted the emergency feedwater system (EFS) upgrade design. The EFS is designed to supply an independent source of water to the steam generator during accident and transient conditions in the event of a loss of main feedwater supply. The major components of the EFS are two (2) emergency feedwater pumps, one of which is a 740 gpm steam turbine driven pump and the other is a 740 gpm motor driven pump. The EFS water supply is provided by the condensate storage tank and by the main condenser hotwell as an alternative water source. An additional water source is available via the Fire Service System. The EFS provides two redundant flow paths (one to each steam generator). Cross-connects between the two flow paths permit either the turbine-driven pump or the motor-driven pump to feed either or both steam generators. Crystal River is a one unit site, therefore General Design Criterion 5 is not applicable.

1. We have reviewed the licensee's submittal in order to verify the acceptability of the EFS design with respect to its classification and operating characteristics.
   a. [Minimum performance requirements for the EFS have not yet been provided by the licensee. This is discussed in more detail in Part II, Section D of this report.]
   b. The licensee indicated that the EFW design shall consider the requirements of General Design Criterion 44 for the capability to isolate components, subsystem, or piping so that the system safety function will be maintained. The EFS feeds directly to the steam generators through six inch discharge lines. The EFS is connected

to the main feedwater piping and is isolated from the main feedwater piping by a lock-closed-motor-operated valve. Essential lines connecting the EFS pump to the condensate storage tanks are provided with motor-operated isolation valves to isolate the EFS from the tank in the event of use of alternative water source. [However, the licensee has not addressed prevention of damage to both EFS pumps due to loss of the condensate storage tank resulting from a tornado. This is discussed in more detail in Part II, Section C recommendation GL-4 of this report. Therefore, we cannot conclude that the EFS meets the isolation requirements of General Design Criterion 44.]

c. The licensee has indicated that the EFS design shall consider the requirements of General Design Criterion 2 and the guidelines of Regulatory Guides 1.26 and 1.29 with respect to its seismic and quality group classification. [However, the licensee has not indicated the quality group classification changes that may result from the proposed upgrade. The licensee is requested to provide the quality group classification of all the components and piping for the emergency feedwater system shown in figure 3.1.1 of the proposed upgrade design submittal. The seismic design review is being conducted separately as part of MPA C-14 "Seismic Qualification of the Auxiliary Feedwater Systems". We cannot conclude that the EFS meets the requirements of General Design Criterion 2 and the guidelines of Regulatory Guide 1.26.]

d. Provisions for EFS testing and inspection are included in the design. Each ESF pump is equipped with a recirculation line to the condensate storage tank which can be used for periodic functional testing purposes. Periodic testing of the EFS pumps and valves is identified in the plant Technical Specifications. Therefore, we conclude that the EFS meets the requirements of General Design Criterion 46 with respect to functional testing. The EFS components are located in areas that are accessible during normal plant operation to permit periodic inservice inspection. The normal EFS valve lineup is used for pump operability testing. Therefore, we conclude that the EFS meets the requirements of General Design Criterion 45 regarding design provisions for inservice inspections.

2. We have reviewed the EFS design for protection against the effects of natural phenomena, pipe breaks or cracks in fluid systems outside containment, single system component failures, loss of an onsite motive power source, or loss of offsite power.

a. The licensee indicated that the EFS upgrade design would consider the requirements of General Design Criterion 2 with respect to the structures housing the system and the system itself being capable of withstanding the effects of earthquakes. The seismic design review is being conducted separately as part of MPA C-14 "Seismic Qualification of Auxiliary Feedwater Systems".

b. The licensee indicated that the EFS upgrade design would consider the requirements of General Design Criterion 2 and 4 with respect to the structures housing the system and the system itself being capable of withstanding the effects of tornadoes, flood, external missiles and internally generated missiles. Additionally, the licensee stated that:

> "System components and piping shall have sufficient physical separation or shielding to protect the essential portions of the system from the effects of internally and externally generated missiles.
>
> Functional capability of the system shall also be assured for fires and the maximum probable flood."

The licensee also indicated that the condensate storage tank was not protected against tornado missiles. [The licensee should identify all EFS components which are not protected from tornadoes, floods, external

missiles and internally generated missiles.] We can not conclude that the EFS is protected from floods, tornadoes, and missiles and meets the requirements of General Design Criteria 2 and 4 and the guidelines of Regulatory Guide 1.102 and 1.117.

c. The EFS is not used during startup and shutdown, therefore, it is considered a moderate energy system for the purposes of pipe breaks in the EFS. Main steam lines are located in the space housing the EFS pumps and the licensee indicated that the turbine-driven and motor driven pumps can withstand the elevated pressure and temperatures following a pipe break. [The licensee should verify that all essential components of the EFS are protected against the effects of high and moderate energy lines. These include the effects of pipe whip, jet impingement and internal flooding.] We can not conclude that the EFS meets the requirements of General Design Criterion 4 and the guidelines of BTP ASB 3-1 with respect to pipe breaks outside containment.

d. The EFS can function automatically as required in the event of a loss of offsite power. The heat transfer path from the steam generators under this condition is to the atmosphere via the atmospheric dump valves. The turbine driven pump receives main steam from both steam generators through six-inch lines containing check valves and normally-open DC motor operated stop-check valves.

Downstream of the DC motor-operated valves the steam supply lines connect to provide a common supply to the turbine. The common supply contains a normally-closed DC motor operated valves which opens on an emergency feedwater initiation signal. The steam supply lines to the turbine driven pump are located upstream of the main steam isolation valves. The EFS pump turbine exhausts to the atmosphere. The motor driven pump is AC powered with back-up power from the diesel generator. The EFS discharge valves are air operated and normally-closed. The discharge valves fail "open" on loss of air. Therefore, we conclude that the EFS meets the requirements of General Design Criterion 44 with respect to its ability to transfer heat from the reactor coolant system under accident conditions. Refer to part(i) below for further discussion.

e. The EFS is designed to accommodate a single failure in any active system component without loss of function. The EFS consists of two trains, supplying both steam generators. The discharge lines of each emergency feedwater pump are cross connected to allow each pump to feed both steam generator. A single failure in one train will not prevent the redundant train from feeding both steam generators. Both EFS pumps are provided with one suction connection to the condensate storage tank and one suction connection to the condenser hotwell.

This is discussed in more detail in Part II, Section C, Recommendation GL-2 of this report. The recirculation line to the condensate storage tank contains a single manually operated valve. [Since the emergency feedwater pumps do not automatically trip, the pumps could be destroyed if the recirculation path was closed when the pumps were started. The licensee is required to eliminate the single failure potential. Acceptable means include removing the internals of the manual valve or providing redundant parallel valves.] Steam supply

to the turbine driven pump is provided from both steam generators through separate DC motor-operated valves connect to provide a common supply to the turbine. A failure of the common steam admission valve for the turbine-driven pump would not prevent operation of the motor-driven train. Thus, adequate feedwater is assured in the event of a postulated design basis accident concurrent with a single failure. Redundant isolation is provided for all portions of the EFS from non-essential system (see Item 1b above). Based on the above, we can not conclude that the EFS meets the requirements of General Design Criterion 44 with respect to the single failure criterion.

f. The turbine driven EFS pump train provides a diverse means of assuring feedwater supply to the steam generator independent of all offsite or onsite AC power sources for at least two hours. The turbine driven pump bearings do not require cooling from an AC dependent source. Automatic actuation and control of the turbine train is provided with battery-backed DC power. Therefore, we conclude that the EFS meets the power diversity position of BTP ASB 10-1.

g. The EFS pumps are automatically started on receipt of an emergency feedwater actuation signal. Steam generator water level is automatically controlled by the emergency feed initiation and control system or manually controlled by the operator from the control room. Therefore, we

conclude that the EFS provides instrumentation and control for prompt initiation of a shutdown in accordance with the requirements of General Design Criterion 19.

h. Manual capability to initate and control the EFS pumps and isolate either ESF train is provided in the control room. The capability for control from a remote shutdown panel will be provided. Therefore, we conclude that the EFS meets the manual initiation guidelines of Regulatory Guide 1.62.

i. EFS function is provided automatically in the event of a main feedwater or main steam line rupture. Both EFS pumps will automatically initiate and steam generator level will be automatically controlled for main feedwater line and steam line ruptures which depressurize the steam generator. The depressurized steam generator will automatically be isolated. The only required operator action is to confirm that the automatic function were taken. For smaller break nor which the steam does not depressurize or depressurizes over a long period of time, the operator must initiate appropriate actions. We conclude that the EFS meets the requirements of General Design Criterion 44 with respect to its ability to transfer heat under accident conditions and provide isolation to assure system function.

j. The licensee indicated each EFS pump is designed to provide 100% of the flow necessary for residual heat removal

over the entire range of reactor operation including all postulated design basis accident. However, the licensee has not addressed our request for additional information on the EFS system flowrate design basis and criteria. We can not conclude that the EFS meets the decay heat removal requirements of General Design Criterion 44. The flow rate design basis is discussed in more detail in Part II, Section D of this report.

The emergency feedwater system includes all components and equipment from the condensate storage tank and the condenser hotwell (including valves and cross connections) to the connection with the steam generators. Based on the review of the design and safety classification for the emergency feedwater system, and system performance requirements during normal, abnormal, and accident conditions, we can not conclude that the design of the emergency feedwater system and supporting systems is in conformanc with all the Commission's regulations as set forth in General Design Criteria 2, 4, 19, 44, 45, and 46 and meets all the guidelines contained in Regulatory Guides 1.26, 1.62, 1.102, 1.117 and Branch Technical Positions ASB 10-1 and ASB 3-1 and, therefore, is not acceptable. Areas of nonconformance are outlined in the above paragraphs.

PART II

Introduction and Background

The Three Mile Island Unit 2 (TMI-2) accident and subsequent investigations and studies highlighted the importance of the Auxiliary Feedwater System (AFWS) in the mitigation of transients and accidents. As part of our assessment of the TMI-2 accident and related implications for operating plants, we evaluated the AFW systems for all operating plants having nuclear steam supply systems (NSSS) designed by Westinghouse (NUREG-0611) or Combustion Engineering (NUREG-0635). Our evaluations of these system designs are contained in the NUREGs along with our recommendations. The objectives of the evaluation were to: (1) identify necessary changes in AFW system design or related procedures of these plants, and (2) to identify other system characteristics of the AFW systems which, on a long term basis, may require system modifications. To accomplish these objectives, we:

(1) Reviewed plant specific AFW system designs in light of current regulatory requirements (SRP) and,

(2) Assessed the relative reliability of the various AFW systems under various loss of feedwater transients (one of which was the initiating event of TMI-2) and other postulated failure conditions by determining the potential for AFW system failure due to common causes, single point vulnerabilities, and human error.

We have applied the generic results and recommendations of the above described review to the Crystal River Unit 3 emergency feedwater system (EFS) design. The detailed reliability analyses

submitted by the licensee were also evaluated. And, we evaluated the licensee's design basis for EFS flow requirements.

Section A and B are our evaluation of the present EFS against our generic short-term recommendations and our short-term recommendation resulting from our review of the reliability analyses. Section C is our evaluation of the EFS upgrade design against our generic long-term recommendations and our long-term recommendations resulting from our review of the reliability analyses. Section D is our evaluation of the design basis for the EFS flow requirements.

A. Generic Short Term Recommendations

In reviewing the short-term recommendation, information from the following sources was considered: the Technical specifications for CR3, the Reliability studies submitted by licensee in a letter dated December 27, 1979, and letters from the licensee dated August 17, 1979, September 16, 1981 and April 1, 1979.

1. Recommendation GS-1 - "The licensee should propose modifications to the Technical Specifications to limit the time that one AFW system pump and its associated flow train and essential instrumentation can be inoperable. The outage time limit and subsequent action time should be as required in current Technical Specifications; i.e., 72 hours and 12 hours, respectively."

The CR3 Technical Specifications require when one emergency feedwater train is inoperable, the inoperable system must be restored to operable status within 72 hours or the plant should be in hot shutdown within the next 12 hours. We conclude that the Technical Specifications are in compliance with our recommendation and are, therefore, acceptable.

2. Recommendation GS-2 - "The licensee should lock open single valves or multiple valves in series in the AFW system pump suction piping and lock open other single valves or multiple valves in series that could interrupt all AFW flow. Monthly inspections should be performed to verify that these valves are locked and in the open position. These inspections should be performed to verify that these valves are locked and in the open position. These inspections should be proposed for incorporation into the surveillance requirements of the plant Technical Specifications. See Recommendation GL-2 for the longer-term resolution of this concern."

In a letter dated September 16, 1981, the licensee stated that "manual valves in the EFS suction and others that could interrupt the EFS flow are locked in their proper position for EFW supply to the steam generators." The licensee indicated that Surveillance Procedure SP-381, "Locked Valve List" require that valve positions be verified once a quarter.

We have reviewed the licensee's response and it is our position that monthly inspections be performed to verify that locked open valves in the EFS flow path are locked and in the proper position. The licensee should propose within 60 days of receipt of this status report, Technical Specifications which incorporate this surveillance requirement. We will report on the resolution of this matter in a supplement to this SER.

3. Recommendation GS-3 - "The licensee has stated that it throttles AFW system flow to avoid water hammer. The licensee should reexamine the practice of throttling AFW system flow to avoid water hammer. The licensee should verify that the AFW system will supply on demand sufficient initial flow to the necessary steam generators to assure adequate decay heat removal following loss of main feedwater flow and reactor trip from 100% power. In cases where this reecaluation results in an increase in initial AFW system flow, the licensee should provide sufficient information to demonstrate that the required initial AFW system will not result in plant damage due to water hammer."

The EFS is not throttled to avoid water hammer, we therefore, conclude that Recommendation GS-3 is not applicable to CR3.

4. Recommendation GS-4 - "Emergency procedures for transferring to alternate sources of AFW supply should be available to the plant operators. These procedures should include criteria to inform the operator when, and in what order, the transfer to alternate water sources should take place. The following cases should be covered by the procedures:

(1) The case in which the primary water supply is not initially available. The procedures for this case should include any operator actions required to protect the AFW system pumps against self-damage before water flow is initiated.

(2) The case in which the primary water supply is being depleted. The procedures for this case should provide for transfer to the alternate water sources prior to draining of the primary water supply."

Emergency Procedure EP-108, "Loss of Steam Generator Feed" directs the operators to open the motor-operated valves that will connect the hotwell (alternative source) to the suction of the EFW pumps and then to close the motor-operated suction valves from the CST, when CST low level is alarmed. The procedures, also, address action required to provide a third source. We conclude that the procedures are in compliance with our recommendation and are, therefore, acceptable.

5. Recommendation GS-5 - "The as-built plant should be capable of providing the required AFW flow for at least two hours from one AFW pump train, independent of any alternating current power source. If manual AFW system initiation or flow control is required following a complete loss of alternating current power, emergency procedures should be established for manually initiating and controlling the system under these conditions. Since the water for cooling of the lube oil for the turbine-driven pump bearings may be dependent on alternating current

power, design or procedural changes shall be made to eliminate this dependency as soon as possible. Until this is done, the emergency procedures should provide for an individual to be stationed at the turbine-driven pump in the event of the loss of all alternating current power to monitor pump bearing and/or lube oil temperatures. If necessary, this operator would operate the turbine-driven pump in a manual on-off mode until alternating current power is restored. Adequate lighting powered by direct current power sources and communications at local stations should also be provided if manual initiation and control of the AFW system is needed. (See Recommendation GL-3 for the longer-term resolution of this concern.)"

In a letter dated September 16, 1981, the licensee stated "the present EFWS was modified such that the turbine driven pump can be automatically actuated when all AC power is lost. The bearings on the turbine-driven pump and turbine are lubricated by slinging oil from reservoirs near the bearings. Lube oil cooling is accomplished by heat transfer to the pumped fluid." We have reviewed the licensee's response and conclude that our recommendation is adequately met, and therefore, acceptable.

6. Recommendation GS-6 - "The licensee should confirm flow path availability of an AFW system flow train that has been out of service to perform periodic testing or maintenance as follows:

(1) Procedures should be implemented to require an operator to determine that the AFW system valves are properly aligned and a second operator to independently verify that the valves are properly aligned.

(2) The licensee should propose Technical Specifications to assure that prior to plant startup following refueling shutdown, or any cold shutdown of longer than 30 days duration a flow test would be performed to verify the normal flow path from the primary AFW system water source to the steam generators. The flow test should be conducted with AFW system valves in their normal alignment."

Surveillance Procedures SP-349, "Emergency Feedwater System Operability Demonstration," requires monthly test to determine that the EFS valves are properly aligned and independent verification of the alignment of the valves. The CR3 Technical Specifications require the EFS be demonstrated operable at least once per 31 days. Operable is demonstrated by verifying that the steam turbine-driven pump develops the proper discharge pressure on recirculation flow. We have reviewed the licensee's Technical Specifications and it is our position that the normal flow path from the primary EFS water source to the steam generators be verified following a refueling shutdown or any cold shutdown of longer than 30 days duration. Within 60 days of receipt of the status report, the licensee should propose modifications to the Technical Specifications to incorporate our recommendation. We will report on the resolution of this matter in a supplement to this SER.

7. Recommendation GS-7 - "The licensee should verify that the automatic start AFW system signals and associated circuitry are safety grade. If this cannot be verified, the AFW system automatic initiation system should be modified in the short-term to meet the functional requirements listed below. For the longer term, the automatic initiation signals and ciruits should be upgraded to meet safety-grade requirements as indicated in Recommendation GL-5.

(1) The design should provide for the automatic initiation of the auxiliary feedwater system flow.

(2) The automatic initiation signals and circuits should be designed so that a single failure will not result in the loss of auxiliary feedwater system function.

(3) Testability of the initiation signals and circuits shall be a feature of the design.

(4) The initiation signals and circuits should be powered from the emergency buses.

(5) Manual capability to initiate the auxiliary feedwater system from the control room should be retained and should be implemented so that a single failure in the manual circuits will not result in the loss of system function.

(6) The alternating current motor-driven pumps and valves in the auxiliary feedwater system should be included in the automatic actuation (simultaneous and/or sequential) of the loads to the emergency buses.

(7) The automatic initiation signals and circuits shall be designed so that their failure will not result in the loss of manual capability to initiate the AFW system from the control room."

The licensee indicated that the present EFS design includes control grade automatic initiation signals and circuits. We have reviewed the licensee's response and conclude that since the automatic initiation circuitry for the EFS presently meets control grade requirements, recommendation GS-7 is met, and therefore acceptable.

B. Additional Short Term Recommendations

1. Recommendation - "The licensee should provide redundant level indication and low level alarms in the control room for the AFW system primary water supply, to allow the operator to anticipate the need to makeup water or transfer to an alternate water supply and prevent a low pump suction pressure condition from occuring. The low level alarm setpoint should allow at least 20 minutes for operator action, assuming that the largest capacity AFW pump is operating."

For long-term, the level indication and alarms must be safety grade with redundant sensors, detectors readouts, and alarms all the way from the CST to control room, including power supplies. Circuitry equipment and power supplies are required to be Class IE.

The licensee indicates that only a level alarm exist in the present design. The level alarm allows the operator one hour to transfer suction. The upgraded EFS will provide redundant safety-grade level indication and low level alarms for the CST. We have reviewed the licensee's response and it is our position that redundant level indications and alarm should be provided prior to startup from the next refueling outage. We will report on the resolution of this matter in a supplement to this SER.

2. Recommendation (This recommendation has been revised from the original recommendation in NUREG-0611) - "The licensee should perform a 48-hour endurance test on all EFS system pumps, if such a test or continuous period of operation has not been accomplished to date. Following the 48-hour pump run, the pumps should be shutdown and cooled down and then restarted and run for one hour. Test acceptance criteria should include demonstrating that the pumps remain within design limits and that pump room ambient conditions (temperature, humidity) do not exceed environmental qualification limits for safety-related equipment in the room."

By letter dated August 17, 1978, the licensee provided the requested information concerning the endurance test of the motor driven end turbine driven emergency feedwater pumps. We have reviewed the licensee's response and conclude that this recommendation is adequately met and therefore, acceptable.

3. Recommendation - "The licensee should implement the following requirements as specified by Item 2.1.7.b on page A-32 of NUREG-0578:

'Safety-grade indication of auxiliary feedwater flow to each steam generator shall be provided in the control room. The auxiliary feedwater flow instrument channels shall be powered from the emergency buses consistent with satisfying the emergency power diversity requirements for the auxiliary feedwater system set forth in Auxiliary Systems Branch Technical Position 10-1 of the Standard Review Plan, Section 10.4.9.'"

The licensee indicated that control grade EFS flow indication is provided for each steam generator. Additionally, the upgraded EFS will provide safety-grade flow indication. The Instrumentation and Control Systems Branch will review this response as part of Item II.E.1.2 of NUREG-0737 and will provide a separate safety evaluation.

4. Recommendation - "Licensees with plants which require local manual realignment of valves to conduct periodic tests on one AFW system train, and there is only one remaining AFW train available for operation should propose Technical Specifications to provide that a dedicated individual who is in communication with the control be stationed at the manual valves. Upon instruction from the control room, this operator would realign the valves in the AFW system train from the test mode to their operational alignment."

The licensee indicated that the EFS pumps are tested using the normally open recirculation flow paths. The normal EFS valve lineup is not changed to perform the test of the EFS pumps to confirm pump capability to operate and produce the required discharge pressure. We have reviewed the licensee's design and conclude that our recommendation is not applicable to the CR3 emergency feedwater system.

5. Recommendation - "Training procedures on AFWS Interruption Due to Steam and Feedwater Line Break Detection and Mitigation System and ICS Faults" Because of the potentially significant interactions with the AFWS possibly resulting from the steam and feedwater line break and mitigation system and the ICS, information should be provided to the operating crews on means to detect and cope with AFWS interruptions caused by failures in these systems. Such information may be in the form of training and/or procedures. Training with respect to interruption caused by ICS faults may already be encompassed by requirements resulting from the Oconee event of November 10, 1979, and the Crystal River event of February 26, 1980.

The licensee indicated that a training course has been presented to all licensed personnel and technicians which included a review of control system interactions caused by NNI/ICS power losses, a review of what indications are available to the operator during system upsets and NNI/ICS power losses and a review

review of emergency and abnormal procedures necessary to shutdown the plant. We have reviewed the licensee's response and conclude that our recommendation is adequately met, and therefore, acceptable.

6. Recommendation -"Human Error During Test and Maintenance"-. The licensee should assure that plant procedures are written to reduce human induced common mode failures of all AFW system trains. For the specific example cited, the licensee should implement staggered testing of AFW system trains, i.e., for planned testing, not more than one AFW train (or pump) should be tested by the same shift ever.

The licensee indicated that normal shift rotation should preclude an EFW train being tested by the same shift each time. Additionally, Surveillance Procedure SP-349, "Emergency Feedwater System Operability Demonstration" requires that each EFW system train be tested separately. We have reviewed the licensee's response and conclude that our recommendation is adequately met, and therefore, acceptable.

7. Recommendation -"Flow Blockage by Plugged Strainers" The licensee should assure that there are no temporary stainers in place in the AFW piping system that may cause flow blockages if plugged. Operating experience at several plants has shown this to be a potential common cause failure mechanism which could fail the entire AFWS. The suction strainers between the condensate storage tank and the pumps are an example.

The licensee indicated that the emergency feedwaer piping contains no temporary strainers which could cause flow block age if plugged. We have reviewed the licensee's response and conclude that our recommendation is adequately, met and therefore acceptable.

8. Recommendation - "Preventive Maintenance Scheduling"

During periods when one AFW train is unavailable due to maintenance or repair, the reliability of the system is significantly affected. FPC states in its proposed plan to improve AFW reliability that "the effect of preventive maintenance on the AFW system reliability is an unavoidable contribution as it must be performed in accordance with the manufacturer's recommendation and FPC policy." The licensee should confirm that:

(1) The preventive maintenance schedules have been reviewed to determine whether all unnecessary or marginally beneficial procedures have been eliminated and the time between maintenance increased so as to minimize, to the extent practical, the time out for preventive maintenance.

(2) The preventive maintenance schedules have been reviewed to assure that the greatest extent practical their procedures will be conducted during periods of cold shutdown.

(3) The maintenance procedures have been reviewed to assure that the operability of at least one single working train is checked and confirmed before preventive maintenance is begun on the train to be serviced.

The licensee's response indicated that preventive maintenance schedules have been reviewed to minimize the time out of service for preventive maintenance and still conform with the recommendation of the manufacturer. The licensee indicated that lubrication for the emergency feedwater pumps will not be performed during power operation and maintenance of electrical breakers would be performed during cold shutdown or refueling outages. Compliance Procedure CP-115, "In-Plant Equipment Clearance and Switching Orders" assures the operability of one emergency feedwater train before service of the other train We have reviewed the licensee's response and conclude that our recommendation is adequately met, and therefore, acceptable.

C. Long-Term Recommendations

In reviewing the long-term recommendations, information from the following sources was considered: the emergency feedwater system upgrade design submitted by the licensee in a letter dated August 11, 1981, the revised Reliability Analysis submitted by a letter dated June 19, 1981 and letters from the licensee dated April 1, 1981, September 16, 1981 and October 19, 1981.

1. Recommendation GL-1 - "For plants with a manual starting AFW system, the licensee should install a system to automatically initiate the AFW system flow. This system and associated automatic initiation signals should be designed and installed to meet safety-grade requirements. Manual AFW system start and control capability should be designed and installed to meet safety-grade requirements. Manual AFW system start and control capability should be retained with manual start serving as backup to automatic AFW system initiation."

The licensee indicated that the upgrade EFS design will provide safety-grade automatic initiation. The Instrumentation and Control Systems Branch will review the licensee's design as part of NUREG-0737, Item II.E.1.2 and will provide a separate safety evaluation.

2. Recommendation GL-2 - Licensees with plant designs in which the primary AFW system water supply passes through valves in a single flow path, but the alternate AFW system water supplies connect to the AFW system pump suction piping downstream of the above valve(s), should

(a) install redundant valves parallel to the above valve(s) or (b) provide automatic opening of the valve(s) from the alternate water supply upon low pump suction pressure.

The licensee should propose Technical Specifications to incorporate appropriate periodic inspections to verify the valve positions into the surveillance requirements.

The licensee's upgrade EFS design does not address either of the alternatives outlined above. The licensee's response to this recommendation provided in a letter dated September 16, 1981 indicated that the present design was considered the best alternative for CR3. We have reviewed the licensee's response and it is our position that the licensee provide one of the two alternatives outlined above or eliminate the single failure potential. Removing the internals of the suction valve is an acceptable method of eliminating the single failure potential. We will report on the resolution of this matter in a supplement to this SER."

3. Recommendation GL-3 - "At least one AFW system pump and its associated flow path and essential instrumentation should automatically initiate AFW system flow and be capable of being operated independently of any AC power source for at least two hours. Conversion of DC power to AC power is acceptable."

The upgraded EFS design indicates that the valves associated with the turbine-driven emergency feedwater pump both flow control and steam supply will be supplied from a battery-backed DC bus. The emergency feed initiation and control system which will automatically initiate both emergency feedwater pumps, will be powered by battery-backed vital AC power. We have reviewed the licensee's response and conclude that our recommendation is adequately met, and, therefore, acceptable.

4. Recommendation GL-4 - "Licensees having plants with unprotected normal AFW water supplies should evaluate the design of their AFW systems to determine if automatic protection of the pumps is necessary following a seismic event or a tornado. The time available before pump damage, the alarms and indications available to the control room operator, and the time necessary for assessing the problem and taking action should be considered in determining whether operator action can be relied on to prevent pump damage. Considerations should be given to providing pump protection by means such as automatic switchover of the pump suctions to the alternate safety-grade source of water, automatic pump trips on low suction pressure, or upgrading the normal source of water to meet seismic Category I and tornado protection requirements."

In reference to this recommendation, the licensee stated in a letter dated October 19, 1981 that "the design basis of the CST does not include being able to withstand tornadic wind forces and associated missiles." The licensee did not address a means of providing pump protection or upgrading the condensate storage tank (CST) to meet tornado protection requirement. It is our position that the licensee evaluate the design of the EFS to determine if automatic protection of the pump is necessary following a tornado as stated in our recommendation. We will report on the resolution of this matter in a supplement to this SER.

5. Recommendation GL-5 - "The licensee should upgrade the AFW system automatic initiation signals and circuits to meet safety-grade requirements.

The licensee indicated that the upgraded EFS design will provide safety-grade automatic initiation signals and circuits. The Instrumentation and Control Systems Branch will review the upgrade design as part of Item II.E.1.2 of NUREG-0737 in detail and will provide a separate evaluation.

6. Recommendation - Interaction of AFW with Integrated Control System (ICS) and with Steam and Feedwater Line Break Detection and Mitigation Systems.

The licensee should separate the ICS from AFW initiation and control, and reduce the interaction of the AFW with Steam and Feedwater Line Break Detection and Mitigation Systems. The potential for common cause failure of the AFW due to interactions with these two systems is discussed in NUREG-0667. The licensee should implement the following recommendations:

(1) The separation of the AFWS initiation and control from the ICS, and

(2) The reduction in adverse interaction of the steam and feedwater line break detection and mitigation systems with the AFWS.

The licensee indicated that the EFS initiation and control is separated from the ICS is the upgraded design.

For small breaks which do not depressurize a steam generator or require a long time to depressurize, the EFS will not be automatically initiated. For breaks which result in the depressurizatio of a steam generator, only the depressurized steam generator will be isolated and only the intact steam generator will receive emergency feedwater flow. We have reviewed the licensee's respons and conclude that our recommendation is adequately met. The separation of automatic initiation signals and circuits from the

ICS will be reviewed as part of Item II.E.1.2 of NUREG-0737 in detail by the Instrumentation and Control Systems Branch (ICSB) and a separate SER will be provided by ICSB.

7. We have not completed our review of the revised Reliability Analysis for the emergency feedwater system upgrade. We will report on the resolution of this matter in a supplement to this SER.

D. "Basis for Auxiliary Feedwater System Flow Requirements"

In Enclosure 3 to our letter of January 28, 1981, we requested the licensee to provide certain information regarding the design basis for ESF flow requirements.

The licensee has not yet responded to this recommendation. We, therefore, will provide our evaluation of their response in a supplement to this SER.