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REID,R.W.	Operating Reactors Branch 4

SUBJECT: Forwards response to 801114 ltr requesting addl info re auxiliary feedwater sys reliability evaluation.

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April 3, 1981

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Mr. R. W. Reid, Chief
Operating Reactors Branch No. 4

Re: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287

Dear Sir:

With regard to your letter of November 14, 1980 requesting additional information concerning the emergency feedwater system at Oconee Nuclear Station, please find attached our response to your request.

Based on the results of our review, it is considered that upon implementation of the necessary modifications to make the turbine driven emergency feedwater pump independent of AC power, the Oconee emergency feedwater system will provide increased assurance that the reactor can be cooled via the secondary system heat removal path. Additional assurance to maintain core cooling for very low probability events will be provided by the Standby Shutdown Facility once it is operational.

Duke will continue to review the Oconee EFW system in light of future regulatory guidance and make additional improvements as required.

Very truly yours,

William O. Parker, Jr.

RLG:pw
Attachment

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DUKE POWER COMPANY

OCONEE NUCLEAR STATION

RESPONSE TO NRC

REQUEST FOR ADDITIONAL INFORMATION

AUXILIARY FEEDWATER SYSTEM RELIABILITY EVALUATION

Request 1:

Regarding the availability of steam for the auxiliary turbine-driven pump, based on operator action in 15 and 30 minute intervals, if the steam supply for the AFWS turbine is the steam remaining in the steam lines after dryout of both steam generators, verify the adequacy of this steam supply to drive the turbine.

Response:

The emergency feedwater pumps, initiated by loss of main feedwater pump discharge pressure, will normally prevent dryout of both steam generators. However, should both steam generators dryout, alternate sources of both steam (to drive the turbine) and emergency feedwater are available from interconnections with the other two Oconee units.

Request 2:

Emergency Procedures for Initiating Back-up Water Supplies (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 operators when, and in what order, the transfer to alternate water sources should take place. The following cases should be covered by the procedures:

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

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

Response:

The primary source of water (the upper surge tanks) are normally available and assured by the locking open of all manual valves in the pump suction paths and by the double verification of valve alignment which is performed following the monthly testing. Pump startup is automatic upon a demand signal.

Operating Procedures OP/1,2,3/1106/06 "Emergency Feed System" states to Maintain a minimum level of 5 feet in the Upper Surge Tanks anytime EFW pumps are required to be operable.

An initial level of 5 feet would provide approximately one hour's supply of AFW. The UST level is normally maintained between six and eight feet (approximately 50,000 gallons).

Emergency Procedure EP/O/A/1800/14 "Loss of Steam Generator Feedwater" provides for transfer to the alternate water source per the following steps:

a) If only Main Feedwater was lost, continue addition of emergency feedwater to the Steam Generators to control RC temperature using the Emergency Feedwater System and when the upper surge tank level decreases to approximately 2 feet, perform the following:

b) To prevent pump cavitation when taking suction from the Hotwell with the MDEFWP's, break vacuum per OP/3,2,1/A/1106/16 (Condenser Vacuum System).

c) To prevent totally draining the UST and losing suction to MDWFWP's, take suction from the Hotwell by closing (3) (2) C-573 (MDEFWP Suction from UST Riser).

NOTE: Vacuum must be broken prior to taking suction from the Hotwell.

d) Transfer Suction of the TDEFWP from the UST to the Hotwell by opening (3) (2) C-391 (TDEFWP Suction from Hotwell) and closing (3) (2) C-157 (TDEFWP Suction from UST).

Request 3:

Emergency Procedures for Initiating AFW Flow Following a Complete Loss of Alternating Current Power (GS-5).

In the licensee's proposed plan to improve reliability of the AFW system at Oconee Units 1, 2 and 3 (December 21, 1979 letter), Duke Power Company indicated it was working to eliminate the AC power dependency of the turbine-driven pump. The following recommendation should be met in the interim.

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 AC power source. If manual AFW system initiation or flow control is required following a complete loss of AC 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 AC power, design or procedural changes shall be made to eliminate this dependency as soon as practicable. 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 AC power to monitor pump bearing and/or lube oil temperatures. If necessary, this operator would operate the turbine-driven pump in an on-off mode until AC power is restored. Adequate lighting powered by direct current (DC) 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.)

Response:

The implementation of modifications necessary to take the turbine-driven emergency feedwater pump independent of AC power is in progress on all three Oconee units. It will be completed on all units by May 30, 1981.

The upper surge tank is the primary source of water for the emergency feedwater pumps. As discussed in the Response to Request 2, the transfer of suction of the emergency feedwater pumps to the hotwell is performed by procedure. (See also the Responses to Request 10, 13).

Because of this relatively short period of time to complete the necessary modifications and the extremely low probability that an extended loss of AC power would occur at Oconee, it is not considered that the Staff's interim recommendations need to be implemented.

Request 4: AFWS Flow Path Verification (GS-6)

The licensee should confirm flow path availability of an AFWS flow train that has been out of service to perform periodic testing or maintenance. Procedures, if not already in place, should be implemented to require verification that the AFWS valves are properly aligned and a second independent verification of the alignment. By a separate licensing action, we are processing your proposed Technical Specification submittal of October 2, 1980 to ensure flow path availability after various shutdowns.

Response:

Periodic Testing of EFW Systems, conducted monthly, require a second independent verification of alignment prior to returning the system to operability.

Any maintenance on the pumps or motors requires the Periodic Test to be performed to verify operability.

Maintenance on individual valves requires a performance stroke test to verify valve operability.

Request 5: Primary AFW Water Source Low Level Alarm (AS-1)

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 make up water or transfer to an alternate water supply and prevent a low pump suction pressure condition from occurring. The low level alarm setpoint should allow at least 20 minutes for operator action, assuming that the largest capacity AFW pump is operating. For the long term, the instrumentation and power supplies should be a safety grade with at least one channel backed by a battery source.

Response:

The primary source of emergency feedwater for Oconee is the Upper Surge Tanks (USTs) which are automatically available to the pumps. There are two 36,000 gallon tanks per unit which are valved together to make one 72,000 gallon tank. The emergency feedwater operating procedure requires a minimum level of five feet (≈30,000 gal.) in the UST anytime the emergency feedwater pumps are required to be operable. Redundant computer alarms are initiated when the level in the UST reaches five feet. This level assures at least 20 minutes (actually approximately one hour) for operator action assuming the largest capacity Emergency Feedwater Pump is operating and feeding the Steam Generators in excess of the normal feed requirement; if the emergency feedwater flow occurring is based on the heat removal requirement of <500 gpm and no other failures are postulated, then approximately one hour is available for operator action. In addition, a low level alarm is initiated to provide time for the operator to transfer to the hotwell or initiate makeup to the UST if feedwater demand is less than makeup capabilities.

There are presently two differential pressure transmitters which provide redundant level indication in the control room. One of the differential pressure transmitters is a pneumatic transmitter which provides the control room annunciator alarm, a remote indicator, and a computer input for monitoring and alarm. This computer input is supplied by a Motorola electronic transmitter connected to the discharge of the pneumatic transmitter. The other differential pressure transmitter is a Rosemount electronic transmitter which provides a redundant input to the computer for monitoring and alarm. Both of the electronic transmitters are supplied power from the DC power supply. The primary DC power supply receives AC power from 240/120 VAC regulated power panelboard (KRB). If the primary DC power supply fails, the loads are automatically transferred to the back-up power supply. The back-up DC power supply receives AC power from 120 VAC inverter panelboard KX. The indications, alarms and procedural limitations listed above are sufficient to satisfy near term requirements.

The long term NRC requirement is to upgrade this instrumentation to safety grade. Duke does not feel that an upgrade to safety grade instrumentation is needed.

The post-accident environment around the upper surge tanks is not significantly different than the normal environment and hence our present instruments are adequate. In addition, as stated above, the power supply to both the electronic transmitters is backed by a battery source. In summary, the existing redundant instrumentation is capable of operating in its environment and is backed by the station batteries in case of AC power failure.

Request 6: AFW Pump Endurance Test (AS-2)

The licensee should perform a 48-hour endurance test on all AFW system pumps, if such a test or continuous period of operation has not been accomplished to date. Details for the test are outlined in Enclosure 2 titled, "Revision to Recommendation No. 2 of 'Additional Short Term Recommendation' Regarding Auxiliary Feedwater Pump Endurance Test".

For those pumps that have already been tested, you should respond to this recommendation to the extent practicable with the data available. For those pumps not yet tested you should apply this recommendation in full.

Response:

Oconee Nuclear Station has three emergency feedwater pumps (one turbine-driven, two motor-driven) per unit. Each turbine-driven pump is essentially identical to the others. Likewise, each motor-driven pump is essentially identical. As such, it is presently not considered to be necessary to test all nine emergency feedwater pumps. Rather, one turbine-driven and one motor-driven pump will be run for 48-hours during a forthcoming outage. The test will conform, to the extent possible, to the test details provided by the Staff. Based on the results of these tests, Duke would determine if additional pump endurance tests are necessary.

Request 7: Administrative Controls on Manual Valves - Lock and Verify Position (AS-4)

The licensee should lock open valves or multiple valves in series in the AFW pump suction piping and lock open other single valves or multiple valves in series that could interrupt all cooling water flow. Monthly inspections should be performed to verify that these valves are locked and in the open position. These inspections should be incorporated in the Plant Operating Procedures.

Response:

Manual valves in the AFW pump suctions are locked open in accordance with the operating and performance procedures.

Cooling water valves are locked open with the exception of one discharge cooling water valve on each pump. This valve is required to be throttled to provide proper flow rate. The "T" handle manual operator for these valves has been removed and the valve has been provided with a White Tag stating that the valve is not to be repositioned.

The double verification following monthly periodic testing verifies correct valve positions.

Request 8: 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 example, 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. As another example, consideration should be given to locking open valves C-575 and C-576 since closure of either valve may result in a non-recoverable failure of the electric pump train due to pump cavitation.

Response:

Periodic Testing is normally performed on 0800-1600 shift once per month. Due to 5 - shift rotation, the test would seldom be performed consecutively by the same personnel. Independent double verification prior to return to service also reduces the possibility of human error.

Valves C-575 and 576 as well as all other manual suction valves are required to be locked open by procedure.

Request 9: Flow Blockage by Plugged Strainers

The licensee should assure that there are no temporary strainers 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.

Response:

After reviewing the flow diagrams and a physical walk down of the emergency feedwater piping system, including suction piping from the upper Surge Tanks and Condenser hotwells to the emergency feedwater pumps, ~~we~~ ~~have~~ Duke has confirmed that no strainers exist in the system.

Request 10: Elimination of AFWS Dependency on Alternating Current Power Following A Complete Loss of Alternating Current Power (GL-3)

At least one AFWS pump and its associated flow path and essential instrumentation should automatically initiate AFWS flow and be capable of being operated independently of any AC power source for at least two hours (including available water supplies). Conversion of DC power to AC power is acceptable. Duke should consider the two hours requirement when designing the backup to the control air system for MS-87 and MS-129 (steam pressure regulating valves) proposed in the December 21, 1979 letter.

Response:

Automatic initiation of the Turbine Driven EFW Pump is independent of AC power. Based on 500 gpm required emergency feedwater flow, sufficient inventory of EFW is available for approximately 2 hours from both upper surge tanks. C-391, an EMO valve isolating the condenser hotwell from the EFW pump suction header, can be manually opened upon loss of AC power to provide an additional 240 minutes of available water at the pump suction (120,000 gallons at 500 gpm). In the recirculation mode, significantly longer periods of time are available. Nitrogen bottle backups to the control air systems for steam presure regulating valves MS-87, MS-126, and MS-129 will be installed to automatically provide a two hour supply of nitrogen in the event of loss of station air and independent of AC power.

Request 11: Proposed Licensee Changes

Recommendation 1 in the letter from W. O. Parker, Jr. to H. R. Denton, dated December 21, 1979, calls for a "second independent cooling water supply to the EFWS turbine lube oil cooler" from the "elevated water storage tank via the HPSW system". To provide the maximum increase in system reliability, this second source should require no manual actions to succeed and have no AC dependencies (e.g., valves requiring AC power to open). This philosophy is consistent with generic short term recommendation (GS) 5 and long term recommendation (GL) 3(a). A schedule should be established to assure implementation of this recommendation.

The commitment to implement recommendations (2) and (3), as described in the Parker to Denton letter of December 21, 1979, and the Duke response to IE Bulletin 79-05 as related to FDW-88, will increase system reliability.

Response:

A second independent cooling water supply to the EFW system turbine lube oil cooler from the HPSW system elevated water storage tank will be installed. Upon loss of AC power, a normally open solenoid valve closes allowing normally closed valve HPSW-184 to fail open providing cooling water to the oil cooler.

This modification will be completed on all units by May 30, 1981.

Request 12: Eliminate Common Cooling Water Supply to AFW Pumps

In Duke Power Company's proposed plan to improve reliability of the AFWS at Oconee Units 1, 2 & 3, the licensee indicated he was working on modifications to eliminate the turbine-driven AFW pump's AC dependency and to provide for diverse cooling supplies for the AFW pumps. Describe the modifications you have performed or propose suitable improvements.

Response:

The following changes are being implemented to provide diverse cooling supplies for the AFW pumps:

a) Replacement of existing manual valve LPSW-138 with air operated valve LPSW-138 which fails open upon loss of AC power; thus, bypassing cooling water flow around EMO valve LPSW-137 to the Turbine Driven EFP cooling water jacket. The source of cooling water will be the AC dependent LPSW system, if available, or the AC independent HPSW system via the elevated water storage tank if LPSW is unavailable. No manual action is required.

b) Addition of a branch line from upstream of valves LPSW-137 and LPSW-138 to the existing cooling water inlet to the EFP Turbine Oil Cooler including air operated valve HPSW-184 which will also fail open upon loss of AC power; thus, providing flow to the oil cooler. The sources of cooling water are the same as those given in a). No manual action is required.

c) Addition of nitrogen backup system to supply air to all instrumentation associated with Steam Control Valves MS-87, MS-126, and MS-129. Again no manual action is required. These changes will be completed by May 30, 1981.

Request 13: Air Operated Valves

Flow control valves FDW 315 and 316 are air operated and fail open on a loss of air. This loss of air will probably occur within minutes following a loss of offsite power as you have indicated in your analysis. Considering our concerns about the sensitivity of the B&W system to AFW flow, evaluate the need to install accumulators which would allow 30 minutes to 2 hours (loss of all AC) of valve operations. This would allow the operator ample time to manually connect the N_2 backup source.

The same should be considered for your proposed backup to the control air system for steam pressure regulating valves MS-87 and 129. Operator action should not be required for at least 30 minutes to connect any manual backup slowly.

Response:

The nitrogen bottle backups to supply air system for valves FDW-315, FDW-316, MS-87, MS-126, and MS-129 require no manual action; therefore, accumulators need not be installed to "allow the operator time to manually connect the N_2 backup source". When supply air system pressure decreases below the nitrogen bottle regulator set point, nitrogen is drawn from the bottle as needed. Check valves are provided in the supply air tubing upstream of the nitrogen through the supply air system. The backup systems will be functionally tested to assure that the associated air operated valves can be cycled to meet the two hour minimum availability requirement.

Request 14: Postulated High Energy Pipe Breaks

In the event of a postulated break in the main steam or main feed system inside or outside containment coupled with a single active failure, discuss how the Oconee AFW design limits or terminates AFW system flow to the depressurized steam generator and directs the minimum flow to the intact steam generator. If manual action is relied upon, verify that sufficient flow to the intact steam generator will occur in sufficient time to provide adequate core cooling. (SRP 10.4.9, I.14 and 10.4.9, II.5).

Response:

In order to provide sufficient EFW flow to the intact steam generator to ensue adequate core cooling, and under a main steam or main feedwater break in OTSG A with a single active failure of motor driven emergency feedwater pump B train, the operator must manually close the EMO isolation valve or the flow control valve FDW 315 on OTSG A. He is able to do this from the Control Room. The same is true for OTSG B and motor driven emergency feedwater pump A. The operator has sufficient Control Room indication of steam generator level and pressure and would immediately be aware of such a situation.

Concurrently, the operator would monitor the intact steam generator to assure adequate inventory and secondary heat removal via either main feedwater or emergency feedwater systems.

In the event of a postulated break in the main steam or main feed system, coupled with a single active failure of either one of the three emergency feedwater pumps, sufficient flow will occur to provide adequate core cooling.

With a postulated break associated with the 'A' OTSG and a failure of the 'B' motor driven emergency feedwater pump, the turbine driven emergency feedwater pump is available as is the normal feedwater system.

Similarly, if the active failure occurs with the flow control valve (FDW-316), emergency feedwater flow can be aligned through the main feedwater startup control valves to either the main or auxiliary nozzles. Additionally, in the unlikely event that FDW-315, 316 failed to open automatically, an operator could manually open either one of the valves as they are located in the Penetration Rooms which are adjacent to the Control Room.

Request 15: Missile Protection

Discuss the physical separation of your AFW system piping and components and evaluate the capability of your system or plant to withstand the effects of internally and externally generated (tornado) missiles. (SRP 10.4.9.II.1 and II.2)

Response:

The Oconee Emergency Feedwater System has not been designed to be able to withstand the effects of internally and externally generated (tornado) missiles. In the event that such an event were to occur and if the main feedwater system is unavailable, the existing Auxiliary Service System (FSAR Section 9.11) would be capable of providing an alternate means of removing heat via the steam generators.

The Standby Shutdown Facility, whose design description was provided for Staff review by letter dated March 28, 1980 and which is currently under construction, will also provide an assured means of providing heat removal from the steam generators. The SSF, when completed, will be capable of providing secondary system heat removal under any condition that causes a total loss of normal or emergency feedwater systems.

A detailed evaluation of the capability of the existing EFW system to withstand missiles is not considered necessary.

Request 16: Long Term Source of AFW Supply

Branch Technical Position 5-1, attached to SRP 5.4.6, requires a seismic Category I water supply with sufficient inventory to permit operation at hot shutdown (as defined by the B&W Standard Technical Specifications) for at least 4 hours followed by cooldown to RHR operating temperature and pressure. The inventory needed shall be based on the longest cooldown time needed with either only onsite or only offsite power available with an assumed single failure (usually 24-36 hours).

Evaluate the capability of your AFW system to meet this position taking credit for water supplies with seismic capability equal to or greater than the overall AFWS. Include any credit you plan to take for your proposed Standby Safe Shutdown Facility.

Requests 15 and 16 represent areas of review that the NRC has not yet taken a position, your responses will be an aid to us in resolving our future positions for operating plants.

By letter dated October 21, 1980 entitled, "Seismic Qualification of Auxiliary Feedwater Systems", we express our concerns about the seismic classification of AFWs at the Oconee Station.

Response:

The upper surge tanks and the associated piping from them to the EFW pump suctions are seismically qualified. These tanks contain a nominal 50,000 gallons which would provide 100 minutes of flow at hot shutdown based on 500 gpm per unit. The condensor hotwell is also seismically qualified with a nominal capacity of 120,000 gallons, but not all of the piping from the hotwell to the EFW pump suctions has been seismically qualified. The Standby Shutdown Facility Auxiliary Service Water System is seismically qualified and is capable of providing sufficient secondary side cooling for over 3-1/2 days.

Request 17: Design Basis for AFWS Flow Requirements

Provide the AFWS flow design basis information requested in Enclosure 3 for the Oconee 1, 2, and 3 design basis transients and accident conditions. This request is related to NUREG-0660. Task II, E.1.1.a(3).

Question 1

a) Identify the plant transient and accident conditions considered in establishing AFWS flow requirements, including the following events:

   1) Loss of Main Feed (LMFW)
   2) LMFW w/loss of offsite AC power
   3) LMFW w/loss of onsite and offsite AC power
   4) Plant cooldown
   5) Turbine trip with and without bypass
   6) Main steam isolation valve closure
   7) Main feed line break
   8) Main steam line break
   9) Small break LOCA
   10) Other transient or accident conditions not listed above

b) Describe the plant protection acceptance criteria and corresponding technical bases used for each initiating event identified above. The acceptance criteria should address plant limits such as:

   - Maximum RCS pressure (PORV or safety valve actuation)

   - Fuel temperature or damage limits, (DNB, PCT, maximum fuel central temperature)

   - RCS cooling rate limit to avoid excessive coolant shrinkage

   - Minimum steam generator level to assure sufficient steam generator heat transfer surface to remove decay heat and/or cool down the primary system.

Response to 1.a

The Emergency Feedwater System (EFW) serves as a backup to the Feedwater/ Condensate System for supplying feedwater to the steam generators when normal feedwater delivery is interrupted or unavailable, thereby maintaining the heat sink capabilities of the steam generators. The EFW system, as designed, is capable of delivering sufficient feedwater to remove decay heat and reactor coolant pump heat including the assumption of the worst single failure in the system.

The EFW system consists of one turbine driven pump capable of delivering to both steam generators (1080 gpm at 1065 psia total flow while feeding both SG's or 880 gpm at 1065 psia while feeding only one SG) and two motor driven pumps (450 gpm each at 1065 psia) each aligned to one steam generator. The EFW pumps will automatically start, following either a loss of both main feedwater pumps or a low feedwater header pressure signal, in addition, to manual actuation. Following pump start, the control valves will modulate

Request 17: (Cont'd)

to control steam generator level at the two foot minimum level, except in the event that all four reactor coolant pumps have tripped, in which case the level setpoint increased to 50% on the operating range to provide for natural circulation.

The EFW System is provided with sufficient feedwater sources to enable cooldown of the Reactor Coolant System to temperatures where a switch over to the Decay Heat Removal System (DHR) for long term decay heat removal is accomplished.

The plant transient which requires the highest Emergency Feedwater System flow, and as such constitutes the design basis transient, is the loss of main feedwater transient. This transient combines the highest heat load, decay heat plus reactor coolant pump heat, with the minimum heat sink due to the instantaneous loss of both main feedwater pumps. A discussion of the demand on the EFW system for each transient follows.

1) Loss of Main Feedwater - Those transients which result in losing feedwater delivery from the Feedwater/Condensate System are classified as a loss of main feedwater. This initiating event causes a turbine and reactor trip and automatically starts the EFW pumps. Since the reactor coolant pumps remain on, the control valves modulate to control steam generator level at two feet. The transient requires feedwater to be delivered at a rate sufficient to remove decay heat and reactor coolant pump heat. One motor driven emergency feedwater pump delivering 450 gpm at a steam generator pressure of 1065 psia will provide adequate heat removal capacity.

2) LMFW w/Loss of Offsite AC Power - This transient is the result of a station blackout condition. The loss of offsite AC power causes the reactor to trip, the turbine to trip, and the condensate booster pumps and hotwell pumps to trip and cause a loss of main feedwater. The emergency feedwater pumps are actuated on the main feedwater pump trip. Since the reactor coolant pumps have tripped, steam generator level control increases the level setpoint to 50% on the operating range to promote the natural circulation mode of heat removal. The emergency feedwater control valves open to allow full system flow until the controlling level is attained. Feedwater requirements are determined by core decay heat removal demand. One MDEFWP can deliver sufficient feedwater to meet the demand.

3) LMFW w/Loss of Onsite and Offsite AC Power - This transient is similar to Case 2 with the additional assumption that the onsite emergency AC power sources have been lost. This results in the loss of the motor driven emergency feedwater pumps. The transient requires the turbine driven emergency feedwater pump to deliver sufficient feedwater to move core decay heat. The TDEFWP has sufficient capacity to meet the heat removal demand.

4) Plant Cooldown - In addition to providing sufficient heat removal capacity immediately following a transient, the requirements for plant cooldown from full power operation to RCS temperatures where switchover to the Decay Heat Removal System can be accomplished has been determined. All heat sources have been included. The average hourly EFW flowrate to meet cooldown rates of 100^{o}F/hr and 50^{o}F/hr down to the switchover temperature of 250^{o}F are given below.

Time	Cooldown Rate 100°F/hr.	50°F/hr.
0-1 hr	547 gpm	480 gpm
1-2 hr	464	390
2-3.3 hr	430	-
2-3 hr	-	354
3-4 hr	-	344
4-5 hr	-	331
5-6 hr	-	325
6-6.6 hr	-	320

Cooldown of the RCS is a manual function controlled by the operator such that the EFW flow is throttled to obtain the cooldown rate desired and within Technical Specification and administrative limits.

5) Turbine Trip - A turbine trip transient causes a reactor trip. The reactor trip initiates the ICS to control steam generator level at the minimum level so that the main feedwater pumps are runback. With the main feedwater pumps in an untripped condition, there is no requirement for the EFW system to function.

6) Main Steam Isolation Valve Closure - This transient, similar to the turbine trip, does not trip the main feedwater pumps so that the EFW system is not required.

7) Main Feedwater Line Break - For a main feedwater line break upstream of the isolation check valve, the transient would have the same response as a loss of main feedwater. A break downstream of the check valve will cause the steam generator to blow down, but will be less severe than a steam line break transient due to less feedwater being delivered to the steam generators. The demand on the EFW system would be for decay heat and reactor coolant pump heat removal via the unaffected steam generator. One MDEFWP has sufficient capacity to perform this function.

8) Steam Line Break - A steam line break transient is primarily an overcooling transient. Only after the overcooling has been turned around and after isolation of the affected SG, the need for heat removal by the intact SG arises. Since the EFW system is capable of delivering to either steam generator, the heat removal demand on the EFW system can be met by one MDEFWP or the TDEFWP in the event the MFW system is unavailable.

9) Small Break LOCA - For small break loss of coolant accidents, feedwater is required to remove the decay heat and reactor coolant pump heat which is not relieved through the break. The analyses submitted in "Evaluation of Transient Behavior and Small Reactor Coolant System breaks in the 177-FA Plant", May 7, 1979, required a minimum flow rate of 300 gpm. One MDEFWP has the necessary capacity.

10) The above transients bound the EFW system performance requirements for all transients.

Response to 1.b

Conditions or Transient	Criteria
Loss of Main Feedwater Station Blackout Turbine Trip	Peak RCS Pressure $\leq$ 2750 psig No fuel failures
Steam Line Break Feedwater Line Break	10CFR 100 dose limits
Small Break LOCA	10CFR 100 dose limits 10CFR 50.56 PCT limit
Loss of All AC Power	Not a design basis event
Plant Cooldown	100°F/hr

Question 2

Describe the analyses and assumptions and corresponding technical justification used with plant condition considered in 1.a above including:

a. Maximum reactor power (including instrument error allowance) at the time of the initiating transient or accident.

b. Time delay from initiating event to reactor trip.

c. Plant parameter(s) which initiates AFWS flow and time delay between initiating event and introduction of AFWS flow into steam generator(s).

d. Minimum steam generator water level when initiating event occurs.

e. Initial steam generator water inventory and depletion rate before and after AFWS flow commences - identify reactor decay heat rate used.

f. Maximum pressure at which steam is released from steam generator(s) and against which the AFW pump must develop sufficient head.

g. Minimum number of steam generators that must receive AFW flow; e.g. 1 out of 2?, 2 out of 4?

h. RC flow condition - continued operation of RC pumps or natural circulation.

i. Maximum AFW inlet temperature.

j. Following a postulated steam or feed line break, time delay assumed to isolate break and direct AFW flow to intact steam generator(s). AFW pump flow capacity allowance to accomodate the time delay and maintain minimum steam generator water level. Also identify credit taken for primary system heat removal due to blowdown.

k. Volume and maximum temperature of water in main feed lines between steam generator(s) and AFWS connection to main feed line.

l. Operating condition of steam generator normal blowdown following initiating event.

m. Primary and secondary system water and metal sensible heat used for cooldown and AFW flow sizing.

n. Time at hot standby and time to cooldown RCS to RHR system cut-in temperature to size AFW water source inventory.

Response to 2

As discussed in the response to Question 1, the requirements for EFW system performance are determined by the heat removal demand for the loss of main feedwater transient, and the successful cooldown of the RCS to decay heat removal mode. The assumptions utilized in the analysis of the plant response are consistent with those typically assumed in an FSAR analysis and allow for margin to realistic system performance for conservatism.

System initial conditions are consistent with an assumed initial 102% power level. Steam generator level is 60% corresponding to 38,000 lbs inventory per steam generator. The turbine bypass system is not available so that steam relief is by the main steam safety valves at a maximum pressure of 1065 psia. The EFW system is limited to one MDEFWP at 90% capacity delivering to one steam generator. The feedwater temperature, which is very insensitive when considering the total enthalpy rise in the steam generator, is 90°F.

A loss of main feedwater is initiated assuming no pump coastdown. The turbine and reactor trip on loss of main feedwater pumps with a one second delay. Reactor coolant pumps are left on to maximize the heat input. Decay heat power is based on infinite burnup with a 1.0 multiplier. The EFW system is assumed available at 40 seconds, at which time the steam generator inventory has decreased to 14,000 lbs/SG. For the cooldown part of the transient, all heat sources (decay heat, pump heat, fuel, structural steel, and coolant sensible heat) were included. The feedwater inventory required for a 100°F/hr cooldown to decay heat removal switchover is 94,000 gallons, and 145,000 gallons for a 50°F/hr cooldown. These requirements are well within the available hotwell and upper surge tank inventory. For cooldown in the recirculation mode, the minimum amount of water in the upper surge tank, condensate storage tank and hotwell is the amount needed for 11 hours of operation per unit. This is based on the conservative estimate of normal makeup being 0.5% of throttle flow. Throttle flow at full load, 11,200,000 lbs/hr., was used to calculate the operation time. For decay heat removal, the operation time with the volume of water specified would be considerably increased due to the reduced throttle flow.

Items in Question 2 which do not apply to the evaluation of the Oconee EFW system are: (j) EFW not required to function in the FSAR steam line break analysis. (k) EFW system does not connect to main feedwater line. (e) There is no steam generator blowdown system.

Question 3

Verify that the AFW pumps in your plant will supply the necessary flow to the steam generator(s) as determined by items 1 and 2 above considering a single failure. Identify the margin in sizing the pump flow to allow for pump recirculation flow, seal leakage and pump wear.

Response to 3

The spectrum of transients which require EFW system performance for post trip heat removal have been evaluated assuming only one motor driven emergency feedwater pump is available to deliver the necessary feedwater. Any single failure in the three pump-two flowpath EFW system design will not result in only one MDEFWP available, so that this assumption is overly conservative. A large margin of 10% reduction in pump flow was also included. These analyses verify the acceptability of the Oconee Emergency Feedwater System design.