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

SUBJECT: Duke Energy Corporation
Docket No(s). 50-269, -270, -287
Oconee Nuclear Station Units 1, 2, and 3
Proposed License Amendment Regarding
Revisions to the Emergency Feedwater System UFSAR
Section

Pursuant to 10 CFR 50.90, this letter submits a proposed license amendment for Facility Operating License Nos. DPR-38, DPR-47, and DPR-55 for Oconee Nuclear Station Units 1, 2, and 3, respectively. The proposed license amendment request (LAR) involves a rewrite of Section 10.4.7 of the Updated Final Safety Analysis Report (UFSAR) to clarify the licensing/design bases regarding the Emergency Feedwater (EFW) System. Certain aspects of this UFSAR revision could be considered as Unreviewed Safety Questions (USQ) requiring NRC review and approval.

Feedwater can be successfully delivered to the Oconee steam generators during the full range of scenarios. The EFW system, when coupled with the additional diverse features unique to Oconee, assures an adequate supply and delivery of feedwater. Notwithstanding, Duke has recently completed a comprehensive engineering single failure analysis to identify and evaluate all EFW vulnerabilities. As a result, certain system modifications are being developed to improve system margin where appropriate, and the attached UFSAR revision was developed to clarify licensing areas that were ambiguous or silent.

The single failure analysis of the EFW system was completed in September 1999. Results of the single failure analysis have been incorporated into the corrective action program and are being resolved in accordance with 10 CFR 50 Appendix B, Criterion XVI. Resolution of the single failure issues involves a combination of modifying the plant and the

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licensing basis. The attached rewrite of UFSAR Section 10.4.7 is based upon the following commitments as discussed in the pre-decisional enforcement conference of April 25, 2000. These commitments are:

1) There are common mode failures associated with the pneumatic supply to EFW control valves FDW-315 and FDW-316. Duke is resolving these common mode failures through modifications that will separate the air supply to these valves.

2) The Upper Surge Tank (UST) is the initial source of inventory for the EFW pumps. The single failure of certain valves on piping connected to the UST could deplete UST inventory during an event and limit the time available for the operators to align alternate suction sources. The limiting failure from a timing perspective is valve C-187. Duke will modify the plant to address single active failures associated with the UST inventory.

The absence of rigorous, historical licensing documentation could suggest that some aspects of this revision involve a USQ. For example, the credit that the NRC assigned to the Standby Shutdown Facility (SSF) for mitigation of certain specific scenarios is not always clear from the historical documents. This proposed amendment clarifies the role of the SSF during these scenarios. This is appropriate because the SSF is a safety related system and controlled via the Oconee Improved Technical Specifications.

Duke is committed to resolving all issues associated with the lack of clarity of the EFW licensing bases. Issues related to interpretation of the EFW system licensing bases were discussed in NRC Inspection Report 50-269/99-10, 50-270/99-10, and 50-287/99-10 (IR 99-10), dated January 26, 1999, a meeting between Duke and the NRC on February 26, 1999, an NRC letter, dated February 24, 1999, and an Oconee Licensee Event Report LER 50-269/1999-01, submitted on March 26, 1999. In addition, EFW licensing bases ambiguity was the subject of a Predecisional Enforcement Conference held in the NRC Region II offices on April 25, 2000, with the results transmitted in an NRC letter dated May 9, 2000. The NRC licensing positions presented during these recent exchanges have in some instances conflicted with Duke's fundamental understanding of the EFW licensing requirements at Oconee. However, it is Duke's understanding that the NRC agrees that these issues are neither individually nor collectively risk significant. Consequently, Duke is requesting NRC review and agreement that this revised UFSAR Section 10.4.7 constitutes an adequate characterization of the EFW licensing bases.

This submittal proposes a revision to the UFSAR that considers the results of the EFW single failure analysis and clarifies the licensing and design basis requirements for the EFW system. Duke has reviewed post-TMI correspondence and considers this UFSAR revision as superseding any previous statements as addressed by the technical justification for each of these items in Attachment 3. As evidenced by the above communications, it is important to resolve these issues. Accordingly, Duke requests that the review of this submittal be completed by December 31, 2000.

Other sections of the UFSAR affected by the submittal will be revised, as necessary, to reflect approval of this submittal in a time frame consistent with normal UFSAR update practices.

This submittal contains the following attachments:

Attachment 1 provides the retyped UFSAR pages.

Attachment 2 provides a mark-up of the Oconee UFSAR, Section 10.4.7.

Attachment 3 provides a discussion of the proposed changes to the UFSAR.

Attachment 4 documents the determination that the amendment contains No Significant Hazards Considerations pursuant to 10 CFR 50.92.

Attachment 5 provides the basis for the categorical exclusion from performing an Environmental Assessment/Impact Statement pursuant to 10 CFR 51.22(c)(9).

In accordance with Duke administrative procedures and the Quality Assurance Program Topical Report, this proposed license amendment has been previously reviewed and approved by the Oconee Plant Operations Review Committee and the Duke Corporate Nuclear Safety Review Board.

Pursuant to 10 CFR 50.91, a copy of this proposed license amendment is being sent to the State of South Carolina.

Duke Inquiries on this matter should be directed to L. E. Nicholson at (864) 885-3292.

Very truly yours,

W. R. McCollum, Jr., Site Vice President
Oconee Nuclear Site

Attachments

xc w/attachments:

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AFFIDAVIT

W. R. McCollum, Jr., being duly sworn, states that he is Site Vice President of Duke Energy Corporation; that he is authorized on the part of said corporation to sign and file with the Nuclear Regulatory Commission this revision to the Oconee Nuclear Station License Nos. DPR-38, DPR-47, and DPR-55; and that all statements and matters set forth therein are true and correct to the best of his knowledge.

W. R. McCollum, Jr., Site Vice President

Subscribed and sworn to me: June 21, 2000
Date

Notary Public: Conice M Breazeale

My Commission Expires: 2/12/2003
Date

SEAL

ATTACHMENT 1

RETYPED UFSAR PAGES

REWRITE OF UFSAR SECTION 10.4.7

EMERGENCY FEEDWATER SYSTEM

10.4.7.1 Design Bases

The Emergency Feedwater (EFW) System provides sufficient feedwater supply to the steam generators (SGs) of each unit, during events that result in loss of the Condensate/Main Feedwater, to remove energy stored in the core and primary coolant. Following a reactor trip, the EFW System is designed to provide sufficient inventory at hot standby to allow adequate time for operator action to align alternate sources to provide feedwater. The alternate sources allow the unit to remain in hot standby or commence with plant cooldown to the point where decay heat removal (DHR) can be placed in service. In some instances, as addressed in this section, alternate flow paths and inventory sources are relied upon to perform the EFW function. The EFW System is shown in Figure 10-8.

The EFW System is designed to start automatically in the event of loss of both main feedwater pumps. Should a main steam line break occur, the Turbine Driven Emergency Feedwater Pump (TDEFWP) is stopped or inhibited from automatically starting. Automatic initiation of the TDEFWP is independent of AC power. All automatic initiation logic and control functions associated with EFW pumps and control valves FDW-315 and FDW-316 are independent from the Integrated Control System (ICS). The automatic initiation circuitry for EFW following a loss of both main FDW pumps provides anticipatory recognition of low steam generator water level. This allows the EFW System to respond to conditions in advance of a low steam generator water level. Enhancements were provided to protect against steam generator dryout. The Motor Driven Emergency Feedwater Pumps (MDEFWPs) are designed to start on low SG level. The low steam generator level start was added in response to Generic Letter 89-19. The low steam generator level start is not designed to meet the single failure criterion in that a two-out-of-two logic is employed. The automatic initiation of the MDEFWPs on low steam generator level is not credited for any design basis accidents or transients. Refer to section 7.4.3 for additional discussion of the EFW controls. The EFW pumps are also capable of being started by the ATWS Mitigation System Actuation Circuitry (AMSAC) discussed in UFSAR Section 7.8.2.1.

The three units are provided with separate EFW Systems. The discharge header of each EFW System is cross-connected making each system capable of supplying any unit.

There are three EFW pumps provided for each unit. There are two motor-driven pumps with a design flow rate of 450 gpm/pump. There is one turbine driven pump with a design flow rate of 1080 gpm. The motor-driven pumps are provided with automatic recirculation control valves that close when sufficient demand from the SGs occurs. The turbine driven pump is provided with a minimum recirculation path that is normally open and limited by fixed orifices. The flow rate through the fixed orifices is not available for feeding the SGs. The fixed orifices are sized to pass < 200 gpm. Therefore, the total combined SG feed capacity of all three EFW pumps is approximately 1780 gpm.

The MDEFWPs are powered by the emergency AC Power System. The TDEFWP is independent of AC power. The turbine driven pump receives steam as its motive force. Steam can be supplied from any of three sources; 'A' Main Steam, 'B' Main Steam, or Auxiliary Steam. Each motor-driven pump is aligned to one SG. The TDEFWP is aligned to both SGs. There is one EFW flow control valve for each SG. The flow control valve is pneumatic. Each flow control valve receives compressed gas from any of three sources; plant instrument air, auxiliary instrument air, or bottled nitrogen.

The Upper Surge Tank (UST) is the primary suction source for the EFW pumps. A minimum inventory of 30,000 gallons of water is maintained in the UST. This inventory requirement assures that the plant operators have at least 20 minutes to act before the UST is emptied, assuming the highest capacity pump is operating. The inventory in the upper surge tanks is assured by auto closure of the hotwell makeup control valves on a low upper surge tank level signal. The upper surge tanks and the associated piping to the EFW pump suctions are seismically qualified. The suction piping from the UST to the MDEFWPs is separate from the suction piping to the TDEFWP.

The UST can be replenished from a number of non-safety related sources. These sources include the plant Demineralized Water System, the Condensate Storage Tank, and the condenser hotwell. In the event that the UST inventory cannot be maintained, EFW pump suction can be aligned directly to the hotwell. The suction piping from the condenser hotwell to the MDEFWPs is separate from the suction piping to the TDEFWP.

10.4.7.1.1 EFW Supply Requirements for Maintaining Hot Standby following Design Basis Accidents

The plant transient that requires the highest EFW System flow is the loss of feedwater transient. For this transient, it is assumed that MFW flow entering the SGs decreases to zero flow 5 seconds after the MFW pumps trip off. A high initial 102 percent power level is assumed to maximize energy removal requirements. A low initial SG mass is assumed to minimize post-trip heat removal during SG boil down. The Turbine Bypass System is assumed to not be available so that steam relief is by the main steam safety valves. The EFW System is limited to one MDEFWP delivering to one SG. The maximum allowable Upper Surge Tank temperature of 130°F is assumed to minimize the heat removal capability of the EFW System. Reactor trip and the subsequent turbine trip are assumed to occur on the high RCS pressure trip function. Reactor coolant pumps are assumed to be left on to maximize the heat input. Decay heat power is based on end-of-cycle burnup. The flowrate demand on the EFW System for other transients is bounded by the loss of main feedwater transient. The safety analyses model of EFW flow rate is a function of SG pressure. Based on the results of the accident analyses, one MDEFWP delivering 375 gpm at a SG pressure of 1064 psia and an EFW temperature of ≤ 130 F provides adequate heat removal capability for this transient. The Safety Analyses acceptance criteria for each transient are as follows:

Conditions of Transient	Acceptance Criteria
Loss of Main Feedwater Loss of Offsite Power Turbine Trip	Peak RCS Pressure ≤ 2750 psig
Main Feedwater Line Break Main Steam Line Break	10CFR 100 dose limits
Small Break LOCA	10CFR 50.46 PCT limits 10CFR 100 dose limits
Steam Generator Tube Rupture	10CFR 100 dose limits

10.4.7.1.2 EFW Supply Requirements for Plant Cooldown

The EFW System is also designed to accommodate a plant cooldown at the maximum allowable cooldown rate. However, the cooldown function is not required to meet the single failure criterion, nor is it required to rely solely upon safety related equipment. The EFW flow demand requirements for plant cooldown (from full power operation to RCS temperatures where switchover to the Decay Heat Removal System is achievable) have been analyzed. All heat sources (decay heat, pump heat, fuel, structural steel, and coolant sensible heat) have been included. The average EFW flowrate to meet cooldown rates of 100°F/hr and 50°F/hr to the LPI switchover temperature of 246°F are given in the following table.

	Cooldown Rate assuming 90°F EFW	
Time	100°F/hr (gpm)	50°F/hr (gpm)
0-1 hr	547	480
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 EFW flow is throttled to obtain the cooldown rate desired and within Technical Specification limits. Without crediting recirculation via the Turbine Bypass System, the feedwater inventory required for a 100°F/hr cooldown to decay heat removal switchover is approximately 94,000 gallons. The feedwater inventory required for a 50°F/hr cooldown to decay heat removal switchover is approximately 145,000 gallons. This inventory is well within the nominal capacity available within the UST, CST and hotwell (refer to Table 10-1). For cooldown in the recirculation mode, the minimum amount of water required by Technical Specifications (72,000 gallons) provides approximately 11 hours of EFW operation. This is based on the assumed normal makeup being 0.5 percent of throttle flow. Throttle flow at full load, 11,200,000 lbs/hr, was used to calculate the operation time. The recirculation mode of cooldown relies upon the Turbine Bypass Valves (TBVs) to steam the SG's to the condenser, the Condenser Circulating Water (CCW) System to condense the steam, the Vacuum System to allow the use of the TBVs, and the hotwell pump recirculation pathway to the UST to maintain UST water level. Operation in the recirculation mode with the assumed minimum inventory required by Technical Specifications provides sufficient time to allow for a 50F/hr or a 100F/hr cooldown to decay heat removal switchover.

10.4.7.1.3 Long Term Inventory

The primary source of EFW inventory is the UST. A minimum inventory of 30,000 gallons of water is maintained in the UST. This inventory requirement assures that the plant operators have at least 20 minutes to act before the UST is emptied, assuming the highest capacity pump is operating. The EFW pumps will remain aligned to the UST as long as adequate inventory can be maintained by makeup to the UST from demineralized water, the condensate storage tank, or the hotwell. If the UST inventory cannot be maintained, the preferred long-term source of EFW inventory is the hotwell. The hotwell is not designed to withstand a single failure. In addition, there are some events, such as a feedwater or condensate line break, that will deplete the hotwell inventory. Thus, for these events, the hotwell inventory would not be available to the EFW pumps. In addition, certain single failures can impact hotwell inventory, hotwell temperature, or the ability to manually align suction from the UST to the hotwell. Although the likelihood of these failures is low, should they occur the hotwell may not be available as a long-term suction source for the EFW pumps. For these postulated events or single failures, sufficient long term inventory can be provided to the steam generators by the SSF ASW System or the station ASW System. The capability of these alternate means of providing feedwater to the SGs is further discussed in UFSAR Sections 9.6 and 9.2.3, respectively. Additionally, the ability to cross-connect to another units EFW System can provide supplemental water to the steam generators, prior to the use of the SSF-ASW or station ASW System.

10.4.7.1.4 Ability to Withstand Adverse Environmental Occurrences and the Effects of Pipe Breaks

10.4.7.1.4.1 Maximum Hypothetical Earthquake (MHE)

The seismic qualification of the EFW System and Quality Group Classification is described in UFSAR Section 3.2.2. Only those components listed in UFSAR Section 3.2.2 are seismically qualified.

The TDEFWP supporting equipment is not fully seismically qualified and therefore is not credited for MHEs. However, it has been evaluated against Seismic Qualification Utility Group (SQUG) criteria and is expected to be available following a seismic event. Although redundancy is provided by two full-capacity seismically qualified MDEFWPs, they are also susceptible to failure in a seismic event due to flooding induced by the event. However, alternative seismically qualified means of decay heat removal are provided by the SSF ASW System, the station ASW System and the HPI System. The SSF ASW System and station ASW System are capable of providing feedwater to the SGs via separate and dedicated feedwater trains. The HPI System can remove decay heat via RCS feed and bleed.

The EFW System is seismically qualified to the MHE level out through the first isolation valves. Piping beyond these boundary points is not seismically qualified. The primary suction to the EFW pumps is from the UST. The UST is seismically qualified. The UST provides makeup via three separate pathways to the non-safety condenser hotwell. These pathways are automatically isolated on a low UST level. The UST also provides a source of water to other non-safety equipment. These pathways are normally isolated by closed manual valves. If malfunctions render the UST unavailable, suction can be taken from the condenser hotwell which is designed to withstand a MHE (References 14, 15, and 16) with a nominal available capacity of 120,000 gallons. The piping from the hotwell to the TDEFWP is not fully qualified, but it is designed and supported in accordance with ANSI B31.1 and would be fully expected to withstand the design basis earthquake. The piping from the hotwell to the MDEFWPs is seismically qualified. Flow from just one of the three EFW pumps to either SG is adequate to maintain a unit at hot standby.

As defined in Reference 5, Oconee was deemed to meet the criteria of Generic Letter 81-14 regarding adequate post-seismic event decay heat removal capability by:

a. requiring portions of the EFW System (defined in UFSAR Section 3.2.2) to be capable of withstanding a MHE, and
b. providing alternative seismically qualified means of decay heat removal with the SSF ASW System and the HPI System.

10.4.7.1.4.2 Tornado

Portions of the EFW System are vulnerable to tornado missiles. Thus, the plant relies upon diverse means to provide feedwater to the SGs in the event of a tornado. These diverse means include the SSF ASW System and the station ASW System. The SSF ASW System is protected against tornado missiles, except for a small portion of piping in the cask decon pump room and in the west penetration room. The probability of failure of the EFW and station ASW Systems combined with the protection against tornado missiles afforded the SSF ASW System is acceptably low (Reference 6).

10.4.7.1.4.3 High Energy Line Break

The effects of High Energy Line Breaks have been analyzed as addressed in UFSAR Section 3.6.1.3.

10.4.7.1.4.4 Internally Generated Missiles

The Emergency Feedwater System has not been designed to be able to withstand the effects of internally generated missiles. If such an event were to occur and if main feedwater were unavailable, the single train SSF ASW System would provide an assured means of providing heat removal from the SGs. A detailed evaluation of the capability of the existing EFW System to withstand missiles was not considered necessary (Reference 2).

10.4.7.1.5 Ability to Perform its Safety Related Function following a Single Failure Coincident with Pipe Breaks, or Environmental Occurrences

The EFW System is capable of performing its safety function coincident with a single active failure, except as described below, during the following events: 1) Loss of Main Feedwater; 2) Main Feedwater Line Break; 3) Main Steam Line Break; 4) Loss of Coolant Accident; and 5) Steam Generator Tube Rupture. Passive failures are not considered in the design of the EFW System.

A failure modes and effects analysis was performed (Reference 7) to confirm the capability of the EFW System to perform its safety function during the events described above coincident with a single active failure. Exceptions to the single failure criterion are discussed below.

10.4.7.1.5.1 Single Failure Exceptions

The EFW System is not considered to be an Engineered Safeguard System and therefore was not designed to meet all design criteria applicable to Engineered Safeguard Systems. As such, the following exceptions to the single failure criteria are applicable for the EFW System:

- Maximum Hypothetical Earthquake (MHE)

  The EFW pumps are located in the basement of the Turbine Building and are therefore, subject to complete failure as a result of flooding caused by a rupture of the non-seismic portion of the condenser circulating water line. In such an event, the SSF ASW System would be relied upon for shutdown decay heat removal. The SSF ASW System is not single failure proof. Penetration seals and waterproof doors have been installed between the Turbine Building and Auxiliary Building in each unit to provide waterproofing up to a height of twenty feet above the Turbine Building basement floor. Thus the High Pressure Injection (HPI) System and station ASW System, located in the Auxiliary Building, would be available as an alternative to the EFW System and the SSF ASW System for shutdown decay heat removal (Reference 5).

  Piping isolation between seismic and non-seismic portions of the EFW System is provided by a single boundary valve. The EFW seismic boundary valves can be of four types. The first type is a manually operated valve. Manually operated valves that provide a seismic boundary are normally closed. A single failure is not assumed to include the failure of a normally closed valve to the open position. These valves may be opened during specific operating conditions. However, due to the short duration and low probability of a seismic event occurring concurrent with the manual valve being open, this single failure vulnerability was found to be acceptable. Another seismic boundary valve type is a check valve. Check valves in the reverse flow direction are considered to be normally closed, and are therefore treated as a normally closed manual valve. A third type of seismic boundary valve is a power operated valve. The power operated EFW seismic boundary valves are normally closed. These valves function as a seismic boundary in that they are designed to fail as-is in the closed position. The last type of seismic boundary valve for EFW is a pneumatically operated valve. There are three pneumatically operated valves that receive an automatic closure signal on a low UST level. The pneumatically operated valves function as a seismic boundary in that they are designed to fail closed on a loss of instrument air or low UST level.

The EFW pump recirculation pathways are exceptions to the above description of seismic boundary valves, in that these pathways remain open. The turbine-driven EFW pump recirculation seismic boundary is provided by fixed orifices. These orifices restrict the amount of EFW that would be diverted from feeding the SGs. The orifices are the devices credited for limiting recirculation flow such that adequate EFW flow can be delivered to the SGs. Each motor-driven EFW pump recirculation line is provided with a normally open manual valve as its seismic to non-seismic boundary. Recirculation flow is regulated by an automatic recirculation control valve for each motor-driven EFW pump. The automatic recirculation control valves are the devices credited for limiting recirculation flow such that adequate EFW flow can be delivered to the SGs.

- EFW Flow Control Valve Single Failures (FDW-315 and FDW-316)

  As addressed in Section 10.4.7.3, flow from only one EFW pump is required to mitigate a design basis event. Therefore, for events where both SGs remain available for heat removal, the failure of an EFW control valve would not impact the ability of the EFW System to perform its intended function. However, some events such as steam generator tube ruptures and some secondary side pipe breaks cause only one steam generator to be available for heat removal. If the EFW flow control valve for the unaffected SG failed to open, the flow path can be realigned to bypass the failed valve and reach the SG through the main feedwater startup flow path. This alternate path through the main feedwater startup control valve relies on non-safety equipment and non-safety support systems (electrical power and instrument air). If the EFW flow control valve on the unaffected SG fails open (on a loss of compressed air and nitrogen), this could result in the SG overcooling and subsequent loss of EFW to the unaffected SG due to pump runout. The safety analyses assume both SGs are isolated within 10 minutes, with subsequent action outside the Control Room for local manual control of the EFW control valve if the valve failed open. The EFW flow control valves are located in the penetration rooms adjacent to the Control Room. Except in those cases where the break makes these valves inaccessible, an operator could manually adjust either valve. In the event this path were unavailable, the SSF ASW System provides an alternate means of establishing feedwater flow to the unaffected steam generator.

- MDEFWP Single Failures

  As addressed in Section 10.4.7.3, flow from only one EFW pump is required to mitigate a design basis event. Therefore, for events where both SGs remain available for heat removal, the failure of a MDEFWP would not affect the ability of the EFW System to perform its intended function. However, for secondary side pipe breaks that result in a loss of the SG pressure boundary, only one steam generator is available for heat removal. In the case of a secondary side pipe break occurring coincident with the failure of the MDEFWP associated with the unaffected steam generator, the EFW System would not be capable of automatically supplying water to the unaffected steam generator. The Main Steam Line Break Detection and Mitigation Circuitry would isolate main feedwater to both steam generators, and inhibit the automatic start of the TDEFWP. The preferred method of mitigating this event, after having isolated flow to the affected SG, would be to start the TDEFWP by manual operator action in the Control Room. However, if the TDEFWP is not available, the remaining MDEFWP could be aligned to the unaffected SG by manual operator action outside of the Control Room.

- High Energy Line Break (HELB) Single Failures

There are certain HELBs that, coupled with a single active failure in the EFW System, can cause a complete loss of main and emergency feedwater on the affected unit (Reference 11). The safety function of delivering feedwater to the SGs is provided by the SSF ASW System or EFW from an alternate unit.

10.4.7.1.6 Means by which the System is Protected from the Effects of Hydraulic Instability (Water Hammer) or the Design Considerations Precluding the Occurrence of Hydraulic Instability

Provisions for water hammer events are considered unnecessary due to the use of Once Through Steam Generators (OTSG) (Reference 10). Additionally, each OTSG is provided with a level control system (see UFSAR section 7.4.3.2) that enables the EFW System to supply on demand sufficient initial and subsequent flow to the necessary SG to assure adequate decay heat removal.

10.4.7.2 System Description

Each reactor unit is provided with a separate EFW System, as shown in Figure 10-8. Controls for each system are located on the main Control Room panels. Each EFW System is provided with two full capacity motor-driven pumps and one full capacity turbine-driven pump. The EFW pumps normally discharge into separate lines feeding a separate SG through the auxiliary feedwater header. Each of the motor-driven pumps normally serves a separate SG; the turbine-driven pump serves both SGs.

10.4.7.2.1 Motor Driven EFW Pumps (MDEFWPs)

There are two MDEFWPs per unit. The pumps are physically located in the basement of the Turbine Building. Each of the MDEFWPs is normally aligned to a separate SG. Each of the MDEFWPs is supplied with its own independent starting circuit, as described in UFSAR Section 7.4.3.1, that allows the operator manual or automatic control of the pump. During periods of shutdown and cooldown the circuit selector switch is normally positioned to automatically start the MDEFWPs on a LOW STEAM GENERATOR WATER LEVEL signal in either steam generator after a time delay to prevent spurious actuation. The LOW STEAM GENERATOR WATER LEVEL initiation function, which was added for SG dryout protection (Reference 13), is not designed to meet the single failure criterion as it is not relied upon for the mitigation of any accident. During normal plant operation, the selector switch is positioned to automatically start the MDEFWPs on a LOSS OF BOTH MAIN FEEDWATER PUMPS, LOW STEAM GENERATOR WATER LEVEL or ATWS Mitigation System Actuation Circuitry (AMSAC) signal. Loss of both main feedwater pumps is sensed by pressure switches that monitor main feedwater pump turbine hydraulic oil pressure. The AMSAC start signal is described in section 7.8.2.1. Once automatically started the MDEFW pumps will continue to operate until manually secured by the operator. The operator can manually start each MDEFWP by placing its associated selector switch in RUN.

The MDEFW pumps require cooling water for continuous operation. Sufficient cooling water is initiated automatically, upon manual or automatic start of MDEFW pumps, from the Low Pressure Service Water System.

The MDEFW pumps are powered from the 4160VAC Switchgear TD and TE. The switchgear are located side by side on the ground floor of the Turbine Building and are not protected from high energy line breaks. The normal station auxiliary AC Power System normally provides power for the switchgear.

During loss of offsite power operation, these switchgear are automatically aligned to the Emergency AC Power System.

10.4.7.2.2 Turbine Driven EFW Pump (TDEFWP)

There is one TDEFWP per unit. The pump is physically located in the basement of the Turbine Building. The TDEFWP is normally aligned to supply both SGs. The TDEFWP is supplied with its own independent starting circuit, as described in UFSAR Section 7.4.3.1, that allows the operator manual or automatic control of the pump. During normal plant operation the circuit selector switch is positioned to automatically start the TDEFWP on a LOSS OF BOTH MAIN FEEDWATER PUMPS or AMSAC signal. Loss of both main feedwater pumps is sensed by pressure switches that monitor feedwater pump turbine hydraulic oil pressure. The AMSAC start signal is described in section 7.8.2.1. If a main steam line break (MSLB) signal is present and the selector switch is in automatic, the TDEFWP will automatically stop or will be prevented from automatically starting. Once automatically started the TDEFWP will continue to operate until manually secured by the operator unless a MSLB signal is received following the automatic start. The operator can manually start the TDEFWP by placing the selector switch to RUN. The TDEFWP can also be started locally in the basement of the Turbine Building.

The TDEFWP requires cooling water to the pump bearing cooling jackets for continuous operation. Upon manual or automatic start of TDEFW, sufficient cooling water is initiated automatically from the Low Pressure Service Water System. Cooling water is also automatically supplied to the turbine oil cooler via an AC driven cooling water pump. Analysis has shown that the pump may operate in excess of 4 hours without cooling water to the oil cooler. Both of these cooling water supplies may be lost following a loss of AC power. A backup source of cooling for both the cooling jacket and the oil cooler is provided by the High Pressure Service Water (HPSW) System and is automatically aligned following a loss of AC power.

Motive steam for the TDEFWP is provided from either of the two SGs by main steam lines upstream of the main turbine stop valves or by the auxiliary steam header, and is exhausted to the atmosphere. Any of the three steam supplies will provide sufficient steam for turbine operation. Any steam supply may be isolated if necessary. A check valve is provided in each main steam supply line to minimize uncontrolled blowdown of more than one SG following a MSLB (refer to UFSAR Section 10.3.2 for further details). Auxiliary Steam is also normally aligned and available to supply the TDEFWP. A check valve is provided in the auxiliary steam supply line to prevent a loss of the main steam source should auxiliary steam be lost. Valve MS-93, the TDEFWP steam admission valve, in the common supply to the turbine will fail open upon loss of station air or power to the normally energized solenoid valve. Upon receipt of a manual or automatic start signal, the solenoid valve will de-energize and immediately start the turbine.

Automatic or manual starting of the TDEFWP from the Control Room relies on DC power from the station power batteries. Each TDEFWP is equipped with a DC auxiliary oil pump (AOP). The auxiliary oil pump is located near the TDEFWP in the basement of the Turbine Building. Power for the AOP is supplied by 250VDC load center DP. This load center is located on the ground floor of the Turbine Building adjacent to the 4160VAC Switchgear TC, TD, and TE. The AOP automatically starts when MS-93 opens. The AOP provides the initial oil pressure to open the turbine governor valve (MS-95) and supply lube oil for the turbine bearings. When the turbine approaches operating speed, the shaft driven oil pump will supply adequate oil pressure for the governor valve and bearing lubrication.

10.4.7.2.3 EFW Pump Suction Source

The condensate/feedwater reserve, specifically the Upper Surge Tank for each unit, is normally aligned to the EFW pump suctions. A minimum of 30,000 gallons of water is maintained in the UST. The condensate/feedwater reserve for each unit is maintained among the sources in Table 10-1. Inventory in the UST can be replenished from a variety of sources. These sources include the plant Demineralized Water System through the makeup demineralizers, the Condensate Storage Tank (CST) via the CST pumps, and the Condenser Hotwell via a hotwell pump recirculation pathway. The makeup sources are non-safety. If the UST inventory cannot be maintained following an accident, the EFW pump suction may be aligned to the condenser hotwell directly. Condenser vacuum must be broken to provide adequate net positive suction head to the EFW pumps when aligned to the hotwell. Condenser vacuum is broken by the opening of a single vacuum breaker valve (V-186). This vacuum breaker valve is normally operated from the Control Room and is physically located on the ground floor of the Turbine Building on the east side of the condenser hotwell. To complete the transfer of suction for the MDEFWPs, a single manual valve in the common suction piping (located in the basement of the Turbine Building near the MDEFWPs) must be closed. TDEFWP suction is transferred by opening the hotwell supply valve (C-391) and closing the UST supply valve (C-156 or C-157). All necessary valves in the discharge flow path are maintained in normal standby alignment to assure an open flow path for each pump, and to assure piping separation and independence. All manually operated valves in the piping from the UST to the suction of the EFW pumps are locked open (Reference 2).

10.4.7.2.4 EFW Pump Minimum Recirculation

A flow path is also provided to the UST dome for minimum recirculation flow and testing purposes. A continuous recirculation flow is provided for the TDEFWP, limited by fixed orifices. A self-contained automatic recirculation valve is provided for each MDEFWP to assure individual pump minimum flow when needed during operation. A flow path is provided from the discharge of each MDEFWP to the UST for full flow testing. During normal system alignment, the test loops are isolated and pump minimum recirculation would be routed back to the UST for reuse.

10.4.7.2.5 EFW Discharge Flow Control Valves

Each EFW discharge line to each SG is provided with a control valve and check valve. Discharge flow from the EFW pumps is normally aligned and controlled by control valves FDW-315 and FDW-316. FDW-315 (EFW flow control to 'A' SG) is physically located in the East Penetration Room. FDW-316 (EFW flow control to 'B' SG) is physically located in the West Penetration Room. Open/Closed valve position indication is provided for each control valve in the main Control Room at the valve manual loader. These valves are controlled independently of the Integrated Control System (ICS) and arranged to fail to the automatic control mode upon loss of DC control power to the manual/auto select solenoid. If the selected train of automatic control experiences a loss of power, then the valve would fail open. The control valves are pneumatically operated. Motive force for valve operation is supplied by any of the following: instrument air, auxiliary instrument air, or bottled nitrogen. Upon a loss of instrument air and auxiliary instrument air, the valves will maintain their position with nitrogen backup. If nitrogen backup fails, then the valve would fail open. In automatic, the control valve manual/auto select solenoid valves are de-energized, thereby aligning the valve to automatic control and positioning the valve per the automatic setting. Control valves FDW-315 and FDW-316 are modulated by separate control air signals. These valves may be automatically controlled, or manually controlled by the operator to limit or increase feedwater as necessary to maintain feedwater inventory and cooldown rate. A pushbutton in the Control Room is provided for each control valve to allow the individual valve to be placed in either an automatic level control mode or in a manual mode of operation. In automatic, the valves are positioned and controlled by the automatic level control. Independent level transmitters are utilized in the automatic control system circuit. Upon loss of all four reactor coolant pumps, such as during LOOP events, the level control setpoint is automatically raised to promote natural circulation in the Reactor Coolant System. For events where core subcooling margin has been lost, operators must manually control SG levels at the loss of subcooling margin setpoint.

10.4.7.2.6 Instrumentation and Controls

Each of the EFW pumps is supplied with an independent starting circuit (described in UFSAR Section 7.4.3.1 and 7.8.3.1). The independent control circuits are powered by the 125 VDC safety-related station batteries.

Sufficient indication is provided in the Control Room to allow the operator to monitor unit parameters during a cooldown. Specific indication provided for the EFW System is listed in Table 10-2.

10.4.7.2.7 Alternate Flow Path

Although not normally aligned or utilized in the safety related function of the EFW System, a redundant, separate flow path to the SGs and means of controlling EFW pump discharge flow is provided by MFW startup control valves FDW-35 and FDW-44. This additional non safety-related flow path is not required for normal EFW System function, but may be aligned manually during startup, shutdown or following EFW flow control valve failures.

The 'A' MDEFWP can be aligned to feed the 'A' SG via the MFW startup path by opening motor operated valves FDW-38 and FDW-374 and closing motor operated valves FDW-33, FDW-36, and FDW-372. The 'B' MDEFWP can be aligned to feed the 'B' SG via the MFW startup path by opening motor operated valves FDW-47 and FDW-384 and closing motor operated valves FDW-42, FDW-45, and FDW-382. These motor operated valves are operated from the Control Room. The valves receive non-safety power. FDW-36, FDW-38, FDW-45, and FDW-47 are DC motor operated valves that receive power from the station power batteries. FDW-372, FDW-374, FDW-382, and FDW-384 are AC motor operated valves that receive power from non-safety, non-load shed sources. FDW-33 and FDW-42 are AC motor operated valves that receive power from a non-safety, load shed source. The MDEFWPs must be stopped to allow alignment of this flow path.

The TDEFWP can be aligned to feed both SGs via the MFW startup path by opening two manually operated valves (FDW-94 and FDW-96) located in the Turbine Building basement and closing motor operated valves FDW-368 and FDW-369. The motor operated valves are operated from the Control Room. FDW-368 and FDW-369 are AC motor operated valves that receive power from non-safety, non-load shed power. Repositioning of FDW-33, FDW-36, FDW-38, FDW-42, FDW-45, and FDW-47 would also be required as described in the alignment of the MDEFWP's to the MFW startup path. The TDEFWP must be stopped to allow alignment of this flow path.

Once the EFW pump is aligned to the MFW startup path, FDW-35 and/or FDW-44 are used to control EFW flow to the SGs. Air operated control valves FDW-35 and FDW-44 are modulated by control signals based on SG water levels by the ICS. The control valves may be operated manually from the Control Room. Air is supplied by the plant Instrument Air System. The ICS and the plant instrument air are non-safety. As in the case of control valves FDW-315 and FDW-316, the level control setpoint is automatically raised upon loss of all four reactor coolant pumps to promote natural circulation in the Reactor Coolant System.

The alignment of EFW through the MFW startup path is vulnerable to LOOP events. FDW-33 and FDW-42 receive power from a load shed source. These valves would have to be manually closed locally or power must be restored to the load shed source to allow the valves to be operated from the Control Room. The valves are located on the ground floor of the Turbine Building. Plant instrument air is also vulnerable. Either power must be restored to the air compressors or the diesel service air compressor must be manually started and aligned to supply the plant Instrument Air System. The diesel service air compressor is located outside by the south end of the Turbine Building.

10.4.7.2.8 Alarms

Sufficient alarms are provided to alert the operator of conditions exceeding normal limits. Essential plant parameters are annunciated or alarmed by the process computer in addition to specific EFW System alarms as listed below:

1. MDEFWPs low suction pressure
2. SG low level alarms
3. Hotwell low level alarms
4. UST low level alarms
5. Low MDEFWP cooling water flow
6. MDEFWP stator winding high temperature
7. MDEFWP motor bearing high temperature
8. MDEFWP bearing high temperature
9. Motor cooler excessive leakage
10. MDEFWP A auto start blocked
11. MDEFWP B auto start blocked
12. TDEFWP EFW pump auto start blocked
13. MDEFWP A low level start
14. MDEFWP B low level start
15. TDEFWP turbine lube oil low pressure
16. TDEFWP turbine oil high temperature
17. TDEFWP turbine hydraulic oil low pressure
18. TDEFWP turbine auxiliary oil pump overload
19. TDEFWP tripped

10.4.7.3 Safety Evaluation

Feedwater inventory is maintained in the SGs following reactor shutdown by one of the following methods listed:

1. Either of the two main feedwater pumps in combination with a hotwell pump and a condensate booster pump are capable of supplying both SGs at full secondary system pressure.
2. The two MDEFWPs are capable of supplying their associated SG at full secondary system pressure.
3. The single TDEFWP is capable of supplying both SGs at full secondary system pressure.
4. An alternate EFW supply available from the EFW System of one of the other units, capable of supplying both SGs at full secondary system pressure.
5. The hotwell and condensate booster pump combination has discharge shutoff head of approximately 620 psia. There are three hotwell pumps and three condensate booster pumps. If required, the Turbine Bypass System or the Atmospheric Dump Valves (ADVs) can be used to reduce secondary system pressure to the point where one hotwell and condensate booster pump combination can supply feedwater to both SGs.
6. The SSF Auxiliary Service Water System is capable of supplying both SGs of all three units at full secondary system pressure.

7. The station Auxiliary Service Water System may be used to maintain SG water inventory following SG depressurization to remove decay heat in the long term.

A sufficient depth of backup measures is provided to allow SG water inventory to be maintained by any of the diverse methods listed above. Although redundancy and diversity is provided as listed above, the EFW System has been designed with special considerations to enable it to function when conventional means of feedwater makeup may be unavailable.

Redundancy is provided with separate, full capacity, motor and turbine driven pump subsystems. Failure of either the MDEFWPs or the TDEFWP will not reduce the EFW System below minimum required capacity. Pump controls, instrumentation, and motive power are separate in design.

The design basis transients that require EFW have been evaluated assuming only one MDEFWP is available to deliver the necessary feedwater. Except as noted in Section 10.4.7.1.5, no single failure in the three pump-two-flowpath EFW System design will result in only one available MDEFWP (i.e., two EFW pumps will remain available). Therefore, the evaluation assuming only one MDEFWP available is conservative.

Assuming the worst case plant transient (loss of feedwater transient assuming an anticipatory reactor trip and loss of offsite power) with three EFW pumps operating, the minimum UST inventory of 30,000 gallons would provide for approximately 44 minutes of emergency feedwater without makeup (Reference 12). With offsite power available, the UST would provide for approximately 50 minutes of emergency feedwater without makeup (Reference 12). These times, which are based on EFW controlling steam generator levels at the appropriate setpoint, meet the design bases of providing at least 20 minutes to act before the UST is emptied. UST makeup should be available using non safety related CST, hotwell, or plant demineralized water. Long term secondary side cooling is discussed in Section 10.4.7.3.8.

These analyses verify the acceptability of the EFW System design.

10.4.7.3.1

A loss of main feedwater is the result of both main feedwater pumps tripping. All three EFW pumps would be available with or without offsite power being available. Both EFW flowpaths should remain available. With offsite power being available, the reactor coolant pumps are assumed to remain running. If any reactor coolant pump is operating, the EFW flow control valves will modulate to control steam generator level at 30 inches. Without offsite power being available, the reactor coolant pumps will not be operating. If no reactor coolant pumps are operating, the EFW flow control valves will modulate to control steam generator level at 240 inches to promote natural circulation mode of heat removal.

10.4.7.3.2 EFW Response Following a HELB

10.4.7.3.2.1 HELBs Resulting in Loss of TC, TD, TE Switchgear

HELBs in the vicinity of the TC, TD, TE switchgear could cause their failure due to steam/water impingement. The consequence of the switchgear failure would cause a complete loss of the Condensate and Feedwater System (loss of pumps). This event is similar to a station blackout on the affected unit. This would also cause a loss of both MDEFWPs due to loss of power. In addition, the DC power supply to the auxiliary oil pump (AOP) for the TDEFWP could be lost due to its location being adjacent to the switchgear. Loss of the AOP results in an inability to start the TDEFWP from the Control Room. The TDEFWP could be locally started. A single failure of the TDEFWP would lead to a complete loss of main and emergency feedwater. The SSF ASW System could be used to feed the SGs. In addition, alignment of an unaffected unit's EFW System could be performed to feed the SGs.

10.4.7.3.2.2 Other HELBs that do not cause a Loss of SG pressure boundary or loss of 4160V Power

This class of HELBs could result in depletion of stored inventory in the hotwell due to continued operation of the hotwell and condensate booster pumps. These line breaks cause the hotwell makeup valves to open to control hotwell level. On a low UST level, automatic closure signals are sent to close the hotwell makeup valves to preserve inventory in the UST's. The SSF ASW System would be available for feeding the SGs. HPI feed and bleed cooling also remains available. In addition, EFW could be aligned from an alternate unit using the unit cross connects.

10.4.7.3.2.3 Feedwater/Main Steam Line Breaks Causing Loss of SG Pressure Boundary

Large line breaks in the Feedwater/Main Steam System that result in a depressurization of the steam generator will result in actuation of the Main Steam Line Break Detection and Mitigation System. Once actuated, all main feedwater will be automatically isolated to both steam generators and the TDEFWP will be inhibited from automatically starting. The MDEFWPs will automatically start and feed both steam generators. The operator is required to manually terminate EFW flow to the faulted steam generator by either closing the EFW flow control valve or by stopping the MDEFWP. These actions can be done from the Control Room. The operator has sufficient Control Room indication of SG level and pressure and would immediately be aware of such a situation. Concurrently, the operator would monitor the intact SG to maintain adequate inventory and secondary heat removal via the EFW System.

In the event of a postulated failure of the EFW flow control valve to the intact steam generator, manual operator action would be required to align the MDEFWP through the main feedwater startup control valve as previously described in Section 10.4.7.1.5.1. The Main Steam Line Break Circuitry (Reference 8) must be disabled by the operator to allow EFW flow alignment through the non-safety MFW startup control valves. In the unlikely event that the EFW flow control valves fail open (on a loss of compressed air and nitrogen), an operator could manually adjust either one of the valves. These valves are located in the Penetration Rooms that are adjacent to the Control Room.

In the event of a single active failure of the MDEFWP to the intact steam generator, manual operator action is required to start the TDEFWP to provide sufficient flow for adequate core cooling. The TDEFWP can be manually started by placing its Control Room switch to RUN. In addition, the remaining MDEFWP could be aligned to the unaffected SG via cross connect (FDW-313 and –314).

10.4.7.3.3 EFW Response Following a LOOP

All three EFW pumps would be available for LOOP events. Both EFW flowpaths should remain available. However, some accidents may result in only one SG being available for decay heat removal. These accidents include MSLBs and main feedwater line breaks downstream of the isolation check valve. A single active failure of the EFW flow control valve to open on the unaffected SG would result in loss of EFW function. For this specific failure, EFW flow can be delivered to the unaffected SG through the MFW startup flow path. This alignment may not be available in LOOP events. The main feedwater startup control valve requires instrument air to operate. The main feedwater startup block valve receives power from load shed power which may not be immediately available following a LOOP. If the EFW control valve on the unaffected SG fails to open and the main feedwater startup path is unavailable, then SSF ASW System would be required to feed the unaffected SG for heat removal.

10.4.7.3.4 EFW Response Following a SBLOCA

For certain size 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 design function is to lower RCS pressure to minimize the loss of inventory through the break while maximizing safety injection. One motor-driven EFW pump has the necessary capacity. The EFW flow rate demand requirements for a SBLOCA are bounded by other events such as a LOMFW in which a break in the primary system is not present to help remove system heat.

10.4.7.3.5 EFW Response Following a SGTR

This event does not assume a loss of offsite power has occurred. With offsite power available, main feedwater should continue to operate and provide inventory to the SGs. In addition, the condenser should remain available as a means of removing heat from the SGs via the Turbine Bypass System to the Condenser Circulating Water (CCW) System. However, should the Main Feedwater System be unavailable, the EFW System would be required to provide secondary side cooling. All three EFW pumps would be available to provide inventory to the SGs. Prior to isolation of the ruptured SG, EFW inventory requirements are diminished to a certain degree due to primary system leakage boiloff in the ruptured SG. If the EFW control valve on the unaffected steam generator fails closed, EFW flow is aligned to this steam generator through the non-safety main feedwater startup flow path. With offsite power being available, the main feedwater startup path should remain available. Prior to cooling the unit down to DHR conditions, one RCP per loop is tripped, further reducing the demand for EFW. The demand for EFW following a SGTR event is bounded by the demand for EFW following a loss of main feedwater with offsite power available.

10.4.7.3.6 EFW Response Following a MHE

Portions of the EFW System are designed to withstand seismic loading. Both supply lines from the UST to the EFW pumps are seismically qualified, including connected branch piping up to and including the first valve that is normally closed or capable of automatic closure when the safety function is required. Both discharge lines from the EFW pumps are seismically qualified to the SGs including piping through the first valve of any connections to these lines. However, the EFW System in each of the three Oconee units is located in the Turbine Building basement and is therefore subject to a complete failure as a result of flooding caused by the rupture of the non-seismic condenser circulating water line. In such an event, the SSF ASW System, station ASW System and HPI System (feed and bleed) would be available to provide seismically qualified alternative capability for heat removal. Reference 5 concludes that Duke demonstrated adequate post-seismic shutdown decay heat removal capability in accordance with Generic Letter 81-14 based on the above capability.

10.4.7.3.7 EFW Response Following a Tornado

A probabilistic risk assessment was developed to address the plant's capability to provide secondary decay heat removal (via the EFW, SSF ASW, and station ASW Systems) in the event of a tornado. Reference 6 concludes that the probability of failure of the EFW and station ASW Systems combined with the protection against tornado missiles afforded the SSF ASW System satisfies the SRP probabilistic criterion.

10.4.7.3.8 EFW Response Following a SBO

This event is similar to the LMFW with LOOP analysis with the additional assumption that the onsite emergency AC power sources have been lost. This results in the loss of the MDEFWPs. The TDEFWP should be available for this event because of its AC power independence; however, the SSF ASW System is credited to remove the decay heat in this event. The SBO event, which is not a design basis event, is described in UFSAR Section 8.3.2.2.4, "Station Blackout Analysis."

10.4.7.3.9 Long-Term Secondary Side Cooling

The UST inventory assures at least 20 minutes is available for operator action before the UST is emptied assuming the highest capacity EFW pump is operating. Prior to the end of this time period, UST makeup should be available via the non safety related CST, hotwell, or plant demineralized water. The hotwell may not be available following a condensate or feedwater line break. In addition, single failures may lead to a depletion of hotwell inventory or result in an inability to directly align EFW pump suction to the hotwell. In the event these sources are not available, redundant and diverse sources of secondary makeup water are available via the SSF ASW System or the station ASW System to provide long term secondary side cooling. The capability of these alternate means of providing feedwater to the SGs is further discussed in UFSAR Section 9.6 and 9.2.3, respectively. Additionally, the ability to cross-connect to another units EFW System can provide supplemental water to the steam generators, prior to the use of the SSF-ASW or station ASW System.

10.4.7.3.10 Failure Mode and Effects Analyses to Ensure Minimum Safety Requirements are Met assuming a single active failure in any System Required to Ensure Performance of the EFW System

For the above events only one EFW pump is needed for heat removal. Any single active failure, except as noted in Section 10.4.7.1.5, in the three pump-two flowpath EFW System design will not result in the loss of more than one of the three EFW pumps. A detailed component/system level analysis of potential failure modes is documented in Reference 7. Exceptions to the single failure criterion are addressed in Section 10.4.7.1.5.1. As described in the introduction to Section 10.4.7.3, the Oconee design includes redundant and diverse methods of providing feedwater to the SGs. These design features adequately address the single failure exceptions described in Section 10.4.7.1.5.1.

10.4.7.4 Inspection and Testing Requirements

A comprehensive test program is followed for the EFW System. The program consists of periodic tests of the activation logic and mechanical components to assure reliable performance during the life of the unit.

During unit operation, the EFW System is tested by utilizing the recirculation test line to the upper surge tank dome. Pump head and flow is verified utilizing this method.

10.4.7.5 Instrumentation Requirements

Sufficient instrumentation and controls are provided to adequately monitor and control the EFW System. The safety related instrumentation and controls which monitor SG level and pressure, automatically start the EFW pumps, and automatically align the supply meet the system requirements for redundancy, diversity and separation.

10.4.7.5.1 TDEFWP

Instrumentation used in the automatic initiation circuitry on loss of main feedwater pumps for the TDEFWP is safety grade, but not all of the equipment required to provide auto start capability is safety grade. Instrumentation used in the automatic initiation of the pump following an ATWS event is not required to be safety grade. A failure in the automatic initiation circuitry will not prevent manual start capability from the Control Room.

10.4.7.5.2 MDEFWP

Instrumentation used in the automatic initiation circuitry on loss of main feedwater pumps for the MDEFWPs is safety grade. Instrumentation used in the automatic initiation of the pumps following an ATWS event is not required to be safety grade. Instrumentation used to provide automatic initiation of the pumps on low steam generator level is QA-1, but is not single failure proof. A failure in the automatic initiation circuitry will not prevent manual start capability from the Control Room.

10.4.7.5.3 EFW Flow Indication to the Steam Generators

Each MDEFWP has a control grade flow transmitter with remote indication in the Control Room. Each EFW flow path to the steam generators contains two safety grade flow transmitters with remote indication in the Control Room. Each steam generator contains two safety grade level transmitters that are used to provide steam generator level control for the EFW System. The operators are capable of manually selecting between the primary and backup level transmitter from the Control Room. Safety grade level indication is provided in the Control Room.

10.4.7.6 References

1. J. A. Klingenfus (FTI), letter to M. E. Henshaw (Duke), CRAFT2 SBLOCA EFW Flows, November 9, 1998.

2. W. O. Parker (Duke) letter to H. R. Denton (NRC), April 3, 1981, page 32.

3. ONOE-11376, changes to support multiple unit alignment to the Auxiliary Steam Header.

4. OSC-5060, justification of reduced valve closing DP (PIR 0-092-0561).

5. NRC Safety Evaluation Report for Oconee Nuclear Station, Units 1, 2, and 3, regarding Seismic Qualification of the EFW System, dated January 14, 1987.

6. NRC Safety Evaluation Report on the Effect of Tornado Missiles on Oconee EFW System, dated July 28, 1989.

7. OSC-7420, Emergency Feedwater (EFW) System Single Failure Analysis.

8. D. E. LaBarge (NRC) letter to W. R. McCollum, Jr. (Duke), Amendments 234, 234, and 233 to DPR-38, DPR-47, and DPR-55 for Oconee Nuclear Station, Units 1, 2, and 3, respectively, dated December 7, 1998.

9. J. W. Hampton (Duke) letter to the USNRC, "Seismic Licensing Basis," dated August 18, 1994.

10. J. F. Stolz (NRC) letter to W. O. Parker, Jr. (Duke), Safety Evaluation Report for Oconee Nuclear Station, Units 1, 2, and 3, regarding NUREG-0737 Item II.E.1.1, "Auxiliary Feedwater System Evaluation," dated August 25, 1981.

11. MDS Report No. OS-73.2, Analysis of Effects Resulting from Postulated Piping Breaks Outside Containment for Oconee Nuclear station Units 1, 2, and 3, dated April 25, 1973.

12. OSC-6217, Loss of MFW with Anticipatory Reactor Trip.

13. LA. Weins (NRC) letter to J.W. Hampton (Duke), Safety Evaluation Report for Response to Generic Letter 89-19, Steam Generator Overfill Protection, dated November 3, 1993.

14. OSC-2826, Seismic Qualification Study of Components Associated with the Hotwell.

15. OSC 2827, Seismic Qualification Study of Components Associated with the Hotwell.

16. OSC 2633, Qualification of Condenser Hotwell Nozzles and Plates for Faulted Load Conditions.

ATTACHMENT 2

MARKUP OF OCONEE UFSAR

7 9. Moisture separator high level

7 10. Manual trip

8 11. Loss of speed feedback

10.4.6.5.2 Automatic Actions

4 (Also see Integrated Control System Description.)

4 1. Low Water level in Upper Surge Tank

10.4.6.5.3 Principal Alarms

1. Low pressure at condensate booster pump suction
2. Low pressure at feedwater pump suction
3. Low vacuum in condenser
4. Low water level in condenser hotwell
5. High water level in condenser hotwell
6. High water level in steam generator
7. Low water level in steam generator
8. High pressure in steam generator
9. Low pressure in steam generator
10. Low feedwater temperature
11. Electrical malfunctions in the EHC

4 12. Low water level in Upper Surge Tank

10.4.6.6 Interactions with Reactor Coolant System

8

Following a turbine trip, the reactor will trip automatically due to anticipatory trip logic. The safety valves will relieve excess steam until the output is reduced to the point at which the steam bypass to the condenser can handle all the steam generated.

In the event of failure of a main feedwater pump, there will be an automatic runback of the power demand. The one main feedwater pump remaining in service will carry approximately 60 percent of full load feedwater flow. If both main feedwater pumps fail, the turbine and reactor will be tripped, and the emergency feedwater pumps started.

1 On failure of a condensate booster pump, the spare condensate booster pump is automatically started.

10.4.7 EMERGENCY FEEDWATER SYSTEM A1 < All of 10.4.7 >

10.4.7.1 Design Bases P1 < All of 10.4.7.1 >

provides — A30 (SGs)

The Emergency Feedwater (EFW) System assures sufficient feedwater supply to the steam generators of each unit, in the event of loss of the Condensate/Main Feedwater System, to remove energy stored in the

during that result in

INSERT 10-22G - A35

P12 Should a main steam line break occur, the Turbine Driven Emergency Feedwater Pump (TDEFWP) is stopped or inhibited from starting. A6

INSERT 10-22E - A31

INSERT 10-22H

Refer to UFSAR Section 7.4.3 for additional discussion of EFW controls

core and primary coolant. The EFW System is designed to provide sufficient secondary side steam generator heat sink to enable cooldown from reactor trip at power operation down to cold shutdown conditions. The EFW System may also be required in some other circumstances such as cooldown following a loss-of-coolant accident for a small break. The EFW System is shown in Figure 10-8. L3 SEE 10.4.7.1.2

The Motor Driven Emergency Feedwater Pumps (MDEFWPs) are designed to start on low SG level.

The EFW System is designed to start automatically in the event of loss of both main feedwater pumps as indicated by Main Feedwater Pump low hydraulic oil pressure. In addition, low water level in either steam generator, after a 30 second delay to prevent spurious actuations, will start the Motor Driven Emergency Feedwater Pumps. The EFW System will supply sufficient feedwater to enable the Reactor Coolant System to cool down to conditions at which the Decay Heat Removal System may be operated. A2 A3

Three EFW pumps are provided, powered from diverse power sources. Two full capacity motor-driven pumps are powered by the emergency A.C. Power System, each supplying feedwater to one steam generator. One turbine-driven pump, supplying feedwater to both steam generators, may be driven by any of three separate steam sources; A Main Steam, B Main Steam, or plant start-up steam (also called the Auxiliary Steam System). Although the total rated capacity of all three EFW pumps is 1780 gal/min, the flow capacity of any one of the pumps is sufficient to enable safe and orderly cooldown of the Reactor Coolant System. Sufficient redundancy and valving are provided in the design of the EFW piping system with isolation and cross-connections allowing the system to perform its safety-related function in the event of a single failure coincident with a secondary pipe break and the loss of normal station auxiliary A.C. power. All automatic initiation logic and control functions are independent from the Integrated Control System (ICS). associated with EFW Pumps and Control valves FDW-315 and FDW-316

The MDEFWP's

INSERT 10-22A - A5

INSERT 10-22B - A4

L3

A6

INSERT 10-22I - A36

The three units are provided with separate EFW Systems. The discharge header of each EFW System is cross connected making each system capable of supplying either unit.

INSERT 10-22C - A-32

Automatic initiation of the turbine-driven EFW pump is independent of AC power. Based on the required emergency feedwater flow, sufficient inventory of EFW is available for maintaining hot shutdown for at least 75 minutes from both upper surge tanks. The inventory in the upper surge tanks is assured by auto closure of the hotwell makeup control valves on a low upper surge tank level signal. The upper surge tanks and the associated piping from them to the EFW pump suctions are seismically qualified. The condenser hotwell is also seismically qualified with a nominal capacity of 120,000 gallons. However, the condenser hotwell is seismically qualified without any piping connected to it, and not all of the piping from the hotwell to the EFW pump suctions has been seismically qualified.

A32 L1 INSERT 10-22D Moved to proposed 10.4.7.1.3.1

INSERT 10-22F - A32

In the event of a postulated break in the Main Steam or Main Feedwater System inside or outside containment coupled with a single active failure, the EFW System provides sufficient flow to ensure adequate core cooling. L3

10.4.7.1.1

The plant transient which requires the highest Emergency Feedwater System flow and as such constitutes the Emergency Feedwater 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. The following, with the exception of Steam Line Break (Section 10.4.7.1.8, "Steam Line Break") and Small Break LOCA (Section 10.4.7.1.9, "Small Break LOCA"), should not be considered Design Basis Transients for the entire plant, but for Emergency Feedwater only.

INSERT from 10-25

A7

P2

10.4.7.1.1 Loss of Main Feedwater (LMFW)

Those transients which result in losing feedwater delivery from the Main Feedwater/Condensate System are classified as a loss of main feedwater. Since the reactor coolant pumps remain on, the control valves modulate to control steam generator level at 30 inches. The transient requires feedwater to be delivered at a rate sufficient to remove decay heat and reactor coolant pump heat. One motor driven emergency

INSERT 10-22A

Each motor driven pump is aligned to one steam generator. The TDEFWP is aligned to both steam generators. There is one EFW flow control valve for each steam generator. The flow control valve is pneumatic. Each flow control valve receives compressed gas from any of three sources; plant instrument air, auxiliary instrument air, or bottled nitrogen.

INSERT 10-22B

There are three EFW pumps provided for each unit. There are two motor driven pumps with a design flow rate of 450 gpm/pump. There is one turbine driven pump with a design flow rate of 1080 gpm. The motor driven pumps are provided with automatic recirculation control valves that close when sufficient demand to the SG's occurs. The turbine driven pump is provided with a minimum recirculation path that is normally open and limited by fixed orifices. The flow rate through the fixed orifices is not available for feeding the SG's. The fixed orifices are sized to pass < 200 gpm.

INSERT 10-22C

The Upper Surge Tank (UST) is the primary suction source for the EFW pumps. A minimum inventory of 30,000 gallons of water is maintained in the UST. This inventory requirement assures that the plant operators have at least 20 minutes to act before the UST is emptied, assuming the highest capacity pump is operating.

INSERT 10-22D

The upper surge tanks and the associated piping to the EFW pump suctions are seismically qualified. The suction piping from the UST to the MDEFWPs is separate from the suction piping to the TDEFWP.

INSERT 10-22E

Following a reactor trip, the EFW System is designed to provide sufficient inventory at hot standby to allow adequate time for operator action to align alternate sources to provide feedwater. The alternate sources allow the unit to remain in hot standby or commence with plant cooldown to the point where decay heat removal (DHR) can be placed in service. In some instances, as addressed in Section 10.4.7.1, alternate flow paths and inventory sources are relied upon to perform the EFW function.

INSERT 10-22F

The UST can be replenished from a number of non-safety related sources. These sources include the plant Demineralized Water System, the Condensate Storage Tank, and the condenser hotwell. In the event that the UST inventory cannot be maintained, EFW pump suction can be aligned directly to the hotwell. The suction piping from the condenser hotwell to the MDEFWPs is separate from the suction piping to the TDEFWP.

INSERT 10-22G

The automatic initiation circuitry for the EFW following a loss of both main FDW pumps provides anticipatory recognition of low steam generator water level. This allows the EFW System to respond to conditions in advance of a low steam generator water level. Enhancements were provided to protect against steam generator dryout.

INSERT 10-22H

The low steam generator level start was added I response to Generic Letter 89-19. The low steam generator level start is not designed to meet the single failure criterion in that a two-out-of-two logic is employed. The automatic initiation of the MDEFWPs on low steam generator level is not credited for any design basis accidents or transients.

INSERT 10-22I

The EFW pumps are also capable of being started by the ATWS Mitigation System Actuation Circuitry (AMSAC) discussed in UFSAR Section 7.8.2.1.

8 feedwater pump delivering 400 gal/min. at a steam generator pressure of 1064 psia and an EFW
temperature of ≤ 130°F will provide adequate heat removal capacity.

P2

3 **10.4.7.1.2 LMFW with Loss of Offsite AC Power (LOOP)**

3 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 causing 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
3 generator level control increases the level setpoint to 240 inches on the extended startup 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 motor driven EFW pump can deliver sufficient feedwater to meet the
demand.

3 **10.4.7.1.3 LMFW with Loss of Onsite and Offsite AC Power (Station Blackout)**

6 This transient is the result of a station blackout condition. This transient is similar to the Section
6 10.4.7.1.2, "LMFW with Loss of Offsite AC Power (LOOP)" analysis with the additional assumption
that the onsite emergency AC power sources have been lost. This results in the loss of the motor driven
3 emergency feedwater pumps. This transient is not a design basis event. The turbine-driven emergency
3 feedwater pump should be available for this event because of its AC power independence; however, the
3 SSF ASW is required to remove the decay heat in this transient. The transient is described in Section
3 8.3.2.2.4, "Station Blackout Analysis."

10.4.7.1.4 3 EFW Supply Requirements for Plant Cooldown INSERT 10-23A A10

P3 ~~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 analyzed. All heat sources have been
included. The average hourly EFW flowrate to meet cooldown rates of 100°F/hr and 50°F/hr down to
6 the switchover temperature of 246°F are given below.

LPI

is achievable

(decay heat, pump heat, fuel, structural steel, and coolant sensible heat)

EFW flow demand

A11

INSERT 10-23A

The EFW System is also designed to accommodate a plant cooldown at the maximum allowable cooldown rate. However, the cooldown function is not required to meet the single failure criterion nor is it required to rely solely on safety related equipment.

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.

INSERT from page 10-25

10.4.7.1.5 Turbine Trip

P2

6 A turbine trip transient causes a reactor trip for reactor power levels higher than the ARTS setpoint. The reactor trip initiates the ICS to control steam generator level at the minimum level so that the main feedwater pumps are run back. With the main feedwater pumps in an untripped condition, there is no requirement for the EFW system to function.

6 **10.4.7.1.6 Deleted per 1996 Revision**

6

10.4.7.1.7 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 motor driven EFW pump has sufficient capacity to perform this function.

10.4.7.1.8 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, does the need for heat removal by the intact SG arise. 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 motor driven EFW pump or the turbine driven EFW pump in the event the MFW system is unavailable.

10.4.7.1.9 Small Break LOCA

For certain small break loss of coolant accidents (break sizes less than 0.1 ft^2), feedwater is required to remove the decay heat and reactor coolant pump heat which is not relieved through the break. A flow
8 rate of 400 gal/min is adequate to provide this heat removal (Reference 1). One motor-driven EFW pump has the necessary capacity.

10.4.7.1.10 Summary of Transients

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

10.4.7.1.1

P2

last part of 10.4.7.1.8

Conditions of Transient	Criteria
3 Loss of Main Feedwater Loss of Offsite Power 6 Turbine Trip	Peak RCS Pressure ≤ 2750 psig
Steam Line Break Feedwater Line Break	10CFR 100 dose limits
Small Break LOCA	10CFR 100 dose limits 7 10CFR 50.46 PCT limit
Steam Generator Tube Rupture	10CFR 100 dose limits
3 ~~Station Blackout~~	~~Not a design basis event~~
~~Plant Cooldown~~	~~100°F/hr~~

A low initial SG mass is assumed to minimize post-trip heat removal during SG boildown

A27 A9 A8 P3

P2

From 10-22 start here

6 As discussed above, 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 allow for margin to realistic system performance for conservatism. P2

A high — is assumed to maximize energy removal requirement

6 ~~System initial conditions are consistent with an assumed~~ initial 102 percent power level. ~~Steam generator~~
6 ~~level is 50 percent corresponding to 34,500 lbs inventory per steam generator.~~ The Turbine Bypass
6 System is not available so that steam relief is by the main steam safety valves. The EFW system is limited to one motor driven EFW pump delivering to one steam generator. The maximum allowable ~~feedwater~~ UST temperature ~~for the above conditions is~~ of 130°F is assumed to minimize the heat removal capability of the EFW system. assumed

For this transient,

6 ~~A loss of main feedwater is initiated by a failure that causes a reduction in MFW pump speed.~~ It is
6 assumed that MFW flow entering the SGs decreases to zero flow 5 seconds after ~~this failure occurs~~ the MFW pumps trip off.
6 Reactor trip and the subsequent turbine trip occur on the high RCS pressure trip function. Reactor
6 coolant pumps are left on to maximize the heat input. Decay heat power is based on ~~infinite~~ end of cycle burnup ~~with~~
6 ~~2 sigma uncertainty.~~ The EFW system is assumed to be available 76 seconds after the EFW low level
6 setpoint is reached. 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
3 cooldown to decay heat removal switchover is 94,000 gallons, or 145,000 gallons for a 50°F/hr cooldown.
6 These requirements are well within the available hotwell and upper surge tank capacity. 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~~ assumed normal makeup being 0.5 percent 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.~~

UFSAR Change 98-37

UFSAR Change 98-37

A11

10.4.7.1.2

P3

within credit recirculation via the Turbine Bypass System

N2

INSERT 10-25A

A13 A12

required by Technical Specifications (72,000 gallons)

Move to pg 10-24

10.4.7.2 System Description

P7 (All of 10.4.7.2) Insert 10-25F A34

Each reactor unit is provided with a separate EFW System, as shown in Figure 10-8. Controls for each system are located on the main control room panels. Each EFW System is provided with two full capacity motor driven pumps and one full capacity turbine driven pump. Each of the motor driven pumps normally serves a separate steam generator; the turbine driven pump serves both steam generators.
6 ~~A minimum of 400 gpm total EFW flow is required.~~ The EFW pumps will start automatically as
2 outlined below: A14

INSERT 10-25E - 10.4.7.1.3 L3 P11

INSERT from pg 10-26

10.4.7.2.1

2 Motor Driven EFW Pumps (MDEFWP's):

provides approximately 11 hours of EFW operation using the MDEFWP's

This inventory is well within the nominal capacity available within the UST, CST and hotwell (Refer to Table 10-1).

A21

INSERT 10-25B - 10.4.7.1.4 P4

INSERT 10-25C - 10.4.7.1.5 P5

INSERT 10-25D - 10.4.7.1.6 P6

INSERT 10-25A

The flowrate demand on the EFW System for other transients is bounded by the loss of main feedwater transient. The safety analyses model of EFW flow rate is a function of SG pressure. Based on the results of the accident analyses, one MDEFWP delivering 375 gpm at a SG pressure of 1064 psia and an EFW temperature of ≤ 130 F provides adequate heat removal capability for this transient. The Safety Analyses acceptance criteria for each transient are as follows:

INSERT 10-25B

10.4.7.1.4 Ability to Withstand Adverse Environmental Occurrences and the Effects of Pipe Breaks

10.4.7.1.4.1 Maximum Hypothetical Earthquake (MHE)

The seismic qualification of the EFW System and Quality Group Classification is described in UFSAR Section 3.2.2. Only those components listed in UFSAR Section 3.2.2 are seismically qualified.

The TDEFWP supporting equipment is not fully seismically qualified and therefore is not credited for MHEs. However, it has been evaluated against Seismic Qualification Utility Group (SQUG) criteria and is expected to be available following a seismic event. Although redundancy is provided by two full-capacity seismically qualified MDEFWPs, they are also susceptible to failure in a seismic event due to flooding induced by the event. However, alternative seismically qualified means of decay heat removal are provided by the SSF ASW System, the station ASW System and the HPI System. The SSF ASW System and the station ASW System are capable of providing feedwater to the SGs via a separate and dedicated feedwater train. The HPI System can remove decay heat via RCS feed and bleed.

The EFW System is seismically qualified to the MHE level out through the first isolation valves, which are normally closed. Piping beyond these boundary points is not seismically qualified. The primary suction to the EFW pumps is from the UST. The UST is seismically qualified. The UST provides makeup via three separate pathways to the non-safety condenser hotwell. These pathways are automatically isolated on a low UST level. The UST also provides a source of water to other non-safety equipment. These pathways are normally isolated by closed manual valves. If malfunctions render the UST unavailable, suction can be taken from the condenser hotwell which is designed to withstand a MHE (References 14, 15, and 16) with a nominal available capacity of 120,000 gallons. The piping from the hotwell to the TDEFWP is not fully qualified, but it is designed and supported in accordance with ANSI B31.1 and would be fully expected to withstand the design basis earthquake. The piping from the hotwell to the MDEFWPs is seismically qualified. Flow from just one of the three EFW pumps to either SG is adequate to maintain a unit at hot standby.

As defined in Reference 5, Oconee was deemed to meet the criteria of Generic Letter 81-14 regarding adequate post-seismic event decay heat removal capability by:

a. requiring portions of the EFW System (defined in UFSAR Section 3.2.2) to be capable of withstanding a MHE, and
b. providing alternative seismically qualified means of decay heat removal with the SSF ASW System and the HPI System.

10.4.7.1.4.2 Tornado

Portions of the EFW System are vulnerable to tornado missiles. Thus, the plant relies upon diverse means to provide feedwater to the SGs in the event of a tornado. These diverse means include the SSF ASW System and the station ASW System. The SSF ASW System is protected against tornado missiles, except for a small portion of piping in the cask decon pump room and in the west penetration room. The probability of failure of the EFW and station ASW Systems combined with the protection against tornado missiles afforded the SSF ASW System is acceptably low (Reference 6).

10.4.7.1.4.3 High Energy Line Break

The affects of High Energy Line Breaks have been analyzed as addressed in UFSAR Section 3.6.1.3.

10.4.7.1.4.4 Internally Generated Missiles

The Emergency Feedwater System has not been designed to be able to withstand the effects of internally generated missiles. If such an event were to occur and if the Main Feedwater System were unavailable, the single train SSF ASW System would provide an assured means of providing heat removal from the SGs. A detailed evaluation of the capability of the existing EFW System to withstand missiles was not considered necessary (Reference 2).

INSERT 10-25C

10.4.7.1.5 Ability to Perform its Safety Related Function following a Single Failure Coincident with Pipe Breaks, Environmental Occurrences, and Loss of Offsite Power

The EFW System is capable of performing its safety function coincident with a single active failure, except as described below, during the following events: 1) Loss of Main Feedwater with or without Offsite Power Available; 2) Main Feedwater Line Break; 3) Main Steam Line Break; 4) Loss of Coolant Accident; and 5) Steam Generator Tube Rupture. Passive failures are not considered in the design of the EFW System.

A failure modes and effects analysis was performed (Reference 7) to confirm the capability of the EFW System to perform its safety function during the events described above coincident with a single active failure. Exceptions to the single failure criterion are discussed below.

10.4.7.1.5.1 Single Failure Exceptions

The EFW System is not considered to be an Engineered Safeguard System and therefore was not designed to meet all design criteria applicable to Engineered Safeguard Systems. As such the following exceptions to the single failure criteria are applicable for the EFW System:

- Maximum Hypothetical Earthquake (MHE)

  The EFW pumps for the three Oconee units are located in the basement of the Turbine Building and are therefore, subject to a complete failure as a result of flooding caused by a rupture of the non-seismic condenser circulating water line. In such an event, the SSF ASW System would be relied upon for shutdown decay heat removal. The SSF ASW System is not single failure proof. Penetration seals and waterproof doors have been installed between the Turbine Building and Auxiliary Building in each unit to provide waterproofing up to a height of twenty feet above the Turbine Building basement floor. Thus the High Pressure Injection (HPI) System and station ASW System located in the Auxiliary Building would be available as an alternative to the EFW System and the SSF ASW System for shutdown decay heat removal (Reference 5).

  Piping isolation between seismic and non-seismic portions of the EFW System is provided by a single boundary valve. The EFW seismic boundary valves can be of four types. The first type is a manually operated valve. Manually operated valves that provide a seismic boundary are normally closed. A single failure is not assumed to include the failure of a normally closed valve to the open position. These valves may be opened during specific operating conditions. However, due to the short duration and low probability of a seismic event occurring concurrent with the manual valve being open, this single failure vulnerability was found to be acceptable. Another seismic boundary valve type is a check valve. Check valves in the reverse flow direction are considered to be normally closed, and are therefore treated as a normally closed manual valve. A third type of seismic boundary valve is a power operated valve. The power operated EFW seismic boundary valves are normally closed. These valves function as a seismic boundary in that they are designed to fail as-is in the closed position. The last type of seismic boundary valve for EFW is a pneumatically operated valve. There are three pneumatically operated valves that receive an automatic closure signal on a low UST level. The pneumatically operated valves function as a seismic boundary in that they are designed to fail closed on a loss of instrument air or on a low UST level.

The EFW pump recirculation pathways are exceptions to the above description of seismic boundary valves, in that these pathways remain open. The turbine-driven EFW pump recirculation seismic boundary is provided by fixed orifices. These orifices restrict the amount of EFW that would be diverted from feeding the SGs. The orifices are the devices credited for limiting recirculation flow such that adequate EFW flow can be delivered to the SGs. Each motor-driven EFW pump recirculation line is provided with a normally open manual valve as its seismic to non-seismic boundary. Recirculation flow is regulated by an automatic recirculation control valve for each motor-driven EFW pump. The automatic recirculation control valves are the devices credited for limiting recirculation flow such that adequate EFW flow can be delivered to the SGs.

- EFW Flow Control Valve Single Failures (FDW-315 and 316)

  As addressed in Section 10.4.7.3, flow from only one EFW pump is required to mitigate a design basis event. Therefore, for events where both SGs remain available for heat removal, the failure of an EFW control valve would not impact the ability of the EFW System to perform its intended function. However, some events, such as steam generator tube ruptures and some secondary side pipe breaks cause only one steam generator is available for heat removal. If the EFW flow control valve for the unaffected SG failed to open, the flow path can be realigned to bypass the failed valve and reach the SG through the main feedwater startup flow path. This alternate path through the main feedwater startup control valve relies on non-safety equipment and non-safety support systems (electrical power and instrument air). If the EFW flow control valve on the unaffected SG fails open (on a loss of compressed air and nitrogen) this could result in the SG overcooling and subsequent loss of EFW to the unaffected SG due to pump runout. The safety analyses assumes both SGs are isolated within 10 minutes with subsequent action outside the Control Room for local manual control of the EFW control valve if the valve failed open. The EFW flow control valves are located in the Penetration Rooms adjacent to the Control Room. Except in those cases where the break makes these valves inaccessible, an operator could manually adjust either valve. In the event this path were unavailable, the SSF ASW System provides an alternate means of establishing feedwater flow to the unaffected steam generator.

- MDEFWP Single Failures

  As addressed in Section 10.4.7.3, flow from only one EFW pump is required to mitigate a design basis event. Therefore, for events where both SGs remain available for heat removal, the failure of a MDEFWP would not affect the ability of the EFW System to perform its intended function. However, for secondary side pipe breaks that result in a loss of the SG pressure boundary, only one steam generator is available for heat removal. In the case of a secondary side pipe break occurring coincident with the failure of the MDEFWP associated with the unaffected steam generator, the EFW System would not be capable of automatically supplying water to the unaffected steam generator. The Main Steam Line Break Detection and Mitigation Circuitry would isolate main feedwater to both steam generators, and inhibit the automatic start of the TDEFWP. The preferred method of mitigating this event, after having isolated flow to the affected SG, would be to start the TDEFWP by manual operator action in the Control Room. However, if the TDEFWP is not available, the remaining MDEFWP could be aligned to the unaffected SG by manual operator action outside of the Control Room.

- High Energy Line Break (HELB) Single Failures

There are certain HELBs that, coupled with a single active failure in the EFW System, can cause a complete loss of main and emergency feedwater on the affected unit (Reference 11). The safety function of delivering feedwater to the SGs is provided by the SSF ASW System or EFW from an alternate unit.

INSERT 10-25D

10.4.7.1.6 Means by which the System is Protected from the Effects of Hydraulic Instability (Water Hammer) or the Design Considerations Precluding the Occurrence of Hydraulic Instability

Provisions for water hammer events are considered unnecessary due to the use of Once Through Steam Generators (OTSG) (Reference 10). Additionally, each OTSG is provided with a level control system (see UFSAR section 7.4.3.2) that enables the EFW System to supply on demand sufficient initial and subsequent flow to the necessary SG to assure adequate decay heat removal.

INSERT 10-25E

10.4.7.1.3 Long Term Inventory

The primary source of EFW inventory is the UST. A minimum inventory of 30,000 gallons of water is maintained in the UST. This inventory requirement assures that the plant operators have at least 20 minutes to act before the UST is emptied, assuming the highest capacity pump is operating. The EFW pumps will remain aligned to the UST as long as adequate inventory can be maintained by makeup to the UST from demineralized water, the condensate storage tank, or the hotwell. If the UST inventory cannot be maintained, the preferred long-term source of EFW inventory is the hotwell. The hotwell is not designed to withstand a single failure. In addition, there are some events, such as a feedwater or condensate line break, that will deplete the hotwell inventory. Thus, for these events, the hotwell inventory would not be available to the EFW pumps. In addition, certain single failures can impact hotwell inventory, hotwell temperature, or the ability to manually align suction from the UST to the hotwell. Although the likelihood of these failures is low, should they occur the hotwell may not be available as a long-term suction source for the EFW pumps. For these postulated events or single failures, sufficient long term inventory can be provided to the steam generators by the SSF ASW System or the station ASW System. The capability of these alternate means of providing feedwater to the SGs is further discussed in UFSAR Sections 9.6 and 9.2.3, respectively. Additionally, the ability to cross-connect to another unit's EFW System can provide supplemental water to the steam generators, prior to the use of the SSF ASW or station ASW System.

INSERT 10-25F

The recirculation mode of cooldown relies upon the Turbine Bypass Valves (TBVs) to steam the SG's to the condenser, the Condenser Circulating Water (CCW) System to condense the steam, the Vacuum System to allow the use of the TBVs, and the hotwell pump recirculation pathway to the UST to maintain UST water level. Operation in the recirculation mode with the assumed minimum inventory required by Technical Specifications provides sufficient time to allow for a 50F/hr or a 100F/hr cooldown to decay heat removal switchover.

Add 2nd ¶ of 10.4.7.2.1 from last ¶ of this page

INSERT 10-26A — A15

Add 3rd ¶ of 10.4.7.2.1 from 1st ¶ of pg. 10-28

10.4.7.2.1 A2 AMSAC INSERT 10-26J — A20

2 Automatic starting of the MDEFWP's is determined by the position of the control room selector switch
2 for each pump. The MDEFWP's are provided with a four position selector switch which allows the
2 operator to select between Off, Auto 1, Auto 2 and Run. When the selector switch is in the Auto 1
3 position, LOW STEAM GENERATOR WATER LEVEL in either steam generator ~~(OTSG)~~ will start
2 the pump after a 30 second time delay to prevent spurious actuations. When the selector switch is in the
2 Auto 2 position, LOW STEAM GENERATOR WATER LEVEL or LOSS OF BOTH MAIN
2 FEEDWATER PUMPS will start the pump. Loss of both main feedwater pumps is sensed by pressure
6 switches which monitor feedwater pump turbine control oil pressure. ~~Loss of both Main Feedwater~~
6 ~~Pumps actuation is by the control oil pressure switches sensing loss of feedwater pumps.~~ A16 A23

INSERT 10-26H

10.4.7.2.2 A15 INSERT 10-26B hydraulic A22 AMSAC

2 Turbine Driven EFW Pump (TDEFWP):

Add 2nd ¶ of 10.4.7.2.2 from INSERT 10-26 I

2 Automatic starting of the TDEFWP is determined by the position of the control room selector switch for
2 the pump. The TDEFWP is provided with a three position-pull ~~to lock~~ selector switch which requires
2 that the control room operator manually take the switch to the OFF position through a deliberate action.
2 ~~The~~ operator can select between Off, Auto and Run. When the selector switch is in the Auto position,
2 LOSS OF BOTH MAIN FEEDWATER PUMPS will start the pump. Loss of both main feedwater
6 pumps is sensed by pressure switches which monitor feedwater pump turbine control oil pressure. If a
5 main steam line break signal is present and the selector switch is in AUTO, the TDEFWP will
5 automatically stop and prevent an auto start. The operator can manually start the TDEFWP by placing
7 the selector switch to RUN. A16

INSERT 10-26G

INSERT 10-26E → (As last ¶) The AMSAC start signal is described in UFSAR Section 7.8.2.1

10.4.7.2.5 MDEFWPs then

8 Once automatically started, the ~~motor driven EFW pumps~~ will continue to operate until manually secured
by the operator. Each emergency feedwater discharge line to each steam generator is provided with a
5 control valve and check valve. ~~The control valves are normally closed due to steam generator level >~~
5 30". The valves are arranged to fail to the automatic control mode upon loss of DC control power to the
manual/auto select solenoid. If the selected train of automatic control fails, then the valve would fail
open. Also, upon loss of station air, the valves will maintain their position with N_2 backup. If N_2
backup fails then the valve would fail open. These modes of operation show that emergency feedwater
2 isolation is not possible with valve control circuitry or motive force failure. Open/Closed valve position
2 indication is provided for each control valve in the main control room at the valve manual loader. A17

INSERT 2 from next page

INSERT 1 from next page

5 In automatic, a solenoid valve on each control valve is de-energized, allowing the valve to receive a
control air signal for valve modulation in response to steam generator level, independent from the ICS.

Move to 10.4.7.2 Intro

The EFW pumps normally discharge into separate lines feeding a separate steam generator through the
auxiliary feedwater header.

The operator can manually start each MDEFWP by placing its associated selector switch in RUN

10.4.7.2.4 A flow path is also provided to the upper surge tank dome (connected to the condenser) for minimum
0 recirculation flow and testing purposes. A continuous recirculation flow is provided for the ~~turbine driven~~ TDEFWP
~~pump~~, limited by fixed orifices. A self-contained automatic recirculation valve is provided for each ~~motor~~ MDEFWP
0 ~~driven pump~~ to assure individual pump minimum flow when needed during operation. A flow path is
0 provided from the discharge of each ~~motor driven pump~~ MDEFWP to the ~~upper surge tank~~ UST for full flow testing. INSERT 10-26C
10.4.7.2.1 1st ¶ Power for the ~~motor driven pumps~~ switchgear is normally provided by the normal station auxiliary A.C. Power
3 System. During loss of offsite power operation, these ~~pumps~~ switchgear are aligned to the Emergency A.C. Power
System. Motive steam for the ~~turbine driven pump~~ TDEFWP is provided from either of the two steam generators
by main steam lines upstream of the main turbine stop valves and is exhausted to the atmosphere. Either steam A17
10.4.7.2.2 3rd ¶, 1st part supply will provide sufficient steam for turbine ~~operation~~. Either steam supply may be isolated if
necessary. A check valve is provided in each main steam supply line to ~~prevent~~ minimize uncontrolled blowdown of
more than one steam generator. or by the auxiliary steam header

INSERT 10-26D A18

INSERT 10-26E

following a MSLB (refer to UFSAR Section 10.3.2 for further details

INSERT 10-26A

There are two MDEFWPs per unit. The pumps are physically located in the basement of the Turbine Building. Each of the MDEFWPs is normally aligned to a separate SG. Each of the MDEFWP's is supplied with its own independent starting circuit, as described in UFSAR Section 7.4.3.1, that allows the operator manual or automatic control of the pump.

INSERT 10-26B

There is one TDEFWP per unit. The pump is physically located in the basement of the Turbine Building. The TDEFWP is normally aligned to supply both SGs. The TDEFWP is supplied with its own independent starting circuit, as described in UFSAR Section 7.4.3.1, that allows the operator manual or automatic control of the pump.

INSERT 10-26C

During normal system alignment, the test loops are isolated and pump minimum recirculation would be routed back to the UST for reuse.

INSERT 10-26D

Auxiliary Steam is also normally aligned and available to supply the TDEFWP. A check valve is provided in the auxiliary steam supply line to prevent a loss of the main steam source should auxiliary steam be lost.

INSERT 10-26E

The MDEFW pumps are powered from the 4160 VAC Switchgear TD and TE. The switchgear are located side by side on the ground floor of the Turbine Building and are not protected from high energy line breaks.

INSERT 10-26F

Automatic or manual starting of the TDEFWP from the Control Room relies on DC power from the station power batteries. Each TDEFWP is equipped with a DC auxiliary oil pump (AOP). The auxiliary oil pump is located near the TDEFWP in the basement of the Turbine Building. Power for the AOP is supplied by 250VDC load center DP. This load center is located on the ground floor of the Turbine Building adjacent to the 4160VAC Switchgear TC, TD, and TE. The AOP automatically starts when MS-93 opens. The AOP provides the initial oil pressure to open the turbine governor valve (MS-95) and supply lube oil for the turbine bearings. When the turbine approaches operating speed, the shaft driven oil pump will supply adequate oil pressure for the governor valve and bearing lubrication.

INSERT 10-26G

Once automatically started the TDEFWP will continue to operate until manually secured by the operator unless a MSLB signal is received following the automatic start.

INSERT 10-26H

The TDEFWP can also be started locally in the basement of the Turbine Building.

INSERT 10-26I

The TDEFWP requires cooling water to the pump bearing cooling jackets for continuous operation. Upon manual or automatic start of the TDEFWP, sufficient cooling water is initiated automatically, from the Low Pressure Service Water System. Cooling water is also automatically supplied to the turbine oil cooler via an AC driven cooling water pump. Analysis has shown that the pump may operate in excess of 4 hours without cooling water to the oil cooler. Both of these cooling water supplies may be lost following a loss of AC power. A backup source of cooling for both the cooling jacket and the oil cooler is provided by the High Pressure Service Water (HPSW) System and is automatically aligned following a loss of AC power.

INSERT 10-26J

The LOW STEAM WATER LEVEL initiation function, which was added for SG dryout protectin (Reference 13), is not designed to meet the single failure criterion as it is not relied upon for the mitigation of any accident.

, specifically the Upper Surge Tank, A minimum of 30,000 gallons of water is maintained in the UST. A19

10.4.7.2.3 The condensate/feedwater reserve(s) for each unit are normally aligned to the EFW pump suctions. The condensate/feedwater reserve for each unit is maintained among the sources in Table 10-1. INSERT 10-27A

safety-related

10.4.7.2.6 Each of the EFW pumps is supplied with its own independent starting circuit. The independent control circuits are powered by the 125 VDC station batteries. ~~These circuits are actuated by trip of both main~~
6 ~~feedwater pumps. Feedwater pump trip is detected by low feedwater pump turbine hydraulic control oil~~
6 ~~pressure for turbine driven and motor driven EFW pumps.~~ Each pump is provided with a control switch with which the operator may start the pump manually. (described in UFSAR Sections 7.4.3.1 and 7.8.3.1)

Then insert from last ¶ of this page

Sufficient indication is provided in the control room to allow the operator to monitor unit parameters during a cooldown. ~~Specific indication provided for the EFW System are listed in Table 10-2.~~

FDW-315 (EFW flow control to 'A' SG) is physically located in the East Penetration Room. FDW-316 (EFW flow control to 'B' SG) is physically located in the West Penetration Room. A17

10.4.7.2.5 Move to previous page (INSERT 1)

~~Discharge flow from the EFW pumps is normally aligned and controlled by control valves FDW-315 and FDW-316.~~ These valves are controlled independently of the Integrated Control System and arranged to fail to the automatic control mode upon loss of DC control power to the manual/auto select solenoid. If
3 the selected train of automatic control fails, then the valve would fail open. ~~Also,~~ upon loss of ~~all station air~~ instrument air and auxiliary air, the valves will maintain their position with N_2 backup. If N_2 backup fails, then the valve would fail
5 open. In automatic, the control valve manual/auto select solenoid valves are de-energized, thereby aligning the valve to automatic control and positioning the valve per the automatic setting. Control valves FDW-315 and FDW-316 are modulated by separate control air signals. These valves may be automatically controlled, or manually controlled by the operator to limit or increase feedwater as
2 necessary to maintain ~~feedwater~~ steam generator inventory and cooldown rate. A pushbutton is provided for each control valve to allow the individual valve to be placed in either an automatic level control mode or in a manual
5 mode of operation. In automatic, the valves are positioned and controlled ~~by the~~ automatic level control
5 circuits. Independent level transmitters are utilized in the automatic control system. Upon loss of all four reactor coolant pumps, such as during ~~blackout conditions~~ LOOP events, the level control setpoint is automatically raised to promote natural circulation in the Reactor Coolant System. INSERT 10-27C A17

Experiences a loss of power A28

The control valves are pneumatically operated. Motive force for valve operation is supplied by any of the following: instrument air, auxiliary instrument air, or bottled nitrogen.

10.4.7.2.5 Move to previous page (INSERT 2).

~~Although not normally aligned or utilized in the safety related function of the~~ EFW System, a redundant, separate path of EFW to the steam generators and means of controlling EFW pump discharge flow is provided by startup control valves FDW-35 and FDW-44. This additional flow path is not required for normal EFW System function, but may be aligned manually ~~if necessary or desirable~~ during ~~normal~~ startup~~, or cooldown.~~ ~~Normally closed motor operated valves FDW-38, FDW-47, FDW-374, and FDW-384 can be opened from the control room to provide this additional flow path if required. Control valves FDW-35 and FDW-44 are modulated by control signals based on steam generator water levels by the ICS. As in the case of control valves FDW-315 and FDW-316, the level control setpoint is automatically raised upon loss of all four reactor coolant pumps to promote natural circulation in the Reactor Coolant System.~~ INSERT 10-27B A26

10.4.7.2.7

Move to previous page, last ¶

10.4.7.2.2 3rd ¶ last 2 sentences

~~The steam supply for the EFW pump turbine is provided from either main steam line.~~ Valve MS-93, the TDEFWP steam admission valve, in the common supply to the turbine will fail open upon loss of station air or power to the normally energized solenoid valve. Upon receipt of a manual or automatic start signal, the solenoid valve will de-energize and immediately start the turbine.

10.4.7.2.3

Sufficient valving is provided to allow isolation and cross-connection as required to select and isolate water sources and assure system function in the event of various failures. During normal orderly shutdown as a result of blackout or loss of feedwater, no valve re-alignments or isolation is necessary. All necessary valves are maintained in normal standby alignment to assure an open flow path for each pump,
2 and to assure piping separation and independence. All manually-operated valves in the piping from the
2 Upper Surge Tanks (UST) to the suction of the EFW pumps are locked open. (Reference 2)

Move last part of subsection

in the discharge flow path A19

shutdown or following EFW flow control valve failures. A37

INSERT 10-27A

Inventory in the UST can be replenished from a variety of sources. These sources include the plant Demineralized Water System through the makeup demineralizers, the Condensate Storage Tank (CST) via the CST pumps, and the Condenser Hotwell via a hotwell pump recirculation pathway. The makeup sources are non-safety. If the UST inventory cannot be maintained following an accident, the EFW pump suction may be aligned to the condenser hotwell directly. Condenser vacuum must be broken to provide adequate net positive suction head to the EFW pumps when aligned to the hotwell. Condenser vacuum is broken by the opening of a single vacuum breaker valve (V-186). This vacuum breaker valve is normally operated from the Control Room and is physically located on the ground floor of the Turbine Building on the east side of the condenser hotwell. To complete the transfer of suction for the MDEFWPs, a single manual valve in the common suction piping (located in the basement of the Turbine Building near the MDEFWPs) must be closed. TDEFWP suction is transferred by opening the hotwell supply valve (C-391) and closing the UST supply valve (C-156 or C-157). All necessary valves in the discharge flow path are maintained in normal standby alignment to assure an open flow path for each pump, and to assure piping separation and independence. All manually operated valves in the piping from the UST to the suction of the EFW pumps are locked open (Reference 2).

INSERT 10-27B

The 'A' MDEFWP can be aligned to feed the 'A' SG via the MFW startup path by opening motor operated valves FDW-38 and FDW-374 and closing motor operated valves FDW-33, FDW-36, and FDW-372. The 'B' MDEFWP can be aligned to feed the 'B' SG via the MFW startup path by opening motor operated valves FDW-47 and FDW-384 and closing motor operated valves FDW-42, FDW-45, and FDW-382. These motor operated valves are operated from the Control Room. The valves receive non-safety power. FDW-36, FDW-38, FDW-45, and FDW-47 are DC motor operated valves that receive power from the station power batteries. FDW-372, FDW-374, FDW-382, and FDW-384 are AC motor operated valves that receive power from non-safety, non-load shed sources. FDW-33 and FDW-42 are AC motor operated valves that receive power from a non-safety, load shed source. The MDEFWPs must be stopped to allow alignment of this flow path.

The TDEFWP can be aligned to feed both SGs via the MFW startup path by opening two manually operated valves (FDW-94 and FDW-96) located in the Turbine Building basement and closing motor operated valves FDW-368 and FDW-369. The motor operated valves are operated from the Control Room. FDW-368 and FDW-369 are AC motor operated valves that receive power from non-safety, non-load shed power. Repositioning of FDW-33, FDW-36, FDW-38, FDW-42, FDW-45, and FDW-47 would also be required as described in the alignment of the MDEFWP's to the MFW startup path. The TDEFWP must be stopped to allow alignment of this flow path.

Once the EFW pump is aligned to the MFW startup path, FDW-35 and/or FDW-44 are used to control EFW flow to the SGs. Air operated control valves FDW-35 and FDW-44 are modulated by control signals based on SG water levels by the ICS. The control valves may be operated manually from the Control Room. Air is supplied by the plant Instrument Air System. The ICS and the plant instrument air are non-safety. As in the case of control valves FDW-315 and FDW-316, the level control setpoint is automatically raised upon loss of all four reactor coolant pumps to promote natural circulation in the Reactor Coolant System.

The alignment of EFW through the MFW startup path is vulnerable to LOOP events. FDW-33 and FDW-42 receive power from a load shed source. These valves would have to be manually closed locally or power must be restored to the load shed source to allow the valves to be operated from the Control Room. The valves are located on the ground floor of the Turbine Building. Plant instrument air is also vulnerable. Either power must be restored to the air compressors or the diesel service air compressor must be manually started and aligned to supply the plant Instrument Air System. The diesel service air compressor is located outside by the south end of the Turbine Building.

INSERT 10-27C

For events where core subcooling margin has been lost, operators must manually control SG levels at the loss of subcooling margin setpoint.

10.4.7.2.1 2nd ¶ The motor driven EFW pumps require cooling water for continuous operation. Sufficient cooling water is initiated automatically, upon manual or automatic start of motor driven EFW pumps.

10.4.7.2.8 Sufficient alarms are provided to alert the operator of conditions exceeding normal limits. Essential plant parameters are annunciated or alarmed by the process computer in addition to specific EFW System alarms as listed below:

MDEFWPs

1. Motor ~~driven~~ EF~~W~~ ~~pumps~~ low suction pressure
2. Steam generator low level alarms
3. Hotwell low level alarms
4. UST low level alarms
5. Low motor driven EFW pump cooling water flow

MDEFWP

6. Motor ~~driven~~ ~~EFW~~ ~~pump~~ stator winding high temperature
7. Motor ~~driven~~ ~~EFW~~ ~~pump~~ motor bearing high temperature
8. Motor ~~driven~~ ~~EFW~~ ~~pump~~ bearing high temperature
9. Motor cooler excessive leakage
10. Motor ~~driven~~ ~~EFW~~ ~~pump~~ A auto start blocked
11. Motor ~~driven~~ ~~EFW~~ ~~pump~~ B auto start blocked

TDEFWP.

12. Turbine ~~driven~~ ~~EFW~~ ~~pump~~ auto start blocked

2 13. Motor ~~driven~~ ~~EFW~~ ~~pump~~ A low level start

2 14. Motor ~~driven~~ ~~EFW~~ ~~pump~~ B low level start

8 15. Turbine ~~driven~~ ~~EFW~~ ~~pump~~ turbine lube oil low pressure

8 16. Turbine ~~driven~~ ~~EFW~~ ~~pump~~ turbine oil high temperature

8 17. Turbine ~~driven~~ ~~EFW~~ ~~pump~~ turbine hydraulic oil low pressure

8 18. Turbine ~~driven~~ ~~EFW~~ ~~pump~~ turbine auxiliary oil pump overload

8 19. Turbine driven ~~EFW~~ ~~pump~~ tripped

in combination with a hotwell pump and a condensate booster pump are

10.4.7.3 Safety Evaluation

P8 (All of 10.4.7.3)

Feedwater inventory is maintained in the steam generators following reactor shutdown by one of the following methods listed:

1. Either of the two main feedwater pumps ~~is~~ capable of supplying both steam generators at full secondary system pressure.

MDEFWPs their associated

2. The two ~~EFW motor driven pumps~~ are capable of supplying ~~both~~ steam generators at full secondary system pressure.

TDEFWP

3. The single ~~EFW turbine driven pump~~ is capable of supplying both steam generators at full secondary system pressure.

An

4. ~~Alternate~~ EFW ~~supplies~~ ~~may be~~ available from the EFW Systems of the other ~~U~~nits, capable of supplying both steam generators at full secondary system pressure.

8 5. The hotwell and condensate booster pump combination has discharge shutoff head of approximately 620 psia. ~~Three~~ ~~pairs of~~ pumps, ~~are provided~~. If required, the Turbine Bypass System or the ADVs

There are hotwell and three condensate booster pumps Atmospheric Dump Valves

A1 <entire page>

10.4.7.3 Intro

can be used to reduce secondary system pressure to the point where one hotwell and condensate booster pump combination can supply feedwater to both steam generators.

6. The station ~~Auxiliary~~ Service Water System may be used to maintain steam generator water inventory following steam generator depressurization to remove decay heat in the long term.

7. The SSF Auxiliary Service Water System is capable of supplying both steam generators of all three units at full secondary system pressure.

A sufficient depth of backup measures is provided to allow steam generator water inventory to be maintained by any of the diverse methods listed above. Although redundancy and diversity is provided as the listed measures above the EFW System has been designed with special considerations to enable it to function when conventional means of feedwater makeup may be unavailable.

A24 INSERT 10-29A

Redundancy is provided with separate, full capacity, motor and turbine driven pump subsystems. Failure of either the MDEFWPs ~~motor driven pumps~~ or the TDEFWP turbine driven pump will not reduce the EFW System below minimum required capacity. Pump controls, instrumentation, and motive power are separate in design. Separate piping subsystems include redundant hotwell, upper surge tank, and condensate supply piping, aligned individually to the separate pump trains. Cross-connection is provided, however, to allow a subsystem to supply all pumps in the event of single failure of a suction piping subsystem. The same design philosophy is included in the discharge piping subsystems. L3

Add 4th P

INSERT 10-29E Add 10.4.7.3.1 A24

10.4.7.3.2.3

In order to provide sufficient EFW flow to the intact steam generator to ensure 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 motor operated isolation valve

6 (FDW-372) or the flow control valve FDW 315 on OTSG A. This action These actions can be done 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.

INSERT 10-29C A38

Concurrently, the operator would monitor the intact steam generator to ~~assure~~ adequate inventory and secondary heat removal via either ~~Main Feedwater~~ or ~~Emergency Feedwater~~ EFW Systems. A30

Add 10.4.7.3.2.1 10.4.7.3.2.2

INSERT 10-29D A39

INSERT 10-29B

A25

In the event of ~~a postulated break in the Main Steam or Main Feed System, coupled with a~~ the single active failure of ~~either one of the three emergency feed water pumps,~~ the MDEFWP to the intact steam generator, manual operator action is required to start the TDEFWP to provide sufficient flow ~~will occur to provide~~ adequate core cooling.

5 With a postulated break associated with the 'A' OTSG and a failure of the 'B' motor driven emergency
5 feedwater pump, the normal feedwater system will be isolated to both steam generators and the TDEFWP
5 will be inhibited from automatically starting. The TDEFWP can be manually started by placing its
7 control switch to RUN. In addition, the remaining MDEFWP could be aligned to the unaffected SG via cross connect (FDW-313 and -314). P13

5 With a postulated break associated with the 'A' OTSG and an active failure occurs with the flow control
5 valve (FDW-316), the Main Steam Line Break Circuitry must be disabled by the operator to allow
5 emergency feedwater flow alignment through the main feedwater startup control valves to either the main
7 or auxiliary nozzles. A40

5 In the unlikely event that FDW-315, 316 fail open (on a loss of compressed air and nitrogen), an operator
5 could manually adjust either one of the valves as they are located in the Penetration Rooms which are
5 adjacent to the Control Room.

10.4.7.3 4th P of Intro

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~~ MDEFWP is available to deliver the necessary

INSERT 10-29A

The design basis transients that require EFW have been evaluated assuming only one MDEFWP is available to deliver the necessary feedwater. Except as noted in Section 10.4.7.1.5, no single failure in the three pump-two-flowpath EFW System design will result in only one available MDEFWP (i.e., two EFW pumps will remain available). Therefore, the evaluation assuming only one MDEFWP available is conservative.

Assuming the worst case plant transient (loss of feedwater transient assuming an anticipatory reactor trip and loss of offsite power) with three EFW pumps operating, the minimum UST inventory of 30,000 gallons would provide for approximately 44 minutes of emergency feedwater without makeup (Reference 12). With offsite power available, the UST would provide for approximately 50 minutes of emergency feedwater without makeup (Reference 12). These times, which are based on EFW controlling steam generator levels at the appropriate setpoint, meet the design bases of providing at least 20 minutes to act before the UST is emptied. However, UST makeup should be available using non safety related CST, hotwell, or plant demineralized water. Long term secondary side cooling is discussed in Section 10.4.7.3.8.

These analyses verify the acceptability of the EFW System design.

INSERT 10-29B

10.4.7.3.2.1 HELBs Resulting in Loss of TC, TD, TE Switchgear

HELBs in the vicinity of the TC, TD, TE switchgear could cause their failure due to steam/water impingement. The consequence of the switchgear failure would cause a complete loss of the Condensate and Feedwater System (loss of pumps). This event is similar to a station blackout on the affected unit. This would also cause a loss of both MDEFWPs due to loss of power. In addition, the DC power supply to the auxiliary oil pump (AOP) for the TDEFWP could be lost due to its location being adjacent to the switchgear. Loss of the AOP results in an inability to start the turbine driven pump from the Control Room. The turbine driven pump could be locally started. A single failure of the Turbine Driven EFW pump would lead to a complete loss of main and emergency feedwater. The SSF ASW System could be used to feed the SGs. In addition, alignment of an unaffected unit's EFW System could be performed to feed the SGs.

10.4.7.3.2.2 Other HELBs that do not cause a Loss of SG pressure boundary or loss of 4160V Power

This class of HELBs could result in depletion of stored inventory in the hotwell due to the continued operation of the hotwell and condensate booster pumps. These line breaks cause the hotwell makeup valves to open to control hotwell level. On a low UST level, automatic closure signals are sent to close the hotwell makeup valves to preserve inventory in the UST's. The SSF ASW System would be available for feeding the SGs. HPI feed and bleed cooling also remains available. In addition, EFW could be aligned from an alternate unit using the unit cross connects.

INSERT 10-29C

Large line breaks in the Feedwater/Main Steam System that result in a depressurization of the steam generator will result in actuation of the Main Steam Line Break Detection and Mitigtion System. Once actuated, all main feedwater will be automatically isolated to both steam generators and the TDEFWP will be inhibited from automatically starting. The MDEFWPs will automatically start and feed both steam generators. The operator is required to manually terminate EFW flow to the faulted steam generator by either closing the EFW flow control valve or by stopping the MDEFWP.

INSERT 10-29D

In the event of a postulated failure of the EFW flow control valve to the intact steam generator, manual operator action would be required to align the MDEFWP through the main feedwater startup control valve as previously described in Sectoin 10.4.7.1.5.1. The Main Steam Line Break Circuitry (Reference 8) must be disabled by the operator to allow EFW flow alignment through the non-safety MFW startup control valves. In the unlikely event tha the EFW flow control valves fail open (on a loss of compressed air and nitrogen), an operator could manually adjust either one of the valves. These valves are located in the Penetration Rooms that are adjacent to the Control Room.

INSERT 10-29E

A loss of main feedwater is the result of both main feedwater pumps tripping. All three EFW pumps would be available with or without offsite power being available. Both EFW flowpaths should remain available. With offsite power being available, the reactor coolant pumps are assumed to remain running. If any reactor coolant pump is operating, the EFW flow control valves will modulate to control steam generator level at 30 inches. Without offsite power being available, the reactor coolant pumps will not be operating. If no reactor coolant pumps are operating, the EFW flow control valves will modulate to control steam generator level at 240 inches to promote natural circulation mode of heat removal.

A1 (continue page)

(i.e., two EFW pumps will remain available)

Except as noted in Section 10.4.7.1.5, no

Therefore, the evaluation assuming only one MDEFWP available is

10.4.7.3 4th ¶ of intro

feedwater. ~~Any~~ single failure in the three pump-two flowpath EFW system design will ~~not~~ result in only one motor driven EFW pump available~~, so that this assumption is overly~~ conservative. These analyses verify the acceptability of the Emergency Feedwater System design.

10.4.7.3 last ¶

10.4.7.3.6

8 ~~The following~~ portions of the system are designed to withstand seismic loading~~, criteria for seismic loading defined in Chapter 3, "Design of Structures, Components, Equipment, and Systems"~~):

8 ~~1.~~ Both supply lines from the upper surge tank to the emergency feedwater pumps, including connected
8 branch piping up to and including the first valve ~~which~~ that is normally closed or capable of automatic
8 closure when the safety function is required. are seismically qualified

8 ~~2.~~ Both discharge lines from the emergency feedwater pumps to the steam generators, including piping
8 through the first valve of any connections to these lines. are seismically qualified

10.4.7.4 Inspection and Testing Requirements

INSERT 10-30A — A33

A comprehensive test program is followed for the EFW System. The program consists of ~~performance tests in the manufacturers' shops, preoperational tests of the system, and~~ periodic tests of the activation logic and mechanical components to assure reliable performance during the life of the unit.

During unit operation, the EFW System is tested by utilizing the recirculation test line to the upper surge tank dome. Pump head and flow is verified utilizing this method.

P10

10.4.7.5 Instrumentation Requirements

Sufficient instrumentation and controls are provided to adequately monitor and control the EFW System. The safety related instrumentation and controls which monitor steam generator level and pressure, automatically start the EFW pumps, and automatically align the supply meet the system requirements for redundancy, diversity and separation. ~~All nonsafety related instrumentation and controls are designed such that any failure will not cause degradation of any safety related equipment function.~~

P10

L2

INSERT 10-30C — P14

INSERT: 10.4.7.3.3 - 5, 7, 9 + 10 — P8 — P9 — INSERT 10-30B

INSERT 10.4.7.3.8 — A8 — INSERT 10-30B

INSERT 10-30A

However, the EFW System in each of the three Oconee units is located in the Turbine Building basement and is therefore subject to a complete failure as a result of flooding caused by the rupture of the non-seismic condenser circulating water line. In such an event, the SSF ASW System, station ASW System and HPI System (feed and bleed) would be available to provide seismically qualified alternative capability for heat removal. Reference 5 concludes that Duke demonstrated adequate post-seismic shutdown decay heat removal capability in accordance with Generic Letter 81-14 based on the above capability.

INSERT 10-30B

10.4.7.3.3 EFW Response Following a LOOP

All three EFW pumps would be available for LOOP events. Both EFW flowpaths should remain available. However, some accidents may result in only one SG being available for decay heat removal. These accidents include MSLBs and main feedwater line breaks downstream of the isolation check valve. A single active failure of the EFW flow control valve to open on the unaffected SG would result in loss of EFW function. For this specific failure, EFW flow can be delivered to the unaffected SG through the MFW startup flow path. This alignment may not be available in LOOP events. The main feedwater startup control valve requires instrument air to operate. The main feedwater startup block valve receives power from load shed power which may not be immediately available following a LOOP. If the EFW control valve on the unaffected SG fails to open and the main feedwater startup path is unavailable, then SSF ASW System would be required to feed the unaffected SG for heat removal.

10.4.7.3.4 EFW Response Following a SBLOCA

For certain size 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 design function is to lower RCS pressure to minimize the loss of inventory through the break while maximizing safety injection. One motor-driven EFW pump has the necessary capacity. The EFW inventory requirements for a SBLOCA are bounded by other events such as a LOMFW in which a break in the primary system is not present to help remove system heat.

10.4.7.3.5 EFW Response Following a SGTR

This event does not assume a loss of offsite power has occurred. With offsite power available, main feedwater should continue to operate and provide inventory to the SGs. In addition, the condenser should remain available as a means of removing heat from the SGs via the Turbine Bypass System to the Condenser Circulating Water (CCW) System. However, should the Main Feedwater System be unavailable, the EFW System would be required to provide secondary side cooling. All three EFW pumps should be available to provide inventory to the SGs. Prior to isolation of the ruptured SG, EFW inventory requirements are diminished to a certain degree due to primary system leakage boiloff in the ruptured SG. If the EFW control valve on the unaffected steam generator fails closed, EFW flow is aligned to this team generator through the non-safety main feedwater startup flow path. With offsite power being available, the main feedwater startup path should remain available. Prior to cooling the unit down to DHR conditions, one RCP per loop is tripped, further reducing the demand for EFW following a loss of main feedwater with offsite power available.

10.4.7.3.7 EFW Response Following a Tornado

A probabilistic risk assessment was developed to address the plant's capability to provide secondary decay heat removal (via the EFW, SSF ASW, and station ASW Systems) in the event of a tornado. Reference 6 concludes that the probability of failure of the EFW and station ASW Systems combined with the protection against tornado missiles afforded the SSF ASW System satisfies the SRP probabilistic criterion.

10.4.7.3.8 EFW Response Following a SBO

This event is similar to the LMFW with LOOP analysis with the additional assumption that the onsite emergency AC power sources have been lost. This results in the loss of the MDEFWPs. The TDEFWP should be available for this event because of its AC power independence; however, the SSF ASW System is credited to remove the decay heat in this event. The SBO event, which is not a design basis event, is described in UFSAR Section 8.3.2.2.4, "Station Blackout Analysis."

10.4.7.3.9 Long-Term Secondary Side Cooling

The UST inventory assures at least 20 minutes is available for operator action before the UST is emptied assuming the highest capacity EFW pump is operating. Prior to the end of this time period, UST makeup should be available via the non safety related CST, hotwell, or plant demineralized water. The hotwell may not be available following a condensate or feedwater line break. In addition, single failures may lead to a depletion of hotwell inventory or result in an inability to directly align the EFW pump suction to the hotwell. In the event these sources are not available, redundant and diverse sources of secondary makeup water are available via the SSF ASW System or the station ASW System to provide long term secondary side cooling. The capability of these alternate means of providing feedwater to the SGs is further discussed in UFSAR Section 9.6 and 9.2.3, respectively. Additionally, the ability to cross-connect to another units EFW system can provide supplemental water to the steam generators, prior to the use of the SSF ASW or station ASW System.

10.4.7.3.10 Failure Mode and Effects Analyses to Ensure Minimum Safety Requirements are Met assuming a single active failure in any System Required to Ensure Performance of the EFW System

For the above events only one EFW pump is needed for heat removal. Any single active failure, except as noted in Section 10.4.7.1.5, in the three pump-two flowpath EFW System design will not result in the loss of more than one of the three EFW pumps. A detailed component/system level analysis of potential failure modes is documented in Reference 7. Exceptions to the single failure criterion are addressed in Section 10.4.7.1.5.1. As described in the introduction to Section 10.4.7.3, the Oconee design includes redundant and diverse methods of providing feedwater to the SGs. These design features adequately address the single failure exceptions described in Section 10.4.7.1.5.1.

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10.4.7.5.1 TDEFWP

Instrumentation used in the automatic initiation circuitry on loss of main feedwater pumps for the TDEFWP is safety grade, but not all of the equipment required to provide auto start capability is safety grade. Instrumentation used in the automatic initiation of the pump following an ATWS event is not required to be safety grade. A failure in the automatic initiation circuitry will not prevent manual start capability from the Control Room.

10.4.7.5.2 MDEFWP

Instrumentation used in the automatic initiation circuitry on loss of main feedwater pumps for the MDEFWPs is safety grade. Instrumentation used in the automatic initiation of the pumps following an ATWS event is not required to be safety grade. Instrumentation used to provide automatic initiation of the pumps on low steam generator level is QA-1, but is not single failure proof. A failure in the automatic initiation circuitry will not prevent manual start capability from the Control Room.

10.4.7.5.3 EFW Flow Indication to the Steam Generators

Each MDEFWP has a control grade flow transmitter with remote indication in the Control Room. Each EFW flow path to the steam generators contains two safety grade flow transmitters with remote indication in the Control Room. Each steam generator contains two safety grade level transmitters that are used to provide steam generator level control for the EFW System. The operators are capable of manually selecting between the primary and backup level transmitter from the Control Room. Safety grade level indication is provided in the Control Room.

10.4.~~8~~6 REFERENCES

8 1. J. A. Klingenfus (FTI), letter to M. E. Henshaw (Duke), CRAFT2 SBLOCA EFW Flows,
8 November 9, 1998.

2 2. W. O. Parker (Duke) letter to H. R. Denton (NRC), April 3, 1981, page 32.

7 3. ONOE-11376, changes to support multiple unit alignment to the Auxiliary Steam Header.

8 4. OSC-5060, justification of reduced valve closing DP (PIR 0-092-0561).

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5. NRC Safety Evaluation Report for Oconee Nuclear Station, Units 1, 2, and 3, regarding Seismic Qualification of the EFW System, dated January 14, 1987.

6. NRC Safety Evaluation Report on the Effect of Tornado Missiles on Oconee EFW System, dated July 28, 1989.

7. OSC-7420, Emergency Feedwater (EFW) System Single Failure Analysis.

8. D. E. LaBarge (NRC) letter to W. R. McCollum, Jr. (Duke), Amendments 234, 234, and 233 to DPR-38, DPR-47, and DPR-55 for Oconee Nuclear Station, Units 1, 2, and 3, respectively, dated December 7, 1998.

9. J. W. Hampton (Duke) letter to the USNRC, "Seismic Licensing Basis," dated August 18, 1994.

10. J. F. Stolz (NRC) letter to W. O. Parker, Jr. (Duke), Safety Evaluation Report for Oconee Nuclear Station, Units 1, 2, and 3, regarding NUREG-0737 Item II.E.1.1, "Auxiliary Feedwater System Evaluation," dated August 25, 1981.

11. MDS Report No. OS-73.2, Analysis of Effects Resulting from Postulated Piping Breaks Outside Containment for Oconee Nuclear station Units 1, 2, and 3, dated April 25, 1973.

12. OSC-6217, Loss of MFW with Anticipatory Reactor Trip.

13. LA. Weins (NRC) letter to J.W. Hampton (Duke), Safety Evaluation Report for Response to Generic Letter 89-19, Steam Generator Overfill Protection, dated November 3, 1993.

14. OSC-2826, Seismic Qualification Study of Components Associated with the Hotwell.

15. OSC 2827, Seismic Qualification Study of Components Associated with the Hotwell.

16. OSC 2633, Qualification of Condenser Hotwell Nozzles and Plates for Faulted Load Conditions.

ATTACHMENT 3

DISCUSSION OF PROPOSED CHANGES

Attachment 3

Description of Proposed Changes

I. Background

Originally, the Emergency Feedwater (EFW) System for the Oconee Nuclear Station, Units 1, 2, and 3, was comprised of a single turbine driven emergency feedwater pump (TDEFWP) per unit. This was documented in Oconee's original (1970) Final Safety Analysis Report (FSAR). The requirements and licensing bases for the EFW System have evolved over time as Oconee and the nuclear industry have recognized and responded to emerging issues.

For example, main feedwater (MFW) line breaks were not addressed in the original design of Oconee and are not addressed in Chapter 15 of the Updated FSAR (UFSAR). In a letter dated December 15, 1972, the Atomic Energy Commission (AEC) requested information on the effects of a High Energy Line Break (HELB) outside of containment. The AEC granted the Oconee Unit 1 operating license on February 6, 1973, while a HELB analysis was in progress. Duke submitted the HELB analyses for Oconee on April 25, 1973, followed by a supplement on June 22, 1973. These submittals indicated that certain postulated breaks could cause the loss of the MFW and EFW Systems. In addition, certain breaks could result in the loss of the 4160 volt engineered safeguards switchgear. The EFW System was modified to add an alternate flow path to each steam generator (SG). The added path was routed to avoid areas postulated to be damaged by the identified breaks. The EFW System previously included the ability to cross-connect between Oconee units. However, due to the location of this tie-in, a feedwater line break could have caused a loss of this pathway. The modification added a second cross-connect header between Oconee units. The NRC subsequently accepted the HELB analysis in a safety evaluation dated July 6, 1973.

Several improvements to the system were implemented following the accident at Three Mile Island (TMI) in 1979. For example, Oconee added two motor driven emergency feedwater pumps (MDEFWPs) and provided flow paths and automatic initiation and controls for the EFW pumps and feedwater control valves FDW-315 and FDW-316 independent of the Integrated Control System (ICS).

The objective of these post-TMI changes was to improve the reliability of secondary side decay heat removal. In Recommendation 1 of NUREG-0667, the NRC offered two general approaches for improving reliability. One approach was to upgrade the EFW System to an engineered safeguards system. The other approach was to demonstrate that the EFW System, in concert with other diverse systems, achieved the desired level of reliability. Duke's response to the post-TMI requirements was consistent with this latter approach. Modifying the EFW System satisfied certain requirements, while crediting the capabilities of other diverse decay heat removal systems such as the Standby Shutdown Facility (SSF) Auxiliary Service Water (ASW) System satisfied other requirements. Although significant correspondence occurred between Duke and the NRC as a result of the post-TMI upgrades, the depth of this correspondence, by both Duke and the NRC, is insufficient to support a clear articulation of the licensing bases. As a result, different interpretations of the licensing bases are possible.

On January 26, 1999, NRC Inspection Report 50-269/99-10, 50-270/99-10, and 50-287/99-10 (IR 99-10) was issued and identified certain issues related to the EFW System design bases. IR 99-10 resulted in a preliminary determination that the Oconee licensing bases requires that the EFW System on the affected unit be capable of mitigating a feedwater line break coincident with a single active failure. IR 99-10 stated that the current design was apparently contrary to the approved licensing bases of the EFW System. Specifically, a single active failure of a unit's Upper Surge Tank (UST) Makeup To Hotwell Isolation Valve (C-187), during certain postulated MFW line breaks, could prevent the EFW System on the affected Oconee unit from performing its safety function of decay heat removal.

Duke met with the NRC staff in Washington on February 8, 1999 to communicate the position that the EFW System is not an Engineered Safeguards System and was not designed or licensed to withstand all potential single failures. Duke stated the position that the design bases of Oconee has always relied on diverse and redundant methods of supplying feedwater to the Steam Generators (SGs) to remove decay heat following various plant transients. The options include the unit's EFW System, cross-connection to another unit's EFW System, and the Standby Shutdown Facility (SSF) Auxiliary Service Water System. Duke considered that the

C-187 single failure vulnerability was not a significant safety issue because it required two simultaneous low probability events, emergency operating procedures could mitigate the event using diverse and redundant methods, and the single failure had a minor impact on the reliability of the EFW System.

In response to IR 99-10 and the February 8, 1999 meeting, the NRC Staff communicated a position that the EFW System on the affected unit must be able to withstand a single active failure coincident with a MFW line break. Therefore, the current design represented a nonconforming condition. This position was documented in a letter from the staff, dated February 24, 1999. This letter acknowledged that there were certain approved exceptions to this requirement, and agreed with Duke that the issues did not represent a significant safety concern.

Duke does not agree with the NRC licensing position stated in their February 24, 1999 letter. However, Duke subsequently submitted Licensee Event Report (LER) 50-269/1999-01 to address the condition described in the staff's February 24, 1999 letter. In the LER, the following commitments were made:

"2. Duke will perform a more detailed single failure analysis of the EFW system for design bases events listed in UFSAR 10.4.7 in order to assure that the scope of the EFW single failure vulnerability issue is fully characterized. Based on current priorities, Duke expects to complete this analysis by September 30, 1999.

3. Following completion of Planned Corrective Action 2 above, Duke will assess potential options and implement corrective actions to clarify the EFW licensing bases and assure the plant conforms to the clarified licensing bases. These options may include implementation of plant modifications to resolve the conflict with the Staff's position or submission of requests to revise the licensing bases, including the UFSAR, so that specific single failure modes would be approved exceptions.

4. Duke is performing a review of the current UFSAR to identify statements related to the EFW system that are not supported by design documents. Such statements

will be reviewed and action taken to provide reasonable assurance that the design bases of the EFW system is accurately reflected in the UFSAR."

The EFW single failure analysis was completed on September 30, 1999. Results of the single failure analysis have been incorporated into the corrective action program and are being resolved in accordance with 10 CFR 50 Appendix B, Criterion XVI. Resolution of the single failure issues involves a combination of modifying the plant and the licensing bases. In general, the specific single failure issues identified by Duke's review can be categorized as follows:

1) There are common mode failures associated with the pneumatic supply to EFW control valves FDW-315 and FDW-316. Duke is resolving these common mode failures through modifications that will separate the air supply to these valves. This modification is an NRC commitment.

2) The Upper Surge Tank (UST) is the initial source of inventory for the EFW pumps. The single failure of certain valves on piping connected to the UST could deplete UST inventory during an event and limit the time available for the operators to align alternate suction sources. The limiting failure from a timing perspective is valve C-187. Duke will modify the plant to address single active failures associated with the UST inventory. This is an NRC commitment.

3) Following a secondary side pipe break that results in a loss of the steam generator pressure boundary, only one steam generator is available for heat removal. If the EFW control valve for the unaffected steam generator failed to open, the non-safety main feedwater startup flow path can be used to provide emergency feedwater to the unaffected steam generator. This submittal clarifies the licensing bases with respect to reliance on alternate means of establishing EFW in the event of a secondary side pipe break with a failure of the EFW control valve on the unaffected steam generator.

4) The initial assured source of EFW inventory is the UST. The preferred long-term source of inventory is the hotwell. However, there are initiating events and/or single failures that can render the hotwell unavailable as a long-term source. This submittal describes the

diverse means at Oconee of establishing long-term inventory for the EFW pumps.

In addition, Duke has completed a review of UFSAR Section 10.4.7 in accordance with Corrective Action 4 of LER 50-269/99-01. This submittal proposes a revision to the UFSAR that considers the results of the EFW single failure analysis, and clarifies the licensing bases for the EFW System. This submittal includes licensing bases changes necessary to address Corrective Action 3 of LER 50-269/99-01 and other UFSAR changes resulting from the review performed per Corrective Action 4 of LER 269/99-01. The UFSAR rewrite explicitly includes certain post-TMI exceptions regarding the ability of the EFW System to mitigate transients/accidents coincident with a single active failure. Revision 1 to LER 50-269/99-01 was submitted on May 15, 2000. This revision did not result in any additional corrective actions from those already identified in Revision 0 of this LER.

II. Description and Justification of Proposed Changes

The proposed changes to the Oconee UFSAR are identified in the mark-up of the UFSAR provided in Attachment 2. The retyped pages of the UFSAR are provided in Attachment 1. Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition," Revision 3 was used as a guide in the rewrite of UFSAR Section 10.4.7. For example, the requirements regarding natural phenomena (i.e., tornado and maximum hypothetical earthquake) were added consistent with the recommendations of Regulatory Guide 1.70.

The proposed changes include numerous administrative changes and clarifications of the licensing bases, as well as changes that could be considered as potential unreviewed safety questions. Although the 10 CFR 50.59 process could address most of these changes, Duke requests NRC review and approval of these changes. The UFSAR markup shows the disposition of existing statements into the proposed UFSAR revision. Where a proposed UFSAR statement differs from an existing statement, individual details of the UFSAR revision are annotated with alphanumeric designators that relate to the appropriate discussion of change (DOC). The DOC provides a concise justification for the change. The DOCs are numbered sequentially within each letter category.

The description and justification of changes are presented for each UFSAR section. Items that could be considered a modification to the licensing bases are annotated with the designator M. Administrative and clarification changes (designators A, P or L) are those changes that result in no additional or reduced restrictions or flexibility. The administrative changes annotated with a designator P are strictly presentation changes and deal with the re-structuring and re-organization of information in UFSAR Section 10.4.7. The designator P changes also address information that has been added to document the current licensing bases. The administrative changes annotated with the designator A are editorial changes that clarify the existing UFSAR Section 10.4.7 by either removing, adding or re-wording existing UFSAR information. Clarifications, designated by the letter L, are intended to minimize the potential for interpretation issues based the reader's understanding of the documentation that supports the current licensing bases for the EFW System.

II.A UFSAR Section 10.4.7

A1 Section 10.4.7 of the UFSAR has been reformatted. This reformatting involved the movement of numerous paragraphs and sentences to new locations, the renumbering and titling of subsections, the adoption of certain wording preferences, English language conventions, the rewriting of phrases or sentences utilized to connect one sentence or paragraph to another and changes to provide standard capitalization practices. These proposed changes do not result in any technical changes to the UFSAR. Changes which are associated only with providing stardard capitalization are not shown on the markup.

II.B UFSAR Section 10.4.7.1, Design Bases

M2 Concerning High Energy Line Breaks (HELBs), an Atomic Energy Commission (AEC) letter dated December 15, 1972 requested that Duke address HELBs. In a letter dated December 29, 1972, Duke indicated that a review of postulated piping system breaks outside of containment was in progress per the AEC's request. In addition, the Duke letter indicated that the postulated pipe rupture was not considered credible for the Oconee Nuclear Station and provided the basis for this position. In a letter dated January 26, 1973, Duke provided a schedule for the completion of the high energy line break studies. Duke's letter dated January 26, 1973, indicated "that Oconee Unit 1 could be shut down safely in the event that the hypothetical accident identified by the AEC criteria did occur. However, Duke is studying the possibility that modifications may be needed to meet the simultaneous imposition of the single failure criteria." Duke provided interim measures that were being taken until the high energy line break analysis was completed and any appropriate design modifications could be implemented. The AEC granted the Oconee Unit 1 operating license on February 6, 1973.

In a report dated April 25, 1973, (MDS Report No. OS-73.2, Analysis of Effects Resulting from Postulated Piping Breaks Outside Containment for Oconee Nuclear Station Units 1, 2, and 3), Duke submitted the analysis of effects resulting from postulated piping breaks outside containment for Oconee. The report indicated that the main feedwater system and emergency feedwater system could be lost as the result of a feedwater line break, auxiliary steam line break, or condensate line break. In addition, specific feedwater line or auxiliary steam line break locations could result in the loss of the 4160 volt engineered safeguards switchgear (1TC, 1TD, and 1TE). Although Duke considered these postulated pipe breaks highly unlikely, several plant modifications were proposed as a result of the high energy line break analysis. Duke addressed single failure concerns by rerouting EFW away from the break locations identified and installing EFW cross-connects between the units. However, these modifications did not eliminate all potential scenarios that could adversely impact the EFW System on the affected unit. The AEC evaluation for the Oconee Units 2 and 3 operating license, dated July 6, 1973 accepted Duke's HELB strategy which relied in part upon cross-connects between units and the station ASW System to address the single failure criterion.

The impact of post-TMI modifications was not addressed with respect to HELBs nor is HELB explicitly addressed by post-TMI submittals. Duke has always considered the original analysis (report dated April 25, 1973 mentioned above) as remaining applicable post-TMI. Based on the above, the licensing bases as it relates to HELBs provides exception to the single failure criterion for those HELBs that can cause a complete loss of main and emergency feedwater on the affected unit when coupled with a single active failure in the EFW System.

Proposed UFSAR Sections 10.4.7.1.4.3 and 10.4.7.1.5.1 indicate that this single failure exception is part of the licensing bases. This is justified considering the low CDF significance of a postulated pipe break that could cause a complete loss of main and emergency feedwater and the alternative methods available for delivering feedwater to the steam generators. The contribution to the Oconee Core Damage Frequency (CDF) from the postulated HELB initiating events is estimated to be less than 1E-06 and less than 1% of the estimated core damage frequency for Oconee. The small contribution to the CDF is due to several factors. HELBs are low frequency events and the occurrence of such a break that results in a complete loss of main and emergency feedwater is expected to be significantly lower still. For the specific main feedwater or auxiliary steam line breaks that damage the 4kV switchgear, both motor driven EFW pumps would be lost due to loss of power. In addition, the DC power supply to the TDEFWP auxiliary oil pump could be lost due its location being adjacent to the switchgear. This results in an inability to start the turbine driven pump from the control room. The turbine driven pump could be locally started. A single failure of the Turbine Driven EFW pump would lead to a complete loss of main and emergency feedwater.

Alternative methods of providing secondary side cooling include the EFW cross-connect capability between units, which was originally installed to address single failure concerns, and the SSF ASW System. However, these alternate means of coping with an HELB were not explicitly addressed in the post-TMI correspondence.

Therefore, Duke proposes to clarify the licensing bases to explicitly state these diverse means of secondary side heat removal are acceptable for the mitigation of any HELBs outside containment (see proposed UFSAR Section 10.4.7.1.5.1) that may render the EFW System, on the affected unit, inoperable. Design analyses demonstrate that restoration of feedwater within 30 minutes is sufficient to assure adequate core cooling following the HELB scenario that results in a loss of power and a complete loss of feedwater. Procedures and training have demonstrated that feedwater would be restored from the SSF or cross-connecting to another unit well within the required 30 minutes.

In addition, operability of an alternate units EFW System is required by Selected Licensee Commitment (SLC) 16.10.7. This cross-connect flow path is QA-1, monitored under the Maintenance Rule and tested by the IST program. The operability of the SSF ASW System is required by Technical Specification (TS) 3.10. Duke believes that the controls placed on the SSF ASW System, by Technical Specifications, are adequate to ensure operability of the SSF at a level commensurate with its level of safety significance. The SSF ASW System is a QA-1 system, monitored under the Maintenance Rule, tested in accordance with TS and the IST program, and is further described in Section 9.6 of the UFSAR. Based on the low likelihood of an HELB and ability to restore feedwater from the SSF ASW System or cross-connecting EFW to another unit, Duke concludes that the current design is acceptable and this modification to the licensing bases to address incomplete post-TMI correspondence is justified. Risk calculations predict that the postulated HELB scenario that damages the 4kV switchgear results in a CDF of approximately 4E-7. Based on this low risk, further modifications to the facility are not justified.

P1 The Section 10.4.7.1 "Design Bases" introduction has been revised to provide an overview of the EFW design bases. The description of transients coupled with a single active failure is moved to a new subsection, 10.4.7.1.1, entitled "EFW Supply Requirements for

Maintaining Hot Standby following Design Basis Accidents."

P2 The last paragraph of Section 10.4.7.1 has been moved to the first part of new subsection 10.4.7.1.1. Old subsections 10.4.7.1.1, 2, 3, 5, 8, 9 and part of 10 related to transients are consolidated into new subsection 10.4.7.1.1. Subsection 10.4.7.1.1 identifies the plant transient that requires the highest EFW System flow as the loss of feedwater transient. The assumptions for the transient indicates that 375 gpm at 1064 psia is adequate for heat removal and that one MDEFWP has this capacity. Since the demand on the EFW System for the other transients that were previously described is bounded by this transient, a general statement is made to this effect, and the other sections that described EFW demand requirements were removed as unnecessary. The safety analysis acceptance criteria for each transient are retained. A description of the EFW response for each transient is retained as appropriate in 10.4.7.3, Safety Evaluation.

P3 The part of current 10.4.7.1.10 related to plant cooldown is consolidated with current 10.4.7.1.4 and moved to a new subsection (10.4.7.1.2) entitled "EFW Supply Requirements for Plant Cooldown." This is intended to remove any confusion between EFW requirements for a normal plant cooldown versus EFW requirements for a design bases event.

P4 Section 10.4.7.1.4, "Ability to Withstand Adverse Environmental Occurrences and the Effects of Pipe Breaks" has been added to define the EFW licensing/design bases regarding the ability to withstand adverse environmental occurrences and the effects of pipe breaks. The description regarding the maximum hypothetical earthquake requirements is consistent with an NRC Safety Evaluation Report (SER) dated January 14, 1987. The description related to tornado missiles is consistent with an NRC SER dated July 28, 1989. The description related to internally generated missiles is consistent with Duke's response to this issue by letter dated April 3, 1981, and the NRC SER dated August 25, 1981, for TMI items which did not specifically address this item. Additionally, references to these NRC SERs, as appropriate, have been added to UFSAR Section 10.4.7.8 (renumbered as Section 10.4.7.6 in the proposed UFSAR revision).

P5 Section 10.4.7.1.5, "Ability to Perform its Safety Related Function following a Single Failure Coincident with Pipe Breaks, Environmental Occurrences, and Loss of Offsite Power" has been added to confirm the capability of the EFW System to perform its safety function coincident with a single active failure with certain exceptions. These exceptions are explicitly described in a new subsection 10.4.7.1.5.1 entitled "Single Failure Exceptions." Further justification of this licensing bases position is provided in DOC L3 below.

P6 Section 10.4.7.1.6, "Means by which the System is Protected from the Effects of Hydraulic Instability (Water Hammer) or the Design Considerations Precluding the Occurrence of Hydraulic Instability," was added to define the EFW licensing/design bases regarding the avoidance of water hammer events. Provisions for water hammer events are considered unnecessary at Oconee due to the use of Once Through Steam Generators. The description regarding the water hammer requirements is consistent with an NRC Safety Evaluation Report dated August 25, 1981. Additionally, a reference to the NRC Safety Evaluation Report has been added to UFSAR Section 10.4.8(renumbered as Section 10.4.6 in the proposed UFSAR revision).

P11 Section 10.4.7.1.3, "Long Term Inventory" has been added to define the EFW licensing/design bases regarding the feedwater inventory requirements related to the long term source of feedwater for maintaining hot standby or to commence plant cooldown. Further justification for this licensing bases position is provided in DOC L3.

P12 The steam generator low level start circuitry was added in response to Generic Letter 89-19. In this response, Duke stated that this was an enhancement to the EFW automatic start circuitry and was not designed to meet the single failure criteria. The NRC accepted this modification as meeting the intent of providing steam generator dryout protection as addressed in Generic Letter 89-19.

A2 The second sentence of the second paragraph of 10.4.7.1 is revised to delete reference to how the MDEFWPs are automatically started in the event of loss of both main feedwater pumps since this is already addressed more thoroughly in the system description section (10.4.7.2.1). This statement was considered incomplete since it did not describe other parameters that automatically actuate the pumps. In addition, the modifier "after a 30 second delay to prevent spurious actuations" is deleted from the Section 10.4.7.1 introduction since it is not pertinent to the general description of EFW automatic initiation. This modifier is retained in the Section 10.4.7.2 system description for the MDEFWPs with the exception of the specific delay time. The specific time delay is not pertinent to the description and is deleted. In addition, a statement was added to indicate that the MDEFWPs are designed to start on low steam generator level.

A3 The following sentence from Section 10.4.7.1 is deleted: "Three EFW pumps are provided, powered from diverse power sources." This sentence is deleted since similar information is included in the description of power sources for the EFW pumps.

A4 Section 10.4.7.1 previously had the following statement: "Although the total rated capacity of all three EFW pumps is 1780 gal/min, the flow capacity of any one of the pumps is sufficient to enable safe and orderly cooldown of the Reactor Coolant System." Additional information is added to define the design flow rate for the EFW pumps and clarify that the "total combined SG feed capacity" is approximately 1780 gpm. The total combined capacity discounts flow that is not available for feeding steam generators due to a minimum recirculation flow path that is normally open in the TDEFWP flow path.

A5 Information is added, to Section 10.4.7.1, to indicate that each MDEFW pump is aligned to a different SG and the TDEFWP is aligned to both. There is one EFW flow control valve to each SG, which is pneumatic. Each EFW flow control valve receives compressed gas from any of three sources, plant instrument air, auxiliary instrument air, or bottled nitrogen. This information is added to demonstrate the diversity of sources for operating the flow control valves.

A6 Section 10.4.7.1 is modified to clarify that following a main steam line break, the TDEFWP is stopped or inhibited from automatically starting. Additionally, clarification is made to the current statement regarding automatic initiation logic and control function being independent from the ICS. A modifier is added to indicate that only those automatic controls associated with EFW pumps and control valves FDW-315 and FDW-316 are independent from the ICS.

A7 The seventh paragraph of UFSAR Section 10.4.7.1 states: "The following, with the exception of Steam Line Break (Section "Steam Line Break" in topic 10.4.7.1.8) and Small Break LOCA (Section "Small Break LOCA" in topic 10.4.7.1.9), should not be considered Design Bases Transients for the entire plant, but for Emergency Feedwater only." The description contained in Section 10.4.7 only applies to the EFW System. The design requirements, including the accidents/transients that the system is required to mitigate, are described in the applicable UFSAR section. Thus, this statement is superfluous and is deleted.

A8 Station Blackout (SBO) is not a design bases event for the EFW System. As such, this event was removed from the list of transients. The EFW response following an SBO is retained in Section 10.4.7.3

A9 Steam Generator Tube Rupture was added as a design bases event for the EFW System. Appropriate safety analyses acceptance criteria are added to proposed UFSAR Section 10.4.7.1.1. This event is bounded by the loss of feedwater transient with respect to EFW flow requirements.

A10 The first sentence of current UFSAR Section 10.4.7.1.4 was revised in proposed UFSAR Section 10.4.7.1.2 to specifically address the fact that the EFW System is designed to accommodate a plant cooldown at the maximum allowable cooldown rate. It is further clarified that the cooldown function is not required to meet single failure criterion nor is it required to rely solely on safety related equipment. The licensing basis and technical justification for this position is provided in DOC L3.

A11 The sentence in current UFSAR Section 10.4.7.1.10 concerning heat sources that were included for plant cooldown is redundant to the statement in current UFSAR Section 10.4.7.1.4 and is deleted. The portion identifying the heat sources was retained in proposed 10.4.7.1.2.

A12 For completeness, a modifier is added to proposed UFSAR Section 10.4.7.1.2 for plant cooldown to indicate that the 100°F/hr cooldown rate is without crediting recirculation via the Turbine Bypass System. For plant cooldown in the recirculation mode, the text is revised to indicate that the TS required inventory of 72,000 gallons provides approximately 11 hours of EFW operation using the MDEFWPs.

A13 The sentence in current UFSAR Section 10.4.7.1.10 concerning the assumption that the EFW System is available 76 seconds after the EFW low level setpoint is reached is deleted because it is not pertinent to the description on EFW supply requirements for maintaining hot standby following a design bases accident. It is also misleading in the sense that it credits the non-single failure proof low steam generator water level channel for initiating the MDEFWPs. While this instrumentation will initiate the MDEFWPs, it was installed for SG dryout protection, not for loss of feedwater. Loss of both MFW pumps is sensed by pressure switches that monitor feedwater pump hydraulic oil pressure. Appropriate additional information is added to clarify the assumptions for these requirements in proposed UFSAR Section 10.4.7.1.1.

A21 A sentence is added to proposed Section 10.4.7.1.2 to indicate that the feedwater inventory required for plant cooldown is well within the nominal capacity available from the UST, CST and hotwell, with reference to Table 10-1 which lists the capacity.

A27 The initial assumptions provided in UFSAR Section 10.4.7.1.4 related to a SG level of 50% corresponding to 34,500 lbs of inventory per steam generator is deleted and replaced with a less specific assumption in proposed UFSAR Section 10.4.7.1.2. The new wording is less specific in that it states that a low initial SG mass is assumed to minimize post-trip heat removal during SG boildown. This change is made since the SG mass assumed is variable and is dependent on steam generator fouling.

A30 UFSAR Section 10.4.7 uses the word "assures" and "assured" when referring to the capability of the EFW System and alternate sources of secondary side cooling. This has been changed to "provides" or "provided" or other appropriate wording in those cases where the only intent is convey the overall purpose of the system(s). This is intended to remove any ambiguity associated with the ability of the EFW System or the alternate methods to provide feedwater to the SGs coupled with a single active failure.

A31 The first paragraph of UFSAR Section 10.4.7.1 is modified to further define the mission of the EFW System and to clarify that in some instances, as addressed in Section 10.4.7.1, alternate flow paths and inventory sources are relied upon to perform the EFW function. This change is made to clarify that in some cases credit is taken for other systems to perform the EFW System function.

A32 Additional information is added to further define the design requirements for the Upper Surge Tank (UST)and the suction piping for the MDEFWPs and the TDEFWP.

A34 Section 10.4.7.1.2 is revised to provide additional detail to describe the recirculation mode of cooldown.

A35 Existing wording has been modified to more clearly describe the function of the EFW automatic initiation circuitry.

A36 This information was added for completeness and mirrors information provided elsewhere in the UFSAR.

L1 UFSAR Section 10.4.7.1, fifth paragraph, second sentence is misleading. The sentence says: "Based on the required emergency feedwater flow, sufficient inventory of EFW is available for maintaining hot shutdown for at least 75 minutes from both upper surge tanks." The 75 minutes was based on the design basis required flow of 400 gpm and an upper surge tank inventory of 30,000 gallons.

Although, the statement was true, it was not realistic since the EFW response to the worst case plant transient (loss of feedwater transient) would have three EFW pumps delivering flow to the SGs. For a loss of feedwater transient with no UST makeup and considering a loss of offsite power, approximately 44 minutes of UST inventory is available. This is based on Duke's latest revision to the applicable engineering calculation.
As such, the misleading sentence is deleted from Section 10.4.7.1 and a description of the time available on the UST for the worst case transient is added to Section 10.4.7.3. In addition, a statement is added to Section 10.4.7.1 that the UST inventory of 30,000 gallons assures that plant operators have at least 20 minutes to act before the UST is emptied. This design requirement is consistent with the staff recommendations in a November 14, 1980, letter to Duke that 20 minutes should be available for operator action, assuming the largest capacity EFW pump is operating. This change is consistent with the design bases of the EFW System in that sufficient time is available on the primary source of inventory (the UST) to allow time to replenish this inventory or align to alternate sources of inventory.

L3 The original safety evaluation dated December 29, 1970, confirms that redundancy within the steam and power conversion system is such that the heat removal adequacy is not impaired by single failures of components, equipment or piping. The SER statement indicates that Oconee's steam and power conversion system could adequately remove the decay heat without reliance on the Low Pressure Injection System and that the redundancy of the steam and power conversion system (main feedwater pumps, hotwell pumps, condensate booster pumps, and turbine drive emergency feedwater pumps) ensured adequate decay heat removal capability following a single failure. Thus, the steam and power conversion system was designed with redundancy for single failure protection; however, each individual part of the steam and power conversion system (i.e., turbine driven emergency feedwater system) was not designed for single failure protection.

Since the original licensing of the Oconee Nuclear Station, the licensing bases for the Emergency Feedwater System has changed due to resolution of HELB concerns, post-TMI concerns and Generic Letter 81-14 Seismic Qualification concerns. During this time period UFSAR Section 10.4.7 was revised to capture the new licensing bases that evolved. These revisions ultimately resulted in UFSAR statements related to the EFW System's ability to mitigate accidents/transients coincident with a single active failure that were misleading. The UFSAR currently does not explicitly identify the single failure exceptions that were reviewed and approved over this time period. This UFSAR revision clarifies the capability of the EFW System to perform its safety function, coincident with a single active failure, during plant transients and explicitly identifies those cases where exception to the single failure criterion is taken. The summary of single failure exceptions is provided in proposed UFSAR Section 10.4.7.1.5. Passive failures are not considered in the design of the EFW System. The licensing bases for each single active failure exception is provided below.

Maximum Hypothetical Earthquake (Seismic Qualification of EFW - GL 81-14)

The NRC issued Generic Letter 81-14, "Seismic Qualification of Auxiliary Feedwater Systems", by letter dated February 10, 1981 requesting information that identified the extent to which the Auxiliary Feedwater Systems are seismically qualified.

By letter dated January 28, 1982, Duke's response to Generic Letter 81-14 indicated that the majority of the EFW System and necessary support systems were seismically qualified. In that response, Duke outlined the overall EFW seismic adequacy and credited the SSF (design review of SSF was in progress) as a dedicated separate train of auxiliary feedwater. Duke stated the position that the Oconee EFW System coupled with the dedicated SSF, currently under construction, met the seismic requirements and no additional modifications to the system were necessary.

Subsequently, the NRC requested additional information related to the SSF (letters dated September 8, 1982, December 26, 1984). The NRC Staff did not concur with the position that the SSF was a substitute for the EFW System. The NRC believed that in order for the SSF to be considered a substitute for the EFW System, the SSF would have to be capable of withstanding a safe shutdown earthquake and a concurrent single active failure.

In response to the NRC Staff's position on the requirements for the SSF to be considered a substitute for the EFW System, Duke indicated that the SSF was designed as a standby system for use under extreme emergency conditions. The SSF was designed to provide an alternate and independent means of decay heat removal following fire, flood, and sabotage. The single failure criterion was not required, in that the SSF was a backup to existing redundant safety systems.

By a letter dated January 14, 1987, the NRC issued a safety evaluation for the review of the seismic qualification of the Oconee EFW System. In the safety evaluation, the NRC included the resolution of the potential backfit concerning the EFW System availability following a safe shutdown earthquake and concurrent single failure. Based on Duke's letters and the NRC's backfit analysis, the NRC concluded that the Oconee EFW System seismic qualification has been adequately addressed. The SER concludes that Duke demonstrated "adequate seismically qualified alternative capability utilizing the SSF ASW pump and HPI pump (feed-and-bleed) in the event of loss of the AFW System as a result of seismically induced flooding. We, therefore, conclude that Oconee meets the requirements of GDC 2 and 34 for post-seismic shutdown decay heat removal capability and is, therefore, acceptable." A single failure exception has been added to UFSAR Section 10.4.7.1.5 to state that the EFW System does not meet the single failure criterion for the maximum hypothetical earthquake and to identify other acceptable means of providing shutdown decay heat removal.

This SER also accepts Duke's position (provided in Duke letter dated May 7, 1986) that reliance on a single seismic boundary valve is acceptable. From UFSAR Section 3.7.3.9, the design criterion for seismic boundary valves is as follows:

"Seismic/non-seismic boundaries are established by valves which are designed to meet the seismic design criteria. Failure in the non-seismic portion of the system cannot cause loss of function to the safety system in that automatic or remote manual-operated valves are used for valves normally open during Reactor Operation."

This design criterion has been applied to the EFW System. Exceptions to normally closed manual boundary valves were provided in Duke's May 7, 1986, submittal. The EFW seismic boundary valves can be of four types.

The first type is a manually operated valve. Manually operated valves that provide a seismic boundary are normally closed. A single failure is not assumed to include the failure of a normally closed valve to the open position. These valves may be opened during specific operating conditions. However, due to the short duration and low probability of a seismic event occurring concurrent with the manual valve being open, this seismic boundary valve vulnerability was found to be acceptable.

Another seismic boundary valve type is a check valve. Check valves in the reverse flow direction are considered to be normally closed, and are therefore treated as a normally closed manual valve.

A third type of seismic boundary valve is a power operated valve. The power operated EFW seismic boundary valves are normally closed. The valves serve as seismic boundary valves in that they are designed to fail as-is, in their normally closed position.

The last type of seismic boundary valve for EFW is a pneumatically operated valve. There are three pneumatically operated valves that receive an automatic closure signal on a low UST level. However, a closed manual seismic boundary valve normally isolates one of these flowpaths. The pneumatically operated valves are designed to fail closed on a loss of instrument air or on a low UST level. Duke's May 6, 1986, submittal stated that "Modifications at this boundary will be made to protect EFW against single failure." This statement is misleading in that modifications were not planned to add double isolation valves. It does not appear that this statement was relevant or significant in the staff's SER on GL 81-14. In the January 14, 1987 SER, the staff accepted Duke's position on seismic boundary valves as follows:

"Normally open boundary valves will be closed, or will be modified to be remotely operated, or analysis will demonstrate that failure of piping beyond these valves will have no impact on system function."

The staff's position is consistent with Oconee's seismic boundary valve design criterion in Section 3.7.3.9 of the UFSAR in that a single seismic boundary valve is acceptable. Thus, these valves satisfy the UFSAR design criterion in that they are automatic valves that close on low UST level.

The EFW pump recirculation pathways are exceptions to the above description of seismic boundary valves, in that these pathways remain open. The turbine-driven EFW pump recirculation seismic boundary is provided by fixed orifices. These orifices restrict the amount of EFW that would be diverted from feeding the SGs. The orifices are the devices credited for limiting recirculation flow such that adequate EFW flow can be delivered to the SGs. Each motor-driven EFW pump recirculation line is provided with a normally open manual valve as its seismic to non-seismic boundary. An automatic recirculation control valve for each motor-driven EFW pump regulates recirculation flow. The automatic recirculation control valves are the devices credited for limiting recirculation flow such that adequate EFW flow can be delivered to the SGs.

EFW Control Valve Single Failures (FDW-315 and 316)

The safety analyses demonstrate that providing EFW flow to one steam generator is sufficient to achieve safe shutdown and remove decay heat. Thus, for most design bases events, a single failure of an EFW control valve to open is acceptable since EFW flow can still be provided to the other steam generator. However, for secondary side pipe breaks that depressurize a steam generator or steam generator tube rupture accidents, it is necessary to isolate the affected steam generator. Thus, for these accidents only one steam generator remains available for decay heat removal. A failure of the EFW control valve to open on the unaffected steam generator isolates flow to this generator.

DOC M1 provides the licensing history associated with EFW control valve single failures. This post-TMI correspondence did not specifically address EFW flow requirements during a SGTR accident. A LOOP is not postulated coincident with a SGTR accident. The original Oconee FSAR SGTR accident analysis credited MFW for decay heat removal using recirculation from the turbine bypass valves. This has been changed by analyses submitted in DPC-NE-3005, UFSAR Chapter 15 Transient Analysis Methodology, approved by the staff in SERs dated October 1, 1998, and May 25, 1999. The UFSAR Chapter 15 accident analyses now rely on EFW flow for decay heat removal. The analyses presented in DPC-NE-3005 assume a single failure of the EFW control valve on the unaffected steam generator. Operator action is required to align EFW flow to the unaffected steam generator via the non-safety main feedwater startup flow path. As stated previously, this methodology was approved by the staff in SERs dated October 1, 1998, and May 25, 1999.

Based on the licensing history provided in DOC M1, the single active failure exceptions taken for FDW-315 and FDW-316 are part of the current licensing bases and the addition of clarifying information to describe these exceptions is justified.

Use of the non-safety alternate path through the MFW startup control valves relies on non-safety equipment and non-safety support systems (electrical power and instrument air). This flowpath is tested under Oconee's Appendix B test program, with the startup control valves in continuous use during normal plant operation.

The selected components tested under the jurisdiction of the Appendix B portion of the Oconee Pump and Valve Testing Program provide a function of safety to the operation of the plant, but do not fall explicitly under the jurisdiction of the ASME Code.

Specifically, the Appendix B program encompasses pumps and valves not included in the ASME program which are active in certain non-Design Basis Events, are cold shutdown valves not associated with a FSAR Chapter 15 event, are significant to plant safety, or are of economic importance and that are considered beyond the scope of 10CFR50.55a. The Appendix B components are tested in accordance with internal Duke Power procedures and requirements (per 10 CFR 50, Appendix B). Where possible, Appendix B components are tested utilizing safety related procedures.

Assuming offsite power is available, Duke safety analyses demonstrate that adequate core cooling is assured if the feedwater to the SGs is restored within 20 minutes. The difference between 20 minutes for this scenario and 30 minutes for the 4kV HELB scenario is the additional heat input from the reactor coolant pumps. Validation exercises have confirmed that this alternate alignment can be performed within 20 minutes. The alignment of the alternate path can be completed as described below.

The 'A' MDEFWP can be aligned to feed the 'A' SG via the MFW startup path by opening motor operated valves FDW-38 and FDW-374 and closing motor operated valves FDW-33, FDW-36 and FDW-372. The 'B' MDEFWP can be aligned to feed the 'B' SG via the MFW startup path by opening motor operated valves FDW-47 and FDW-384 and closing motor operated valves FDW-42, FDW-45 and FDW-382. These motor operated valves are operated from the control room. The valves receive non-safety power. FDW-36, FDW-38, FDW-45, and FDW-47 are DC motor operated valves which receive power from the station power batteries. FDW-372, FDW-374, FDW-382, and FDW-384 are AC motor operated valves which receive power from non-safety, non-load shed sources. FDW-33 and FDW-42 are AC motor operated valves which receive power from a non-safety, load shed source. The MDEFWPs must be stopped to allow alignment of this flow path.

The TDEFWP can be aligned to feed both SGs via the MFW startup path by opening two manually operated valves (FDW-94 and FDW-96) located in the turbine building basement and closing motor operated valves FDW-368 and FDW-369. The motor operated valves are operated from the control room. FDW-368 and FDW-369 are AC motor operated valves which receive power from non-safety, non-load shed power. Repositioning of FDW-33, FDW-36, FDW-38, FDW-42, FDW-45, and FDW-47 would also be required as described in the alignment of the MDEFWP's to the MFW startup path. The TDEFWP must be stopped to allow alignment of this flow path.

Once the EFW pump is aligned to the MFW startup path, FDW-35 and/or FDW-44 are used to control EFW flow to the SGs. Air operated control valves FDW-35 and FDW-44 are modulated by control signals based on SG water levels from the ICS. The control valves may be operated manually from the control room. Air is supplied by the plant Instrument Air System. The ICS and the plant instrument air are non-safety. As in the case of control valves FDW-315 and FDW-316, the level control setpoint is automatically raised upon loss of all four reactor coolant pumps to promote natural circulation in the Reactor Coolant System.

MDEFWP Single Failures

In response to IE Bulletin 80-04, Duke modified the plant to automatically isolate MFW flow to the affected SG in the event of a Main Steam Line Break (MSLB). The automatic MFW isolation function is not single failure proof. If the MFW main control valve fails to close or if the TDEFWP autostart inhibit (or failure to trip if already running) circuitry fails, the potential for exceeding the containment design pressure exists due to continued feedwater addition from the MFW or EFW System.

The NRC concluded in their safety evaluation (December 7, 1998) that, with the MSLB modifications, Duke had adequately addressed the issues identified in IE Bulletin 80-04. This was based on: 1) the unique design of the Oconee Main Steam System (i.e., no main steam isolation valves) that results in dose consequences from the design bases MSLB outside containment bounding the dose consequences from an MSLB inside containment (even with containment leakage), 2) the low probability of an MSLB inside containment coupled with the coincidental failure of an MFW control valve to close, and 3) the licensee analysis, which shows no fuel damage even with continued feedwater addition. The staff concluded that the design of the MSLB Isolation System, although not single failure proof, was acceptable because the design bases and most limiting MSLB for Oconee is a break outside containment that does not rely on automatic MFW isolation.

As a result of this change UFSAR Section 10.4.7.3 was revised to state: "With a postulated break associated with the 'A' OTSG and a failure of the 'B' motor driven emergency feedwater pump, the normal Feedwater System will be isolated to both steam generators and the TDEFWP will be inhibited from automatically starting. The TDEFWP can be manually started by placing its control switch to RUN."

However, in the case where a secondary side pipe break occurs coincident with the failure of the MDEFWP associated with the unaffected steam generator, the EFW System would not be capable of automatically supplying water to the unaffected steam generator. MSLB Detection and Mitigation Circuitry would isolate MFW to both steam generators, and inhibit the automatic start of the TDEFWP. To mitigate this event, manual operator action would be required to start the TDEFWP by placing the control switch to run.

This single active failure vulnerability was created when the Main Steam Line Break Detection and Mitigation Circuitry was installed. The single failure of the MDEFWP to start was addressed in the 10 CFR 50.59 evaluation for the modification, which concluded that no unreviewed safety question existed because this failure was no different than the failure of the EFW flow control valve to open. Both failures require operator action and both can be mitigated from the control room.

Duke analysis confirms that, for the limiting case with offsite power available, adequate core cooling is assured if feedwater to the SGs is restored within approximately 20 minutes. This is well within the time needed to start the TDEFWP which can be manually started from the Control Room by placing the start circuitry selector switch in the RUN position. In addition, there are other alternative means of providing feedwater to the intact SG. These include using another unit's EFW System, the ASW System and the SSF ASW System. The operability of an alternate unit's EFW System and the ASW System is required by Selected Licensee Commitments (SLCs) 16.10.7 and 16.9.9, respectively. The operability of the SSF ASW System is required by TS 3.10. Additionally, analysis of this single active failure exception yields a low CDF based on the low CDF significance of a secondary side pipe break occurring coincident with a failure of the MDEFWP associated with the unaffected steam generator given the ability to mitigate the event with the TDEFWP using manual operator action.

Long Term Inventory

The original design bases for EFW inventory was to have sufficient inventory to cool down to decay heat removal conditions following a loss of main feedwater with offsite power available. The original EFW inventory design basis was reflected in a Technical Specification requirement for 72,000 gallons of EFW inventory. This inventory is adequate to cool down to DHR conditions via the recirculation mode using the turbine bypass valves. The original Technical Specification inventory requirement of 72,000 gallons remains in Technical Specifications today and was not altered by the post-TMI EFW reviews.

The initial assured source of EFW inventory is the UST. The normal operating level in the UST is maintained > 8 feet (which provides > 50,000 gallons of water). However, the minimum inventory required by Technical Specifications is 30,000 gallons. The initial inventory in the UST provides time to align makeup from the CST or plant Demineralized Water System. The hotwell can also be used to replenish inventory in the UST for extended operation of the EFW System. The normal operating level in the hotwell is 58 to 60 inches. This normal operating level corresponds to > 145,000 gallons of water. The stored inventory in the hotwell could be lost during certain events (ie., condensate/feedwater/main steam line breaks with offsite power available). In these events, the hotwell would be unavailable for makeup to the UST or as a direct suction source to the EFW pumps. The hotwell is also susceptible to single failures that would prevent direct alignment of the EFW pump suction to the hotwell.

No post-TMI documentation could be located where Duke stated that the EFW System on the affected unit must be capable of cooling down to decay heat removal conditions assuming a single active failure for any design bases event. In a letter dated November 14, 1980, the staff requested the following information in Item 16, Long Term Source of AFW Supply:

"Branch Technical Position 5-1, attached to SRP 5.4.6, requires a seismic category 1 water supply with sufficient inventory to permit operation at hot shutdown (as defined by the B&W STS) for at least 4 hours followed by cooldown to RHR operating temperature and pressure. The inventory 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 SSF.

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."

Duke responded to the November 14, 1980, NRC letter as follows:

"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 condenser 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 SSF ASW System is seismically qualified and is capable of providing sufficient secondary side cooling for over 3-1/2 days."

It is clear in this response that the SSF ASW System was credited as a source of long term inventory. It is also clear that Duke made no claims regarding the cooldown capability of the EFW System satisfying the single failure criterion or relying totally on safety-related equipment. For example, in Duke's April 3, 1981, response to Item 17 from the staff's November 14, 1980, letter, the following cooldown information was provided:

"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 DHR System can be accomplished has been determined. All heat sources have been included."

Note that no capability to perform this function for any design bases event including a single failure is stated.

The original post-TMI item from the staff's November 14, 1980, letter regarding inventory and single failure design cites BTP 5.1, which describes methods for meeting GDC 34. GDC 34 did not exist at the time ONS was licensed and the plant was not designed to meet the requirements of this GDC. As such, Oconee is considered a hot shutdown plant, with no design requirement to achieve cold shutdown assuming a single active failure following any design bases event. This is clearly supported by the fact that Oconee has only one decay heat removal drop line, which is clearly not single failure proof. BTP 5.1 states that "the extent to which the implementation guidance in Table 1 will be backfitted for all operating reactors and all other plants (custom or standard) for which issuance of the

OL is expected before January 1, 1979, will be based on the combined I&E and DOR review of related plant features for operating reactors."

The staff's August 25, 1981, SER on NUREG-0737, Item II.E.1.1, "Auxiliary Feedwater System Evaluation" does not directly address long-term EFW inventory requirements. It appears that Item 16 evolved into a requirement for EFW to be designed for seismic events and tornadoes. The January 15, 1987, SER for GL 81-14 concludes that Duke demonstrated "adequate seismically qualified alternative capability utilizing the SSF ASW pump and HPI pump (feed and bleed) in the event of loss of the AFW System as a result of seismically induced flooding." This SER states "We, therefore, conclude that Oconee meets the requirements of GDC 2 and 34 for post-seismic shutdown decay heat removal capability and is, therefore, acceptable." Thus, the staff's evaluation of long-term inventory credited alternate means of satisfying GDC 34 and no explicit requirement was imposed on Oconee for the EFW System, by itself, to be able to cool down to DHR assuming a single active failure.

The NRC also evaluated the EFW System during the Safety System Functional Inspection performed over the period of May 5 to June 11, 1986. During this inspection, weaknesses were cited by the NRC concerning EFW water supplies. The main concern with the water supplies involved the reliance on non-safety systems for long term operation of the EFW System. To reduce the reliance on non-safety systems for long term operation of the EFW System, several station modifications were implemented. The motor driven EFW pump suction was reconfigured to allow the full capacity of the hotwell to be available to the motor driven EFW pumps. Station modifications were made to provide safety grade level indication for the UST, and to isolate the UST makeup to the hotwell on a low level in the UST to guarantee sufficient time would be available to align alternate sources. In response to the SSFI, Duke stated that the EFW design relies on several diverse means of inventory. In a letter dated April 30, 1987, the staff accepted Duke's position as follows:

"In response to the concern regarding utilization of the condenser hotwell as a backup EFW water supply, the licensee noted that other sources of EFW supply and means of providing flow to the steam generators are available without reliance on the hotwell. Further, a modification already implemented on Units 1 and 2 will be installed in Unit 3 to provide additional water from the hotwell for delivery by the motor driven EFW pumps. The staff concurs with the licensees response on this issue."

Duke maintains that the current Oconee design has sufficient redundancy and diversity to assure the ability to bring the affected unit to hot standby followed by a cooldown to decay heat removal (Low Pressure Injection) operating conditions. Adequate inventory to perform this function is available from the following sources. The inventory in the UST allows at least 20 minutes for the operators to take action. These actions could include making up to the UST from the hotwell, demineralized Water System, or the CST. Although these are non-safety makeup sources, makeup from the hotwell and Demineralized Water System is monitored under the Maintenance Rule. If UST inventory cannot be maintained, the EFW pumps may be aligned directly to the hotwell. Although the hotwell is a non-safety suction source, this flowpath is included in Oconee's IST program and monitored under the Maintenance Rule. If the hotwell is unavailable on the affected unit, EFW may be aligned from an unaffected unit. If sufficient inventory cannot be maintained from an unaffected unit, the SSF ASW System, or the station ASW System can be used for long term decay heat removal inventory. Proposed UFSAR Sections 10.4.7.1.3 and 10.4.7.3.8 (see Attachment 1) are included in the UFSAR to address the above described design basis for long-term inventory.

The SSF ASW System can be aligned to provide long term cooling to the steam generators using lake water. The SSF ASW System is a seismically qualified, QA-1 system that is required to be maintained operable by Technical Specification 3.10. Since the SSF ASW suction source is lake water, the inventory is more than sufficient to achieve a cooldown to decay heat removal conditions.

The Oconee PRA includes the condenser hotwell, the cross-connect capability of the EFW Systems, and the SSF ASW as means to maintain a long term supply of water to the steam generators. Failure modes that result in loss of the hotwell as a long term supply, have been determined to be of low risk significance, contributing to the CDF at a frequency of less than 1E-06, less than 1% of the total Oconee CDF. The ability to refill the UST on unaffected units and the large volume of water available to the SSF ASW pump make the cross-connect and the SSF available to supply the steam generators for the long term.

The station ASW System can also be aligned to provide long term cooling to the steam generators using lake water. Operability of the station ASW System is controlled by SLC 16.9.9. Use of this system requires the SGs to be depressurized. Since the station ASW suction source is lake water, the inventory is more than sufficient to achieve a cooldown to decay heat removal conditions. The station ASW System is included in Oconee's Appendix B test program and monitored under the Maintenance Rule. The station ASW switchgear receives safety grade power from the Standby Buses. The switchgear itself is classified as QA-1. The pump motor is non-QA. The pump and flow path are classified as QA-1.

In summary, adequate long term inventory is available. The EFW System is not designed to cool down to DHR conditions following any design bases event assuming a single active failure relying solely on the UST and hotwell of the affected unit.

II.C UFSAR Section 10.4.7.2, System Description

P7 Section 10.4.7.2 is reorganized to provide an introduction followed by distinct subsections that provide a description of the major components of the EFW System. The following subsections were added: 10.4.7.2.1, Motor Driven EFW Pumps (MDEFWPs); 10.4.7.2.2, Turbine Driven EFW Pumps (TDEFWPs); 10.4.7.2.3, EFW Pump Suction Source; 10.4.7.2.4, EFW

Pump Minimum Recirculation; 10.4.7.2.5, EFW Discharge Flow Control Valves; 10.4.7.2.6, Instrumentation and Controls; 10.4.7.2.7, System Interconnections and; 10.4.7.2.8, Alarms. Previously this system description was presented in one major section with two major subtitles; MDEFWPs and TDEFWPs. The new presentation provides a clearer description of the EFW System.

A14 The sentence in current UFSAR Section 10.4.7.2 regarding minimum EFW flow required is deleted. This information does not belong in the System Description section and is already contained appropriately in proposed UFSAR Section 10.4.7.1.1.

A15 Information is added to the first paragraphs of the descriptions for the MDEFWPs and TDEFWP in Section 10.4.7.2 to indicate the number of pumps of each type, their physical location and their normal alignment.

A16 The descriptions related to the independent starting circuits for each EFW pump in Section 10.4.7.2 are modified to describe the circuit in less detail and refer to other UFSAR Sections (7.4.3.1 and 7.8.2.1) that address the starting circuits in more detail. For completeness, the fact that the EFW pumps start on an AMSAC signal is added. This is currently addressed in UFSAR Section 7.8.2.1. Also, clarification is made that the LOW STEAM GENERATOR WATER LEVEL initiation function for the MDEFWPs is not designed to meet the single failure criterion.

A17 The description related to EFW discharge control valves in the third and fourth paragraphs on page 10-26 and in the fourth paragraph on page 10-27 is modified and combined into a new subsection (10.4.7.2.5) entitled "EFW Discharge Control Valves." Information is added to indicate the physical location of the EFW discharge control valves. Clarification is made that "all station air" means "instrument air and auxiliary air." Also added is that motive force for operation of these valves is provided by instrument air, auxiliary air, or bottled nitrogen.

A18 The descriptions related to the TDEFWP in the second and sixth paragraph on page 10-26 and in the sixth paragraph of page 10-27 are consolidated into one subsection (10.4.7.2.2) entitled "Turbine Driven EFW Pump (TDEFWP)." Information is added to indicate motive steam for the TDEFWP can be provided by auxiliary steam as well as main steam and that a check valve is provided in the auxiliary steam supply line to prevent a loss of steam source should the auxiliary steam source be lost. Information is added to indicate that the turbine driven EFW pump requires cooling water to the pump bearing cooling jackets for continuous operation and that it is initiated automatically, upon manual or automatic start of the turbine driven EFW pump from the Low Pressure Service Water System. Also mentioned is that LPSW may be lost following a station blackout and that a backup source of cooling (HPSW) is provided automatically. Information is added to indicate automatic or manual starting of the TDEFWP from the control room relies on DC power from the station power batteries and further describes other support equipment required to support TDEFWP operability. Also, clarification is made to indicate that the check valve provided in each steam supply line is to minimize uncontrolled blowdown of more than one SG following a MSLB.

A19 The first and last paragraph on page 10-27 are consolidated into one subsection (10.4.7.2.3) entitled "EFW Pump Suction Source." Clarification that the condensate/feedwater reserve is the UST and that a minimum of 30,000 gallons is maintained in the UST. Information is added regarding available makeup sources for the UST and the ability and the method to align EFW pump suction directly to the hotwell. Also, clarification is made to the statement that all necessary valves are maintained in the normal standby alignment to assure an open flow path for each pump, and to clarify that piping separation and independence are only relative to those valves in the discharge flow path.

A20 Proposed UFSAR Section 10.4.7.2.1 was modified to indicate that the low SG water level initiation function was installed for SG dryout protection and is not designed to meet the single failure criterion. This is acceptable based on NRC's SER for Duke's Response to GL 89-19 dated November 3, 1993.

A22 Proposed Sections 10.4.7.2.1 and 10.4.7.2.2 are revised to indicate that loss of both main feedwater pumps is sensed by pressure switches which monitor feedwater pump hydraulic oil pressure rather than control oil pressure for consistency with UFSAR Section 7.4.3.1.

A23 The second paragraph of proposed Section 10.4.7.2.2 is added to describe the TDEFWP cooling water requirements.

A26 The fifth paragraph on page 10-27 has been modified to include a detailed description of the non safety related flow path to the SGs using the MFW startup control valves. The proposed revision to the UFSAR creates a separate subsection (10.4.7.2.7) entitled System Interconnections, to capture this information.

A28 Section 10.4.7.2 indicates that if a selected train of automatic control fails, then the valve would fail open (page 10-27, third paragraph, third sentence). Since this statement is true if the only failure considered is a loss of electrical power the sentence has been revised to clarify that if the selected train of automatic control "experiences a loss of power" then the valve would fail open.

A37 This provides clarification to further describe when non-safety startup flowpaths may be used.

II.D UFSAR Section 10.4.7.3, Safety Evaluation

M1 **EFW Control Valve Failures During a LOOP**

The safety analyses demonstrate that providing EFW flow to one steam generator is sufficient to achieve safe shutdown and remove decay heat. Thus, for most design bases events, a single failure of an EFW control valve to open is acceptable since EFW flow can still be provided to the other steam generator. However, for secondary side pipe breaks that depressurize a steam generator or steam generator tube rupture accidents, the affected steam generator must be isolated. Thus, for these accidents only one steam generator remains available for decay heat removal. A failure of the EFW control valve to open on the unaffected steam generator isolates flow to this generator.

As part of NUREG-0660, Item II.E.1.1, "Auxiliary Feedwater System Evaluation," the NRC reviewed the EFW reliability study which was performed on the Oconee EFW System. Additionally, the NRC did a deterministic review of the auxiliary feedwater system using the acceptance criteria of SRP 10.4.9 and BTP ASB 10-1 (ref. Letter 10/31/80). As a result of these reviews, the NRC issued a request for additional information on November 14, 1980. Item 14 of this staff letter requested additional information concerning how the Oconee EFW design limits or terminates EFW System flow to the depressurized steam generator and directs the minimum flow to the intact steam generator 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. The NRC also requested Duke to verify that sufficient flow to the intact steam generator will occur in sufficient time to provide adequate core cooling if manual action is relied upon.

Duke responded to the NRC's request for additional information by letter dated April 3, 1981. In the response to Item 14 on postulated main steam and main feedwater line breaks, Duke stated that in order to provide sufficient EFW flow to the intact steam generator to ensure adequate core cooling, considering 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. This action can be completed from the Control Room. The same is true for OTSG B with a failure of motor driven emergency feedwater pump A. 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 fail open (on a loss of compressed air and nitrogen), an operator could manually adjust either one of the valves as they are located in the Penetration Rooms which are adjacent to the Control Room.

Subsequently, the NRC SER for this item dated August 25, 1981 concluded that the Duke response to the postulated main steam or main feedwater line break was acceptable. In the SER, NRC reiterated that the licensee responded that in order to provide EFW flow to the intact steam generator and isolate the ruptured steam generator the operator must take manual action. NRC also confirmed their understanding that the EFW System is designed so that a single active failure of any of the EFW pumps or valves will not prevent the operator from directing sufficient flow to the intact steam generator. NRC also acknowledged that the operator has sufficient Control Room indication of steam generator level and pressure to take actions necessary to provide sufficient flow to the intact steam generator in time to maintain adequate core cooling.

However, the post-TMI correspondence did not explicitly address the EFW control valve single failure for a main steam line or feedwater line break coincident with a loss of offsite power (LOOP). Note that a LOOP is not postulated coincident with a SGTR accident. The alignment of EFW through the MFW startup flow path is vulnerable to LOOP events because certain valves have power load shed, and either load shed must be reset or the valves must be locally operated. Both of these methods for aligning the MFW startup flow path require operator actions outside the control room. Thus, for a main steam or main feedwater break with a LOOP and a single active failure of the EFW flow control valve on the intact steam generator, the MFW startup path will not be immediately available from the Control Room. For this event, with a single active failure of the EFW flow control valve, the SSF ASW System is credited to provide feedwater to the SG within 30 minutes. Design calculations demonstrate that restoration of feedwater within 30 minutes is sufficient to minimize primary system inventory losses from the pressurizer code safeties and assure core cooling following a complete loss of feedwater. In addition, HPI feed and bleed cooling is available as an alternate means of decay heat removal.

The SSF was designed and licensed to maintain natural circulation at hot shutdown conditions. However, design calculations demonstrate that the SSF ASW System is also fully capable of providing sufficient feedwater to the intact steam generator following a secondary side pipe break to remove decay heat. The SSF ASW pump is a high head pump that can provide adequate feedwater flow over the range of steam generator pressures. Thus, the SSF ASW System serves as a diverse train of emergency feedwater to address the potential single failure of an EFW control valve. Since the SSF has not previously been credited in this event, Duke will ensure that the portions of the SSF systems, necessary for event mitigation, are fully qualified.

Based on the above, proposed UFSAR Section 10.4.7.3.2, EFW Response Following a LOOP, has been added to the UFSAR. This UFSAR section concisely summarizes the potential unavailability of the main feedwater startup flow path following a secondary side pipe break coincident with a LOOP. If the EFW control valve on the unaffected steam generator fails to open and the main feedwater startup path is unavailable, the SSF ASW System would be required to feed the unaffected steam generator.

A LOOP coincident with a secondary line break is a very low frequency occurrence. Combined with the single failure in the EFW System, a failure of the SSF ASW, and failure of feed and bleed, these sequences do not contribute meaningfully to the CDF. These sequences have been estimated to occur with frequencies less than 1E-08, less than 0.01% of the Oconee CDF.

Duke believes that crediting the SSF as an alternate means of restoring feedwater following a secondary side pipe break. There is a low likelihood of these scenarios coincident with a LOOP and a single failure of an EFW control valve. Main steam and main feedwater line breaks are low frequency initiators. The occurrence of a LOOP and a single failure of the EFW control valve coincident with these initiators is even lower in frequency. The core damage risk significance of these sequences has been evaluated to be very low. In addition, sufficient time is available to restore feedwater to the intact steam generator. Operability of the SSF ASW System is required by Technical Specification 3.10.

P8 Section 10.4.7.3, "Safety Evaluation," is reorganized to provide an introduction followed by distinct subsections (10.4.7.3.2 - 10.4.7.3.7) that provide a description of the EFW Response to each type of transient. Subsection 10.4.7.3.8, "Long-Term Secondary Side Cooling," is added to indicate that the response for long term secondary side cooling is either by UST makeup or redundant and diverse sources of secondary makeup water.

P9 Section 10.4.7.3.9, "Failure Mode and Effects Analyses to Ensure Minimum Safety Requirements are Met assuming a single active failure in any System Required to Ensure Performance of the EFW System," is added to indicate a FMEA was performed and that exceptions to the single failure criterion are addressed in Section 10.4.7.1.4.1.

P13 This was added to clarify possible MDEFDWP alignment following feedwater/main steam line breaks which cause a loss of steam generator pressure.

A24 The last three paragraphs of proposed Section 10.4.7.3 were added to provide additional explanation of the spectrum of transients analyzed and the assumptions made for the EFW response to those transients. Section 10.4.7.3.1 has been added to provide an description of the EFW System response to a loss of main feedwater event.

A25 Sections 10.4.7.3.1.1 and 10.4.7.3.1.2 were added to describe the EFW Response to HELBs resulting in loss of switchgear and other HELBs that do not cause a loss of SG pressure boundary or loss of 4160V power.

A29 UFSAR Section 10.4.7.3 indicates that separate piping subsystems include redundant hotwell, upper surge tank, and condensate supply piping, aligned individually to the separate pump trains and that cross-connection is provided to allow a subsystem to supply all pumps in the event of single failure of a suction piping subsystem. The same design philosophy is included in the discharge piping subsystems. This statement has been deleted since this characterization is not entirely accurate and is not completely supported by design documentation.

A38 Reworded and clarified discussion to provide a more detailed description of EFW response following events where the main steam line break detection and mitigation circuitry may actuate.

A39 Added to provide clarification of required operator actions following acutation of MSLB detection and mitigation circuitry.

II.E UFSAR Section 10.4.7.4, Inspection and Testing Requirements

P10 Section 10.4.7.4 is retained with only slight modification.

A33 Additional information is added in UFSAR Section 10.4.7.4 to further define the EFW System capability to withstand seismic loading and describe other seismically qualified alternative capability for heat removal. A Reference is added to indicate that Duke demonstrated adequate post-seismic shutdown decay heat removal capability in accordance with Generic Letter 81-14 based on this capability.

II.F UFSAR Section 10.4.7.5, Instrumentation Requirements

P10 Section 10.4.7.5 is retained with only slight modification.

P14 These sections were added to address requirements for the TDEFWP, the MDEFWPs and EFW flow indication. Revisions were made to clarify that although the TDEFWP has safety grade automatic initiation circuitry, it relies on non-safety grade equipment to provide an automatic start. Revisions were also made to clarify that the automatic initiation of the MDEFWP, on low steam generator level, is not single failure proof. Additionally, information was added to describe what EFW indications are available to the operator to ensure adequate flow is delievered to the steam generators.

L2 The last sentence of Section 10.4.7.5 indicates that all non-safety related instrumentation and controls are designed such that any failure will not cause degradation of any safety related function. This statement is incomplete and, for clarity, has been deleted since portions of the EFW System do utilize non-safety equipment whose failure could cause loss of related component function (e.g., failure of the non safety related TDEFWP auxiliary oil pump and control logic would prevent auto start of the TDEFWP).

II.G UFSAR Section 10.4.7.6, References

P10 Section 10.4.7.8 is retained and renumbered 10.4.7.6. Additional references were added to this section as appropriate.

Attachment 4

No Significant Hazards Determination

Pursuant to 10 CFR 50.91, Duke Power Company (Duke) has made the determination that this amendment request involves a No Significant Hazards Consideration by applying the standards established by the NRC regulations in 10 CFR 50.92. This ensures that operation of the facility in accordance with the proposed amendment would not:

(1) Involve a significant increase in the probability or consequences of an accident previously evaluated:

No. The EFW System is utilized to mitigate the consequences of an accident. Failure of the EFW System is not a precursor to any accident evaluated in the UFSAR.

The UFSAR change proposes additional exceptions to the ability of the EFW system to mitigate specific events coupled with a single failure. These exceptions are appropriate, because diverse systems (i.e., the SSF ASW System or EFW System from another unit) are available to mitigate the defined transient/accident and the probability of the defined transient/accident occurring is small.

The proposed UFSAR changes do not involve any adverse impact on containment integrity, radiological release pathways, fuel design, filtration systems, main steam relief valve set points, or radwaste systems. In addition, it does not create any new radiological release pathways.

Therefore, it is concluded that the proposed changes will not significantly increase the probability or consequences of an accident previously evaluated.

(2) Create the possibility of a new or different kind of accident from any kind of accident previously evaluated:

No. The EFW System is utilized to mitigate the consequences of an accident. Failure of the EFW System is not a precursor to any accident evaluated in the UFSAR. The proposed UFSAR changes do not physically effect the plant, nor do they increase the risk of a unit trip or reactivity excursion. This proposed change does not introduce any new accident precursors. Therefore, these proposed changes do not create the possibility of any new or different kind of accident.

(3) Involve a significant reduction in a margin of safety.

No. A Probabilistic Risk Assessment (PRA) evaluation of the single failures identified in a failure modes and effects analysis performed for the EFW System concluded that there are no single active failures that contribute significantly to core damage frequency.

The UFSAR change proposes additional exceptions to the ability of the EFW system to mitigate specific events coupled with a single failure. These exceptions are appropriate, because the probability of the defined transient/accident occurring is small, and diverse systems (i.e., the SSF ASW System or EFW System from another unit) are available to mitigate the defined transient/accident.

The proposed UFSAR changes do not involve: 1) a physical alteration of the plant; 2) the installation of new or different equipment; or 3) any impact on the fission product barriers or safety limits.

Therefore, it is concluded that the proposed UFSAR changes will not result in a significant decrease in the margin of safety.

Duke has concluded, based on the above, that there are no significant hazards considerations involved in this amendment request.

Attachment 5

Environmental Assessment

Pursuant to 10 CFR 51.22 (b), an evaluation of the license amendment request (LAR) has been performed to determine whether or not it meets the criteria for categorical exclusion set forth in 10 CFR 51.22 (c) 9 of the regulations. The LAR does not involve:

1) A significant hazards consideration.

   This conclusion is supported by the determination of no significant hazards contained in Attachment 4.

2) A significant change in the types or significant increase in the amounts of any effluents that may be released offsite.

   This LAR will not change the types or amounts of any effluents that may be released offsite. The proposed UFSAR changes do not involve any adverse impact on containment integrity, radiological release pathways, fuel design, filtration systems, main steam relief valve set points, or radwaste systems. No new radiological release pathways are created.

3) A significant increase in the individual or cumulative occupational radiation exposure.

   This LAR will not increase the individual or cumulative occupational radiation exposure.

In summary, this LAR meets the criteria set forth in 10 CFR 51.22 (c) 9 of the regulations for categorical exclusion from an environmental impact statement.