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RECIP.NAME RECIPIENT AFFILIATION
DENTON,H.R. OFFICE OF NUCLEAR REACTOR REGULATION

SUBJECT: FORWARDS EMERGENCY FEEDWATER SYS,SYS CONCEPT & ANALYSIS.PUMP INSTALLATION TO BE COMPLETE BY 790825.OVERSIZED DRAWING ENCL.

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May 10, 1979

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

Reference: Oconee Nuclear Station
Units 1, 2 and 3
Docket Numbers 50-269, 50-270 and 50.287

Dear Sir:

Pursuant to my letter of April 25, 1979 and Mr. W. S. Lee's letter of April 26, 1979 attached is a system concept and analysis for the addition of two motor driven emergency feedwater pumps for each Oconee unit. With regard to Oconee 3, which is currently shutdown for refueling these pumps are scheduled for installation during the current outage, prior to June 2, 1979. Installation on Oconee 1 and 2 will subsequently be completed as promptly as practicable, prior to August 25, 1979.

Very truly yours,

William O. Parker, Jr.

DCH:scs
Attachment

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CYS ADVANCED TO:
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DUKE POWER COMPANY

OCONEE NUCLEAR STATION

EMERGENCY FEEDWATER SYSTEM

SYSTEM CONCEPT AND ANALYSIS

EMERGENCY FEEDWATER SYSTEM

Design Bases

The Emergency Feedwater (EFW) System assures sufficient feedwater supply to the steam generators of each unit, in the event of loss of the Condensate/ Feedwater System, to remove energy stored in the 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 evacuation of the main control room or cooldown following a loss-of-coolant accident for a small break, including maintaining a water level in the steam generators following such a break.

The EFW System is designed to start automatically in the event of loss of both main feedwater pumps or low feedwater header pressure. The EFW System will supply sufficient feedwater for approximately five hour cooldown at a flowrate of at least 720 GPM to enable the Reactor Coolant System to reach conditions at which the Residual Heat Removal System may be operated.

Three EFW pumps are provided, powered from diverse power sources. Two 65% capacity motor driven pumps are powered by the Emergency A.C. Power System, each supplying feedwater to one steam generator. One 150% capacity turbine driven pump, supplying feedwater to both steam generators, is driven from steam contained in either steam generator. Although the total rated capacity of all three EFW pumps is 2080 GPM, only 720 GPM is required as a minimum 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.

System Description

Each reactor unit is provided with a separate EFW System, as shown in Figure 1. Controls for each system are located on the main control room panels, as well as local to the equipment. The control room controls may be overridden in the event of control room evacuation.

Each EFW System is provided with two 500 GPM capacity motor driven pumps and one 1080 GPM capacity turbine driven pump. Each of the motor driven pumps normally serves a separate steam generator; the turbine driven pump serves both steam generators. The EFW pumps will automatically start immediately following either or both of the listed conditions:

a) Loss of both main feedwater pumps

b) Low feedwater header pressure

Once automatically started, the EFW pumps will continue to operate until manually secured by the operator. Each auxiliary feedwater pump discharge line is provided with a control valve and check valve. As the control valve for each pump is normally closed for isolation purposes, the valves are

arranged to fail open to a preset limit (in the case of the motor driven pumps) or fail as-is (in the case of the turbine driven pump), upon loss of station air or A.C. power, thereby eliminating the possibility of valve failure from isolating needed feedwater.

Upon automatic start of the EFW System of a given unit, solenoid valves on each control valve will de-energize, allowing the valve to open and admit feedwater. The control valves will receive a control air signal for valve modulation in response to feedwater demand. The EFW pumps normally discharge into separate piping which join into two single lines prior to penetrating the Reactor Building; each line feeding a separate steam generator through the emergency feedwater header.

A flow path is also provided to the upper surge tank dome (connected to the condenser) for minimum recirculation flow and testing purposes. A continuous recirculation flow is provided the turbine driven pump, limited by fixed orifices. Self-contained automatic recirculation valves are provided the motor driven pumps to assure individual pump minimum flow when needed during operation. Power for the motor driven pumps is normally provided by the normal station auxiliary A.C. Power System. During blackout operation, these pumps are aligned to the Emergency A.C. Power System. Motive steam for the turbine driven pump is provided from either of the two steam generators by main steam lines upstream of the turbine stop valves, and is exhausted either to the condenser or to the atmosphere. Either steam supply will provide sufficient steam for turbine operation. Either steam supply may be isolated if necessary. A check valve is provided in each steam supply line to prevent uncontrolled blowdown of more than one steam generator.

The feedwater reserves for each unit are normally aligned to the EFW pump suctions. The condensate reserve for each unit is maintained among the following sources:

	Source	Max. Capacity	
a.	Upper Surge Tank A	36,000 gallons/unit	
b.	Upper Surge Tank B	36,000 gallons/unit	
c.	Condenser Hotwell	142,000 gallons/unit	
d.	Condensate Storage Tank	30,000 gallons/unit	
e.	Makeup Demineralizers	900 gallons/minute	(Total Station)

Additional condensate may also be provided from condensate sources associated with the other units, if these sources are available and operable.

System Function

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 feedwater pumps (detected by turbine hydraulic control oil pressure 75 psig decreasing pressure) or low discharge pressure of both main feedwater pumps (detected by discharge pressure 750 psig decreasing pressure). Each pump is provided with a control switch with which the operator may start the pump manually.

Sufficient indication is provided in the control room to allow the operator to monitor unit parameters such as steam generator pressure and level, and pressurizer level during a cooldown. Specific indication provided for the EFW System are listed below:

	Local	Control Room
Turbine Driven EFW Pump Suction Pressure	X	
Motor Driven EFW Pump A Suction Pressure	X	
Motor Driven EFW Pump B Suction Pressure	X	
Turbine Driven EFW Pump Discharge Pressure	X	X
Motor Driven EFW Pump A Discharge Pressure		X
Motor Driven EFW Pump B Discharge Pressure		X
Turbine Drive EFW Pump Recirculation Flow	X	
Motor Driven EFW Pumps A&B Recirculation Flow	X	
Turbine Driven EFW Pump Seal Injection Water Pressure	X	
Motor Driven EFW Pump A Discharge Flow		X
Motor Driven EFW Pump B Discharge Flow		X
Emergency-EFW Supply to Steam Generator A Flow		X
Startup Header EFW Supply to Steam Generator A Flow		X
Emergency-EFW Supply to Steam Generator B Flow		X
Startup Header EFW Supply to Steam Generator B Flow		X

Discharge flow from the turbine driven EFW pump is controlled by control valves FDW-35 and FDW-44. These valves are arranged to fail as-is upon loss of station air or power to the normally energized solenoid valve. Upon automatic or manual start of the turbine driven EFW pump, the solenoid valve on each control valve is de-energized, thereby unloading the valve actuator and allowing the valve to open. At this time, a signal is generated to open motor operated valves FDW-38 and FDW-47, thereby assuring an open flow path. Although these motor operated valves are normally aligned in the open position, this measure provides additional assurance of an open flow path. Control valves FDW-35 and FDW-44 are modulated by control signals based on steam generator water levels by the Integrated Control System (ICS). Upon loss of all four reactor coolant pumps, such as during blackout conditions, the level control setpoint is automatically raised by the ICS to promote natural circulation in the Reactor Coolant System. Limit switches indicate valve position status in the control room.

Discharge flow from motor driven EFW pump A is controlled by control valve FDW-315; likewise, motor driven EFW pump B flow is controlled by control valve FDW-316. These valves are controlled independently of the Integrated Control System and arranged to fail open upon loss of station air or power to the normally energized solenoid valve. Upon automatic or manual start of each motor driven EFW pump, the associated control valve solenoid valve is de-energized, thereby unloading the valve actuator and allowing the valve to open. A signal is generated to open valve FDW-333 or FDW-343, depending upon which pump is started. Although these motor operated valves are normally aligned in the open position, this measure provides additional assurance of an open flow path. 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 during a cooldown. A selector switch 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 loader mode of operation. Upon automatic start of the EFW pumps, the valves will open and be controlled by the automatic level control or by the manual loaders. Control valve stem travel is limited by preset handwheel position to limit pump runout. Manual loaders are maintained in standby mode such that initial EFW valve position is at the travel stop before manual operator control. Independent level transmitters are utilized in the automatic control system. Limit switches indicate valve position status in the control room.

The steam supply for the EFW pump turbine is provided from either main steam line. Valve MS-93 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. As valve MS-93 leaves the closed position, a limit switch starts the EFW pump turbine oil pump.

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, and to assure piping separation and independence. Below are listed necessary valves and their required alignment for EFW System standby:

Valve	Position	Function	Motor Operated with Control Room Indication & Control	Manual Handwheel
C-156	Open	UST B Supply to TDEFWP	X	X
C-157	Open	UST B Supply to TDEFWP		X
C-158	Open	UST A Supply to EFW Pumps	X	X
C-166	Open	UST A Supply to EFW Pumps		X
C-180	Open	UST A Supply to MDEFW Pumps		X
C-573	Open	UST A Supply to MDEFW Pumps		X
C-160	Closed	UST A Supply to TDEFWP	X	X
C-162	Open	UST A Supply to TDEFWP		X
C-153	Closed	UST Cross-connection	X	X
C-152	Closed	UST Cross-connection	X	X
C-391	Open	Condenser Supply to TDEFWP	X	X
C-184	Open	Condenser Supply to MDEFW Pumps		X
C-569	Open	Condenser Supply to MDEFW Pumps		X
C-575	Open	MDEFW Pump A Suction Isolation		X
c-576	Open	MDEFW Pump B Suction Isolation		X
FDW-85	Open	TDEFWP Seal Injection Water Isolation		X
FDW-89	Throttled	TDEFWP Min. Flow Recirculation Isolation		X
FDW-88	Closed	TDWFWP Test Recirculation Isolation		X
FDW-94	Open	TDEFWP Discharge to S.G. A Isolation		X

FDW-307	Open	TDEFWP Discharge to S.G. A Isolation		X
FDW-100	Open	TDEFWP Discharge to S.G. A Isolation		X
FDW-34	Open	TDEFWP Discharge to S.G. A Isolation		X
FDW-38	Open	TDEFWP Discharge to S.G. A Isolation	X	X
FDW-96	Open	TDEFWP Discharge to S.G. B Isolation		X
FDW-308	Open	TDEFWP Discharge to S.G. B Isolation		X
FDW-102	Open	TDEFWP Discharge to S.G. B Isolation		X
FDW-43	Open	TDEFWP Discharge to S.G. B Isolation		X
FDW-47	Open	TDEFWP Discharge to S.G. B Isolation	X	X
FDW-340	Open	MDEFW Pump A Min. Flow Recirc. Isolation		X
FDW-350	Open	MDEFW Pump B Min. Flow Recirc. Isolation		X
FDW-333	Open	MDEFW Pump A Discharge to S.G. A Isolation	X	X
FDW-335	Closed	MDEFW Pump A Discharge to EFW Header Isolation	X	X
FDW-343	Open	MDEFW Pump B Discharge to S.G. B Isolation	X	X
FDW-345	Closed	MDEFW Pump B Discharge to EFW Header Isolation	X	X
FDW-313	Closed	MDEFW Pump A Discharge to EFW Header Isolation		X
FDW-314	Closed	MDEFW Pump B Discharge to EFW Header Isolation		X
FDW-97	Closed	TDEFWP Discharge to EFW Header Isolation		X
FDW-98	Closed	TDEFWP Discharge to EFW Header Isolation		X
FDW-309	Closed	TDEFWP Discharge to Emergency-EFW Header S.G. A		X
FDW-310	Closed	TDEFWP Discharge to Emergency-EFW Header S.G. B		X
FDW-33	Closed	Startup Feedwater Header to S.G. A Isolation	X	X
FDW-42	Closed	Startup Feedwater Header to S.G. B Isolation	X	X
FDW-36	Closed	Startup Feedwater Header to S.G. A Isolation	X	X
FDW-45	Closed	Startup Feedwater Header to S.G. B Isolation	X	X

The motor driven EFW pumps require cooling water for continuous operation. Sufficient cooling water is assured automatically, upon manual or automatic start of the motor driven EFW pumps.

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:

a) Motor driven EFW pumps low suction pressure
b) Steam generator low level alarms
c) Hotwell low level alarms
d) UST low level alarms
e) Low motor driven EFW pump cooling water flow
f) Motor driven EFW pump stator winding high temperature
g) Motor driven EFW pump motor bearing high temperature
h) Motor driven EFW pump bearing high temperature
i) Motor cooler excessive leakage
j) Motor driven EFW pump A auto start blocked
k) Motor driven EFW pump B auto start blocked
l) Turbine driven EFW pump auto start blocked
m) Any EFW pump discharge flow control valve not open following EFW System actuation

Safety Evaluation

Feedwater inventory is maintained in the steam generators following reactor shutdown by one of the following methods listed in order of their desirability and/or priority:

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

b. The two EFW motor driven pumps are capable of supply both steam generators at full secondary system pressure.

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

d. Alternate EFW supplies may be available from the EFW Systems of the other Units, capable of supplying both steam generators at full secondary system pressure.

e. The hotwell and condensate booster pump combination has discharge shutoff head of approximately 700 psia. Three sets of pump pairs are provided. If required, the turbine bypass system 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.

f. The Auxiliary Service Water System may be used to maintain steam generator water inventory following cold shutdown to remove decay heat in the long term.

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 in the listed measures, the EFW System has been designed with special considerations to enable it to function during any postulated design basis event 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 motor driven pumps or the 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 and upper surge tank 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.

Following a loss-of-coolant accident, the EFW System may be used for supply water to the steam generators to develop a water head and thereby prevent potential leakage from the primary to the secondary side of the steam generators. Any of the listed methods of feedwater addition may be employed to accomplish this purpose.

Inspection and Testing Requirements

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 may be tested by utilizing the recirculation test line to the upper surge tank dome. Pump head and flow may be verified utilizing this method.