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September 2, 1988

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ATTN: Mr. Jose A. Calvo, Director
Project Director, Region IV
Division of Reactor Projects
III, IV, V and Special Projects

SUBJECT: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Resolution of GI-124, AFW Reliability
Response to Staff Assessment Report
TAC No. 64760

Dear Mr. Calvo:

An NRC staff review group was formed to prepare an overall reliability assessment for each of seven plants with a two train auxiliary feedwater (AFW) system, including ANO-2. This review was performed in connection with the resolution of Generic Issue GI-124, AFW System Reliability. The staff review group conducted an on-site walkdown and review of the design and configuration of the ANO-2 AFW System during December 1986. A draft report of the results of the team's findings was transmitted by NRC letter dated July 31, 1987 (2CNA078707). By letter dated November 17, 1987 (2CNA118701), the staff requested AP&L's comments on the concerns identified in the draft report. Our responses were provided by letter dated January 29, 1988 (2CAN018802). The subject report documenting the results of the staff review of our responses, and staff conclusions concerning AFW system reliability at ANO-2, was transmitted by letter dated June 14, 1988 (2CNA068801).

The staff's draft report for ANO-2 identified 18 concerns or open items. After consideration of our responses, the subject report concluded that all of these issues have been resolved with the exception of the need for additional features to improve secondary side decay heat removal reliability. The staff stated that they did not agree with our conclusion that the level of AFW system reliability was adequate based upon plant specific data and existing compensatory decay heat features such as the method of feeding the steam generators with the condensate pumps following the unlikely event of a loss of both main and both emergency feedwater pumps.

The transmittal letter requested our response to the findings in the report and our specific proposals to upgrade AFW system reliability.

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Although it is clear that the ANO-2 AFW System meets applicable licensing requirements, we understand the staff's position is based upon the AFW system reliability criterion (10^{-4} to 10^{-5} per demand) given in Section 10.4.9 of the Standard Review Plan (SRP). This SRP section also specifically allows compensating factors such as other methods of accomplishing the safety functions of the AFW system or other reliable methods for cooling the reactor core during abnormal conditions to be considered to justify a larger AFW system unavailability. The revision to the SRP which included Section 10.4.9 was made after the licensing of ANO-2. Our review of the considerations regarding the development of the language in this SRP section indicates that "feed and bleed" cooling was specifically addressed by the staff, and due to the initiation uncertainties and containment contamination concerns associated with it, the staff position was developed that while it was appropriate for inclusion in emergency procedure guidance for coping with a loss of all feedwater, it was an unsatisfactory compensating feature with respect to the SRP 10.4.9 criterion. No documented evidence has been found indicating that the staff specifically addressed the acceptability of other types of alternate secondary cooling methods during the development of the SRP acceptance criteria, such as feeding the steam generators with condensate pumps. Rather, it is clear from various staff transmittals and Commission transcripts that the specific numerical criterion in SRP 10.4.9 was selected somewhat arbitrarily such that only plants with three AFW pumps could meet the criterion without consideration of compensating factors (for example, see transcript of the April 4, 1983 Commission Briefing).

Nevertheless, in the ANO-1 AFW System Reliability Assessment Report, transmitted by NRC letter dated August 24, 1988 (1CNA088808), the staff specifically stated their position that only features which relate to secondary side decay heat removal capability (e.g., a startup feedwater pump, AFW pump discharge crossconnections between units, or a third AFW pump) can be considered acceptable for satisfying the SRP criterion. It has been and continues to be AP&L's position that the ANO-2 method of feeding the steam generators with condensate pumps in the unlikely event of a loss of both main and both emergency feedwater pumps is an acceptable alternate secondary side decay heat removal method and therefore satisfies the SRP criterion. This method has been discussed during our various conversations with the staff on this issue, has been demonstrated to NRC staff members on the ANO-2 plant specific simulator, and is included in operator training.

AP&L has recently completed an extensive, detailed evaluation of the established alternate method of feeding the steam generators with the condensate pumps to accomplish the safety functions of the emergency feedwater pumps. This evaluation included specific modelling of the ANO-2 condensate system for the CEPAC plant analysis code to perform the transient evaluation, and a fault tree analysis of the ANO-2 emergency feedwater, main feedwater and condensate systems to determine the unavailability of these systems to perform the decay heat removal function on demand. This evaluation demonstrated the use of a condensate pump to provide an additional source of feedwater to at least one SG following a loss of all feedwater to be both operationally and probabilistically feasible. This evaluation is attached for your information.

As demonstrated by the attached evaluation, decay heat removal via the condensate pumps is an adequate compensatory measure in full conformance with the SRP. However, should the NRC staff choose to evaluate the cost benefit of requiring even further means of decay heat removal, the attached evaluation also quantifies the cost vs. potential benefits of additional modifications such as an additional AFW pump or an AFW crossconnect to ANO-1.

Further reductions in the AFW system unavailability do not appear to be warranted by cost-benefit considerations, based on the capability of the condensate pump method as demonstrated by the attached evaluation, and the high cost of modifications such as an additional AFW pump. Present estimates indicated the cost at between $1.5 to $2 m 'lion dollars for a startup feedwater pump or AFW crossconnect line betw.en units. Additionally, these modifications would provide no real normal operational benefit.

As discussed in our previous submittals and conversations on this issue, AP&L is in the process of developing full plant Probabilistic Risk Assessments (PRAs) for both ANO-1 and ANO-2. This will provide insights into overall plant risk as well as AFW reliability. Our present schedule for completion of this effort is mid-1990. It is AP&L's position that the contribution of AFW system unavailability should be appropriately factored into the overall plant risk, in accordance with ongoing staff activities related to resolution of the severe accident policy issue, as described SECY-88-147, "Integration Plan for Closure of Severe Accident Issues". A main element of the plan involves the Individual Plant Examination (IPE), which involves the formulation of an integrated and systematic approach to an examination of the plant for possible risk contributors. The staff expects each utility to promptly fix any significant vulnerabilities uncovered by the IPE progress, and will review each utility's examination specifically for vulnerabilities not addressed by the utility but considered important by the staff. SECY-88-147 further states that the staff is almost ready to issue a generic letter containing guidance for implementing the IPEs. This should allow more accurate determination of which plant modifications are necessary and most beneficial, including identifying any appropriate AFW system modifications.

Very truly yours,

Dan Howard

Dan R. Howard
Manager, Licensing

DRH:RBT

Attachment

ATTACHMENT TO 2CANØ888Ø8

EVALUATION OF THE ANO-2 CONDENSATE PUMPS AS A METHOD OF ACCOMPLISHING THE SAFETY FUNCTION OF THE EMERGENCY FEEDWATER SYSTEM

PURPOSE

To evaluate the established alternate method of providing emergency feedwater to the Steam Generators (SGs) following the loss of Emergency Feedwater (EFW) Pumps 2P7A&B and Main Feedwater (MFW) Pumps 2P1A&B. This alternate method of accomplishing the safety function of the Emergency Feedwater System (EFWS) requires using Condensate Pump(s) 2P2A, B, C and/or D feeding through the Feedwater System to the SGs.

RELEVANT SYSTEM DESCRIPTIONS

The Feedwater System is designed to provide a continuous feedwater supply to the steam generators at the required pressures and temperatures under all anticipated plant conditions. It also has the capability to support unit operation when the system has to operate under abnormal conditions due to a feed pump, condensate pump, heater drain pump, or string of headers being out of service. The Feedwater System is composed of two trains (A and B), with each train taking suction from its own upstream condensate train and discharging into its own steam generator (with cross-connect capability).

The components contained in the Feedwater System are:

a. Turbine driven feedwater pumps 2P1A and 2P1B (see Table 1 and Figure 1)
b. Main feedwater regulator valves 2CV-0740 and 2CV-0748 and their bypass valves.
c. High pressure feedwater heaters.
d. Emergency Feedwater System consisting of two emergency feedwater pumps, one motor-driven and one turbine-driven, and their outlet valves.

In the event of a failure of both main feedwater pumps, the rapidly decreasing steam generator level will result in a reactor trip and an initiation of the Emergency Feedwater System.

The Emergency Feedwater System consists of two identical multistage centrifugal pumps that take suction from the Condensate Storage Tanks (CST) 2T41A and B, the outlet of the Start-Up (SU) and Blow Down (BD) Demineralizer, or (in emergencies) the Service Water loops. The water is delivered to the S/G Main Feed Lines through two separate and independent feed trains via associated valves and piping. Suction supply to both pumps is normally aligned to the CST and SU and BD Demineralizer effluent during a startup, or CST only during power operation. In the event of an Emergency Feed Actuation Signal, suction will shift to Service Water if 2P7A and B suction pressure falls to 5 psig (indicating that the CST is pumped down). Provision is also made for suction from the recirculation to the "Q" CST (T41B) through valves 2CS-814 and 2CS-815. The system is designed to handle 2.9% full power heat load (~100MWT) with one pump and train out of service. Although the pumps are identical, the drivers are different to assure system diversity and therefore, reliability. Pump 2P7A is turbine driven with a DC power supply for the entire train (AC power independent), while pump 2P7B is motor driven with an AC power supply (see Table 2 and Figure 2).

TABLE 1
MAIN FEEDWATER PUMP DATA

CHARACTERISTICS	DATA
Equipment Numbers	2P1A, B
Type	Single-Stage, Double Suction, Vertically Split Case Model 1BSx1524
Quantity	2
Suction Nozzle	24" Flanged
Discharge Nozzle	24" Welded
Operating Temperature	385.2°F
Capacity	14,500 GPM
Suction Pressure	475 PSIG
Discharge Pressure	1117 PSIG
Minimum Flow	5000 GPM at 4234 RPM
Injection Seal Flow	30-40 GPM Per Seal
Total Head, Ft.	1700
Speed	4234 RPM
Horse Power Required	6031 BHP
First Critical Speed	7400 RPM
DRIVER	
Type	6 Stage, Dual Inlet Turbine
Rating	7000 HP at 4600 RPM (L.P. Steam) 12,200 HP at 5050 RPM (H.P. Steam)
Rated Steam Condition	
Inlet Steam Pressure	
At L.P. Stop Valve	215 PSIA
At H.P. Stop Valve	898 PSIA
Inlet Steam Temperature	
At L.P. Stop Valve	501°F
At H.P. Stop Valve	532°F
Exhaust Pressure	5.0" HgA (LP Steam) 7.0" HgA (HP Steam)

DE LAVAL TURBINE INC. TRENTON, NEW JERSEY

TEST RESULTS OF SINGLE STAGE FEEDWATER PUMP
FOR
THE ARKANSAS POWER & LIGHT CO.
ARKANSAS NUCLEAR 1-UNIT 2
TAG 2P1B

ORDER NO. 6218
TYPE 18SXI524
SPEED 5050 RPM
SUCTION 385°F
DATE 12-30-74

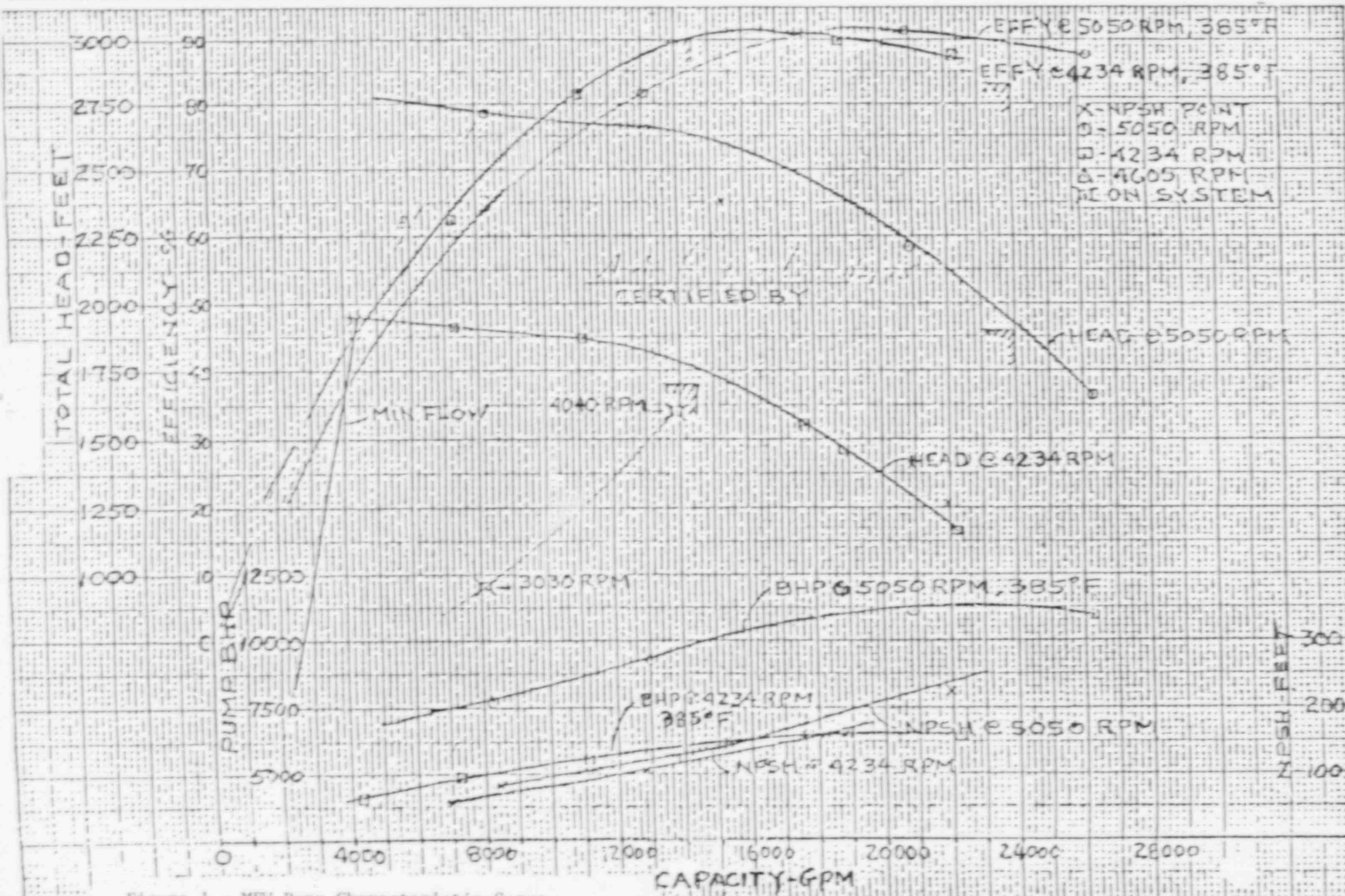

Figure 1 - MFW Pump Characteristic Curve

TABLE 2
EMERGENCY FEEDWATER PUMP DATA

CHARACTERISTICS	DATA
Equipment Numbers	2P7A, B
Quantity	2
Type	Centrifugal-Horizontal-Multistage
Design Pressure, PSIG	1600
Design Temperature, F	100°F
Design Flow Rate, GPM	575
Design Head, Ft.	2800
NPSH Required at Design Flow Rate, Ft.	16
Minimum Available NPSH, Ft.	32
Discharge Pressure at Shutoff, PSIG	1390
Rated Speed, RPM	3575
Materials of Construction:	
Casing	ASME SA 216 Gr. WCB
Impeller	ASME SA 351 Gr. CA-15
Shaft	ASME SA 479 Type, 410 H.T.
Turbine Driver:	
Type	Solid Wheel, Variable Speed, Horizontal
Steam Inlet Pressure: PSIA	
Operating	990
Minimum	60
Maximum	1100
Steam Condition, 0/0 Moisture	1/2
Back Pressure, PSIG	10
Rated BHP	575
Rated Speed	3575
Electric Motor Driver:	
Voltage	4000
Rated RPM	3600
Rated BHP	600

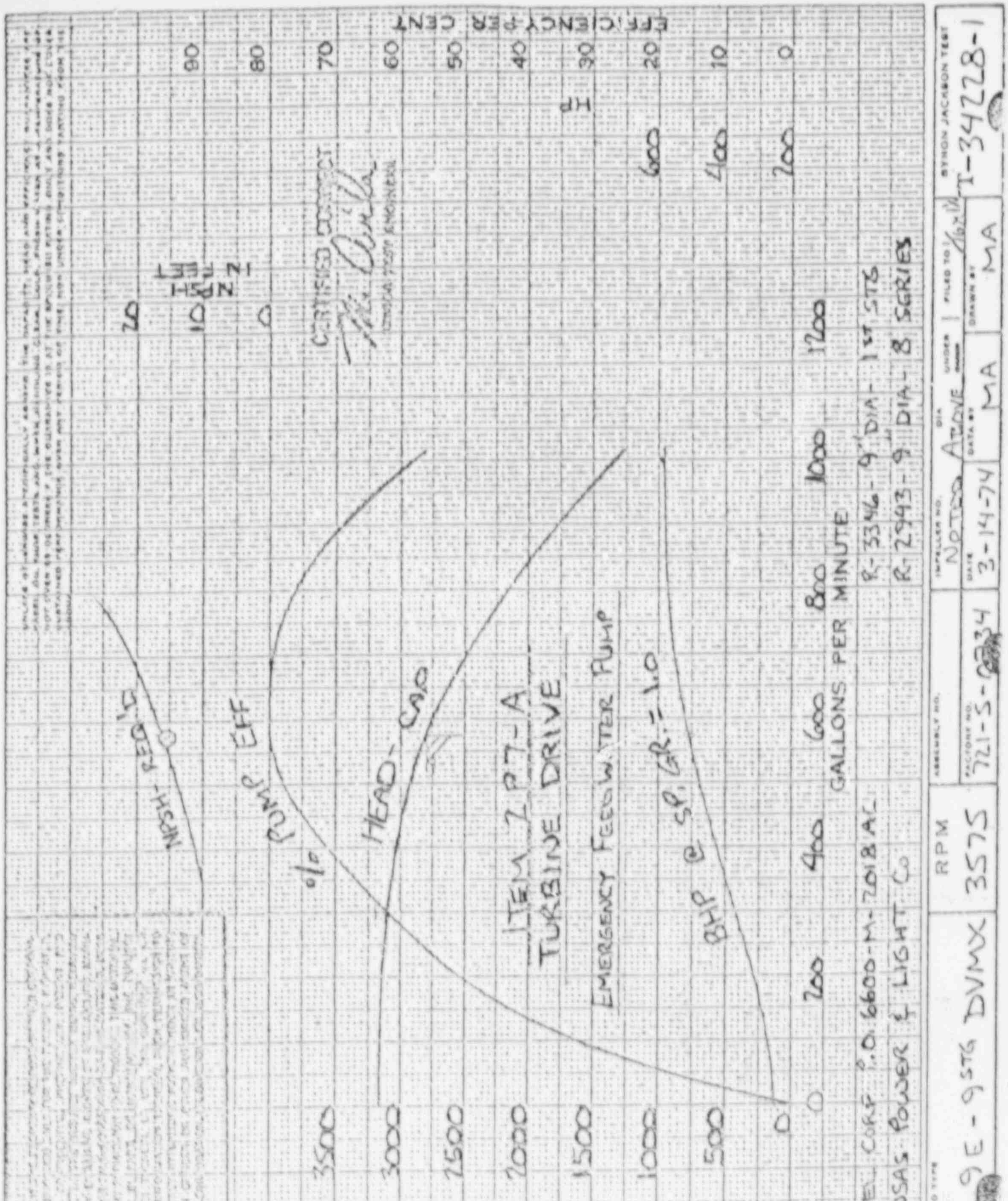

Figure 2 - EFW Pump Characteristic Curve

The Condensate System consists of two interconnected condensate trains (A&B). The condensate trains supply the Main Feedwater pumps with deaerated and preheated demineralized water. The Condensate System is made up of four 50% capacity, vertical "High Head" Condensate Pumps 2P2A, B, C, & D (see Table 3 and Figure 3) and five stages of low pressure feedwater heaters (2E7A/B, 2E6A/B, 2E5A/B, 2E4A/B, and 2E3A/B) each capable of 160% of normal flow.

Condensate Train "A" (2P2A/C) takes suction from the high pressure condenser shell and Train "B" (2P2B/D) takes suction from the low pressure condenser shell with the condensate suction headers cross connected by a 24" pipe (allowing water to be drawn from both shells). The condensate pumps discharge to a normally cross-connected discharge header and then through the low pressure feedwater heaters to the suction of the main feedwater pumps.

The Condensate System also includes a Condensate Storage and Transfer System that allows the use of the CSTs for condenser hotwell makeup. The Condensate Storage and Transfer System is designed to have sufficient capacity to supply all anticipated normal condensate make-up requirements for the plant, while retaining a volume of at least 160,000 gallons. This minimum water volume ensures that sufficient water is available to maintain the RCS at HOT STANDBY conditions for one hour with steam discharge to atmosphere concurrent with total loss of off-site power. The contained water volume limit includes an allowance for water not usable because of tank discharge line location or other physical characteristics.

MAIN FEEDWATER PUMP FAILURES

In the event of a failure of both Main Feedwater (MFW) Pumps, the rapidly decreasing steam generator level will result in a reactor trip and an initiation of the Emergency Feedwater System (EFWS). The EFWS is designed to handle 2.9% of the full power heat load (~100MWt) with one pump and train out of service. Actuation of the Emergency Feedwater Actuation Signal (EFAS) will result in the initiation of EFW flow to provide an adequate means of decay heat removal.

MFW AND EFW PUMP FAILURES

In the unlikely event of a loss of both the MFW and EFW Pumps, the discharge flow from the "High Head" Condensate Pumps 2P2A, B, C, D can be routed through and controlled by the MFW system to establish a controllable feedwater supply to the steam generators. The "High Head" Condensate Pump curve (Figure 6) shows the pump's capability to provide adequate feedwater flow at or below 800 psig (575 gpm = EFWS design flow). The maximum pump pressure of the condensate system is limited by protective circuitry to a pressure of 753 psi. Therefore, the steam generator pressures must be reduced below this condensate system maximum pump head pressure before condensate feed can be established; however, the steam generator pressure can be rapidly reduced using the turbine bypass valves or atmospheric dump valves.

TABLE 3
CONDENSATE PUMP DATA

CHARACTERISTICS	DATA
Equipment Numbers	21P2A, B, C, D
Type	Vertical, 10 stage/centrifugal
Quantity	4
Suction Nozzle	30-inch flanged
Discharge Nozzle	18-inch buttweld
Design Pressure, PSIG	850
Design Temperature, F	100
Design Flowrate, gpm	6,500
Design Head, Ft.	1,510
NPSH required at design flow rate, Ft.	12.5
Maximum operating flow rate, gmp	9,400
NPSH required at maximum operating flow rate, Ft.	24
Minimum available NPSH, Ft.	27
Shut off head, Ft.	1860
Materials of Construction	
Casing	ASTM A217
Impeller	
First stage	ASTM A296 CA-15
Subsequent stages	ASTM B143-1970
Shaft	AISI 416 SS
Driver	
Type	Induction motor
Service factor	1.0
Nameplate rating, hp	4,000
Voltage	4,000
RPM	1,180

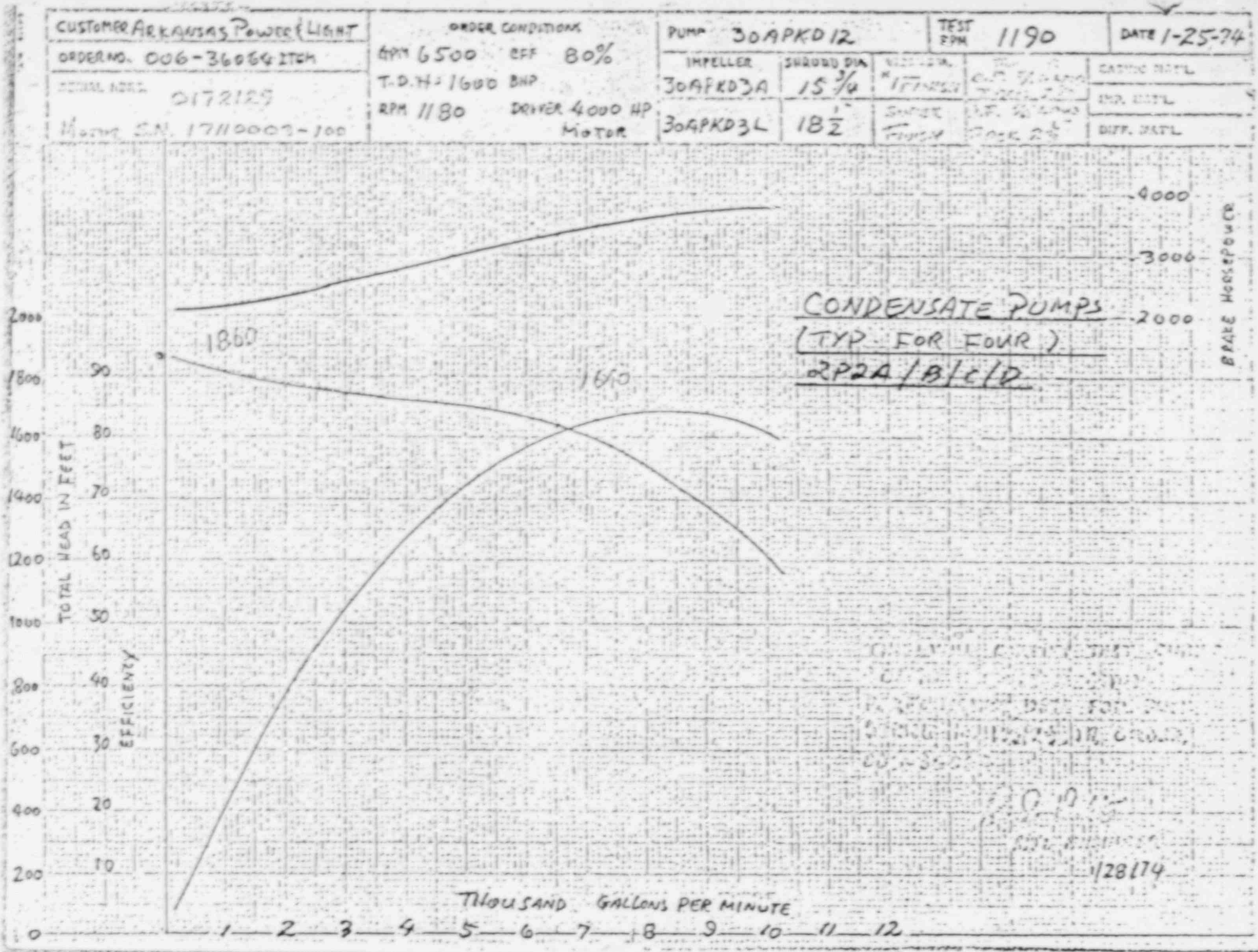

Figure 3 - Condensate Pump Characteristic Curve

Emergency Operating Procedure 2202.01 (Inadequate Core Cooling Section) outlines the steps to establish condensate feed flow as follows:

> IF EFW OR MFW flow cannot be established, attempt to establish condensate flow to S/G(s).
>
> 1) Verify at least one condensate pump running.
>
> 2) Close both MFW regulating valves.
>
> 3) Close both MFW regulating bypass valves.
>
> 4) Close both MFW pump recirc valves
>
> 5) *Throttle both condensate pump recirc valves to raise condensate pump discharge pressure as high as possible.
>
> 6) *IF available, use SDBCS turbine bypass valves to depressurize S/G(s) below condensate pump discharge pressure.
>
> 7) *IF necessary, use SDBCS atmospheric dump valves to depressurize S/G(s) below condensate pump discharge pressure.
>
> 8) Throttle MFW regulating bypass valves to establish flow to S/G(s).
>
> 9) Monitor hotwell levels AND makeup via CST water, IF necessary.

*NOTE: IF a condensate pump high discharge pressure alarm actuates ($\geq$ 753 psig) for approximately 3 minutes, then condensate pump trip will occur.

Additional notes and cautions include:

CAUTION: Ensure that MSIS variable trip setpoints are reset while depressurizing (S/G(s))

CAUTION: Monitor RCS Pressure and reset SIAS variable trip setpoint, if necessary.

NOTE: If possible, when establishing condensate feed to S/G(s), minimize condensate flow rate to S/G(s) for 5 minutes OR until a S/G level rise is indicated.

TRANSIENT EVALUATION RESULTS

The Combustion Engineering Plant Analysis Code (CEPAC) has been used to analyze the use of a condensate pump to provide feedwater flow to the SGs during a loss of MFW and EFW transient. The CEPAC code, as originally configured, does not include a separate condensate system. However, the original modeling has been modified to include a "Post Loss of All Feedwater" Condensate Feed model. This model represents the flow path from "A" or "C" condensate pump to the SGs as defined by the ANO-2 Piping and Instrumentation Drawings. The model includes both the MFW regulating bypass valve and the condensate pump recirc valve flow paths, with elevation and friction head requirements based upon a review of the ANO-2 Piping Isometric Drawings.

Figures 4 to 9 describe the primary and secondary systems responses during the transient. Table 4 lists the sequence of events for the transient. Overall the system response is relatively slow and provides ample time for any required operator action.

Following initial system alignment the operator actions (other than normal shutdown) are comprised of modulating the valve position of the turbine bypass valves, the MFW regulating bypass valve, and the condensate pump recirc valve. Due to the potential for a rapid cooling that can occur as the SGs are fed following "Dry Out" conditions, feed flow must be initially limited. Figure 8 shows that very little water is required to perform the required cooldown since the wide range SG level monitors remain off scale low. If condensate pump feeding had begun before the SG levels approached zero (which is very likely since SG dryout requires 15 minutes or more), then SG levels would have been able to have been maintained without excessively cooling the RCS. This transient is intended to demonstrate a worst case condition.

During this transient, cooldown rates were maintained within the 100°F/hr limit and the pressurizer level control system returned pressurizer pressure and level to their normal ranges. The SG pressure was maintained just below that required to prevent a condensate pump trip on high discharge pressure. Overall, it should be seen that using the condensate pumps to provide feedwater to the SGs when no other sources are available is thermal-hydraulically feasible and does not present an excessive operator burden.

TABLE 4

SEQUENCE OF EVENTS

TIME (SEC)	EVENT
0	Normal Full Power Operation
30	Sudden and Total Loss of All Feedwater
300	Trip Two Reactor Coolant Pumps as directed by Step 1 of the ICC Tab of the EOP
900	5% Turbine Bypass Valve 100% Open 11.5% Turbine Bypass Valve 75% Open Reset low SG Pressure Variable Setpoint as needed throughout transient
970	5% Turbine Bypass Valve 100% Open 11.5% Turbine Bypass Valve 4% Open 6" Feedwater Regulating Bypass Valve 6% Open 6" Condensate Recirc. Valve 10% Open Condensate Pump Started Note: Feedwater Regulating Valve and Feedwater Recirc Valve Modeled Closed
99[illegible]	Turbine Bypass Valves Closed 6" Condensate Recirc. Valve 12% [illegible]en
1010	6" Condensate Recirc. Valve 15% Open
1042	5% Turbine Bypass Valve 54% Open 11.5% Turbine Bypass Valve Closed
1068	5% Turbine Bypass Valve 65% Open
1080	6" Condensate Recirc Valve 13% Open
1128	6" Condensate Recirc. Valve 12% Open
1450	6" Condensate Recirc. Valve 11% Open
1760	5% Turbine Bypass Valve 70% Open
3076	5% Turbine Bypass Valve 65% Open
3340	5% Turbine Bypass Valve 60% Open
4365	5% Turbine Bypass Valve 54% Open
4700	5% Turbine Bypass Valve 57% Open
5000	5% Turbine Bypass Valve 56% Open
5400	Transient Stopped upon demonstration of controlled cooldown

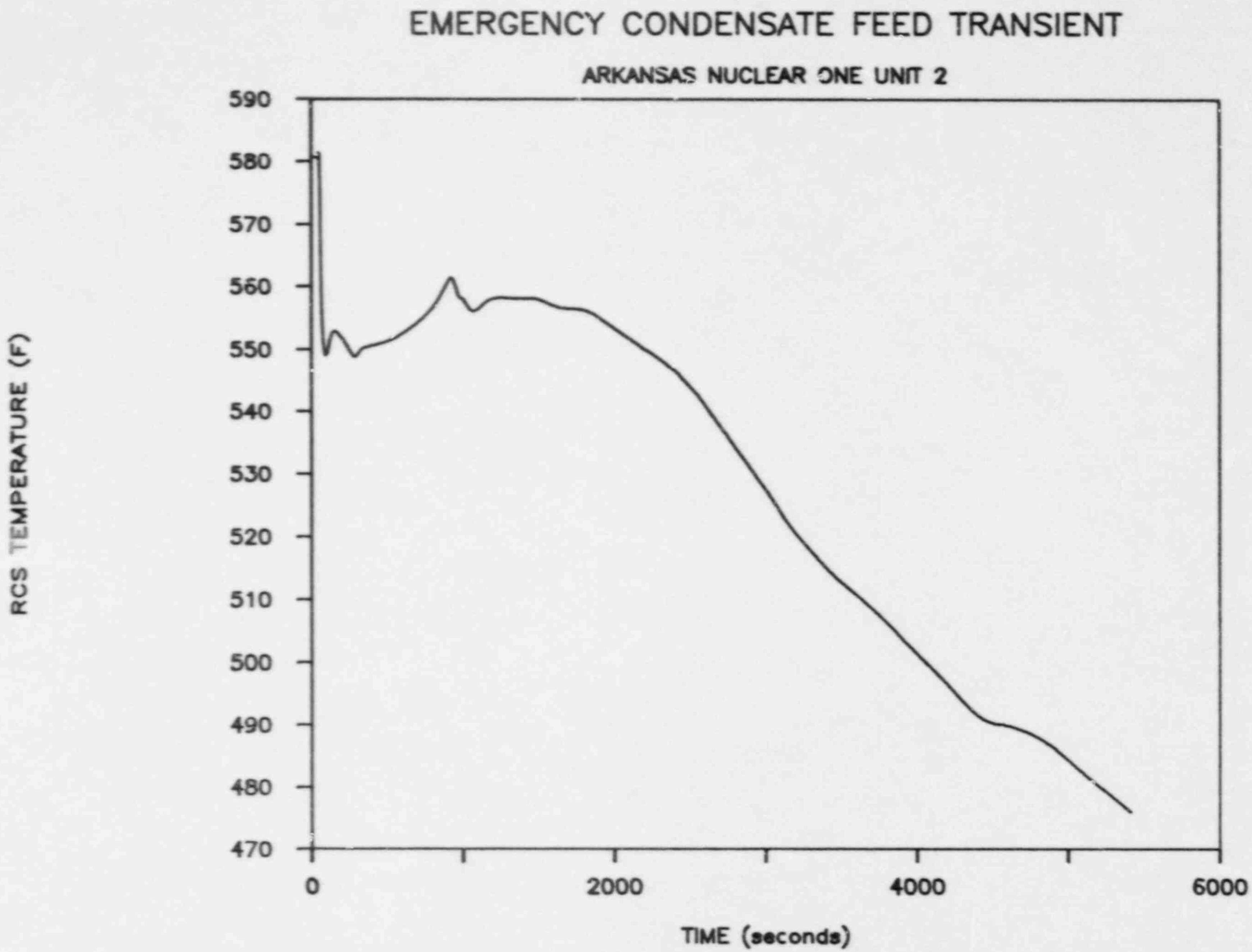

Figure 4 - RCS Average Temperature vs. Time

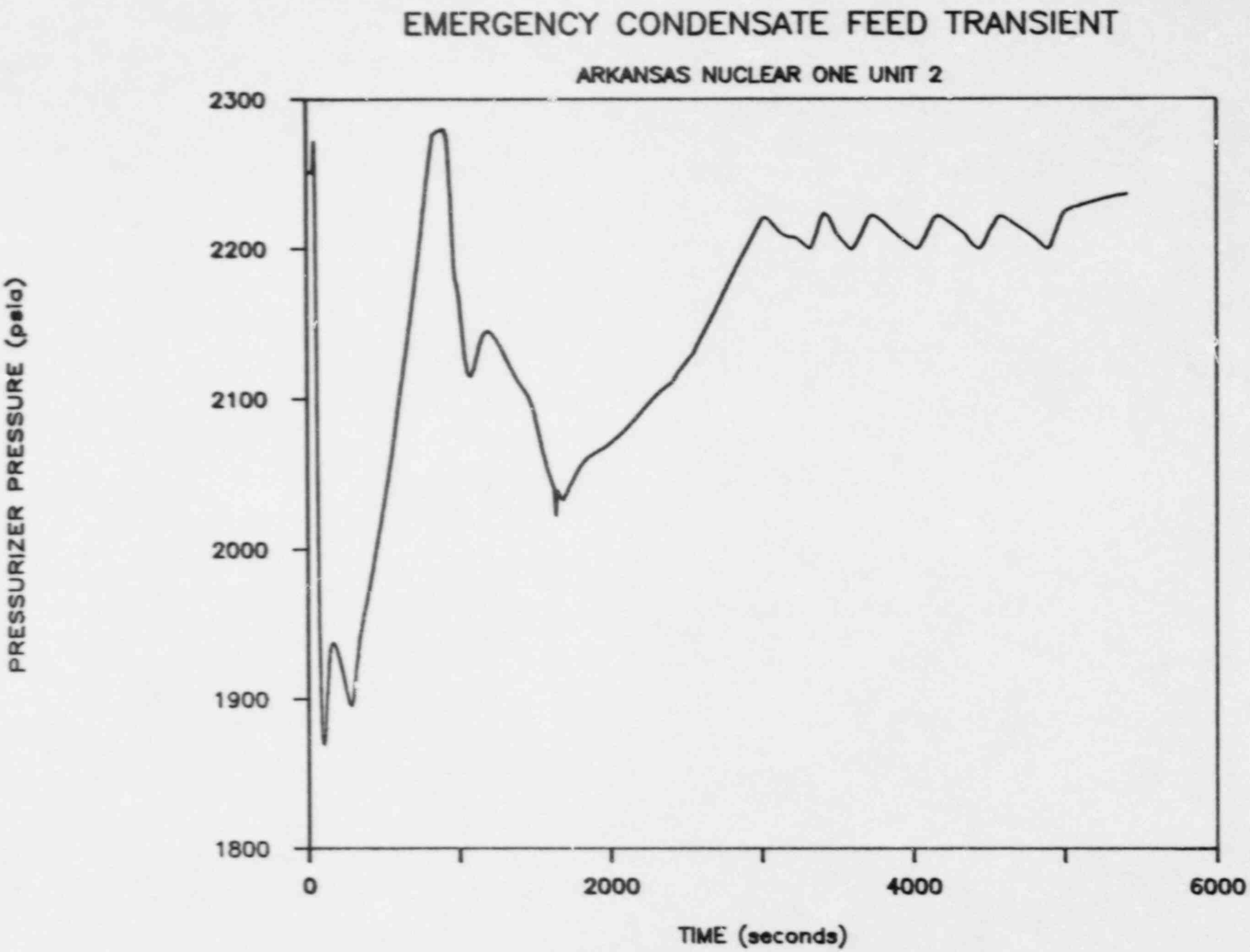

Figure 5 - Pressurizer Pressure vs. Time

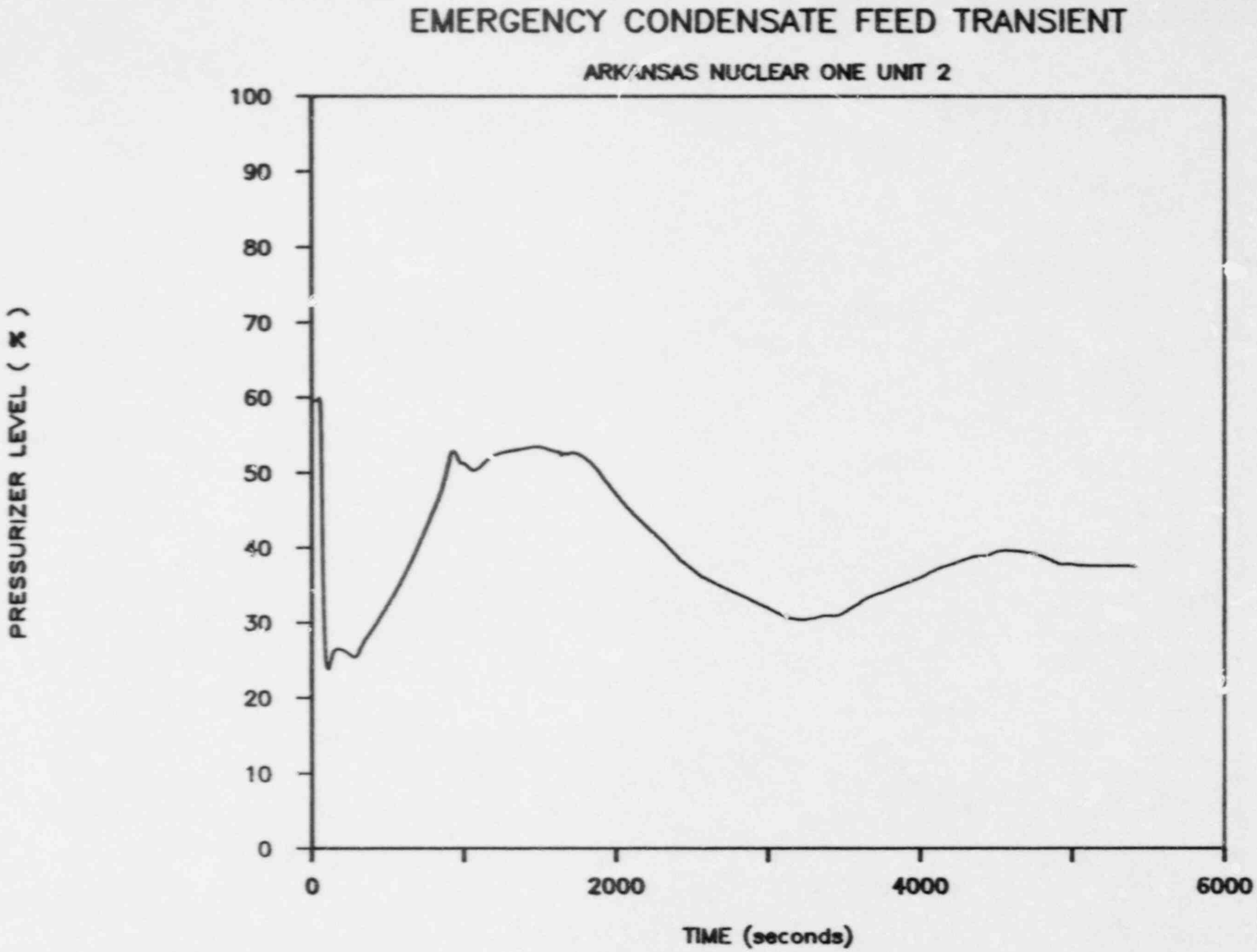

Figure 6 - Pressurizer Level vs. Time

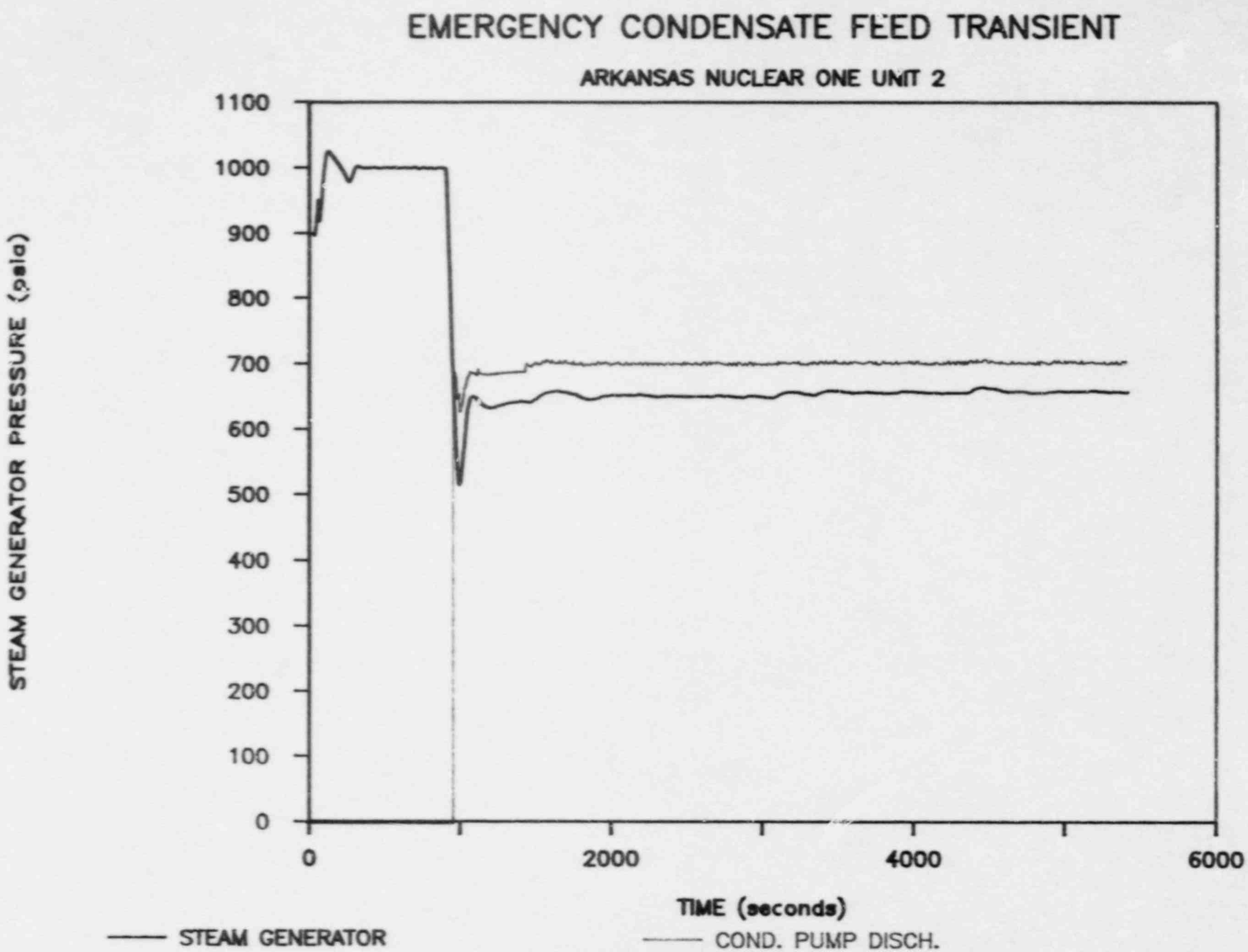

Figure 7 - Average Steam Generator Related Pressures vs. Time

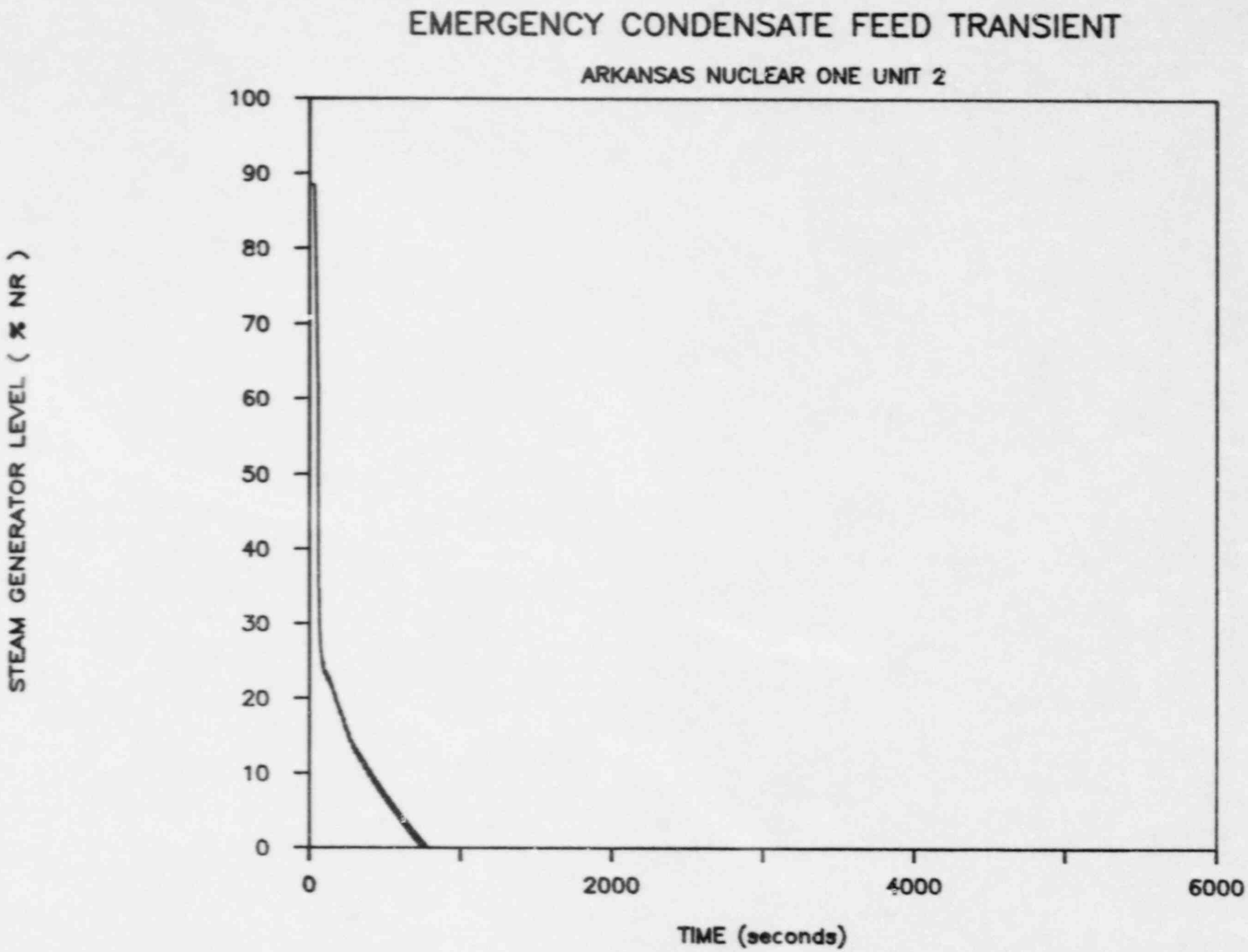

Figure 8 - Average Steam Generator Level vs. Time

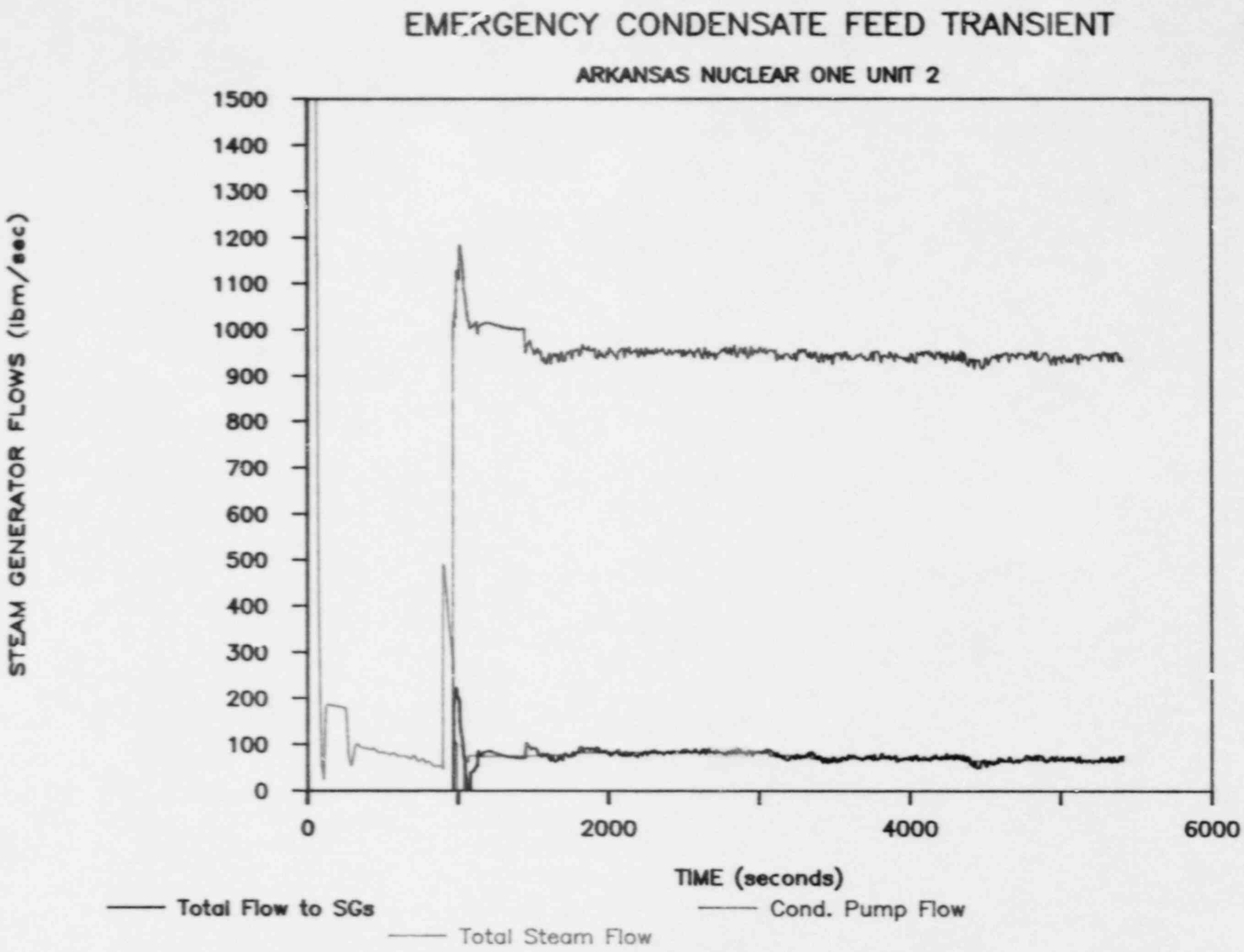

Figure 9 - Steam Generator Related Flows vs. Time

PROBABILISTIC EVALUATION RESULTS

Fault tree analysis of the ANO-2 EFWS and the MFW and Condensate systems has been performed to determine the unavailability of these systems to perform the decay heat removal function on demand. System unavailability was defined as failure to provide rated EFW flow from at least one EFW or condensate pump to at least one SG for an eight hour mission time. This is the primary function of the EFWS and a secondary function for the MFW and condensate system.

The analysis was performed using data and methodology provided by the NRC in NUREG-0611, NUREG-0635 and NUREG/CR-3529; modeling the MFW and condensate feed trains as a manually actuated alternate source of EFW. The operator action required to provide this alternate feedwater source was outlined on Page 9. NUREG-0611 and NUREG-0635 assign an overall estimate for the failure of "non-dedicated" control room operators to actuate the EFWS as 5x10-2 failures/demand for actuation within 5 minutes after demand and 5x10-3 failures/demand for actuation within 15 minutes after demand. These estimates were assumed to be applicable to the use of the condensate pump as described above with the depressurization of the SG and the valve line-up being considered as two separate operator actions.

The recent fault tree analysis, along with previous NRC analysis, utilized the conservative generic assumptions that the probability of the EFWS failing upon demand ranges between 5x10-4 and 1x10-3 failures/demand, depending upon modeling assumptions and detail. The use of the condensate pumps as an additional source of EFW has also been analyzed using fault tree modeling. The analysis indicates that operator error dominates the failure combinations, with estimates for the failure of operators to successfully provide feedwater using the condensate pumps ranging from 1x10-1 to 1x10-2 failures/demand. Since the use of the condensate pump provides an alternate feedwater source for credible failure combinations in the EFWS, the two system unavailabilities can simply be multiplied together to give a combined unavailability. The resulting probability that the EFWS and a condensate pump fail to provide feedwater to at least one SG ranges from 1x10-4 to 5x10-6 failures/demand. This falls within the SRP target range of 1x10-4 to 1x10-5 failures/demand, and therefore indicates that the use of a condensate pump is an adequate compensating factor to accomplish the safety function of the EFWS. The feedwater unavailability ranges are summarized in Table 4.

The NRC letter dated June 14, 1988 (2CNAØ688Ø1) reporting the EFWS review team's findings states that the staff estimates the risk to the public as a result of total loss of main feedwater and auxiliary feedwater systems to be 1480 person-rems. The basis for this estimate is unknown but apparently does not account for the contribution of recovery via condensate pump feeding (a common over-conservative assumption). When the contribution of condensate pump feeding is combined with the review team's estimate for a total loss of feedwater, it has been shown that the unavailability and corresponding public risk estimates are reduced by at least a factor of ten. Therefore the risk to the public as a result of a total loss of main and auxiliary feedwater systems when condensate pump feeding is adequately credited is conservatively estimated to be 148 person-rems. As a result, the maximum reasonably achievable risk reduction by EFWS related enhancements is estimated to be 147 person-rems. Although this reduction represents a benefit (potential

$147,000 savings), it is not considered significant relative to the $1.5 to $2 million required to achieve this reduction through the addition of a third auxiliary feedwater pump or a crossconnect between the ANO-1 and 2 EFW systems.

The conservativeness of the review team's cost benefit conclusions can be put into perspective by considering the results from a recent value-impact analysis of possible modifications at ANO-1 (NUREG/CR-4713, "Shutdown Decay Heat Removal Analysis of a B&W PWR). Detailed event tree/fault tree analysis was used to determine the averted offsite and onsite dose resulting from several plant enhancements, one of which was the upgrading of the auxiliary feedwater (AFW) pump to include a Class 1E power source and a direct connection to the "Q" condensate storage tank (CST). Since the "base case" model did not credit the use of the AFW pump as currently configured, this enhancement can be considered essentially equivalent to the addition of a third safety grade pump (the only deviation from safety grade status would be seismic qualification). The total averted dose (offsite and onsite) based on the availability of this pump and the following additional modifications:

- installation of a turbine driven generator to provide vital AC and DC power
- installation of a third low pressure injection (LPI) pump
- addition of a parallel borated water storage tank (BWST) discharge valve
- addition of braces to the BWST and CST
- installation of additional anchorages for several buses
- installation of a redundant fire deluge valve in the cable spreading room
- installation of additional supports for the EDG exhaust lines

was only estimated to be 303 person-rems. Therefore the averted dose due to the addition of an AFW pump only must be considerably less than 303 person-rems. It should be noted that the significantly longer time to steam generator dryout following a loss of all feedwater at ANO-2 compared to ANO-1 should make this a conservative assumption.

CONCLUSION

The use of a condensate pump to provide an additional source of feedwater to at least one SG following a loss of all feedwater has been demonstrated to be both operationally and probabilistically feasible. The use of condensate pumps as a means of accomplishing the safety function of the EFWS is therefore an adequate compensatory factor to justify an EFWS unavailability greater than the SRP goal of 1x10-4 to 1x10-5 failures/demand. Further reductions in the EFWS unavailability do not appear to be warranted by cost-benefit considerations.

TABLE 4

LOFW UNAVAILABILITY DATA

	Non-recoverable LOFW with no credit for condensate feeding	Non-recoverable LOFW with credit for condensate feeding	SRP (10.4.9) Goal
Unavailability (failures/demand)	1x10-3 to 5x10-4	1x10-4 to 5x10-6	1x10-4 to 1x10-5
Public Risk (person-rems)	1480 to 740	148 to 7.4	N/A
Potential Liability	$1,480,000 to $740,000	$148,000 to $7,400	N/A