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ACCESSION NBR:9010240185 DOC.DATE: 90/10/15 NOTARIZED: NO DOCKET #
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AUTH.NAME AUTHOR AFFILIATION
LOWERY,H.R. Duke Power Co.
BARRON,H.B. Duke Power Co.
RECIP.NAME RECIPIENT AFFILIATION

SUBJECT: LER 90-001-00:on 900913,manual reactor trip while subcritical after 2A feedwater pump trip.

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	RGN2 FILE 01	1	1			
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	NRC PDR	1	1	NSIC MAYS,G	1	1
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Seneca, S.C. 29679

(803) 882-5363

DUKE POWER

October 15, 1990

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
LER 270/90-01

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report (LER) 270/90-01 concerning manual reactor trip while subcritical after 2A feedwater pump trip due to equipment malfunction.

This report is being submitted in accordance with 10 CFR 50.73 (a)(2)(iv). This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

H. B. Barron
Station Manager

RSM/ftr

Attachment

xc: Mr. S. D. Ebneter
Regional Administrator, Region II
U.S. Nuclear Regulatory Commission
101 Marietta St., NW, Suite 2900
Atlanta, Georgia 30323

Mr. L. A. Weins
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Mr. P. H. Skinner
NRC Resident Inspector
Oconee Nuclear Station

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NRC FORM 366 (6-89)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO. 3150-0104
EXPIRES: 4/30/92

ESTIMATED BURDEN PER RESPONSE TO COMPLY WTH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Oconee Nuclear Station, Unit 2	0 5 0 0 0 2 7 0	1 OF 1 1

TITLE (4) Manual Reactor Trip While Subcritical After 2A Feedwater Pump Trip Due to Equipment Malfunction

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
										0 5 0 0 0
0 9	1 3	9 0	9 0	0 0 1	0 0	1 0	1 5	9 0		0 5 0 0 0

OPERATING MODE (9)	POWER LEVEL (10)	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
N	- 0 -	20.402(b)	20.405(c)	X 50.73(a)(2)(iv)	73.71(b)
		20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	X OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	50.72(b)(2)(ii)
		20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
Henry R. Lowery, Chairman Oconee Safety Review Group	AREA CODE 8 0 3 8 8 5 - 3 0 3 4

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CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	
X	S J	T U R B	G 0 8 0	Y							

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

ABSTRACT

On September 13, 1990, at 0244 hours, with Unit 2 subcritical and Group 1 control rods positioned at 50% withdrawn, the Reactor was manually tripped in accordance with the Operations Management Procedure when the only operating main feedwater pump turbine (FWPT), 2A FWPT, tripped. Unit 2 was in the process of being shut down in preparation for a refueling outage. Emergency Feedwater (EFDW) was manually initiated after the 2A FWPT tripped because its automatic actuation had been previously bypassed by the shutdown procedure. EFDW performed as expected and cooldown was maintained within limits. The Reactor Coolant System (RCS) was at approximately 490 degrees Fahrenheit and 2150 psig prior to the event. EFDW was secured 47 minutes later with the Condensate Booster Pump feeding the Steam Generators and the RCS was at approximately 465 degrees Fahrenheit and 1950 psig. The Root Cause is Equipment Malfunction.

BACKGROUND

The Feedwater (FDW)[EIIS:SJ] system contains two turbine-driven FDW pumps (FDWP)[EIIS:P] to increase FDW pressure to be sufficient to enter the Steam Generators (SGs)[EIIS:AE]. By varying the speed, the FDWP will produce the required amount of flow to the SGs. FDWP turbine (FWPT)[EIIS:TRB] speed is controlled by two means from the Control Room [EIIS:NA]. The Motor Speed Changer (MSC)[EIIS:JK] is normally used by the operator to control the FWPT speed on startup or shutdown from 0 RPM to approximately 2800 RPM. The Motor Gear Unit (MGU) controls the speed from approximately 2800 RPM to the speed required for plant conditions. The High Speed Stop for both the MSC and the MGU is set at 5000 RPM. FWPT speed is controlled by the controller that has the most restrictive control (lowest speed setting). The FWPT speed is normally controlled automatically by the Integrated Control System (ICS)[EIIS:JA] but may be controlled manually by the operator using the MGU from the Control Room. The MGU Low Speed Stop is set at 2800 RPM because this is the lowest speed that the auto circuit of the ICS can provide control without producing large FDW swings. FWPT speed control is supported by two of three FWPT oil systems.

The FWPT oil systems includes the:

1) Lubricating Oil System (Bearing Oil) which provides oil to the turbine and pump bearings to prevent damaging the bearings.

2) Control Oil System which supplies oil to position the speed setting devices in response to the MSC and the MGU.

3) Hydraulic Oil System which supplies oil to open the High Pressure and Low Pressure Stop Valves and to operate the Control Valves.

The FWPT oil systems are supported by the following oil pumps:

1) Shaft-Driven Oil Pump provides oil for the Control Oil System, Bearing Oil System and the Hydraulic Oil System.

2) AC motor-driven Auxiliary Oil Pump (AOP) also supplies oil for all three oil systems. It has an auto-start feature that when Control Oil pressure drops to <43 psig, the AOP will start and run until stopped by the operator.

3) DC motor-driven Emergency Bearing Oil Pump (EBOP) only supplies oil to the Bearing Oil header. It has an auto-start feature that when Control Oil header pressure drops to <36 psig, the EBOP will start and run until stopped by the operator.

EVENT DESCRIPTION

On September 12, 1990, at 1945 hours, Operations Shift personnel commenced a Unit 2 shutdown in preparation for a refueling outage. The 2B Feedwater Pump Turbine (FWPT) was secured at 2206 hours in accordance with the procedures. Unit 2 was brought to hot shutdown conditions; reactor [EIIS:AC] subcritical by at least 1% dk/k, with all control rods [EIIS:ROD] inserted to Group 1 Control Rods at 50% withdrawn to provide app. 0.5% dk/k for negative reactivity insertion, and Tave at approximately 532 degrees Fahrenheit.

As cooldown continued and the Steam Generator (SG) pressure approached 800 psig, the Motor Gear Unit for the 2A FWPT had automatically run back to its Low Speed Stop as expected (FWPT speed <3000 RPM). The differential pressure (dP) across the Feedwater (FDW) Control Valves [EIIS:V], normally automatically controlled at 35 psig by the Integrated Control System (ICS), was off scale high. Therefore, to control the dP within its normal range, Control Room Operator A (CRO A) placed the ICS FWPT A control of the Motor Gear Unit in "MANUAL" in preparation for further FWPT speed reduction using the Motor Speed Changer.

CRO A then placed the controls for the Emergency FDW Pumps in "MANUAL" in accordance with the procedure to prevent an automatic initiation of Emergency FDW.

CRO A operated the Motor Speed Changer to further lower the speed of the 2A FWPT. The first indication was that the Motor Speed Changer came off the High Speed Stop (previously set at 5000 RPM). The Motor Speed Changer was held in the "speed-lower" position a number of times, for about 1 second each time. The goal was to obtain control of the FWPT speed and thereby decrease the dP across the FDW control valves to approximately 35 psig. The Motor Speed Changer had to move from the High Speed Stop to the current speed setting (approximately 2600 RPM) before it could take control. Therefore, CRO A did not expect the Motor Speed Changer adjustment to effect the FWPT speed immediately.

According to CRO A, the 2A FWPT was at approximately 2600 RPM by the indication on the Control Room Front Board gage prior to the 2A FWPT trip. CRO A had positioned the Motor Speed Changer in the "speed-lowering"

direction several times and was concerned that the speed did not decrease after a few pulses of the Motor Speed Changer. This concern was discussed with Control Room Operator B.

After approximately 1.5 minutes, the Feedwater Pump low discharge header pressure alarm actuated and the Low Pressure Governor (LP GOV) valve indicated closed (2:44:48). The LP GOV valve reopened 2 seconds later. The 2A FWPT tripped several seconds later (2:44:53). The Reactor Coolant System (RCS)[EIIS:AB] was at approximately 2100 psig and 490 degrees Fahrenheit. CRO A reported that he did not observe any indication of a FWPT speed decrease prior to the trip.

Upon the 2A FWPT trip, Control Oil Pressure decreased (Att. #1) below the pressure required to automatically start both the Auxiliary Oil Pump (AOP) and the Emergency Bearing Oil Pump (EBOP). The control oil pressure recovered immediately upon the start of the AOP. Five seconds after the trip, a pressure switch alarm indicated that the EBOP started.

Within 15 seconds of the 2A FWPT trip, CRO A manually initiated Emergency FDW by starting Motor-Driven Emergency FDW Pumps A & B in accordance with AP/2/A/1700/19 (LOSS OF FEEDWATER). SG levels increased slightly and were then maintained at a normal level. Emergency FDW flow was controlled automatically at 30 inches with 2FDW-315 and 2FDW-316 (Steam Generator Emergency FDW Control Valves).

There was a question amongst the Unit 2 Operations Shift whether there was a need to manually trip the reactor or not. CRO A did not see the need for this action since the reactor was already below "hot shutdown" with a Shutdown Margin maintained greater than 1% dk/k. However, the Operations Management Procedure required operators to manually trip the reactor on a loss of both FWPTs. After CRO A stabilized the Emergency FDW flow to the SG, he asked the Control Room Senior Reactor Operator about the requirement to trip the reactor. The Control Room Senior Reactor Operator was not sure about the requirement's applicability to this situation and contacted the Unit 2 Shift Supervisor. The Unit 2 Shift Supervisor directed the Control Room Senior Reactor Operator to enter the Emergency Operating Procedure (EOP) and trip the reactor. Approximately 2 minutes after the 2A FWPT trip, CRO A manually tripped the reactor causing Group 1 control rods to drop into the core (2:47:01). The EOP Subsequent Actions were followed and completed without encountering any problems.

The Operations Unit 2 Shift personnel, prior to restarting the 2A FWPT, investigated the cause of the 2A FWPT trip. They noted the dip in control oil pressure on the strip chart and that both the auxiliary oil pump and

the emergency bearing oil pump had started. The control oil pressure had recovered due to the operation of the auxiliary oil pump. An attempt was made to restart the FWPT, but before it could be restarted, the SG pressure had decreased to the point that the Condensate Booster Pump's (CBP) dP was sufficient to feed the SGs. AP/2/A/1700/19 did not provide specific directions for securing Emergency FDW when feedwater was available from the CBP. Therefore, there was some discussion about meeting the intent of the Abnormal Procedure steps concerning the regaining of feedwater flow from a FWPT. At 0331 hours, after an agreement between the Unit 2 Operations personnel that regaining feedwater from the CBP met the intent of regaining feedwater flow from a FWPT, both MDEFWPs were secured in accordance with AP/2/A/1700/19. The RCS was at approximately 465 degrees Fahrenheit and 1950 psig. The Operations Shift personnel continued with the Unit 2 shutdown in accordance with Step 2.3 of Enclosure 4.2, OP/2/A/1102/10 (CONTROLLING PROCEDURE FOR UNIT SHUTDOWN).

Upon further investigation of the 2A FWPT trip, the Operations Shift Personnel noted that the only alarms indicated on the Alarm typer or the Event typer that were associated with the FWPT trip were the following:

D1972 FWPT A TRIP (Alarm typer),

D1975 FWPT A SV TRIP (Alarm typer), and

#291 FWPT 2A TRIP (Event typer).

These alarms are indications of low hydraulic oil pressure and are normally received when the High Pressure and Low Pressure Stop Valves trip shut. Work request #29949c was written to investigate & repair Aux Oil Pump &/or Emergency BRG Oil Pump. However, Maintenance Engineering had planned to perform Preventative Maintenance (PM) on the 2A FWPT Hydraulic and Control Oil System during the outage and decided to investigate the cause of the 2A FWPT trip using the PM work request, #57272E.

CONCLUSIONS

An investigation of the Control Oil Pressure strip chart indicates that the pressure control for 2A FWPT had been erratic prior to this event (Att. #1). The 2A FWPT control oil pressure, rather than a steady pressure decrease, decreased in step increments.

The Maintenance Group performed Work Request (WR) #57272E, Preventive Maintenance (PM) of the Hydraulic and Control Oil Systems with the assistance of a Vendor Technical Representative (VTR) in overseeing the disassembly and inspection of the FWPT oil systems.

According to the VTR, the inadequate response of the FWPT speed to a "speed-lowering" signal from the Motor Speed Changer is usually a result of binding or restrictions in the governor control system. After several pulses of the Motor Speed Changer in the "speed-lower" direction, the closing force overcame the restriction (i.e., friction) and signaled the Low Pressure Governor valve to close. Because 2A FWPT was operating near the Motor Gear Unit Low Speed Stop, the signal demand when the restriction was overcome called for an abnormally closed valve position. The control oil system reopened the control valve 2 seconds later. The FWPT speed was already low, therefore the shaft-driven oil pump had low output capability and the auxiliary oil pump (AOP) started. Though there is no direct evidence, it is believed that this situation led to the erratic control oil pressure indication and the subsequent 2A FWPT trip. The Alarm Typer indicates that the AOP started at the same time the FWPT Stop Valves closed.

The findings of the PM indicated that two problems appear to be the cause for the FDWPT response during the event:

1) Excessive friction or clearance in the control linkage system resulted in the failure of the Motor Speed Changer to change FWPT speed. Several linkages and a hydraulic piston were found to be out-of-design tolerances.

2) Lack of cleanliness of the oil system could also contribute the failure of the FWPT speed to change. The inlet strainers to the pressure regulating valves for the bearing oil header and control oil systems were found to be severely plugged with lint and debris. Debris in the oil could lead to erratic control.

The Root Cause for this event is classified Equipment Malfunction due to the problems discovered during the PM of the Hydraulic and Control Oil System.

Every refueling outage, Maintenance performs a PM on the Main Feedwater Pump Turbine Hydraulic and Control Oil System. An investigation of work performed per this PM over the past two outages indicates that work performed from outage to outage was not consistent and was more than was called for per the WR job sequence description. The Maintenance personnel perform the PM with the use of a technical manual. The use of the WR and

the technical manual do not seem to be adequate to provide specific directions for PM or accountability that the FWPT Hydraulic and Control Oil System is properly inspected. A written procedure, though not required by Station Directives, could greatly enhance the FWPT PM program. Maintenance will incorporate into an existing procedure the steps taken at present to ensure reliability of the FWPT Hydraulic and Control System.

Another PM is performed each outage to lubricate the control linkage per Standing WR #57729E. No problems were detected during the last performance of this PM, 6/13/89.

In addition to the above PMs, Maintenance performs MP/0/B/1320/02 (TURBINE-FEEDWATER-OVERSPEED AND LUBRICATION SYSTEMS-OPERATIONAL TEST) on 2A FWPT each outage to verify the proper setup of the oil pressure regulators and operation of the overspeed trip. A test to ensure the correct operation of the oil systems on FWPT speed changes is not included in the test procedure. Maintenance will evaluate the existing testing method to ensure that the Hydraulic and Control Oil System will respond properly upon FWPT speed changes.

The FWPTs have a history of problems concerning controls sticking and moving erratically. To correct these problems Station Problem Report #2001 was written on 7/6/87. The approved resolution, Nuclear Station Modification #2796, will "Modify the existing system by providing a filtration system that can remove water and particulates." An extensive lube oil system cleaning program has been implemented as a result of the debris discovered in the oil of Unit 1's FWPTs during the 1990 Unit 1 Outage and will be used on Unit 2's FWPTs this outage .

It has been the practice of Operations to verify that the AOP starts automatically as control oil pressure decreases to 43 psig during the shutdown of a FWPT. The FWPT oil system pressure regulators receive a final setup when the FWPT is operating at 3800 RPM in accordance with MP/0/B/1320/02. During this event, 2A FWPT was operating at 2600 RPM. If an AOP is started prior to decreasing speed below 3800 RPM it would provide a more adequate source of control oil than the shaft-driven oil pump when the FWPT is operating at lower speeds. Operations will correct this problem by providing a step in power reduction procedure to start an AOP prior to reducing reactor power below 15%.

During this event the Operations Shift personnel on Unit 2 questioned whether the trip of the reactor was required upon loss of the FWPT and with the Reactor subcritical. Operations Management Procedure (OMP) 2-1 states, "If both FWPTs trip, then manually trip the reactor." The Operations personnel have been trained that the purpose of this action is

to ensure that the reactor is not critical upon the initiation of Emergency Feedwater to the Steam Generators. Operations will determine if a reactor trip is only required when the reactor is critical. A document change will be made to reflect their decision and training will be provided to licensed personnel.

Use of the Emergency Operating Procedure is appropriate when the reactor is manually tripped because it provides the operators with conservative actions to ensure that the reactor is placed and maintained in a safe condition.

The equipment malfunction involved in this event is NPRDS reportable. The equipment is a General Electric Steam Turbine Boiler Feed Pump Drive, manufacturer model number 7TDRV631R31. A review of the events occurring during the past 24 months reveal that this event is nonrecurring. The health and safety of the public were not compromised at a result of this event. There were no radioactive releases, radiation exposures or personnel injuries resulting from this event.

CORRECTIVE ACTIONS

Immediate

1) Control Room Operator A manually started both Motor Driven Emergency Feedwater Pumps in accordance with the Loss of Main Feedwater Abnormal Procedure.

2) Control Room Operator A manually tripped the Reactor.

3) Operations Shift personnel performed Immediate Manual Actions in accordance with the Emergency Operating Procedures.

Subsequent

1) Operations Shift personnel performed Subsequent Action in accordance with the Emergency Operating Procedures.

2) Operations Unit 2 Shift Supervisor wrote Work Request #29949C to investigate Auxiliary Oil Pump.

3) Maintenance personnel performed preventive maintenance performed on 2A FWPT per work request 57272E. The problems concerning out-of-design tolerance linkages and hydraulic piston were either corrected or the components were replaced. Instrument and Electrical personnel checked the calibration and proper activation of all associated pressure switches using procedure IP/0/B/0270/005B-1 (FWPT INSTRUMENTATION BEARING TEMPERATURE AND OIL SYSTEM).

Planned

1) Maintenance will evaluate the existing testing method in MP/0/B/1320/02 to ensure that the Hydraulic and Control Oil System will respond properly upon Feedwater Pump Turbine speed changes.

2) Maintenance will incorporate into an existing procedure, MP/0/B/1320/003 (TURBINE-FEEDWATER-DISASSEMBLY-INSPECTION -REASSEMBLY), the steps taken at the present to ensure reliability of the FWPT Hydraulic and Control Oil System.

3) Operations will determine the required action concerning tripping the Reactor upon the loss of FDW when the Reactor is subcritical. Make the necessary changes to the affected documents and provide training to Licensed personnel.

4) Nuclear Station Modification 2796 will be implemented to assist in maintaining oil cleanliness.

5) Operations will add a step to OP/1,2,3/A/1102/04, Enclosure 4.3, that would require starting the Auxiliary Oil Pump on the operating FWPT prior to completing the procedure.

6) An extensive lube oil system cleaning will be performed on the Unit 2 FWPTs during this outage per TM/2/B/1320/001 (TRANSFER OIL FROM RESERVOIR TO THE LUBE OIL STORAGE TANK AND BACK TO THE RESERVOIR).

SAFETY ANALYSIS

At the initiation of the transient, the Reactor Coolant system was at 490 degrees Fahrenheit and 2150 psig. The reactor was subcritical, shutdown margin maintained greater than 1% dk/k, and the control rods had been inserted to Group 1 at 50% to provide 0.5% dk/k for negative reactivity

insertion. The cooldown limit was to be maintained in accordance with OP/2/A1102/10; <45 degrees Fahrenheit per any 1/2 hour period while Tc was > 280 F.

Within 15 seconds of the loss of the 2A Feedwater Pump Turbine (FWPT), the Control Room Operator manually started the Motor-Driven Emergency Feedwater Pumps (MDEFWP). The Emergency Feedwater system (EFW) 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. Total rated capacity is 1780 GPM. The limiting transient requiring maximum EFDW flow is a loss of main feedwater with offsite power available. For this transient, a minimum EFDW flow rate equivalent to 405 GPM at 1050 psig is adequate. Each of the three EFDW pumps is capable of delivering 500 GPM. Therefore the capability of the EFDW was more than adequate to mitigate the effects of this event, loss of feedwater with the reactor below hot shutdown.

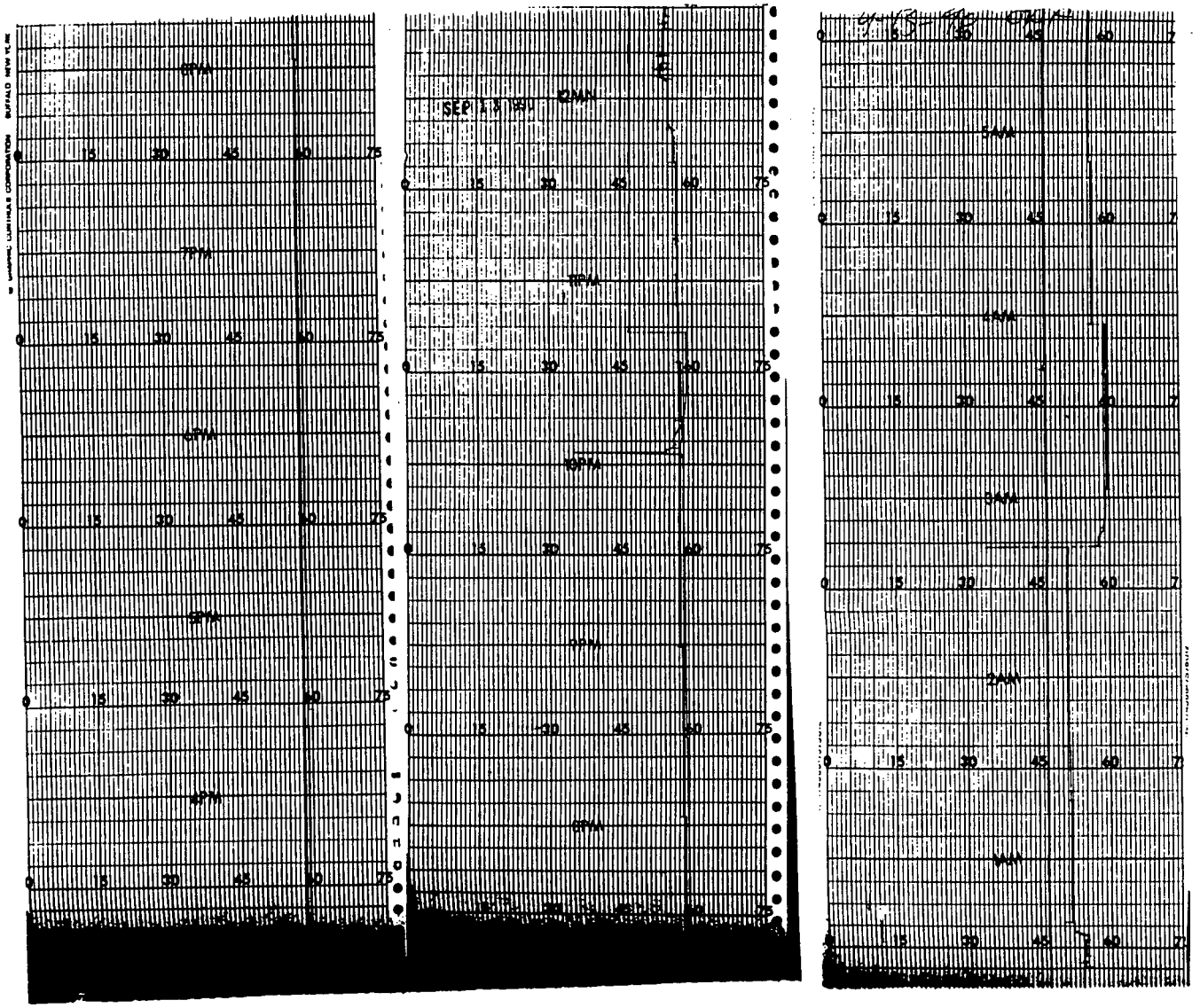
SG level was controlled automatically at 30 inches. If an overcooling event occurred, the Emergency Operating Procedure directed the operator to throttle Emergency FDW flow to maintain the Reactor Coolant System cold leg temperature constant.

Within 47 minutes of the 2A FWPT trip, the SGs pressure had decreased enough to allow the condensate booster pump to supply feedwater and the MDEFWPs were secured. The RCS temperature had decreased approximately 25 degrees Fahrenheit during this time period which is within the cooldown limits of Enclosure 4.5 (RCS COOLDOWN LIMITATIONS), OP/2/A/1102/10.

The health and the safety of the public were not compromised as a result of this event. There were no personnel injuries, no releases of radioactive materials, or excessive exposures associated with this event.

ATTACHMENT 1

CONTROL OIL PRESSURE



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LOWERY,H.R. Duke Power Co.
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Duke Power Company
Oconee Nuclear Station
P.O. Box 1439
Seneca, S.C. 29679

(803) 882-5363

DUKE POWER

October 15, 1990

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
LER 270/90-01

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report (LER) 270/90-01 concerning manual reactor trip while subcritical after 2A feedwater pump trip due to equipment malfunction.

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Very truly yours,

H. B. Barron
Station Manager

RSM/ftr

Attachment

xc: Mr. S. D. Ebneter
Regional Administrator, Region II
U.S. Nuclear Regulatory Commission
101 Marietta St., NW, Suite 2900
Atlanta, Georgia 30323

Mr. L. A. Weins
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Mr. P. H. Skinner
NRC Resident Inspector
Oconee Nuclear Station

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NRC FORM 366 (6-89)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO. 3150-0104
EXPIRES: 4/30/92

ESTIMATED BURDEN PER RESPONSE TO COMPLY WTH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Oconee Nuclear Station, Unit 2	0 5 0 0 0 2 7 0	1 OF 1 1

TITLE (4) Manual Reactor Trip While Subcritical After 2A Feedwater Pump Trip Due to Equipment Malfunction

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
										0 5 0 0 0
0 9	1 3	9 0	9 0	0 0 1	0 0	1 0	1 5	9 0		0 5 0 0 0

OPERATING MODE (9)		THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
N		20.402(b)	20.405(c)	X 50.73(a)(2)(iv)	73.71(b)
POWER LEVEL (10)		20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
- 0 -		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	X OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	50.72(b)(2)(ii)
		20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
Henry R. Lowery, Chairman Oconee Safety Review Group	AREA CODE 8 0 3 8 8 5 - 3 0 3 4

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	
X	S J	T U R B	G 0 8 0	Y							

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

ABSTRACT

On September 13, 1990, at 0244 hours, with Unit 2 subcritical and Group 1 control rods positioned at 50% withdrawn, the Reactor was manually tripped in accordance with the Operations Management Procedure when the only operating main feedwater pump turbine (FWPT), 2A FWPT, tripped. Unit 2 was in the process of being shut down in preparation for a refueling outage. Emergency Feedwater (EFDW) was manually initiated after the 2A FWPT tripped because its automatic actuation had been previously bypassed by the shutdown procedure. EFDW performed as expected and cooldown was maintained within limits. The Reactor Coolant System (RCS) was at approximately 490 degrees Fahrenheit and 2150 psig prior to the event. EFDW was secured 47 minutes later with the Condensate Booster Pump feeding the Steam Generators and the RCS was at approximately 465 degrees Fahrenheit and 1950 psig. The Root Cause is Equipment Malfunction.

BACKGROUND

The Feedwater (FDW)[EIIS:SJ] system contains two turbine-driven FDW pumps (FDWP)[EIIS:P] to increase FDW pressure to be sufficient to enter the Steam Generators (SGs)[EIIS:AE]. By varying the speed, the FDWP will produce the required amount of flow to the SGs. FDWP turbine (FWPT)[EIIS:TRB] speed is controlled by two means from the Control Room [EIIS:NA]. The Motor Speed Changer (MSC)[EIIS:JK] is normally used by the operator to control the FWPT speed on startup or shutdown from 0 RPM to approximately 2800 RPM. The Motor Gear Unit (MGU) controls the speed from approximately 2800 RPM to the speed required for plant conditions. The High Speed Stop for both the MSC and the MGU is set at 5000 RPM. FWPT speed is controlled by the controller that has the most restrictive control (lowest speed setting). The FWPT speed is normally controlled automatically by the Integrated Control System (ICS)[EIIS:JA] but may be controlled manually by the operator using the MGU from the Control Room. The MGU Low Speed Stop is set at 2800 RPM because this is the lowest speed that the auto circuit of the ICS can provide control without producing large FDW swings. FWPT speed control is supported by two of three FWPT oil systems.

The FWPT oil systems includes the:

1) Lubricating Oil System (Bearing Oil) which provides oil to the turbine and pump bearings to prevent damaging the bearings.

2) Control Oil System which supplies oil to position the speed setting devices in response to the MSC and the MGU.

3) Hydraulic Oil System which supplies oil to open the High Pressure and Low Pressure Stop Valves and to operate the Control Valves.

The FWPT oil systems are supported by the following oil pumps:

1) Shaft-Driven Oil Pump provides oil for the Control Oil System, Bearing Oil System and the Hydraulic Oil System.

2) AC motor-driven Auxiliary Oil Pump (AOP) also supplies oil for all three oil systems. It has an auto-start feature that when Control Oil pressure drops to <43 psig, the AOP will start and run until stopped by the operator.

3) DC motor-driven Emergency Bearing Oil Pump (EBOP) only supplies oil to the Bearing Oil header. It has an auto-start feature that when Control Oil header pressure drops to <36 psig, the EBOP will start and run until stopped by the operator.

EVENT DESCRIPTION

On September 12, 1990, at 1945 hours, Operations Shift personnel commenced a Unit 2 shutdown in preparation for a refueling outage. The 2B Feedwater Pump Turbine (FWPT) was secured at 2206 hours in accordance with the procedures. Unit 2 was brought to hot shutdown conditions; reactor [EIIS:AC] subcritical by at least 1% dk/k, with all control rods [EIIS:ROD] inserted to Group 1 Control Rods at 50% withdrawn to provide app. 0.5% dk/k for negative reactivity insertion, and Tave at approximately 532 degrees Fahrenheit.

As cooldown continued and the Steam Generator (SG) pressure approached 800 psig, the Motor Gear Unit for the 2A FWPT had automatically run back to its Low Speed Stop as expected (FWPT speed <3000 RPM). The differential pressure (dP) across the Feedwater (FDW) Control Valves [EIIS:V], normally automatically controlled at 35 psig by the Integrated Control System (ICS), was off scale high. Therefore, to control the dP within its normal range, Control Room Operator A (CRO A) placed the ICS FWPT A control of the Motor Gear Unit in "MANUAL" in preparation for further FWPT speed reduction using the Motor Speed Changer.

CRO A then placed the controls for the Emergency FDW Pumps in "MANUAL" in accordance with the procedure to prevent an automatic initiation of Emergency FDW.

CRO A operated the Motor Speed Changer to further lower the speed of the 2A FWPT. The first indication was that the Motor Speed Changer came off the High Speed Stop (previously set at 5000 RPM). The Motor Speed Changer was held in the "speed-lower" position a number of times, for about 1 second each time. The goal was to obtain control of the FWPT speed and thereby decrease the dP across the FDW control valves to approximately 35 psig. The Motor Speed Changer had to move from the High Speed Stop to the current speed setting (approximately 2600 RPM) before it could take control. Therefore, CRO A did not expect the Motor Speed Changer adjustment to effect the FWPT speed immediately.

According to CRO A, the 2A FWPT was at approximately 2600 RPM by the indication on the Control Room Front Board gage prior to the 2A FWPT trip. CRO A had positioned the Motor Speed Changer in the "speed-lowering"

direction several times and was concerned that the speed did not decrease after a few pulses of the Motor Speed Changer. This concern was discussed with Control Room Operator B.

After approximately 1.5 minutes, the Feedwater Pump low discharge header pressure alarm actuated and the Low Pressure Governor (LP GOV) valve indicated closed (2:44:48). The LP GOV valve reopened 2 seconds later. The 2A FWPT tripped several seconds later (2:44:53). The Reactor Coolant System (RCS)[EIIS:AB] was at approximately 2100 psig and 490 degrees Fahrenheit. CRO A reported that he did not observe any indication of a FWPT speed decrease prior to the trip.

Upon the 2A FWPT trip, Control Oil Pressure decreased (Att. #1) below the pressure required to automatically start both the Auxiliary Oil Pump (AOP) and the Emergency Bearing Oil Pump (EBOP). The control oil pressure recovered immediately upon the start of the AOP. Five seconds after the trip, a pressure switch alarm indicated that the EBOP started.

Within 15 seconds of the 2A FWPT trip, CRO A manually initiated Emergency FDW by starting Motor-Driven Emergency FDW Pumps A & B in accordance with AP/2/A/1700/19 (LOSS OF FEEDWATER). SG levels increased slightly and were then maintained at a normal level. Emergency FDW flow was controlled automatically at 30 inches with 2FDW-315 and 2FDW-316 (Steam Generator Emergency FDW Control Valves).

There was a question amongst the Unit 2 Operations Shift whether there was a need to manually trip the reactor or not. CRO A did not see the need for this action since the reactor was already below "hot shutdown" with a Shutdown Margin maintained greater than 1% dk/k. However, the Operations Management Procedure required operators to manually trip the reactor on a loss of both FWPTs. After CRO A stabilized the Emergency FDW flow to the SG, he asked the Control Room Senior Reactor Operator about the requirement to trip the reactor. The Control Room Senior Reactor Operator was not sure about the requirement's applicability to this situation and contacted the Unit 2 Shift Supervisor. The Unit 2 Shift Supervisor directed the Control Room Senior Reactor Operator to enter the Emergency Operating Procedure (EOP) and trip the reactor. Approximately 2 minutes after the 2A FWPT trip, CRO A manually tripped the reactor causing Group 1 control rods to drop into the core (2:47:01). The EOP Subsequent Actions were followed and completed without encountering any problems.

The Operations Unit 2 Shift personnel, prior to restarting the 2A FWPT, investigated the cause of the 2A FWPT trip. They noted the dip in control oil pressure on the strip chart and that both the auxiliary oil pump and

the emergency bearing oil pump had started. The control oil pressure had recovered due to the operation of the auxiliary oil pump. An attempt was made to restart the FWPT, but before it could be restarted, the SG pressure had decreased to the point that the Condensate Booster Pump's (CBP) dP was sufficient to feed the SGs. AP/2/A/1700/19 did not provide specific directions for securing Emergency FDW when feedwater was available from the CBP. Therefore, there was some discussion about meeting the intent of the Abnormal Procedure steps concerning the regaining of feedwater flow from a FWPT. At 0331 hours, after an agreement between the Unit 2 Operations personnel that regaining feedwater from the CBP met the intent of regaining feedwater flow from a FWPT, both MDEFWPs were secured in accordance with AP/2/A/1700/19. The RCS was at approximately 465 degrees Fahrenheit and 1950 psig. The Operations Shift personnel continued with the Unit 2 shutdown in accordance with Step 2.3 of Enclosure 4.2, OP/2/A/1102/10 (CONTROLLING PROCEDURE FOR UNIT SHUTDOWN).

Upon further investigation of the 2A FWPT trip, the Operations Shift Personnel noted that the only alarms indicated on the Alarm typer or the Event typer that were associated with the FWPT trip were the following:

D1972 FWPT A TRIP (Alarm typer),

D1975 FWPT A SV TRIP (Alarm typer), and

#291 FWPT 2A TRIP (Event typer).

These alarms are indications of low hydraulic oil pressure and are normally received when the High Pressure and Low Pressure Stop Valves trip shut. Work request #29949c was written to investigate & repair Aux Oil Pump &/or Emergency BRG Oil Pump. However, Maintenance Engineering had planned to perform Preventative Maintenance (PM) on the 2A FWPT Hydraulic and Control Oil System during the outage and decided to investigate the cause of the 2A FWPT trip using the PM work request, #57272E.

CONCLUSIONS

An investigation of the Control Oil Pressure strip chart indicates that the pressure control for 2A FWPT had been erratic prior to this event (Att. #1). The 2A FWPT control oil pressure, rather than a steady pressure decrease, decreased in step increments.

The Maintenance Group performed Work Request (WR) #57272E, Preventive Maintenance (PM) of the Hydraulic and Control Oil Systems with the assistance of a Vendor Technical Representative (VTR) in overseeing the disassembly and inspection of the FWPT oil systems.

According to the VTR, the inadequate response of the FWPT speed to a "speed-lowering" signal from the Motor Speed Changer is usually a result of binding or restrictions in the governor control system. After several pulses of the Motor Speed Changer in the "speed-lower" direction, the closing force overcame the restriction (i.e., friction) and signaled the Low Pressure Governor valve to close. Because 2A FWPT was operating near the Motor Gear Unit Low Speed Stop, the signal demand when the restriction was overcome called for an abnormally closed valve position. The control oil system reopened the control valve 2 seconds later. The FWPT speed was already low, therefore the shaft-driven oil pump had low output capability and the auxiliary oil pump (AOP) started. Though there is no direct evidence, it is believed that this situation led to the erratic control oil pressure indication and the subsequent 2A FWPT trip. The Alarm Typer indicates that the AOP started at the same time the FWPT Stop Valves closed.

The findings of the PM indicated that two problems appear to be the cause for the FDWPT response during the event:

1) Excessive friction or clearance in the control linkage system resulted in the failure of the Motor Speed Changer to change FWPT speed. Several linkages and a hydraulic piston were found to be out-of-design tolerances.

2) Lack of cleanliness of the oil system could also contribute the failure of the FWPT speed to change. The inlet strainers to the pressure regulating valves for the bearing oil header and control oil systems were found to be severely plugged with lint and debris. Debris in the oil could lead to erratic control.

The Root Cause for this event is classified Equipment Malfunction due to the problems discovered during the PM of the Hydraulic and Control Oil System.

Every refueling outage, Maintenance performs a PM on the Main Feedwater Pump Turbine Hydraulic and Control Oil System. An investigation of work performed per this PM over the past two outages indicates that work performed from outage to outage was not consistent and was more than was called for per the WR job sequence description. The Maintenance personnel perform the PM with the use of a technical manual. The use of the WR and

the technical manual do not seem to be adequate to provide specific directions for PM or accountability that the FWPT Hydraulic and Control Oil System is properly inspected. A written procedure, though not required by Station Directives, could greatly enhance the FWPT PM program. Maintenance will incorporate into an existing procedure the steps taken at present to ensure reliability of the FWPT Hydraulic and Control System.

Another PM is performed each outage to lubricate the control linkage per Standing WR #57729E. No problems were detected during the last performance of this PM, 6/13/89.

In addition to the above PMs, Maintenance performs MP/0/B/1320/02 (TURBINE-FEEDWATER-OVERSPEED AND LUBRICATION SYSTEMS-OPERATIONAL TEST) on 2A FWPT each outage to verify the proper setup of the oil pressure regulators and operation of the overspeed trip. A test to ensure the correct operation of the oil systems on FWPT speed changes is not included in the test procedure. Maintenance will evaluate the existing testing method to ensure that the Hydraulic and Control Oil System will respond properly upon FWPT speed changes.

The FWPTs have a history of problems concerning controls sticking and moving erratically. To correct these problems Station Problem Report #2001 was written on 7/6/87. The approved resolution, Nuclear Station Modification #2796, will "Modify the existing system by providing a filtration system that can remove water and particulates." An extensive lube oil system cleaning program has been implemented as a result of the debris discovered in the oil of Unit 1's FWPTs during the 1990 Unit 1 Outage and will be used on Unit 2's FWPTs this outage .

It has been the practice of Operations to verify that the AOP starts automatically as control oil pressure decreases to 43 psig during the shutdown of a FWPT. The FWPT oil system pressure regulators receive a final setup when the FWPT is operating at 3800 RPM in accordance with MP/0/B/1320/02. During this event, 2A FWPT was operating at 2600 RPM. If an AOP is started prior to decreasing speed below 3800 RPM it would provide a more adequate source of control oil than the shaft-driven oil pump when the FWPT is operating at lower speeds. Operations will correct this problem by providing a step in power reduction procedure to start an AOP prior to reducing reactor power below 15%.

During this event the Operations Shift personnel on Unit 2 questioned whether the trip of the reactor was required upon loss of the FWPT and with the Reactor subcritical. Operations Management Procedure (OMP) 2-1 states, "If both FWPTs trip, then manually trip the reactor." The Operations personnel have been trained that the purpose of this action is

to ensure that the reactor is not critical upon the initiation of Emergency Feedwater to the Steam Generators. Operations will determine if a reactor trip is only required when the reactor is critical. A document change will be made to reflect their decision and training will be provided to licensed personnel.

Use of the Emergency Operating Procedure is appropriate when the reactor is manually tripped because it provides the operators with conservative actions to ensure that the reactor is placed and maintained in a safe condition.

The equipment malfunction involved in this event is NPRDS reportable. The equipment is a General Electric Steam Turbine Boiler Feed Pump Drive, manufacturer model number 7TDRV631R31. A review of the events occurring during the past 24 months reveal that this event is nonrecurring. The health and safety of the public were not compromised at a result of this event. There were no radioactive releases, radiation exposures or personnel injuries resulting from this event.

CORRECTIVE ACTIONS

Immediate

1) Control Room Operator A manually started both Motor Driven Emergency Feedwater Pumps in accordance with the Loss of Main Feedwater Abnormal Procedure.

2) Control Room Operator A manually tripped the Reactor.

3) Operations Shift personnel performed Immediate Manual Actions in accordance with the Emergency Operating Procedures.

Subsequent

1) Operations Shift personnel performed Subsequent Action in accordance with the Emergency Operating Procedures.

2) Operations Unit 2 Shift Supervisor wrote Work Request #29949C to investigate Auxiliary Oil Pump.

3) Maintenance personnel performed preventive maintenance performed on 2A FWPT per work request 57272E. The problems concerning out-of-design tolerance linkages and hydraulic piston were either corrected or the components were replaced. Instrument and Electrical personnel checked the calibration and proper activation of all associated pressure switches using procedure IP/0/B/0270/005B-1 (FWPT INSTRUMENTATION BEARING TEMPERATURE AND OIL SYSTEM).

Planned

1) Maintenance will evaluate the existing testing method in MP/0/B/1320/02 to ensure that the Hydraulic and Control Oil System will respond properly upon Feedwater Pump Turbine speed changes.

2) Maintenance will incorporate into an existing procedure, MP/0/B/1320/003 (TURBINE-FEEDWATER-DISASSEMBLY-INSPECTION -REASSEMBLY), the steps taken at the present to ensure reliability of the FWPT Hydraulic and Control Oil System.

3) Operations will determine the required action concerning tripping the Reactor upon the loss of FDW when the Reactor is subcritical. Make the necessary changes to the affected documents and provide training to Licensed personnel.

4) Nuclear Station Modification 2796 will be implemented to assist in maintaining oil cleanliness.

5) Operations will add a step to OP/1,2,3/A/1102/04, Enclosure 4.3, that would require starting the Auxiliary Oil Pump on the operating FWPT prior to completing the procedure.

6) An extensive lube oil system cleaning will be performed on the Unit 2 FWPTs during this outage per TM/2/B/1320/001 (TRANSFER OIL FROM RESERVOIR TO THE LUBE OIL STORAGE TANK AND BACK TO THE RESERVOIR).

SAFETY ANALYSIS

At the initiation of the transient, the Reactor Coolant system was at 490 degrees Fahrenheit and 2150 psig. The reactor was subcritical, shutdown margin maintained greater than 1% dk/k, and the control rods had been inserted to Group 1 at 50% to provide 0.5% dk/k for negative reactivity

insertion. The cooldown limit was to be maintained in accordance with OP/2/A1102/10; <45 degrees Fahrenheit per any 1/2 hour period while Tc was > 280 F.

Within 15 seconds of the loss of the 2A Feedwater Pump Turbine (FWPT), the Control Room Operator manually started the Motor-Driven Emergency Feedwater Pumps (MDEFWP). The Emergency Feedwater system (EFW) 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. Total rated capacity is 1780 GPM. The limiting transient requiring maximum EFDW flow is a loss of main feedwater with offsite power available. For this transient, a minimum EFDW flow rate equivalent to 405 GPM at 1050 psig is adequate. Each of the three EFDW pumps is capable of delivering 500 GPM. Therefore the capability of the EFDW was more than adequate to mitigate the effects of this event, loss of feedwater with the reactor below hot shutdown.

SG level was controlled automatically at 30 inches. If an overcooling event occurred, the Emergency Operating Procedure directed the operator to throttle Emergency FDW flow to maintain the Reactor Coolant System cold leg temperature constant.

Within 47 minutes of the 2A FWPT trip, the SGs pressure had decreased enough to allow the condensate booster pump to supply feedwater and the MDEFWPs were secured. The RCS temperature had decreased approximately 25 degrees Fahrenheit during this time period which is within the cooldown limits of Enclosure 4.5 (RCS COOLDOWN LIMITATIONS), OP/2/A/1102/10.

The health and the safety of the public were not compromised as a result of this event. There were no personnel injuries, no releases of radioactive materials, or excessive exposures associated with this event.

ATTACHMENT 1

CONTROL OIL PRESSURE