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AUTH.NAME	AUTHOR AFFILIATION
BENESOLE,S.G.	Duke Power Co.
HAMPTON,J.W.	Duke Power Co.
RECIP.NAME	RECIPIENT AFFILIATION

SUBJECT: LER 93-001-00:on 930429,equipment failure resulted in manual reactor protective sys actuation while unit subcritical. Caused by faulty current limit module.Fuses & current limit module replaced.W/930527 ltr.

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Duke Power Company
Oconee Nuclear Generation Department
P.O. Box 1439
Seneca, SC 29679

J.W. HAMPTON
Vice President
(803)885-3499 Office
(704)373-5222 FAX

DUKE POWER

May 27, 1993

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

Subject: Oconee Nuclear Site
Docket Nos. 50-269, -270, -287
LER 270/93-01

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report (LER) 270/93-01, concerning a possible equipment failure resulting in a manual reactor protective system actuation while subcritical.

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,

Joe M Davis
for J. W. Hampton
Vice President

/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. Wiens
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

INPO Records Center
Suite 1500
1100 Circle 75 Parkway
Atlanta, Georgia 30339

Mr. P. E. Harmon
NRC Resident Inspector
Oconee Nuclear Site

NRC FORM 366 (5-92)	U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104 EXPIRES 5/31/95

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Oconee Nuclear Station, Unit Two	05000 270	1 OF 8

TITLE (4) Possible Equipment Failure Results In A Manual Reactor Protective System Actuation While Subcritical

EVENT DATE (5)			LER NUMBER (6)			REPORT NUMBER (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER 05000
04	29	93	93	-- 01 --	00	05	27	93	FACILITY NAME	DOCKET NUMBER 05000

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)							
			20.402(b)		20.405(c)	X	50.73(a)(2)(iv)		73.71(b)
POWER LEVEL (10)	0		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)		OTHER
			20.405(a)(1)(iii)		50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		(Specify in Abstract below and in Text, NRC Form 366A)
			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 (Include Area Code)
S. G. Benesole, Safety Review Manager	(803) 885-3518

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
F	EJ	GEN	B569	Yes						

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 15 single-spaced typewritten lines) (16)

On April 29, 1993, at 0505 hours, Unit 2 was taken subcritical in preparation for a refueling outage. At 0556 hours, with Control Rod Groups 3 through 7 inserted and Group 2 Safety Control Rods insertion in progress, a momentary loss of 2KI power was experienced. A computer alarm was received indicating a "Main Steam Pressure Mismatch" on the 2B Main Steam header pressure. Also observed was that the operating 2A Main Feedwater Pump had tripped, the Emergency Feedwater Pumps started and the Loss of Feedwater Abnormal Procedure was entered. The Reactor Protective System was manually initiated, inserting the remaining Control Rods. The Control Room personnel entered the Emergency Operating Procedure, and the unit was stabilized. An investigation revealed a faulty Current Limit Module caused the opening of the Inverter Power fuse and the Static Transfer Switch fuse resulting in a temporary loss of power to 2KI. The root cause of this event is Equipment Failure/Malfunction. Corrective actions include the replacement of both fuses and the Current Limit Module. Also, an evaluation will be performed on the inverter and static transfer switch that led to the momentary loss of 2KI.

BACKGROUND

The Integrated Control System (ICS)[EIIS:JA] Power System is composed of a 125 VDC isolating transfer diode assembly 2ADF, a static inverter 2KI, a backup transfer switch (ASCO), an external inverter bypass, an isolation transformer and panelboard. The static inverter unit consists of a static inverter, a static transfer switch, and an internal manual bypass switch. The external inverter bypass unit consists of three breakers. The output of the inverter is synchronized with the AC Regulated Power System through the static switch to minimize transfer time from the inverter to the alternate supply. A backup transfer switch is provided for automatic transfer of system loads to the alternate power source should the inverter and static transfer switch become unavailable.

The Emergency Feedwater System [EIIS:BA] will actuate on loss of both Main Feedwater Pumps (MFDWP). The actual initiating conditions are low discharge pressure on both MFDWPs and/or low hydraulic oil pressure on both MFDWPs.

Shutdown Margin is that instantaneous amount of reactivity by which the reactor is, or would be, subcritical from its present condition assuming all full length Control Rods are fully inserted. Technical Specifications 3.1.11 stipulates the minimum shutdown margin of greater than 1 percent $\Delta K/K$ is required for power and shutdown plant conditions. This shutdown margin is a reactivity balance calculated to determine the net reactivity conditions present in the core with the highest worth Control Rod fully withdrawn.

EVENT DESCRIPTION

On April 29, 1993, at 0505 hours, Unit 2 was taken subcritical in preparation for a refueling outage. At 0530 hours, Control Room personnel began inserting the Safety Control Rods [EIIS:ROD] to 50 percent on Group 1. At 0556 hours, while inserting Group 2 Safety Control Rods, a computer alarm was received indicating a "Main Steam (MS) Pressure Mismatch" on the 2B MS header pressure. A pressure of approximately 835 psig was observed that was approximately 45 psig less than 2A MS header pressure. Control Room Operator (CRO) "A" verified that the 2B Turbine Bypass Valves were closed and that Reactor Coolant System (RCS) [EIIS:AB] average Temperature (Tave) was stable at 536 degrees F. Moments later, the CRO "A" observed a flickering of various control board indications, RCS temperature decreasing and that 2A Main Feedwater Pump (MFDWP) had tripped. CRO "A" then manually tripped the Reactor Protective System (RPS) [EIIS:JC], inserting the remainder of Group 2 and all of Group 1 Safety Control Rods. The Control Room personnel entered the Emergency Operating Procedure. Critical system

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TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

parameters and Emergency Feedwater Pump operation were verified and the Loss of Feedwater Abnormal Procedure was entered. The 2A and 2B Motor Driven Emergency Feedwater Pumps (MDEFDWP) automatically started at approximately 0556 hours. The Turbine Driven Emergency Feedwater Pump automatically started at approximately 0556 hours and was secured at approximately 0605 hours. During the unit recovery, the CROs observed that 2A main steam header pressure had decreased to approximately 725 psig and the 2A Turbine Bypass Valves were partially open. RCS Tave had decreased to approximately 519 degrees F. The 2A and 2B Turbine Bypass Valves control stations were found in manual and the CRO closed the 2A Turbine Bypass valves. RCS Tave partially recovered to approximately 529 degrees F.

Specific post-transient parameters remained within acceptable limits. RCS average temperature decreased from 535 degrees F to a low of 519 degrees F and stabilized at approximately 527 degrees F. RCS pressure decreased from approximately 2146 psig to 2021 psig. Pressure then slowly increased to approximately 2211 psig. Pressurizer [EIIS:VSL] level reached a minimum of 157 inches and stabilized at approximately 193 inches. The 2A/2B Steam Generator (SG) pressures reached a post-transient high of 844/809 psig before stabilizing at approximately 830/807 psig. The 2A/2B SG levels decreased to a minimum of 26/22.7 inches and was maintained at approximately 30/27 inches by the Emergency Feedwater System. The RCS was stabilized at hot shutdown.

Following the RCS Tave decrease, a Reactor Engineer was directed to calculate the available shutdown margin, Chemistry was notified to commence a RCS boron concentration sample program and make-up to the RCS was commenced from the Concentrated Boric Acid Storage Tank at 0614 hours.

By using an existing procedure that does not allow full credit for Xenon, personnel conducting the post transient review concluded that less than one percent ΔK/K Shutdown Margin (SDM) may have existed following the transient. This conclusion was based on the following core conditions: allowable credit for Xenon concentration, reduced RCS temperatures (519.8 degrees F) and low boron concentration. All pertinent data was collected and sent to Nuclear Engineering for evaluation.

In reviewing the alarm boards, the Control Room personnel found that several "Integrated Control System Inverter Trouble" alarms were lit. Per the Alarm Response Manual, the Control Room personnel directed Non-Licensed Operator (NLO) "A" to investigate the cause of the alarms associated with 2KI Inverter. NLO "A" found the following alarms: "Output Voltage Low," "Back-up Transfer Switch Load Connected to Emergency" and "Power Fuse Blown" lights illuminated. These indications were reported to the Control

Room. Instrumentation and Electrical (IAE) personnel were directed to determine the problem with 2KI inverter.

The investigation revealed that the Inverter Power fuse and the Static Transfer Switch fuse had blown. Fuse failures were investigated and both fuses were replaced and the inverter was aligned for troubleshooting. However, large voltage swings (20 to 120V) forced the IAE personnel to shutdown the inverter. Further investigation uncovered a faulty Current Limit Module. It has not been determined if this faulty module was the initiator or a casualty of this event. However, the inverter instruction manual suggests that problems with the module may cause low AC output voltage or blown inverter fuses. This module was replaced and the panelboard was placed in service via the AC Line circuit per procedure.

It is suspected that erratic operation of the Current Limit Module caused erratic operation of the static switch resulting in the opening of the Power fuse (200 amp fast blow fuse), and the Static Transfer Switch fuse (80 amps). This resulted in a brief loss of power to the 2KI panelboard. The loss of voltage was detected by the ASCO Backup Transfer Switch, which transferred to its emergency position in approximately 1.5 seconds. The abnormal procedure for the loss of 2KI bus was consulted during the recovery; however, none of the procedural conditions applied and the abnormal procedure was exited.

At 1137 hours, after 2KI was placed on "AC" line, 2A Main Feedwater Pump was returned to service per procedure and at 1147 hours, emergency feedwater pump operation per the abnormal procedure was secured.

On May 4, 1993, at 0743 hours, after repairing the inverter and completing component preventive maintenance, 2KI inverter was returned to service per procedure supplying power via its normal source.

CONCLUSIONS

The root cause of this event is Equipment Failure/Malfunction. It is suspected that a Current Limit Module component failed, thus causing a voltage oscillation within the inverter circuitry. The power fuse and static transfer switch fuse opened. This caused a loss of power to 2KI until the backup transfer switch transferred to its emergency position regaining power to 2KI.

Emergency high steam generator level control is powered from Integrated Control System (ICS) power panelboard 2KI. A loss of 2KI, "Hand or Auto" power, will initiate a trip of both Main Feedwater Pumps, and the Main Turbine. A signal is subsequently sent to actuate the Reactor Protective

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System (RPS) anticipatory trip circuitry. The Main Turbine anticipatory trip is bypassed at or below 28 percent power and the Main Feedwater Pump trip is bypassed at or below .5 percent power. No anticipatory signal was initiated because the reactor was shutdown and power level was well into the source range during the loss of 2KI event. However, the Control Room Operator (CRO) manually deenergized the Control Rods to insert Safety Groups 1 and 2 based on the following reasons. The reactor had just recently been made subcritical and Shutdown Margin (SDM) was based on the available Xenon concentration and a very low RCS boron concentration. With these conditions and decreasing RCS temperatures, the CRO assumed that additional negative reactivity was needed to increase the SDM; therefore, the CRO manually actuated RPS.

The existing Oconee SDM calculation procedure does not allow full credit for the negative reactivity worth of Xenon/Samarium poisons for RCS temperatures below 530 degrees F. The temperature division between full credit and half credit was arbitrarily chosen and was a result of concerns over the unquantified accuracy of neutron cross sections for nuclides of interest over a wide temperature range. Because the division of temperature was arbitrarily and conservatively chosen, the RCS temperature of 520 degree F does not represent a significant change from 530 degree F. Due to the additional conservatism in the SDM calculations, it was determined to be acceptable to take full credit for Xenon for this SDM calculation at 520 degree F. Per Duke Power Nuclear Engineering, Oconee Unit 2's reactor was shutdown by a total of approximately 2.5 percent $\Delta K/K$ after the trip and during the cooldown to 519.8 degrees F., thus, satisfying the SDM requirements.

The failure of the 2KI Inverter due to the blown fuses is NPRDS reportable. The power switch fuse is a Tron Recitifer KAA200 amp/130V manufactured by Bussmann Manufacture, a Division of McGraw-Edison Company (B569). The transfer switch fuse is an Amptrap A130V/80 amp, type 4 fuse manufactured by Shawmut-Gould Incorporated (S156). The Current Limit Module is manufactured by Exide Industry. 2KI Inverter is a model number 120/9.F1 inverter manufactured by Exide Industry (E355).

During a loss of Integrated Control System (ICS) and Non-nuclear Instrumentation power, steam generator pressure control is established by the Main Steam relief valves. When power is restored, the Turbine Bypass Valves will randomly reposition due to the random output voltage produced by the Static Analog Memories. ICS testing at Oconee in 1980 confirmed this action. Administrative guidelines have been provided within the Loss of KI Abnormal Procedure to terminate this transient. In this event the overcooling could have placed the unit in a less than adequate shutdown margin position had not the operators taken prompt action to close the Turbine Bypass Valves.

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Response of the primary system to the unit trip was normal. Reactor Coolant system inventory, pressure and temperatures were all maintained within the post-transient envelope. Secondary system response was also normal. Both steam generators' level and pressure were maintained at or near their setpoints.

A review of events over the last two years, indicates that this is not a recurring problem. There were no personnel injuries, radiation exposures, or uncontrolled releases of radioactive materials associated with this event.

CORRECTIVE ACTIONS

Immediate

1. Operations personnel took the appropriate actions according to the Emergency Operating Procedure, Operation Management Procedures, Alarm Response Manual and the Abnormal Procedures for Loss of Feedwater and Loss of KI.

Subsequent

1. Replaced the blown Inverter Power fuse and Static Transfer Switch fuse.

2. Replaced erratic Current Limit Module.

3. Returned 2A Main Feedwater Pump to service and shutdown the Motor Driven Emergency Feedwater Pumps.

4. Shutdown Margin data was sent to Nuclear Engineering and verified that greater than one percent Shutdown Margin existed during the unit transient.

Planned

1. Blown fuses and the Current Limit Module will be evaluated by Component Engineering to determine the failure mode of these components. This analysis will determine if further corrective actions will be required on the inverter and static transfer switch.

2. Oconee Engineering will evaluate the Integrated Control System to enhance the Turbine Bypass Valve control circuitry.

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SAFETY ANALYSIS

The Integrated Control System (ICS) power supply is arranged such that it is normally powered from a dedicated static inverter system, which receives a DC input from the Vital Instrument and Control batteries [EIIS:EJ], and is backed by an AC input from one of the plant's regulated non-load shed buses. Both automatic and manual transfer switching is provided to select between supplies.

In addition to the power supply reliability for the ICS, essential plant parameters necessary for shutdown have been arranged with their power supplies independent of the ICS source. Also, a "display group" has been developed and defined on the plant operator aid computer such that upon a loss of ICS power, the operator may have complete information on key primary and secondary system parameters. Emergency procedures have also been developed to designate alternate sources of information on key plant parameters if the computer is unavailable, thus assuring the operator can obtain sufficient systems information.

The worst case overcooling accident is a double-ended rupture of the main steam line from rated power conditions with offsite power available. At rated power, the steam generator inventory is at its maximum, so that the blowdown will result in the greatest heat removal. If a loss of offsite power was assumed, the heat transfer in the steam generator would be less due to the loss of forced flow and the loss of the main feedwater system. Therefore, these initial conditions result in the most rapid cooldown of the RCS. The worst case assumptions for the steam line break accident, in addition to no operator action, is when the ICS does not perform its design function of controlling feedwater on steam generator level (approximately 135 percent feedwater assumed delivered to the effected steam generator). The return to power peaks at approximately eight percent. The power excursion will be terminated by a strong negative Doppler coefficient effect alone, if no other protective reactor trips are actuated. The steam line break accident has been analyzed with several assumptions, regarding ICS and operator action to isolate feedwater. The results show that the unit can successfully mitigate the transient without taking credit for ICS or operator action, although normal ICS and operator action will significantly moderate the plant response. The peak return to power is not great enough to cause fuel damage. In this event, operator action terminated the possible overcooling event by closing 2A Turbine Bypass Valves.

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This event is bounded by a reactor trip or loss of feedwater, because main feedwater was restored during the event. Also, no overcooling was observed as part of this event. Therefore, this event does not represent a higher core damage potential than a normal loss of feedwater or reactor trip event. Therefore, this event is not considered an accident sequence precursor.

A sufficient Shutdown Margin (SDM) ensures that the reactor can be made subcritical from all operating conditions, the reactivity transients associated with postulated accident conditions are controllable within acceptable limits, and the reactor will be maintained sufficiently subcritical to preclude inadvertent criticality in the shutdown condition. Per Duke Power Nuclear Engineering's review of the reactor information, Oconee Unit 2's reactor contained more than the required one percent $\Delta K/K$ SDM after the trip and during the cooldown to 519.8 degrees F..

The health and safety of the public were not endangered by this event. It did not involve the uncontrolled release of radioactive material, overexposure to radiation, or personnel injuries.