NRC FORM 366 (5-92) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 5/31/95

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, 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)
Arkansas Nuclear One, Unit Two	05000368	1 OF 6

TITLE (4) Technical Specifications Requirements For Logarithmic Power Level Instrumentation Operability Not Met Due To Inadequate Post-Maintenance Test

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 NAME	DOCKET NUMBER
03	12	94	94	001	01	11	21	94	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	3	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR: (Check one or more) (11)							
POWER LEVEL (10)	000		20.402(b)		20.405(c)		50.73(a)(2)(iv)		70.71(b)
			20.405(a)(1)(i)		50.36(c)(1)		50.73(a)(2)(v)		70.71(c)
			20.405(a)(1)(ii)		50.36(c)(2)		50.73(a)(2)(vii)		OTHER
			20.405(a)(1)(iii)	X	50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		Specify in Abstract Below
			20.405(a)(1)(iv)		50.73(a)(2)(ii)		50.73(a)(2)(viii)(B)		and in Text
			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)
Thomas F. Scott, Nuclear Safety and Licensing Specialist	501-858-4623

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
B	IG	CON	C490	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 15 single-spaced typewritten lines) (16)

With the plant in Hot Standby conditions at the start of a refueling outage, excore nuclear instrumentation channels were being tested for electronic noise. When a jumper bypassing a filter was removed from the cable of one channel, the high voltage pin came loose and remained with the jumper. Without high voltage to the detector, the logarithmic power high trip function from that channel was inoperable. Performance of the functional test and comparison with other channel outputs failed to reveal the condition since all indications were near the lower end of the scale. Another channel was placed in bypass for testing. The broken pin was found in the jumper connector while establishing test conditions of the subsequent channel. The configuration of one channel in bypass and another inoperable but not tripped along with having an inoperable channel neither bypassed nor tripped for greater than one hour are conditions prohibited by Technical Specifications. The non-compliance with Technical Specifications existed for one hour and thirty-two minutes and was corrected immediately upon discovery. The root cause was determined to be an inadequate post-maintenance test because connector failure was not considered. Corrective actions included enhancement of the post-maintenance test method and discussion with appropriate maintenance personnel.

A. Plant Status

At the time this condition was discovered, Arkansas Nuclear One Unit 2 (ANO-2) was in Hot Standby (Mode 3) conditions with Reactor Coolant System (RCS) [AB] temperature 325 degrees and pressure 445 psia at the start of a scheduled refueling outage. Reactor trip circuit breakers were closed with all trippable Control Element Assemblies (CEAs) [AA] fully inserted.

B. Event Description

At 1731 hours on March 12, 1994, excore nuclear instrumentation [IG] detector operability was discovered to be less than required by Technical Specifications (TS) for existing plant conditions.

The excore nuclear instrumentation includes neutron detectors located around the reactor core and signal conditioning equipment located in the Auxiliary Building [NF]. Neutron flux is monitored from source levels through full power and signal outputs are provided for reactor control, reactor protection, and for information display. There are eight channels of instrumentation, four of which are safety channels. The four safety channels provide neutron flux information from startup neutron flux levels to 200 percent of rated power covering a single range of approximately E-8 to 200 percent power (10 decades). Each safety channel consists of three fission chambers, a preamplifier and a signal conditioning drawer containing power supplies, a logarithmic amplifier, linear amplifiers, test circuitry and a rate-of-change of power circuit. Preamplifiers for the fission chambers are mounted outside the biological shield but inside the containment. High logarithmic power level trips are provided from each excore neutron flux safety channel to ensure the integrity of the fuel cladding and RCS pressure boundary in the event of unplanned criticality from a shutdown condition that could result from withdrawal of Control Element Assemblies. The nominal setpoint for these trips is 0.75 percent power. The trip for each channel is manually bypassed when reactor power exceeds E-4 percent. The bypasses are automatically removed when reactor power decreases to less than or equal to E-4 percent.

Due to a history of problems associated with electronic noise on the signals from excore nuclear instrumentation detectors, choke filters were installed at the preamplifier output of each logarithmic power safety channel. As a method of detecting connector or insulation degradation, repetitive tasks were developed to record noise levels and time domain reflectometer (TDR) traces during each outage. Reactor trip circuit breakers are closed while the tasks are being performed because they provide power to the primary noise source. The choke filters are bypassed by installing a jumper while data are being obtained so that noise can be accurately characterized.

On March 12, 1994, channel "C" excore testing for noise was being performed. Following testing, the bypass jumper around the choke filter was removed and the cabling returned to its normal configuration. A monthly excore functional test was performed. Licensed Operations personnel verified that the output was consistent with other channels and as expected for existing plant conditions (near the lower end of the scale at approximately E-7 percent) prior to removing "C" from bypass at 1553 hours. Channel "D" was bypassed at 1559 hours in order to conduct a similar test. When Instrumentation and Control (I&C) Maintenance personnel attempted to connect the choke filter bypass jumper, they noticed that the center pin from the "C" high voltage cable had broken off the conductor and remained inside the female connector of the jumper when "C" testing was completed. Without high voltage, "C" excore detector was inoperable. This condition was immediately questioned and reported to Control Room Operations personnel at 1731 hours at which time the reactor trip circuit breakers were immediately opened. Channel "D" was removed from bypass at 1740 hours.

Technical Specification (TS) Table 3.3-1 requires that a minimum of three of the four channels of "logarithmic power level-high" instrumentation be operable when the reactor is not in Power Operation (Mode 1) and the reactor trip breakers are in the closed position with the CEA drive system capable of CEA withdrawal. Without high voltage available to "C" excore detector, when the channel was removed from bypass at 1553 hours, TS Action 2a required placing this inoperable channel in either the bypassed or tripped condition within one hour. Also, with channel "D" in bypass, TS Action 2c required channel "C" to be placed in the tripped condition. Since it was not realized until 1731 hours that channel "C" was inoperable, these action requirements were not met. Immediately upon notification of the problem with channel "C" excore, the reactor trip breakers were opened to establish conditions in which the TS was not applicable.

C. Root Cause

Examination of the connector revealed that there had been a mechanical failure of the center conductor at the soldered junction of the connector pin. When securing this type of connector, a lock ring on the male half is rotated 90 degrees in the clockwise direction as viewed from the cable end of the connector. The only rotational support for the male and female center pins in the coaxial connectors is the solder joint with the center conductor. If the male connector body is allowed to rotate when the lock ring is being secured, a clockwise twisting force on the center conductor of one or both cables could be created. Uncoupling the connectors requires reversing the sequence. Rotation of the connector body in this sequence could create a counter-clockwise force on the conductors. Repeated cycles of this type could result in cyclic fatigue and mechanical failure of the conductor.

Microscopic analysis of the base of the connector pin indicates that the conductor was probably being twisted in a clockwise direction relative to the body of the pin at the time of failure. Since the design of this type of connector does not provide any alignment or indexing provisions to prevent rotation of the two assembled connector halves relative to each other, it is feasible that rotation of the connector locking ring during installation could have resulted in the apparent "twisting" seen on the pin's base. Any conductor flaws at the base of the pin, such as a nick or cut, would make the failure of a conductor subjected to this cyclic fatigue more likely. It could not be determined if a pre-existing flaw was present on this particular conductor.

The exact cause of the conductor failure at the base of the connector pin is not known and cannot be clearly established. The most probable cause is the cyclic fatigue the conductors in these connectors can experience during installation and removal along with the possibility of a pre-existing flaw on the conductor.

An evaluation of the expected logarithmic power channel indication with existing plant conditions and high voltage failure was performed. On the basis of experience with monthly testing, the indication of approximately E-7 should not be considered abnormal.

The post-maintenance test (PMT) was not developed to verify the integrity of all connections that were disturbed by the activity. An assumption in the development of the PMT was that integrity is not expected to be compromised for connections that are specifically designed for repeat cycles of connection. Another assumption was that the channel output would differ significantly from redundant channels if the connector had not been adequately re-assembled. The circumstances of actual power level and indicated power level of the instrument without high voltage present contributed to the failure of the PMT to detect the condition; however, the root cause of this condition is attributed to an inadequate post-maintenance test.

D. Corrective Actions

The channel "C" excore cable connector was replaced and the channel restored to an operable status at 0328 hours on March 13, 1994.

A review of site failure report documentation was conducted. No similar instance of failure of the excore cable connectors was discovered. It was concluded that the failure was a unique, isolated event and no additional corrective action regarding the connector was indicated.

As a method of detecting any future failures of these connectors, instructions for the routine tasks to measure excore cable noise were revised to include a final TDR measurement to verify continuity of the connector. The post-maintenance test for other channels tested during the outage in progress was revised to include this measurement. Subsequent review of these changes indicated that a better method of verification of excore cable and connector integrity could be obtained by using installed test switches. These switches increase the gain of the individual linear subchannels to allow detection of current present on each chamber due to high voltage excitation. This PMT method has been included in the restoration and checkout section of applicable surveillance procedures. The requirement for TDR measurements added as part of the initial corrective actions will be deleted from routine noise measurement tasks.

Discussions were held with I&C Maintenance technicians of both units to emphasize the importance of being alert for pin damage and the desire to minimize rotation of the connector body when mating this type of connector.

The nuclear instrumentation system and Technical Specifications for Arkansas Nuclear One Unit 1 are different from those of ANO-2; however, evaluation of this event for applicability to post-maintenance testing methods of Unit 1 was completed. It was determined that there was no need to change the Unit 1 PMT program based on this event.

E. Safety Significance

The ANO-2 accident analysis contained in the Safety Analysis Report (SAR) credits the logarithmic power high level trip for reactor protection in only one event, "Uncontrolled Control Element Assembly (CEA) Withdrawal from a Subcritical Condition." The scenario for this accident involves the withdrawal of CEAs from subcritical conditions. This CEA withdrawal adds reactivity to the reactor core and causes both the core power level and the core heat flux to increase. The Reactor Protective System (RPS) [JC] is designed to prevent such a transient from resulting in a Departure from Nuclear Boiling Ratio (DNBR) of less than 1.3 by the logarithmic power high level trip. The trip function is required only in operating modes below Power Operation when a powered withdrawal of CEAs could occur. When the trip circuit breakers are open, the logarithmic power level channels are only used for reactivity monitoring purposes and Control Room annunciation in the event of an unplanned criticality

At the time of this event, RCS boron concentration was approximately 2400 parts per million. Since the plant was being shutdown and CEAs were not being withdrawn, the probability of an uncontrolled withdrawal was minimized. Channel "C" was out of bypass thirty-eight minutes longer than allowed by one action requirement. Channel "D" was bypassed without "C" being tripped for one hour and thirty-two minutes. During this time channels "A" and "B" remained operable; however, both channels would

have been required to actuate a trip signal if a CEA withdrawal had occurred. On the basis of the existing plant conditions and limited duration of the non-conformance with Technical Specifications, the event is considered to have minimal safety significance.

F. Basis for Rep[illegible]

Failure to place channel "C" in either the bypassed or tripped condition within one hour after it was inoperable and removed from bypass with the reactor trip breakers closed is prohibited by Action 2a of TS Table 3.3-1. Failure to place channel "C" in the tripped condition prior to bypassing channel "D" is prohibited by Action 2c of TS Table 3.3-1. Operation prohibited by Technical Specifications is reportable pursuant to 10CFR50.73(a)(2)(i)(B).

G. Additional Information

There have been no previous similar events reported by Arkansas Nuclear One as Licensee Event Reports.

Energy Industry Identification System (EIIS) codes are identified in the text as [xx].

The connector that failed is a MHV-coaxial, straight, rated 55 to 199 degrees Celsius, manufactured by Arrow Kierulff Electronics and supplied by Combustion Engineering (manufacturer code C490).