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SUBJECT: LER 94-005-01:on 940326,control rod failed to scram due to degradation of pilot valve elastomers.Caused by inservice aging.Scram time tests performed weekly of operable control rods & SSPVs replaced.W/940624 ltr.

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WASHINGTON PUBLIC POWER SUPPLY SYSTEM

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June 24, 1994
GO2-94-145

Docket No. 50-397

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Gentlemen:

Subject: **WNP-2, OPERATING LICENSE NPF-21**
LICENSEE EVENT REPORT NO. 94-005, REVISION 1

Licensee Event Report No. 94-005, Revision 1 is attached. This revision is submitted to satisfy the reporting requirements of 10 CFR 21.

Should you have any questions or desire additional information regarding this matter, please call me or D. A. Swank at (509) 377-4563.

Sincerely,

J. V. Parrish (Mail Drop 1023)
Assistant Managing Director, Operations

BRH/bk
Attachments

cc: LJ Callan - NRC RIV
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NS Reynolds - Winston & Strawn
DL Williams - BPA/399
NRC Sr. Resident Inspector - 927N
INPO Records Center - Atlanta, GA

LICENSEE EVENT REPORT (LER)

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TITLE (4) Failure of Control Rod to Scram Due to Degradation of Pilot Valve Elastomers Caused by In-service Aging

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)
03	26	94	94	- 0 0 5 -	0 1	06	24	94	N/A	0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9)	1
POWER LEVEL (10)	0 7 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR: (11)

___ 20.402(b)	___ 20.405c	___ 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	
___ 20.405(a)(1)(iv)	___ 50.73(a)(2)(ii)	___ 50.73(a)(2)(viii)B	Part 21
___ 20.405(a)(1)(v)	___ 50.73(a)(2)(iii)	___ 50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER – AREA CODE	
Bruce R. Hugo, Licensing Engineer	509	377-8593

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

CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS
B	A A	V	A 6 1 0	Y					

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

ABSTRACT (16)

On March 26, 1994, Control Rod 06-39 failed to scram during routine scram time testing. This was the first failure at WNP-2 of a control rod to scram. The control rod was manually inserted into the reactor and disarmed. The scram solenoid pilot valves (SSPVs) for the control rod had degraded exhaust and pressure diaphragms which had been in service for just under 4 years. The remaining 184 control rods were scram time tested; these control rods scrammed normally with scram times within Technical Specification limits.

The cause of the failure of Control Rod 06-39 to scram was an unusual combination of degradation of both the SSPV pressure and exhaust diaphragms. The cause of the degradation is believed to be accelerated aging due to manufacturing differences in diaphragm composition.

Corrective actions included weekly scram time testing of all operable control rods and expedited replacement of SSPV diaphragms. Following disassembly of the SSPV, direction was provided to plant operators to perform an orderly plant shutdown if any additional control rod failed to scram. The SSPVs were rebuilt.

This event had low safety significance since only one rod failed to scram, Technical Specification scram time requirements were met for all other control rods, and several backup systems were available to insert control rods or otherwise shut down the reactor. This report is submitted to meet the requirements of 10 CFR Part 21.

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Event Description:

At 1343 hours on March 26, 1994, during routine control rod [AA, ROD] scram time Technical Specification surveillance testing with the plant at 70% power in Mode 1, Control Rod 06-39 failed to scram when its local scram switches [HS] were toggled. Pulling the fuses [FU] to deenergize the Scram Solenoid Pilot Valves [V] (SSPVs) for Control Rod 06-39 also failed to initiate control rod motion, although operators could hear the solenoid [SOL] moving in the SSPV. The SSPVs continuously vented air when the solenoid coils were deenergized.

Immediate Corrective Action:

Control Rod 06-39 was manually inserted into the reactor [RCT] at 1352 hours, declared inoperable, and hydraulically disarmed at 1422 hours on March 26, 1994. The control rod did not stick and operation was normal, indicating it was free to move.

The scope of the scram time testing was increased to include the remaining 184 control rods to determine the potential for common mode failure. Testing was completed at 1200 hours on March 27, 1994. All other control rods scrammed normally with scram times within Technical Specification limits.

The two SSPVs (CRD-SPV-117/118) for control rod 06-39 were inspected revealing a severe degradation of the 118 Valve exhaust diaphragm. The degradation included hardened elastomers and a 90 degree circumferential through-wall crack that turned radially inward at the crack ends. The 118 Valve pressure diaphragm was hardened with an elongated set but not cracked. The 117 Valve had a hardened exhaust diaphragm and a flexible pressure diaphragm.

All o-rings were flexible. The internals of both SSPVs and the pilot tubing [TBG] were clean and free of visible debris. The diaphragms were intact with no flaking or loss of material. In addition, no macroscopic signs of degradation, foreign material, binding, or scoring were noted in the inspection of the only other movable parts, i.e., the solenoid cores and their associated guides and spring works. All material was accounted for in the disassembly and inspection of the two SSPVs.

Four control rods with slower than expected scram times from the full out position (notch 48) to notch 45 were inserted into the reactor, declared inoperable, and hydraulically disarmed. Although these control rods met Technical Specification requirements for two-by-two array average scram times, this action was taken as a conservative measure. Plant management also concluded (following disassembly of the SSPV for Control Rod 06-39) that the reactor would be shutdown if any additional control rods failed to scram.

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The SSPVs for Control Rod 06-39 were refurbished. Post maintenance testing demonstrated scram times typical of those experienced historically and within Technical Specification limits. Control Rod 06-39 was restored to service at 1525 hours on March 27, 1994.

A service test was performed beginning March 29, 1994, on the 40 core peripheral control rods. This testing consisted of scramming each control rod, initiating 5 scram signals with the rod inserted to cycle the SSPVs, followed by withdrawal and performance of a scram time test. Each control rod scrammed and no degrading trend in scram times was noted. This testing was completed on March 30, 1994.

All control rods were again individually scram time tested from March 30 through April 2, 1994. All control rods met Technical Specification scram time requirements. As part of this testing, exhaust port air leakage data was collected with and without a scram inserted. Air leakage data may be usable for estimating SSPV diaphragm degradation; however, the data are still being evaluated.

Weekly scram time testing of all operable control rods was initiated. Testing completed on April 11, April 16, and April 23, 1994, demonstrated that the control rods continue to meet Technical Specification scram time requirements.

The exhaust diaphragms were replaced on all SSPVs by April 9, 1994. As described in the root cause section, proper operation of the exhaust diaphragm precludes the failure observed with Control Rod 06-39. Also, exhaust diaphragms have exhibited significantly greater degradation (hardening, cracking and set) than the pressure diaphragms.

SSPVs were rebuilt on an expedited basis. This effort was initiated on March 27, 1994 and completed during the Spring 1994 refueling outage.

A review of plant records identified four other solenoid pilot valves from the same manufacturer in safety applications that require continuous solenoid energization. The elastomers in these valves, which could undergo accelerated aging due to the higher temperatures produced by the energized solenoid coils, were replaced during the Spring 1994 refueling outage. No problems attributed to aging of elastomers have been experienced with these valves.

The newly installed SSPV diaphragms will be evaluated for acceptable service life. The use of a new diaphragm material is also being evaluated.

Further Evaluation:

This report satisfies the reporting requirements of 10 CFR 21.

The SSPVs for the four control rods with slower than expected scram times were disassembled and examined; degradation was similar to that observed for control rod 06-39's SSPVs. The predominant degradation was hardening and cracking of the 118 Valve exhaust diaphragm and some hardening of the 117 Valve exhaust diaphragm. There was no significant hardening of the pressure diaphragms and the o-rings remained serviceable.

The life of the Buna-N diaphragms used in the SSPVs had been addressed in General Electric (GE) Services Information Letter (SIL) 575, dated October 27, 1993, which recommended a 3 to 4 year service life. The Supply System evaluated this SIL and concluded that existing plans to replace the diaphragms in 1995 were still appropriate. The diaphragms in use on March 26, 1994, had been installed in 1990. The degradation observed in 1994 occurred in just under 4 years of service; therefore, the 3 to 4 year service life recommended in SIL 575 may require reevaluation.

Root Cause:

The cause of the failure of Control Rod 06-39 to scram was an unusual combination of degradation of both the SSPV pressure and exhaust diaphragms. This mechanism requires degradation induced leakage across the exhaust diaphragm such that the pressure drop across the diaphragm is too low to result in the required diaphragm position shift. There must also be sufficient air leakage from the degraded pressure diaphragm to replenish the air leaking past the exhaust diaphragm. The condition of one of the two SSPVs for Control Rod 06-39 supports this scenario. The 118 Valve exhaust diaphragm had a unique 90 degree circumferential crack with the crack ends curving radially inward, the 118 Valve pressure diaphragm had a permanent set, and air was noted to be exhausting from the exhaust port following the scram attempts.

A bench test using the 118 Valve pressure diaphragm and a faulted (holes were drilled to simulate cracks) exhaust diaphragm reproduced the failure to scram. This test demonstrated that both a degraded pressure diaphragm and a leaking exhaust diaphragm were required to produce the observed failure to scram. In addition, the exhaust diaphragm hole flow area had to be greater than the bleed passage through the topworks (0.077 inch diameter) for the failure to occur.

The diaphragms removed in 1994 had more degradation than those replaced in 1990, despite a shorter period in service (those replaced in 1990 had been in service for up to 6.6 years). The cause of the degradation of the SSPV diaphragms in less than 4 years

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of service has not yet been determined. The difference in aging could be due to changes in elastomer composition, temperature, stress, or contamination.

Analyses of diaphragm material performed on diaphragms removed in 1990 and 1994, and on a kit drawn from the warehouse indicate that some changes in diaphragm material composition had been made.

Using thermography, SSPV body temperatures were measured for energized valves. Temperatures up to 120 degrees F were measured. This should not lead to premature reduction in the service life of the elastomers based on SSPV manufacturer information. Although some temperature effect on aging is believed to exist, premature aging of the SSPV elastomers cannot be solely attributed to operating temperatures. Observed diaphragm hardness has not readily correlated to higher operating temperatures; likewise, some degraded diaphragms were found in lower operating temperature valves.

Trace amounts of chloride contamination have been found on diaphragm samples; however, no mechanism for chlorine induced degradation has been identified.

Extensive evaluations performed to date indicate that the most likely cause of the accelerated diaphragm degradation is manufacturing differences in the material composition of diaphragms produced between 1989 and 1994. Specifically, these diaphragms contain a lower nitrile content, which could result in reduced resistance to aging.

Safety Significance:

The safety significance of this event was minimal; however, the Supply System considers any degradation of the control rod drive system to be serious. Immediate actions were taken to increase the scope of the scram time testing and this testing was repeated weekly until the shutdown for the 1994 maintenance and refueling outage. Operators were directed to begin an orderly reactor shutdown if any additional control rod failed to scram. The Supply System was preparing to replace the entire elastomeric kit including diaphragms beginning April 4, 1994, when Control Rod 06-39 failed to scram on March 26, 1994. This plan was in place due to the indications in February 1994 that the elastomers were nearing end of life.

The mechanism that prevented Control Rod 06-39 from scramming was a low probability combination of pressure and exhaust diaphragm malfunctions resulting from elastomer degradation. No other case of a control rod failing to scram has occurred at WNP-2.

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Bench tests demonstrated that both a degraded pressure diaphragm and an exhaust diaphragm containing a crack are required to reproduce the failure to scram. The exhaust diaphragm crack must also have a flow area greater than the bleed passage through the topworks for the failure to occur. Due to the conditions that must be met for a rod to fail to scram, the chance of diaphragm degradation causing more than one rod to fail to scram is considered low. The plant's Final Safety Analysis Report documents that occurrence of a limited number of rods failing to scram would not adversely affect the capability of the reactivity control systems to maintain the core within transient analysis fuel design limits.

Several systems and methods are available to insert a control rod that fails to scram or to shut down the reactor if necessary. These systems and methods include the control rod drive system, the backup scram solenoid valves, the alternate control rod insertion system, boron injection, and local manual control rod drive system valve operation.

Two backup scram solenoid valves energize to depressurize the control rod drive air header upon a scram signal from the Reactor Protection System. Actuation of either valve vents the air supply for the scram valves. This action initiates insertion of withdrawn control rods regardless of the action of the SSPVs. Periodic testing is performed to verify proper operation of the backup scram solenoid valves.

The alternate control rod insertion system can be manually initiated from the control room front panel to depressurize the control rod drive air header. This system operates without reliance on the SSPVs. Emergency Operating Procedures direct manual initiation of this system if control rods fail to fully insert following a scram. Periodic testing is performed to verify proper operation of this system.

An Emergency Operating Procedure provides direction for injection of boron as a soluble neutron absorber using the Standby Liquid Control [BR], Reactor Core Isolation Cooling [BN], or Reactor Water Cleanup [CE] systems.

Individual control rods may be inserted by locally venting control rod overpiston volumes.

In summary, this event had low safety significance since only one rod failed to scram (an analyzed condition), the unusual failure mechanism had a low probability of occurrence making additional failures unlikely, and several redundant or backup systems were available to insert control rods or otherwise shut down the reactor. All Technical Specification scram time requirements were met for the remaining control rods.

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Previous Similar Events:

There have been no previous events at WNP-2 where a control rod has failed to scram.

Two recent events were identified where SSPV diaphragm degradation was found. On December 4, 1993, Control Rod 14-55 was found to have a slower than normal, but Technical Specification allowable, scram time. When Control Rod 14-55 was scrammed for SSPV replacement on January 7, 1994, its two-by-two array average insertion time exceeded Technical Specification limits. On January 31, 1994, Control Rod 02-19 exhibited air leakage from a SSPV exhaust port while performing half scram surveillance testing. The SSPVs for these control rods were disassembled and inspected in February 1994. The diaphragms were found degraded (hardened, cracked, and set). All SSPVs were originally scheduled to be refurbished during the 1995 refueling outage; this date had been selected based on the previous replacement in 1990 and a 5.5 year qualified service life. Due to the discovery of the degraded diaphragms, the refurbishment was rescheduled to begin on April 4, 1994, prior to the planned start of the 1994 refueling outage. These corrective actions had not begun by the March 26 failure of Control Rod 06-39 to scram, but had been planned and replacement diaphragms had been delivered.

One event was identified where hardening of elastomers caused a SSPV malfunction. On May 3, 1989, a SSPV stuck in an intermediate position following insertion of a half scram for Average Power Range Monitor [IG] system repair. This created a partial vent path from the scram header, but leakage was not large enough to cause an unplanned scram. The SSPV diaphragms were in good condition (pliable with no set); however, several o-ring gaskets had become brittle. This condition did not affect the scram capability for the control rod. Corrective actions resulting from this event resulted in the rebuilding of SSPVs during the 1990 refueling outage and the reduction of the qualified service life from 7 years to 5.5 years.

The original qualified life had been set to 7 years based on GE operating experience at the time (1983) with no reduction for shelf time applied. Extensive studies performed from 1987 to 1989 of natural aging of stored elastomers confirmed that shelf time had very little effect on elastomer life when proper storage conditions, as applied at WNP-2, are used.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

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Additional information required by 10 CFR 21:

Component supplier: General Electric (GE) Nuclear Energy

Supplier part number: 317A6168P002

Component manufacturer: Automatic Switch Company (ASCO)

Use of component: 740 of these diaphragms are used in SSPVs at WNP-2. Other GE Boiling Water Reactors use these diaphragms in similar applications; however, the Supply System does not have a comprehensive list of all uses of these diaphragms at other facilities subject to 10 CFR 21.

Advice: GE Nuclear Energy Rapid Information Communication Services Information Letter (RICSIL) No. 069 Revision 1 dated May 11, 1994, contains interim recommendations that should be reviewed by other plants using these diaphragms.