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July 22, 1994

**C. R. Hutchinson**

Vice President

Operations

Grand Gulf Nuclear Station

U.S. Nuclear Regulatory Commission  
Mail Station P1-137  
Washington, D.C. 20555

Attention: Document Control Desk

SUBJECT: Grand Gulf Nuclear Station  
Unit 1  
Docket No. 50-416  
License No. NPF-29  
Update to Voluntary Report Due to Slow Scram Times  
for Multiple Control Rods  
LER 94-006-01

GNRO-94/00100

Gentlemen:

Attached is Licensee Event Report (LER) 94-006-01 which is a final report.

Yours truly,

CRH/RR/  
attachment

cc:

Mr. R. H. Bernhard (w/a)  
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NRC FORM 366 (5-92)		U.S. NUCLEAR REGULATORY COMMISSION				APPROVED BY OMB NO. 3150-0104 EXPIRES 5/31/95				
<b>LICENSEE EVENT REPORT (LER)</b>						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 (MNB 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				
FACILITY NAME (1) <b>Grand Gulf Nuclear Station</b>						DOCKET NUMBER (2) <b>05000-416</b>		PAGE (3) <b>01 of 05</b>		
TITLE (4) <b>Update to Voluntary Report Due To Slow Scram Times Of Multiple Control Rods</b>										
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
05	28	94	94	006	01	07	22	94	N/A	05000
OPERATING MODE (9)			THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR § (Check one or more (11))							
1			20.402(b)			20.405(c)			50.73(a)(2)(iv)	
POWER LEVEL (10)			20.405(a)(1)(i)			50.36(c)(1)			50.73(a)(2)(v)	
100			20.405(a)(1)(ii)			50.36(c)(2)			50.73(a)(2)(vii) <input checked="" type="checkbox"/> OTHER	
			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)	
			20.405(a)(1)(v)			50.73(a)(2)(iii)			50.73(a)(2)(x)	
(Specify in abstract below and in text, NRC Form 366A) <b>10 CFR 21 VOLUNTARY</b>										
LICENSEE CONTACT FOR THIS LER (12)										
NAME <b>Riley Ruffin / Licensing Specialist</b>						TELEPHONE NUMBER (Include Area Code) <b>601-437-2167</b>				
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
SUPPLEMENTAL REPORT EXPECTED (14)						EXPECTED		MONTH		DAY
YES (If yes, complete EXPECTED SUBMISSION DATE)				<input checked="" type="checkbox"/> NO		SUBMISSION DATE (15)				
<b>ABSTRACT</b> (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16) <p>On May 28, 1994 during scram time testing of control rods, plant personnel identified that the scram times (to notch 43) for two control rods were not acceptable as defined by GGNS Technical Specifications. The two failures only constituted 10 percent of the random sample of rods which is an acceptable number of failures as specified by GGNS TS. Therefore, further testing was not required by GGNS TS. However, testing continued due to recent concerns with delayed operation of the scram pilot valves identified on March 26, 1994 and reported in LER 94-004, dated April 26, 1994. Subsequently, all control rods were tested. Out of all rods tested, 38 had unacceptable scram times. As a part of the continued testing, pilot valves associated with slow rods were reworked, retested and returned to service. All TS requirements were met during testing. Based on current fuel exposure, an engineering evaluation indicated that the Minimum Critical Power Ratio safety limit would not have been exceeded as a result of the observed scram times. Therefore, the health and safety of the public were not compromised as a result of this condition.</p> <p>The malfunction is believed to be the retarded release of the disc material from the seating surface in the upper valve body. Subsequent test results indicate that the elastomer disc material is different from the disc material in pilot valves and rebuild kits installed prior to RFO6. The affected valves have been reworked using a more reliable top head assembly vintage. Rebuild kits or top head assemblies manufactured after 1989 appear to be suspect.</p> <p>Even though this condition does not meet reporting criteria as specified in 10 CFR 50.73, it is being submitted as a voluntary event report. This condition is considered to be reportable pursuant to 10 CFR 21.</p>										

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

### A. Reportable Occurrence

During scram time testing on May 28, 1994, several control rods were observed to have unacceptable scram times to notch 43 (10 percent insertion). Even though during testing no condition was identified that would compromise plant safety, or meet the reporting requirements, the observed condition is being voluntarily submitted as an event report. Additionally, this condition is reportable pursuant to 10 CFR 21.

### B. Initial Condition

On March 27, 1994, the plant was voluntarily shutdown to investigate control rods with slow scram times. At that time, the cause of this condition was incorrectly attributed to the use of a thread sealant compound that contained a methacrylate ester on the air supply connections for the scram pilot valves. Based on the available information, it was surmised that the compound caused the elastomer seats to slightly adhere to the adjacent seating surface which resulted in a slight delay in the initial opening of the pilot valve's exhaust port. This condition was reported in LER 94-004, dated April 26, 1994. All top head assemblies were cleaned using a dilute cleaning solution. Following retesting, the plant was restarted and returned to full power operations. Efforts to confirm the root cause were continued through additional testing by onsite personnel, GE labs as well as limited testing by an independent lab.

On May 28, the scram time surveillance was being performed at an increased frequency, as directed by the Plant Safety Review Committee (PSRC), to confirm the adequacy of previous corrective actions. The reactor was in OPERATIONAL CONDITION 1 with reactor power at approximately 75 percent power.

### C. Description of Occurrence

On May 28, 1994, plant personnel were performing scram time testing of control rods [AA]. A random sample of 20 rods was chosen for testing. Two of the 20 rods had scram times to notch 43 which exceeded GGNS TS surveillance time requirements. These rods were declared inoperable, reworked and satisfactorily returned to service. Even though the number of failures that occurred during this test met the TS limit of less than 20 percent failures, the PSRC directed subsequent testing for the remaining rods.

The plant operated at approximately 75 percent power while testing was performed using existing plant procedures. Upon identification of unacceptable (exceeding TS values) scram times, personnel declared the applicable rod inoperable and took appropriate actions. All TS requirements were met during testing.

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Of the 193 tested rods, 153 were fast (reached notch 43 within ~300 ms), 5 were normal (notch 43 between ~300 and 310 ms), 25 were slow (reached notch 43 between ~310 and 380 ms), 8 failed (reached notch 43 greater than ~380 ms). Due to test switch failures, as-found data for two additional rods was not taken. Scram pilot valves for the two rods with no data and the 38 rods which were not considered fast were reworked and retested satisfactorily.

#### D. Apparent Cause

GGNS has completed its investigation of this condition at this time although additional vendor testing is ongoing. The existing data indicates a defect (as defined by 10 CFR 21.3(d)(4)) in the pre-assembled top head assemblies used to rebuild the scram pilot valves during RFO6. The defect appears to be associated with the seating material located in the disc holder sub-assembly ("milk stool") of the scram pilot valves. The seating material is an elastomer which seats against an internal air port. The seating force is supplied by the disc spring along with energized solenoids. Upon deenergization of the solenoids, the milk stool must be unseated which allows air to vent from above the pilot valve diaphragm. The venting of the air results in a scram of the associated rod. The malfunction is believed to be the retarded release of the disc material from the seating surface in the upper valve body which results in a slow (only milliseconds) start of the control rod. This slow start causes the rod to be slow to notch 43 (greater than ~310 ms).

Results from root cause investigation activities indicate that the seating material furnished in new pre-assembled top head assemblies (Part # 167B4163P002) is different from the seating material that was installed prior to Refueling Outage 6. However, the exact failure mechanism is still under investigation by vendor personnel.

Testing of solenoid valves has confirmed a defect (as defined by 10 CFR 21.3(d)(4)) in the pre-assembled top head assemblies which were installed during RFO6. Results from vendor testing of spare valves of the same vintage obtained from KKL Station in Leibstadt, Switzerland are described below. The test consisted of installing new top head assemblies on pressurized volumes and measuring the time from deenergization of the solenoids to volume depressurization. On July 2, the valves were initially tested after being energized for less than an hour. The valves were then reenergized for 11 consecutive days and retested on July 13. Three of the eight valves tested exhibited increases in response times which indicated valve degradation over a period of time without the introduction of contaminants.

Additionally, on July 16, 1994, GGNS commenced as-found scram time testing of 60 control rods. The rods were divided into three categories. **Group A** consisted of 20 reinstalled pre-RFO6 top head assemblies; **Group B** consisted of 20 top head assemblies that had been rebuilt with pre-1989 vintage rebuild kits which had been cleaned using a dilute cleaning solution, and **Group C** consisted of 2 older vintage rebuild kits and 18 newer top head assemblies which were not cleaned using the cleaning solution and had not been exposed to a methacrylate ester thread sealant.

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Control rods in each Group were scram time tested to position 43. The results are as follows:

**Group A**--no failures / average time (233 ms);

**Group B**--no failures / average time (228 ms);

**Group C**--5 of the 18 newer head assemblies exceeded GGNS administrative acceptance criteria (2 slow, 3 marginal; data for one rod was not recorded due to equipment problems).

The Group C failure rate is consistent with failure rates observed during earlier testing.

The results of the July 13 vendor testing and the July 16 testing of installed valves at GGNS clearly indicate a difference in the performance and reliability of the newer pre-assembled top head assemblies as compared to the previously supplied valves and rebuild kits (pre-1989). Inspections and material testing also indicate differences in the characteristics of the pre-RFO6 seating material as compared to the newer vintage seating material which was installed during RFO6. Although these differences could not be absolutely tied to the root cause failure mechanism, it is believed that further testing by the vendor will reveal the exact nature of the problem with the top head assemblies as delivered. Therefore, the cause of the observed anomalies is attributed to a material defect, as defined by 10 CFR 21.3(d)(4).

#### **E. Corrective Actions**

GGNS has completed testing and replacement activities of the new top head assemblies with head assemblies from an older vintage known not to have the defect. The accelerated testing scheduled will continue until reasonable assurance exists that the appropriate steps have been taken to correct the observed anomalies. Additional vendor testing is currently in progress in an attempt to determine the relationship between possible material differences and slow scram times.

#### **F. Safety Assessment**

The affected control rods experienced slow starts. The individual scram times observed for some rods were slower than those used in the Cycle 7 safety analyses. In the analyses, this condition is of primary concern during rapid pressurization transients (e.g., Generator Load Reject Without Bypass). The conservative analyses indicate that in the event of slow rods, the Minimum Critical Power Ratio (MCPR) limits could be exceeded near the end-of-core life (when the axial power shape is peaked towards the top of the core). Therefore, the control rod insertion time to the point where power is turned becomes the limiting action.



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At the time of discovery, GGNS was approximately 35 percent into cycle 7; thus the axial power peak shape was closer to the bottom of the core. This allows rods being inserted from the full-out position to promptly turn power which would prevent MCPR safety limit violations in the event of a transient that depends upon control rod insertion for mitigation. Even though some rod times are slower than those assumed by the Cycle 7 analyses, the average time was well within the assumed time to notch 43. Additionally, localized over-power conditions in the area of slow rods are not expected to occur due to the closely coupled design of the GGNS core in which core-wide negative reactivity effects dominate. Therefore, the analyses bound the identified condition due to the current fuel exposure, core design and operating strategy.

As the cycle progresses, the axial power shape will shift upward in the core, fewer control rods are inserted and the void coefficient of reactivity becomes more negative. Subsequently, core conditions will be reached where a limiting transient coupled with the scram times observed during testing could violate the MCPR safety limit. This condition was conservatively determined to be 132 EFPD from May 28, 1994.

All rods have been satisfactorily retested. Therefore, there are no concerns associated with approaching plant safety limits due to slow control rods. In the present plant condition, there is no compromise in the health and safety of the public.

#### G. Additional Information

Manufacturer:    **Automatic Switch Co.**  
Valve Model:    **HV-176-816**  
Supplier:        **General Electric (Part # 922D138)**

The Part Number for the Top Head Assemblies that were installed during RFO6 is **167B4163P002**.

Energy Industry Identification System (EIIIS) codes are identified in the text within brackets [ ].