



Entergy Operations, Inc.

Waterloo Road
P.O. Box 756
Port Gibson, MS 39150
Tel 601 437 6299

Charles A. Bottemiller

Manager
Plant Licensing

GNRO-2006/00043

August 14, 2006

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Document Control Desk

Subject: LER 2006-001-00 – Division 1 Diesel Generator Exhaust Valve
Failure
Grand Gulf Nuclear Station
Unit 1
Docket No. 50-416
License No. NPF-29

Dear Sir or Madam:

Attached is Licensee Event Report (LER) 2006-001-00 which is a final report.

This letter does not contain any commitments.

Yours truly,

A handwritten signature in black ink, appearing to be "CAB".

CAB/DMC/dmc

Attachment: LER 2006-001-00
cc: (See Next Page)

cc: NRC Senior Resident Inspector
Grand Gulf Nuclear Station
Port Gibson, MS 39150

U. S. Nuclear Regulatory Commission
ATTN: Dr. Bruce S. Mallet (w/2)
Regional Administrator, Region IV
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011-4005

U. S. Nuclear Regulatory Commission
ATTN: Mr. Bhalchandra Vaidya, NRR/DORL (w/2)
ATTN: ADDRESSEE ONLY
ATTN: U. S. Postal Delivery Address Only
Mail Stop OWFN/O-7D1A
Washington, DC 20555-0001

Mr. D. E. Levanway (Wise Carter)
Mr. L. J. Smith (Wise Carter)
Mr. N. S. Reynolds
Mr. J. N. Compton

LICENSEE EVENT REPORT (LER)

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

Estimated burden per response to comply with this mandatory collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/Privacy Service Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

1. FACILITY NAME

Grand Gulf Nuclear Station, Unit 1

2. DOCKET NUMBER

05000 416

3. PAGE

1 OF 5

4. TITLE Division 1 Diesel Generator Exhaust Valve Failure

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED																																					
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER																																				
05	12	2006	2006	- 001 -	00	08	09	2006	N/A	N/A																																				
9. OPERATING MODE			11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR§: (Check all that apply)																																											
1			<table border="0"><tr><td><input type="checkbox"/> 20.2201(b)</td><td><input type="checkbox"/> 20.2203(a)(3)(i)</td><td><input type="checkbox"/> 50.73(a)(2)(i)(C)</td><td><input type="checkbox"/> 50.73(a)(2)(vii)</td></tr><tr><td><input type="checkbox"/> 20.2201(d)</td><td><input type="checkbox"/> 20.2203(a)(3)(ii)</td><td><input type="checkbox"/> 50.73(a)(2)(ii)(A)</td><td><input type="checkbox"/> 50.73(a)(2)(viii)(A)</td></tr><tr><td><input type="checkbox"/> 20.2203(a)(1)</td><td><input type="checkbox"/> 20.2203(a)(4)</td><td><input type="checkbox"/> 50.73(a)(2)(ii)(B)</td><td><input type="checkbox"/> 50.73(a)(2)(viii)(B)</td></tr><tr><td><input type="checkbox"/> 20.2203(a)(2)(i)</td><td><input type="checkbox"/> 50.36(c)(1)(i)(A)</td><td><input type="checkbox"/> 50.73(a)(2)(iii)</td><td><input type="checkbox"/> 50.73(a)(2)(ix)(A)</td></tr><tr><td><input type="checkbox"/> 20.2203(a)(2)(ii)</td><td><input type="checkbox"/> 50.36(c)(1)(ii)(A)</td><td><input type="checkbox"/> 50.73(a)(2)(iv)(A)</td><td><input type="checkbox"/> 50.73(a)(2)(x)</td></tr><tr><td><input type="checkbox"/> 20.2203(a)(2)(iii)</td><td><input type="checkbox"/> 50.36(c)(2)</td><td><input type="checkbox"/> 50.73(a)(2)(v)(A)</td><td><input type="checkbox"/> 73.71(a)(4)</td></tr><tr><td><input type="checkbox"/> 20.2203(a)(2)(iv)</td><td><input type="checkbox"/> 50.46(a)(3)(ii)</td><td><input type="checkbox"/> 50.73(a)(2)(v)(B)</td><td><input type="checkbox"/> 73.71(a)(5)</td></tr><tr><td><input type="checkbox"/> 20.2203(a)(2)(v)</td><td><input type="checkbox"/> 50.73(a)(2)(i)(A)</td><td><input type="checkbox"/> 50.73(a)(2)(v)(C)</td><td><input checked="" type="checkbox"/> OTHER</td></tr><tr><td><input type="checkbox"/> 20.2203(a)(2)(vi)</td><td><input type="checkbox"/> 50.73(a)(2)(i)(B)</td><td><input type="checkbox"/> 50.73(a)(2)(v)(D)</td><td>Specify in Abstract below or in NRC Form 366A</td></tr></table>								<input type="checkbox"/> 20.2201(b)	<input type="checkbox"/> 20.2203(a)(3)(i)	<input type="checkbox"/> 50.73(a)(2)(i)(C)	<input type="checkbox"/> 50.73(a)(2)(vii)	<input type="checkbox"/> 20.2201(d)	<input type="checkbox"/> 20.2203(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(viii)(A)	<input type="checkbox"/> 20.2203(a)(1)	<input type="checkbox"/> 20.2203(a)(4)	<input type="checkbox"/> 50.73(a)(2)(ii)(B)	<input type="checkbox"/> 50.73(a)(2)(viii)(B)	<input type="checkbox"/> 20.2203(a)(2)(i)	<input type="checkbox"/> 50.36(c)(1)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(iii)	<input type="checkbox"/> 50.73(a)(2)(ix)(A)	<input type="checkbox"/> 20.2203(a)(2)(ii)	<input type="checkbox"/> 50.36(c)(1)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(iv)(A)	<input type="checkbox"/> 50.73(a)(2)(x)	<input type="checkbox"/> 20.2203(a)(2)(iii)	<input type="checkbox"/> 50.36(c)(2)	<input type="checkbox"/> 50.73(a)(2)(v)(A)	<input type="checkbox"/> 73.71(a)(4)	<input type="checkbox"/> 20.2203(a)(2)(iv)	<input type="checkbox"/> 50.46(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(v)(B)	<input type="checkbox"/> 73.71(a)(5)	<input type="checkbox"/> 20.2203(a)(2)(v)	<input type="checkbox"/> 50.73(a)(2)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(v)(C)	<input checked="" type="checkbox"/> OTHER	<input type="checkbox"/> 20.2203(a)(2)(vi)	<input type="checkbox"/> 50.73(a)(2)(i)(B)	<input type="checkbox"/> 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A
<input type="checkbox"/> 20.2201(b)	<input type="checkbox"/> 20.2203(a)(3)(i)	<input type="checkbox"/> 50.73(a)(2)(i)(C)	<input type="checkbox"/> 50.73(a)(2)(vii)																																											
<input type="checkbox"/> 20.2201(d)	<input type="checkbox"/> 20.2203(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(viii)(A)																																											
<input type="checkbox"/> 20.2203(a)(1)	<input type="checkbox"/> 20.2203(a)(4)	<input type="checkbox"/> 50.73(a)(2)(ii)(B)	<input type="checkbox"/> 50.73(a)(2)(viii)(B)																																											
<input type="checkbox"/> 20.2203(a)(2)(i)	<input type="checkbox"/> 50.36(c)(1)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(iii)	<input type="checkbox"/> 50.73(a)(2)(ix)(A)																																											
<input type="checkbox"/> 20.2203(a)(2)(ii)	<input type="checkbox"/> 50.36(c)(1)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(iv)(A)	<input type="checkbox"/> 50.73(a)(2)(x)																																											
<input type="checkbox"/> 20.2203(a)(2)(iii)	<input type="checkbox"/> 50.36(c)(2)	<input type="checkbox"/> 50.73(a)(2)(v)(A)	<input type="checkbox"/> 73.71(a)(4)																																											
<input type="checkbox"/> 20.2203(a)(2)(iv)	<input type="checkbox"/> 50.46(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(v)(B)	<input type="checkbox"/> 73.71(a)(5)																																											
<input type="checkbox"/> 20.2203(a)(2)(v)	<input type="checkbox"/> 50.73(a)(2)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(v)(C)	<input checked="" type="checkbox"/> OTHER																																											
<input type="checkbox"/> 20.2203(a)(2)(vi)	<input type="checkbox"/> 50.73(a)(2)(i)(B)	<input type="checkbox"/> 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A																																											
10. POWER LEVEL																																														
100																																														

12. LICENSEE CONTACT FOR THIS LER

FACILITY NAME

Grand Gulf Nuclear Station - Dennis M. Coulter, Senior Licensing Specialist

TELEPHONE NUMBER (Include Area Code)

601-437-6595

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

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
B	EK	DG	T383	Yes					

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES (If yes, complete 15. EXPECTED SUBMISSION DATE)☒ NO

15. EXPECTED SUBMISSION DATE

MONTH	DAY	YEAR

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)

NRC FORM 366 (6-2004)

This is a Voluntary LER.

On May 12, 2006 following a post maintenance test of Division 1 Diesel Generator, both exhaust valves in cylinder head 8L were found to have developed cracks going through the outer lapping tool holes on the valves. One of the valve cracks had propagated to failure.

The cracked valves were shipped to an off-site laboratory for analysis. Intergranular Corrosion Cracking was determined to be the cracking mechanism. The root cause of the valve cracking was the valve material - highly sensitized austenitic stainless steel. This sensitized valve material in the presence of moisture in the valve head creating sulfurous acid from the residual sulfur in combustion products led to cracking and subsequent failure. The source of the moisture was jacket cooling water leaking through a small crack in the cylinder head.

The diesel was repaired and returned to service. An evaluation determined that the diesel could have performed its design function even with one of sixteen cylinders not firing. However, due the importance of communicating this issue to the nuclear industry, GGNS has elected to submit this voluntary LER.

LICENSEE EVENT REPORT (LER)

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
Grand Gulf Nuclear Station, Unit 1	05000 416	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	2 OF 5
		2006	— 001 —	00	

A. REPORTABLE OCCURRENCE

This is a voluntary LER to provide information to the NRC and nuclear industry concerning cracking of two Division 1 Diesel Generator [DG] exhaust valves. One of the valve cracks propagated to failure resulting in a piece of the valve breaking off.

Prior to this failure the DG successfully ran on April 26, 2006 as well as on May 11, 2006. The failure occurred on a second run on May 11, 2006. Based on the two prior successful runs and the failure analysis, there is no firm evidence that the failure would have occurred earlier. As such the failure is assumed at the time of discovery – May 11, 2006 at 1707.

B. INITIAL CONDITIONS

At the time of the event the reactor was in Mode 1 operating at approximately 100% power and 1350 MW electrical. Reactor parameters were about: temperature 527 degrees Fahrenheit, pressure 1034 psig, and water level 36 inches. Planned maintenance was being performed on Division 1 DG.

C. DESCRIPTION OF OCCURRENCE

On May 10, 2006 at 0358 a planned 44 hour maintenance outage on the Division 1 DG was begun. Division 1 DG is a TransAmerica Delaval Model DSRV-16-4 diesel.

On May 11, 2006 at 1700 planned outage activities were successfully completed on schedule. At 1707 about 20 minutes into a loaded maintenance retest the DG tripped on "High Vibration." (Note: high vibration trip is bypassed in emergency run.) An investigation revealed that the left bank turbocharger vibration switch had tripped. There were no other performance problems. No abnormal noises were observed locally by operators, maintenance, or engineers during the event.

On May 11, 2006 at 1800 the turbocharger vibration switch was replaced and the removed vibration switch was quarantined for later testing. During the retest run, the governor was observed to be "hunting" and abnormal cylinder exhaust temperature readings were observed. The expected range for cylinder exhaust temperatures is 760 to 960 degrees Fahrenheit. The abnormal readings were: #8L cylinder about 320 degrees Fahrenheit, the #1L cylinder about 1190 degrees Fahrenheit, and #3R cylinder at about 1015 degrees Fahrenheit. However, as noted in section F, the diesel remained functional.

NRC FORM 366A (1-2001)		U.S. NUCLEAR REGULATORY COMMISSION		
LICENSEE EVENT REPORT (LER)				
1. FACILITY NAME	2. DOCKET	6. LER NUMBER		3. PAGE
Grand Gulf Nuclear Station, Unit 1	05000 416	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER
		2006	-- 001 --	00
				3 OF 5

On the morning of May 12th, an analysis team was formed and potential causes for the abnormal cylinder exhaust temperature readings were identified. The combustion air path for #8L cylinder was inspected and no blockages were found. Next, the fuel injector was removed and boroscopic inspection of the #8L cylinder revealed that one of the two exhaust valves was broken and a piece of the valve was missing. Cylinder head #8L was removed and found to have a small crack. This small crack was later determined to be a through-wall crack that allowed jacket cooling water to enter the cylinder. This crack was the source of moisture in the cylinder. The #8L cylinder head was a Group 1 head (see NUREG 1216 for a discussion of head Groups).

Operations verified actions required to enter a 14 day allowed outage time to permit systematic troubleshooting and repair of Division 1 DG. Actions included briefing operators on loss of power actions, briefing Operations and Electrical Maintenance personnel on emergency contingency procedures for cross tying the Division 3 DG with Division 1 DG switchgear, and verifying that no maintenance was planned or in progress in the switchyard or on high pressure systems.

D. APPARENT CAUSE

The failure mechanism of the two exhaust valves was intergranular corrosion cracking.

The failure of the exhaust valves was the result of two issues:

- 1) A susceptible valve material.
- 2) A through-wall crack in the group 1 cylinder head.

The valves were made of valve steel 21-12N, an austenitic stainless steel. This material is susceptible to intergranular corrosion cracking.

The through-wall crack in the Group 1 cylinder head resulted in a source of moisture in the #8L cylinder. The leak was so small that it was not detectable by air rolling the diesel prior to start. No water was observed in the cylinder upon disassembly.

The water that leaked into the cylinder head reacted with the sulfur in the carbon deposits on the valves to form a sulfurous acid species. This species of sulfurous acid consists of 2 hydrogen atoms, 2 to 7 sulfur atoms and 6 oxygen atoms. The small amount of moisture that entered the cylinder resulted in a high concentration of sulfurous acid species. If the leak had been large enough to have been detectable during an air roll, a condition that would render the diesel inoperable, the sulfurous acid formed would have been diluted to a point where it would not have contributed significantly to intergranular corrosion cracking.

LICENSEE EVENT REPORT (LER)

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Grand Gulf Nuclear Station, Unit 1	05000 416	2006	-- 001 --	00	4 OF 5

E. CORRECTIVE ACTIONS**Immediate Corrective Actions**

1. Inspected #8 L cylinder head, exhaust header, and turbocharger.
2. Shipped damaged exhaust valves and intake valves from the #8 LB cylinder head off-site for metallurgical analysis.
3. Removed broken piece of valve from the stationary vane of the turbocharger.
4. Replaced the cylinder liner, cylinder head, piston rings, and both exhaust and intake valves on DG, #8L cylinder.
5. Cleaned, polished and reinstalled the #8L piston.
6. Conducted boroscopic examination of the remaining 15 cylinders. No additional water leaks or valve cracking found.
7. Sampled Lube Oil to confirm that no Jacket Water had entered into the Lube Oil system.
8. Performed post-maintenance retest on the DG to break-in new piston rings and other maintenance items.
9. Implemented new monitoring method for detecting small amounts of moisture in engine cylinders. Method uses an aluminum plate with moisture detection paste.

Long Term Corrective Actions

CR-GGN-2006-01955 was written.

Inspected Division 2 DG for similar concerns.

Perform quarterly boroscope visual inspections of group 1 heads in both Division 1 and Division 2 DGs.

Continue using moisture detection paste to detect moisture in diesel cylinders during air rolls.

LICENSEE EVENT REPORT (LER)

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Grand Gulf Nuclear Station, Unit 1	05000 416	2006	-- 001 --	00	5 OF 5

F. SAFETY ASSESSMENT

This is a Voluntary LER to provide information to the NRC and nuclear industry concerning cracking of two Division 1 DG exhaust valves. One of the valve cracks propagated to failure resulting in a piece of the valve breaking off.

A detailed evaluation of DG operability and event reportability for the exhaust valve failure was conducted. The evaluation addressed numerous issues in detail, such as crankshaft stresses from an unloaded cylinder and frequency and voltage fluctuations, and concluded that none of the issues represented a condition that would have prevented the Division 1 DG from performing its safety function of providing electric power to the loads on the Division 1 ESF bus within rated voltage and frequency. The diesel was originally rated at 7 MW and was later derated to 5.74 MW in the mid-1980s. Sufficient margin remained with the loss of one of sixteen cylinders to produce an output of 5.74 MW.

Based on this evaluation, the DG would have been capable of starting and accepting the sequenced loads while restoring voltage and frequency within specification. The DG would have been capable of supplying power to these loads for a 30 day post accident period and was considered fully functional. As a result there was no safety significance with regard to the ability of the DG to respond to plant initiations and perform its mitigating function.

Additionally, Division 2 DG was operable during the time of discovery and throughout the allowed outage time.

G. ADDITIONAL INFORMATION

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

There were no previously submitted GGNS LERs or occurrences similar to the event described in this LER during the last ten years.