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10 CFR 50.73

W3F1-2013-0063

November 7, 2013

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
11555 Rockville Pike
Rockville, MD 20852

Subject: Licensee Event Report (LER) 2013-005-01
Waterford Steam Electric Station, Unit 3 (Waterford 3)
Docket No. 50-382
License No. NPF-38

Dear Sir or Madam:

Entergy is hereby submitting Licensee Event Report (LER) 2013-005-01, a revision, for Waterford Steam Electric Station, Unit 3 (Waterford 3). This report provides details associated with inoperability of an emergency diesel generator due to failure of the room exhaust fan and includes a planned update to the safety significance evaluation.

Based on plant evaluation, it was determined that this condition is reportable pursuant to 10 CFR 50.73(a)(2)(i)(B), 10 CFR 50.73(a)(2)(ii)(B), and 10 CFR 50.73(a)(2)(v)(D).

This report contains no new commitments. Please contact John P. Jarrell, Licensing Manager, at (504) 739-6203 if you have questions regarding this information.

Sincerely,

JPJ/WH

Attachment: Licensee Event Report 2013-005-01

IE22
NRR

cc: Mr. Marc L. Dapas, Regional Administrator
U.S. NRC, Region IV
RidsRgn4MailCenter@nrc.gov

U.S. NRC Project Manager for Waterford 3
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U.S. NRC Senior Resident Inspector for Waterford 3
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Attachment to

W3F1-2013-0063

Licensee Event Report 2013-005-01

NRC FORM 366 (10-2010) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 10/31/2013

LICENSEE EVENT REPORT (LER)

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

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
Waterford 3 Steam Electric Station	05000 382	1 OF 6

4. TITLE

Emergency Diesel Generator Inoperable Due To Room Exhaust Fan 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
5	22	2013	2013	- 005 -	01	11	07	2013	FACILITY NAME	DOCKET NUMBER

9. OPERATING MODE

Mode 1

10. POWER LEVEL

100%

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)

☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(i)(C)	☐ 50.73(a)(2)(vii)
☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☒ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☐ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☐ OTHER Specify in Abstract below or in NRC Form 366A
☐ 20.2203(a)(2)(vi)	☒ 50.73(a)(2)(i)(B)	☒ 50.73(a)(2)(v)(D)	

12. LICENSEE CONTACT FOR THIS LER

FACILITY NAME	TELEPHONE NUMBER (*Include Area Code*)
Waterford 3 Steam Electric Station John Jarrell	(504) 739-6685

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
X	VJ	FAN	J127	Y						

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*)

Waterford 3 declared Emergency Diesel Generator B (EDG-B) inoperable on May 22, 2013 due to inability to maintain room temperature within design limits. Subsequent trouble shooting revealed that the variable pitch room exhaust fan had failed due to separation of the fan hub from the hub sleeve. Examination of recent operating data showed that the first evidence of fan failure had been during a surveillance test the previous month. An apparent cause evaluation determined the probable cause of the failure to be the result of repairs made during a previous (1999) fan motor replacement. These repairs caused additional stresses on the fan hub components which eventually resulted in fan hub separation from the hub sleeve. The EDG-B room exhaust fan was repaired and EDG-B operability was restored on May 26, 2013. Safety significance for the event is characterized as low to moderate. This condition is reportable under the following criteria:
10 CFR 50.73(a)(2)(i)(B), 10 CFR 50.73(a)(2)(ii)(B), and 10 CFR 50.73(a)(2)(v)(D).

INITIAL CONDITIONS
Waterford Steam Electric Station, Unit 3 (Waterford 3), was at or near 100% power when Emergency Diesel Generator B [EK] was declared inoperable due to failure of the room exhaust fan [FAN].

EVENT DESCRIPTION
On 3/17/1999, Emergency Diesel Generator (EDG) B was in operation per OP-903-116, EDG Integrated Test. During the EDG-B fan operation, the fan motor tripped on overcurrent (Condition Report CR-WF3-1999-0381). Trouble shooting determined the motor windings had failed. The fan hub assembly was removed from the motor, a new motor was installed, and the fan hub assembly was reinstalled. During the electrical rotation test for the new motor, the technicians noted the motor was operating in reverse direction. Additionally, the technicians noted that the fan hub spanner nut had loosened and the fan hub had dropped down approximately one foot (vertical fan arrangement with motor on top, fan on bottom) and was no longer attached to the hub sleeve (CR-WF3-1999-0425). The apparent cause evaluation determined that the reverse torque on the fan hub was sufficient to cause the fan hub spanner nut to back off its threads and allow the hub to drop down off the hub sleeve. As the fan hub dropped off the hub sleeve, apparently the spanner nut and hub sleeve threads were slightly damaged. The work order documents that the spanner nut and hub sleeve threads were reworked. In an effort to reduce the likelihood of future events with the spanner nut backing off the sleeve, an Engineering Request (ER) was developed and approved by Design Engineering to allow EDG-B fan hub/sleeve to be reassembled with 6 new set screws instead of the originally furnished 2 set screws. The original equipment manufacturer (Joy Fans purchased by Howden Buffalo) was consulted and approval to make this change was obtained. However, the ER was focused on the like-for-like aspect of the new replacement set screws; there was no discussion of the additional stress the 6 new set screws could potentially have on the spanner nut and hub sleeve threads.

On 3/18/2013, EDG-B was successfully operated for approximately 6 hours per OP-903-068, EDG and Subgroup Relay Operability Test. Room temperature remained in the normal range for the ambient conditions, fan motor current was operating in its normal range at 66 amps, and the fan LO FLOW computer point (PMC point D60417) was indicating normal (NT LO). All of these parameters remained normal throughout this 6 hour diesel run.

On 4/22/2013, Operations department operated EDG-B for approximately 8 minutes for post maintenance checks. Trend records indicate that the EDG-B exhaust fan NT LO FLOW computer point (indicating normal flow) was recorded by the plant monitoring computer (PMC point D60417) for the duration of this run. This was the last time EDG-B exhaust fan was operated with normal air flow indications (NT LO).

On 4/23/2013, planned maintenance was performed on the fan pitch actuator, HVR-502B [TCV]. The maintenance staff replaced the hydramotor with a refurbished hydramotor. The actuator is located outside the fan shroud. Bench testing for the rebuilt hydramotor through full open and full closed stroke was satisfactory.

On 4/25/2013, hydramotor replacement retesting was completed by satisfactorily operating EDG-B per OP-903-068. A later review of trends indicated the fan LO FLOW computer point (PMC point D60417) was indicating abnormal (LO) for the duration of this run; the LO FLOW condition had not occurred prior to this 4/25/2013 run. The LO FLOW PMC point does not alarm in the control room and was not detected by Operations or Engineering at this time. This point is for long term trending and is not necessarily monitored during each EDG run. Computer trends indicated the fan motor current was approximately 64 amps and ambient temperature was approximately 60 deg. F.

On 5/20/2013, planned surveillance testing was completed by satisfactorily operating EDG-B per OP-903-068. A review of trends indicated the fan LO FLOW computer point (PMC point D60417) was abnormal (LO) for the duration of this run. Trends indicated the fan motor current was approximately 64 amps and ambient temperature was approximately 86 deg. F. Operations and Engineering staff noticed that the EDG-B room temperature was above normal with a maximum temperature of approximately 118 deg F and generated CR-WF3-2013-2497 to document this condition. The Operations staff discussed the abnormal EDG-B room temperature with the EDG

and HVAC System Engineers. The engineers indicated the exhaust fan control system does not start to pitch the exhaust fan blades until the room temperature reaches 120 deg F. Engineering provided Engineering Change EC-44759, which indicated the most likely cause for the elevated room temperature was due to a slight misadjustment to the minimum pitch setting on the fan actuator (HVR-502B hydramotor). This was based on knowing the pitch actuator had been replaced on 4/23/2013 and both subsequent times the fan was operated, the LO FLOW indicator was received. Additionally, the fan motor current had also reduced from 67 to 63 amps, which supported this theory. A work request was generated to trouble shoot HVR-502B.

On 5/22/2013, Mechanical maintenance performed trouble shooting. The blade pitch mechanism was inspected, which revealed the EDG-B fan blades not rotating while the fan motor was operating. The blades were viewed from the duct inspection port just below the fan blades. CR-WF3-2013-2530 was generated on this condition and EDG-B was declared inoperable. An Engineering Failure Modes Analysis (FMA) Team was established and an FMA table was completed. The FMA concluded the most likely cause of the fan failure was motor to fan hub coupling damage.

On 5/23/2013, Mechanical maintenance performed further trouble shooting and determined the fan failure was due to a separation of the fan hub from the hub sleeve. The fan hub assembly was disassembled and removed from the fan housing.

On 5/24/2013, a new fan assembly (hub, blades, and sleeve) from the Waterford 3 warehouse was installed in the fan housing. A temporary emergency diesel generator was installed for this maintenance to allow extending the allowed outage time to 10 days.

On 5/25/2013, EDG-B and the room exhaust fan were started for purposes of fan dynamic balancing; vibration data was collected and no balance weights were necessary. Final adjustments were made to the hydramotor and pitch linkage.

On 5/26/2013 at 02:32, EDG-B was declared operable.

REPORTABLE OCCURRENCE

Technical Specification (TS) 3.8.1.1 requires, in part, two separate and independent diesel generators. This requirement is applicable in Modes 1, 2, 3, and 4. An allowed outage time (AOT) of up to 72 hours is specified, or be in at least Hot Standby (Mode 3) within the next 6 hours and in Cold Shutdown (Mode 5) within the following 30 hours. The requirement for restoration to operable status within 72 hours may be extended to 10 days if a temporary emergency diesel generator is verified available.

Examination of recent operating data showed that the first evidence of fan failure had been during a surveillance test the previous month.

As the duration of EDG-B past inoperability exceeded the prescribed AOT, this condition is reportable under the following criteria:

10 CFR 50.73(a)(2)(i)(B): Any operation or condition which was prohibited by the plant's Technical Specifications.

10 CFR 50.73(a)(2)(ii)(B): Any event or condition that resulted in the nuclear power plant being in an unanalyzed condition that significantly degraded plant safety.

10 CFR 50.73(a)(2)(v)(D): Event or condition that could have prevented fulfillment of a safety function of structures or systems that are needed to mitigate the consequences of an accident.

BACKGROUND – SYSTEM DESIGN
Waterford 3 is a Combustion Engineering design pressurized water reactor [AC] with two recirculating type steam generators [SG].

The purpose of the EDG Ventilation System is to remove the heat associated with diesel operation from the EDG A and B Rooms. During normal plant operations, the Reactor Auxiliary Building (RAB) Normal Ventilation System [VF] maintains temperature in the EDG rooms while the EDG Ventilation System [VJ] remains in standby and starts in conjunction with a diesel start.

Each EDG room has its own separate ventilation system consisting of an outside air intake damper, an axial flow exhaust fan, a gravity damper, and an outside air exhaust louver.

Each axial exhaust fan is provided with a STOP/AUTO/START switch. With the switch in the AUTO position, startup of the diesel automatically initiates startup of the respective fan and opening of the respective air intake damper. Flow through the system is controlled by varying the pitch of the axial fan blades in response to its respective room temperature sensor.

In the event of a Loss of Off-site Power, each system is powered from its respective EDG. A single active failure in the ventilation system affects only one of the two EDGs; therefore, one EDG is available to mitigate the consequences of a design basis accident. The EDG room exhaust fan is not a permissive for EDG operation; therefore, a failed EDG room exhaust system will not prevent the EDG from operating.

The amount of air that the axial fan moves is determined by the temperature of the EDG room. The temperature sensor sends a 4-20 milliamp signal, based upon temperature, to the control system. The control system sends a signal to the variable pitch blade controller.

The variable pitch blade controller is a hydramotor. The hydramotor (HVR-502A or B) uses an internal positive displacement pump to provide hydraulic pressure that operates a piston that in turn changes the pitch of the fan blade. By changing the blade pitch, the fan acts to control the amount of air being forced through the system. HVR-502A(B) failure causes the fan blades go to their maximum pitch position. The fan blades also go to their maximum pitch position on a loss of power.

Exhaust fan E-28 (3A-SA) for EDG-A is powered by a 60-horsepower 480 VAC motor which receives power from MCC 3A312-S. Exhaust fan E-28 (3B-SB) for EDG-B is powered by a 100-horsepower 480 VAC motor which receives its power from switchgear bus 3B31. The larger horsepower rating for fan 3B-SB is due to the fan being required to pull air through more intake ductwork. The exhaust fans are both located in the HVAC Equipment Room on the +46 ft elevation.

CAUSAL FACTORS
The apparent cause for the EDG-B room exhaust fan blades not rotating while the fan motor was energized is a combination of three factors that originated in 1999:

- Reworking the threads reduced the allowable stress of the fan hub to sleeve connection.
- Using 6 set screws instead of the original 2 set screws increased the loading on the hub sleeve threads and thus further reduced the allowable stress of the fan hub to sleeve connection.
- Low cycle fatigue loading on the already weakened hub to sleeve connection eventually exceeded the allowable stress level of the connection.

Any single apparent cause alone would not have created this failure; however, when combined, they yield a sufficient reduction in allowable stress to cause the failure of the fan hub. Historical work records do not give sufficient details to make a determination on the degree to which each of these factors played (how much thread

material was removed during the thread rework process or the torque applied to the additional set screws). Therefore, all three factors are considered the apparent cause.

EXTENT OF CONDITION

The failure mechanism for the failed fan was a weakened hub and sleeve threaded connection due to a) previously weakened threads from reworking damaged threads, b) approval to use 6 set screws instead of 2 for the hub to sleeve spanner nut, and c) low cyclic fatigue stress. The only other similar type fan with this hub/sleeve arrangement would be the EDG-A room exhaust fan. The EDG-A room exhaust fan is identical to EDG-B exhaust fan with the exception of the electrical motors. EDG-A room exhaust fan is powered by a 60-horsepower 480 VAC motor and EDG-B room exhaust fan is powered by a 100-horsepower 480 VAC motor. The larger horsepower rating for B fan is due to the fan being required to pull air through more intake ductwork. A review of the maintenance history for the A fan shows the motor was replaced in 2003; however, the work order shows:

1) the fan hub was removed and reinstalled without reverse rotation during the bump test,
2) the fan hub was not removed from the hub sleeve,
3) the hub or spanner nut threads were not reworked, and
4) the spanner nut has only 2 set screws (as furnished from the original equipment manufacturer).
5) Additionally, EDG-A has a 60 hp motor, which reduces the starting torque experienced by the hub by approximately 40% (as compared to EDG-B with a 100 hp motor).

Hence, this condition does not affect the EDG-A room exhaust fan.

CORRECTIVE ACTIONS

- Replace EDG-B Exhaust Fan Hub Assembly (completed).
- Restore EDG-B operability (completed).
- Perform a Safety Significance Determination for the time the EDG-B was not available (completed).
- Inspect the hub assembly on EDG-A exhaust fan (planned CR-WF3-2013-2530).
- Evaluate maintenance practices on the EDG exhaust fan components and discuss with the OEM to determine what additional tasks are necessary (planned CR-WF3-2013-2530).
- Review the system monitoring plan and make any necessary improvements to detect future similar incidents (planned CR-WF3-2013-2530).

SAFETY SIGNIFICANCE

Industrial Safety: There was no industrial safety significance associated with this issue.

Radiological Safety: There was no radiological safety significance associated with this issue.

Nuclear Safety: EDG-B became unreliable starting on 4/25/2013 and was successfully repaired on 5/26/2013. However, the Temporary Emergency Diesel Generators (TEDs) were connected for back-up power from 4/19/2013 – 5/15/2013. Upon realization of the exhaust fan issue and inoperable EDG-B, the site took steps to have the TEDs re-connected for back-up power on 5/24/2013. The installation of the TEDs increases the TS allowed outage time from 72 hours to 10 days. The time that EDG-B was unreliable and the TEDs were not connected was only 9 days.

The potential consequences of the event are that EDG-B was inoperable during the period of time the exhaust fan was not reliable. The maximum temperature that the diesel room is designed for is 120 degrees F. Had the plant needed EDG-B, the room temperature would have eventually exceeded the design basis temperature for the components in the room and this train of emergency power would have eventually become unavailable.

The two time periods (TEDs available, TEDs not available) were quantified with EDG-B exhaust fan out of

service, base plant alignment, average weather conditions, average Test and Maintenance, and 1E-11 Truncation limit. Then the core damage frequency (CDF) for each case was adjusted to incorporate the fire analysis. The resulting core damage probabilities (CDP) for both time periods were added together to get the final CDP which determines the safety significance of the event.

The resulting total CDP for the EDG-B exhaust fan out of service period is 2.08E-06. The final CDP is compared against a scale that is used to determine the severity of the unavailability event. NRC Inspection Manuals IMC 0308 & 0609 characterize any event with a CDP between 1E-06 and 1E-05 as WHITE with a low to moderate safety significance.

SIMILAR EVENTS

A search was performed using the NRC's ADAMS search engine for other similar reported events at Waterford 3 and in the industry. No similar events were identified.

ADDITIONAL INFORMATION

Energy industry identification system (EIIS) codes and component function identifiers are identified in the text with brackets [ ].

Reporting Date Discussion

The difference between the event date and original report date exceeds 60 days because this condition was not recognized as a reportable condition until another review was performed of the available information. This was identified on August 21, 2013 under CR-WF3-2013-4025. Revision 01 to this LER was submitted to include the safety significance evaluation, which was not completed at the time of the original submittal.