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Waterford 3

10 CFR 50.73

W3F1-2015-0087

December 2, 2015

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

Subject: Submittal of Licensee Event Report (LER) 2015-008-00, Automatic Reactor Trip Due to Failed Circuit Card in Control Element Assembly Calculator 2 Waterford Steam Electric Station, Unit 3 (Waterford 3)
Docket No. 50-382
License No. NPF-38

Dear Sir or Madam:

On October 3, 2015, Waterford Steam Electric Station, Unit 3 (Waterford 3) experienced an Automatic Reactor Trip Due to Failed Circuit Card in Control Element Assembly Calculator (CEAC) 2.

It was determined that this condition is reportable pursuant to 10 CFR 50.73(a)(2)(iv)(A) (System Actuation); specifically: 10 CFR 50.73(a)(2)(iv)(B)(1), Reactor Protective System (RPS) Including Reactor Scram or Reactor Trip, due to an automatic reactor trip, and 10 CFR 50.73(a)(2)(iv)(B)(6), PWR Auxiliary or Emergency Feedwater System, due to automatic initiation of the Emergency Feedwater System.

This report contains no new commitments. Please contact John P. Jarrell, Regulatory Assurance Manager, at (504) 739-6685 if you have questions regarding this information.

Sincerely,

A handwritten signature in blue ink, appearing to read "J. Jarrell", written over the word "Sincerely,".

JPU/MMZ

Attachment: 1. LER 2015-008-00

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

U.S. NRC Project Manager for Waterford 3
April.Pulvirenti@nrc.gov

U.S. NRC Senior Resident Inspector for Waterford 3
Frances.Ramirez@nrc.gov
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Attachment 1
to
W3F1-2015-0087

Licensee Event Report LER 2015-008-00



LICENSEE EVENT REPORT (LER)

(See Page 2 for required number of digits/characters for each block)

Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the FOIA, Privacy and Information Collections Branch (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to Infocollects.Resource@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 Waterford 3 Steam Electric Station	2. DOCKET NUMBER 05000382	3. PAGE 1 OF 5
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4. TITLE
Automatic Reactor Trip Due To Failed Circuit Card In Control Element Assembly Calculator 2

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
10	03	2015	2015	008	00	12	02	2015	FACILITY NAME	DOCKET NUMBER

9. OPERATING MODE	11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: <i>(Check all that apply)</i>			
1	<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)
10. POWER LEVEL 100	<input type="checkbox"/> 20.2203(a)(2)(ii)	<input type="checkbox"/> 50.36(c)(1)(ii)(A)	<input checked="" 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 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

12. LICENSEE CONTACT FOR THIS LER

LICENSEE CONTACT John Jarrell	TELEPHONE NUMBER <i>(Include Area Code)</i> (504) 739-6685
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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	IG	RES	009174	Y					

14. SUPPLEMENTAL REPORT EXPECTED <input type="checkbox"/> YES <i>(If yes, complete 15. EXPECTED SUBMISSION DATE)</i> <input checked="" type="checkbox"/> NO	15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR

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

On October 3, 2015, at 2307 CDT, Waterford 3 experienced an automatic reactor trip and all Control Element Assemblies (CEAs) inserted into the core. Emergency Feedwater (EFW) actuated following the plant trip as expected, but was not required to maintain Steam Generator level. The plant entered the Emergency Operating Procedure for an uncomplicated reactor trip.

The trip was due to Core Protection Calculators (CPC) Channels B and C generating a High Local Power Density (LPD) / Low Departure from Nucleate Boiling Ratio (DNBR) trip due to erroneous signals from Control Element Assembly Calculator (CEAC) 2. Follow up investigation has determined that the direct cause of this event was a failed resistor on a circuit card in CEAC-2. The card was a High Level Multiplexer Gate (Mux) Card (Systems Engineering Laboratories, Model Number 160-100311) in the Multipurpose Acquisition Control System (MACS) Chassis of the CEAC. The direct cause has been corrected by replacing the card. Corrective actions include replacement of additional high level mux cards in a phased approach, development of a performance monitoring plan to identify CEAC card degradation, a full re-analysis of the CPC/CEAC system for Single Point Failure (SPF) vulnerabilities, and implementation of a CPC/CEAC reliability plan.



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Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the FOIA, Privacy and Information Collections Branch (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to Infocollects.Resource@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.

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NARRATIVE

REPORTABLE OCCURRENCE

Initial reportability (Message EN# 51447) was performed within 4 hours per 10 CFR 50.72(b)(2)(iv)(B), 4-hour Non-Emergency RPS Actuation (Scram), and 10 CFR 50.72(b)(3)(iv)(A), 8-hour Non-Emergency Specified Systems Actuation.

This condition is reportable pursuant to 10 CFR 50.73(a)(2)(iv)(A) (System Actuation), specifically: 10 CFR 50.73(a)(2)(iv)(B)(1), Reactor Protective System (RPS) Including Reactor Scram or Reactor Trip, due to an automatic reactor trip; and 10 CFR 50.73(a)(2)(iv)(B)(6), PWR Auxiliary or Emergency Feedwater System, due to automatic initiation of the EFW system.

INITIAL CONDITIONS

Waterford 3 was in Mode 1 at approximately 100% power. Reactor power, CEA [ROD] position, and reactor coolant system [AB] operating parameters were within normal operating limits when the CPC [IG] trips occurred. Plant Protection System Channel A [JC] was in bypass for the duration of the event to support an unrelated scheduled calibration. There were no other structures, components, or systems that were inoperable at the start of the event that contributed to the event.

EVENT DESCRIPTION

On October 3, 2015, at 2208 CDT, Waterford 3 received annunciators [ANN] for CEA withdrawal prohibit and CEA channel C deviation. The indications for CEAs 50 and 51 on CEAC-2 [IG] were oscillating with increasing amplitude. Diagnosis determined that there was no actual rod motion and the indications provided by CEAC-2 were erroneous. The decision to remove CEAC-2 from service was made. Procedures to perform diagnostics and a "warm restart" of CEAC-2 were completed at 2250. The restart was unsuccessful in solving the indication errors. Procedure to remove CEAC-2 from service by changing an addressable constant in each CPC Channel commenced. By 2306, the crew had successfully changed the constant in CPC D.

At 2307, CEAC-2 sensed a deviation in a subgroup which was large enough to generate a penalty factor that was transmitted to all four CPCs. CPCs B and C generated a High LPD/Low DNBR trip when the penalty factor was received. Since channels B and C were not [yet] bypassed, a reactor trip was generated. The system responded as expected.

SYSTEM DESCRIPTION

The CPCs initiate a Low DNBR and a High LPD trip in the RPS [JC]. The CPC initiates automatic protective action to assure that the specified acceptable fuel design limits on DNBR and LPD are not exceeded during anticipated operational occurrences, and to initiate automatic protective action during certain accident conditions to aid the Engineered Safety Features Actuation System [JE] in limiting the consequences of the accidents.

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The purpose of the CEACs is to provide the CPCs with information about individual CEA deviations. The CEACs monitor the CEAs and send penalty factors to the CPCs if rods in a subgroup deviate from each other by more than a specified value. CEA position indication is transmitted to the CEACs as an analog input from the Reed Switch Position Transmitters (RSPTs) [ZT] located on each CEA. Each CPC and CEAC has a MACS chassis [CPU] which processes the incoming analog signals and converts them to digital data. The analog input system includes multiple high level mux cards [CBD], which receive the inputs from the RSPTs. These signals are then converted to digital signals for processing by the CEAC.

PREVIOUS OCCURRENCES

A review of internal operating experience found the following previous occurrences which were precursors to this event:

CR-WF3-2013-3317, Erratic CEA Position Indication (7/15/2013)

Several annunciators and indications were received due to an erroneous input from CEA 45. A warm restart of CEAC-2 was performed followed by another failure. The high level mux card for CEA 45 was replaced but this did not resolve the issue. The CEA Position Isolation Amplifier (CPIA) [OB] for channel D was replaced and this resolved the condition.

CR-WF3-2013-3574, CEAC-2 Failure (8/28/2013)

CEAC-2 failed during normal operation. There was no indication of abnormal rod motion. The lower memory board [CBD] had failed resulting in CEAC-2 halting operation. Replacement of the lower memory board resolved the issue.

CR-WF3-2014-5493, CEAC-2 Failure (10/27/2014)

The CEAC-2 computer halted. An unsuccessful warm restart was attempted. A cold restart was successful and CEAC-2 was restarted. Diagnostic testing could not determine the cause. CEAC-2 was declared operable following troubleshooting and satisfactory completion of the functional test. Subsequent monitoring for 45 days revealed no abnormal indications.

CR-WF3-2014-6319, Erratic CEA Position Indication (12/16/2014)

CEAC-2 failed during normal rod deviation. Position indications for CEAs 67 and 75 were fluctuating greater than 7 inches on CEAC-2. The failure remained locked in following warm restart. The cause was determined to be failure of the high level mux gate card in CEAC-2 MACS Chassis 0 slot 4.

CAUSAL FACTORS

A root cause evaluation was completed for this condition. Vendor analysis of the high level mux gate card installed in slot 5 of the CEAC-2 MACS chassis was performed.

The direct cause of this event was that a resistor [RES] on the card failed, thereby preventing proper gating of the input voltage signals through the card's transistors. The defect was likely due to a manufacturing defect or assembly flaw. The failure is most likely attributed to the component's expected service life being reduced as a result of the defect that accelerated the normal in-service wear mechanisms.

The root cause of this event was the failure to fully implement and periodically revisit the requirements of the Single Point Vulnerability (SPV) processes outlined in the Single Point Failure Review Process.

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The contributing causes to this event are as follows:

- (1) The SPVs in the design of the CPC/CEAC System were not consistently and adequately communicated to management after the initial CPC replacement project was postponed; mitigating strategies were not carried forward.
- (2) The SPV of the CPC/CEAC system was not factored into the component classification of the equipment during the 2008 reclassification.
- (3) The operations procedure guidance for responding to CEAC malfunctions is vague and cumbersome and prevented operators from responding in a timely manner to the CEAC-2 malfunction and possibly preventing a plant trip.
- (4) The current monitoring for the CEAC performance is ineffective for early detection of CEAC or CPIA degradation.

EXTENT OF CONDITION

Plant data was reviewed for all analog inputs to CEAC-2 and CEAC-1 (identical equipment – opposite train). No deviations in CEA position were noted on other CEAs.

The CPCs use the same analog input equipment as the CEACs for input of field signals to the CPCs. All analog inputs into the CPCs were reviewed. No deviations in the analog input signal were found.

The review noted that an unusual set of data where all CEA indications began to show increased gain as far back as July 28, 2015, and which lasted until October 1, 2015 leading right into the indications on October 3, 2015 and this event. A corrective action has been created to perform a detailed fault tree analysis to determine if this condition is related to this event.

CORRECTIVE ACTIONS

The high level mux card installed in the CEAC-2 was replaced. To prevent repetition, a full re-analysis of SPF vulnerabilities on the CPC/CEAC System will be performed per the SPF Review Process. To prevent recurrence of a CPC/CEAC induced plant trip, the results and progression of the SPF re-analysis will be documented, tracked, and communicated by way of a CPC/CEAC Reliability Plan.

Additional corrective actions:

- (1) All CEA Positions sensed by CEAC-1 and CEAC-2 and all field sensors sensed by CPCs A, B, C, and D were reviewed for potential degradation. No degradation was found with the exception of those CEAs affected by the defective high level mux card installed in CEAC-2 MACS Chassis 0 slot 5.
- (2) The operating procedure was revised to provide streamlined actions to render a CEAC inoperable in the event of a malfunction.
- (3) Four high level mux cards in CEAC-2 were replaced.

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- (4) A performance monitoring plan was developed as a mitigating action to identify and respond to potential degradation of CEAC cards.
- (5) Perform effectiveness review action by validating that there have been no plant trips due to a SPF within the CPC/CEAC system through three refuel cycles.

SAFETY SIGNIFICANCE

In this event, the CEAC sensed an erroneous subgroup deviation and conservatively generated a penalty factor which resulted in a reactor trip and subsequent forced outage. There was no loss of safety function. There were no other actual consequences to general safety of the public, nuclear safety, industrial safety or radiological safety for this event. The potential consequences to general safety of the public, nuclear safety, industrial safety and radiological safety of this event if response actions were delayed were negligible. The potential consequences to general safety of the public, nuclear safety, industrial safety and radiological safety of this event if one additional barrier becomes missing or broken is negligible since the CPC reaction is a plant trip into a safe condition. Had the CEAC failed so that a true subgroup deviation was not detected, the other CEAC would have sensed the deviation and applied the appropriate penalty factor to the CPCs to generate a LPD or DNBR trip. Based on this analysis, the risk is considered Low.

ADDITIONAL INFORMATION

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