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2CAN021401

10CFR 50.73

February 5, 2014

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: Licensee Event Report 50-368/2013-004-00
Automatic Reactor Trip and Emergency Feedwater Actuation
Arkansas Nuclear One – Unit 2
Docket No. 50-368
License No. NPF-6

Dear Sir or Madam:

Pursuant to the reporting requirements of 10 CFR 50.73(a)(2)(iv)(A), attached is the subject Licensee Event Report concerning an automatic reactor trip on December 9, 2013, with a subsequent Emergency Feedwater actuation.

There are no new commitments contained in this submittal. Should you have any questions concerning this issue, please contact Stephenie Pyle, Manager, Regulatory Assurance at 479-858-4704.

Sincerely,

Original Signed by Jeremy G. Browning

JGB/car

Attachment: Licensee Event Report 50-368/2013-004-00

cc: Mr. Marc L. Dapas
Regional Administrator
U. S. Nuclear Regulatory Commission
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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 digits/characters for each block)										
1. FACILITY NAME Arkansas Nuclear One – Unit 2					2. DOCKET NUMBER 05000368			3. PAGE 1 OF 5		
4. TITLE Fire and Explosion of the Unit Auxiliary Transformer resulted in an Automatic Reactor Scram and Initiation of the Emergency Feedwater System										
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
12	09	2013	2013	004	00	02	05	2014	Arkansas Nuclear One – Unit 1	05000313
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)				
100			<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 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										
FACILITY NAME Stephenie L. Pyle, Manager, Regulatory Assurance							TELEPHONE NUMBER <i>(Include Area Code)</i> 479-858-4704			
13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT										
CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	
B	FK	2X-02	G080	Y						
14. SUPPLEMENTAL REPORT EXPECTED							15. EXPECTED SUBMISSION DATE			
<input type="checkbox"/> YES <i>(If yes, complete 15. EXPECTED SUBMISSION DATE)</i> <input checked="" type="checkbox"/> NO							MONTH	DAY	YEAR	
							N/A	N/A	N/A	
ABSTRACT <i>(Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)</i>										
<p>On December 9, 2013, at approximately 0747 CST, Arkansas Nuclear One, Unit 2 (ANO-2), experienced an electrical fault on the Unit Auxiliary Transformer (2X-02) buses resulting in a fire and catastrophic failure of the transformer. This caused an automatic reactor and main turbine trip, lockout of the Switchyard Auto Transformer, lockout of (ANO-2) Startup 3 Transformer (2X-03) and loss of power to Arkansas Nuclear One, Unit 1 (ANO-1) Startup 1 Transformer (X-03) The switchyard auto transformer supplies one of the two credited offsite sources supplying both Startup 3 Transformer (2X-03) and Arkansas Nuclear One, Unit 1 (ANO-1) Startup 1 Transformer (X-03). A loss of one of the two available offsite power sources for ANO-2 resulted in an auto-start of the ANO-2 Emergency Diesel Generator (2K-4B) to supply ANO-2 safety bus 2A-4 and initiation of the Emergency Feedwater (EFW) System. Investigations determined the most probable cause of the event that led to failure of the Unit Auxiliary Transformer began with a phase-to-ground fault on the 6900V 'C' phase non-segregated bus flexible link for 2X-02. Transformer 2X-02 protective relays designed to isolate the bus from an electrical fault actuated, but due to a disconnected lead, the Main Generator Lockout relays failed to actuate leading to 2X-02 failure. A root cause evaluation determined a flexible link for 2X-02 was not properly installed which led to an insulation breakdown at the bolted connection. The subsequent 2X-02 explosion and fire resulted from a non-landed wire due to a human performance error most likely occurring in 1995 that failed to connect the DC conductor to the output contacts for the protective relays.</p>										

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NARRATIVE

A. Plant Status

At the time of the subject event, Arkansas Nuclear One Unit 2 (ANO-2) was at approximately 100% power. All structures, systems, and components that were needed to mitigate, reduce the consequences of, or limit the safety implications of the event were available.

B. Event Description

On December 9, 2013, at approximately 0747 CST, ANO-2 experienced an electrical fault on the Unit Auxiliary Transformer (2X-02) [EA][XFMR] buses resulting in a fire and catastrophic failure of the transformer. This caused an automatic reactor and main turbine [TB] trip, lockout of the Switchyard Auto Transformer [FK][XFMR], loss of power to Arkansas Nuclear One Unit 1 (ANO-1) Startup 1 Transformer (X-03) [FK][XFMR] and a lockout of (ANO-2) Startup 3 Transformer [FK][XFMR] (2X-03) when voltage degraded on the non-vital 6900V buses supplied by 2X-02. The lockout of the switchyard auto transformer occurred because of an overcurrent protective relay initiated trip suspected to have been caused by a line to line or line to ground fault at the 22kV structure that supplies 2X-03 transformer. The initial 2X-02 fault is suspected to have been caused by conductive air in the vicinity of the 22kV structure. Lockout of the switchyard auto transformer is designed to initiate a lockout of both X-03 and 2X-03 transformers, however only a 2X-03 lockout occurred. A loss of one of the two available offsite power sources for ANO-2 resulted in an auto-start of the ANO-2 Emergency Diesel Generator (2K-4B) [EK][DG] to supply ANO-2 safety bus 2A-4 [EB]. When the 6900V buses supplied by 2X-02 de-energized, the circulating water system [KE] was unavailable and a loss of condenser vacuum [SH] occurred as the normal main feedwater system [SJ] was unavailable and an automatic actuation of Emergency Feedwater (EFW) System [BA] occurred upon loss of condenser vacuum to support natural circulation cooling [SB].

At approximately 0800 CST on December 9, 2013, ANO-2 declared a Notification of Unusual Event (NUE) based on a Fire or Explosion Inside Protected Area not extinguished in fifteen (15) minutes. The NUE was exited at approximately 1215 CST.

The switchyard auto transformer supplies one source of offsite power to ANO-1 transformer X-03 and to ANO-2 transformer 2X-03. Lockout of the switchyard auto transformer resulted in a loss of one of the available two offsite power sources for ANO-1 and ANO-2 that is required by the units' Technical Specifications. Transformer 2X-02 is the normal power supply to in-house loads on ANO-2.

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NARRATIVE (Continued)

A reactor and main turbine trip normally fast-transfers power to in-house loads from 2X-02 to 2X-03. With 2X-03 unavailable due to the lockout of the switchyard auto transformer, the system automatically transferred one train of in-house loads to the redundant offsite power source provided by ANO-2 Startup 2 Transformer (X-04) [EA][XFMR] which is designed to be shared between ANO-1 and ANO-2. The remaining in-house electrical train initially de-energized followed by a start of 2K-4B, restoring power to the vital electrical equipment on the affected train. All safety systems remained available. Because the non-vital 6900V buses are not designed to remain energized in this configuration, power to reactor coolant pumps [AB][P] was not available. Operations established safe and stable plant operation using natural circulation cooling. The station Fire Brigade assisted by the local fire department responded to the 2X-02 explosion and contained the fire, which was extinguished approximately 1.5 hours following the initial event. At the time of the event, ANO-1 was operating at approximately 100% power with in-house loads powered from the ANO-1 Unit Auxiliary Transformer (X-02) [EA][XFMR].

C. Event Cause

Based on the physical evidence available, the initial fault is suspected to have occurred at the 'C' phase 6900V flexible link on the 2X-02 6900V non-segregated bus, which propagated to the associated 'C' phase bus. Damage from the explosion led to phase-to-phase and phase-to-ground faults on the 6900V and 4160V buses. Based on observations of the 2X-02 'A' and 'B' phase flexible links at this location, there was evidence of corona exposure on the tapping around the bolted connections, moisture and corrosion on the copper flexible links, and no vendor recommended putty on the bolt heads. Without the putty, partial discharge (corona) occurred which degraded the tape insulation. The flexible links and insulation have been installed in this configuration since at least 1979. In addition, the duct design air gap in the flex link area had a marginal air gap as compared to applicable electrical codes that combined with the lack of putty lowered margin for fault protection.

2X-02 is protected by various protective relays including high speed phase differential relays to actuate the main generator lockout relays for isolation of the transformer and the associated fault. Upon fault detection, these relays are designed to initiate prompt actuation of the main generator lockout relays that open the main generator output breakers, exciter field breaker, and associated 4160V and 6900V bus breakers. Although the relays did actuate during this event as evidenced by the instantaneous element target flags, subsequent inspections identified the output contact for the 2X-02 differential relays were not terminated. Failure of the relays to clear the fault allowed 2X-02 to source the fault for approximately 4 to 5 seconds prior to its failure, which exceeds the typical maximum through-fault current rating of 2 seconds for this class of transformer.

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NARRATIVE (Continued)

A Root Cause Evaluation (RCE) for the initial bus fault determined that the initial construction of the bus did not utilize the required putty around the bolted connections of the failed flexible link as required by the vendor technical manual. The absence of this putty is suspected to have led to a breakdown in the taped insulation caused by partial discharge or corona of the air space around the bolted flex connections. A contributing cause identified an inadequate design associated with the minimum air gap clearances between the flex links and the duct that in combination with a breakdown in the insulation of the bolted connection and allowed a phase-to-ground fault to occur. A second contributing cause was insufficient periodic maintenance necessary to identify insulation degradation over time at the location of the flexible link. The RCE for the fire and catastrophic failure of 2X-02 was determined to be a latent (1995) human performance error associated with the output contact for the 2X-02 differential relays which was not terminated, thus rendering the relays incapable of actuating the main generator lockout relays. This error is suspected to have occurred during implementation of a 1995 modification.

D. Corrective Actions

Corrective actions include replacement of the unit auxiliary transformer and its associated 4160V and 6900V buses with redesigned buses and ducts, revisions to the non-segregated bus Periodic Maintenance program for inspections, protective relay testing and reviews for controls for lifted leads.

E. Safety Significance Determination

Systems and components required to shutdown the reactor, maintain safe shutdown conditions, remove residual heat, and control the release of radioactive material were available and performed as required. There were no actual consequences related to the subject event with regards to Nuclear Safety.

F. Basis for Reportability

This event is reported pursuant to the 10 CFR 50.73(a)(2)(iv)(A): "Any event or condition that resulted in manual or automatic actuation of any of the systems listed in paragraph (a)(2)(iv)(B)."

Applicable systems in 10 CFR 50.73(a)(2)(iv)(B):

- “Reactor protection system (RPS) including: reactor scram or reactor trip” and
- “PWR auxiliary or emergency feedwater system.”

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G. Additional Information

10 CFR 50.73(b)(5) states that this report shall contain reference to “any previous similar events at the same plant that are known to the licensee.” NUREG-1022, Revision 3 reporting guidance states that the term "previous occurrences" should include previous events or conditions that involved the same underlying concern or reason as this event, such as the same root cause, failure, or sequence of events.

A review of the ANO corrective action program and Licensee Event Reports for the previous three years revealed no relevant similar events.

Energy Industry Identification System (EIIIS) codes and component codes are identified in the text of this report as [XX].