Form 1062.01A

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LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Arkansas Nuclear One, Unit Two	0 5 0 0 0 3 6 8	1 OF 0 7

TITLE (4) Unplanned Automatic Actuation of Engineered Safety Features Actuation System Due to Deenergizing an Electrical Distribution System Vital Power Panel for Maintenance

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 Names	Docket Number(s)
0 3	1 0	8 8	8 8	-- 0 0 3	-- 0 0	0 4	1 1	8 8	N/A	0 5 0 0 0
									N/A	0 5 0 0 0

OPERATING MODE (9): N

POWER LEVEL (10): 0 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

__ 20.402(b)	__ 20.405(c)	X 50.73(a)(2)(iv)	__ 73.71(b)
__ 20.405(a)(1)(i)	__ 50.36(c)(1)	__ 50.73(a)(2)(v)	__ 73.71(c)
__ 20.405(a)(1)(ii)	__ 50.36(c)(2)	__ 50.73(a)(2)(vii)	__ Other (Specify in Abstract below and in Text, NRC Form 366A)
__ 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)	

LICENSEE CONTACT FOR THIS LER (12)

Name	Telephone Number (Area Code)
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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
X	E K	D G	C 4 7 0						
X	E K	2 I	2 1 2						

SUPPLEMENT REPORT EXPECTED (14)

__ Yes (If yes, complete Expected Submission Date) X No

EXPECTED SUBMISSION DATE (15): Month | Day | Year

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

On 3/10/88 at approximately 0320 hours, an unplanned automatic actuation of the Engineered Safety Features Actuation System (ESFAS) occurred when a 120 volt AC vital power panel (2RS-2) was deenergized for maintenance. The actuation resulted in generation of a Safety Injection Actuation Signal (SIAS) and a containment Cooling Actuation Signal (CCAS). The unit was defueled with all fuel assemblies stored in the spent fuel pool at the time of the event. A significant amount of plant equipment was out of service for maintenance related activities therefore minimum equipment actuations occurred as a result of the SIAS and CCAS. The "B" train emergency diesel generator (EDG) 2K4B, started as designed upon receipt of the SIAS. However, a few seconds later the engine shutdown relay actuated causing the engine to automatically stop. Operations personnel restored power to 2RS-2 and reset the ESFAS. Equipment which had actuated as a result of the signals was realigned to desired configurations. The cause of the unplanned ESFAS actuation was determined to be loss of power to the "B" channel ESFAS by deenergizing 2RS-2 in conjunction with the presence of a trip signal in channel "C." The cause of the EDG automatic shutdown was due to drift of a time delay (TD) relay in the engine protection circuit. The TD relay was recalibrated and tested satisfactorily. There was no safety significance related to the occurrence of this event.

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I. Description of Event

A. Plant Status

At the time of occurrence of this event, Arkansas Nuclear One, Unit Two (ANO-2) was in a refueling outage. All of the reactor core fuel assemblies had been removed from the reactor pressure vessel and placed in storage racks in the ANO-2 spent fuel pool, i.e., reactor defueled. The reactor had been shutdown since the beginning of the refueling outage on 2/12/88. The "B" train Emergency Diesel Generator (EDG), 2K4B, was aligned for standby operation and the "A" train EDG, 2K4A, was out of service for preventive maintenance activities.

B. Component Identification

This event involved an unplanned automatic actuation of the ANO-2 Engineered Safety Features Actuation System (ESFAS) following the deenergization of 120 volt AC vital power inverter 2Y22 (EIIS ID = ED-VJX) and its associated 120 volt AC vital power panel, 2RS-2 (EIIS ID = ED-PL). The actuation resulted in the generation of a Safety Injection Actuation Signal (SIAS) and a Containment Cooling Actuation Signal (CCAS).

Upon initiation of the SIAS, a vital power emergency diesel generator, 2K4B, started automatically and then tripped as a result of an automatic shutdown signal. The EDG is a model 38TD8-1/8 manufactured by the Fairbanks Morse Division of Colt Industries. The EIIS identifier is EK-DG and the vendor code is C470.

A time delay (TD) relay used in the automatic shutdown circuit of the EDG timed out prematurely causing the engine to stop. The relay is a 125 VDC, 3 pole, model number J13P30 with a model number J20T3 timer block. Both are manufactured by ITE Gould. The EIIS identifier is EK-2 and the vendor code is I212.

C. Sequence of Events

On 3/10/88, operations personnel were removing from service and tagging out a 120 VAC vital power inverter (2Y22) and its associated 120 VAC power panel (2RS-2) in preparation for preventive maintenance on the equipment by electrical maintenance personnel. At approximately 0320 hours, immediately following opening of the power supply feeder breaker to 2RS-2, an unexpected automatic actuation of the ESFAS occurred. As a result of the actuation, a SIAS and CCAS were generated. Several control room alarms annunciated indicating the actuation signals. The Engineered Safety Features (ESF) equipment designed to function upon receipt of these signals and that was available for automatic operation; i.e., not tagged out for maintenance or locked out, actuated as designed. There were no adverse consequences as a result of the equipment actuations.

The "B" train EDG, 2K4B, which was aligned for standby operation prior to the event, started automatically as designed upon receipt of the SIAS. However, a few seconds later the engine shutdown relay actuated causing the engine to automatically stop.

2RS-2 was reenergized by reclosing the power supply feeder breaker. Control room operators responded to the ESFAS actuation by resetting the ESFAS and realigning the actuated equipment to the desired configurations. The EDG shutdown relay was reset, however, automatic starting of the engine was defeated by placing the start switch in a "Pull-to-Lock" position, pending investigation into the cause of the automatic engine trip.

Evaluation of the unplanned ESFAS actuation and EDG automatic trip were initiated to attempt to determine the cause of these occurrences.

II. Event Analysis

A. Event Cause - ESFAS Actuation

The ANO-2 ESFAS is a subsystem of the Plant Protection System and consists of the sensors, initiating logic and actuation logic circuits which monitor selected plant parameters and

provide actuation signals to components in the ESF systems if these parameters reach preselected setpoints.

The following actuation signals are generated by the ESFAS.

1. Containment Isolation Actuation Signal (CIAS)
2. Containment Spray Actuation Signal (CSAS)
3. Containment Cooling Actuation Signal (CCAS)
4. Main Steam Isolation Signal (MSIS)
5. Safety Injection Actuation Signal (SIAS)
6. Recirculation Actuation Signal (RAS)
7. Emergency Feedwater Actuation Signal (EFAS)

Four independent measurement channels (A, B, C and D) are provided and designed such that a two-out-of-four coincidence of like initiating trip signals is required to actuate an ESF system. Each channel is separated from other channels to provide physical and electrical isolation of the signals to the ESFAS initiating logic. Each channel is supplied power from a separate Class 1E, 120 VAC vital electrical distribution panel (2RS-1 through 2RS-4). The ESFAS system is designed so that a loss of power to the measurement channels and/or to the logic systems will cause system actuation, i.e., fail safe. A loss of power from vital power panel 2RS-2 will cause channel "B" to deenergize and results in what is termed a "half-leg" trip. This produces essentially half of the logic necessary for generation of all ESF actuation signals, however, no component actuation (no ESF signal generation) should occur as a result of this condition alone. With the system in this condition, a failure of other ESFAS components (power supplies, relays, etc.) or the presence of an initiating signal of some type in channels, "A," "C," or "D" could produce an actuation signal. The type of signal generated would be dependent upon the specific component failure or the type of initiating signal present.

In addition to the discussion above of the ESFAS, two other design features of the system are of importance with respect to the unplanned actuation which occurred on 3/10/88. These are: (1) The ESFAS measurement channels, initiation logic, and actuating logic are contained in cabinets located in the rear of the ANO-2 control room. A remote control module (RCM) for each channel is provided in a panel in the front of the control room near a licensed control room operator's normal duty station. Each RCM provides channel and signal status information to the operator. A series of normally energized indicating lamps, one for each ESFAS channel trip path status e.g., channel "A" SIAS trip path, is provided to indicate the status of the trip path for each ESF function in that channel. If a trip path is deenergized, the normally lit light on the RCM is extinguished. Power to these trip path status lamps is not channelized. Vital distribution power panel 2RS-2 provides power for all indicating lamps in all four channels. Therefore, if power to the system from 2RS-2 is interrupted all of these indicating lamps will be extinguished. This indication, if utilized by itself, would be indicative of a condition or event which caused generation of all ESF actuating signals. (2) The initiating signal monitored and used to generate a SIAS and CCAS is reactor coolant system pressurizer pressure. The actuation setpoint for this parameter is variable and can be manually reduced. In order to prevent an unnecessary SIAS generation during plant cooldowns from operating conditions, the setpoint is periodically reduced manually as pressurizer pressure is decreased. After reaching a pressure of approximately 400 psia, the signal from the sensor to the initiating logic is manually bypassed in all four channels (automatic actuation of this system is not required below 400 psia). If for any reason, sensed RCS pressure increases above 500 psia, the bypass is automatically removed. If pressure subsequently decreases and reaches the trip setpoint without reestablishing the bypass the ESF signals (SIAS And CCAS) will be generated in the affected channel(s).

On 3/10/88 immediately following deenergization of 2RS-2, control room operators observed that the trip path status indicating lights for all ESF actuation signals in all four channels of the RCMs were extinguished. Although the design of the system as discussed above indicates that this should have occurred, the operators concluded that an actuation of all ESF signals had occurred. Power to 2RS-2 was immediately restored and control room operators began resetting the ESFAS to clear the actuation signals. Since it was thought that all signals had been generated, personnel did not attempt to identify or note if any signals had not actuated prior to resetting the entire system. This information was available from the system

indicating lights in the rear of the control room and the RCMs after reenergizing 2RS-2. A subsequent detailed review and evaluation of the components which had received actuation signals concluded that only an SIAS and CCAS had been generated during the event. While resetting the system, a control room operator observed that the low pressurizer trip in Channel "C" was removed from bypass. A trip signal was present in this channel because the RCS was depressurized and at atmospheric pressure during the refueling outage. It is not known if the channel "C" low pressurizer pressure trip was in an unbypassed condition prior to deenergizing 2RS-2 or if the bypass was removed for some reason concurrent with or following 2RS-2 deenergization. It was concluded, however, that the SIAS and CCAS were caused as a result of the channel "C" low pressurizer pressure trip not being bypassed in combination with removal of power for channel "B" of the ESFAS by deenergizing 2RS-2.

Since a detailed evaluation of the event did not conclusively determine if a problem existed with the pressurizer pressure bypass circuit of channel "C" and because the plant was in a condition where an ESFAS actuation presented no safety concerns, a decision was made to perform a test to duplicate the sequence of events leading to the unplanned actuation of the system. On 3/12/88, with personnel stationed at locations to monitor specific system responses, vital power panel 2RS-2 was deenergized again. The system responded as designed with no actuation signals being generated. This verified proper response of the ESFAS upon a failure or loss of this vital power supply.

B. Event Cause - EDG Automatic Shutdown

The ANO-2 onsite emergency power supply system consists of two diesel generator units designed to provide emergency power to the redundant 4.16 KV emergency safety features buses, 2A3 and 2A4. EDG 2K4B supplies power to bus 2A4. Each EDG is designed to start automatically upon receipt of a SIAS or by signals from undervoltage relays located on the respective 4.16 KV bus. Upon receipt of an SIAS, the EDG should start and attain rated speed and rated voltage within 15 seconds. If the normal power supply (offsite power) to the 4.16 KV bus is available the EDG will remain in an operating standby condition. Should the bus undervoltage relays sense a loss of the normal power source, the EDG will automatically energize the bus and supply power to the ESF loads. The EDGs can also be started manually from the control room or from local panels located at the units.

The EDGs are Fairbanks-Morse, turbo-charged, opposed piston type engines. The engine is equipped with a pressure lubrication system which supplies a continuous flow of oil to all surfaces requiring lubricating oil (LO) and to the pistons for cooling when the engine is operating. An engine driven LO pump draws oil from the oil sump and supplies oil headers to different parts of the engine. The engine is also equipped with a manually operated electric motor-driven, pre-lubricating pump for lubricating the engine prior to normal starts. With the engines secured in a standby condition, the main bearings on the upper crankshaft are not provided with a continuous supply of LO and the upper oil header is partially drained. Under conditions of an emergency start, there is no lubrication of the upper crankshaft bearings until the engine driven LO pump develops sufficient discharge pressure and fills the upper header with oil. This usually requires a few seconds to accomplish.

Three oil pressure sensing switches monitor pressure in the engine upper oil header. Actuation of any one of the three switches on a decreasing LO pressure to 23 psig will actuate an alarm at a local annunciation panel and also in the control room. If any two of the three pressure switches sense low oil pressure, the engine will be automatically shut down. In a standby condition with the engine driven LO pump not operating to supply lubricating system oil pressure, the oil pressure sensing switches discussed above will be in an actuated condition. To allow starting of the engine upon receipt of either a manual or emergency start signal, the automatic engine shutdown feature associated with sensed low LO pressure is bypassed for a period of approximately 20 seconds by two TD relays in the engine start circuit. This allows time for the engine driven oil pump to develop discharge pressure and fill the upper oil header as the engine accelerates in speed. The TD relays are actuated by devices that monitor engine parameters that are indicative that the engine is in a running condition. One TD relay is actuated on an increasing engine jacket cooling water pressure and the other is actuated when an engine driven tachometer reaches a preset value. Upon actuation, the TD relays start to "time out". Either relay completing its timing sequence will automatically

reinstate the low LO pressure trip circuit of the engine. If system oil pressure has not increased to a value sufficiently high enough to reset the oil pressure sensing switches or subsequently decreases to the actuation setpoint of the switches, an automatic shutdown of the engine will occur. Some of the EDG units protective features are automatically bypassed if the start signal to the engine is an emergency signal. However, the low LO pressure protective feature is not bypassed and is present even if the EDG has started as a result of an emergency start signal.

On 3/10/88, following the inadvertent ESFAS actuation, EDG 2K4B started automatically as a result of the SIAS and then automatically shut down a few seconds later. During recovery from the actuation and while resetting the EDG, operations personnel noted that the low LO pressure annunciator light at the local EDG control panel was lit. This indicated that the cause of the automatic EDG shutdown was due to a sensed low LO system pressure condition.

As part of the previously discussed test related to verification of proper response of the ESFAS upon loss of power from 2RS-2, a simulated SIAS start of the 2K4B EDG was performed during this test and system response was observed. After initiation of the signal, the engine started as designed and tripped on low LO pressure approximately 16 seconds after starting. Engine LO system pressure at the time of the trip was observed to be approximately 20 psig. The oil pressure sensing switches will not reset, i.e., clear trip signal to engine, until oil system pressure has increased to approximately 25 psig. The EDG starting circuit is designed to allow a total time of approximately 20 seconds (5 seconds to energize TD relays plus 15 seconds for relays to time out) to establish oil pressure to the engine before reinstating the engine shutdown circuit for low LO pressure. Based on the observed trip of the engine after only approximately 16 seconds it was concluded that the cause of the engine shutdown was related to some portion of the starting circuitry associated with the TD relays which reinstate the engine shutdown feature on low oil pressure after a start. On 3/24/88 while performing an 18 month calibration of the EDG relays, electrical maintenance personnel found that one of the TD relays in this circuit timed out in approximately 11 seconds instead of the required 15 seconds. The early timing out of this relay caused the engine shutdown circuit to be reinstated prematurely. Upon receiving a start signal the protective circuit would be reinstated before the engine could accelerate to a sufficient speed to allow the engine driven LO pump to establish adequate system oil pressure to reset the oil pressure sensing switches. This caused the engine to stop on sensed low LO pressure.

C. Safety Significance of Events

There was no safety significance as a result of the ESFAS actuation or EDG automatic shutdown on 3/10/88. The unit was defueled with all of the core fuel assemblies stored in racks in the spent fuel pool. Cooling of the spent fuel pool was being accomplished with the spent fuel pool cooling system which utilizes redundant pumps to recirculate the pool water through a heat exchanged cooled by the service water system (SWS). The SIAS actuation caused the SWS supply valves to the heat exchanger to automatically close as designed, temporarily interrupting cooling of the spent fuel pool water. However, service water flow was restablished after resetting the SIAS. During this short period of time the overall temperature increase of the pool water was negligible due to the large volume of water in the pool. Even if cooling could not have been reestablished promptly, a significant amount of time (several hours) was available before the pool temperature would have reached an excessive value. Offsite power remained available to the in-plant electrical distribution system throughout the event, therefore, even though the EDG shut down after starting on the SIAS signal the emergency power source was not needed to provide power to its emergency bus. A significant portion of the equipment powered from the emergency buses was either out of service for maintenance related activities or defeated from automatic operation because it was not required to be operational. Therefore, a minimum amount of equipment actuated as a result of the SIAS and CCAS. The ANO-2 Technical Specifications did not require any ESF equipment to be operable for the plant conditions that existed during this event.

As previously discussed, the onsite emergency power system is only used in the unlikely event of a loss of all offsite power sources to the ESF buses. This is true even under conditions of design basis events which may result in the generation of a SIAS. The ANO-2 offsite power system consists of two independent sources of power for the in-plant electrical distribution system, including the ESF buses. The power sources, i.e.,

transmission lines, transformers, etc., and interconnecting in-plant electrical system components such as breakers and buswork, are highly reliable and are maintained and periodically tested to ensure their availability. The last significant occurrence of a loss of these offsite power sources occurred nearly eight years ago and there were no safety consequences as a result of the event. Even considering the unavailability of offsite power concurrent with a design basis event, under normal conditions the redundant EDG, 2K4A, should have been available to provide power to any necessary ESF equipment.

D. Root Cause

The root cause of the unplanned actuation of the ESFAS was not conclusively determined. The plant computer was not available during the event which limited the amount of information available for investigation. However, based on a detailed review and evaluation of the system design, observed response of systems following the actuation and subsequent testing performed on the system it was concluded that the most likely root cause of this event was that a low pressure pressurizer trip signal was present in channel "C" with the channel not in a bypassed condition when vital power panel 2RS-2 was deenergized.

A detailed review and evaluation of the EDG system design and subsequent testing following the automatic shutdown of EDG 2K4B concluded that the root cause of this event was drift of a TD relay in the EDG control circuit that reinstates the low LO pressure engine shutdown protective circuitry after the EDG has started.

E. Reportability

This event constituted a condition that resulted in an automatic actuation of engineered safety features equipment which was not part of a preplanned sequence during testing and is considered to be reportable per 10CFR50.73(a)(2)(iv). The occurrence was also reported as a non-emergency event per the requirements of 10CFR50.72(b)(2)(ii) at 0735 hours on 3/10/88.

III. Corrective Action

A. Immediate

Operations personnel responded to the unplanned ESFAS actuation by reenergizing vital power panel 2RS-2 and resetting the system, clearing the actuation signals. The ESF equipment which had actuated as a result of the SIAS and CCAS was realigned as desired. The 2K4B EDG automatic shutdown signal was cleared and automatic starting of the engine was defeated pending investigation and resolution of the problem that caused the trip.

B. Subsequent

Evaluations of the ESFAS and EDG systems were performed to attempt to identify the root causes of the unplanned actuation and automatic diesel shutdown. Testing of both systems was performed. The TD relay in the EDG protective circuit that was found to be out of tolerance when tested was recalibrated and subsequently tested satisfactorily.

A detailed review of plant records related to calibration and testing of the EDG TD relay was performed. No discrepancies were noted with operation of the relay during the last calibration in June 1986. The reviews also indicated no evidence that the relay was susceptible to excessive drift between calibration intervals.

C. Future

An engineering evaluation is being performed to determine the feasibility of modifying the power supply to the ESFAS trip path indications on the RCMs in the ANO-2 control room so that the status lamps for all channels are not powered from a common electrical source, i.e., 2RS-2.

The design of the engine low LO pressure protection circuit is being reviewed and evaluated to determine if the design can be modified to minimize recurrence of this type of event. Changes to the circuit being evaluated include: (1) the use of more accurate and reliable TD

relays in the circuit, (2) increasing the present TD to allow more time after an engine start to establish oil pressure before reinstating the protective trip, and (3) bypassing the protective circuit completely if an SIAS is present.

Routine preventative maintenance activities are being performed on the EDG during the current refueling outage. Operability of the EDG will be verified by currently scheduled surveillance tests to be performed prior to plant heatup.

The ANO-2 Technical Specifications require periodic testing of the EDGs to demonstrate operability. Plant procedures used to perform these tests currently require operation of the engine pre-lubricating system for a short period of time immediately prior to starting the engine in order to minimize unnecessary wear on engine mechanical components. Pre-lubricating the engine may, however, decrease the amount of time required for the engine driven oil pump to build up system oil pressure and reset the oil pressure sensing switches used to trip the engine. As a result, the degradation of some components may not be identified during testing. In order to address this concern, the procedures used for testing of the EDGs are being reviewed and will be revised if appropriate to provide for periodic EDG testing with a simulated emergency start signal with no pre-lubing of the engine prior to the test.

IV. Additional Information

A. Similar Events

Similar events related to unplanned ESFAS actuations were previously reported in the following Licensee Event Reports (LERs).

368/80-024	Inadvertent Containment Spray Initiation
368/83-015	Inadvertent Containment Spray Actuation
368/84-003	Main Steam Isolation Signal Actuation and Reactor Trip
368/85-009	Inadvertent Engineered Safeguards Actuations During Design Change Modifications
368/85-014	Reactor Trip Caused by Inadvertent Actuation of Engineered Safeguards During Plant Protection System Surveillance Testing.

ARKANSAS POWER & LIGHT COMPANY

April 11, 1988

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U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

SUBJECT: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Licensee Event Report 368/88-003-00

Gentlemen:

In accordance with 10CFR50.73(a)(2)(iv), attached is the subject report concerning an unplanned automatic actuation of the Engineered Safety Features Actuation System due to deenergizing an electrical distribution system vital power panel for maintenance.

Very truly yours,

J. M. Levine
Executive Director,
Nuclear Operations

JML:DJM:dm
attachment

cc w/att: Regional Administrator
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