

# ACCELERATED DISTRIBUTION DEMONSTRATION SYSTEM

## REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR: 9204230047      DOC. DATE: 92/04/16      NOTARIZED: NO      DOCKET #  
 FACIL: 50-388 Susquehanna Steam Electric Station, Unit 2, Pennsylv      05000388  
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 STANLEY, H.G.      Pennsylvania Power & Light Co.  
 RECIP. NAME      RECIPIENT AFFILIATION

SUBJECT: LER 92-001-00: on 920416, Unit 2 manual scram following loss  
 of engineered safeguards 4.16 KV bus. Caused by failed diode.  
 Evaluation of ESS Bus 2C via its protective circuitry.  
 W/920416 ltr.

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NOTES: LPDR 1 cy Transcripts.

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EXTERNAL:	EG&G BRYCE, J.H.	3 3	L ST LOBBY WARD	1 1	
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April 16, 1992

U.S. Nuclear Regulatory Commission  
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SUSQUEHANNA STEAM ELECTRIC STATION  
LICENSEE EVENT REPORT 92-001-00  
FILE R41-2  
PLAS - 522

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Docket No. 50-388  
License No. NPF-22

Attached is Licensee Event Report 92-001-00. This event was determined reportable per 10CFR50.73(a)(2)(iv) in that Susquehanna Unit 2 experienced unplanned actuations of Engineered Safety Features (ESF) following the lock out of an Engineered Safeguard System (ESS) 4.16 KV electrical distribution bus. Operators manually scrambled the unit in anticipation of a Main Steam Isolation Valve closure. This resulted in additional ESF actuations. This document also reports a condition per 10CFR50.73(a)(2)(v) and 10CFR50.73(a)(2)(vi) in which two of four Emergency Onsite AC Power channels could have been unavailable for responding to a design basis event. The Susquehanna Safety Analysis requires three channels to be operable. This report also fulfills the requirement of a Special Report pursuant to Technical Specification section 4.8.1.1.4 for a failure of the 'B' Emergency Diesel Generator.

H.G. Stanley  
Superintendent of Plant - Susquehanna

RRW/mjm

cc: Mr. T. T. Martin  
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LICENSEE EVENT REPORT (LER)

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1) Susquehanna Steam Electric Station - Unit 2		DOCKET NUMBER (2) 0 5 0 0 0 3 8 8 1	PAGE (3) 1 OF 0 6
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TITLE (4)  
Unit 2 Manual Scram Following Loss of Engineered Safeguards 4.16 KV Bus

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 8	9 2	9 2	0 0 1	0 0	0 4	1 6	9 2		0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (8) 1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)									
POWER LEVEL (10) 1 0 0	20.402(b)	20.406(c)	60.73(a)(2)(iv)	73.71(b)						
	20.406(a)(1)(i)	60.36(c)(1)	60.73(a)(2)(v)	73.71(c)						
	20.406(a)(1)(ii)	60.36(c)(2)	60.73(a)(2)(vi)							
	20.406(a)(1)(iii)	60.73(a)(2)(i)	60.73(a)(2)(vii)(A)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)						
	20.406(a)(1)(iv)	60.73(a)(2)(ii)	60.73(a)(2)(viii)(B)							
	20.406(a)(1)(v)	60.73(a)(2)(iii)	60.73(a)(2)(ix)							

LICENSEE CONTACT FOR THIS LER (12)		TELEPHONE NUMBER
NAME Richard R. Wehry - Power Production Engineer	AREA CODE 7 1 7	5 4 2 - 3 6 6 4

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

CAUSE	SYSTEM	COMPONENT	MANUF. TURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUF. TURER	REPORTABLE TO NPRDS
X	E K	DIODE	P 2 9 2	YES					

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

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single space typewritten lines) (18)

On March 18, 1992, with Unit 2 operating in Condition 1 at 100% power and Unit 1 in refueling, Condition 5, at 0% power, the 'B' Emergency Diesel Generator (EDG) was being run for its monthly surveillance test. At 0831 hours on 3/18/92, the 'B' EDG tripped on "Generator Loss Of Field". While in the process of substituting in the 'E' EDG for the 'B' EDG, the Operator reset a relay target on Engineered Safeguard System (ESS) 4.16 KV Bus 2C. When the relay target was reset at 0949 hours on 3/18/92, the bus locked out. The loss of the ESS Bus 2C resulted in several ESF actuations including, auto start of the 'C' EDG, Reactor Water Cleanup and Containment Instrument Gas (CIG) containment isolations and Unit 2 Reactor Building HVAC Zones II and III isolations. Additional bus loads, including Drywell cooling fans were lost and additional isolations occurred. Because the CIG system became isolated from the Main Steam Isolation Valves (MSIV), operators manually scrambled Unit 2 in anticipation of MSIV closure. Following the scram, reactor water level reached Level 3 (+13") resulting in Level 3 isolations. Unit 2 was taken to Cold Shutdown. The root cause of this event was attributed to misoperation of a primary bus differential relay, which occurred when the target reset pushbutton was depressed by the Operator. Following electrical investigation/evaluation of the bus and its protective circuitry, power was restored to the bus at 2053 hours on 3/18/92. The subject relay was tagged to identify that in the event a relay target is observed, Operations should contact Systems Engineering prior to resetting. The relay will be replaced at a later date and more thoroughly examined/tested to aid in understanding the misoperation resulting from resetting the target. All similar relays on Unit 2 were inspected and those on Unit 1 will be inspected prior to startup from its 1992 refueling outage. Repairs were completed on the 'B' EDG and it was restored to operable status. There were no safety consequences or compromise to public health or safety as a result of this event.

**LICENSEE EVENT REPORT (LER)  
TEXT CONTINUATION**

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-630), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

DESCRIPTION OF EVENT

On March 18, 1992, with Unit 2 operating in Condition 1 at 100% power and Unit 1 in refueling, Condition 5, at 0% power, the 'B' Emergency Diesel Generator (EDG; EIIS Code: EK) was being run for its monthly surveillance test. At 0831 hours on 3/18/92, the 'B' EDG tripped on "Generator Loss Of Field". While in the process of substituting in the 'E' EDG (which is a fifth and spare EDG) for the 'B' EDG, the Operator reset a relay target on Engineered Safeguard System (ESS) 4.16 KV Bus 2C (EIIS Code: EB). When the relay target was reset (at 0949 on 3/18/92), the ESS Bus 2C locked out. The loss of the ESS Bus 2C resulted in several Engineered Safety Feature (ESF) actuations including, auto start of the 'C' EDG (remained unloaded), Reactor Water Cleanup (RWC; EIIS Code: CE) and Containment Instrument Gas (CIG) system containment isolations and Unit 2 Reactor Building Heating, Ventilating and Air Conditioning (HVAC) Zones II and III (EIIS Code: VA) isolations. Additional ESS Bus 2C loads were lost, including Drywell Cooling Fans (EIIS Code: VB) and additional isolations occurred. Because the CIG system became isolated to the inboard Main Steam Isolation Valves (MSIV; EIIS Code: SB), Operators reduced reactor recirculation flow to minimum and manually scrammed Unit 2 in anticipation of MSIV closure. All control rods fully inserted. Following the scram, reactor water level reached Level 3 (+13") resulting in associated Level 3 isolations. Minimum reactor level reached was -17.6 inches. Maximum reactor pressure reached was 994 psig. Average Drywell temperature reached 165 degrees F. Unit 2 was taken to Cold Shutdown to allow Drywell entry for inspection.

CAUSE OF EVENT

An Event Review Team was formed to perform investigations and root cause analysis of this event. Investigations into the cause of the 'B' EDG trip identified a failed diode in the generator field rectifier bridge as a potential cause. Also investigated was the effect on EDG stability when a large load, Reactor Building Chiller (EIIS Code: VA), was started during the 'B' EDG surveillance test run. Preliminary computer modeling has indicated that the start of a large load, such as this chiller, can result in a large increase of KVAR output from the EDG when in the test (DROOP) mode. When the chiller was started at 0831 on 3/18/92, the 'B' EDG load increased from 4000 KW to 5075 KW and KVARs increased from +161 to -6025 KVARs and the 'B' EDG tripped on "Generator Loss Of Field". The large increase in KVARs measured correlates with the computer model data and may have precipitated failure of the generator field rectifier diode, resulting in the loss of field trip.

The lockout of ESS Bus 2C was unrelated to the trip of the 'B' EDG. It was during the evolution of substituting in the 'E' EDG for the 'B' EDG that the Bus lockout occurred. Specifically, in accordance with operating procedures, the Operator (utility; non-licensed) was checking all Unit 2 ESS 4.16 KV buses for indicating targets and resetting the targets as necessary. The Operator



LICENSEE EVENT REPORT (LER)  
TEXT CONTINUATION

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TEXT (If more space is required, use additional NRC Form 368A's) (17)

found the relay target actuated on Primary Bus Differential Relay 87A1-B on ESS Bus 2C. When the Operator reset the relay target, he noticed a "spark" in the area of the relay seal-in unit (internal to the relay) and bus lockout relays actuated, tripping and locking out all ESS Bus 2C circuit breakers.

The investigation of the ESS Bus 2C lockout relay operation was divided into two areas:

- Physical and electrical checks of the bus and its appurtenances to determine if physical damage occurred which could have caused the 87A1-B relay to operate in a normal fashion for bus protection.
- Physical and electrical checks of the 87A1-B Primary Bus Differential Relay and its associated circuits to determine if relay misoperation was the cause of the ESS Bus 2C lockout.

The ESS Bus 2C was found intact and not degraded. This was determined by megger testing of the bus and associated potential transformer circuitry. No faults were detected. Additionally, a faulted bus condition is likely to trip at least two Primary Bus Differential Relays, which did not occur.

The 87A1-B Primary Bus Differential Relay and its associated circuits were found to function properly. No physical or electrical defects or anomalies were observed. The relay was checked for functional calibration and alignment/distortion both in place and removed and manually manipulated several times to verify that no mechanical binding or erratic motion was present.

It is PP&L's engineering judgement that the root cause of the ESS Bus 2C lockout was a misoperation of the 87A1-B Primary Bus Differential Relay which occurred when the target reset pushbutton was depressed by the Operator. Several factors support this conclusion:

- The operation of the 87A1-B Primary Bus Differential Relay is designed to cause the lockout of ESS Bus 2C in the exact manner observed on 3/18/92.
- The observations of the Operator, from the moment he depressed the target reset pushbutton, are consistent with the intended design function of this electrical protection scheme for the bus alignment which existed prior to the event.
- The mechanism for the postulated misoperation of the 87A1-B Relay could not be replicated during subsequent investigation. However, the seal-in contact of the 87A1-B Relay is part of the seal-in target assembly. The action of depressing the target reset applies a force in the direction of seal-in contact closure. The seal-in contact is the primary circuit path to trip the lockout relays. As such, the Operator's observation of a

LICENSEE EVENT REPORT (LER)  
TEXT CONTINUATION

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"spark" leads to the conclusion that the seal-in circuit conducted for a sufficient period to initiate lockout relay operation at the same moment the Operator was depressing the target reset pushbutton. The absence of any other anomaly after thorough investigation of all related buses, relays, relay circuitry and station activities at the time of the event leads to the conclusion that the Operator action and the lockout relay operation were not coincidental. Therefore, the misoperation of the 87A1-B Relay, on this occasion, was directly related to the operation of the target reset pushbutton.

REPORTABILITY/ANALYSIS

The events resulting from the lockout of the ESS Bus 2C and the subsequent manual scram of the Unit 2 reactor were determined reportable per 10CFR50.73(a)(2)(iv) as unplanned Engineered Safety Feature (ESF) actuations and an ESF actuation in response to a plant transient (manual scram). The following unplanned ESF actuations occurred upon the lockout of the ESS Bus 2C:

- 'C' EDG auto start (remained unloaded)
- RWCU containment isolation
- CIG containment isolation
- Unit 2 Reactor Bldg. HVAC Zones II and III isolations

In anticipation of a MSIV closure, Unit 2 was manually scrammed resulting in an ESF actuation of the Reactor Protection System (RPS; EIIS Code: JC). Following the scram, reactor water level reached Level 3 (+13"). The reactor water Level 3 isolations constituted unplanned ESF actuations.

All control rods fully inserted during the manual scram. Maximum reactor pressure reached was 994 psig. Minimum reactor water level reached was -17.6 inches. All system initiations and isolations occurred per design in response to both the lockout of the ESS Bus 2C and the manual scram of the Unit 2 reactor.

The 'B' EDG was declared inoperable following its surveillance run trip at 0831 on 3/18/92 and the 'C' EDG could not energize ESS Bus 2C due to the bus being locked out. This constituted a condition reportable per 10CFR50.73(a)(2)(v) and 10CFR50.73(a)(2)(vi) in that a condition existed which alone could have prevented fulfillment of the safety function of structures or systems needed to shutdown the reactor and maintain it in a safe shutdown, remove residual heat, control rad release or mitigate consequences of an accident. Specifically, the Susquehanna Safety Analysis requires three OPERABLE EDGs to safely shut down the plant in the event of a design basis accident. The locked out ESS Bus 2C (Channel 'C') and the inoperable 'B' EDG (Channel 'B') represented the potential for two channels being unavailable in the event of an accident. The 'C' EDG successfully started and continued running in an unloaded condition, as per design, given the locked-out bus condition.



**LICENSEE EVENT REPORT (LER)  
TEXT CONTINUATION**

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-830), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

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The plant was safely shut down and there were no radioactive releases recorded by effluent instrumentation. The emergency operating procedures were properly implemented by Operations personnel.

An engineering evaluation concluded that the maximum average Drywell temperature of 165 degrees F reached during the event had insignificant effect on equipment qualified life and no effect on Drywell or piping structural integrity. A Drywell walkdown confirmed that there were no visual indications of heat induced damage present.

There were no safety consequences or compromise to public health or safety during this event.

Investigations into the cause of the 'B' EDG trip at 0831 on 3/18/92 identified a failed diode in the generator field rectifier bridge. It is believed that the start of a large load (Reactor Bldg. Chiller) while the 'B' EDG was in the Test (DROOP) mode resulted in a large increase in the KVAR output from the EDG and may have precipitated failure of the diode, resulting in the trip on "Generator Loss Of Field". The 'E' EDG was substituted in for the 'B' EDG within the required Technical Specification 72 hour LCO Action time. The 'B' EDG was unavailable for 19 days, 7 hours and 49 minutes. However, the total time out of service included time in which the 'B' EDG was kept out of service as a result of Unit 1 ESS Bus refueling outage modification activities. The 3/18/92 'B' EDG trip is considered a valid test and valid failure. The 'B' EDG Start Log indicates there is one (1) 'B' EDG failure in the last 20 valid tests. The 'B' EDG test interval is one start at least once per 31 days per Technical Specification Table 4.8.1.1.2-1. This Licensee Event Report also satisfies reportability pursuant to Technical Specification section 4.8.1.1.4.

In accordance with the guidelines provided in NUREG 1022 Supp. 1 Item 14.1 and 10CFR50.4(d), the required submission date for this report was determined to be April 20, 1992.

CORRECTIVE ACTIONS

Following investigations and evaluations of the ESS Bus 2C and its protective circuitry, power was restored to the ESS Bus 2C via its normal offsite supply at 2053 hours on 3/18/92.

The subject 87A1-B Relay was tagged to identify that in the event a relay target is observed, Operations should contact Systems Engineering prior to resetting the target. The relay will be replaced at a later date and thoroughly examined/tested to aid in understanding the misoperation resulting from resetting the target. The incident was reviewed with all Operations personnel including a discussion of proper relay target reset practices. All similar Primary Bus Differential Relays on Unit 2 were

**LICENSEE EVENT REPORT (LER)  
TEXT CONTINUATION**

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inspected for proper relay alignment and operation of the seal-in relay target. The similar relays on Unit 1 will be inspected prior to startup from its 1992 refueling/inspection outage.

An engineering evaluation was performed to determine the effects, if any, of reaching an average Drywell temperature of 165 degrees F during the event. The evaluation concluded that the increase in Drywell temperature had insignificant effect on equipment qualified life and no effect on Drywell or piping structural integrity. A Drywell walkdown confirmed that there were no visual indications of heat induced damage present.

The diode was replaced on the 'B' EDG generator field rectifier and the EDG was successfully retested and restored to operable status. Engineering is continuing to study the dynamics of EDG response to voltage transients.

ADDITIONAL INFORMATION

Failed Component Identification: The 87A1-B Relay is not considered to be a failed component but rather a relay misoperation.

Field rectifier diode  
Manufacturer: PORTEC, Inc. P292  
Diesel Manufacturer: Cooper-Bessemer C634

Previous Reported Similar Events: None identified.