

## PHILADELPHIA ELECTRIC COMPANY

LIMERICK GENERATING STATION  
 P. O. BOX A  
 SANATOGA, PENNSYLVANIA 19464  
 (215) 327-1200 EXT. 2000

J. DEERING, JR.  
 PLANT MANAGER  
 LIMERICK GENERATING STATION

March 26, 1992  
 Docket Nos. 50-352  
 50-353  
 License Nos. NPF-39  
 NPF-85

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

SUBJECT: Licensee Event Report  
Limerick Generating Station - Units 1 and 2

This revised LER reports automatic actuations of the Unit 1 and Unit 2 Primary Containment and Reactor Vessel Isolation Control System, an Engineered Safety Feature, and other Engineered Safety Features due to a loss of power to the '1B' Reactor Protection System/Uninterruptible Power Supply power distribution panel from a failed inverter inductor.

Reference: Docket Nos. 50-352  
 50-353  
 Report Number: 1-91-018  
 Revision Number: 01  
 Event Date: June 18, 1991  
 Report Date: March 26, 1992  
 Facility: Limerick Generating Station  
 P.O. Box 2300, Sanatoga, PA 19464-2300

This LER is being revised to refine the corrective actions. Changes are indicated by revision bar markers in the right hand margins. This LER is being submitted pursuant to the requirements of 10 CFR 50.73(a)(2)(iv).

Very truly yours,

KOS:cah

cc: T. T. Martin, Administrator, Region I, USNRC  
 T. J. Kenny, USNRC Senior Resident Inspector, LGS

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LICENSEE EVENT REPORT (LER)

FACILITY NAME (1): Limerick Generating Station, Unit 1  
 DOCKET NUMBER (2): 0 5 0 0 0 3 1 5 1 2 0 1 4

TITLE (4): Primary Containment and Reactor Vessel Isolation Control system actuation resulting from a Reactor Protection System/Uninterruptible Power Supply inverter inductor failure

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)		
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISED NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER	
06	18	91	91	018		01	03	26	Limerick, Unit 2	0 5 0 0 0 3 1 5 1 3	
										0 5 0 0 0 3 1 5 1 1	

OPERATING MODE (9): 1  
 POWER LEVEL (10): 100  
 THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR 43.61 (Check one or more of the following) (11):

20.402(b)	<input checked="" type="checkbox"/>	20.405(a)	<input type="checkbox"/>	20.73(a)(2)(iv)	<input type="checkbox"/>	20.73(a)	<input type="checkbox"/>
20.405(a)(1)(ii)	<input type="checkbox"/>	20.28(a)(1)	<input type="checkbox"/>	20.73(a)(2)(v)	<input type="checkbox"/>	20.73(a)	<input type="checkbox"/>
20.405(a)(1)(iii)	<input type="checkbox"/>	20.28(a)(2)	<input type="checkbox"/>	20.73(a)(2)(vi)	<input type="checkbox"/>	OTHER (Specify in Abstract)	<input type="checkbox"/>
20.405(a)(1)(iv)	<input type="checkbox"/>	20.72(a)(2)(i)	<input type="checkbox"/>	20.73(a)(2)(vii)(A)	<input type="checkbox"/>	20.73(a)(2)(vii)(B)	<input type="checkbox"/>
20.405(a)(1)(v)	<input type="checkbox"/>	20.73(a)(2)(ii)	<input type="checkbox"/>	20.73(a)(2)(viii)	<input type="checkbox"/>	20.73(a)(2)(ix)	<input type="checkbox"/>
20.405(a)(1)(vi)	<input type="checkbox"/>	20.73(a)(2)(iii)	<input type="checkbox"/>	20.73(a)(2)(ix)	<input type="checkbox"/>		<input type="checkbox"/>

LICENSEE CONTACT FOR THIS LER (12):  
 NAME: G. J. Madsen, Regulatory Engineer, Limerick Generating Station  
 TELEPHONE NUMBER: 211 15 312171-11121010

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

CAUSE	SYSTEM	COMPONENT	MANUFAC TURE	REPORTABLE TO NRC	CAUSE	SYSTEM	COMPONENT	MANUFAC TURE	REPORTABLE TO NRC
X	J,C	I,N,V,T,E	3,5,3	YES					

SUPPLEMENTAL REPORT EXPECTED (14):  
 YES (If yes, complete EXPECTED SUBMISSION DATE)  NO  
 EXPECTED SUBMISSION DATE (15):

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

On June 18, 1991, an unexpected gross failure of an inductor in the Unit 1 '1B' Reactor Protection System (RPS)/Uninterruptible Power Supply (UPS) inverter caused a loss of power to the '1B' RPS/UPS power distribution panel (1BY160). This loss of power resulted in automatic actuations of the Primary Containment and Reactor Vessel Isolation Control System (PCRIVICS) (E11S:JM), an Engineered Safety Feature (ESF). All systems responded as designed and power was restored to the panel within 18 minutes. An investigation conducted with the vendor of previous inductor failures determined the failure to be due to an inadequate design by the vendor, but was thought to be limited to newer inductors. Preventive maintenance tasks which were written following previous inductor failures to replace the newer inductors for all inverters on site on an annual frequency have been expanded to include the older inductors unless past thermographic inspections reveal temperatures well within the maximum temperature for the inductor. Thermographic inspections will continue to be performed on all inverter inductors on a quarterly frequency. If any indications of hot spots or significant temperature differences are detected, the inductor will be replaced. A modification had been initiated due to the previous inverter problems to replace the currently installed inverters with more reliable equipment. This modification is projected to be completed by the end of the next refueling outage for each unit.

## LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)		
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER			
Limerick Generating Station, Unit 1	016101013152	911	0118	011	02	OF	04

TEXT (IF MORE SPACE IS REQUIRED, USE ADDITIONAL NRC Form 365A's) (12)

Unit Conditions Prior to the Event:

Unit 1 was in Operational Condition 1 (Power Operation) at 100% power level.

Unit 2 was in Operational Condition 1 at 99% power level.

Description of the Event:

On June 18, 1991, at 1842 hours, a failure of an inductor in the Unit 1 '1B' Reactor Protection System (RPS)/Uninterruptible Power Supply (UPS) inverter (E11S:INVT) caused a loss of power to the '1B' RPS/UPS power distribution panel (1BY160). This loss of power resulted in automatic actuations of the Primary Containment and Reactor Vessel Isolation Control System (PCRIVICS) (E11S:JM), an Engineered Safety Feature (ESF), causing isolations of the following Unit 1 systems or subsystems by closing their outboard primary containment isolation valves:

- o Drywell Chilled Water (DWCW) (E11S:KM),
- o Reactor Enclosure Cooling Water (RECW) (E11S:CC),
- o Primary Containment Instrument Gas (PCIG) (E11S:LK), and
- o Reactor Water Cleanup (RWCU) (E11S:CE).

The following system lines received isolation signals but no valve motion occurred since the associated valves were in the normally closed position:

- o Unit 1 Shutdown Cooling Mode of the Residual Heat Removal (RHR) system (E11S:BO),
- o Unit 1 RHR Heat Exchanger Sample Drains and RHR Drain to Radwaste lines,
- c Unit 1 RHR Heat Exchanger Vacuum Breaker (E11S:VACB) lines,
- o Unit 1 and Unit 2 Primary Containment Nitrogen Inerting,
- o Unit 1 and Unit 2 Primary Containment Purge Supply and Exhaust,
- o Unit 1 and Unit 2 Primary Containment Exhaust to Reactor Enclosure Equipment.

In addition, the following ESFs also initiated as designed due to the loss of power to the RPS/UPS distribution panel. The Unit 1 Reactor Enclosure (RE) Heating, Ventilation and Air Conditioning (HVAC) system isolated. The 'B' trains of the Standby Gas Treatment System (SGTS) (E11S:BM), a common plant system, and the Unit 1 Reactor Enclosure Recirculation System (RERS) (E11S:VA) automatically initiated following the isolation of the normal RE HVAC. Additionally, the common Refuel Floor HVAC system isolated.

Operations personnel immediately investigated the '1B' RPS/UPS inverter following the loss of power to panel 1BY160 and found an inductor in the '1B' static inverter smoking and sparking. The inverter was bypassed and the smoking and sparking stopped.

Main Control Room (MCR) operators restored the DWCW, RECW and PCIG systems by 1848 hours using PCRIVICS isolation bypass switches in accordance with the Event Procedure E-1BY160, "Loss of 1B RPS and UPS Power," Off Normal Procedure ON-113, "Loss of RECW," and General Plant Procedure GP-8, "Primary and Secondary Containment Isolation Verification and Reset." The alternate AC power supply to the '1B' RPS/UPS bus was placed in service restoring power to the RPS/UPS power distribution panel at 1900

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

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		YEAR 9 1 1	SEQUENTIAL NUMBER - 0 1 1 8	REVISION NUMBER - 0 1 1			
					0 1 3	OF	0 1 4

TEXT (if more space is required, use additional NRC Form 266A's) (17)

hours. All remaining isolations were reset by 1930 hours. The duration of the loss of power to the 1BY160 panel was 18 minutes. The failed inductor was replaced and the inverter was tested for proper operation on June 19, 1991.

A four hour notification was made to the NRC at 2135 hours on June 18, 1991, in accordance with the requirements of 10CFR50.72(b)(2)(ii), since this event resulted in automatic ESF actuations. This report is being submitted in accordance with the requirements of 10CFR50.73(a)(2)(iv).

Analysis of the Event:

The isolations were bypassed or reset in accordance with plant procedures and the systems were restored expeditiously by operators, preventing any adverse impacts on plant systems. All systems responded as designed during the loss of power to the RPS/UPS power distribution panel. There was no release of radioactive material to the environment as a result of this event.

If immediate corrective actions were not taken quickly enough by licensed MCR operations personnel, the potential exists that this event could have resulted in securing of the Reactor Recirculation Pumps followed by a plant shutdown. Plant shutdown could have also been required due to Drywell temperature and pressure increases as a result of the isolation of DWCW and the resultant loss of Drywell cooling. Additionally, if the PCIG system were left out-of-service for an extended period of time, the Main Steam Isolation Valves (MSIVs) could have drifted closed, resulting in a reactor trip and subsequent challenges to safety-related systems.

Immediate and follow-up actions for this type of event, loss of power to an RPS power distribution panel, are provided in procedures E-1BY160, ON-113, and GP-8. Licensed MCR operators receive requalification training to review and practice responses to simulated plant transients of this type. This training reinforces immediate operator actions, minimizing the time that systems are isolated, and reducing the impact on the plant. Therefore, as a result of this adequate procedural guidance, training, and prompt operator actions, the consequences of this type of event are minimized.

Cause of the Event:

The proximate cause of this event is the unexpected gross failure of an inductor in the '1B' RPS/UPS inverter. The failure of the inductor caused a reduction in output voltage of the inverter causing the '1B' RPS/UPS bus undervoltage relays to trip. This caused the loss of power to the '1B' RPS/UPS power distribution panel; thereby, initiating the resultant ESF actuations due to loss of logic power. Instrumentation and Controls (I&C) technicians performed tests of the inverter circuitry and verified that only the inductor failed.

As a result of previous inductor failures an investigation was conducted with the inverter manufacturer, Exide Electronics, to determine the cause of the inductor failures. The inductor failure is believed to be due to an inadequate design by Exide Electronics. The failed inductor in this event, manufactured in 1977, exhibited similar symptoms to previous inductors. The type H insulation used in the



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Limerick Generating Station, Unit 1	015000352	91	018	01	04	OF 04

TEXT (if more space is required, use additional NRC Form 306A (1/77))

manufacturing of the inductor is designed for a temperature of approximately 356 degrees F. Several of the inductors manufactured in 1987 found in Exide inverters at Limerick Generating Station (LGS) have had operating temperatures as high as 400 degrees F. These elevated temperatures shorten the service life of the inductor, resulting in insulation breakdown and coil failure. Thermographic inspections performed by Maintenance personnel on January 24, 1991 revealed that inductors manufactured in 1977 were not operating at elevated temperatures and the failure mechanism was believed to be limited to inductors manufactured in 1987.

Corrective Actions:

As a result of previous inductor failures, preventive maintenance (PM) tasks were written to replace the inductors in the RPS/UPS, security, and computer inverters on an annual frequency. Since thermographic inspections performed on January 24, 1991 revealed that inductors manufactured in 1977 were not operating at elevated temperatures, the PM tasks were removed from the PM baseline schedule for these inductors in February 1991. Since this event resulted from the failure of an inductor manufactured in 1977, the PM tasks have been restored in the PM baseline schedule to replace all inductors on all inverters on an annual frequency unless past thermographic inspections reveal temperatures well within the maximum temperature for the inductor, which is 356 degrees F. Thermographic inspections will continue to be performed on all inverter inductors on a quarterly frequency. If any indications of hot spots or significant temperature differences are detected, the inductor will be replaced at that time.

A modification had been initiated due to previous inverter problems to replace the Exide RPS/UPS and security static inverters with more reliable equipment. This modification is expected to be completed by the end of the next refueling outage on each unit, currently scheduled for the Spring of 1992 and 1993 for Unit 1 and Unit 2 respectively. Once the inverters are replaced, the interim corrective actions discussed above will be replaced by the PM program recommended by the manufacturer.

Previous Similar Occurrences:

Two previous events reported in LGS Unit 2 LER 2-90-007 and Security Event Report 90-003 reported a loss of power due to failure of inverter inductors. Following these failures, an investigation into the cause, involving the inverter manufacturer, was begun.

The corrective actions for these previous events would not have prevented this event since this event resulted from an unexpected equipment failure. The corrective actions identified pertained to inductors manufactured in 1987 because the inductors manufactured in 1977 had not been experiencing high operating temperatures resulting in failure.

Tracking Codes: B: Design, manufact, constr/install deficiency