

LICENSEE EVENT REPORT (LER)

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

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 60.0 HRS. REPORTED LESSONS LEARNED ARE INCORPORATED INTO THE LICENSING PROCESS AND FED BACK TO INDUSTRY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (T-6 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20565

FACILITY NAME (1)

Browns Ferry Nuclear Plant (BFN) Unit 3

DOCKET NUMBER (2)

05000296

PAGE (3)

1 OF 8

TITLE (4)
Loss of the Emergency Core Cooling Systems (ECCS) Division I and Division II Instrumentation Renders ECCS Equipment Inoperable.

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 NAME	DOCKET NUMBER
07	17	96	96	004	02	04	29	97	N/A	
									FACILITY NAME	DOCKET NUMBER
									N/A	

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR 5: (Check one or more) (11)							
POWER LEVEL (10)	100	20.2201(b)	20.2203(a)(2)(v)	<input checked="" type="checkbox"/>	50.73(a)(2)(i)(B)	<input type="checkbox"/>	50.73(a)(2)(viii)	<input type="checkbox"/>	
		20.2203(a)(1)	20.2203(a)(3)(i)	<input type="checkbox"/>	50.73(a)(2)(ii)	<input type="checkbox"/>	50.73(a)(2)(x)	<input type="checkbox"/>	
		20.2203(a)(2)(i)	20.2203(a)(3)(ii)	<input type="checkbox"/>	50.73(a)(2)(iii)	<input type="checkbox"/>	73.71	<input type="checkbox"/>	
		20.2203(a)(2)(ii)	20.2203(a)(4)	<input type="checkbox"/>	50.73(a)(2)(iv)	<input type="checkbox"/>	OTHER	<input type="checkbox"/>	
		20.2203(a)(2)(iii)	50.36(c)(1)	<input type="checkbox"/>	50.73(a)(2)(v)	<input type="checkbox"/>	Specify in Abstract below or in NRC Form 366A	<input type="checkbox"/>	
		20.2203(a)(2)(iv)	50.36(c)(2)	<input checked="" type="checkbox"/>	50.73(a)(2)(vii)	<input type="checkbox"/>		<input type="checkbox"/>	

LICENSEE CONTACT FOR THIS LER (12)

NAME
James E. Wallace, Licensing Engineer

TELEPHONE NUMBER (Include Area Code)
(205) 729-7874

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	AD	SCR	H177	N	X	AD	FU	B569	
X	AD	INVT	H177	Y					

SUPPLEMENTAL REPORT EXPECTED (14)

YES (If yes, complete EXPECTED SUBMISSION DATE) NO

EXPECTED SUBMISSION DATE (15)

MONTH DAY YEAR

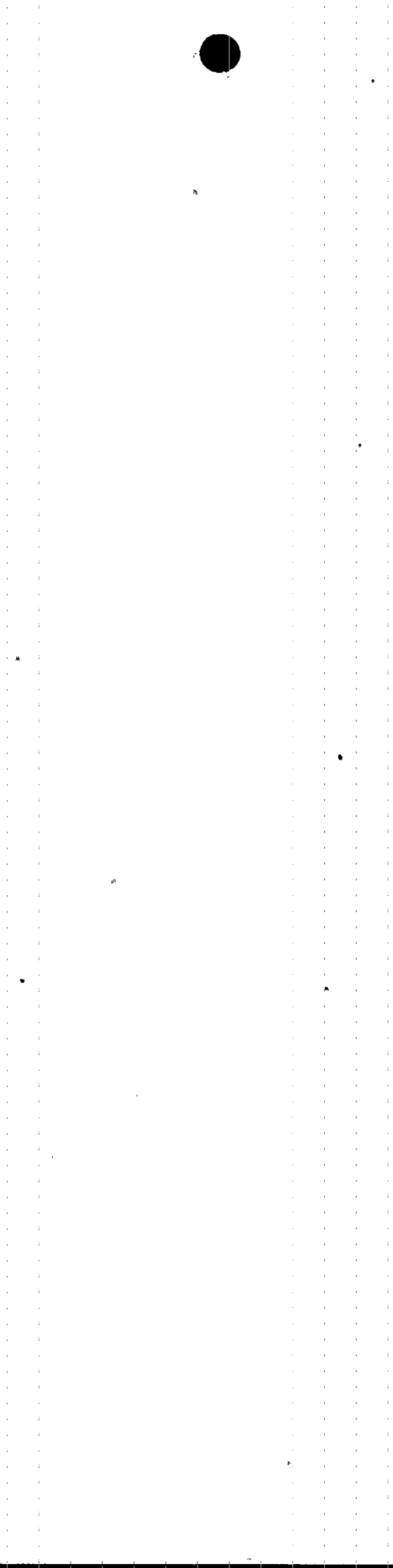
ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On July 17, 1996, with Units 2 and 3 at approximately 100 percent power and Unit 1 shutdown and defueled, Unit 3 operators declared ECCS Division I instrumentation inoperable, in accordance with TS 3.2.B. This event was presumed to be caused by a failed control board in the ECCS Division I Analog Trip Unit Inverter, which resulted in the loss of the inverter output. The failed components were replaced, the ECCS instrumentation was declared operable. On August 6, 1996, a second similar event occurred on the Division I instrumentation. On November 6, 1996, a third similar event (LER 50-296/96006) occurred on the Division I instrumentation, and on December 17, 1996, a fourth similar event (LER 50-296/96008) occurred on the Division II instrumentation. After much testing/investigating, two root causes were identified: (1) shorted silicone controlled rectifiers and (2) a shorted commutation capacitor. The Corrective action to minimize the impact for any future inverter failures was to install an alternate power supply to each inverter cabinet independent of the cabinet's associated ECCS ATU inverter.

This report is being submitted in accordance with 10 CFR 50.73 (a)(2)(i)(B) for a condition prohibited by Technical Specifications and 10 CFR 50.73 (a)(2)(vii) as any event where a single cause or condition caused at least one independent train or channel to become inoperable in multiple systems designed to remove residual heat or mitigate the consequences of an accident.

LERs on similar events were: 260/94001, 260/94006, 260/94010, 296/96006 and 296/96008.

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I. PLANT CONDITIONS

At the time of the initial discovery on July 17, 1996, Units 2 and 3 were operating at approximately 100 percent power. Unit 1 was shutdown and defueled. At the time of a second event on August 6, 1996, Unit 2 and Unit 3 were operating at approximately 36 percent power and 100 percent power, respectively and Unit 1 remained defueled. [See LERs 50-296/96006 and 50-296/96008 for the Plant Conditions for the third and fourth events]

II. DESCRIPTION OF EVENT

A. Event

INITIAL EVENT

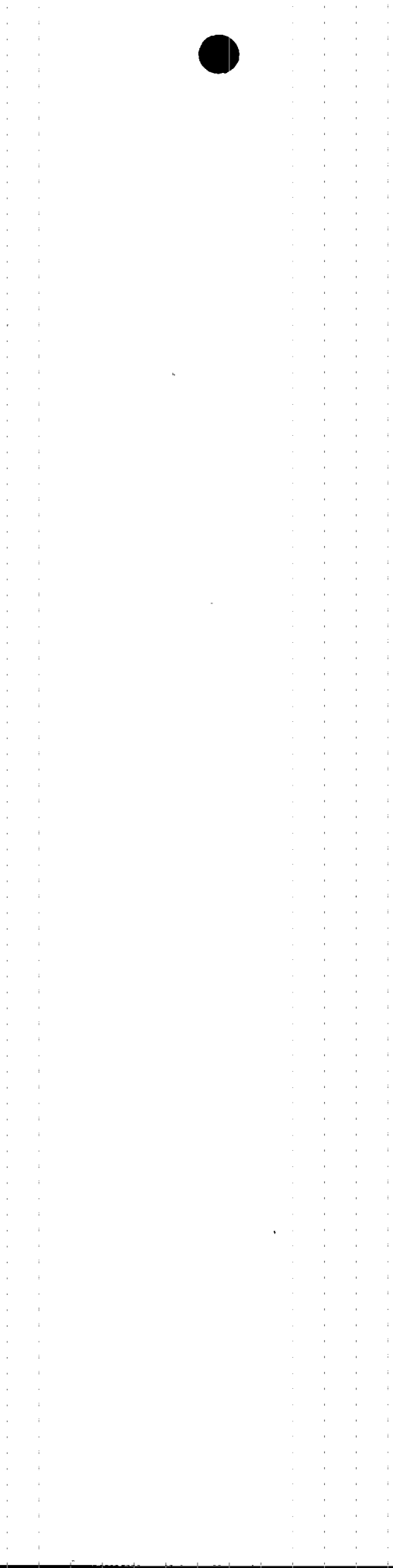
On July 17, 1996, at 1300 hours Central Daylight Time (CDT), the Unit 3, Division I Emergency Core Cooling Systems (ECCS) Analog Trip Unit (ATU) inverter power was lost as a result of a shorted Silicon Control Rectifier (SCR) that cleared a fuse. This failure affected two of the four channels of the drywell pressure and reactor water level sensors. These sensors feed both divisions of initiation logic for the ECCS (Residual heat removal (RHR) [BO] system, core spray (CS) [BG] system, high pressure core injection (HPCI) [BJ] system, automatic depressurization systems (ADS) [JC], Anticipated Transient Without Scram (ATWS) [JC], and the Unit 3 diesel generators (EDG) [EK]). Additionally the failure affected the Reactor Core Injection Cooling (RCIC) [JN] system.

The above ECCS and RCIC were declared inoperable due to the loss of control power as delineated in Technical Specifications (TS) Table 3.2.B. Since the ADS was declared inoperable, the plant was placed in limiting condition for operations (LCO) requiring the unit to be in hot shutdown within 12 hours. Additionally TS 3.5.A.3 and 3.5.B.8 for RHR and CS require the unit to be in cold shutdown within 24 hours. These were the most restrictive LCOs. As a result of these LCOs, power reduction was initiated on Unit 3 at 1700 hours. At 1757 hours, the ECCS ATU Inverter was repaired by the replacement of a cleared fuse, a shorted SCR, and removed an ATU Inverter control board. At this time, the LCOs were exited.

It should be noted that HPCI was out of service for the first two and a half hours because of scheduled maintenance.

SECOND EVENT

On August 6, 1996, a second similar event occurred at 2041 hours Central Daylight Time (CDT), the Unit 3, Division I ECCS ATU inverter power was lost again as a result of a shorted SCR that



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cleared a fuse. This failure also affected two of the four channels of the drywell pressure and reactor water level sensors. These sensors feed both divisions of initiation logic for the ECCS (RHR [BO] system, CS [BG] system, HPCI [BJ] system, ADS [JC], ATWS [JC], and the Unit 3 EDG [EK]). Additionally the failure affected the RCIC [JN] system.

The above ECCS and RCIC were declared inoperable due to the loss of logic inputs as delineated in Technical Specifications (TS) Table 3.2.B. Since the ADS was declared inoperable, the plant was placed in limiting condition for operations (LCO) requiring the unit to be in hot shutdown within 12 hours. Additionally, TS 3.5.A.3 and 3.5.B.8 for RHR and CS require the unit to be in cold shutdown within 24 hours. At 2200 hours, Maintenance and Technical Support personnel [utility, nonlicensed] commenced troubleshooting the ECCS Division I ATU inverter. At 0256 hours on August 7, 1996, the ATU Inverter was declared operable after the replacement of a fuse, a SCR, and an ATU Inverter control board. At this time, the LCOs were exited.

THIRD AND FOURTH EVENTS

[See LER 50-296/96006 and 96008 for Description of the Events.]

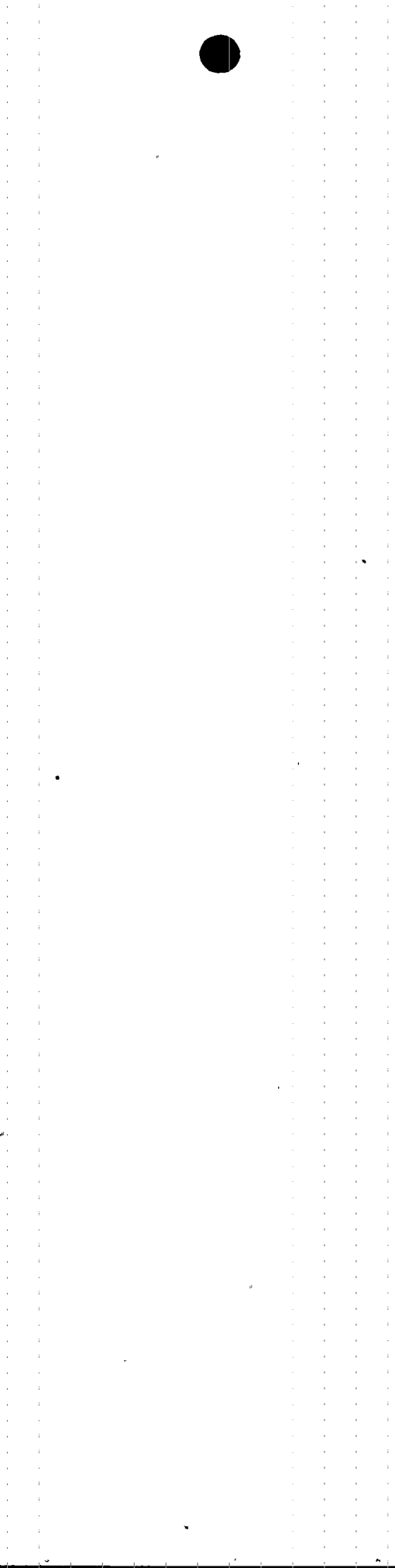
REPORTING REQUIREMENTS

BFN notified the NRC Operations Center of a one-hour non-emergency report due to the initiation of the plant shutdown per TSS in accordance with 10 CFR 50.72(b)(1)(i)(A). For the second event, the one-hour reporting requirement was not applicable because the ECCS ATU inverter was repaired before the power reduction commenced. Therefore, a four-hour non-emergency report to the NRC was made due to a condition that alone could have prevented the fulfillment of the safety function of systems that are needed to remove residual heat or mitigate the consequences of an accident in accordance with 10 CFR 50.72(b)(2)(iii).

These events were submitted in accordance with 10 CFR 50.73 (a)(2)(i)(B) for a condition prohibited by Technical Specifications and 10 CFR 50.73 (a)(2)(vii) as events where a single cause or condition caused at least one independent train or channel to become inoperable in multiple systems designed to remove residual heat or mitigate the consequences of an accident.

B. Inoperable Structures, Components, or Systems that Contributed to the Event:

None.



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C. Dates and Approximate Times of Major Occurrences:

INITIAL EVENT

July 17, 1996, at 1300 hours, CDT Unit 3 ECCS ATU Inverter power was lost.
 1700 hours, CDT Unit 3 power reduction was initiated.
 1747 hours, CDT One-hour non-emergency report to the NRC was made due to the initiation of the plant shutdown per TSs in accordance with 10 CFR 50.72 (b) (1) (i) (A).
 1757 hours, CDT The ECCS ATU Inverter was repaired, and ICOs were exited.

SECOND EVENT

August 6, 1996, 2041 hours, CDT Unit 3 ECCS ATU Inverter power was lost.
 2200 hours, CDT Troubleshooting commenced.
 August 7, 1996, 0037 hours CDT, A four-hour non-emergency report to the NRC was made due to a condition that alone could have prevented the fulfillment of the safety function of systems that are needed to remove residual heat or mitigate the consequences of an accident in accordance with 10 CFR 50.72 (b) (2) (iii).
 0256 hours, CDT The ECCS ATU Inverter was repaired, and ICOs were exited.

THIRD AND FOURTH EVENTS

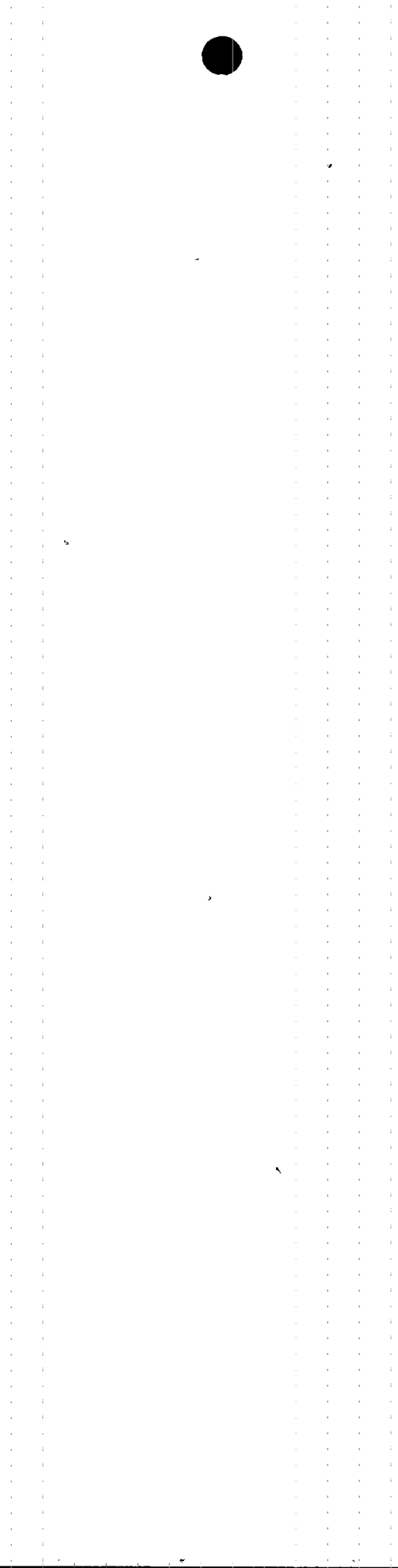
[See LER 50-296/96006 and 96008 for Major Occurrences.]

D. Other Systems or Secondary Functions Affected:

No other systems or secondary functions were affected in the four events.

E. Method of Discovery:

The first two events were promptly discovered when control room alarms indicated ECCS Division I instrumentation problems. [See LER 50-296/96006 and 96008 for Method of Discovery for third and



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fourth events.]

F. Operator Actions:

In all four events, steps were taken to identify the problems, and maintenance actions were initiated as appropriate.

G. Safety System Responses:

No safety systems were required to respond in any of the four events.

III. CAUSE OF THE EVENT

A. Immediate Cause:

The immediate cause in the four events was a loss of inverter output.

B. Root Cause:

After extensive testing, there appears to be two root causes for the four events. In the first, second, and fourth events where the inverter fuse cleared and one of the SCRs shorted, the most probable root cause was a SCR failure due to a manufacturing defect. This cause appears to be limited in scope because not all SCRs failed. In the third event where the fuse cleared but a SCR did not short, the most probable root cause was a shorting of the commutation capacitor bus by contact with an air-core inductor when its restraining strap failed.

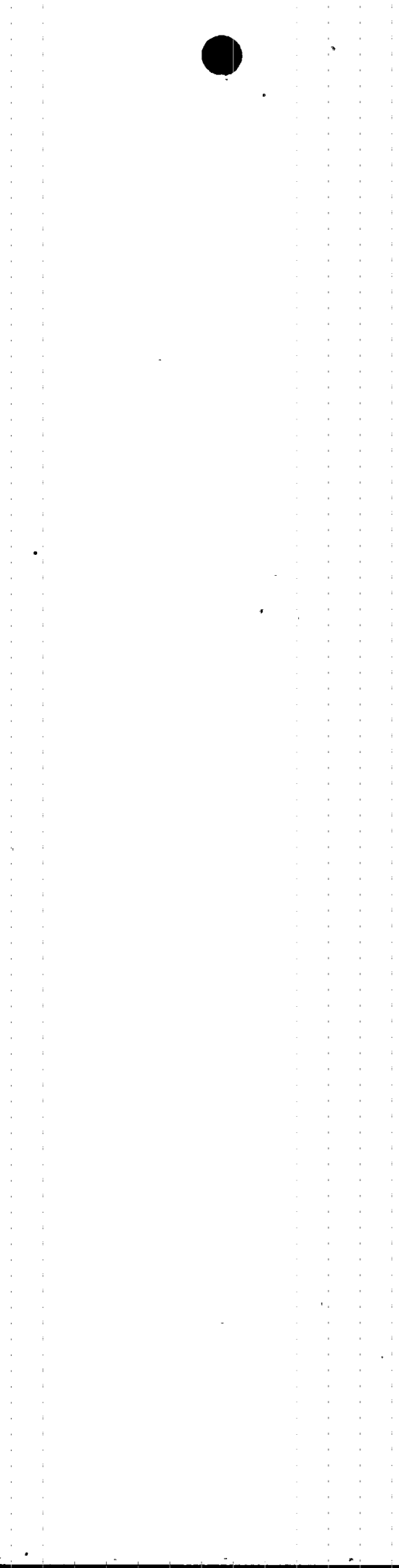
C. Contributing Factors:

None.

IV. ANALYSIS OF THE EVENT

The failed ECCS ATU Inverters caused a loss of level and/or pressure input signals to the HPCI, CS, RHR, ATWS, and ADS from their respective instrumentation logic systems.

- The first two events resulted from a power supply failure to the instrumentation logic for Division I of the ECCS. However, the Division II instrumentation logic in these events remained operable for automatic initiation during the event. Additionally, the Division I ECCS equipment was available for automatic initiation except for the following equipment: (1) RCIC would not automatically inject water into the reactor vessel as a result of a loss of flow controller power. However, HPCI was available to initiate and to inject water into the reactor vessel, and (2) Core Spray (CS) loop I would also not inject



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water into the reactor vessel due to the loss of the inboard injection valve control circuit to sense a reactor pressure less than 450 psig. However, CS loop I inboard injection valve could be manually opened at the handwheel to allow water to inject into the reactor vessel.

- [See LER 50-296/96006 and 96008 for Analysis of the Event for third and fourth events.]
- The BFN Final Safety Analysis Report (FSAR), Section 6.5.2, states in part "...the reliability and the redundancy of the controls and instrumentation of the Emergency Core Cooling Systems show that no failure of a single initiating sensor either prevents or falsely starts the initiations of these cooling systems. No single control failure prevents the combined cooling systems from providing the core with adequate cooling."
- The four events did not result in any plant transient described in the BFN FSAR, Chapter 14, Accident Analyses.

Therefore, based on the above, the four events did not result in a condition outside the design basis of the plant, nor did they adversely affect the health and safety of plant personnel or the public.

V. CORRECTIVE ACTIONS

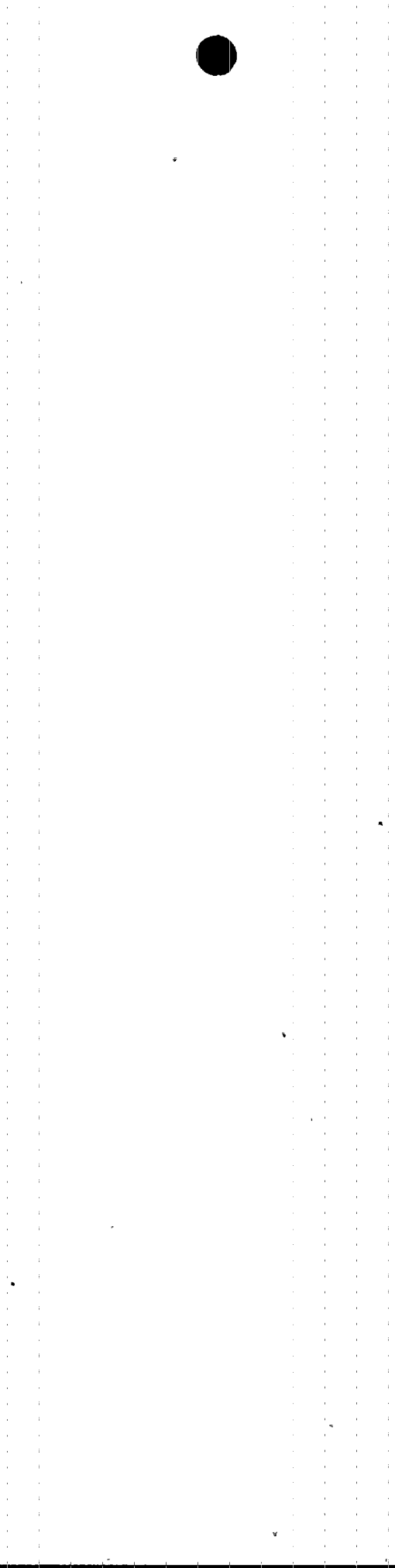
A. Immediate Corrective Actions:

In the four events, failed components were replaced in the respective ECCS Division I and II ATU Inverter circuitry. As a result of these replacements, the instrumentation logic was restored. The existing LCOs were exited.

B. Corrective Actions To Prevent Recurrence:

TVA sent failed components to an independent laboratory and the vendor. Additionally, TVA performed in-situ monitoring of the Division I circuitry to trend any electrical perturbations that might have caused any of these events. No definitive adverse trend was identified. TVA repaired the failed restraining strap and inspected the Division I restraining strap for heat damage that could cause its failure.

An alternate power supply which will minimize the impact of the loss of a single ATU Inverter has been installed in both Unit 3 ATU inverter circuits. This modification removes one 120 VAC to 24 VDC power supply from each ECCS ATU inverter cabinet and replaces it with a 250 VDC to 24 VDC converter. Unit 2's installation of the alternate power supplies will be implemented



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during the next Unit 2 refueling outage. This modification will allow uninterrupted operation of ATUs in the event of an inverter failure.

VI. ADDITIONAL INFORMATION

A. Failed Components:

July 17, 1996 and August 6, 1996 Events

- Silicon Controlled Rectifiers, Part No. TD 42 F-HDR 6841310 13C, manufactured by HDR Power Systems, Inc.
- ATU Inverter control board, Part No. 2033189G REV 0 and H2033189 SN 104 Rev A, respectively, manufactured by HDR Power Systems, Inc.
- BUSS Semiconductor fuses, Part No. FWH-125A, 550v AC/DC manufactured by Bussmann, Inc.
- [See LER 50-296/96006 and 96008 for Failed Components for third and fourth events.]

B. Previous LERs on Similar Events:

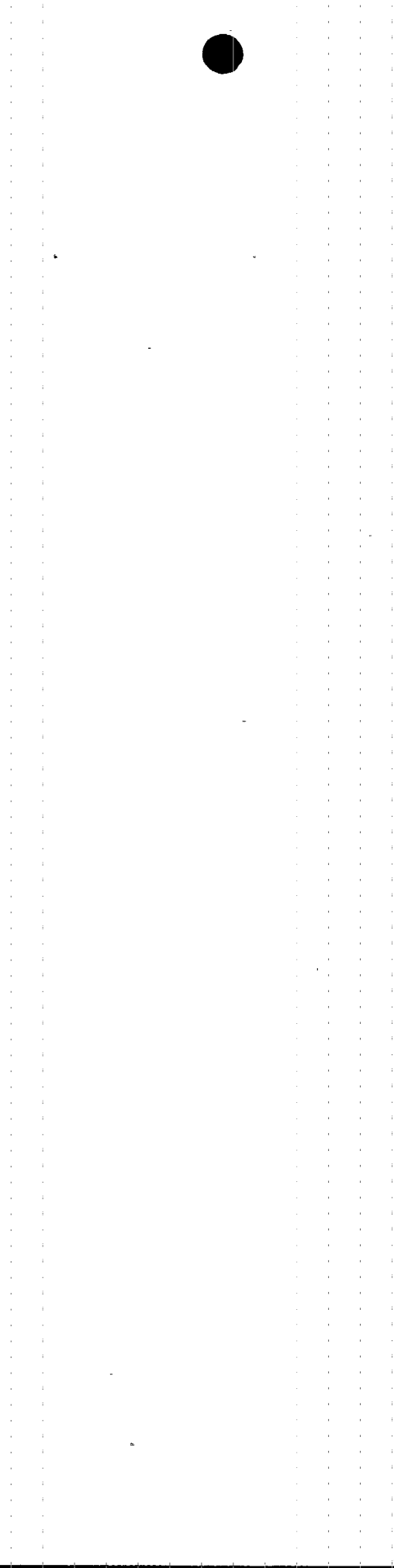
TVA has reviewed previous BFN LERs to determine if similar events have occurred. Three previous events have occurred:

LER (260/94001) was written as a result of an ATU DC input fuse failure. However, the root cause of the event was determined to be a failure of the ECCS ATU Inverter control board. Since this event occurred on a different unit, the corrective actions taken in LER 260/94001 would not have precluded this event (296/96004).

LER 260/94006 described the failure of an ECCS Division I ATU Inverter, 250 VDC reactor motor operator valve (RMOV) breaker trip. This ECCS RMOV breaker tripped as a result of a shorted SCR. Therefore, corrective actions taken for LER 260/94006 would not have precluded this event (296/96004).

LER 260/94010 addressed the failure of C1 capacitor in the Division II ATU Inverter capacitor bank. This failed capacitor was a result of a manufacturing defect. Therefore, corrective actions for LER 260/94010 would not have precluded this event (296/96004).

TVA has had previous reportable events. At that time, TVA believed that corrective actions taken to resolve those previous LERs would not have precluded this event. Based on the extensive testing of these events, TVA confirmed that no prior corrective actions would have precluded these events.



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VII. COMMITMENTS

An alternate power supply will be installed for the Unit 2 ECCS ATU Inverters during the next Unit 2 refueling outage (currently scheduled to begin September 21, 1997).

Energy Industry Identification System (EIIS) system and component codes are identified in the text with brackets (e.g., [XX]).

