NRC FORM 366 (4-95)

NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 04/30/98

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 50.0 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 20555

# LICENSEE EVENT REPORT (LER)

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

| FACILITY NAME (1) | DOCKET NUMBER (2) | PAGE (3) |
|---|---|---|
| Browns Ferry Nuclear (BFN) Plant Unit 2 | 05000260 | 1 OF 6 |

TITLE (4)

Unit 2 Scram On Turbine Control Valve Fast Closure Due to Loss of Excitation to Main Generator

| 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 |
| 10 | 29 | 96 | 96 | 007 | 00 | 11 | 27 | 96 | NA | NA |
| | | | | | | | | | FACILITY NAME | DOCKET NUMBER |
| | | | | | | | | | NA | NA |

| OPERATING MODE (9) | N |
|---|---|
| POWER LEVEL (10) | 100 |

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

| | | | |
|---|---|---|---|
| 20.2201(b) | 20.2203(a)(2)(v) | 50.73(a)(2)(i) | 50.73(a)(2)(viii) |
| 20.2203(a)(1) | 20.2203(a)(3)(i) | 50.73(a)(2)(ii) | 50.73(a)(2)(x) |
| 20.2203(a)(2)(i) | 20.2203(a)(3)(ii) | 50.73(a)(2)(iii) | 73.71 |
| 20.2203(a)(2)(ii) | 20.2203(a)(4) | X 50.73(a)(2)(iv) | OTHER |
| 20.2203(a)(2)(iii) | 50.36(c)(1) | 50.73(a)(2)(v) | Specify in Abstract below or in NRC Form 366A |
| 20.2203(a)(2)(iv) | 50.36(c)(2) | 50.73(a)(2)(vii) | |

LICENSEE CONTACT FOR THIS LER (12)

| NAME | TELEPHONE NUMBER (Include Area Code) |
|---|---|
| David Matherly, Operations Specialist | (205)729-2048 |

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 |
|---|---|---|---|---|---|---|---|---|---|
| D | TL | EXC | G080 | Y | | | | | |
| | | | | | | | | | |

| SUPPLEMENTAL REPORT EXPECTED (14) | | | EXPECTED SUBMISSION DATE (15) | MONTH | DAY | YEAR |
|---|---|---|---|---|---|---|
| YES (If yes, complete EXPECTED SUBMISSION DATE). | X | NO | | | | |


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

On October 29, 1996, at approximately 1538 hours, a full reactor scram on control valve fast closure occurred. The Unit 2 main generator field collapsed due to an exciter malfunction, and the resultant voltage and current condition caused the generator backup relays to operate. The associated switchyard breakers opened and the power load imbalance initiated fast closure of the turbine control valves, which resulted in an automatic reactor scram. Automatic Engineered Safeguard Features and automatic isolations or actuations occurred as expected with exception of main steam safety relief valves failing to lift within their Technical Specifications setpoint tolerances. Peak reactor pressure reached approximately 1130 psig. The setpoint on the lowest setpoint MSRV is 1105 +/- 11 psig. The cause of the exciter malfunction was determined to be personnel error in that the applicable maintenance instruction was inadvertently revised with incorrect guidance on exciter brush replacement. The procedure criteria for replacement of the brushes did not meet the specified vendor guidance. Corrective actions taken were: The collector ring was repaired and brushes were replaced per vendor guidance. The Unit 3 exciter brushes were inspected and three brushes were replaced. The affected procedure was revised. All safety relief valve pilot cartridges were replaced or tested and recertified. The individual involved in the erroneous procedure revision was counseled.

Failure of the main steam safety relief valves to meet Technical Specifications setpoint tolerance requirements will be addressed in LER 260/96008.

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## I. PLANT CONDITIONS

Units 2 and 3 were operating at approximately 100 percent power (3293 megawatts thermal). Unit 1 was shutdown and defueled.

## II. DESCRIPTION OF EVENT

### A. Event

On October 29, 1996, at approximately 1538 hours, a scram occurred on turbine control valve fast closure. The Unit 2 main generator [TB] field collapsed due to an exciter [EXC] malfunction. Arcing between the exciter field brushes and positive collector ring caused deterioration of the collector ring surface and brushes resulting in the loss of excitation to the main generator. The ensuing current and voltage condition caused the generator backup relays [RLY] to operate which automatically opened the associated switchyard breakers [BKR] and unit station service transformer [XFMR] breakers, and initiated a main turbine [TA] trip, an exciter field breaker trip, and a generator power circuit breaker trip. The power load imbalance initiated fast closure of the main turbine control valves, which resulted in an automatic reactor scram.

Automatic Engineered Safeguard Features and automatic isolations or actuations occurred as expected with exception of main steam [SB] safety relief valves [RV] (MSRV) failing to lift within their Technical Specifications setpoint tolerances. The first set of 4 MSRVs has a setpoint of 1105 +/- 11 psig, the second set of 4 MSRVs has a setpoint of 1115 +/- 11 psig, and the third set of 5 MSRVs has a setpoint of 1125 +/- 11 psig. Peak reactor pressure reached approximately 1130 psig which was well below the vessel pressure design limit (1250 psig), however, no MSRVs lifted. The turbine bypass valves operated as expected to limit the pressure rise. Reactor water level was controlled automatically by the Feedwater Level Control System [JB] and no Emergency Core Cooling Systems initiated. The Anticipated Transient Without Scram/Alternate Rod Insertion (ATWS/ARI) logic initiated due to high reactor pressure at 1118 psig. The reactor recirculation [AD] pumps tripped automatically due to the load reject/turbine trip above 30 percent power.

In addition to the above actuations, the scram resulted in the actuation or isolation of the following Primary Containment Isolation [JE] (PCIS) systems/components.

- PCIS group 2, shutdown cooling mode of Residual Heat Removal [BO] system; Drywell floor drain [WK] isolation valve [VLV], Drywell equipment drain sump isolation valve
- PCIS group 3, Reactor Water Cleanup [CE]
- PCIS group 6, Primary Containment Purge and Ventilation [JM]; Unit 2 Reactor Zone Ventilation [VA]; Refuel Zone Ventilation [VA]; Standby Gas Treatment (SGT) [BH] system; Control Room Emergency Ventilation (CREV)[VI]
- PCIS group 8, Traversing Incore Probe [IG].

The reactor scram was reset by 1542 hours. Plant conditions were stabilized using reactor feedwater pumps [SJ] for reactor water level control, and a reactor recirculation pump was returned to service by 1551 hours.

This event is reportable in accordance with 10 CFR 50.73 (a)(2)(iv), as any event or condition that resulted in manual or automatic actuation of any engineered safety feature including the reactor protection system.

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

None.

C. Dates and Approximate Times of Major Occurrences:

| | |
|---|---|
| October 29, 1996, at 1538 CDT | The Unit 2 reactor received a full scram due to turbine control valve fast closure. |
| October 29, 1996, at 1542 CDT | The scram was reset. |
| October 29, 1996, at 1551 CDT | Plant conditions stabilized and reactor recirculation pump returned to service. |
| October 29, 1996, at 1655 CDT | TVA made a 4 hour notification to NRC in accordance with 10 CFR 50.72 (a)(2)(iv) for actuations of RPS and PCIS. |

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D. Other Systems or Secondary Functions Affected:

None.

E. Method of Discovery:

The reactor scram and generator load reject were discovered when the control room operations personnel [licensed, utility] received alarms and indications that the reactor tripped due to control valve fast closure.

F. Operator Actions:

Once the reactor scrammed, Operations personnel responded to the scram in accordance with appropriate procedures. The reactor was stabilized using reactor feedwater pumps for level control and safely brought to a hot shutdown condition.

G. Safety System Responses:

Automatic Engineered Safeguard Features and automatic isolations or actuations occurred as expected, with exception of the MSRVs failing to lift within their Technical Specifications setpoint tolerances. Reactor pressure reached a peak pressure of approximately 1130 psig, which was well below the vessel pressure design limit (1250 psig) but slightly above the MSRV setpoint tolerances of 1105 and 1115 +/- 11 psig.

III. CAUSE OF THE EVENT

A. Immediate Cause:

The immediate cause of the reactor scram was the turbine control valve fast closure.

B. The Cause Of The Event:

The root cause of the exciter malfunction was determined to be personnel error in that the applicable maintenance instruction was inadvertently revised to contain incorrect guidance on exciter brush replacement. The original maintenance instruction specified that an exciter brush be replaced when the top of the brush or pigtail was even with the top of the brush holder, which was in accordance with vendor recommendations. In 1990, during a procedure consolidation project, a new maintenance instruction inadvertently combined the sections for main generator and exciter brushes. When this was done, the criteria for the main generator brushes was used, which specified that brushes be no less than 1/4 inch below the top of the brush holder. This was correct for the generator brushes but was not in accordance with vendor guidance for the exciter brushes. Failure to change

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brushes per the vendor guidance allowed the brushes to wear excessively and develop a gap between the brushes and collector ring. This produced arcing which deteriorated the collector ring and brushes and led to the loss of excitation.

## IV. ANALYSIS OF THE EVENT

Plant safety systems and associated components performed as designed during the event, with the exception of the MSRVs failure to lift within their Technical Specifications setpoint tolerances. The peak reactor pressure of approximately 1130 psig was well below the vessel pressure design limit (1250 psig). Reactor water level was maintained by the Feedwater Level Control System [JB] and no ECCS initiated. Therefore, the event did not affect the health and safety of plant personnel or the public.

## V. CORRECTIVE ACTIONS

### A. Immediate Corrective Actions:

Operations personnel stabilized the reactor in accordance with applicable plant procedures. The affected systems were restored to operable status. The exciter collector ring was repaired and brushes replaced in accordance with vendor guidance. The Unit 3 exciter brushes were inspected and three brushes were replaced. The MSRV pilot cartridges were subsequently removed and tested. All thirteen safety relief valve pilot cartridges were replaced with certified cartridges or tested and recertified with their setpoint within Technical Specifications requirements.

### B. Corrective Actions to Prevent Recurrence:

1. The associated maintenance instruction was revised to specify the appropriate criteria for exciter brush replacement.

2. The individual involved in the erroneous procedure revision was counseled.

3. GEK 5584 Volume 2, Generator Section (Unit 1 and Unit 2) and GEK 33780 Volume 2, Generator Section (Unit 3) information applicable to the affected maintenance instruction were reviewed to ensure no other omissions occurred.

4. Corrective Actions associated with the MSRVs failure to lift within their Technical Specifications setpoint tolerance will be provided in LER 260/96008.

## VI. ADDITIONAL INFORMATION

### A. Failed Components:

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The failed component, 2-EXC-242-0001, was a General Electric model Alterrex exciter, component type GENERA.

B. Previous LERs on Similar Events:

No previous scrams since 1994 involved inadequate procedures or failures of main generator exciter brushes or collector ring.

VII. COMMITMENTS

None.

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