NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/88

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
BROWNS FERRY UNIT 2	0 5 0 0 0 2 6 0	1 OF 0 8

TITLE (4)

ELECTRICAL FAULT ON TRANSFORMER CAUSES ENGINEERED SAFETY FEATURE ACTUATIONS

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	0 9	8 9	8 9	0 0 8	0 0	0 4	0 7	8 9	BROWNS FERRY UNIT 1	0 5 0 0 0 2 5 9
										0 5 0 0 0

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	0 0 0	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
Stephen C. Willard, Engineer, Plant Reporting Section	2 0 5 — 7 2 9 - 2 5 3 6

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	

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 fifteen single-space typewritten lines) (16)

At 1032 hours on March 9, 1989, an ESF actuation occurred due to an electrical fault on the unit station service transformer (USST) 2B. The fault led to the loss of shutdown bus 2 (the alternate feed was tagged out for maintenance). As a result, 4kV shutdown boards C and D sensed the undervoltage condition and automatically started diesel generators C and D. Emergency equipment cooling water pumps C1 and D3 also auto started per design due to the diesel generator starts.

The transformer fault occurred because of 1) inadequate insulation above the bus joint 2) the design of the bus duct allowed collection of condensation, and 3) vendor recommended preventive maintenance was not performed.

During the post event restoration of power, additional ESF actuations occurred when Reactor Protection Systems circuit protectors tripped on units 1 and 2.

As immediate corrective action, stable electrical power was restored and safety systems were returned to normal. Long term corrective action includes inspection and testing of other transformers of this type and preventive maintenance practices will be reviewed. Design changes to the bus connection and bus duct will be made on the 2B USST. Additionally, comprehensive corrective action plans were developed to incorporate lessons learned from this event.

Units 1 and 3 were defueled and unit 2 was in cold shutdown during this event.

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FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
BROWNS FERRY UNIT 2	0 5 0 0 0 2 6 0	8 9	— 0 0 8	— 0 0	0 2 OF 0 8

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

Description of Event

At 1032 hours on March 9, 1989, engineered safety feature (ESF) actuations occurred due to an electrical fault on the secondary side, "Y" winding bus of unit station service transformer (USST) 2B (20.7-4.16kV)(EIIS code EA). A momentary shutdown board undervoltage condition auto started diesel generators C and D (EIIS code EK). Emergency equipment cooling water pumps (EECW) (EIIS code BI) C1 and D3 also auto started due to the diesel generator starts. The diesel generators did not tie on to their respective shutdown boards since the shutdown boards transferred to shutdown bus 1 which was supplying power.

The USST 2B bus shorted to ground causing damage to the 4160 volt bus, the bus duct and the transformer bushing connections on all three phases. A trip signal on unit station service transformer (USST) 2B from the differential current relay was received. This caused power circuit breakers in the 500 kV switchyard (EIIS code FK) to operate, isolating 2A and 2B USST from the 500kV system. 4160 volt unit boards 2A, 2B and 4160V common board B deenergized due to their transfer switches being in manual which prevented their transfer to the 161 kV system. The 4160 volt unit board 2C transfer switch was in auto and the board transferred to its alternate power supply. Shutdown bus 2 deenergized since its alternate feed from 4160V unit board 1B was tagged out for maintenance at the time of the event. As a result, 4160V shutdown boards C and D (EIIS code EB) sensed the bus undervoltage (due to loss of power on shutdown bus 2) and automatically transferred to shutdown bus 1.

During the post event restoration at 1048 hours, the 4160V common board B and 4160 volt unit board 2A and shutdown bus 2 were manually reenergized. 4160V shutdown boards C and D automatically transferred back to their normal power supply (shutdown bus 2). During this automatic transfer, three Reactor Protection System (RPS)(EIIS code JC) motor generator sets were disconnected from the RPS system by the RPS circuit protectors due to power fluctuations during the board transfers. As a result RPS buses 1B, 2A, and 2B were deenergized, initiating the following engineered safety features.

Unit 1 RPS half scram, channel B
Unit 2 RPS scram, channels A and B

Containment Isolations/Actuations (EIIS code JM)

-Unit 1

Group 2 (Residual Heat Removal)(RHR) outboard isolation (EIIS code BO)
Group 3 (Reactor Water Cleanup)(RWCU) outboard isolation (EIIS code CE)
Group 6 (purging and venting) outboard isolation (EIIS code VB)
Group 8 (Traversing Incore Probe)(TIP) isolation (EIIS code IG)

*U.S. GPO: 1988-520-589:00070

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
BROWNS FERRY UNIT 2	0 5 0 0 0 2 6 0	8 9	— 0 0 8	— 0 0	0 3 OF 0 8

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

Description of Event (continued)

-Unit 2

Group 1 Main Steam Isolation Valves (MSIV) isolation
(EIIS code SB)
Group 2 isolation
Group 3 isolation
Group 6 isolation
Group 8 isolation

-Common

Standby Gas Treatment (SBGT) trains A, B, and C (EIIS code BH)
Control Room Emergency Ventilation (CREV), trains A and B
(EIIS code VI)
Units 1, 2, and 3 refuel zone isolations
(EIIS code VG)

The control rods were fully inserted and groups 1 and 8 were isolated on both units prior to this event.

4160V unit board 2A was manually de-energized following these ESF actuations due to concerns of possible faults on the grid. The 4160V shutdown boards C and D automatically transferred back to shutdown bus 1 and their transfer switches were placed in manual.

At approximately 1100 hours, unit 2 RPS power was restored and the scram and isolations reset. Unit 1 half scram and isolations were reset when unit 1 RPS power was restored at approximately 1120 hours. SBGT and CREV were also secured at this time. At 0737 hours on March 10, 1989, shutdown bus 2 was reenergized by the 500kV system through 4160V unit board 1B. 4160V shutdown board C and D were then manually transferred to shutdown bus 2 and the transfer switches placed in automatic.

Units 1 and 3 were defueled and unit 2 was in cold shutdown during this event.

Analysis of Event

The Engineered Safety Feature (ESF) and isolation functions involved are designed to shutdown the reactor or contain and process radioactive releases. These systems are designed to fail in the safe configuration upon loss of power to their logic systems. These actuations were successful completions of those design functions. While these events would significantly disrupt normal plant operation they do not degrade the plant's safe shutdown capabilities.

Analysis of Event (continued)

Evaluation of Plant and Equipment Response

Upon event initiation, a unit station service transformer (USST) 2B differential relay operation occurred. As a result of differential relay operation, both USST 2B and 2A were isolated from 500kV as designed. The normal feeder breakers to 4160V unit boards 2A, 2B, 2C, and common board B tripped as designed. The recirculation pump boards, 2A and 2B, were deenergized and tagged out.

Breaker 1712 was tagged out-of-service for maintenance, therefore the 4160V shutdown bus 2 could not autotransfer to its alternate power supply as designed. 4160V shutdown board C and D automatically transferred to shutdown bus 1 as designed. The undervoltage condition on 4160V shutdown boards C and D auto started diesel generators (DGs) C and D. Due to transfer of shutdown boards C and D to shutdown bus 1 and shutdown board voltage recovery, DGs C and D did not tie to the boards. DG response was both as expected and as designed.

4160V common board B, and unit boards 2A and 2B tripped, but did not autotransfer to their alternate power supply because their transfer (43) switches had been placed in the manual position and tagged. This was due to special refueling requirements established by the TVA design organization.

4160V common board B and unit board 2A were reenergized by manually transferring to start bus 1 (161kv). Upon reenergizing 4160V unit board 2A, shutdown bus 2 also reenergized. This caused 4160V shutdown boards C and D to automatically transfer back to their normal power supply (shutdown bus 2), as designed. As this auto transfer was in progress, unit 2 full reactor scram and containment isolation signals were received due to RPS 2A and 2B circuit protector trips. This circuit protector trip was as designed and due to an underfrequency or undervoltage condition on the generator side of the RPS MG set. Also, RPS 1B tripped, which resulted in a half scram and partial containment isolation on unit 1 as designed. This also was due to an underfrequency or undervoltage condition on the generator side of the RPS MG set.

Upon recieving the full scram signal on unit 2, Operations personnel (utility, licensed) reopened the alternate feeder breaker to 4160V unit board 2A, resulting in loss of voltage to shutdown bus 2. 4160V shutdown board C and D auto transferred to shutdown bus 1, as designed.

Evaluation of Operator Performance

The Assistant Shift Operations Supervisor (ASOS) initially believed that the event was caused by electricians who were working on an undervoltage relay at the time. The operators knew that by reenergizing the 4160V unit board 2A from its alternate power supply, shutdown bus 2 would also reenergize, but did not recognize that 'C' and 'D' shutdown boards would transfer back to their normal source of power. By not recognizing this, the operators believed they had closed the breaker onto a faulted condition, when in fact, the ESF actuations were caused by circuit protector trips as discussed previously. This action further

*U.S. GPO: 1988-520-589:00070

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
BROWNS FERRY UNIT 2	0 5 0 0 0 2 6 0	8 9	— 0 0 8	— 0 0	0 5 OF 0 8

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

Analysis of Event (continued)

convinced the ASOS that the electricians were causing the problem. During a review of the event, it was determined that the Shift Operations Supervisor (SOS) had information that would have helped the ASOS find the problem faster but did not communicate that information to him until later.

Cause of Event

The electrical failure on the "y" bus termination which caused the initial ESF actuations occurred due to the following reasons:

1. Corona tracking to ground from inadequate insulation above the bus joint. This led to a building phase to ground path. The corona deteriorated the Noryl sleeving beginning at a factory cut end, approximately 1/4" above the bus flex connector connection. This deterioration created a valley in the Noryl under the insulating tape. Since the bus connection was not insulated per vendor standards (i.e. inadequate for a 5kV bus system) the corona continued to track, increasing the path to ground. To complicate the problem, condensation had formed on the transformer side (lower side) of the seal plate and created a cleaner path to ground.

2. Condensation forming from the transformer (lower side) of the duct seal plate. This was attributed to the design of the bus enclosure and other contributing causes such as atmospheric conditions (rain) and/or fire extinguishing system testing before the fault and changes in external ambient temperature. This made conditions favorable for more than a normal amount of condensation to form around the area that failed.

3. The vendor recommended preventive maintenance (e.g. inspection, cleaning, testing) was not performed. If the bus had been properly inspected the condensation spots that had formed on the bus insulation and/or corona tracking would have been noticed and may have prevented the actual electrical failure.

The cause of the ESF actuations during restoration of electrical power can, in the broad sense, be attributed to inappropriate personnel action. However, this apparent cause can be traced to more fundamental basic or root causes.

Although the ASOS did not take the appropriate action when reenergizing unit board 2A by not recognizing the auto transfer which would occur, as explained above, the actual root causes were the multiple abnormal electrical system alignments due to various activities ongoing in the plant. This, coupled with inadequate communication by the SOS, who possessed the needed information, led to the inappropriate action.

*U.S. GPO: 1988-520-589/00070

Cause of Event (continued)

Additionally, plant management did not have in place a clear policy on how to evaluate, approve, and track special requirements and compensatory actions when procedures are not in place to specifically control recovery evolutions. Further, specific guidance or training is not routinely conducted for the abnormal alignments which occur during an outage with the magnitude of work currently ongoing to restart the plant.

Recognizing this, plant management has developed and will implement comprehensive corrective actions in an effort to incorporate the lessons learned from this event. These actions are detailed below.

Corrective Actions

Immediate Corrective Actions:

Upon termination of the event and confirmation that no other abnormalities existed, operations personnel realigned electrical power supplies; reset isolation and actuations; and, restored the plant to a standby readiness condition. Maintenance personnel were dispatched to unit station service transfer 2B along with operations personnel to determine the cause of the event and assess electrical equipment damage. The duty plant manager was notified; an event manager was assigned; and, an investigative team was assembled in accordance with Plant Manager Instruction 15.9. Unit station service transformer 2B was isolated and all nonemergency electrical transfers were placed under administrative control until the investigation was complete.

Work was expedited to obtain a qualified power supply for shutdown bus 2. The transformer testing and internal inspection was performed along with bus disassembly and repair.

Long Term Corrective Actions:

For the electrical failure, the following action plans are proposed.

1. A design change (a) to extend the bus into the bushing box, and (b) relocation of the duct seal plate to a lower position on the "Y" secondary bus on the 2B USST. Completion of design 7-1-89.

2. Evaluate preventive maintenance (PM) requirements and recommended practices to be performed on the switchyard components. Completion date 6-30-89.

3. All taped connections on the 4160V Ferranti-Packard transformers will be untaped at the bushing connections, disconnected, and the secondary busses will receive high-potential testing to prove the adequacy of insulation. Completion date 9-30-89.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
BROWNS FERRY UNIT 2	0 5 0 0 0 2 6 0	8 9	— 0 0 8	— 0 0	0 7 OF 0 8

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

Corrective Actions (continued)

For problems identified during the restoration activities the following action plans are being implemented:

1. Discuss with the operators involved in this specific event on the need for proper communications. Provide and discuss with operations personnel a description of this event to emphasize the need for thorough and precise communications. Completion date 5-17-89.

2. Conduct live time training for all licensed operators. This training will cover the event as well as stress the need to thoroughly plan and analyze activities not covered by procedures and are not time critical. Completion date 7-31-89.

3. All licensed Operations personnel should be made aware of the special conditions existing on the 161-kV system. The availability of information to the operators on board transfer schemes will be reviewed for adequacy, and provide a single line drawing will be provided for reference showing abnormal alignments. Review existing special requirements notebook for accuracy and validity. Completion date 5-31-89.

4. The switchyard and electrical distribution procedure will be reviewed for adequacy considering the special operating conditions in effect. Completion date 5-24-89.

5. The functions and responsibilities of the control room operations personnel will be explicitly defined and routine training provided to reinforce this concept. Completion date is 5-31-89.

6. Evaluate the adequacy of Plant Operations Review Committee's (PORC) review of the special operating condition. Revise Site Directors Standard Practice 27.4. Completion date is 5-31-89.

7. Determine all organizations involved in reviewing compensatory measures related to this event and list their present review responsibilities. The results of this review will be presented to PORC to determine if corrective measures need to be taken. Consideration will be given to recommending who is responsible for determining the degree of guidance to be given to Operations. The results of the above review will be evaluated against SDSP 12.11 (Special Requirements and Compensatory Actions) to determine if a revision is required. Develop standardized evaluation criteria for special requirements and compensatory actions and evaluate valid special requirements and compensatory actions against criteria established. Review other special requirements and compensatory actions. Completion date is 6-15-89.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
BROWNS FERRY UNIT 2	0 5 0 0 0 2 6 0	8 9	— 0 0 8	— 0 0	0 8 OF 0 8

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

Corrective Actions (continued)

8. Operations to resolve with plant management the problem of restricted operating configurations and required maintenance. A system of priorities will be considered which would expedite unavoidable maintenance that reduces the plant capabilities. Completion date is 6-1-89.

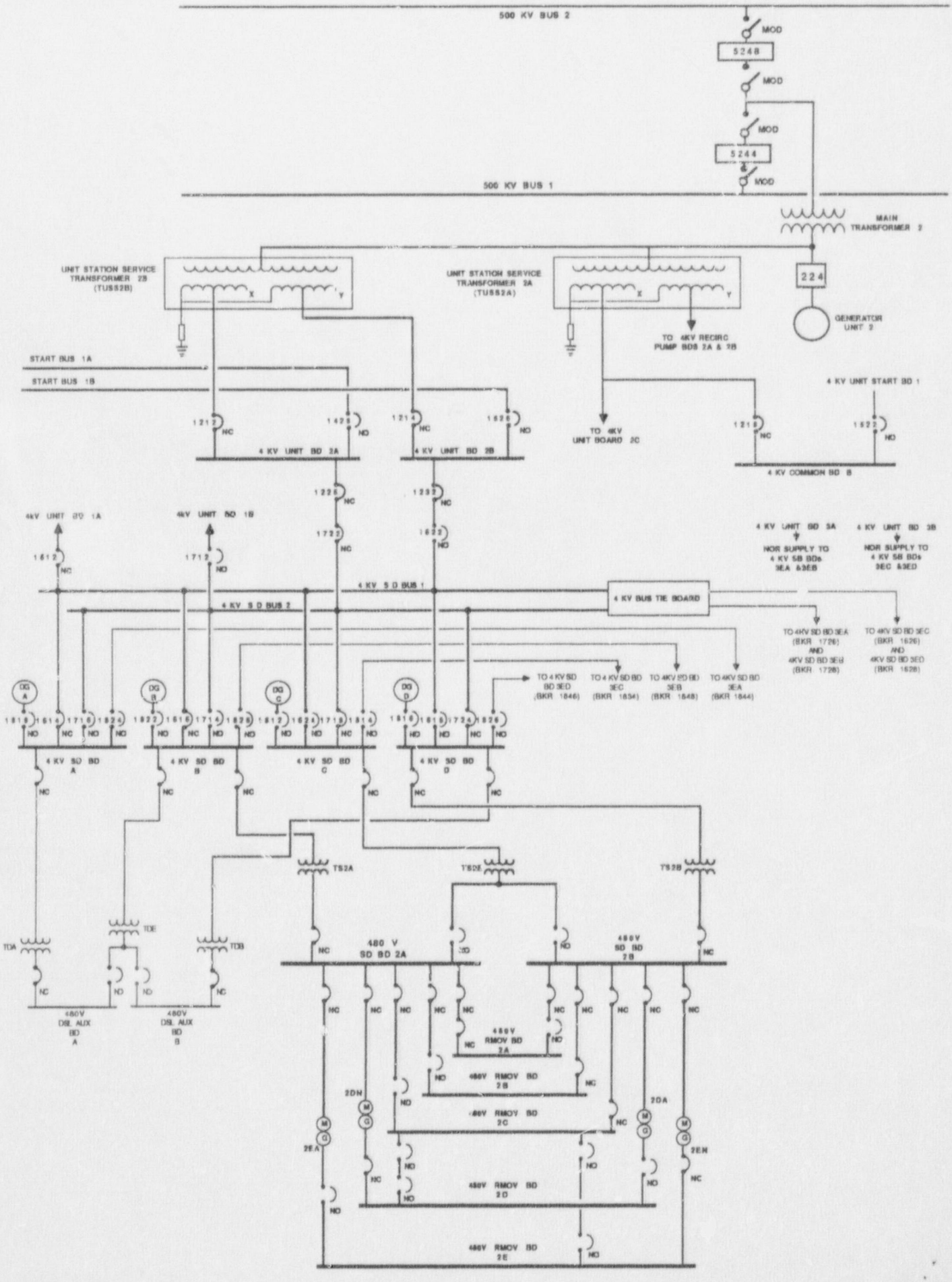
Commitments

The action plan items listed in the corrective actions are considered commitments.

Previous Similar Events - BFRO-50-259/96003

This event involved engineered safety feature actuations caused by an electrical function, however this event did not result from the same root cause.

Attachment


500 KV BUS 2
MOD
5248
MOD
MOD
5244
MOD
500 KV BUS 1
MAIN TRANSFORMER 2
UNIT STATION SERVICE TRANSFORMER 2B (TUSS2B)
UNIT STATION SERVICE TRANSFORMER 2A (TUSS2A)
224
GENERATOR UNIT 2
TO 4KV RECIRC PUMP BDS 2A & 2B
START BUS 1A
START BUS 1B
4 KV UNIT BD 2A
4 KV UNIT BD 2B
TO 4KV UNIT BOARD 2C
4 KV UNIT START BD 1
4 KV COMMON BD B
4KV UNIT BD 1A
4KV UNIT BD 1B
4 KV UNIT BD 3A
NOR SUPPLY TO 4 KV SB BDs 3EA &3EB
4 KV UNIT BD 3B
NOR SUPPLY TO 4 KV SB BDs 3EC &3ED
4 KV S D BUS 1
4 KV S D BUS 2
4 KV BUS TIE BOARD
TO 4KV SD BD 3EA (BKR 1726) AND 4KV SD BD 3EB (BKR 1726)
TO 4KV SD BD 3EC (BKR 1626) AND 4KV SD BD 3ED (BKR 1626)
TO 4 KV SD BD 3ED (BKR 1846)
TO 4 KV SD BD 3EC (BKR 1834)
TO 4KV SD BD 3EB (BKR 1848)
TO 4KV SD BD 3EA (BKR 1844)
DG A
DG B
DG C
DG D
4 KV SD BD A
4 KV SD BD B
4 KV SD BD C
4 KV SD BD D
TS2A
TS2E
TS2B
TDA
TDE
TDB
480V DSL AUX BD A
480V DSL AUX BD B
480 V SD BD 2A
480V SD BD 2B
480V RMOV BD 2A
480V RMOV BD 2B
480V RMOV BD 2C
480V RMOV BD 2D
480V RMOV BD 2E
2DH
2DA
2EA
2EH

TENNESSEE VALLEY AUTHORITY
Browns Ferry Nuclear Plant
Post Office Box 2000
Decatur, Alabama 35609-2000

APR 07 1989

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

Dear Sir:

TVA - BROWNS FERRY NUCLEAR PLANT (BFN) UNIT 2 - DOCKET NO. 50-260 - FACILITY OPERATING LICENSE DPR-52 - REPORTABLE OCCURRENCE REPORT BFRO-50-260/89008

The enclosed report provides details concerning the engineering safety feature actuations caused by an electrical fault on a transformer. This report is submitted in accordance with 10 CFR 50.73 (a)(2)(iv).

Very truly yours,

TENNESSEE VALLEY AUTHORITY

D. C. Mims for
Guy G. Campbell
Plant Manager

Enclosures
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NRC Resident Inspector, BFN

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1/1