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10CFR50.73

Nuclear Generation

November 6, 1989
NRC-89-0192

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

References: 1) Fermi 2
NRC Docket No. 50-341
Facility Operating License No. NPF-43

2) Detroit Edison letter, NRC-87-0183, dated October 8, 1987

Subject: Licensee Event Report (LER) No. 87-045-01

Please find enclosed LER No. 87-045-01, dated November . 1989. This revision updates LER 87-045-00, which was submitted in Reference 2. A copy of this LER is also being sent to the Regional Administrator, USNRC Region III.

If you have any questions, please contact Lynne Goodman at (313) 586-4211.

Sincerely,

Enclosure: NRC Forms 366, 366A

cc: A. B. Davis
R. Defayette
J. R. Eckert
W. G. Rogers
J. R. Stang

Wayne County Emergency
Management Division

IE22
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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)
Fermi 2	0 5 0 0 0 3 4 1	1 OF 1 1

TITLE (4): Low Pressure Coolant Injection Swing Bus Design Flaw Identified By Personnel Error

EVENT DATE (5) Month	Day	Year	LER NUMBER (6) Year	Sequential Number	Revision Number	REPORT DATE (7) Month	Day	Year	OTHER FACILITIES INVOLVED (8) Facility Names	Docket Number(s)
0 9	0 8	8 7	8 7	0 4 5	0 1	1 1	0 6	8 9	N/A	0 5 0 0 0
									N/A	0 5 0 0 0

OPERATING MODE (9): 4
POWER LEVEL (10): 0 0 0

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

20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
20.405(a)(1)(i)	50.36(c)(1)	X 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)	X 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)
Lynne S. Goodman, Director Nuclear Licensing	3 1 3 5 8 6 - 4 2 1 1

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)

YES (If yes, complete EXPECTED SUBMISSION DATE) X NO

EXPECTED SUBMISSION DATE (15): MONTH DAY YEAR

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

On September 8, 1987, an operator, removed a fuse which deenergized the DC control power to the Bus 72C while attempting to deenergize a component for maintenance activities. This Bus is the normal feed to the Low Pressure Coolant Injection (LPCI) swing bus. The loss of DC control power resulted in the loss of the power supply to the swing bus and consequently to the LPCI Loop Selection Valves.

Subsequently, the design was reviewed by Nuclear Engineering and it was determined that the DC control circuitry for MCC 72CF equipment was inadequate. The LPCI operation could be prevented by either of two independent failures external to the swing bus. The DC control circuitry for the MCC 72CF has been redesigned to meet the plants design basis.

In October 1989 a new scenario was postulated which involved degradation of the voltage on the 480 V bus supplying MCC 72CF such that the swing bus loads might not operate properly and the bus would not transfer to its alternate supply.

NRC Form 366 (9-83)

Initial Conditions:

Operational Condition: 4 (Cold Shutdown)
Reactor Power: 0 Percent
Reactor Pressure: 0 psig
Reactor Temperature: 135 degrees Fahrenheit

Description of Event:

On September 8, 1987 at 1255 hours, an operator was supposed to deenergize the DC control circuit to the Division I Emergency Equipment Cooling Water (EECW) (CC) pump. The operator removed the fuse (FU) as instructed by the Red Tag Record/Abnormal Lineup Sheet for the protective maintenance tag out. The fuse he removed was in a circuit supplying DC control power to Bus 72C. It was identified to be removed, in error, by the maintenance crew requesting the protective tag out. An operator (Utility Licensed) had reviewed and accepted the Abnormal Line Up Sheet. The removed fuse fed DC control power to the entire Bus 72C (ED) rather than just position 3D for the Division I EECW pump.

When DC control power was removed from Bus 72C and its associated breakers, the breakers did not change state. Loss of DC control power to Bus 72C position 3C caused the DC coil magnetic contactor in the Bus 72C which feeds the 480 volt AC Motor Control Center (MCC) 72CF to drop out. This deenergized the MCC 72CF. The MCC 72CF Low Pressure Coolant Injection (LPCI) Swing bus provides AC motive power and control to seven LPCI loop Selection, Injection and Isolation Valves (ISV).

The swing bus is normally energized from electrical Division I. Upon the loss of normal feed it throws over to its standby feed from Division II via Bus 72F position 5C. The design of the throwover circuit required that the Bus 72C position 3C and associated DC coil magnetic contactor open. This provided a permissive to close for Bus 72F position 5C and its associated DC coil magnetic contactor. Because Bus 72C position 3C did not open on loss of DC control power, and the magnetic contactor did open, the MCC 72CF deenergized and the throwover was blocked. The operations shift on duty recognized the MCC 72CF was de-energized from alarms and annunciators in the control room. When they determined that the swing bus did not throwover, the fuse was replaced. By this quick action the power to the swing bus was lost for only five minutes.

On September 10, 1987 at 1600 hours, it was determined that a design error in the DC control circuitry for the Bus 72C equipment existed. An event was identified which places the plant beyond the analyzed conditions for the design base. The event is a Loss of Coolant Accident (LOCA) coincident with a Loss of Offsite Power (LOSP) where a single failure, the loss of one division of DC power occurs. The previously analyzed LOCA and LOSP with a loss of part or all of one division of DC system did not correctly consider the response of the MCC 72CF and its associated feed breakers. The "Loss of DC System" analysis only identified the loss of one division of redundant equipment. It did not identify the potential loss of MCC 72CF, resulting in the loss of control over the LPCI valves fed from the MCC 72CF. The result is the loss of capability for all four LPCI pumps to inject into the reactor vessel. For the loss of the DC system in one division associated with the loss of MCC 72CF after reactor vessel depressurization through a pipe break, only two core spray pumps in the remaining division would be available to inject to the reactor vessel.

The MCC 72CF power bus used for LPCI loop selection is the only transferable bus utilized at the plant to support ECCS equipment and the only power bus that interfaces with both divisional Engineered Safety Feature (ESF) power sources.

During this same period another design deficiency in the DC control circuitry was discovered. The load shedding string strips the loads from the Bus 72C on an undervoltage in preparation for the automatic digital load sequencer to restore loads to the Emergency Diesel Generator (EDG) (EK). The load shed string was determined to not meet the applicable single failure criteria as it is related to the ECCS equipment.

Since a condition has been identified that could alone have prevented the fulfillment of the safety function of the LPCI system, which is needed to shut down the reactor and maintain it in a safe shut down condition, this event is being reported.

On October 4, 1989, during a phone conversation between Fermi 2 and Monticello Licensing personnel, Fermi 2 was informed of another postulated scenario which could impact the operation of the swing bus. The Fermi plant was in a refueling outage at the time. The scenario involves a loss of offsite power coincident with a LOCA compounded by a single partial failure involving degraded voltage, occurring after the EDG starts loading, of the power supply of the EDG feeding the swing bus.

The postulated scenario was evaluated to determine if it is applicable to Fermi 2. On October 6, 1989 a preliminary evaluation was completed which concluded that the situation is applicable to Fermi 2.

The LPCI (BO) loop select motor operated valves fed from the swing bus MCC 72CF are designed to operate with 87% of rated voltage minimum (at the valves). This requires a minimum voltage of 94.3% of the rated voltage on the 480 volt bus feeding the swing bus. The current design of 480 volt bus provides loss of voltage protection if the voltage on the bus degrades below approximately 43%, so that on a loss of the 480 volt bus, the swing bus would transfer to the opposite division. If the voltage were to degrade to a level between 43% and 94.3% of rated voltage, the existing loss of voltage swing bus transfer logic would not be initiated.

The low voltage on the 480 volt bus will also inhibit operation of the core spray injection valve (BM) (INV) on the affected division. This condition could result in one division of the core spray system and both divisions of the LPCI system being disabled, leaving only one division of core spray system available to mitigate a large break LOCA.

Cause of Event:

An operator (utility licensed) during a maintenance protection tag-out identified the wrong fuse to be removed. When the operator in the field removed the fuse, DC control power was lost to Bus 72C position 3C and that deenergized the LPCI swing bus.

The loss of the LPCI swing bus revealed a design error in the DC control logic for the LPCI swing bus source breakers. The design error was the result of the design engineers believing that the bus would swing over to Division II under all LOSP plus single failure scenarios for single failures external to the swing bus associated equipment.

The new single failure postulated in October 1989 (i.e., degraded regulator performance) was reviewed and was compared with the original Fermi 2 design basis and NRC Branch Technical Position PSB-1, "Adequacy of Station Electrical Distribution System voltages", issued July 1981.

The existing Fermi 2 design basis for onsite power uses the loss of all voltage as a failure for the power source. That is, sustained degraded voltage conditions are not a postulated failure mode, and therefore not part of the plant design basis. This understanding was applied in the early days to both offsite and onsite design basis.

NRC reports of degraded voltage conditions occurring at nuclear power plants resulted in the issuance of NRC Branch Technical Position PSB-1, "Adequacy of Station Electrical Distribution System Voltages", in July 1981. With the issuance of this Branch Technical Position (BTP) the NRC presented recommendations as a new requirement for plants in the design phase to address and implement. This BTP effectively changed the requirements for considering and addressing degraded voltage conditions from offsite power sources.

The potential degraded voltage condition of the on-site emergency diesel generators represents an analogous condition to that considered in the BTP (which was for off-site power sources). Extension of the BTP recommendation to the on-site power sources would represent a new design requirement beyond the plant design basis and the BTP recommendations.

Since partial failures were not addressed as part of the original design basis, this condition was not considered during the review performed in 1987. Single failures evaluated at that time involved complete failure of a component rather than degraded operation. Since this new type of failure has been identified, it is being reported here even though it was not considered in the original design basis.

Analysis of Event:

General Electric was notified of the design deficiency and requested to perform an analysis of the degraded Emergency Core Cooling System (ECCS) (BO) using the current plant power history and other licensing basis assumptions. The analysis showed that under the worst situation with only two Core Spray (CS) (BG) pumps in Division II and the current power history power level not greater than 50 percent rated core thermal power, the peak cladding temperature does not exceed 1915 degrees Fahrenheit. This is much less than the 2200 degrees Fahrenheit safety limit.

In addition a site contractor performing Probability Risk Assessment (PRA) work was requested to provide a PRA of the current design. This provided an evaluation of the increased susceptibility of core damage scenarios with the degraded ECCS condition. They determined that the relative increase in probability for core damage was approximately 1 percent.

The additional condition postulated in October 1989 involves a degraded voltage of the emergency diesel generator feeding the Swing Bus Motor Control Center where the voltage has decayed to a point where the operability of the essential loads is jeopardized, yet power is still available. A sufficiently low voltage could drop out relays (RLY) and starters, as well as prevent large motors (MO) from accelerating to speed.

The emergency diesel generator output breaker (BKR) closes on loss of off-site power when the EDG reaches rated speed and voltage (provided there is no cable fault or that the generator or bus differential relays do not pick up). The EDG output breaker will never close under degraded voltage and the Swing Bus Feed can transfer successfully to the opposite division due to complete loss of voltage.

The new type of postulated failure is degraded voltage caused by a partial failure of the voltage regulator (RG). The failure has to meet all the following conditions in order to reduce available Emergency Core Cooling System (ECCS) equipment to less than that assumed in the accident analysis:

- Loss of off-site power
- Loss of coolant accident (large break)
- EDG reaches rated voltage and starts loading by Load Sequencer.
- Subsequent partial failure of voltage regulator causing the voltage to degrade to a band of 43% to 94.3% of rated voltage.
- The failure of the regulator has to be after the EDGs output breaker closing and before the LPCI loop select motor operated valves complete their function.

The EDG voltage regulator is Type SVS (Static Voltage Regulator Exciter System) manufactured by Portec Inc. The Type SVS system is a vector summing unit, deriving its power from the vector sum of the alternator output voltage and line current. The voltage regulator is composed of circuits that perform four basic functions. They are (1) sensing of the generator output voltage, (2) generation of an error signal based on the sensed generator voltage and an internal reference signal, (3) development of a firing signal that is synchronized to the voltage appearing on each individual phase and (4) generating a feedback signal for stability.

The Nuclear Plant Reliability Data System (NPRDS) record was reviewed. An instance of a partial failure of a voltage regulator was found, but no cases of partial failure of voltage regulators after the output breaker of the EDG closed were identified.

Due to the nature of the voltage regulator failure and the new kind of single failure postulated, the probability of having a degraded voltage failure that meets all conditions described above is extremely low. This was verified by using probabilistic risk analysis (PRA) methodology.

The analysis results indicated that the probability of this situation is between 7.4E-9 and 1.2E-10 per year. Based on this probability, the plant was exposed to an insignificant increase in risk due to the potential of a faulty voltage regulator resulting in failure of the swing bus during the period since plant startup.

Also, the results of the analysis presented in the BWR Owners' Group Technical Specification Improvement Methodology dated November 1985, NEDC-30936P, show that the peak clad temperature limit of 2200°F would not have been exceeded in the event of a LOCA with loss of offsite power, even with only one division of core spray operating. This analysis assumes full power, which the plant has operated at in 1988 and 1989. The analysis presented in the NEDC-30936P Licensing Topical Report is based on a realistic approach and has been used by utilities for PRA success criteria.

For small and intermediate break LOCAs, the High Pressure Coolant Injection System and Automatic Depressurization System would also be available to mitigate the consequences of an accident.

Corrective Actions:

A design change was made which causes the MCC 72CF associated breakers and magnetic contactors to respond correctly to loss of all or part of the DC system. The plant is now placed within the previously analyzed events. A review of the plant design relative to the throw over buses was performed, however no other design flaws of this type were identified.

The new design adds a DC coil operated, AC magnetic contactor in series with the breaker and the present magnetic contactor of each power feed to the MCC 72CF. This new magnetic contactor and its auxiliary contacts have replaced the interlock contact functions of the 480 volt breaker used in the opposite feed breaker control. The design still assures the double break criteria between divisions necessary when either feed is tied to the MCC 72CF. Loss of DC power to the normal feed causes both contactors on that feed to drop out allowing the transfer to the standby feed to reenergize the MCC 72CF.

A DC undervoltage relay was added to monitor the DC control power to the normal feed breaker. This provides necessary permissive interlocks to allow transfer of MCC 72CF when DC control power is lost.

Loss of DC power to the Bus 72C load shedding string was also a concern. The 480 Volt bus load shed string lacked redundancy to open the Bus 72C position 3C breaker to allow transfer. A redundant undervoltage trip string was added to trip this breaker position. This forces transfer of the MCC 72CF in the event of LOCA with LOSP and a single failure of the loss of DC power to the load shed string only.

Training to emphasize the importance of the swing bus feature was instituted.

Personnel involved in this event were counselled and discipline administered as appropriate. A standing order was issued to require that drawings are marked up and to be included with the tag out when the job is researched.

Even though the postulated degraded voltage has an extremely low probability of occurrence, it has been decided to further enhance the reliability of the swing bus operation by adding degraded voltage protection to the swing bus feed. Detroit Edison is currently evaluating whether other conditions (i.e underfrequency or overvoltage) could occur on the swing bus MCC and how they could affect overall system reliability. The EDGs are protected from overfrequency by existing overspeed protection during operation.

Previous Similar Occurrences:

This is the second time a licensed operator has identified the wrong fuse to be removed during a maintenance protection tag out. The first time was reported in Licensee Event Report 87-022.

This LER is the third LER for which an electrical design problem has been identified as a root cause. The two previous events were reported in Licensee Event Reports 86-036 and 86-044.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

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APPROVED OMB NO. 3150–0104
EXPIRES: 8/31/88

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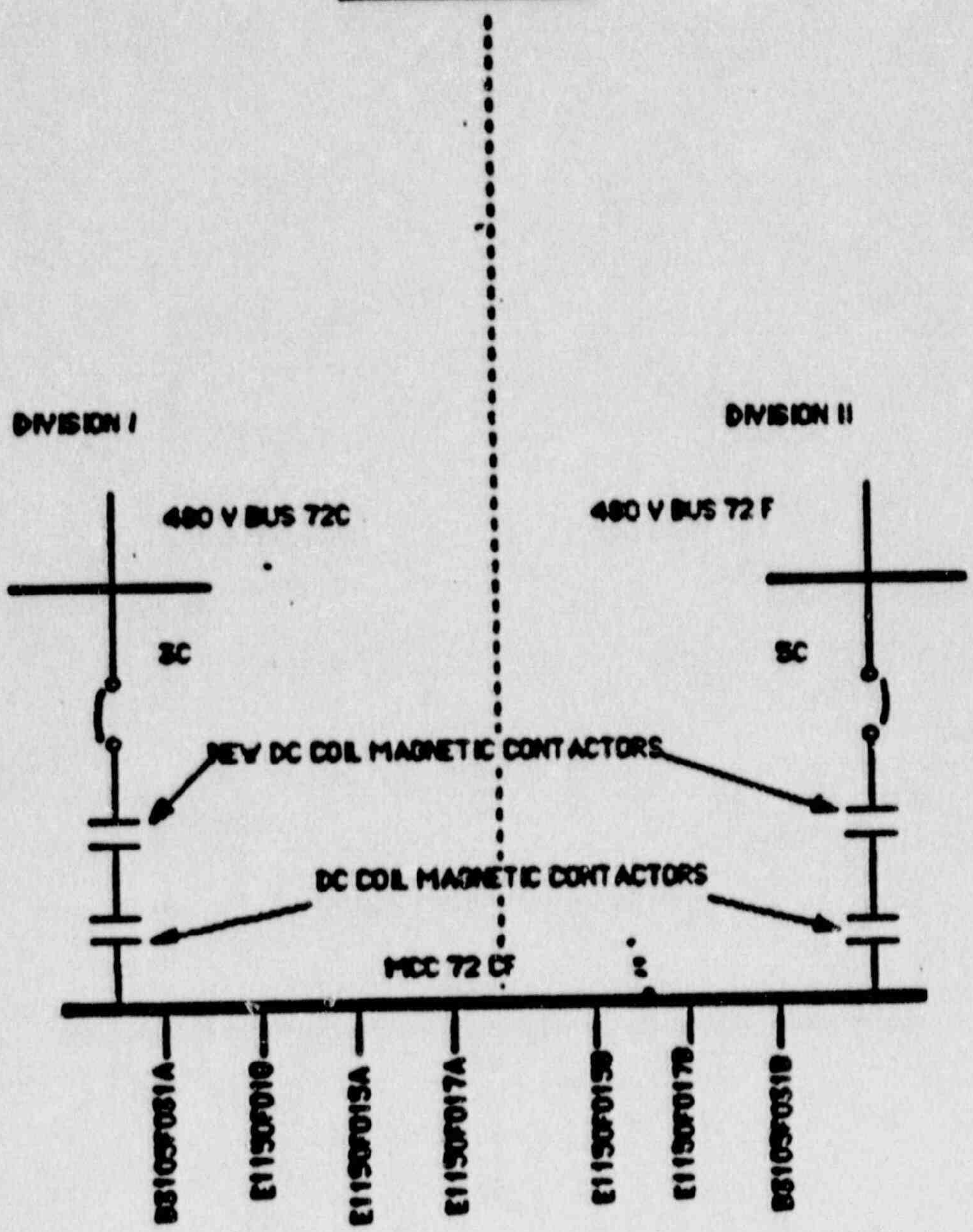
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Fermi 2	0 5 0 0 0 3 4 1	8 9	— 0 4 5 —	0 1	1 0 OF 1 1

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

INFORMATION ONLY



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

NRC Form 366A (9-83)

U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

APPROVED OMB NO. 3150-0104
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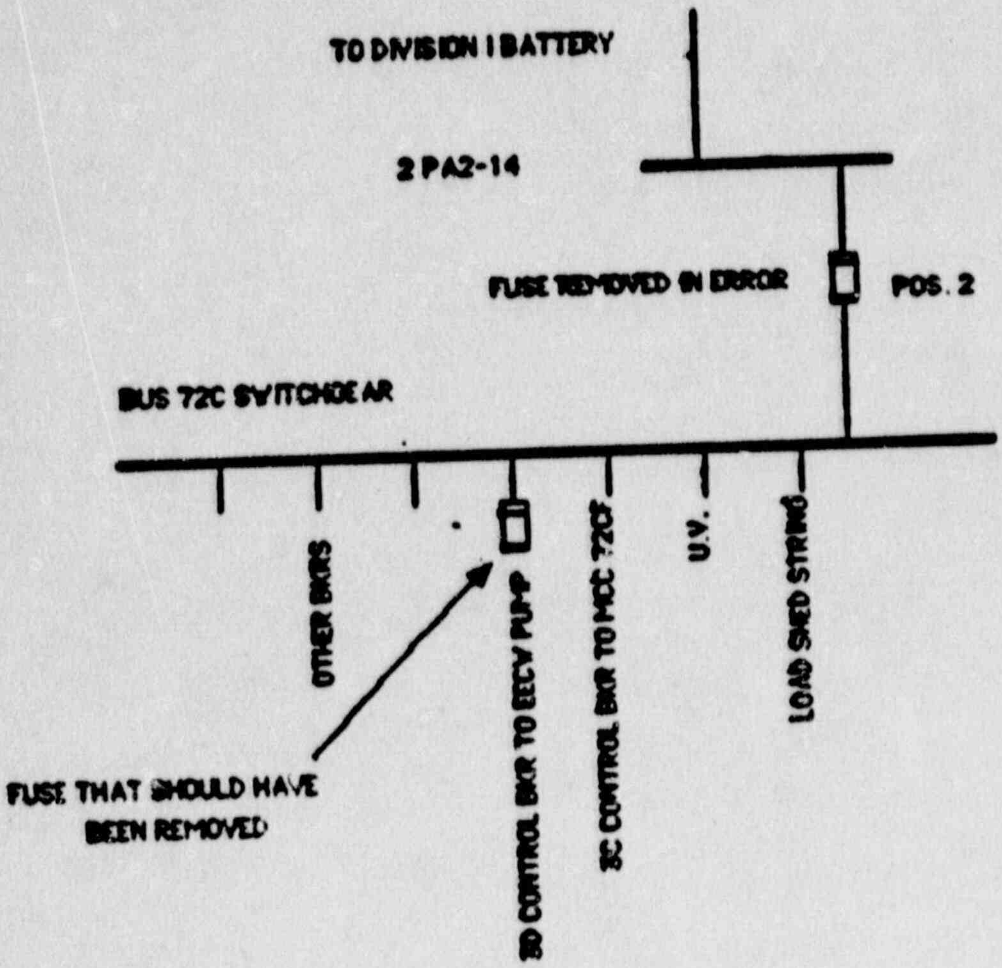
FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	PAGE (3)
Fermi 2	0 5 0 0 0 3 4 1	8 9	— 0 4 5	— 0 1	1 1 OF 1 1

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

INFORMATION ONLY



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