NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES 8/31/85

# LICENSEE EVENT REPORT (LER)

| FACILITY NAME (1) | DOCKET NUMBER (2) | PAGE (3) |
|---|---|---|
| Palisades Nuclear Plant | 0 5 0 0 0 2 5 5 | 1 OF 0 5 |

TITLE (4)

Postulated DC Bus Failure Results in Inoperable ESS Equipment

| 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 8 | 2 6 | 8 6 | 8 6 | 0 3 4 | 0 0 | 0 9 | 1 8 | 8 6 | NA | 0 5 0 0 0 |
| | | | | | | | | | NA | 0 5 0 0 0 |

OPERATING MODE (9): N

POWER LEVEL (10):

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) | 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) |
|---|---|
| Keith E Osborne, Technical Engineer, Palisades | 6 1 6 7 6 4 - 8 9 1 3 |

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)

During August 1986, with the plant in cold shutdown, an evaluation of the 125 Volt DC buses concluded that a postulated single failure of one DC bus can result in no engineered safeguard system pumps delivering water until manual operator action is taken. This design deficiency has existed since original construction.

The design error will be corrected, prior to startup from the current outage, by modifying the recirculation actuation system logic from two-out-of-four to one-out-of-two taken twice.



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

Description

On August 26, 1986, @ 1500, following an evaluation of the 125 Volt DC buses [EJ] it was concluded that a postulated single failure of one DC bus can defeat some automatic engineered safety system functions. The single failure of one DC bus disables all engineered safeguard system (ESS) equipment on the 2,400 volt safety related bus in the same power division because no control power exists to start any of the equipment. The resulting loss of the two preferred AC buses, fed from the failed DC bus, causes the operable, high pressure safety injection (HPSI) pump [P:BQ], low-pressure safety injection (LPSI)pump [P:BP], and containment spray (CS) pump [P:BE] associated with the operable DC bus to have their suction piping aligned to a dry containment sump. Without manual action to immediately stop the HPSI and CS pumps, they would soon fail. The LPSI pump, however, is tripped when the failed DC bus de-energizes and its failure is preempted by this automatic actuation.

ESS pump alignment to the dry sump is the result of actuation of the Recirculation Actuation System (RAS) [JE] two-out-of-four control logic, which is satisfied by two channels of the Safety Injection and Refueling Water Tank (SIRWT) level switch [LS:BP] auxiliary relays [RLY:BP] de-energizing. When the two-out-of-four logic control circuit is satisfied, the SIRWT outlet valves [V:BP] are closed and the containment sump valves are opened aligning the suction of the ESS pumps to the dry containment sump.

The postulated single failure of a DC bus coincident with or preceding a LOCA will result in an event that is outside the Palisades design basis. If, however, a DC bus is lost subsequent to a LOCA, then the ESS pumps on the affected DC bus will have already been started and will remain aligned to the SIRWT. The postulated failure of a DC bus after a LOCA will then result in loss of only half of the ESS equipment, including HPSI, LPSI and CS and is within the plant design basis.

Palisades is designed with two separate DC buses. Each is supplied from one station battery and two battery chargers. Each bus supplies one division of normal DC loads plus two inverters, each of which in turn supplies one preferred AC bus. The four preferred AC buses supply the four channels of instrumentation for the various protective functions.

A discussion of some of the results of the postulated DC bus failure on equipment follows. The electrical division which has lost its DC bus will be referred to as the affected side. The electrical division with DC available will be called the opposite side.

The following occur on the affected side as a result of the loss of DC:

1. Safety Injection Signal (SIS) [JE] logic is satisfied by two-out-of-four pressurizer pressure channels failing low but SIS functions cannot occur because no AC is available to operate SIS and SISX relays.

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2. RAS logic is satisfied as two-out-of-four SIRWT low level relays drop out but no RAS actions occur because no DC is available to energize valve solenoids or auxiliary relays.

3. Two-out-of-four logic is satisfied for Containment High Pressure (CHP) and Containment High Radiation (CHR) [JE] isolations of containment but no direct actions occur because preferred AC is not available to energize the CHR, 5R, and CHP, 5P, relays. Containment isolation valves in this division do close, however, because DC is lost to the air solenoid valves which causes the isolation valves to fail closed.

4. It is likely that the 2400 V bus [EB] on the affected side will remain energized (even with loss of DC to bus UV devices). Even if the bus remains energized, however, no loads can start since no DC control power is available.

5. The two-out-of-four steam generator (S/G) [SG] low pressure [PS]logic will be satisfied by the loss of the two preferred AC buses. This will cause both MSIVs [ISV:SB] to close as the MSIV solenoid valves energize from DC from the opposite division.

6. A reactor trip will occur. Since no DC would be available to effect fast transfer or close a diesel generator breaker, the vital bus on the affected division would continue to be powered from station power and would coast down with the generator.

After the loss of one DC bus, the following actions, among others, would occur on the opposite side for which DC and preferred AC remain available.

1. Safety Injection Signal (SIS) two-out-of-four logic is satisfied by failure of the two pressurizer pressure channels on the affected side. Normal SIS functions will occur on the opposite side including normal start of ESS pumps.

2. Recirculation Actuation System (RAS) logic is satisfied by dropout of two SIRW low level auxiliary relays on the affected side. All normal RAS functions will occur on the opposite side. Functions of greatest interest here are closure of SIRWT outlet valve, opening of containment sump valve and tripping of the LPSI pump.

3. Loss of the two preferred AC buses will drop out two containment high radiation auxiliary relays (RIAX). These cause the two-out-of-four containment isolation on the opposite division to be satisfied and the containment isolation valves from that electrical division will then close.

4. Loss of two preferred AC buses on the affected side satisfy two-out-of-four S/G low pressure logic. This will cause four (of six) solenoid valves in the opposite side and two (of six) in the affected side to energize and cause both MSIVs to close.

In summary, the single failure of one DC bus disables the ESS equipment on the affected side because no control power exists to start any required components. At the same time, the resulting loss of the two preferred AC buses cause operable ESS pumps on the opposite side to take suction from a dry containment sump.

Cause

The cause of the RAS actuation logic situation is the result of inadequate design consideration by the Architectural/Engineer. The uniqueness of the situation to this particular system is that the SIRWT outlet and containment sump isolation valves have two safety states. At different times during an accident, the "safe" valve position changes. There is no single fail-safe state for these valves as there is for most other active plant components. The typical design considerations for actuation logic do not encounter this dual safety state condition. Therefore, the error in using the two-out-of-four logic matrix in this case is unique. Review of other control circuits showed no other detrimental interactions like that in the RAS initiation logic.

Corrective Action

Two alternative changes to the RAS actuation logic were considered; a one-out-of-two logic and a one-out-of-two taken twice (1/2 x 2) logic. The 1/2 x 2 logic has been chosen because it provides the least susceptibility to causing an inadvertent RAS Initiation due to a spurious component failure. The 1/2 x 2 logic also eliminates the potential single failure that can disable an entire DC bus and is compatible with the demands of the duel safety states of the system valves. A modification of the RAS initiation logic to the 1/2 x 2 logic will be completed prior to startup from the present outage.

Analysis

The original two-out-of-four logic scheme is incompatible with the demands for safety state dual positions of the RAS actuated valves. Immediately after the onset of a LOCA, while the SIRWT has appreciable inventory, the safety state of RAS is to not have been actuated and its corresponding valves to not have been repositioned. This ensures that ESS pumps will be aligned to the filled SIRWT. An inadvertent actuation at this time would align the pumps to a dry sump and immediate post LOCA injection would be disrupted with the possible consequences being inadequate core inventory. Operator demand early into the

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accident is heavy and timely actions to manually realign the pumps suctions could be preempted.

When the SIRWT level approaches depletion (a minimum of 20 minutes into the accident) RAS auto-initiates upon low tank level to its other safety state; that of actuating the tank outlet valves to close and the sump outlet valves to open. In this state, the ESS pumps are aligned from the tank to the containment sump. Failure of auto-realignment would require manual operator action, however, operator demand will likely have decreased and timely manual action could be expected, without affecting core cooling.

Given the inherent advantages and disadvantages of the alternative logic configurations, a 1/2 x 2 logic is preferred. The advantages of the 1/2 x 2 logic are consistent with system requirements, consistent with operator needs, and is the most reliable in ensuring that inadvertent actuation does not compromise the initial valve safety state at a time when: a) required decay heat removal rate is the greatest, and b) operator demand is high.

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DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT -
LICENSEE EVENT REPORT 86-034 - POSTULATED DC BUS
FAILURE RESULTS IN INOPERABLE ESS EQUIPMENT

Licensee Event Report (LER) 86-034 (Postulated DC Bus Failure Results in Inoperable ESS Equipment) is attached. This event is reportable to the NRC per 10CFR50.73(a)(2)(ii).

James L Kuemin

James L Kuemin
Staff Licensing Engineer

CC Administrator, Region III, USNRC
NRC Resident Inspector - Palisades

Attachment

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