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SUBJECT: LER 90-011-00:on 900627,boron dilution sys do not meet single failure design criteria due to design deficiency.
W/9 ltr.

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DUKE POWER

July 26, 1990

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

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
LER 269/90-11

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report (LER) 269/90-11 concerning boron dilution systems not meeting single failure design criteria due to design deficiency, unanticipated interaction of systems.

This report is being submitted in accordance with 10 CFR 50.73 (a)(2)(vii)(B). This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

Joe M. Davis
for
H. B. Barron
Station Manager

RSM/ftr

Attachment

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NRC FORM 366 (6-89)

U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

APPROVED OMB NO. 3150-0104
EXPIRES: 4/30/92

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Oconee Nuclear Station, Unit 1	0 5 0 0 0 2 6 9	1 OF 1 1

TITLE (4) Boron Dilution Systems Do Not Meet Single Failure Design Criteria Due to Design Deficiency, Unanticipated Interaction of Systems

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 6	2 7	9 0	9 0	— 0 1 1 —	0 0	0 7	2 6	9 0	Unit 2, Oconee	0 5 0 0 0 2 7 0
									Unit 3, Oconee	0 5 0 0 0 2 8 7

OPERATING MODE (9): N

POWER LEVEL (10): 1 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)	50.73(a)(2)(v)	73.71(c)
20.405(a)(1)(ii)	50.36(c)(2)	X 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	
Henry R. Lowery, Chairman Oconee Safety Review Group	8 0 3	8 8 5 - 3 0 3 4

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	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)

On June 26, 1990, Design Engineering, in reviewing electrical power supplies to key components which impact Post-LOCA Reactor Building cooling, discovered that the Boron Dilution System (BDS) on all three units did not meet the single failure criterion. Valves on the two redundant trains of the Boron Dilution System (Post-LOCA Reactor Coolant Drain lines) are powered from the same 600 Volt motor control center (MCC) XS1. Therefore a failure of MCC XS1 would render both trains of the BDS inoperable. Independent sources of electrical power were initially provided for both trains. But, during the implementation of the Standby Shutdown Facility (SSF) between 1980 and 1985, power cables for two valves on Train B were rerouted from MCC XS2 to MCC XS1, the same power supply as one valve on Train A. All three Units have operated in all modes since the cables were rerouted to MCC XS1. The station has provided damage control equipment and procedures for establishing emergency power from an alternate source until a modification to correct this problem is implemented. The Root Cause is classified as Design Deficiency, Unanticipated Interaction of Systems, Design Oversight.

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

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

BACKGROUND

The Boron Dilution System (BDS) provides redundant means of ensuring at least 40 gpm of continuous flow through the reactor vessel [EIIS:AC] following a large cold leg break. This will prevent unacceptably high concentrations of boron from building up in the reactor core region. Without this continuous flow, only a fraction of the low pressure injection (LPI)[EIIS:BP] water flows into the core while the rest spills directly out the break in the cold leg. The LPI water is boiled in the core and the resulting steam flows through the reactor vessel vent valves and out the break. Therefore, boron will concentrate in the core region since it does not flow out of the vessel with the steam. If the boron concentration becomes too high, the boron may precipitate out of solution and could potentially block flow channels in the core, inhibiting long-term core cooling.

The system operates by providing a gravity flow path from the decay heat drop line (off the bottom of the hot leg) to the Reactor Building [EIIS:NH] emergency (RBE) sump. Two redundant flow paths, or trains, are available. Train A, normal dilution flow path, goes through LP-103 and LP-104 (Post LOCA Boron Dilution valves) directly to the RBE sump. Train B, the alternate boron dilution flow path, runs through LP-1 (LPI Return Block from the Reactor Coolant System), LP-2 (LPI Return Block), and other valves to the RBE sump. (See attachment 1)

The Standby Shutdown Facility provides an alternate means of assuring that any or all units can be brought to, and maintained in, a hot shutdown condition following the loss of:

1) any one fire zone due to fire, or

2) all equipment (except cabling) in non-vital areas due to sabotage, or

3) equipment in the Turbine [EIIS:NM] and Auxiliary Buildings [EIIS:NF] due to flood.

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

EVENT DESCRIPTION

In October 1975, the NRC requested information concerning post-LOCA long-term cooling capabilities. The NRC required that a means be provided for Oconee units to prevent boron concentration buildup in the reactor core during the long-term cooling phase following a postulated LOCA, specifically a cold leg break. In response, Nuclear Station Modification (NSM) ON-0507 was implemented on all three units by October 1, 1976. The initial design of the Boron Dilution System (BDS) provided that the electrical power supplies for the electric motor operated (EMO) valves in each of the two flow paths would be arranged such that a single electrical failure could not affect both dilution paths.

In 1980, during the design phase of the Standby Shutdown Facility (SSF) modification, NSM ON-1012, the following power and control modifications were made to meet fire and security design criteria:

1) LP-1 and LP-2 were reassigned to motor control center (MCC) XS1 [EIIS:ED]. The valve cable routes were changed from the East Penetration room to the West Penetration room. A remote disconnect breaker for LP-2 was added in the SSF. According to the Nuclear Safety Evaluation Check List, "This provides sabotage protection for this line. Since these valves, LP1 and LP2, were originally yellow power and control and SSF to containment cabling is grey power and control cable, these valves were moved to allow proper channel separation to be maintained; allow system to operate as intended and prevent sabotage induced LOCA from occurring."

2) LP-103 was reassigned to the 600 Volt MCC XSF and SSF controls were provided.

3) LP-104 was left on MCC XS1. The power supply for this reactor coolant system boundary and boron dilution valve is normally removed with the breaker locked-out. Indicating lights are powered from a separate power circuit.

In order to provide "proper train separation" and "sabotage protection", thereby meeting the design criteria of the SSF, it was determined that valves LP-1 and LP-2 would have to be "... powered from motor control center XS1...via the west penetration room..." This required a transfer of power from MCC XS2 where the cables had been routed through the east penetration room. The "sabotage protection" was required to prevent an intentional LOCA event. The "train separation" was to insure that the loss of all equipment and cabling in any one fire zone due to fire would

not disable both the SSF shutdown functions and the normal shutdown functions provided by the redundant safety trains.

The Nuclear Safety Evaluation Check List, prepared September 24, 1980, included the evaluation of all the existing equipment, power and controls that were to be modified to allow the implementation of the electrical portion of the SSF design. In evaluating the impact of these changes on the FSAR commitments and Technical Specifications, the "Electrical Safety Evaluation" for NSM ON-1012 drew the following conclusion:

> Part A--The installation and/or operation of these systems will have no impact on the present safety analysis of the plant....
>
> Part B--The operation and/or testing of these systems will have no impact on the present technical specifications.....
>
> Part C--Since these systems are composed of safety related equipment (i.e. valves, motors, motor control centers) and safety class power and controls, the present level of plant safety will not be degraded.

The FSAR was updated in July 1982 to include the following; "... the system (Boron Dilution) has been designed with redundant drain lines and has been shown to be single failure proof (Section 15.14.8)."

Modifications, per NSM ON-1012, to LP-1 and LP-2 control and power cables were completed, tested, and declared operable on all 3 units by May 20, 1984.

Recently, the Design Engineering Safety Analysis group (SA) has been reviewing electrical power supplies to key components which impact post-LOCA RB cooling. This was done in order to identify the most limiting single failure for containment temperature calculations. Based on this review, they discovered (June 26, 1990) that the BDS may not meet the single failure criterion. Valves on Train B (LP-1 and LP-2) and Train A (LP-104) are all powered from MCC XS1 and should MCC XS1 fail, both trains of the BDS would be rendered inoperable.

Subsequent meetings were held on 6/27/90 and 6/28/90 to discuss the operability status of the BDS and a resolution to the potential problem due to the shared power supply. It was determined that the system was conditionally operable based on the adequacy of the time allowed for the operator to take action (24 hours from the initiation of a LOCA) to restore power to and open LP-104 in the event the power supply (MCC XS1) is lost. The final problem resolution was determined to be a reassignment of LP-104 to an alternate power supply. The following corrective actions were identified:

1) Instrument & Electrical Section (I&E) would develop procedures as soon as possible to provide guidance for LP-104 power restoration.

2) Design Engineering (DE) would take the lead for an operability statement.

3) Operations Staff will require information concerning the problem to be carried in the Unit Supervisors turnover log. This information includes instructions to inform the Emergency Support Center should LP-104 require an alternate power supply.

4) DE Oconee Electrical will write a Station Problem Report to initiate the necessary modifications.

DE completed the operability evaluation (Reference Calculation OSC-4035) on June 29, 1990. The BDS was recommended to be conditionally operable on the condition that adequate station guidelines are in place for the emergency response organization to jumper power from a suitable power source to open valve LP-104. It was also recommended that phase rotation checks of the alternate power source be performed within a reasonable period of time to ensure correct installation of power to LP-104.

On June 29, 1990, I&E initially prepared procedure TI/0/A/3001/18, "Procedure to Install Jumper Cables to Provide Emergency Power to LP-104", for restoration of power to LP-104 from MCC XS2 should MCC XS1 become inoperable concurrent with a Large Break LOCA. I&E shift personnel were informed of the requirements. Phase rotation checks on MCC XS2 for all units were also completed by the I&E shift personnel. Procedure TI/0/A/3001/18 was approved July 3, 1990.

CONCLUSIONS

The current assignment of Boron Dilution System (BDS) electric motor operated valves LP-1, LP-2, and LP-104 to a common power supply does not meet the original design criteria and NRC commitment to have the system single failure proof. Information concerning the transfer of power supply was shared with various members of Design Engineering during the Standby Shutdown Facility modification design phase. The procedure used for the actual transfer of power from motor control center (MCC) XS2 to MCC XS1 was prepared by Oconee Nuclear Station Projects section. It was then reviewed by the Instrument and Electrical section, the Operations group, and Quality Assurance. But none of these groups realized the effect of the Standby Shutdown Facility (SSF) design criteria and the resulting

modifications on the single failure design criteria of the BDS. Therefore, the root cause of this event is classified **Design Deficiency, Unanticipated Interaction of Systems, Design Oversight because it was not recognized that in transferring the power supply for LP1 and LP-2, the single failure criteria for the BDS would be defeated.**

This event is also assigned a contributing cause of Management deficiency, inadequate policy with respect to the failure to maintain the FSAR current and failure to review all available documentation concerning the BDS. Though the modification to install the BDS was completed on all three units by October 1, 1976, the FSAR was not updated with information concerning the BDS until July 1982. The only documentation, concerning the BDS design criteria for redundant power supplies, available during the design phase of the SSF, was the licensing correspondence and the Nuclear Station Modification (NSM) file. There is no evidence that this information was consulted and it could be concluded that it might not have been readily available. The accountable engineer had reviewed the FSAR and Technical Specifications as required by the Nuclear Safety Evaluation Check List.

For several years after initial licensing approved, the FSAR was considered a "closed" document, not subject to revision. Therefore, significant changes due to plant modifications were not incorporated in the FSAR. Since July 26, 1982, Duke Power Company has committed to updating the FSAR annually. Changes are to include the effects of: changes made to Oconee Nuclear Station or procedures as described in the original FSAR; safety evaluations performed by Duke Power Company (DPC), either in support of requested license amendments or in support of conclusions that changes did not involve an unreviewed safety question; and analyses of new safety issues performed by or on behalf of DPC at Commission request.

Current Design Engineering policies and programs, such as "TOPFORM" which was implemented in 1987, should minimize future problems of this nature. "TOPFORM" strategies require engineering personnel to investigate in depth the effects of modifications, including replacement of station equipment, with respect to system design and operation.

The Design Basis Document (DBD) program was established in 1989 with the intent to provide readily available documents on the current design basis for certain systems. For inclusion in this document, systems must be evaluated in-depth so that a full understanding is reached and can be documented. Once completed, the DBD will be an important reference for Problem Investigation Reports (PIR), operability evaluations, 50.59 evaluations, design input to station testing programs and NSM development, and will provide general information on system functions and operations.

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To maintain the DBD current, revisions may be required because of modifications, changes to Technical Specifications, new NRC requirements, or resolutions of PIRs. An accountable engineer will be assigned to be responsible for conducting a coordinated station review of documents initiating changes and the affected DBD. By providing a controlled central reference document, the DBD will help prevent similar events in the future. The DBD program is scheduled for completion in 1995.

The Containment Isolation [EIIS:JM] and Low Pressure Injection Systems were scheduled to be evaluated by the Design Basis Documentation program (DBD) this year. These evaluations most likely would have lead to the discovery of this event even if it had not been detected during the evaluation of containment cooling capacity.

This event is identified as recurring based on two previous events which also included potential loss of function of safety systems under certain accident scenarios due to design deficiencies:

1) LER 269/90-04 Unanticipated System Interaction During Undervoltage Condition in the 230KV Switchyard Results in Failure to Comply with Technical Specifications

2) LER 269/90-05 Design Deficiency/unanticipated Interaction of systems Results in the Potential Closure of the Startup Transformer "E" Breaker on to a Degraded (Low Voltage) Switchyard

Since this report documents discovery of a design deficiency which occurred in 1980, none of the corrective actions from these previous events could have prevented this event.

There were no personnel injuries, radiation exposures, or release of radioactive materials as a result of this event. The health and safety of the public were not compromised. This event did not involve any component failure; therefore, it is not NPRDS reportable.

CORRECTIVE ACTIONS

Immediate

1) Appropriate levels of Management were informed of evaluation findings and actions were taken to assess the extent of the problem.

Subsequent

1) Design Engineering (DE) performed an operability evaluation and determined that the Boron Dilution system was conditionally operable.

2) Instrument and Electrical Section developed a procedure to restore power to LP-104 should motor control center (MCC) XS1 become unavailable.

3) I&E shift personnel checked the phase rotation on each units' MCC XS2.

4) Operations Staff informed Operations shift personnel to notify the Emergency Support Center to provide temporary power to LP-104 if required since LP-1, LP-2, LP-104 have a common power supply.

Planned

1) A Nuclear Station Modification which will result in LP-104 being powered from an alternate power supply.

SAFETY ANALYSIS

Boron Dilution System (BDS) electric motor operated (EMO) valves LP-1, LP-2, and LP-104 currently share a common power supply; motor control center (MCC) XS1. This is a violation of the single failure criteria for the system.

The BDS provides a gravity flow path from the reactor outlet piping to the Reactor Building (RB) emergency sump to maintain a minimum core flow in excess of 40 GPM to ensure boric acid solubility. The design basis for the BDS requires it to be placed into operation within 24 hours following a large break LOCA. Duke Power Company calculations indicate that the system would not be required until approximately 45 hours after the LOCA for the worst case, which corresponds to an accident from 55% of full power. For the most likely initial condition, 100% power, more than four days would be available to put the system into operation. For any hot leg breaks, the boric acid concentration buildup will not occur because of the forced circulation nature of the Low Pressure Injection system flow and the fact that abundant Emergency Core Cooling System flow is available.

The worst case power loss scenario that is postulated is a fault on the MCC XS1 bus, such that physical damage is assumed to occur on the bus, breaker cubicle, and power leads at the cubicle. If a fault occurred on

the power leads, protective relaying will ensure breaker trip prior to damage to the EMO. If damage is assumed to occur at the breaker cubicle, station personnel can trace the cable back to a point where they are able to ascertain the cable identification numbers. Each of the cable conductors are number coded along the entire ~~the~~ length of the cable. In the event of damage to the cubicle and any portion of the cable fed from the cubicle, the station procedure, TI/0/A/3001/18, will provide direction to splice cables from an alternate power supply to the existing undamaged portion of the cables supplying valve LP-104. This would allow LP-104 to be powered and made operable. LP-103 is currently powered from MCC XSF, the Standby Shutdown Facility (SSF) MCC. LP-103 and LP-104 are the only valves in Train A. Thus Train A will be capable of passing flow to the emergency sump and accomplishing the design function of the system even in the event of the worst case power failure on MCC XS1. The worst case failure bounds the postulated failure in which the MCC XS1 compartment which feeds LP-104 is not damaged. In this case, the station procedure will provide latitude to jumper power from an alternate power source directly to the breaker cubicle for LP-104, which would be significantly less time consuming to accomplish than splicing cable.

As a general assumption, the worst case single active failure for a Design Basis Accident (DBA) is taken to be at Time(T)=0 (i.e., initiation of the accident). An exception to this is the Emergency Core Cooling System, which is designed to tolerate a single active failure (short term) or single active or passive failure (long term) and still accomplish its design function. This position is reasonable, given the nature of mitigative systems (which is to respond immediately to the accident, or shortly into the accident duration). However, as the BDS is not utilized until 24 hours into the accident sequence, it is prudent and most conservative to assume that the limiting failure occurs at T=24 hours for this system. The BDS serves as long term mitigative function rather that a short term. Additionally, it is plausible to apply the ECCS criteria discussed above to this system, because the ECCS design function cannot be fully accomplished if boron precipitation blocks the flow channels in the core.

Therefore, the effect of the postulated failure at T=24 must be addressed. Based on Babcock & Wilcox analyses, boron precipitation prevention is not expected to be required until a minimum of 30 days after initiation of a DBA LOCA. But according to Duke Power Company's calculation, OSC-4040, only 45 hours may be available before reaching the boric acid solubility limit in the worst case. Station personnel have stated that 1 day to return power to LP-104 is easily attainable. Therefore, there is sufficient conservatism even if the postulated failure occurs at the procedurally required initiation of the BDS. Even if an event similar to this had occurred in the past, with the assistance of the Emergency Support Center, this problem would be identified and corrective actions

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U.S. NUCLEAR REGULATORY COMMISSION

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would be taken to restore the BDS, thus ensuring continuous flow through the core. The Oconee Probabilistic Risk Assessment indicates that the likelihood of having a large break LOCA and a subsequent failure of MCC XS1 in the next 24 hours is <1E-7. No events as described above have occurred at Oconee Nuclear Station. Therefore, the health and safety of the public has not been affected.

NRC FORM 366A
(6-89)

U.S. NUCLEAR REGULATORY COMMISSION

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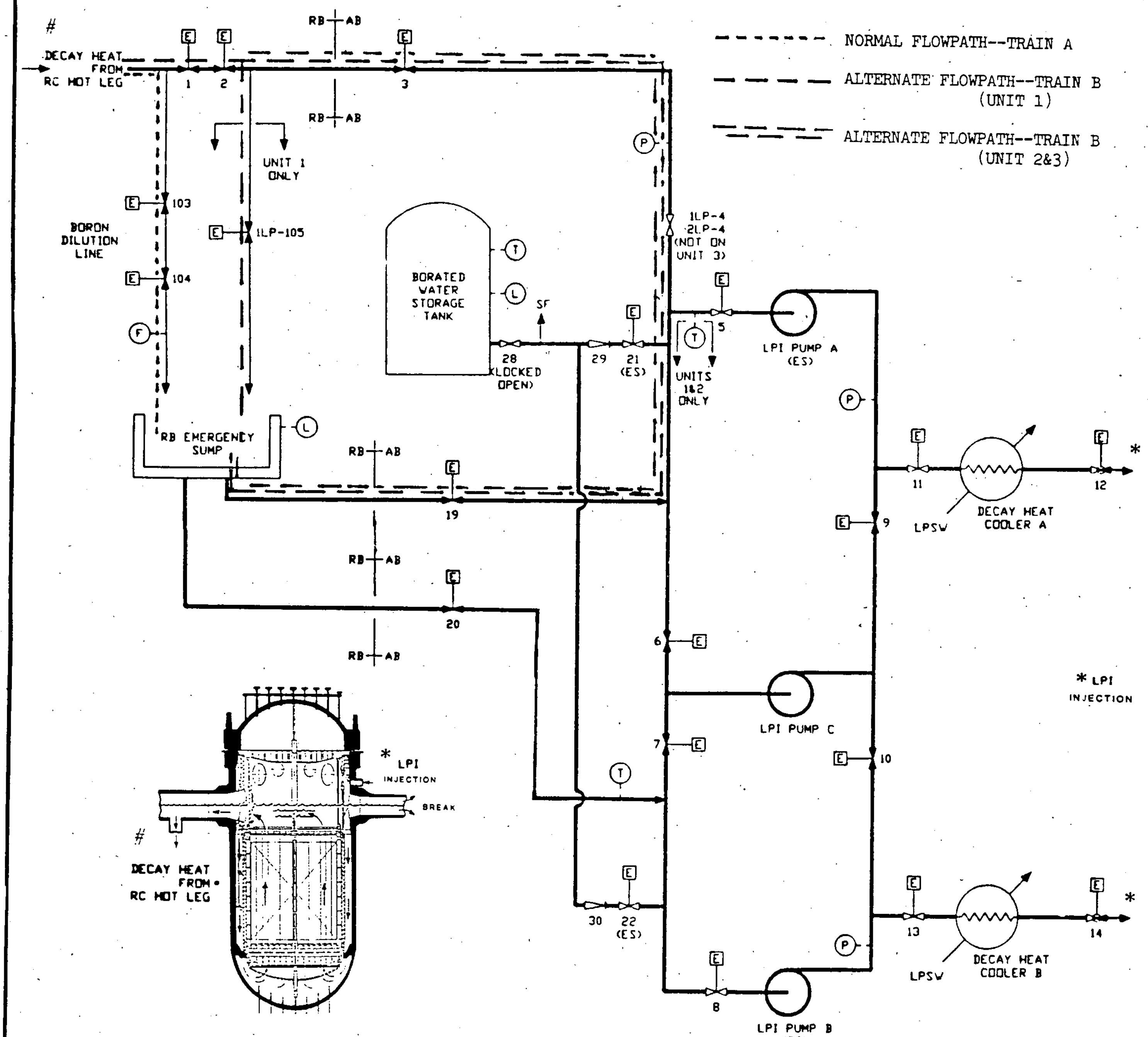
ATTACHMENT 1

BORON DILUTION FLOWPATHS VIA THE LOW PRESSURE INJECTION SYSTEM



BORON DILUTION FLOW THRU THE REACTOR VESSEL