UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

September 20, 1979

Docket No. 50-312

FACILITY: Rancho Seco Nuclear Generating Station

LICENSEE: Sacramento Municipal Utility District

SUBJECT: SUMMARY OF MEETING HELD ON AUGUST 30, 1979 TO DISCUSS THE PRELIMINARY RESULTS OF THE AUXILIARY FEEDWATER SYSTEM RELIABILITY STUDY FOR RANCHO SECO

On August 30, 1979, members of the NRC staff met in Bethesda, Maryland with representatives of the Sacramento Municipal Utility District (SMUD) and the Babcock & Wilcox Company (B&W) to discuss the preliminary results of the auxiliary feedwater (AFW) system reliability study for the Rancho Seco Nuclear Generating Station. A list of attendees is provided as Enclosure 1.

BACKGROUND

As part of the long-term requirements of the Commission Orders issued to each B&W operating plant licensee in May 1979, the licensees are committed to further review and upgrade their AFW/EFW systems. In order for each licensee to assess which areas of its AFW/EFW system are in need of improvement, the staff directed that each licensee perform a reliability study of its AFW/EFW system. The study is to be of a similar scope as that done by the NRC staff for each of the Westinghouse (W) and Combustion Engineering (CE) operating plants. On August 9, 1979, the NRC staff met with the B&W Owners' Group to discuss the scope and schedule for such a program. The Owners' Group picked Rancho Seco as the lead plant for the study. It was agreed to at that meeting that the NRC staff would meet with SMUD and B&W on August 30, 1979 to discuss the preliminary results of that study.

DISCUSSION

The meeting was divided into two parts: (1) a review of the Rancho Seco AFW system and (2) a discussion of the plant specific reliability analysis.

Part 1 (Rancho Seco AFW system discussion)

B&W presented a detailed summary of the Rancho Seco AFW system. Basically, the Rancho Seco AFW system is comprised of two separate trains. Each train has a separate suction header connected to the seismic Category I condensate storage tank (CST). Backup water supplies can be obtained from the Folsum South Canal or the plant reservoir. Neither of these alternate water sources are classified

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as seismic Category I. One train utilizes a turbine/motor-driven AFW pump (P-318) and the other train uses a straight motor-driven AFW pump (P-319). Each of the pumps can supply a total of 840 gpm, with 780 gpm fed to the steam generators (S/G) and 60 gpm recirculated to the high pressure and low pressure condensers. The discharge of each pump is cross-connected through a header containing two normally open, motor-operated valves. Thus, either pump can be used to supply water to either S/G. Flow control to each S/G is controlled through two parallel paths. The normal path is through a flow control valve which receives its actuation signal from the integrated control system (ICS). The flow control valve is electro/pneumatically actuated and will fail to the full open position upon loss of air pressure and to the 50% open position upon loss of electrical power. The alternate path is through the safety-grade, AFW bypass valves. These valves will fully open on a safety features actuation signal (SFAS). The AFW bypass valves are independent of ICS control.

Automatic starting of both AFW pumps occurs upon loss of all four reactor coolant pumps (RCPs) or low discharge pressure (850 psig) on both main feedwater (MFW) pumps. In addition, auto-start of the turbine/motor-driven pump will occur upon receipt of an ESFAS signal. All motor-operated valves can be controlled from the control room. Indication of AFW flow to each S/G and level in the CST are also provided in the control room. All conditions of auto-start of the AFW system are annunciated in the control room.

Upon initiation of AFW, either manually or automatically, no repositioning of valves is necessary to get water from the CST to the S/G. Functional tests of the system are performed monthly and quarterly a full flow test is performed on the AFW system.

Enclosure 2 shows the basic mechanical and electrical layout of the Rancho Seco AFW system.

Part 2 (AFW Reliability Analysis)

In performing the reliability analysis, SMUD defined mission success as being able to provide AFW flow from at least one pump to at least one S/G within either 5, 15, or 30 minutes. These times were obtained from the NRC studies conducted on the W and CE plants. The staff suggested that proper justification of these times for B&W plants should be made in the draft report which will be supplied to the NRC staff for review. SMUD also used NRC values for unreliability data for hardware, human factors, and preventive maintenance.

The study looked at the reliability of the AFW system under three conditions of power availability: (1) loss of main feedwater (LMFW), with both AC and DC power available with a probability of 1.0, (2) loss of offsite power (LOOP) with the most limiting DG unavailable with a probability of 10^{-2} (the other DG is available with a probability of 1.0, and (3) loss of all AC power (LOAC) with only DC and battery-backed AC power available with a probability of 1.0.

Other assumptions which were made in the study included:

(1) Lines smaller than 1 inch were not considered as possible diverted flow paths.

(2) Where valves of identical function were required to be opened or closed manually, both were considered to either be actuated together or not actuated at all.

(3) Degraded failures were not considered (components were either fully operable or considered failed).

(4) The probability of failure of the CST was assumed 5×10^{-6}.

(5) The probability of failure of a single train of AFW due to a malfunction of ICS control and initiation was assumed 7×10^{-3}.

The major contributors, identified by B&W during the study, which contribute to the unavailability of the AFW system are: (1) a manually operated full flow recirculation valve (FWS-055), (2) the necessity to manually load the motor-drives for the AFW pumps upon loss of offsite power and (3) equipment outages due to preventive maintenance.

FWS-055 is a normally closed, manually-operated valve, located between the discharge of the AFW pumps and the H.P. and L.P. condensers. This valve is manually opened (locally) during the quarterly surveillance testing of the AFW pumps. This valve, when opened, allows full AFW pump discharge flow to be pumped to the H.P. and L.P. condensers. This bypass allows testing of the pumps at rated flow without injecting water into the S/Gs. This valve is not operable from the control room; however, surveillance procedures require that an operator be stationed at the valve whenever the valve is open. This operator must be in continuous communication with the control room, such that if AFW flow is needed while FWS-055 is open, the local operator can manually shut the valve in a timely manner.

In the event of a loss of offsite power, the motor-driven AFW pump must be manually loaded on a vital bus (nuclear service bus "4A"). Also, in the event the turbine-drive on the dual-drive AFW pump is inoperable, the motor for this pump must be manually loaded on a vital bus (nuclear service bus "4B"). While procedures have been developed and the operators trained on performing this evolution, the reliability study shows that this could be a major contributor to AFW unavailability during the first 15 minutes of a LOOP transient.

Preventive maintenance is the major contributor to AFW unavailability in the case of loss of all AC power. The assumption in this case, is preventive maintenance being performed on the turbine-drive of the dual-drive pump at the time a total LOAC power is experienced.

In all three cases, the probability of mission success is lower for the first 5 minutes than for the 15 and 30 minute cases. This is due to credit being taken in the latter two cases for operator action to correct for malfunctioning components.

Three areas which will be discussed in detail in the report will be: (1) automatic actuation of AFW, (2) reliability of back-up water supplies and (3) AFW system dependence on AC power. These areas were found to be weak areas on certain non-B&W designed plants.

Enclosure 3 contains a copy of the reliability analysis handouts used at the meeting. An outline for the report is included as Enclosure 4.

CONCLUSIONS

The overall methodology for performing the study appears to be consistent with the techniques used to perform the same type of study for W and CE plants.

The NRC staff requested that the draft report, which would be submitted to the NRC for review, should incorporate the following items which were not covered in the meeting:

(1) The time segments used in the definition of mission success (i.e., 5, 15, and 30 minutes) need more definition. That is, the time segments chosen should be justified as being applicable and meaningful for B&W plants.

(2) The system description should include failure modes for each active component.

(3) The presentation made at the meeting contained no recommendations on improvements which should be made to the AFW system based on the study. It was pointed out that the purpose of the study was to define or point out dominant faults and/or major contributors to AFW unavailability. Therefore, prior to submitting its report, SMUD should incorporate its recommendations on upgrading the timeliness and reliability of the AFW system based on this report.

Consistent with the commitments made at the August 9, 1979 meeting, the draft report will be sent to the NRC for review by September 17, 1979.

R. A. Capra

R. A. Capra, B&W Project Manager
Project Management Group
Bulletins & Orders Task Force

Enclosures:
1. List of Attendees
2. Rancho Seco AFW System
3. Reliability Evaluation
4. Proposed Outline for SMUD Report

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cc w/enclosures:
See attached

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1226 320

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1226 321

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1226 322

ENCLOSURE 1

LIST OF ATTENDEES

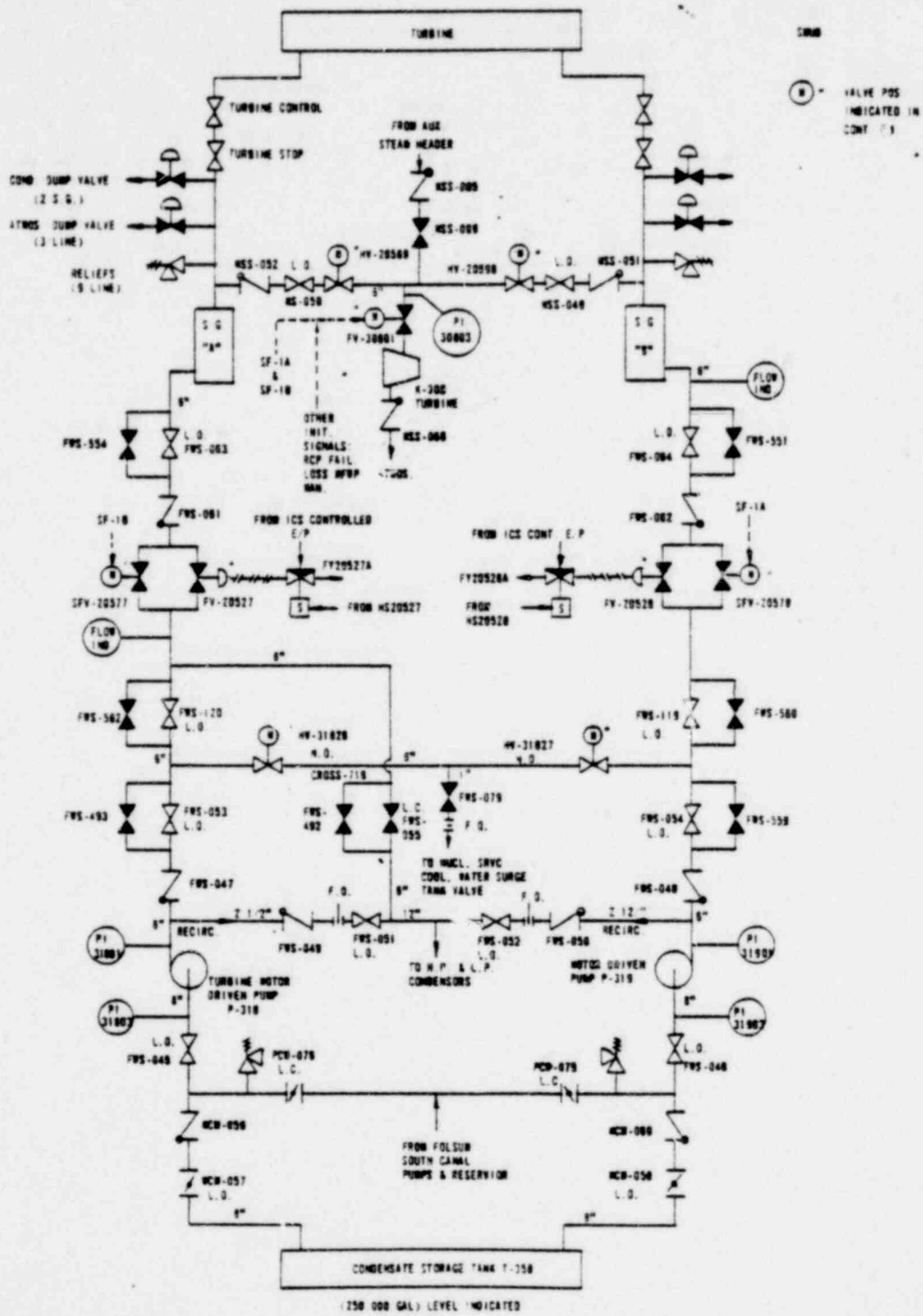
RANCHO SECO AFW RELIABILITY STUDY MEETING

AUGUST 30, 1979

NAME	ORGANIZATION
S. I. Anderson	SMUD (Nuclear Engineer)
R. J. Finnin	B&W (Licensing)
W. W. Weaver	B&W (Tech. Staff)
R. W. Dorman	B&W (Plant Integration)
B. J. Short	B&W (Customer Service)
T. M. Novak	NRC (Deputy Dir. B&O Task Force)
P. R. Matthews	NRC (Section Leader, Systems Group, B&O Task Force)
C. Y. Liang	NRC (Systems Group, B&O Task Force)
W. T. LeFave	NRC (Systems Group, B&O Task Force)
M. A. Taylor	NRC (Probabilistic Analysis Branch)
R. A. Capra	NRC (B&W Project Manager, B&O Task Force)

1226 323

ENCLOSURE 2



POOR ORIGINAL

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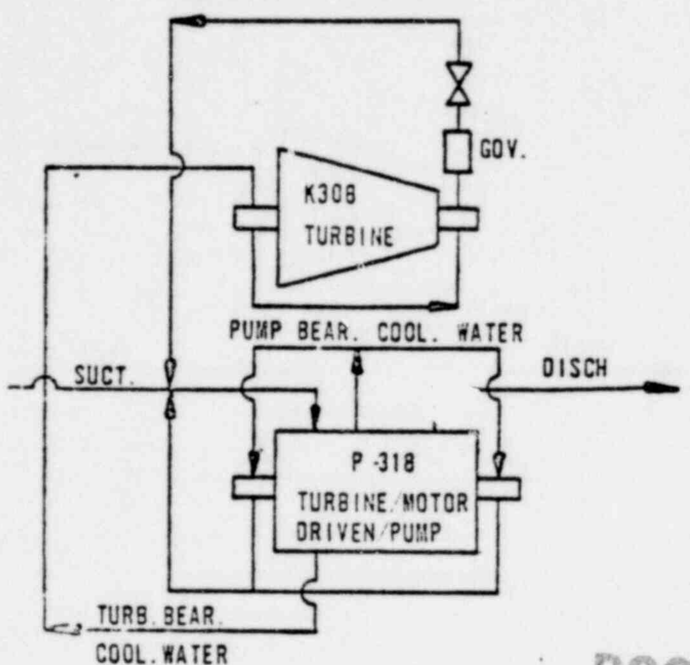
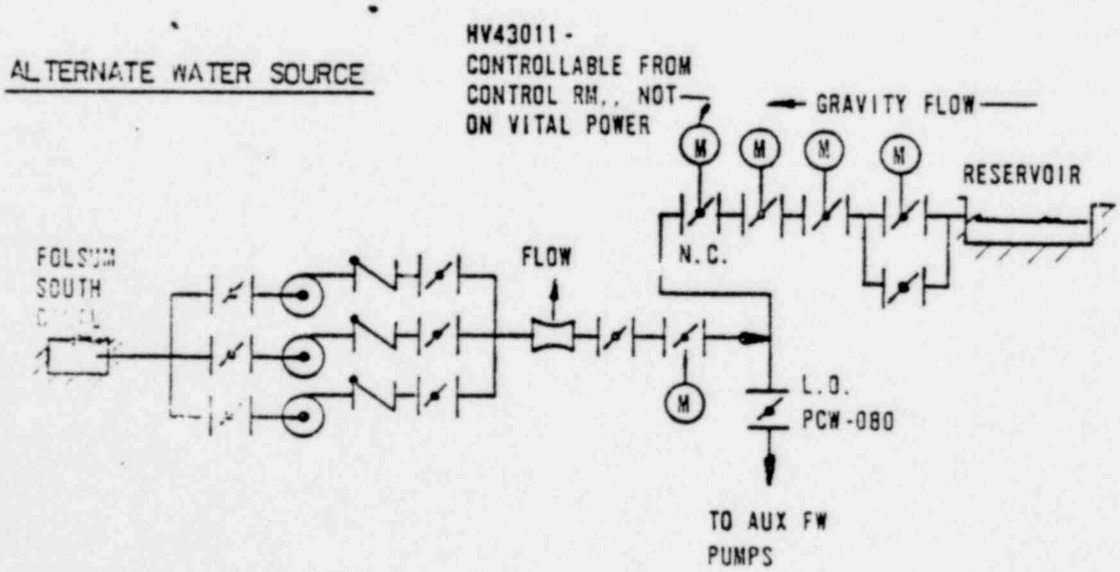


SMUD
TURBINE/MOTOR DRIVEN
PUMP BEARING COOLING
WATER SCHEME

POOR ORIGINAL



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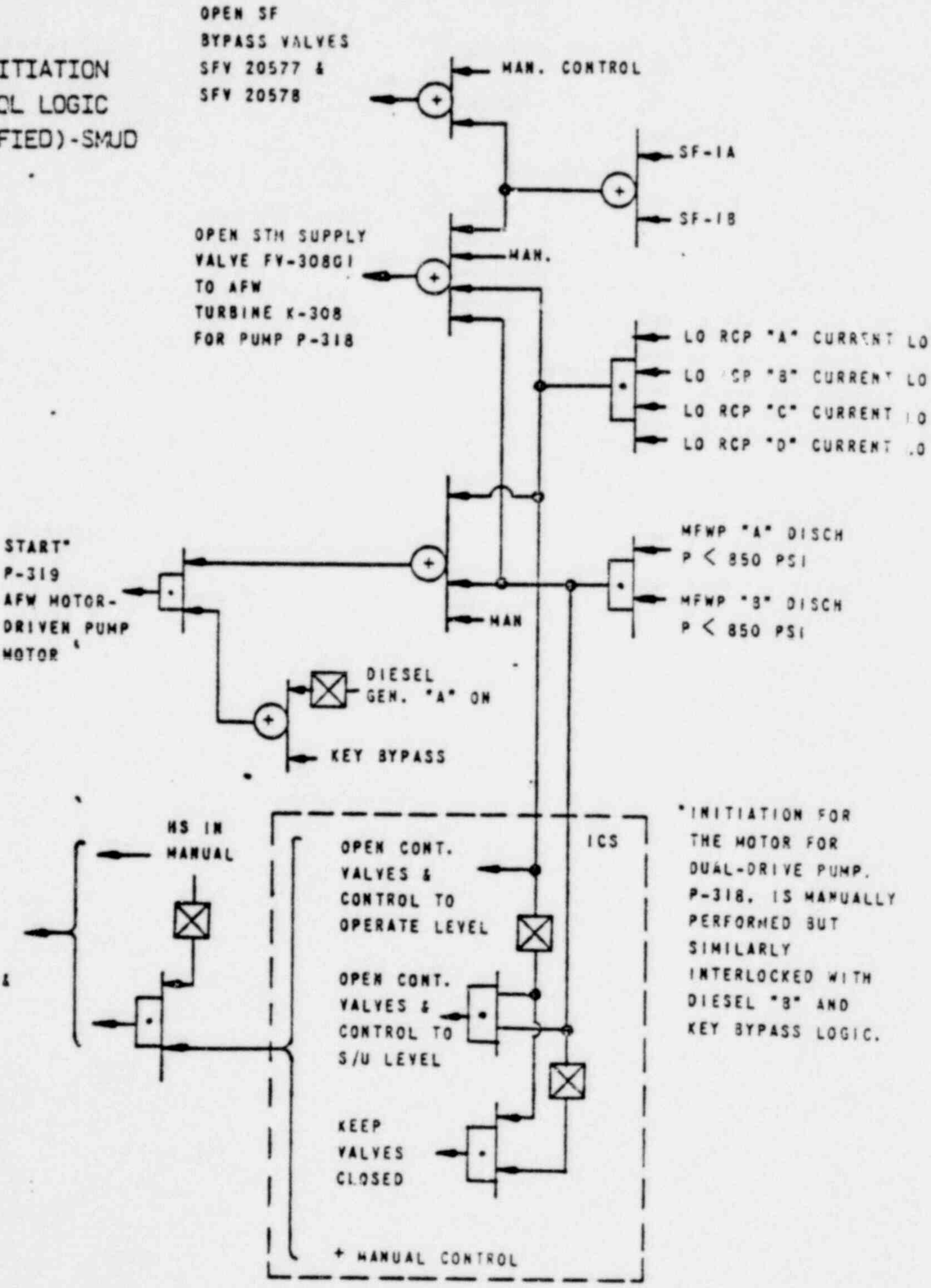
AFWS INITIATION
& CONTROL LOGIC
(SIMPLIFIED)-SMUD



*INITIATION FOR THE MOTOR FOR DUAL-DRIVE PUMP, P-318, IS MANUALLY PERFORMED BUT SIMILARLY INTERLOCKED WITH DIESEL "B" AND KEY BYPASS LOGIC.

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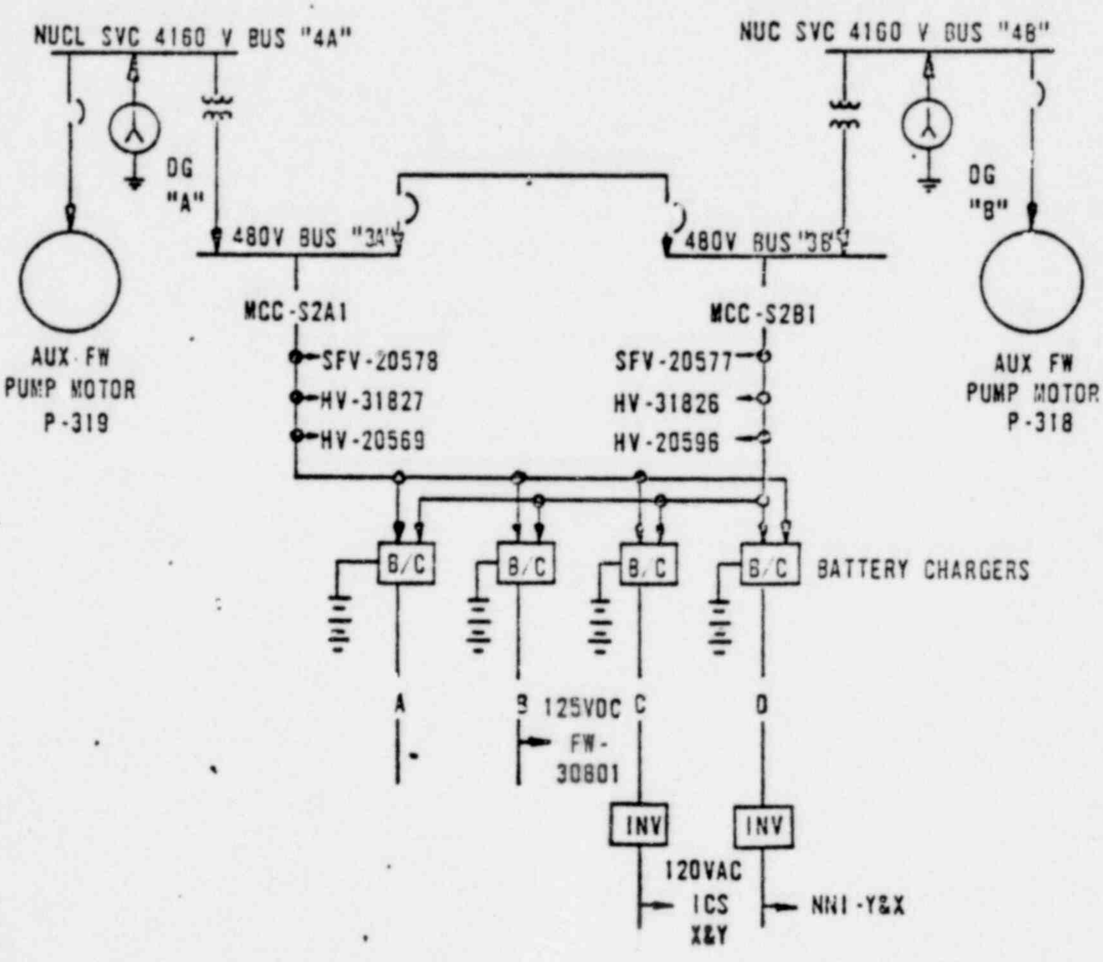
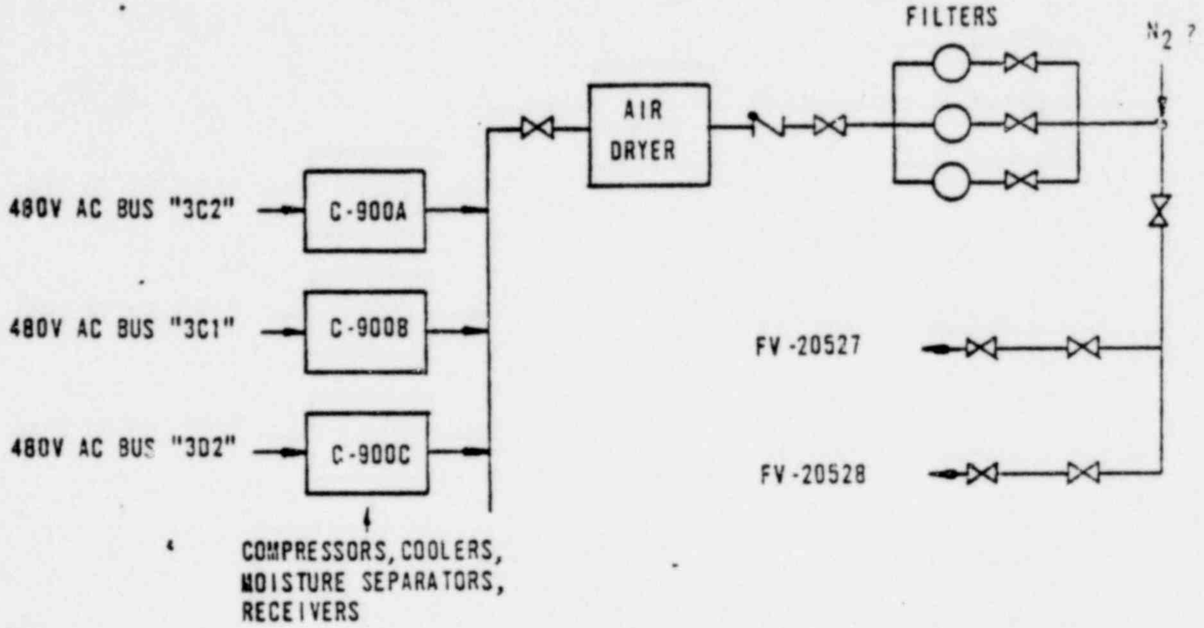


SIMPLIFIED POWER DISTRIBUTION FOR DG
& BATTERY-BACKED AFWS COMPONENTS - SMUD



AIR SUPPLY TO AFWS CONTROL VALVES-SMUD

ASSUMPTIONS/CRITERIA
FOR SMUD AFWS RELIABILITY STUDY

1. Definition of Mission Success -

   Flow from at least one pump to at least one steam generator within 5, 15 and 30 minutes.

2. Assumed validity of NRC - supplied unreliability data including hardware, human factors, preventive maintenance.

3. Power Availability -

   LMFW - All AC and DC available with probability of 1.0.

   LOOP - Most limiting DG is unavailable with a probability of 10^{-2}. The other generator (typically DG "B") is available with a probability of 1.0

   LOAC - Only DC and battery-backed AC is available with a probability of 1.0.

4. Lines of $\lesssim$ 1" were ignored as possible diverted flow paths.

5. Assumed coupled manual initiation of valves with identical function. i.e., valves were assumed both opened manually or both not opened.

6. Degraded failures were not considered i.e., components were either 100% okay or were considered failed. (Exception was loss of power to E/P converters resulting in 50% valve position - considered not failed closed).

7. Condensate Storage Tank failure probability = $5x10^{-6}$.

8. Assumed a single train for ICS control and initiation with a failure probability of $7x10^{-3}$.

MAJOR CONTRIBUTORS TO UNAVAILABILITY

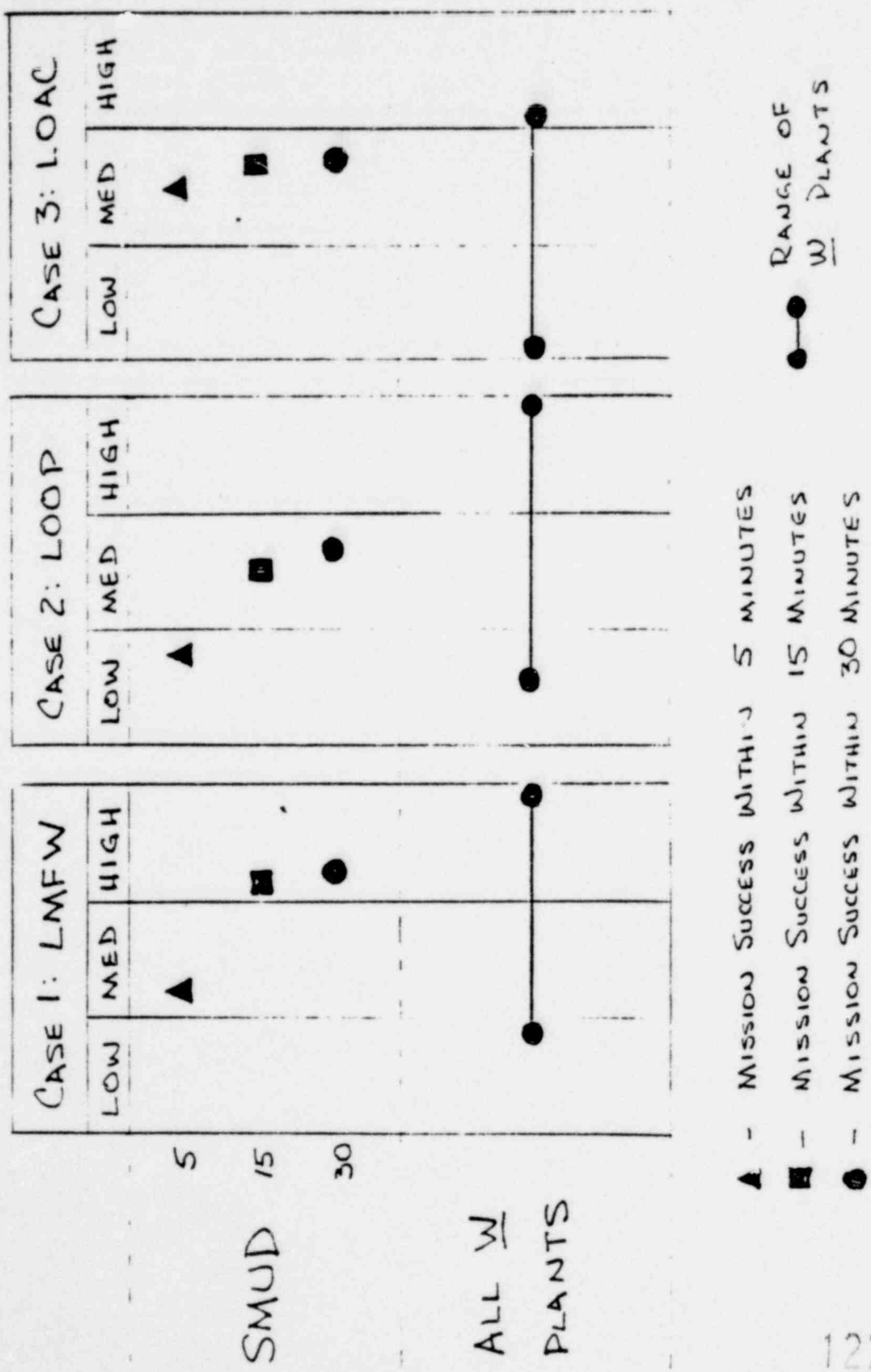
- FWS-055
- MANUAL LOADING OF MOTOR DRIVES FOR PUMPS
- PREVENTIVE MAINTENANCE

OTHER ITEMS

- AUTOMATIC ACTUATION
- BACKUP WATER SUPPLY
- AC DEPENDENCIES

POOR ORIGINAL

ENCLOSURE 3 page 3



COMPARISON OF SMUD AFWS RELIABILITY WITH NRC RESULTS FOR W PLANTS

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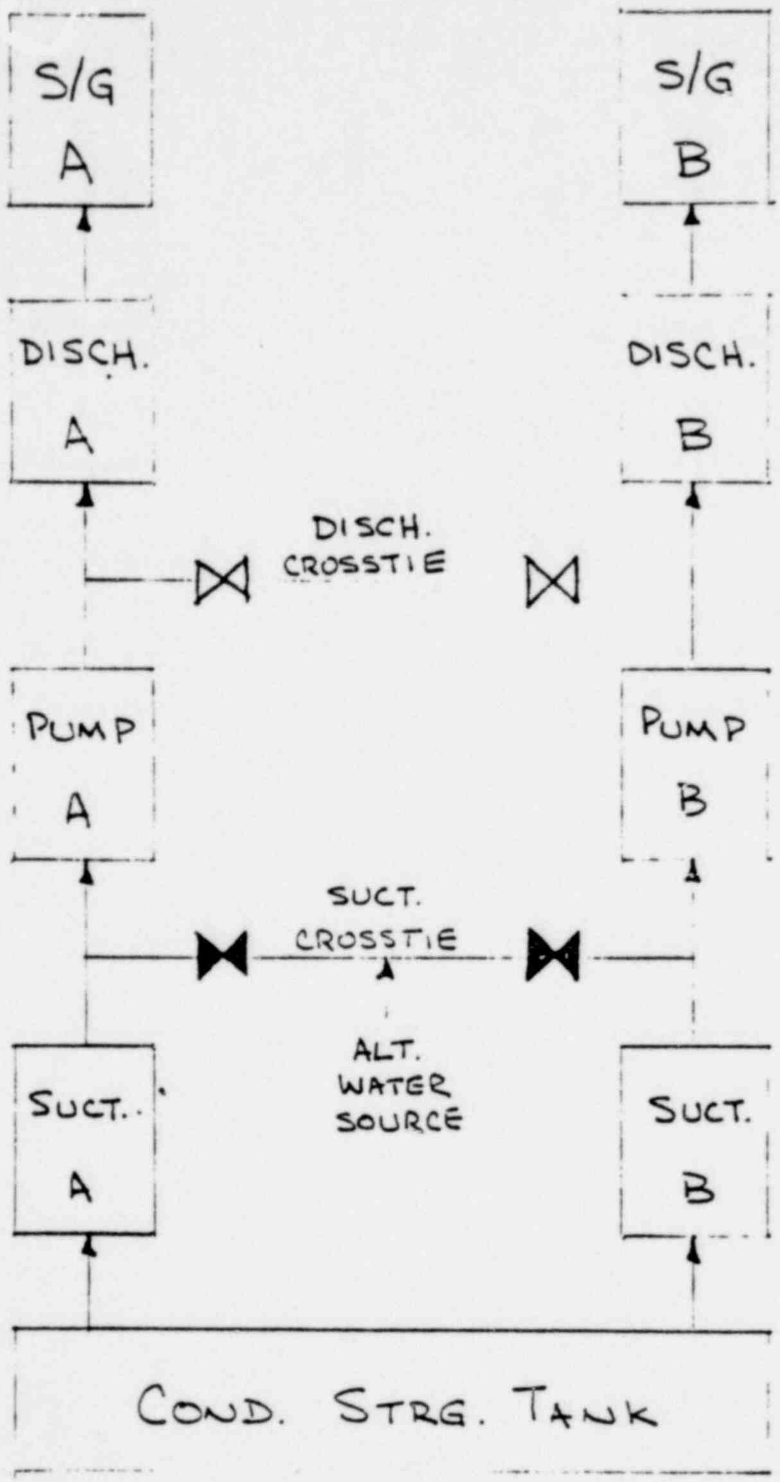
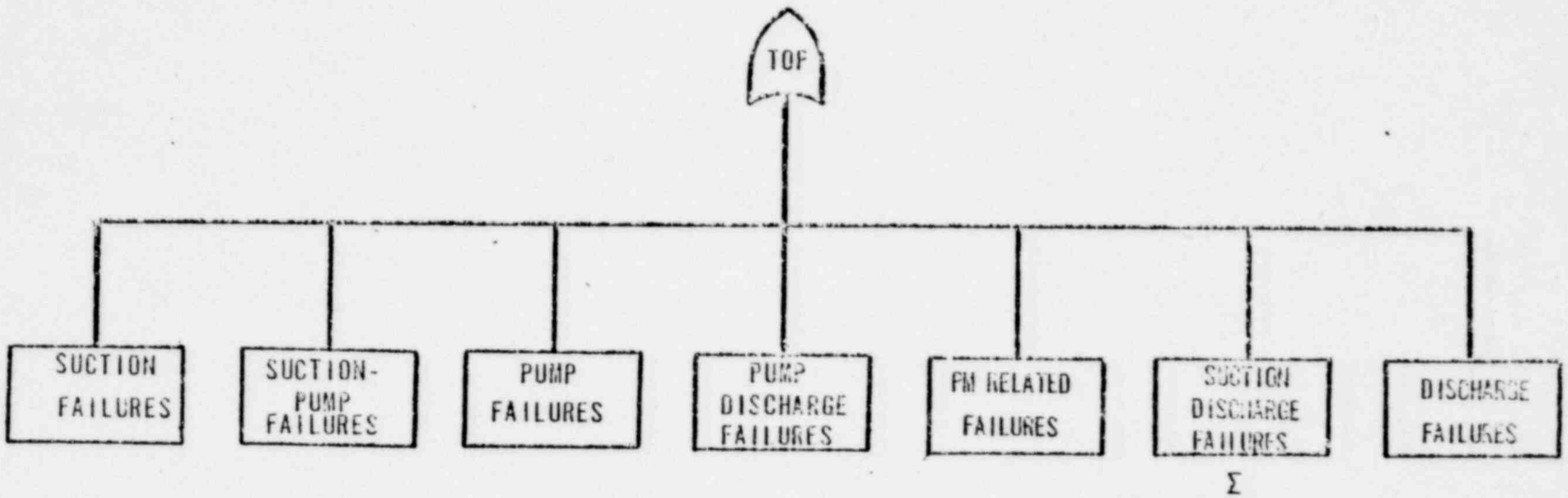


POOR ORIGINAL

SMUD AFWS SYSTEM-LEVEL BLOCK DIAGRAM

ENCLOSURE 3 page 5



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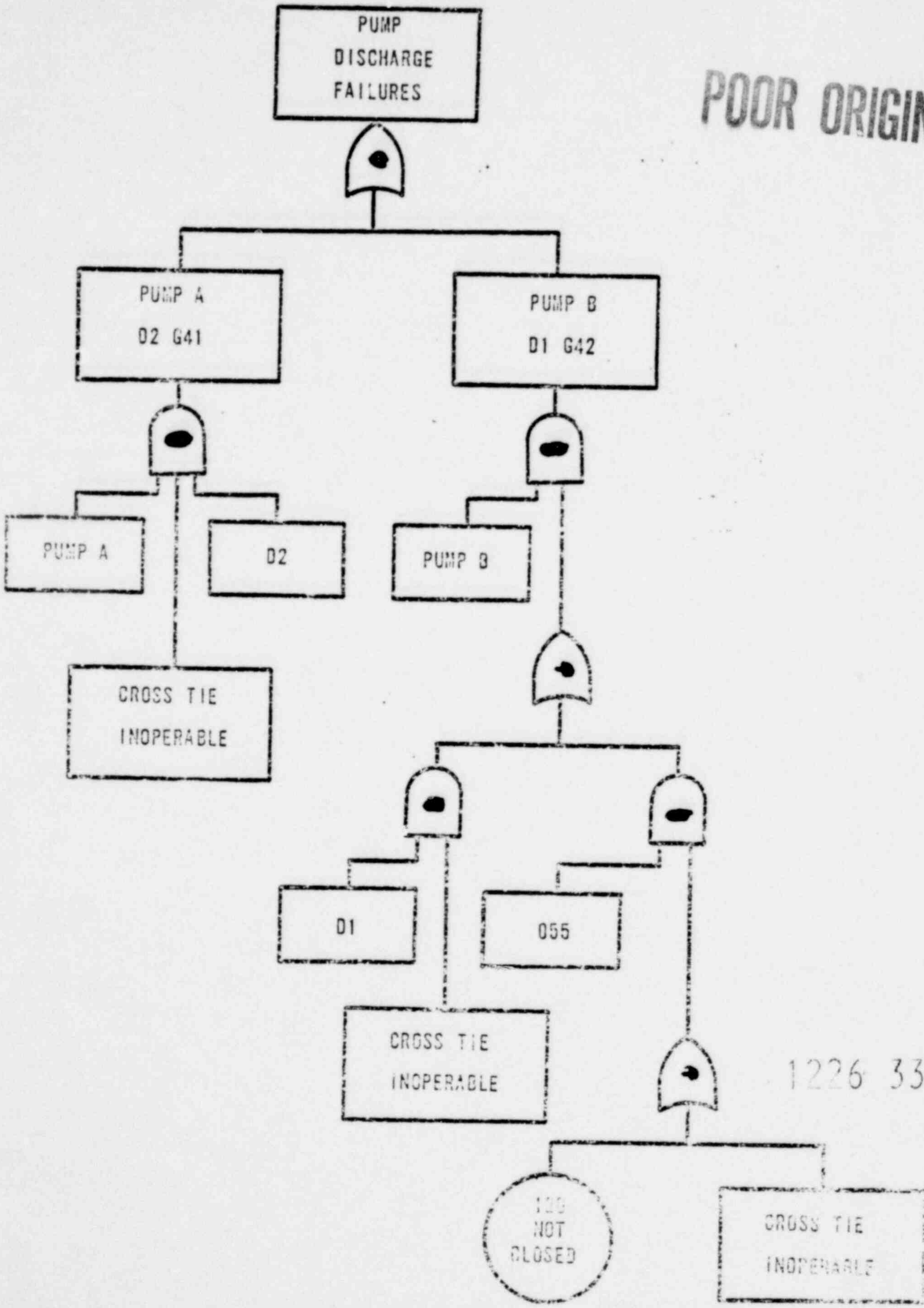
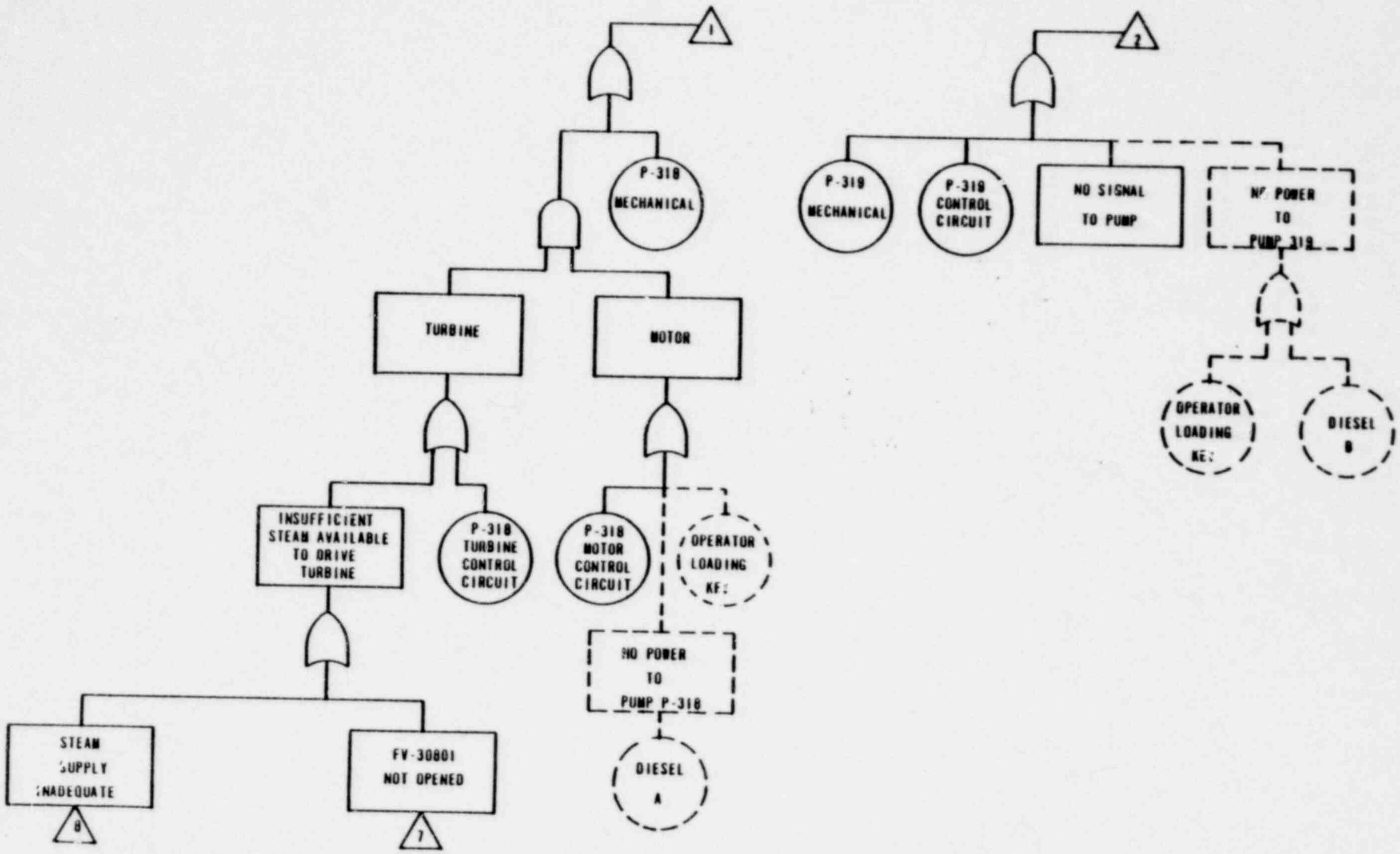
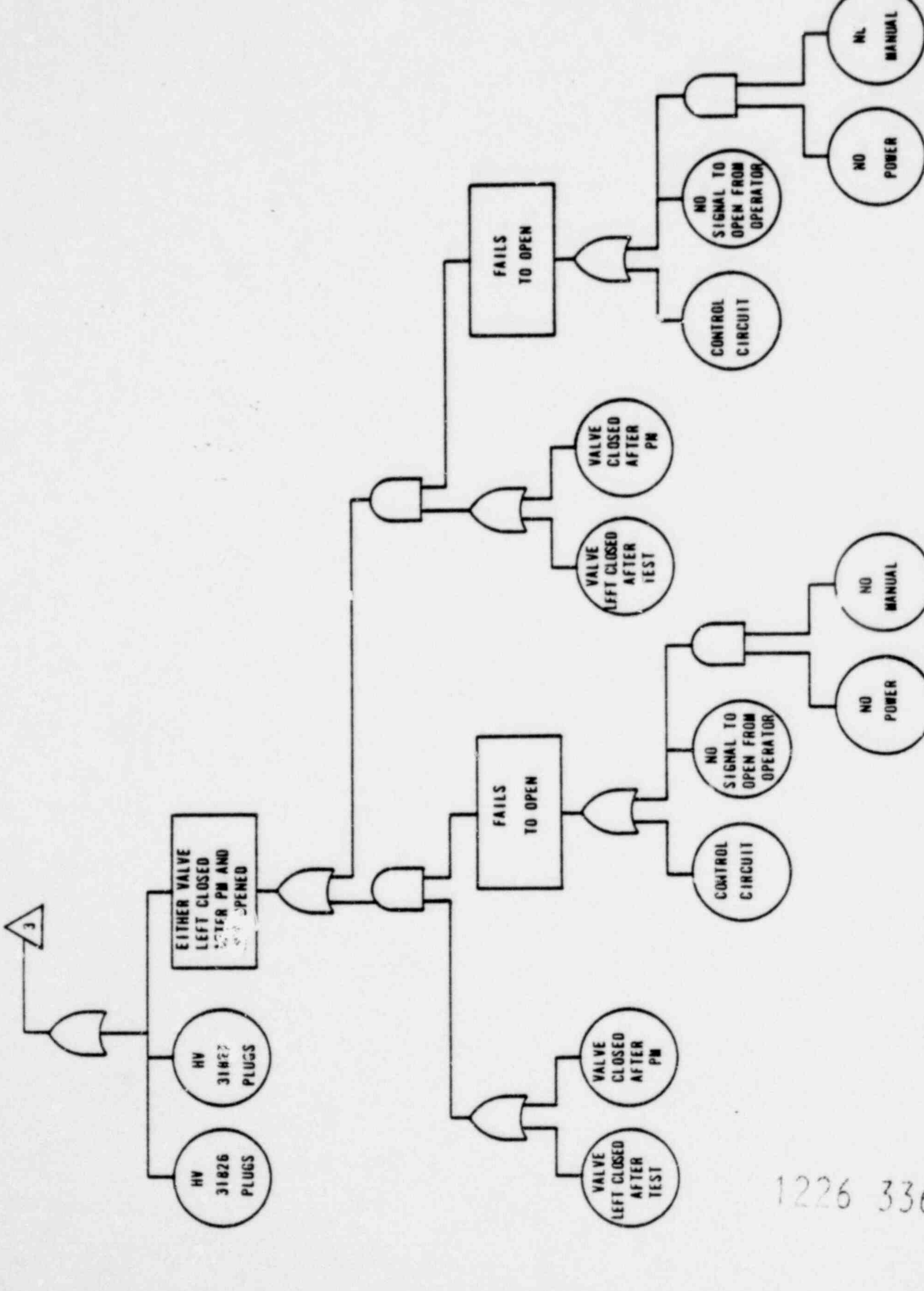

PUMP
DISCHARGE
FAILURES
PUMP A
D2 G41
PUMP B
D1 G42
PUMP A
D2
PUMP B
CROSS TIE
INOPERABLE
D1
055
CROSS TIE
INOPERABLE
NOT
CLOSED
CROSS TIE
INOPERABLE

1226 334



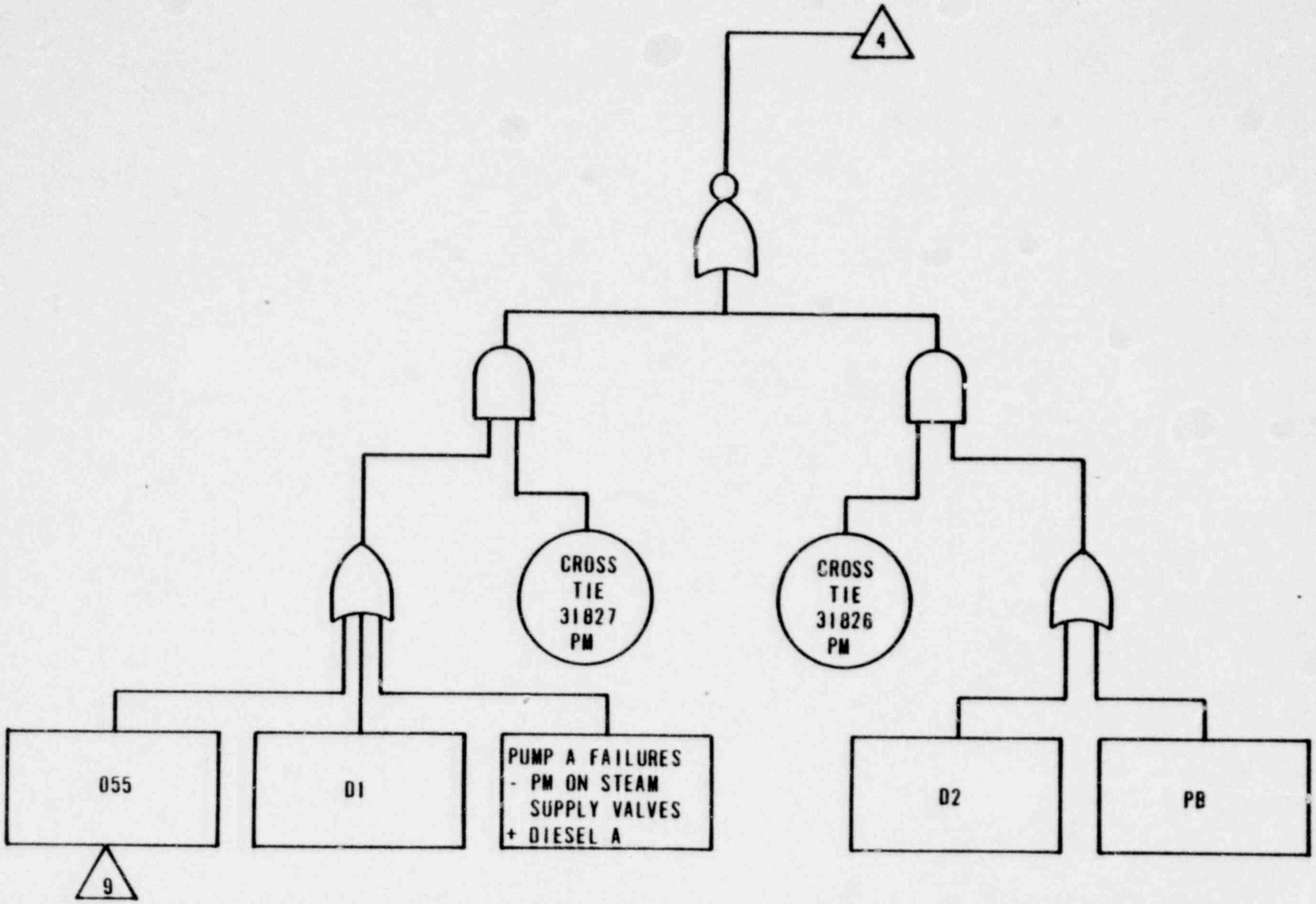
ENCLOSURE 3 page 7

1226 335

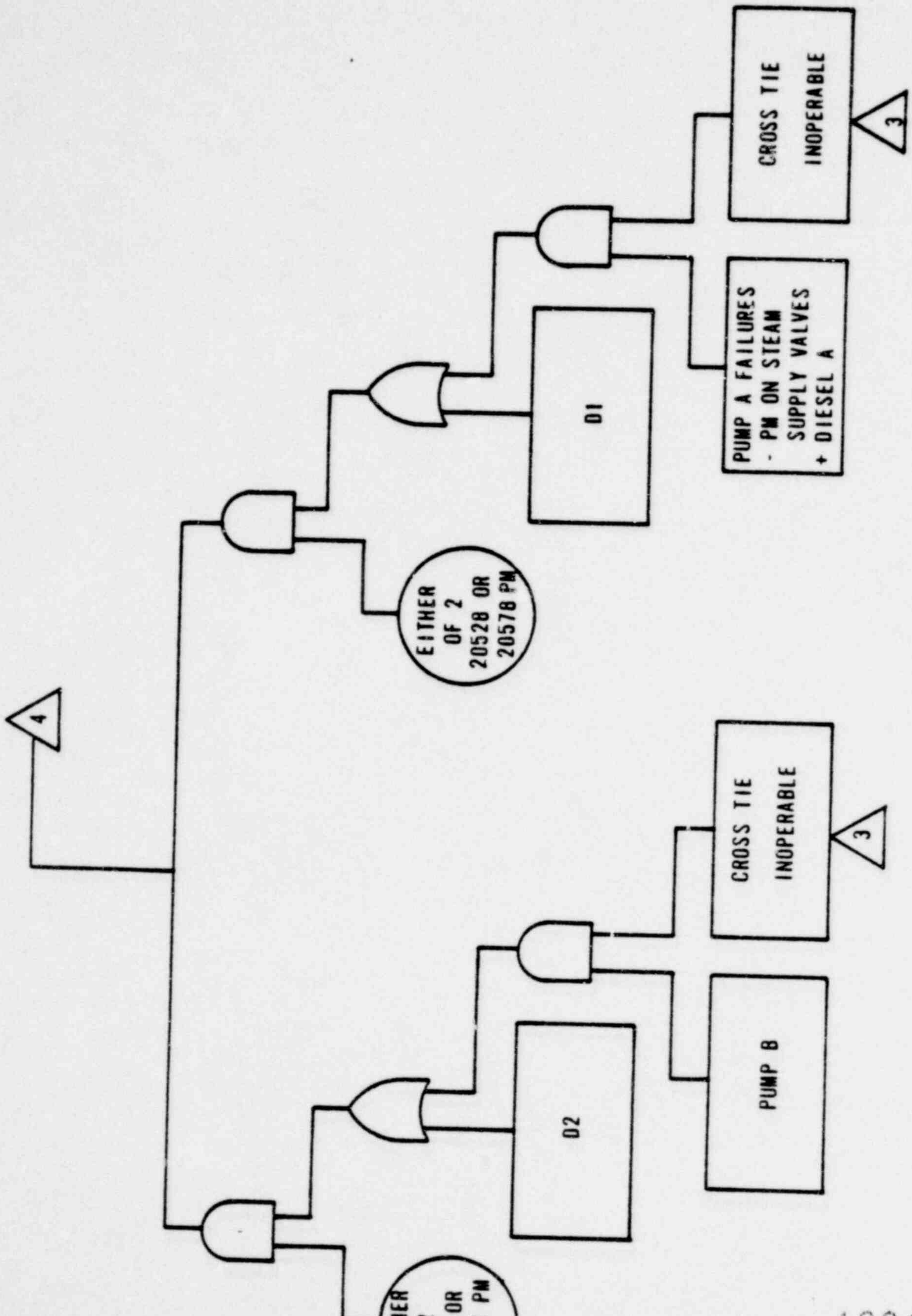

HV 31826 PLUGS
VALVE LEFT CLOSED AFTER TEST
VALVE CLOSED AFTER PM
FAILS TO OPEN
CONTROL CIRCUIT
NO SIGNAL TO OPEN FROM OPERATOR
NO POWER
NO MANUAL
FAILS TO OPEN
CONTROL CIRCUIT
NO SIGNAL TO OPEN FROM OPERATOR
NO POWER
VALVE LEFT CLOSED AFTER TEST
VALVE CLOSED AFTER PM
3

1226 336

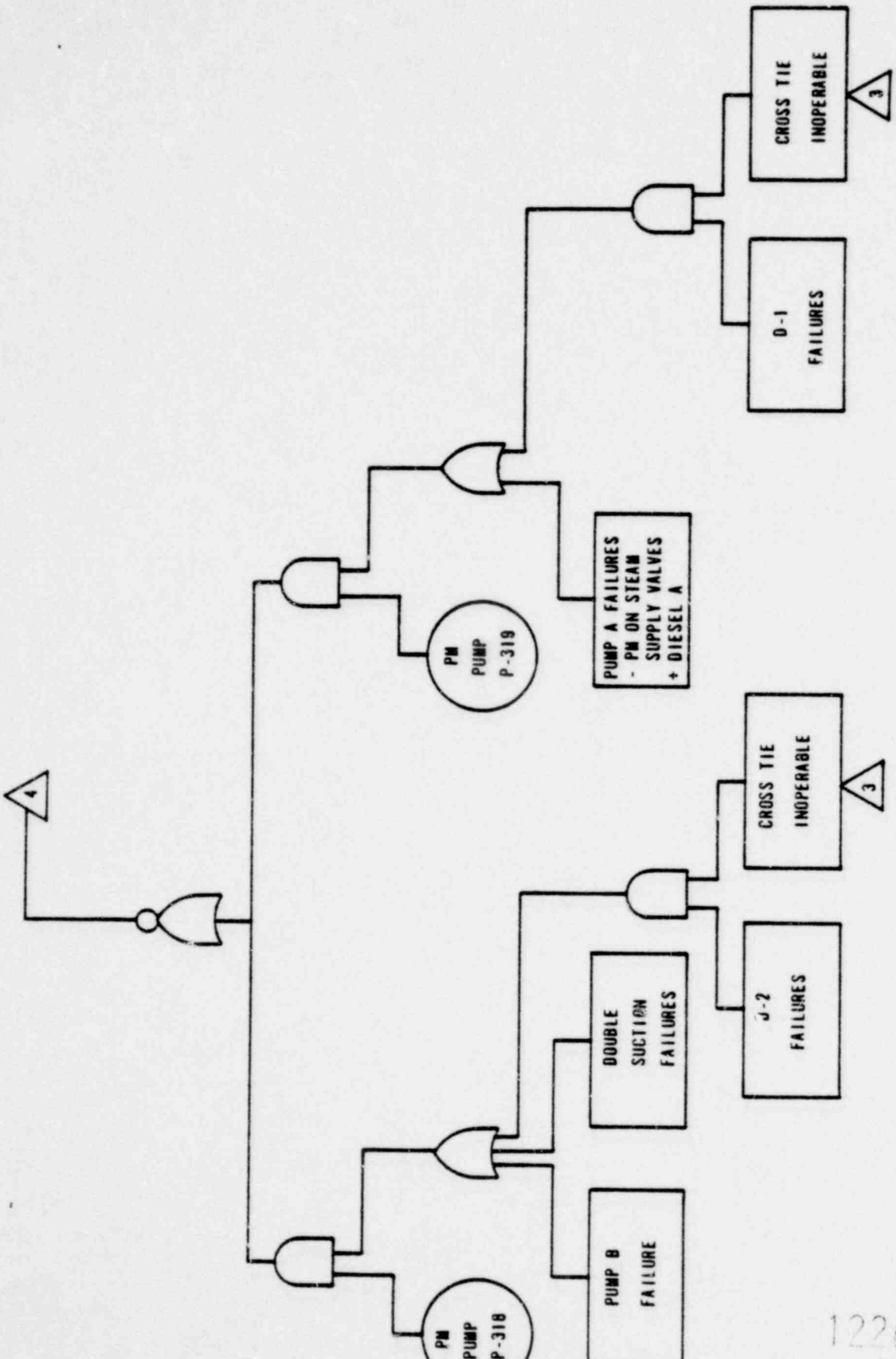
ENCLOSURE 3 page 9



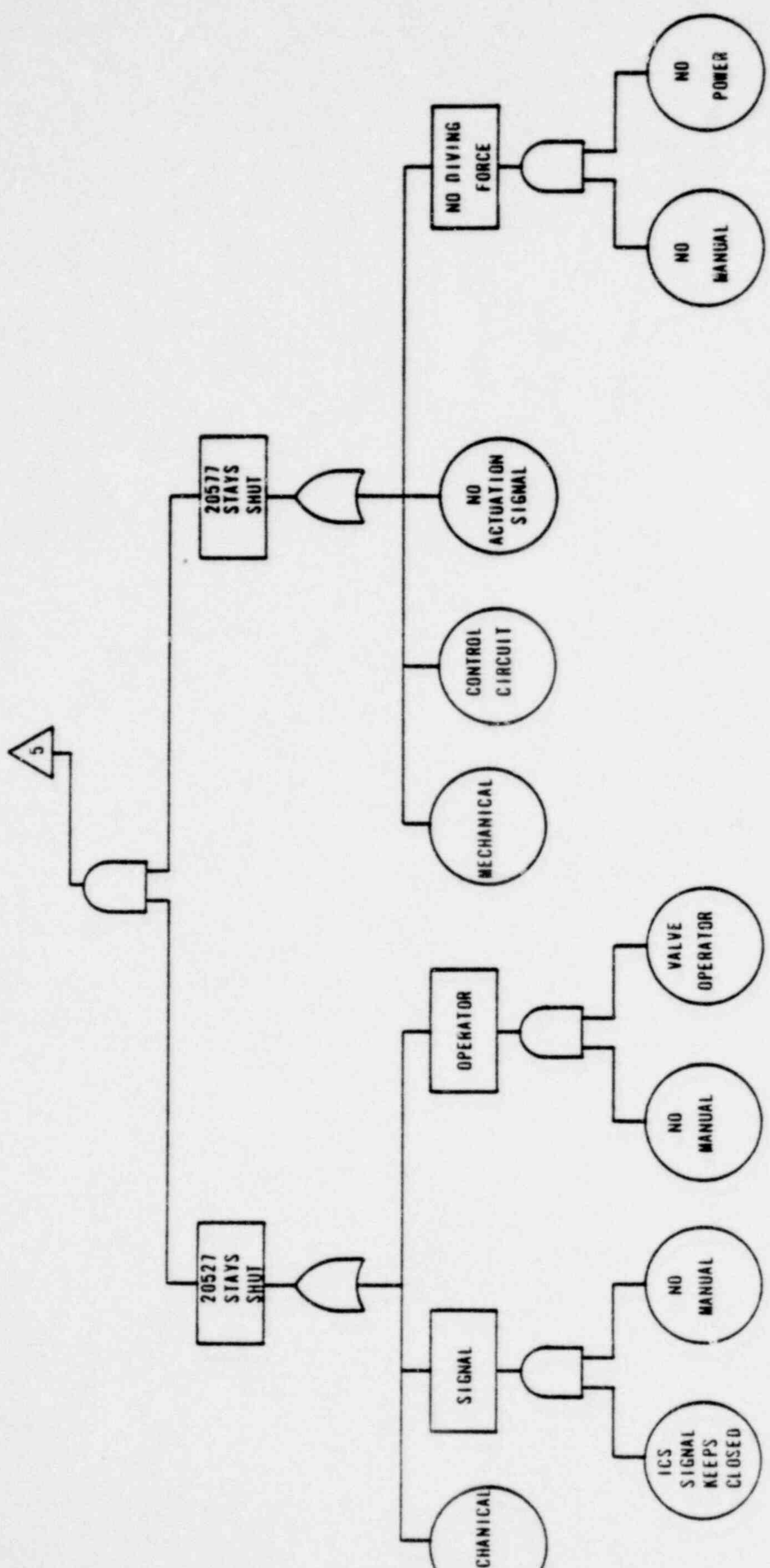
1226 337


CROSS TIE INOPERABLE
3
PUMP A FAILURES
- PM ON STEAM SUPPLY VALVES
+ DIESEL A
D1
EITHER OF 2 20528 OR 20578 PM
4
CROSS TIE INOPERABLE
3
PUMP B
D2
EITHER OF 2 20577 OR 20527 PM

1226 338


4
CROSS TIE INOPERABLE
3
D-1 FAILURES
PUMP A FAILURES
- PM ON STEAM SUPPLY VALVES
+ DIESEL A
PM PUMP P-319
CROSS TIE INOPERABLE
3
D-2 FAILURES
DOUBLE SUCTION FAILURES
PUMP B FAILURE
PM PUMP P-318

1226 339


5
20577 STAYS SHUT
NO DIVING FORCE
NO POWER
NO MANUAL
NO ACTUATION SIGNAL
CONTROL CIRCUIT
MECHANICAL
20527 STAYS SHUT
OPERATOR
VALVE OPERATOR
NO MANUAL
SIGNAL
NO MANUAL
ICS SIGNAL KEEPS CLOSED
MECHANICAL

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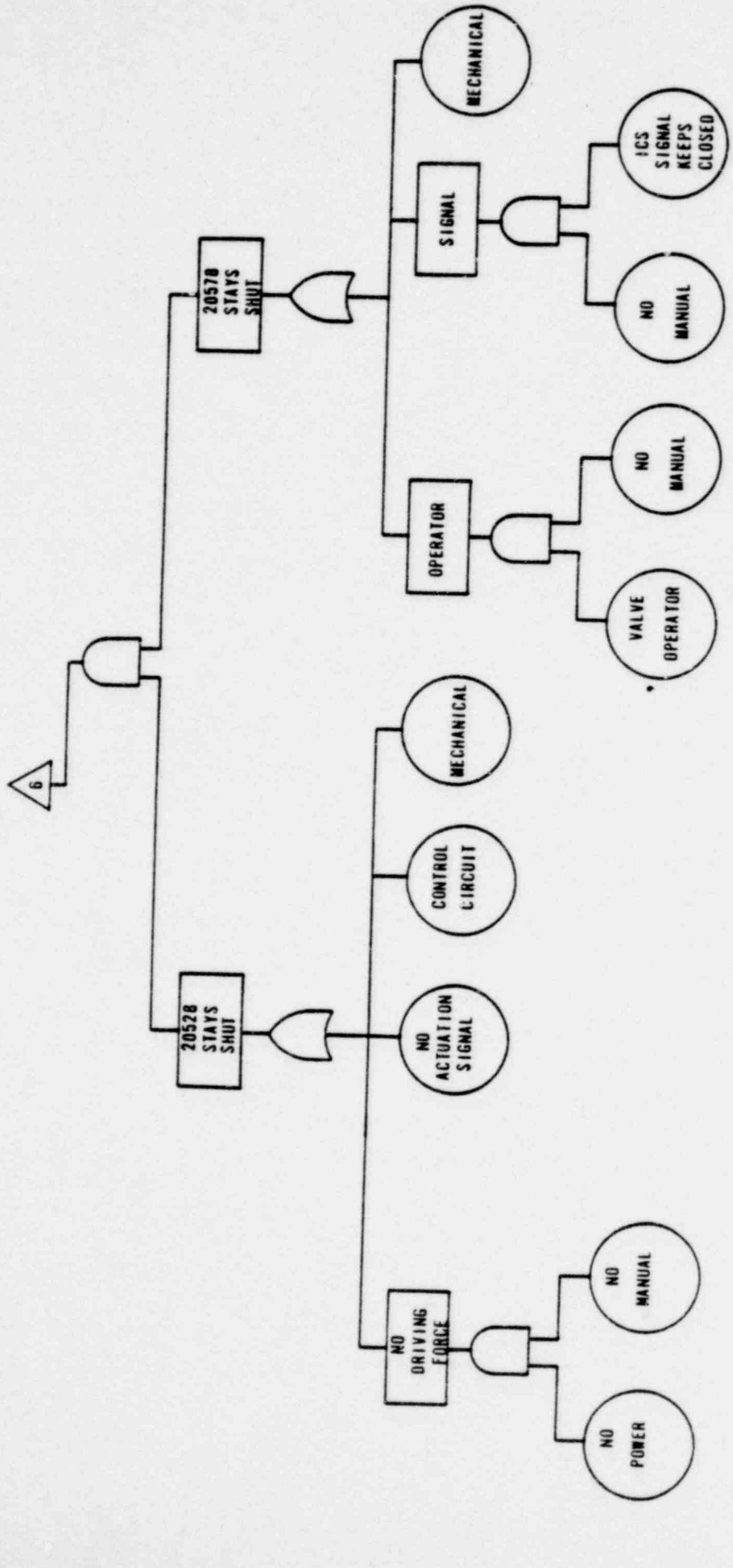
MECHANICAL
ICS SIGNAL KEEPS CLOSED
SIGNAL
20578 STAYS SHUT
NO MANUAL
NO MANUAL
OPERATOR
VALVE OPERATOR
6
MECHANICAL
CONTROL CIRCUIT
20528 STAYS SHUT
NO ACTUATION SIGNAL
NO MANUAL
NO DRIVING FORCE
NO POWER

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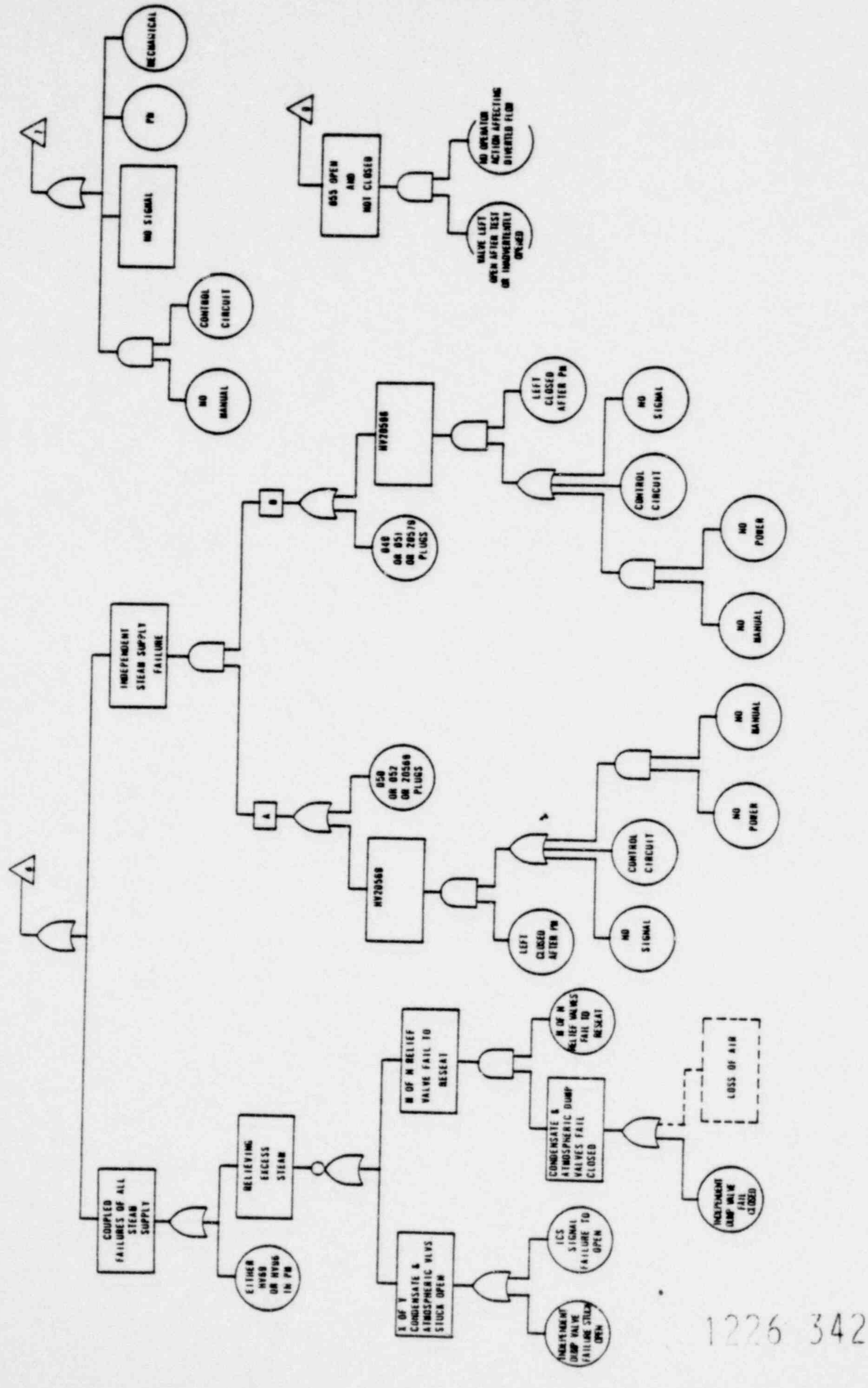
COUPLED FAILURES OF ALL STEAM SUPPLY
INDEPENDENT STEAM SUPPLY FAILURE
RELIEVING EXCESS STEAM
NO SIGNAL
MECHANICAL
PM
CONTROL CIRCUIT
NO MANUAL
NO POWER
LEFT CLOSED AFTER PM
LOSS OF AIR

1226 342

ENCLOSURE 4

PROPOSED OUTLINE FOR SMUD REPORT ON AUXILIARY FEEDWATER SYSTEM RELIABILITY

1.0 Introduction

1.1 Background - NRC study for W and CE

1.2 Objectives - Comparative reliability assessment, identification of dominant failure contributors

1.3 Scope - 3 cases: LMFW, LOOP and LOAC; 3 times: 5, 15 and 30 minutes; Baseline configuration: 1 August 1979

1.4 Analysis Technique - Fault tree analysis leading to reliability insights

1.5 Assumptions and Criteria

1) Power availability for each case
2) Criteria for mission success
3) NRC failure data
4) etc.

2.0 System Description

2.1 Overall AFWS Design

2.2 Supporting Systems - Including backup water sources

2.3 Power Sources

2.4 Instrumentation and Control - Initiation and Control

2.5 Human Factors - Initiation, backup actions, indications and contols available

2.6 Maintenance/Testing - Frequency, extent, duration

2.7 Tech Spec - Limitations imposed

3.0 Reliability Evaluation

3.1 Comparative Reliability - Table for comparison with W and CE

3.2 Dominant Failure Contributors

3.2.1 LMFW

3.2.2 LOOP

3.2.3 LOAC

1226 343