

SHOULD AN ADDITIONAL INDEPENDENT POWER  
SOURCE BE REQUIRED FOR DHRS?

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B. ATEFI  
R. LINER  
A. HUGHES

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PDR FOIA  
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- OUTLINE -

SCHEMATIC

KEY SYSTEM CHARACTERISTICS

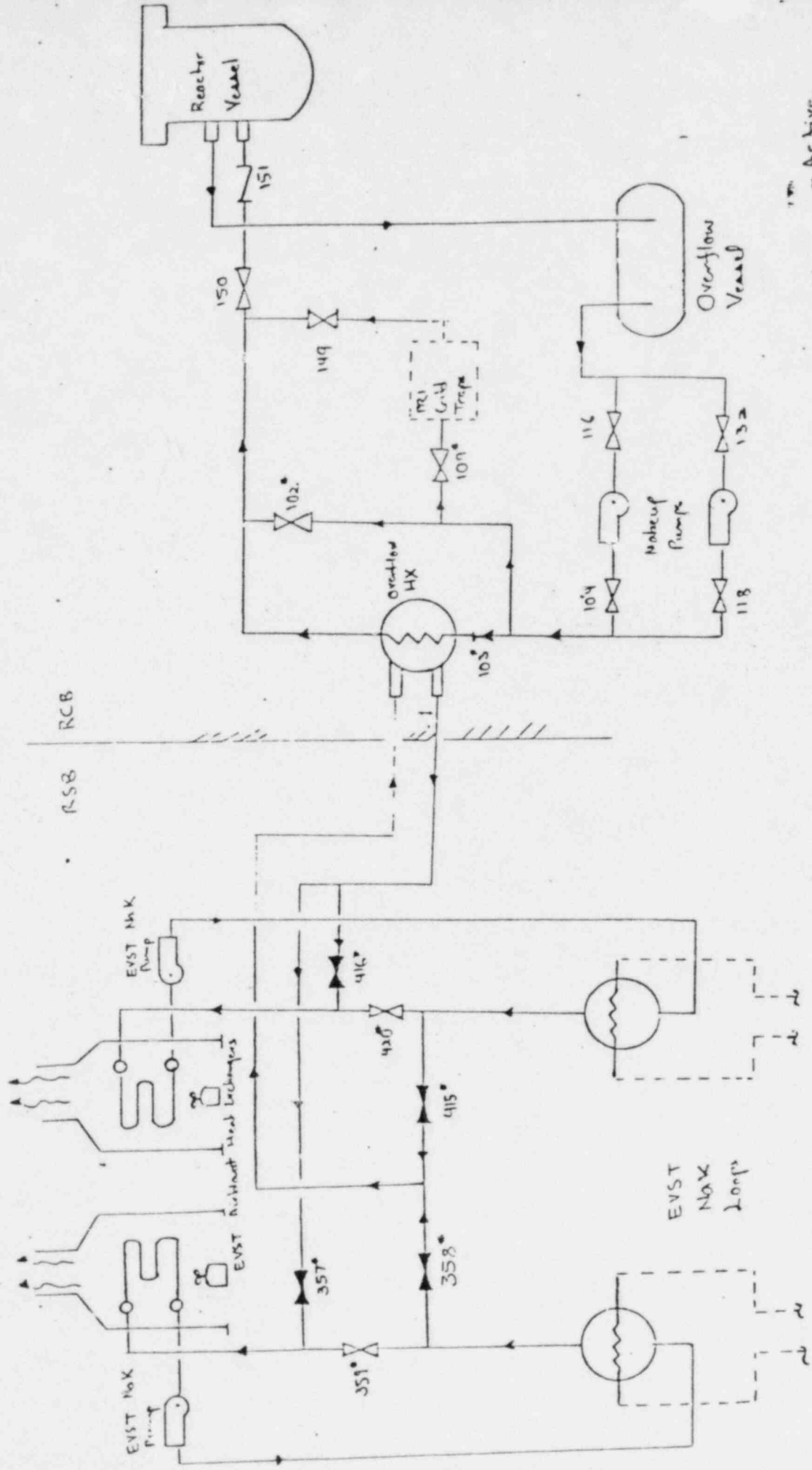
FAULT TREE

QUANTIFICATION

SUMMARY OF KEY POINTS

POSSIBLE SYSTEM IMPROVEMENTS

CONCLUSIONS

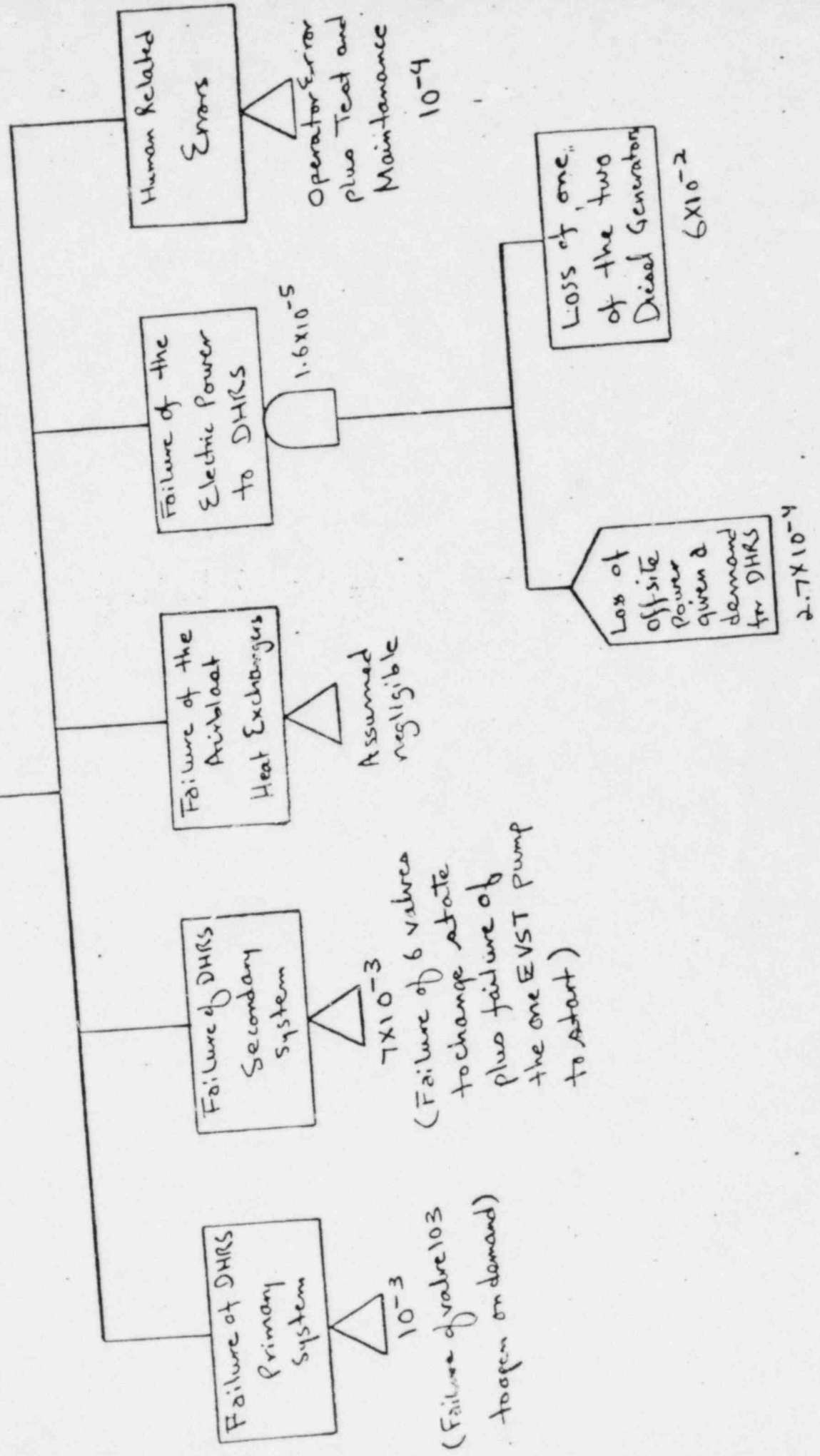


CONFIGURATION OF DIRECT HEAT REMOVAL SERVICE (DHRS)  
DURING NORMAL PLANT OPERATION

- KEY SYSTEM CHARACTERISTICS -

- DHRS DEMANDED ONLY WHEN ALL THREE MAIN COOLING LOOPS HAVE FAILED
- MAKEUP PUMPS AND ABXs (AND THEREFORE DIESELS) NOT REDUNDANT
- MAKEUP PUMPS AND ONE ABHX NORMALLY RUNNING; MISSION TIME ASSUMED SHORT ENOUGH THAT FAILURE-TO-RUN NO. IMPORTANT
- SEVEN VALVES CHANGE STATE (ALL SINGLES)
- OPERATOR INITIATED, AUTOMATIC SEQUENCER; GOOD CHANCE FOR RECOVERY IN EVENT OF ERROR
- DETAILED INFORMATION ON OPERATING PROCEDURES, HUMAN FACTORS, TEST AND MAINTENANCE, ETC. NOT AVAILABLE

Failure of DHRS



P (DHRS FAILURE): QUANTIFICATION

$$\text{FAILURE OF DHRS} = 8.01 \times 10^{-3} + \text{OPE}$$

DUE TO LARGE REACTION TIME AVAILABLE AN OPERATOR  
ERROR OF  $10^{-4}$  IS ASSUMED

$$\text{FAILURE OF DHRS} = 8.11 \times 10^{-3}$$

SENSITIVITY OF DHRS TO HUMAN ERROR (OPERATOR ERROR  
PLUS TEST AND MAINTANANCE)

FAILURE OF DHRS

$$9.01 \times 10^{-3}$$

$$1.8 \times 10^{-2}$$

$$0.108$$

HUMAN ERROR

$$10^{-3}$$

$$10^{-2} \text{ (DOMINATES)}$$

$$10^{-1} \text{ (DOMINATES)}$$

DOMINANT ACCIDENT SEQUENCE INVOLVING DHRS

INITIATOR: FAILURE OF THREE LOOPS, DOMINATED  
BY THE FAILURE OF THE THREE RUPTURE  
DISKS FREQUENCY:  $2 \times 10^{-2}/\text{YR}$

CORE MELT FREQUENCY:  $(2 \times 10^{-2}) (8.11) 10^{-3} =$   
--  $1.6 \times 10^{-4}/\text{YR}$

THIS SEQUENCE IS THE DOMINANT SEQUENCE AMONG  
PROTECTED TRANSIENTS OR FAULTS LEADING TO A  
CDA.

OTHER IMPORTANT SEQUENCES INCLUDE:

COMPLETE LOSS OF FEEDWATER SYSTEM	$4.5 \times 10^{-5}$
LOSS OF OFFSITE POWER	$1.8 \times 10^{-5}$

(BASED ON SAND82-0720, NUREG/CR-2681, APRIL 1982)

- LOSS OF OFFSITE POWER IS NOT A DOMINANT INITIATOR FOR THE SEQUENCES WHERE DHR IS REQUIRED
- DHR IS REQUIRED ONLY WHEN ALL THREE MAIN HEAT REMOVAL LOOPS ARE FAILED
- SIMULTANEOUS LOSS OF THREE MAIN LOOPS AND OFFSITE POWER IS UNLIKELY
- LOSS FOR UP TO ABOUT 2 HOURS AND FAILURE OF ALL DIESELS IS NOT A SUFFICIENT CONDITION FOR CORE MELT BECAUSE OF POSSIBILITY OF NATURAL CIRCULATION AND STEAM-DRIVEN AFW SYSTEM



ALTERNATIVES FOR POSSIBLE INCREASE IN THE  
RELIABILITY OF THE DHRS

- A. COMPLETE REDUNDANCY OF THE PRIMARY AND SECONDARY SODIUM LOOPS OF THE DHRS. THIS ALSO HAS THE EFFECT OF MAKING THE DIESELS REDUNDANT. FAILURE PROBABILITY OF DHRS REDUCED FROM  $8.1 \times 10^{-3}$  TO  $2.5 \times 10^{-5} + OPE = 1.24 \times 10^{-4}$  (ASSUMING OPE =  $10^{-4}$ )

CORE MELT SEQUENCE REDUCED FROM  $1.6 \times 10^{-4}$  TO  $2.5 \times 10^{-6}$

- B. CHANGING VALVE CONFIGURATION
- O SMALLER NUMBER OF VALVE NEEDING CHANGE OF STATE
  - O REDUNDANCY (PARALLEL VALVES)
- C. DEDICATED POWER SOURCE
- O HYDROELECTRIC
  - O ANOTHER DIESEL
  - O GAS TURBINE

## CONCLUSIONS

- AN ADDITIONAL INDEPENDENT AND DIVERSE POWER SOURCE FOR DHRs PROBABLY WOULD NOT LEAD TO SIGNIFICANT REDUCTION IN CORE MELT PROBABILITY

- DHRs IS AN IMPORTANT ELEMENT IN POTENTIAL CORE MELT SEQUENCES REGARDLESS OF POWER RELIABILITY BECAUSE LOSS OF THREE MAIN COOLING LOOPS IS A HIGH FREQUENCY INITIATOR AND DHRs FAILURE HAS A HIGH PROBABILITY

- IF THE PROBABILITY OF THE LOOPS-DHRs SEQUENCE IS LOWERED TO COMPARABILITY WITH THE LOSP SEQUENCES, IMPROVEMENT IN EMERGENCY POWER RELIABILITY WOULD BE ONLY MARGINALLY EFFECTIVE IN REDUCING CORE MELT PROBABILITY

- IF THE PROBABILITY OF THE LOOPS-DHRs SEQUENCE IS FURTHER LOWERED SO THAT LOSP SEQUENCES CLEARLY DOMINATE CORE MELT PROBABILITY - THEN IMPROVEMENT IN EMERGENCY POWER RELIABILITY MIGHT BE HELPFUL

- LOSP MAY ASSUME GREATER RELATIVE IMPORTANCE WHEN PERSPECTIVE IS BROADENED TO INCLUDE CONTAINMENT FAILURE MODES, RELEASE CATEGORIES AND RISK

- IF IMPROVEMENTS IN EMERGENCY POWER RELIABILITY ARE DEEMED DESIRABLE, A DEDICATED HYDROELECTRIC POWER LINE FROM A NEARBY DAM WOULD BE ATTRACTIVE FROM A RELIABILITY POINT OF VIEW