

EVENT SEQUENCES
AND
COMPUTER CODES

ZION/INDIAN POINT
PROBABILISTIC RISK ASSESSMENT
STUDY REVIEW BOARD MEETING

Prepared for
COMMONWEALTH EDISON COMPANY
Chicago, Illinois
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PICKARD, LOWE AND GARRICK, INC.
CONSULTANTS - NUCLEAR POWER
IRVINE, CALIFORNIA WASHINGTON, D.C.

SCENARIO PROGRAM

BASIS

- ZION/INDIAN POINT ACTUAL PLANTS AND NEW WORK ON PHENOMENOLOGY

EARLY RESULTS

- EVENT TREE SEQUENCES THROUGH WASH-1400 RELEASE CATEGORIES
- DETERMINATION OF DOMINANT SEQUENCES IN EACH RELEASE CATEGORY

REVISION OF RESULTS

- CALCULATE POSSIBLE PROGRESSIONS OF DOMINANT SEQUENCES USING MARCH
- COMPARE WITH WASH-1400 RELEASE CATEGORIES
- REVISE CONSEQUENCE CALCULATIONS IF NECESSARY

SCENARIO DEVELOPMENT

- MASTER LOGIC DIAGRAM FOR EXTENSIVE FUEL DAMAGE
- INITIATING EVENT CATEGORIES
- EVENT TREES ON A DISCRETIZED SET OF IE CATEGORIES
- COMMON CAUSE SEQUENCES
- CONTAINMENT RELEASE EVENT TREE(S) ON A DISCRETIZED SET OF CORE/RCS/CONTAINMENT STATES
- ASSIGNMENT OF SEQUENCES TO WASH-1400 RELEASE CATEGORIES

DEPENDENCIES

- SYSTEM DEPENDENCIES (INTERACTIONS)
CONSIDERED EXPLICITLY
- SEQUENTIAL DEPENDENCIES
DEFINE EVENT TREE
STRUCTURE AND CHANGE SYSTEM
FAULT TREES

9

QUALITATIVE COMMON CAUSE ANALYSIS

- COMPONENT

A

B

C

D

- QUALITATIVE
FAILURE
CHARACTERISTICS

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- CUT SETS

A B

A C D

A B

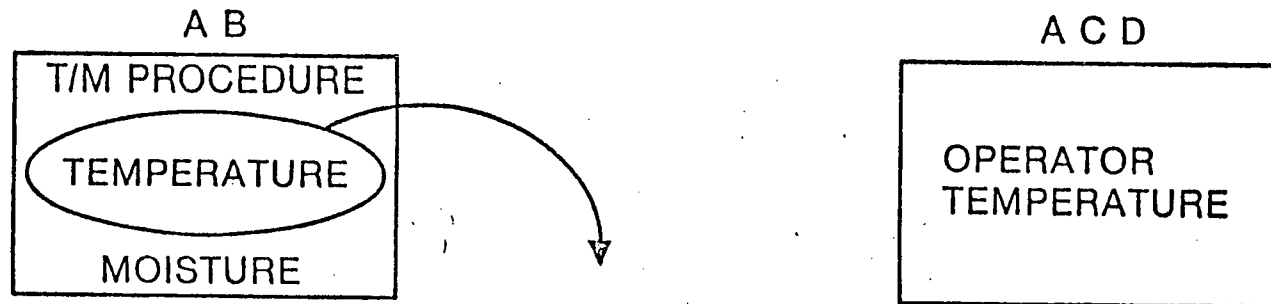
A C D

- QUALITATIVE
COMMON
CAUSE

T/M PROCEDURE
TEMPERATURE
MOISTURE

OPERATOR
TEMPERATURE

QUANTITATIVE COMMON CAUSE ANALYSIS



- PHYSICAL LOCATION (BARRIERS TO CAUSE)
- FREQUENCY OF CAUSE
- SENSITIVITY OF COMPONENTS
- NUMBER OF CUT SETS
(IS ACD IN SAME LOCATION?)

PROCEDURES ANALYSIS

- **PROCEDURE REVIEW**

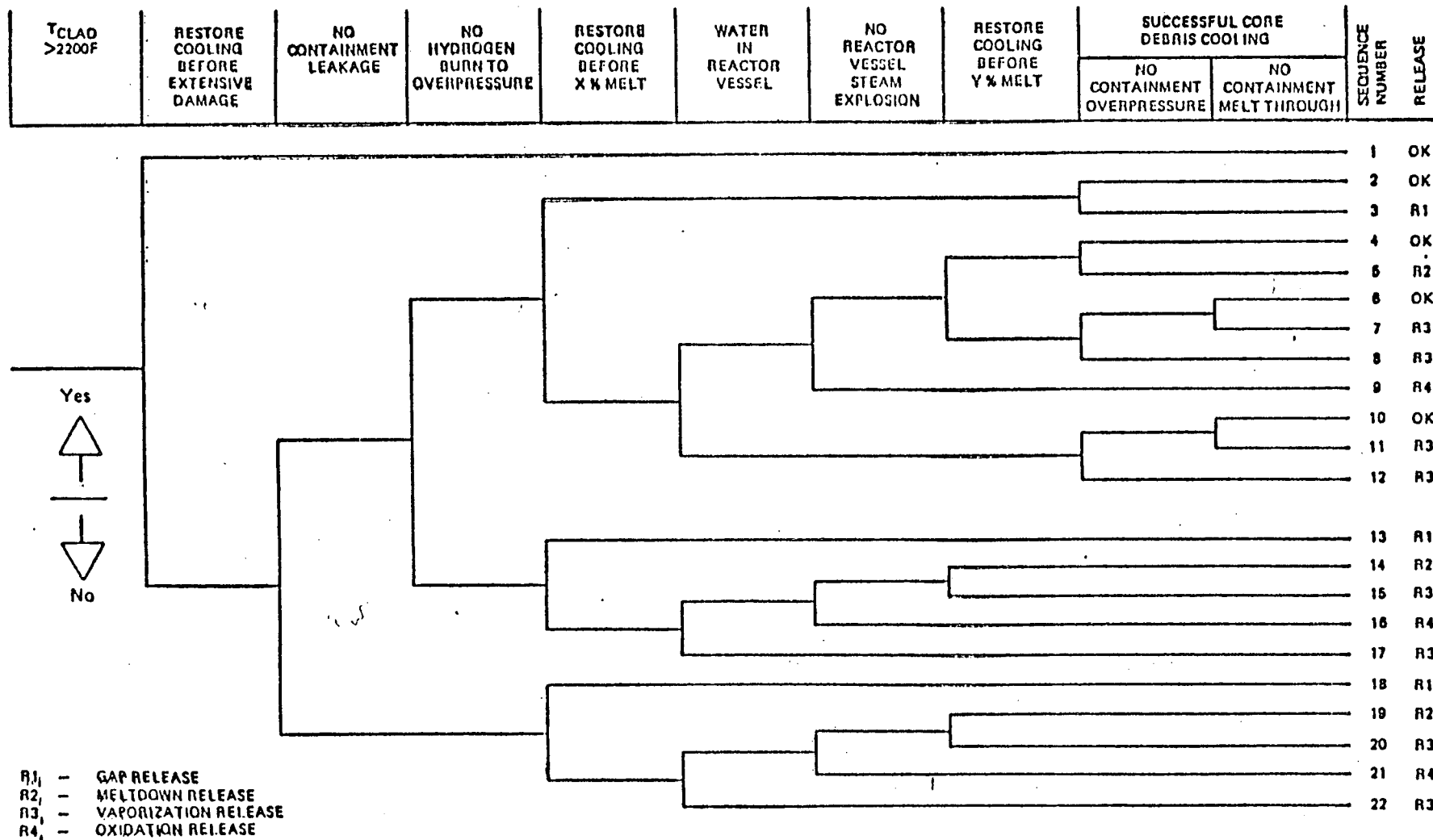
OPERATING PROCEDURES

MAINTENANCE PROCEDURES

EMERGENCY PROCEDURES

- **IDENTIFY HOW PROCEDURES IMPACT SYSTEM RELIABILITY**

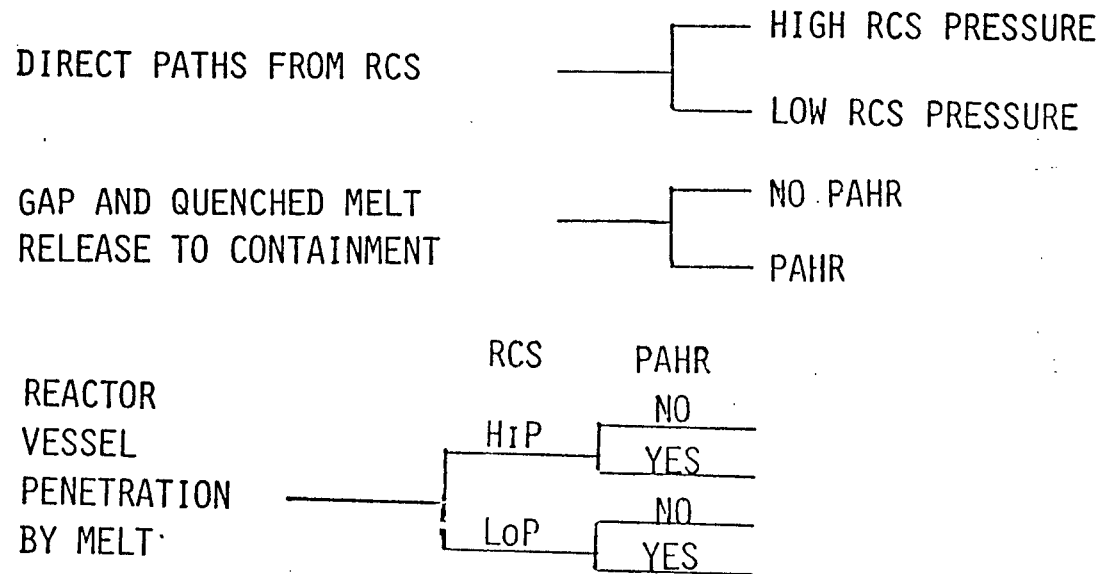
- **VERIFY IMPLEMENTATION OF PROCEDURES IN PLANT**



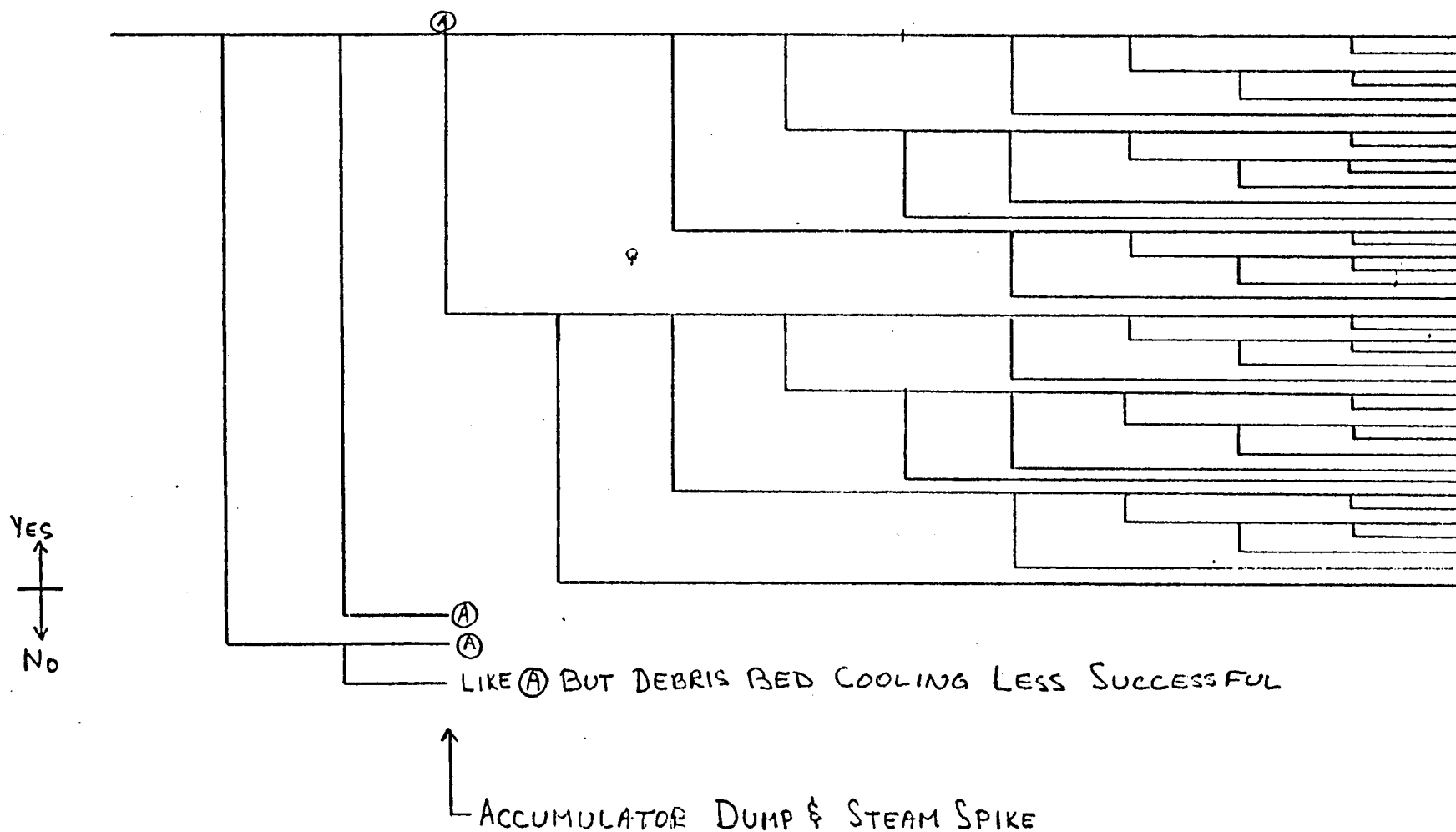
POSSIBLE EVENT PROGRESSIONS FOLLOWING OVERHEATING OF CORE

Pickard, Lowe & Garrick, Inc.

DISCRETIZED CORE/RCS/CONTAINMENT STATES



VESSEL FAILURE	DISBURSIVE	WATER IN CAVITY	NO H ₂ BURN	NO OVER-PRESSURE FAILURE	NO H ₂ EVOLUTION (CONCRETE)	NO LONG TERM STEAM GENERATION	NO OVER-PRESSURE FAILURE	RECOVERY OF PAHR	NO H ₂ BURN	NO OVER-PRESSURE FAILURE	NO MELT THROUGH
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CONTAINMENT EVENT TREE FOR REACTOR VESSEL MELT THROUGH / HIGH RCS PRESSURE / NO PAHR

COMPUTER PROGRAMS FOR SYSTEMS ANALYSIS

RELIABILITY ANALYSIS SYSTEM (RAS)

MOCUS	QUALITATIVE ANALYSIS. DETERMINES MINIMAL CUT SETS AND MINIMAL PATH SETS.
POCUS	QUANTITATIVE ANALYSIS. RAPID ACQUISITION OF SYSTEM CHARACTERISTICS FROM COMPONENT CHARACTERISTICS.
KITT-1	QUANTITATIVE ANALYSIS. ACQUISITION OF SYSTEM CHARACTERISTICS.
SRTPRN	9 SORTS MINIMAL CUTSETS BY IMPORTANCE.
COMCAN	COMMON CAUSE FAILURE ANALYSIS.
FATRAM	SIMILAR TO MOCUS BUT MORE EFFICIENT.
MOCARS	MONTE CARLO SIMULATION TO EVALUATE FUNCTIONS OF RANDOM VARIABLES.
PREP	QUALITATIVE ANALYSIS. DETERMINES MINIMAL CUT SETS AND MINIMAL PATH SETS.
KITT-2	QUANTITATIVE ANALYSIS. ACCEPTS TIME-DEPENDENT FAILURE RATES AS INPUT.
BACFIRE	COMMON-CAUSE FAILURE ANALYSIS.
DPD	DISCRETE PROBABILITY DISTRIBUTION ARITHMETIC.
ETC	EVENT TREE CONSTRUCTION AND COMPUTATION.