EVENT SEQUENCES AND COMPUTER CODES

ZION/INDIAN POINT PROBABILISTIC RISK ASSESSMENT STUDY REVIEW BOARD MEETING

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PICKARD, LOWE AND GARRICK, INC. CONSULTANTS - NUCLEAR POWER

IRVINE, CALIFORNIA

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WASHINGTON, D.C.

SCENARIO PROGRAM

<u>BASIS</u>

ZION/INDIAN POINT ACTUAL PLANTS AND NEW WORK ON PHENOMENOLOGY

EARLY RESULTS

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- 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)

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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

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DEPENDENCIES

• SYSTEM DEPENDENCIES (INTERACTIONS) CONSIDERED EXPLICITLY

 SEQUENTIAL DEPENDENCIES DEFINE EVENT TREE
STRUCTURE AND CHANGE SYSTEM FAULT TREES

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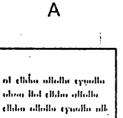
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QUALITATIVE COMMON CAUSE ANALYSIS

• COMPONENT

QUALITATIVE
FAILURE
CHARACTERISTICS



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ΑB

ACD

nllanha ylla nisan Hat yaalio ullanha yitaa hu onha yila ahan Hat ali ullanha yila ahan Hat yaalio ullanha yilaa ku onha yila ahan Hat ali

allenha yllo nhua Hat

yaalla allonha yttoo ha

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youthy flatha ying alle cytega gliaghach 'e alleada yike oloneth youthy flatha ying alle cythy gliaghach e alleada yike chondh youthy flatha ying alle cythyn gliaghach

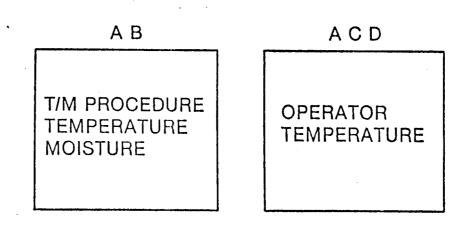
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• CUT SETS

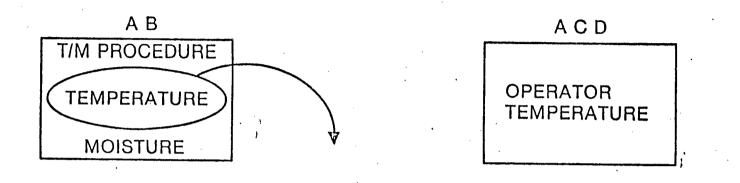
QUALITATIVE COMMON CAUSE



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QUANTITATIVE COMMON CAUSE ANALYSIS



- PHYSICAL LOCATION (BARRIERS TO CAUSE)
- FREQUENCY OF CAUSE
- SENSITIVITY OF COMPONENTS
- NUMBER OF CUT SETS

(IS ACD IN SAME LOCATION?)

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PROCEDURES ANALYSIS

PROCEDURE REVIEW

OPERATING PROCEDURES MAINTENANCE PROCEDURES EMERGENCY PROCEDURES

• IDENTIFY HOW PROCEDURES IMPACT SYSTEM RELIABILITY

VERIFY IMPLEMENTATION OF PROCEDURES IN PLANT

SUCCESSFUL CORE DEBRIS COOLING TCLAD >2200F RESTORE SECUENCE NUMBER RESTORE NO CONTAINMENT RESTOR WATER NO NO RELEASE COOLING REACTOR HYDROGEN COOLING IN BEFORE BEFORE **DURN TO** DEFORE VESSEL LEAKAGE REACTOR NO NO Y % MELT EXTENSIVE OVENPRESSURE XNMELT VESSEL STEAM CONTAINMENT CONTAINMENT DAMAGE EXPLOSION OVERPRESSURE MELT THROUGH OK ΟK R1 OK B2 oκ • • 83 83 84 Yes ΟK 10 R3 12 A3 81 13 R2 14 R3 No 15 ۰*ر ب*۲ 16 **R4** 17 RJ. 18 **R1** 19 82 20 83 GAP RELEASE MELTDOWN RELEASE VAPORIZATION RELEASE OXIDATION RELEASE 21 84 1), j 182, 1 1 1 1 22 R3 กว'

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POSSIBLE EVENT PROGRESSIONS FOLLOWING OVERHEATING OF CORE

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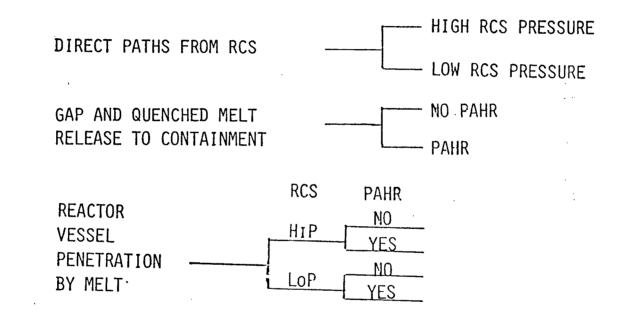
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R4

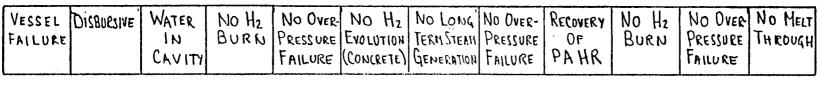
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DISCRETIZED CORE/RCS/CONTAINMENT STATES



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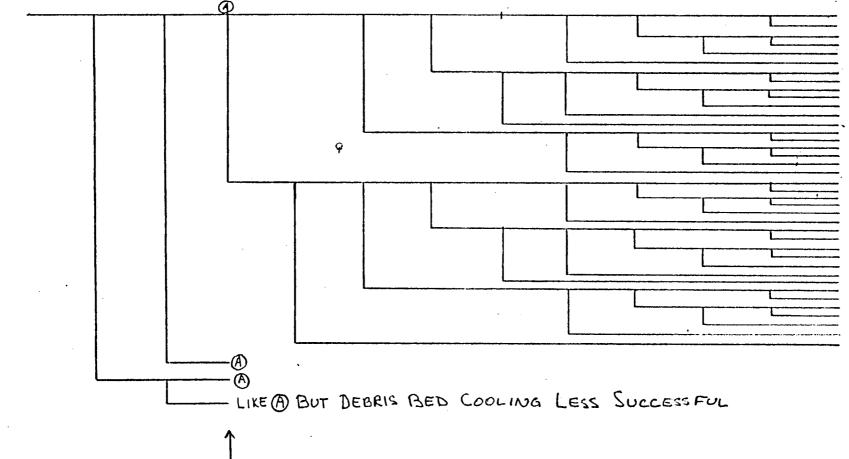


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YES

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- ACCUMULATOR DUMP & STEAM SPIKE

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	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.

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