

FOIA 85-784

cat C

NUREG-1150 ANALYSIS OF RISK-DOMINANT UNCERTAINTIES

J. A. MURPHY

OCTOBER 22, 1985

B602060382 B60106
PDR FOIA
SHOLLY85-784 PDR

A14

NUREG-1150

RISK REFERENCE DOCUMENT

- o UPDATED CORE MELT FREQUENCY AND RISK ESTIMATES OF SIX REFERENCE PLANTS
(PWR--LARGE DRY, SUBATMOSPHERIC, AND ICE CONDENSER CONTAINMENTS, BWR--MARK I, MARK II, AND MARK III CONTAINMENTS)
- o DISCUSSIONS OF UNCERTAINTIES AND SENSITIVITIES ASSOCIATED WITH ESTIMATES
- o EVALUATION OF POSSIBLE RISK REDUCTION MODIFICATIONS
- o INSIGHTS ON ABILITY TO EXTRAPOLATE FROM REFERENCE PLANTS TO INDUSTRY AT LARGE
- o EVALUATION OF NEW RISK PERSPECTIVES AND APPLICABILITY OF RESULTS TO REGULATORY ACTIONS
- o SUGGESTED FRAMEWORK FOR INCORPORATION OF SEVERE ACCIDENT INSIGHTS INTO REGULATORY STRUCTURE
- o DOCUMENT AVAILABLE IN DRAFT FORM MID-SUMMER, PEER REVIEW WORKSHOP ON DRAFT IN FALL 1986, FINAL REPORT EARLY SPRING 1987

NUREG-1150 SUPPORT

RISK REBASELINING

- o PERFORMING LIMITED RISK ANALYSES ON SIX PLANTS TO OBTAIN UPDATED ESTIMATES OF CORE MELT FREQUENCY AND FREQUENCY OF PLANT DAMAGE STATES
- o PERFORMING SEVERAL ADDITIONAL SOURCE TERM CODE PACKAGE RUNS FOR EACH REFERENCE PLANT
- o ESTIMATING SOURCE TERM UNCERTAINTIES FOR ONE PLANT, PERFORMING SENSITIVITY STUDIES FOR OTHER PLANTS
- o INTEGRATING INFORMATION ABOVE TO GENERATE RISK ESTIMATES AND RISK REDUCTION INSIGHTS FOR REFERENCE PLANTS
- o RISK REBASELINING TO BE COMPLETED SPRING 1986

NUREG-1150 SUPPORT

ISSUE RESOLUTION

- o INVESTIGATING RISK IMPORTANT ISSUES ON ACCIDENT PROGRESSION, CONTAINMENT BEHAVIOR, AND SOURCE TERMS
- o IDENTIFYING DOMINANT PARAMETERS AND PERFORMING SENSITIVITY STUDIES TO ASCERTAIN IMPACTS ON RISK
- o DEVELOPING NRC STAFF POSITION ON PARAMETER VALUES TO BE USED IN NUREG-1150
- o TYPICAL TOPICS INCLUDE NON-VOLATILE (LANTHANIDE, ACTINIDE) RELEASE FRACTIONS DURING CORE-CONCRETE INTERACTION, DIRECT HEATING, HYDROGEN GENERATION AND OXIDATION WITH RESULTANT CONTAINMENT LOADING, AND REVOLATIZATION
- o EXPANDED EFFORTS TO UNDERSTAND UNCERTAINTIES
 - QUEST-2
 - CONTAIN

GENERAL PRINCIPLES FOR ANALYSIS OF
RISK-DOMINANT UNCERTAINTIES

- o ASSESS IMPORTANCE OF SOURCES OF UNCERTAINTY TO DECISIONS
- o NEED REASONABLE, CREDIBLE RANGE IN WHICH ACTUAL VALUE WILL BE FOUND (90 PERCENT DEGREE OF BELIEF)
- o NEED NOT BE EXPRESSED IN FORMAL STATISTICAL BOUNDS
- o PURPOSE IS TO FOCUS ATTENTION ON IMPORTANT ASSUMPTIONS

REPRESENTATIONS OF UNCERTAINTY

o RIGOROUS BOUNDS

TYPICALLY:

- EASILY DEFENDED (IN PRINCIPLE)
- TOTALLY USELESS (IN PRACTICE)

o REFUSE TO STATE (DEMAND MORE RESEARCH)

TYPICALLY:

- EASILY DEFENDED
- TOTALLY USELESS

o PLAUSIBLE RANGES (NOT RIGOROUS)

- SUBJECTIVE
- OFTEN DIFFICULT TO DEFEND
- USEFULNESS DEBATABLE

ACCIDENT SEQUENCES AND CORE MELT FREQUENCY

- o DETERMINE UNCERTAINTY RANGE BY PROPAGATION OF DATA UNCERTAINTIES
- o CONDUCT SENSITIVITY STUDIES BY VARYING KEY ASSUMPTIONS AND PARAMETERS AND RECOMPUTE UNCERTAINTY DISTRIBUTION FOR EACH VARIATION
- o CONSIDER MULTIPLE VARIATIONS WHEN CORRELATED OR WHEN LITTLE CONFIDENCE (ABOUT 50 PERCENT) IN BASE CASE
- o UNLIKELY TO CONVOLUTE MORE THAN THREE INDEPENDENT PARAMETERS

INTERIM PRODUCT

- o VARIATION IN MEANS OF VARIOUS DISTRIBUTIONS OF SENSITIVITY STUDIES
- o 5 AND 95 PERCENT BOUNDS FOR EACH SENSITIVITY STUDY AND BASE CASE
- o IDENTIFICATION OF FACTORS DRIVING UNCERTAINTY ESTIMATES AND VARIATION OF MEANS
- o HIGHLY DESIRABLE TO ASSIGN "DEGREE OF BELIEF" TO BASE CASE AND EACH SENSITIVITY STUDY AND COMBINE FOR
NUREG-1150

CONTAINMENT EVENT TREES

- o AT PRESENT, THREE INDEPENDENT PASSES THROUGH THE TREE (OPTIMISTIC, CENTRAL, PESSIMISTIC). FOR NUREG-1150 CONSIDER ONLY THE CENTRAL CASE AND PERFORM SENSITIVITY STUDIES

- o ASSIGN DEGREE OF BELIEF (NEUTRAL BETTING ODDS) TO VARIOUS SENSITIVITY STUDIES AND CONVOLUTE TO YIELD AN OVERALL EXPRESSION OF AN APPROXIMATE DEGREE OF BELIEF ASSOCIATED WITH VARIOUS CONTAINMENT FAILURE MODES FOR EACH PLANT DAMAGE STATE

SOURCE TERMS

- o TYPICALLY APPROXIMATELY 15 RELEASE BINS
- o TYPICALLY APPROXIMATELY 6 STCP RUNS/PLANT
- o STCP RUNS DIRECTED TOWARD CENTRAL ESTIMATE
- o EXTRAPOLATION REQUIRED FOR REMAINING CENTRAL ESTIMATE OF SOURCE TERMS (ISOTOPIC RELEASE FRACTIONS, RELEASE ENERGY AND TIMING CHARACTERISTICS) AND ALL OPTIMISTIC AND PESSIMISTIC ESTIMATES
- o PERFORM SENSITIVITY ANALYSES ON KEY PARAMETERS, DEVELOP AN ASSOCIATED DEGREE OF BELIEF FOR EACH SENSITIVITY ANALYSES AND COMBINE APPROPRIATELY

CONSEQUENCE CALCULATIONS

- o BASE CASE FOUNDED ON PLANT-SPECIFIC METEOROLOGICAL DATA AND EMERGENCY PREPAREDNESS ASSUMPTIONS, BEST ESTIMATE VALUES FOR OTHER PARAMETERS
- o LIMITED SENSITIVITY STUDIES ON THESE ASSUMPTIONS AND CODE INTERNAL PARAMETERS
- o COMBINATION OF SENSITIVITY STUDIES, WEIGHTED BY DEGREE OF BELIEF, AS ABOVE
- o FINAL PRODUCT--ENGINEERING ESTIMATE OF REASONABLE BOUNDS AND DISCUSSION OF FACTORS DRIVING ESTIMATES OF RISK DOMINANT UNCERTAINTIES

SUMMARY

SIX FACTORS ANALYZED FOR DOMINANT CONTRIBUTORS TO UNCERTAINTY IN RISK PREDICTIONS:

- o BASIC EVENT DATA (COMPONENT FAILURE RATES, HUMAN ERROR PROBABILITIES)
- o PRE-CORE-MELT PHENOMENOLOGICAL CONSIDERATIONS ASSOCIATED WITH ACCIDENT SEQUENCE FREQUENCIES (SUCCESS/FAILURE CRITERIA)
- o PHENOMENOLOGICAL CONSIDERATIONS PERTAINING TO CONTAINMENT FAILURE MODE LIKELIHOODS
- o PHENOMENOLOGICAL CONSIDERATIONS ASSOCIATED WITH FISSION PRODUCT RELEASES TO THE ATMOSPHERE AS A FUNCTION OF ACCIDENT SEQUENCES
- o METEOROLOGICAL VARIABILITY AND EFFECT OF VARIATIONS IN IMPORTANT CONSEQUENCE MODEL PARAMETERS
- o EFFECT OF EMERGENCY RESPONSE ASSUMPTIONS

ACRS meeting.

10/31/85

FOIA 85-784

Para E.

EMERGENCY PLANNING

AND

SEVERE LOW FREQUENCY NATURAL PHENOMENA

115

Got E

BACKGROUND

- 0 BEFORE DECEMBER 1981 - LIMITED CONSIDERATION OF EARTHQUAKES (UP TO SSE) ON A CASE BY CASE BASIS
- 0 DECEMBER 1981 - SAN ONOFRE DECISION
- 0 AUGUST 1984 - DIABLO CANYON DECISION
- 0 DECEMBER 1984 - PROPOSED RULE PUBLISHED IN FEDERAL REGISTER
- 0 JULY 1985 - ACRS MET WITH COMMISSION AND STATED THAT "WE...SEE NO TECHNICAL REASON FOR THE EXCLUSION OF EARTHQUAKES FROM THE NATURAL PHENOMENA CONSIDERED IN OFFSITE PLANNING."
- 0 SEPTEMBER 9, 1985 - STAFF PRESENTATION TO COMMISSION PROPOSING LIMITED CONSIDERATION OF SEVERE, LOW FREQUENCY NATURAL PHENOMENA.

THE SAN ONOFRE AND DIABLO DECISION AND THE PROPOSED RULE ALL STATED THAT THE POTENTIAL COMPLICATING EFFECTS OF EARTHQUAKES ON EMERGENCY PLANNING NEED NOT BE CONSIDERED.

ALTERNATIVES

- 0 PROMULGATION OF THE PROPOSED RULE
- 0 LEAVING THE ISSUE OPEN FOR ADJUDICATION ON A CASE BY CASE BASIS
- 0 PROMULGATE A FINAL RULE WHICH LIMITS THE CONSIDERATION OF THE COMPLICATING EFFECTS OF SEVERE LOW FREQUENCY NATURAL PHENOMENA ON EMERGENCY PLANNING

PUBLIC COMMENTS

- 0 61 PUBLIC COMMENT LETTERS RECEIVED
 - 0 25 LETTERS FAVORED THE PROPOSED RULE
 - 0 34 LETTERS OPPOSED THE PROPOSED RULE-9 WERE IN PETITION FORM WITH 94 SIGNATURES
 - 0 2 TAKING NO OBVIOUS POSITION
- 0 JAPAN, FRANCE, SWEDEN, GERMANY & TAIWAN ALL STATED THAT THE POTENTIAL COMPLICATING EFFECTS OF EARTHQUAKES WERE NOT SPECIFICALLY CONSIDERED IN THEIR EMERGENCY PLANS.

RECOMMENDED RULE CHANGE

0 "THE PLANS SHALL ASSURE THAT THE FOLLOWING CAPABILITIES EXIST RELATIVE TO THE COMPLICATING IMPACTS OF SEVERE, LOW FREQUENCY NATURAL PHENOMENA CHARACTERISTIC OF THE SITE. IN ADDRESSING THE FOLLOWING CAPABILITIES THE LICENSEE SHALL ASSUME THAT THE SEVERE NATURAL PHEONOMENON HAS DISRUPTED NORMAL COMMUNICATION AND ROAD NETWORKS."

- CAPABILITIES
- SEVERE, LOW FREQUENCY NATURAL PHENOMENA
- ASSUMPTIONS

RECOMMENDED CAPABILITIES & PROPOSED IMPLEMENTATION

OVERALL THRUST IS TO CODIFY FLEXIBILITY IN ORDER TO DO THE BEST YOU CAN FOR ANY NATURAL PHENOMENA.

- 0 ABILITY TO TRANSPORT PERSONNEL BACK INTO THE PLANT - COULD BE IMPLEMENTED BY AN AGREEMENT BETWEEN A LICENSEE AND A TRANSPORTATION PROVIDER.
- 0 ABILITY TO COMMUNICATE PLANT STATUS WITH OFF-SITE AUTHORITIES - COULD BE IMPLEMENTED BY REDUNDANT AND DIVERSE TRANSMITTING CAPABILITIES.
- 0 RECOMMEND THAT STATE AND LOCAL GOVERNMENTS IDENTIFY ALTERNATE ROUTES OF TRAVEL AND METHODS FOR DETERMINING WHETHER TO SHELTER OR EVAUCATE - FOR MOST SEVERE NATURAL PHENOMENA SHELTERING WOULD BE THE MOST VIABLE AND PREFERRED PROTECTIVE ACTION - DO THE BEST YOU CAN UNDER THE CIRCUMSTANCES.

Commissioner 7/2/85

FOIA 85-784
Para. E

EMERGENCY PLANNING

AND

SEVERE, LOW FREQUENCY NATURAL PHENOMENA

Cat E

A/6

BACKGROUND

- 0 BEFORE DECEMBER 1981 - LIMITED CONSIDERATION OF EARTHQUAKES (UP TO SSE) ON
A CASE BY CASE BASIS
- 0 DECEMBER 1981 - SAN ONOFRE DECISION
- 0 AUGUST 1984 - DIABLO CANYON DECISION
- 0 DECEMBER 1984 - PROPOSED RULE PUBLISHED IN FEDERAL REGISTER

THE SAN ONOFRE AND DIABLO DECISIONS AND THE PROPOSED RULE ALL STATED THAT THE POTENTIAL COMPLICATING EFFECTS OF EARTHQUAKES ON EMERGENCY PLANNING NEED NOT BE CONSIDERED.

ALTERNATIVES

- 0 PROMULGATION OF THE PROPOSED RULE
- 0 LEAVING THE ISSUE OPEN FOR ADJUDICATION ON A CASE BY CASE BASIS
- 0 PROMULGATE A FINAL RULE WHICH LIMITS THE CONSIDERATION OF THE COMPLICATING EFFECTS OF SEVERE LOW FREQUENCY NATURAL PHENOMENA ON EMERGENCY PLANNING

PUBLIC COMMENTS

0 61 PUBLIC COMMENT LETTERS RECEIVED

0 25 LETTERS FAVORED THE PROPOSED RULE

0 34 LETTERS OPPOSED THE PROPOSED RULE-9 WERE IN PETITION FORM WITH 94 SIGNATURES

0 2 TAKING NO OBVIOUS POSITION

0 JAPAN, FRANCE, SWEDEN, GERMANY & TAIWAN ALL STATED THAT THE POTENTIAL COMPLICATING EFFECTS OF EARTHQUAKES WERE NOT SPECIFICALLY CONSIDERED IN THEIR EMERGENCY PLANS.

0 ACRS STATED THAT THEY SEE NO TECHNICAL REASON FOR THE EXCLUSION OF EARTHQUAKE CONSIDERATION IN EMERGENCY PLANNING. HOWEVER, ONLY LIMITED CONSIDERATION WAS NEEDED.

RECOMMENDED RULE CHANGE & PROPOSED IMPLEMENTATION

- 0 ABILITY TO TRANSPORT PERSONNEL BACK INTO THE PLANT - COULD BE IMPLEMENTED BY AN AGREEMENT BETWEEN A LICENSEE AND A TRANSPORTATION PROVIDER.
- 0 ABILITY TO COMMUNICATE PLANT STATUS WITH OFF-SITE AUTHORITIES - COULD BE IMPLEMENTED BY REDUNDANT AND DIVERSE TRANSMITTING CAPABILITIES.
- 0 RECOMMEND THAT STATE AND LOCAL GOVERNMENTS IDENTIFY ALTERNATE ROUTES OF TRAVEL AND METHODS FOR DETERMINING WHETHER TO SHELTER OR EVACUATE - FOR MOST SEVERE NATURAL PHENOMENA SHELTERING WOULD BE THE MOST VIABLE AND PREFERRED PROTECTIVE ACTION
 - DO THE BEST YOU CAN UNDER THE CIRCUMSTANCES.

MAJOR ISSUES (UNCERTAINTIES) IDENTIFIED BY COMMENTORS

- 0 LIMITED OR NO RECORD TO SUPPORT GENERIC FINDING OF FLEXIBILITY IN EMERGENCY PLANS.
- RESPONSE: REVIEW OF EMERGENCY PLANS AND EXERCISES SUCCESSFULLY CONDUCTED USING SEVERE NATURAL PHENOMENA IN INITIATING OR COMPLICATING ELEMENTS IN THE ON-SITE SCENARIO; TWENTY (20) NONRADIOLOGICAL EVACUATIONS STUDIED; AND FEMA'S RADIOLOGICAL EMERGENCY PREPAREDNESS (REP).
- 0 DEFECTS IN CONSTRUCTION, SEISMIC DESIGN, QUALITY ASSURANCE AND OPERATOR STRESS CAN UNDERMINE SEISMIC STRENGTHS.
- RESPONSE: THIS ISSUE IS ACCOMMODATED BY DEFENSE IN DEPTH, CONSERVATIVE MARGINS IN SEISMIC DESIGN, INDEPTH OPERATOR TRAINING AND THE FINAL RULE.
- 0 CURRENT EMERGENCY PLANS ARE DESIGNED TO CONSIDER A BROAD SPECTRUM OF EVENTS THE WORST OF WHICH HAVE PROBABILITIES OF $10E(-4)$ TO $10E(-5)$ - WHY NOT CONSIDER NATURAL PHENOMENA WITH A RETURN FREQUENCY IS IN THE SAME RANGE.
- RESPONSE: THE STAFF AGREES, THE FINAL RULE ACCOMMODATES THIS ISSUE.
- 0 THERE EXISTS LIMITED INFORMATION ON THE CONTRIBUTION OF SEISMIC EVENTS TO OVERALL CORE MELT FREQUENCIES.
- RESPONSE: THE STAFF AGREES, THE FINAL RULE ACCOMMODATES THIS ISSUE.