



NRC PERSPECTIVE ON ISSUE OF VOLCANISM

**PRESENTATION TO
U.S. NUCLEAR WASTE TECHNICAL
REVIEW BOARD
PANEL ON STRUCTURAL GEOLOGY AND ENGINEERING**

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BASIC QUESTION

- **WHAT ARE THE REGULATORY REQUIREMENTS CONTROLLING LEVEL OF INVESTIGATIONS AND ANALYSES?**
 - **WHAT LEVEL OF PROOF IS NEEDED?**

PRIMARY REGULATORY ELEMENTS

- **60.112 - OVERALL SYSTEM PERFORMANCE OBJECTIVES (EPA STANDARD)**
- **60.122(C) - POTENTIALLY ADVERSE CONDITIONS**
- **60.122(A)(2) - QUALITATIVE DESCRIPTION OF LEVEL OF NECESSARY INVESTIGATIONS AND ANALYSES**

**60.112 - OVERALL SYSTEM PERFORMANCE
CUMULATIVE RELEASE OF RADIONUCLIDES
TO ACCESSIBLE ENVIRONMENT**

- PROBABILITIES FOR CATEGORIES OF PROCESSES AND EVENTS
- REQUIRED SUMMATION OF ALL RELEASES DURING PERIOD OF PERFORMANCE

60.122(C)
POTENTIALLY ADVERSE CONDITIONS
(PACS)

- PACS ARE FACTORS WHICH REDUCE ABILITY TO PROJECT GEOLOGIC PROCESSES WITH CONFIDENCE.
- ALL PACS MUST BE CONSIDERED IN PERFORMANCE ASSESSMENT.

60.122(A)(2)

PAC INVESTIGATION AND ANALYSIS REQUIREMENTS

- **THREE STEP PROCESS**

**1. ESTABLISH DEGREE OF RESOLUTION OF
INVESTIGATIONS: WHAT COULD BE PRESENT AND
UNDETECTED?**

AND

**2. DEMONSTRATE SENSITIVITY AND ASSURE THAT
EFFECTS NOT UNDERESTIMATED**

AND

3. DEMONSTRATE EITHER

A) INSIGNIFICANT

OR

B) CAN BE COMPENSATED

OR

C) CAN BE REMEDIED OR MITIGATED

RESPONSE TO BASIC QUESTION

- **REGULATIONS QUALITATIVE**
- **MUST DESCRIBE**
 - **PROGRAM OF INVESTIGATIONS**
 - **RESOLUTION OBTAINED**
 - **FEATURES/CHARACTERISTICS DETECTED**
 - **FEATURES/CHARACTERISTICS WHICH COULD HAVE BEEN MISSED**
- **ASSESSMENTS MUST BALANCE KNOWN AND UNKNOWN TO ASSURE EFFECTS NOT UNDERESTIMATED.**

EXAMPLE CONCERNS

INTERRELATIONSHIP BETWEEN SURFACE AND SUBSURFACE FEATURES

- PRIMARY DATA BASE FROM STUDY OF SURFACE FEATURES-RELATIVELY HIGH DEGREE OF RESOLUTION
- LOCATION AND CHARACTERISTICS OF SUBSURFACE FEATURES - LOW DEGREE OF RESOLUTION
- VOLUME/FREQUENCY RELATIONSHIPS HAVE BEEN POSTULATED BASED ON SURFACE VOLUME
 - WHAT IS EFFECT OF SUBSURFACE VOLUME ON MAGMA/FREQUENCY CALCULATIONS
 - WHAT IS RELATIONSHIP WHICH DOES NOT UNDERESTIMATE EFFECTS

EXAMPLE CONCERNS

STRUCTURAL RELATIONSHIP TO VOLCANISM

- **MODELS SUGGEST EITHER A NORTHWEST TREND OR NORTH-NORTHEAST TREND.**
- **PROBABILITY OF ADVERSE EFFECTS GENERALLY LOWER FOR "NORTHWEST MODELS"**
- **WITHOUT DATA TO DISCRIMINATE, "NORTH-NORTHEAST MODEL LESS LIKELY TO "UNDERESTIMATE EFFECTS".**

EXAMPLE CONCERNS

AGE OF EVENTS

- **RESOLUTION OF MODELS OF POLYCYCLIC/ MONOCYCLIC, WAXING/WANING VOLCANIC ACTIVITY DEPENDENT ON AGE DETERMINATION**
- **RESULTS OF VARIOUS AGE DETERMINATION TECHNIQUES ARE CONFLICTING**
- **WHICH MODELS CAN BE SHOWN TO “NOT UNDERESTIMATE THE EFFECTS”**

EXAMPLE CONCERNS

PRESENCE OF MAGMA CHAMBERS IN SITE VICINITY

- **SEISMIC REFLECTION TEST LINE COULD INDICATE MAGMA CHAMBER -**
 - OTHER EXPLANATIONS POSSIBLE
 - LOW DEGREE OF RESOLUTION
- **STUDY PLANS INDICATE PRESENCE OF MAGMA CHAMBER COULD AFFECT PROBABILITY CALCULATIONS.**
- **WITHOUT ADDITIONAL INVESTIGATIONS ASSUME MAGMA CHAMBER IS PRESENT - ANY OTHER ASSUMPTION COULD "UNDERESTIMATE EFFECTS"**

EXAMPLE CONCERNS

CONSEQUENCE ANALYSIS

- TO DATE ANALYSES MAY HAVE UNDERESTIMATED EFFECTS
 - HAVE NOT INCORPORATED SECONDARY EFFECTS.
 - GENERALLY ASSUMED A SINGLE FEEDER DIKE.
 - MODELS ASSUME REPOSITORY WILL REACT SAME AS COUNTRY ROCK.
 - POSSIBILITY OF HYDROVOLCANIC STAGE NOT CONSIDERED.

EXAMPLE CONCERNS

EXPERT JUDGEMENT

- LICENSING PROCESS WILL USE EXPERT JUDGEMENT
- LICENSING BOARD WILL BE GUIDED BY 60.122(A)(2)
- EXPERT JUDGEMENT DOES NOT INCREASE DATA BASE.
UNDETECTED FEATURES REMAIN THE SAME
- EXPERT JUDGEMENT DOES NOT ELIMINATE REQUIREMENT
TO ASSURE EFFECTS NOT UNDERESTIMATED.
- WHILE EXPERT JUDGEMENT ASSURES A MORE INFORMED
DECISION, DOE SHOULD BE CAUTIONED AGAINST RELIANCE
ON EXPERT JUDGEMENT IF DATA TO SUPPORT LICENSING
CAN BE OBTAINED WITH REASONABLE EFFORT.

CONCLUSIONS

- AT PRESENT
 - DATA BASE LIMITED
 - MULTIPLE MODELS ARE PERMISSIBLE
 - MANY AREAS OF CONCERN

- 60.122(A)(2) PROVIDES QUALITATIVE REQUIREMENTS TO GUIDE DOE'S INVESTIGATION AND ANALYSES

- FOR LICENSING, DOE MUST DEMONSTRATE COMPLIANCE WITH PERFORMANCE OBJECTIVES

CONCLUSIONS (Continued)

- FOR LICENSING, DOE MUST ADDRESS PACs BY
 - DESCRIBING INVESTIGATIONS INCLUDING FEATURES/PROCESSES THAT COULD BE "UNDETECTED"
 - ASSURING ANALYSIS USED NOT LIKELY TO UNDERESTIMATE EFFECTS
- EXPERT OPINION WILL ALSO BE EVALUATED BY 60.122(A)(2) REQUIREMENTS

**SUMMARY OF NRC CONCERNS WITH SCP
AND DOE STUDY PLANS ON VOLCANISM**

SCP/SCA

- A. INVESTIGATION OF TECTONIC PHENOMENA SHOULD RECEIVE EARLY ATTENTION/HIGH PRIORITY**

- B. INTEGRATION OF SITE CHARACTERIZATION PROGRAM**

- C. SPECIFIC OPEN COMMENTS IN THREE MAIN AREAS**
 - 1. GEOPHYSICS - INTEGRATION OF PROGRAM, SUFFICIENCY OF PROGRAM, AND SPECIFICS RELATED TO VOLCANISM (COMMENTS 32, 51 AND 52)**

 - 2. DOE PERFORMANCE PARAMETERS, PERFORMANCE MEASURES, AND GOALS VS NRC PERFORMANCE OBJECTIVES (COMMENT 43 AND 49)**

 - 3. VOLCANIC RATE CALCULATIONS APPEAR INDEPENDENT OF KNOWLEDGE OF PROCESS (COMMENT 45)**

CHARACTERIZATION OF VOLCANIC FEATURES

- A. WORK OUTLINED APPEARS NEEDED**
- B. MINOR QUESTIONS ON STUDY PLAN ITSELF**
 - 1. AGE DATING METHODS - RESOLVED**
 - 2. ORIENTED CORE - RESOLVED**
 - 3. ANALOGS - STILL UNCLEAR WHAT ANALOG STUDIES BEING PLANNED**
- C. ONGOING CONCERN WITH INTEGRATION OF PROGRAM**

PROBABILITY OF MAGMATIC DISRUPTION OF THE REPOSITORY

- A. VIDEO CONFERENCES - AUGUST 25, 1992**
- B. CONCERN WITH HAVING SUFFICIENT AND NECESSARY
DATA TO UNDERSTAND MAGMATIC PROCESSES - EMPHASIS ON
NEEDED GEOPHYSICS**
- C. CONCERN WITH USE OF EXPERT JUDGEMENT - EMPHASIS ON
WEIGHTING**
- D. SPECIFIC COMMENTS HAVE MAIN THEME - SCOPE TOO
NARROW TO SOLVE REGULATORY AND TECHNICAL CONCERNS**
 - 1. EVENTS OF CONCERN ARE MORE THAN
JUST CONE FORMATION**
 - 2. SURFACE EXTRUSION RATES AS SURROGATE OF
MAGMA PRODUCTION RATES**
 - 3. CRUSTAL "MAGMA BODIES" NEED EVALUATION**

PROBABILITY OF MAGMATIC DISRUPTION OF THE REPOSITORY

4. PROBABILITY CALCULATIONS DO NOT APPEAR TO INCLUDE ALL SIGNIFICANT PROCESS & EVENTS
5. VALIDITY OF RECURRENCE MODEL WITHOUT RANGE OF INPUT PARAMETERS
6. RECURRENCE RATE VS. AVERAGE RECURRENCE RATE
7. FULL CONSIDERATION OF NON-POISSONIAN MODELS
8. DISQUALIFICATION FORMULA APPEARS INVALID
9. INPUT GEOPHYSICS PROGRAM APPEARS TOO LIMITED
10. MODEL 1 METHODOLOGY APPEARS INCORRECT
11. EQUATION FOR DISRUPTION APPEARS IN NEED OF CORRECTION.
12. USE OF WEIGHTED MODELS AND BIAS REDUCTION
13. USE OF EXPERT JUDGEMENT.

RECENT SIGNIFICANT DEVELOPMENTS

EVANS AND SMITH, 1992, TELESEISMIC TOMOGRAPHY OF THE YUCCA MOUNTAIN REGION: VOLCANISM AND TECTONISM, HIGH LEVEL WASTE MANAGEMENT CONFERENCE, 1992

HUMPREYS, DUEKER AND BIASI, 1992, WESTERN U.S. TECTONIC AND VOLCANIC ACTIVITY: THE ROLE OF THE MANTLE, GSA CORDILLERAN SECTION ABSTRACT

EVANS, 1992, FUTURE TOMOGRAPHIC STUDIES OF THE YUCCA MOUNTAIN AREA AND REGION, MEMORANDUM TO LARRY HAYES, CHIEF, YUCCA MOUNTAIN PROJECT

PRESENT NRC PERSPECTIVE ON ISSUE OF VOLCANISM

- **INTEGRATION OF SITE CHARACTERIZATION PROGRAM IS NOT APPARENT**
- **INTERGRATION OF VOLCANIC PROGRAM IS NOT APPARENT**
- **GEOPHYSICS PROGRAM DOES NOT APPEAR SUFFICIENT**
- **THAT PART OF VOLCANIC PROGRAM WHICH HAS BEEN SUBMITTED TO NRC FOR REVIEW APPEARS TOO LIMITED TO ADDRESS REGULATORY CONCERNS**