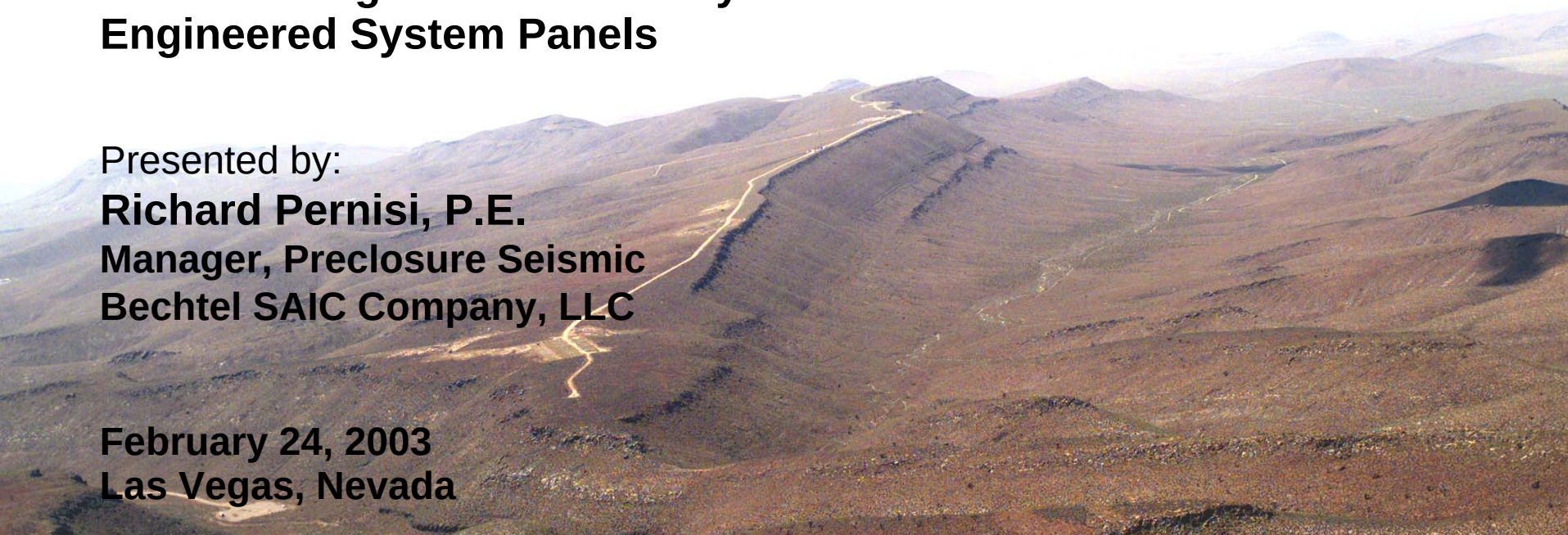
U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN PROJECT

DOE Approach to Preclosure Analysis and Design

Presented to:
Nuclear Waste Technical Review Board
Joint Meeting of the Natural System and Engineered System Panels



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Introduction

- Approach Requirements
- Preclosure Safety Analysis
- Repository Design
- Integration of PSA and Repository Design
- Summary

Approach Requirements

- **Postclosure Safety Analysis (PSA) is required by 10 CFR 63.112**
  - **DOE's approach to PSA is outlined in PSA Guide**
  - **PSA Guide provides basis for ensuring that design will comply with preclosure performance objectives in 63.111**
- **Preclosure design and safety analyses are integrated to ensure compliance with:**
  - **Preclosure safety objectives of 10 CFR 63**
  - **Yucca Mountain Review Plan**

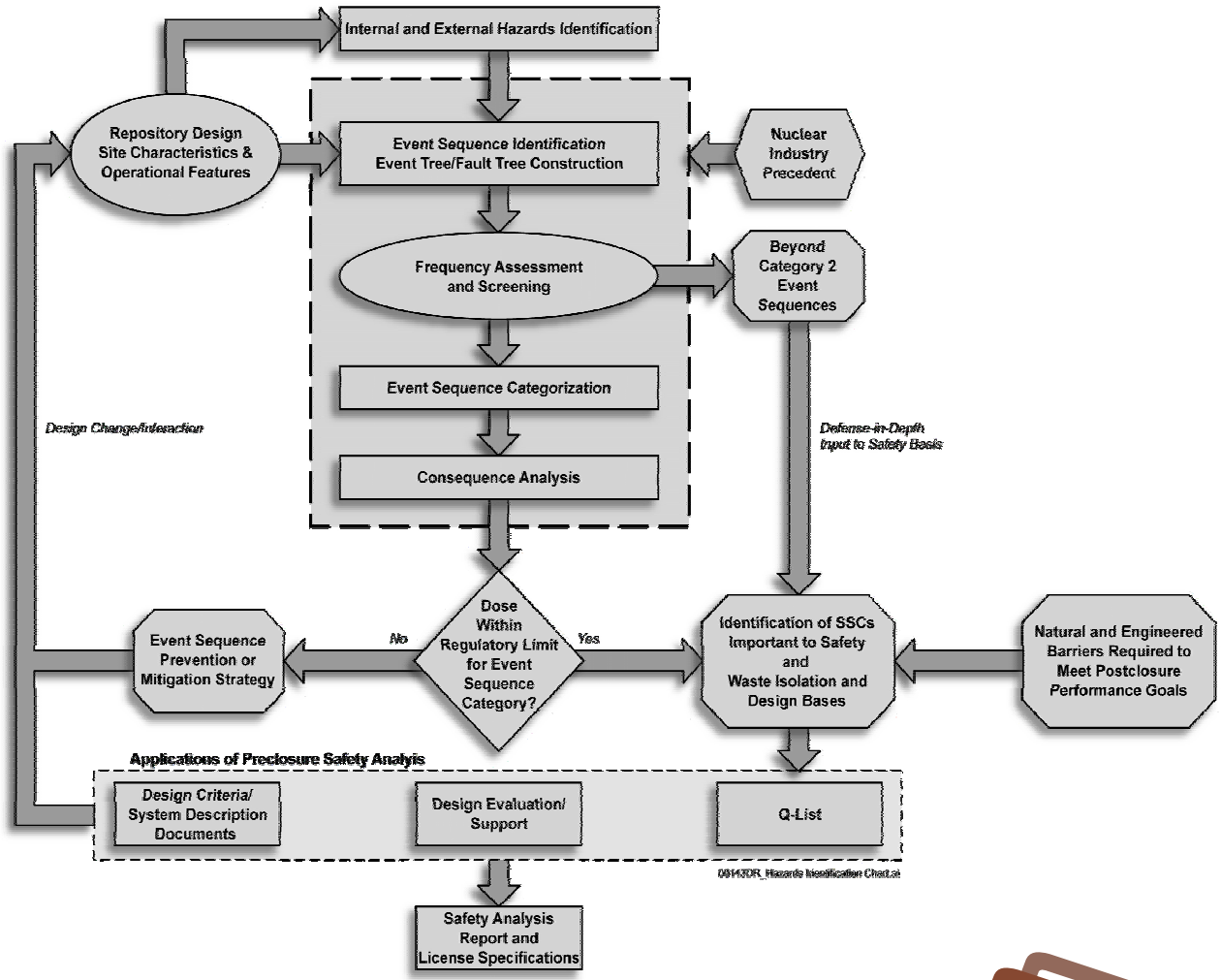
Approach Requirements
(Continued)

- **Preclosure safety objectives and design requirements are given in 10 CFR 63**
  - **§63.111 Preclosure Performance Objectives:**
    - **Protection against radiation exposures and uncontrolled releases of radioactive material**
    - **Worker and public dose requirements**
    - **Radiation protection standards for the public:**
      - **Category 1 event sequences (design basis events): aggregate dose must not exceed total effective dose equivalent (TEDE) of 15 mrem**
      - **Category 2 event sequences: any single event sequence must not exceed TEDE of 5 rem**
    - **A PSA must be conducted to demonstrate that the facilities as designed will meet requirements**
    - **Conduct performance confirmation**
    - **Retrieve the waste**

Approach Requirements
(Continued)

- §63.112 Requirements for PSA
  - Description of structures, systems, and components (SSCs)
  - Systematic analysis of naturally occurring and human-induced hazards
  - Identification of SSCs important to safety, including controls relied on to prevent or mitigate potential event sequences that could result in non-compliance
- NRC staff guidance on implementing requirements of 10 CFR 63 provided in the Yucca Mountain Review Plan
- Detailed DOE guidance on conducting PSA provided in the PSA guide

Preclosure Safety Analysis



Preclosure Safety Analysis

- **As part of the the Yucca Mountain Project analysis and design process the PSA and Repository Design teams identify the natural phenomena, and accident events that form the basis of the hazards analysis for the Project:**
  - **Natural phenomena**
    - **Earthquakes, wind, tornado winds and missiles, floods, volcanism, and temperature extremes**
  - **Accidents events**
    - **Load drops, off normal fuel events, loss of power, and transporter accidents**

Repository Design

- **Design Engineering for the SSCs of the YMP uses:**
  - **Design Requirements, Basis, Criteria and Methodologies:**
    - **Preclosure design requirements are provided by the DOE and refined by Repository Design engineering**
    - **Design basis documents operational and functional design considerations**
    - **Design Criteria documents the acceptance codes and standards, and details for development of design solutions**
    - **Design Methodologies used are those accepted by the nuclear industry**

Integration of Preclosure Safety Analysis and Repository Design

- **Preparation of the PSA and Repository Design uses the following steps:**
  - **Repository Design team prepares the analyses and initial designs and coordinates with PSA team to provide the necessary design inputs for the safety analyses**
  - **The PSA identifies those SSCs that are important to safety because they are credited in the PSA to preclude or mitigate consequences**
  - **The Repository Design and PSA Teams iterate the designs as needed to ensure compliance to 10 CFR 63 performance objectives**

Integration of Preclosure Safety Analysis and Repository Design

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- The PSA team prepares the Q-List of all important to safety SSCs
- The design team ensures that all items on the Q-List are designed such that the intended functional, and performance requirements are achievable under all design conditions, and issues the design documents

Summary

- PSA objectives and requirements are given in 10 CFR 63 and the Yucca Mountain Review Plan
- Preclosure repository design is risk-informed and the PSA provides the risk information
- PSA will identify the event sequences and their probabilities that can lead to potential exceedances of the performance objectives
- Safety analyses will iterate with repository design to ensure that SSCs important to safety will prevent or mitigate event sequences that could lead to noncompliance
- All analyses and design work are prepared to demonstrate that the SSCs that make up the preclosure facilities will meet preclosure objectives provided in 10 CFR 63

Backup

Yucca Mountain Review Plan

- **Yucca Mountain Review Plan (NRC 2002), Section 4.1 Repository Safety Before Permanent Closure**
- **Specifies risk-informed review process for the PSA that must include:**
  - **Site description**
  - **Description of SSCs, equipment, and operational process activities**
  - **Identification of hazards and initiating events**
  - **Identification of event sequences**
  - **Consequence analysis**
  - **Identification of SSCs important to safety, safety control, and measures to ensure availability of the safety systems**

Yucca Mountain Review Plan

(Continued)

- Design SSCs important to safety and safety controls
- Design criteria and design bases
- Design methodologies
- Geologic repository operations area layout and design analyses
- Meeting the 10 CFR Part 20 as low as reasonably achievable requirements for normal operations and Category 1 event sequences
- Plans for retrieval and alternate storage of radioactive wastes
- Plans for permanent closure and decontamination, and dismantlement of surface facilities

Preclosure Safety Analysis Guide

- **Purpose is to describe and standardize DOE's approach and methods to conduct safety analyses in conformance with NRC regulations and the Yucca Mountain Review Plan**
  - **Preclosure safety strategy**
  - **PSA elements and approaches**
  - **Description of site, facilities, and operations**
  - **Hazards analysis**
  - **Event sequence (design basis event) frequency analysis**
  - **Consequence analysis**

Preclosure Safety Analysis Guide
(Continued)

- Uncertainty and sensitivity analysis
- External events: earthquakes, floods, winds and tornado, lightning and extreme temperatures, wild fires
- Criticality (radioactive materials)
- Quality assurance classification of structures, systems, and components important to safety
- Selection of 10 CFR 63.2 Design Bases
- Documentation and preparation of license application