10 CFR Part 63
Preclosure Safety Analysis

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Purpose

- Clarify the process for performing the PCSA
- Discuss information needed to review the PCSA
- Communicate expectations for estimating reliability of structures, systems, and components (SSCs)
- Identify approaches for developing reliability estimates and provide examples

Key Messages

- 10 CFR Part 63 is a risk-informed and performance-based regulation
- Two levels of information:
  - general information supporting PCSA
  - specific information for SSCs designated as important to safety (ITS)
- More design information may be necessary for unique SSCs
- Reliability estimates are needed to perform PCSA and categorize event sequences
- Several approaches for estimating reliability:
  - Accepted engineering practice
  - Empirical data for similar SSCs
  - Modeling

Key Messages (continued)

- Provide technical bases for reliability estimates and approaches used
- Reliability data needs to be related to the design bases and design criteria of the SSCs credited with prevention or mitigation of an event sequence
- Uncertainties and limitations associated with a particular approach or method of analysis and data, need to be addressed in the PCSA

Risk-informed Performance-Based

- 10 CFR Part 63 is a risk-informed, performance-based regulation
- Risk-informed performance-based approach allows use of risk insights, engineering analysis, and judgment to:
  - Focus attention on most important activities
  - Establish objective criteria for evaluating and monitoring performance
  - Provide flexibility to determine how to meet performance criteria
  - Focus on results as primary basis for regulatory decision making

Licensing Approach

- One license application for geologic repository
- Two fundamental regulatory decisions at different times:
  - 10 CFR 63.31 - Whether to grant a Construction Authorization based on license application
  - 10 CFR 63.41 - Whether to grant a license to Receive and Possess nuclear material

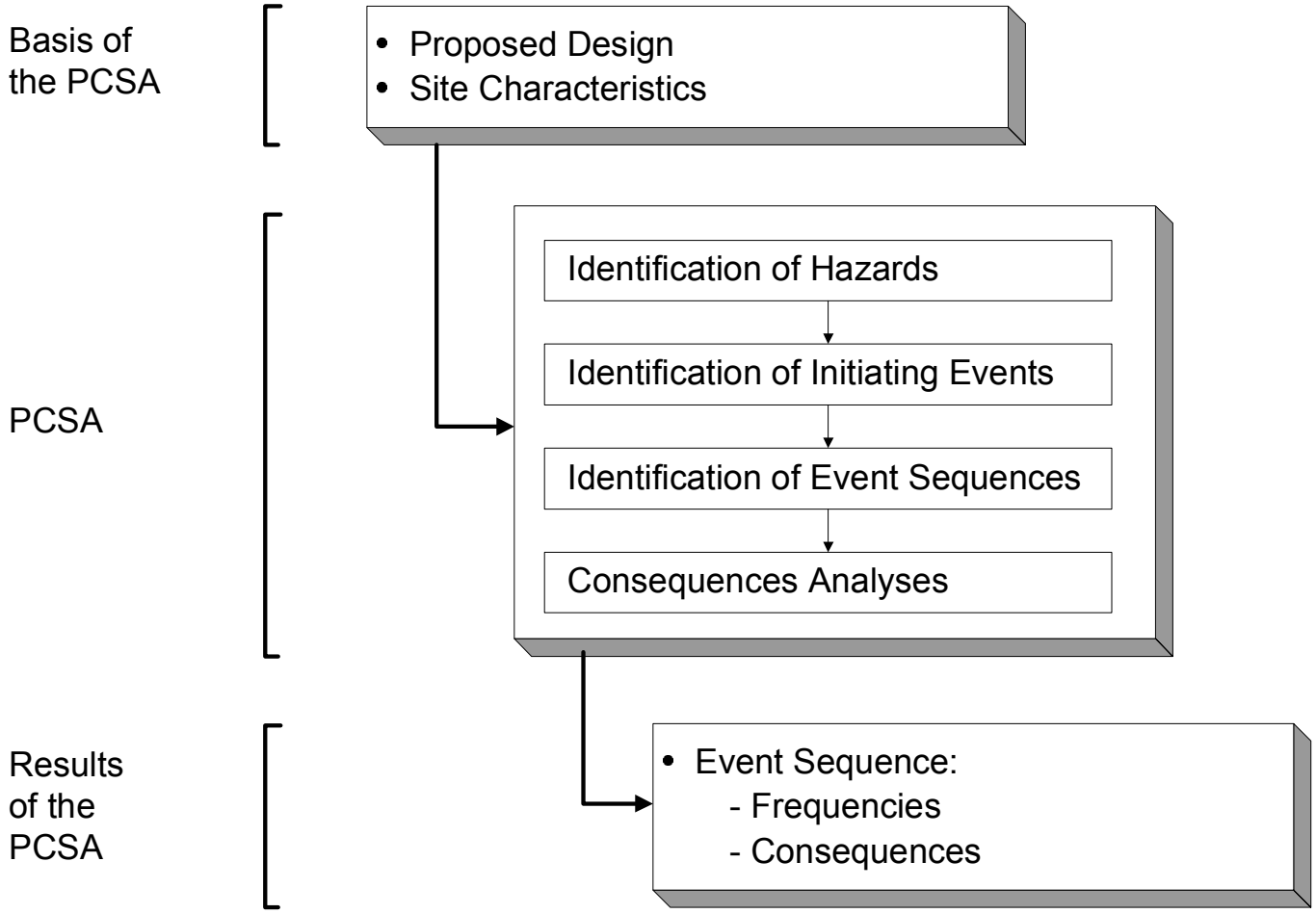
PCSA Level of Information

Chris Ryder

Preclosure Safety Analysis

- Preclosure safety analysis is a systematic examination of the site; the design; and potential hazards, initiating events, and event sequences and their consequences
  - Verify compliance with the performance objectives
  - Identify ITS SSCs

Preclosure Safety Analysis Process



Levels of Information

- Two levels of information
  - General information supporting the PCSA
  - Specific information about SSCs that are determined by analysis to be ITS

- Information on proposed design is influenced by similarity with SSCs or operations at other facilities and is bounded by:
  - Analogous SSCs or operations
  - Unique SSCs or operations

General Information Supporting the PCSA

- Description of the facilities and their functions
- Description of SSCs within the facilities
- Design bases and design criteria
- Basic operations, controls, and monitoring
- Key dimensions
- Relationships and interdependencies of SSCs, as needed
- Application of and exceptions to codes and standards

Specific Information for ITS SSCs

- For ITS SSCs, sufficient information on technical bases is necessary to demonstrate ability of SSCs to perform their intended safety functions at the stated reliability
- PCSA and reliability data for ITS SSCs need to be related to design bases and design criteria, and describe how performance objectives are met
  - Design criteria describe functions to be accomplished
  - Design bases identify specific functions performed by an SSC and specific values chosen for controlling parameters for design
- Examples of specific information for ITS SSCs
  - Specificity in design, particular SSCs, and operations
  - Greater description of data, models, judgments
  - Closer ties of design to reliability

Review of Level of Information

- 10 CFR 63 provides DOE with flexibility in designing the repository to meet specific safety performance objectives
- Two levels of information necessary for the review; general information supporting the PCSA and specific information about SSCs designated as ITS
- Level of information depends on the approach taken for the design (analogous operations versus unique operations)

Estimating Reliability and Addressing Uncertainty

Rosemary Reeves

Need for Estimating Reliability

- An estimate of reliability is needed to determine the probability of occurrence of an event sequence
- Reliability of SSCs (active and passive), analyzed in event sequences, is needed to perform the PCSA and categorize event sequences [63.112(b)]
- Reliability provides a measure of the ability of SSCs to perform their intended safety functions, assuming the occurrence of event sequence [63.112(e)]

Reliability Estimation

- Approaches that may be used to develop reliability estimates, include:
  - Accepted Engineering Practice: expert judgment and good engineering practice (e.g. applicability of consensus codes and standards)
  - Empirical: using data from similar SSCs in other applications
  - Modeling: constructing reliability model
- Regardless of the approach, a technical basis for the reliability estimate and the approach chosen must be provided

Reliability Estimation (continued)

- When determining reliability, use SSC analogs at the highest level possible (typically system level)
- If insufficient data, or unique SSC, build reliability from analogs at next level down (component level)
- Other attributes may provide confidence in reliability estimates (e.g., QA, testing, maintenance, inspection, training programs, etc.)

Addressing Uncertainty

- Reliability estimates should address the uncertainties and limitations associated with a particular method of analysis and data
- Defend and support selected approach, accounting for uncertainties
  - Traceability of supporting information
  - Include qualitative and quantitative information
- Review the range of uncertainty and variability considering:
  - Proximity to category limit
  - Severity of consequence (radiological release)
  - Reliance on SSC to prevent or mitigate a potential occurrence

Examples of Estimating Reliability

Amitava Ghosh

Example: Crane

- Description
  - Handle welded canisters (e.g., bridge crane inside a facility)
  - Designed to ASME NOG-1 Type 1
- Event sequence
  - Credited with reducing the likelihood of occurrence of a drop
- Estimation of reliability
  - Empirical data for reliability of cranes may be used (e.g., NUREG-1774, 2003)
  - Data used may be in the form of “n drops in m lifts”
- Technical basis supporting selected reliability value
  - Use of design codes and standards (e.g., ASME NOG-1 Type 1)
  - Justification for data being applicable to this crane (e.g., operating environments, training levels, maintenance, quality assurance)

Example: Canister

- Description
  - Handled by lifting devices inside the facility
- Event sequence
  - Potential drops from within its design basis lift height
  - Canister is credited to withstand a drop from within its design basis lift height and reduces the likelihood of occurrence of the event sequence
- Estimation of reliability
  - Engineering judgment applied to the capability for the canister to avoid breaching
- Technical basis supporting estimated reliability value
  - Use of design codes and standards (e.g., ASME Boiler and Pressure Vessel code, conservatism in codes and standards)
  - Justification of estimated reliability
    - Industry data on similar items
    - Manufacture (e.g., quality assurance requirements)
    - Testing (e.g., nondestructive testing)

Example: HVAC

- Description
  - Remove airborne radioactive particulates
  - Maintain negative differential pressure
  - Designed to ASME AG-1
- Event sequence
  - Credited with preventing release of radioactive particulates
  - Reduces the likelihood of occurrence of the event sequence
- Estimation of reliability
  - Empirical data of HVAC systems from existing facilities
  - Modeling to reflect the configuration, design, and components using empirical data for reliability of HVAC components within the system (e.g., IEEE Standard 500)
- Technical basis supporting calculated reliability value
  - Use of design codes and standards (e.g., ASME AG-1)
  - Justification for assumptions (e.g., applicability of data)

Summary

- Two levels of design information for the PCSA
  - General information for the PCSA
  - Specific design information for SSCs designated as ITS
- Design information depends on the approach taken to design the facility
  - Analogous to an existing facility
  - Completely novel facility
- Reliability information for SSCs (active and passive) is needed to demonstrate compliance with Part 63 performance requirements and conduct the preclosure safety analysis.

Summary (continued)

- Reliability can be estimated by using any combination of accepted engineering practice, empirical data for similar SSCs, or modeling
- Regardless of the method used, a technical basis should be included
- Reliability data should be related to design bases and design criteria of SSC credited with prevention or mitigation of an event sequence
- Uncertainties and limitations associated with a particular method of analysis and data should be addressed