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Features, Events, and Processes (FEPs)

KHNP Training Program
Module 6: Assembly of a Safety Case

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Outline

I. General Approach

II. WIPP FEPS

III. Group Exercise

What is a FEP?

A Feature: Rock Unit, river, ocean, fault, etc.

An Event: Earthquake, Tsunami, Drilling Intrusion, etc.

A Process: Tectonics, groundwater flow, erosion, etc.

EPA Says:

Performance assessment (PA) is an analysis that:

(1) Identifies the features, events, and processes (FEPs) that *might* affect the disposal system;

(2) examines the effects of these FEPs may have on the performance of the disposal system; and

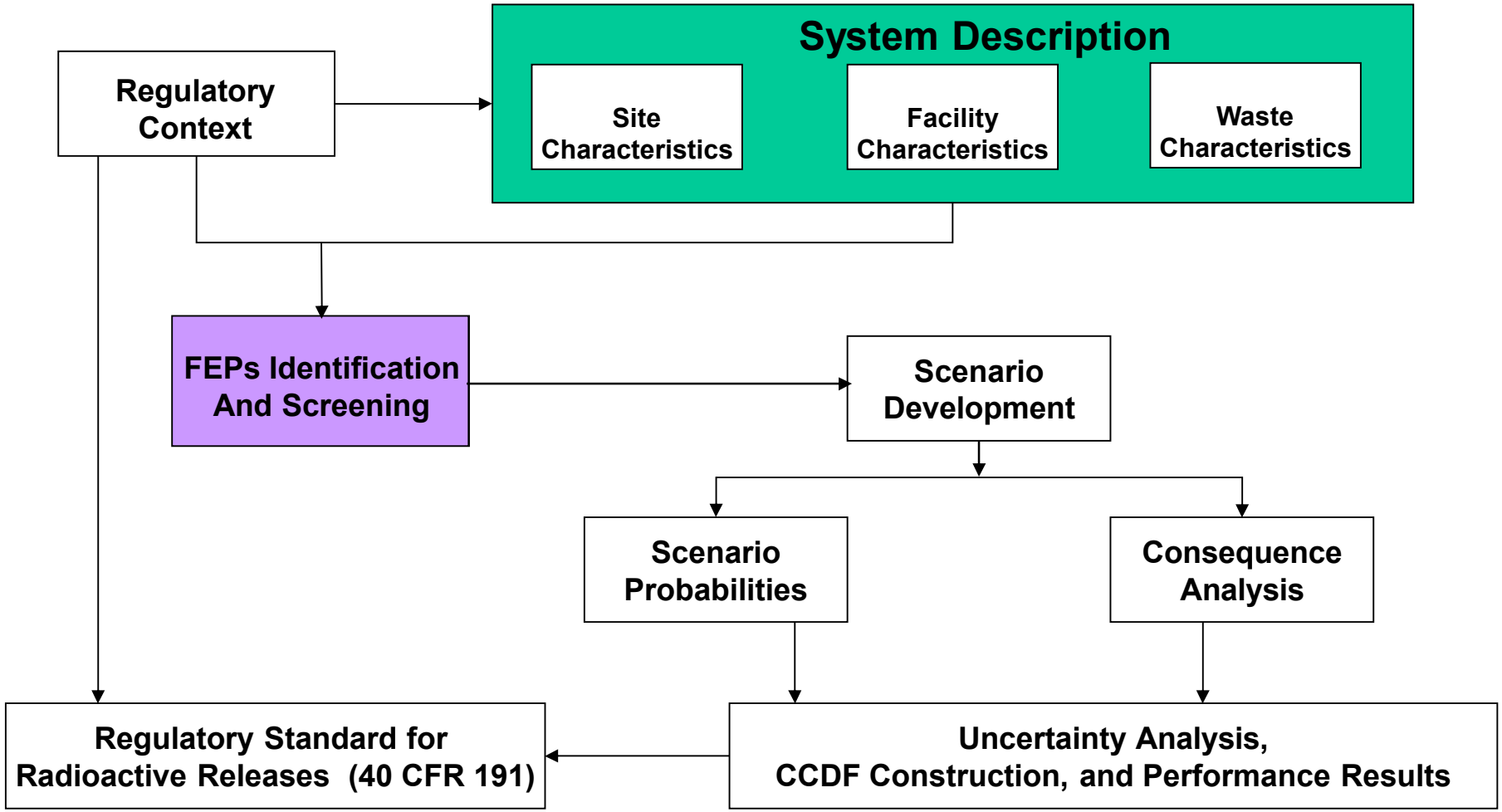
(3) estimates the cumulative releases of radionuclides, considering the associated uncertainties, caused by all significant FEPs. (summarized from §191.12)

Nuclear Energy Agency (NEA) Says:

…A relevant and reliable assessment of the safety of a disposal system… begins with:

- (i) Identification and classification of all phenomena potentially relevant to the performance of the repository and site.
- (ii) Elimination of phenomena according to well-defined screening criteria.
- (iii) Identification or formation of scenarios relevant to the performance of the repository and site.
- (iv) Specification of scenarios for consequence analysis.

PA Methodology



FEP Identification

- Site specific
- Err on side of inclusion
- Use regulations for guidance when possible
- Use other disposal programs as sources

FEPs Identification

- **Determine which FEPs need to be considered for screening**
  - **Identify *potentially applicable* natural FEPs**
  - **Identify *potentially applicable* human-induced FEPs**
  - **Identify *potentially applicable* waste & repository FEPs**

    -- *Tsunamis* are NOT potentially applicable to WIPP

    -- *Erosion* IS potentially applicable to WIPP

WIPP FEP List Development

- **A compilation of 9 FEP lists developed in different countries and internationally was used as a starting point. For example:**
  - **Netherlands (Prij et al., 1993),**
  - **Sweden (Stenhouse et al., 1993),**
  - **US (Guzowski and Newman, 1993),**
  - **Others…**

- **Confidence in the comprehensiveness was gained through:**

  – Formal presentations to the regulator(s) and stakeholders of the initial FEP list
  – Extensive, formal, documented review of the draft list within the project, by stakeholders, and by the EPA.
  – Reduction of the draft FEP list in a documented, logical manner.
  – Formal documented review of the final FEP list within the project.

- For WIPP, this process resulted in reducing an initial list of over 900 FEPs to 240 more concise and meaningful WIPP-specific FEPs

WIPP FEPs Classifications

For WIPP, three different classes of FEPs are appropriate:

1. **Natural FEPs**
2. **Waste and Repository FEPs**
3. **Human-induced FEPs**

These classifications help to avoid confusion and duplication

E.g., Natural geochemistry vs. human-induced changes in geochemistry

FEPs Screening

- **Determine which FEPs need to be included (screened in) PA calculations**

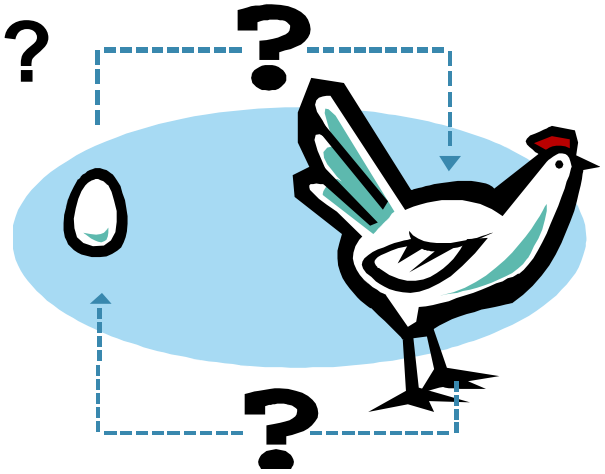
FEPs are screened according to:

- **Probability: If a FEP has a probability of occurring less than 10^{-4} in 10,000 years it does not have to be included in PA (e.g., meteorite impact)**
- **Consequence: if a FEP is beneficial to performance or is not relevant to WIPP it does not have to be included in PA (e.g., lakes, oceans, tides, floods).**
- **Regulation: Certain FEPs are either screened in or out by regulation (e.g., mining, resource extraction following drilling).**

What's First?

The FEP?

Or



The Scenario?

Experience Shows Iterative Process

- **Initial FEPs list development occurred before scenario development, *but*;**
- **Preliminary PAs were used to refine, and make FEPs list more appropriate and meaningful**
- **Evolving Regulations also caused changes to FEPs (e.g., mandated human intrusion affected disturbed and undisturbed scenarios, specific screening criteria, etc.)**

WIPP FEPs

1) Since the CCA, FEPs basis reduced from 240 to 235 WIPP FEPs
   a) 70 Natural FEPs
   b) 107 Waste and Repository FEPs
   c) 58 Human-induced FEPs

2) 91 FEPs Retained for PA and incorporated in Scenarios
   a) Undisturbed Scenarios
      - One undisturbed scenario (the "Base Case")
   b) Disturbed Scenarios
      - Five disturbed performance scenarios

FEPs and Scenario Development

- All retained FEPs are accounted for in PA in at least one scenario.
- FEPs can be included by explicit modeling or by parameter assignment.
- Base-case FEPs are included in all scenarios
  - Creep closure
  - Brine flow, gas generation
- Disruptive FEPs are included in disturbed scenarios.
  - Drilling, mining, brine pocket encounter

FEPs Basis Management

- **FEPs are now evaluated for every change to the compliance basis**
  - **Proceduralized**
  - **Systematic**
  - **Documented**

- **Changes to FEPS basis are justified, documented, and incorporated into performance scenarios as appropriate**

Conclusion

- **Any meaningful performance assessment must begin with a complete list of FEPs**
- **Well-defined screening criteria must be used**
- **FEPs screening must be well documented**
- **FEPs basis must be maintained and updated throughout the life of the project**

Group Activity

- Brainstorming Exercise on FEPs