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

YUCCA MOUNTAIN PROJECT

# Decision Analysis Process Used to Develop the Performance Confirmation Program

## Phase 1 – Parameter and Activity Evaluation

Presented to:
**Nuclear Regulatory Commission**
**February 26, 2002**
**Las Vegas, NV**

Presented by:
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# The decision analysis approach separates parameter from portfolio evaluation

- **The Performance Confirmation Program consists of a "portfolio" of parameters and activities**
  - A set of specific activities designed to monitor or test performance confirmation parameters
  - An activity is a combination of a performance confirmation parameter and a data acquisition method
- **The best portfolio does not necessarily result from simply including the top ranked activities**
  - There may be objectives or goals for a performance confirmation program that are unrelated to the specific activities included
  - There can be interactions among activities that make it more or less desirable to include two specific activities together
- **However, the value of the portfolio depends at least in part on the value of the specific components of that portfolio.**
- ***Evaluating the individual activities is a prerequisite to evaluation of portfolios***

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# Approach

## Phase 1: Parameter evaluation for Performance Confirmation

- Define parameter evaluation criteria
- Develop list of candidate activities
- Use technical judgment to evaluate candidate activities in terms of how well they meet the evaluation criteria
- Combine technical judgments of activities with formal management value judgments about the importance of the criteria, to obtain an overall "utility"or figure of merit for using each activity as part of a performance confirmation program

## Phase 2: Portfolio development and evaluation

- Define portfolio "philosophies"
- Use criteria and results of Phase 1 to develop candidate "portfolios", which are alternative definitions of the Performance Confirmation Program
- Evaluate the cost and robustness of each portfolio
- Select a portfolio of activities as the Performance Confirmation Program for the license application

# Decision Analysis valuation philosophy

## The Decision Analysis approach

- Provides a consistent, logical, defensible basis for evaluating and comparing activities considered for inclusion in the Performance Confirmation program
- Explicitly acknowledges that tradeoffs among different objectives and goals may be necessary
- Bases the evaluation on :
  - the potential impacts of including the parameter on the key objectives of the Program ("technical judgments")
  - the relative importance and value of achieving those objectives ("management value judgments")
  - Combining technical judgments and management value judgments yields a "utility," or overall estimate of the value of including the potential activity
- Facilitates documentation of the technical and management basis for the selected portfolio of activities

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# The technical basis for the approach is formal multi-attribute utility analysis

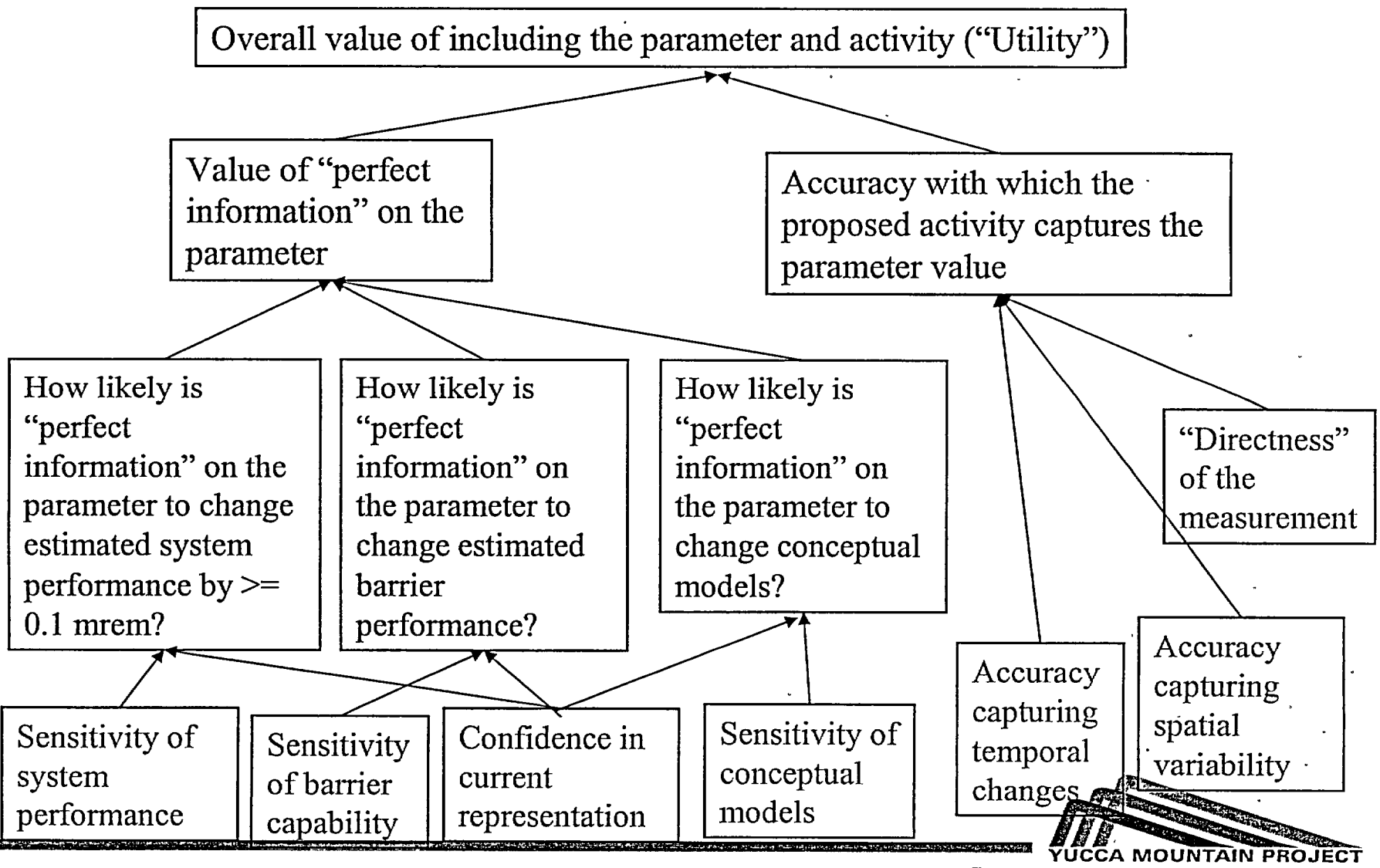
- **A technically sound mathematical approach for evaluating alternatives where more than one objective is important.**
- **Has been used by DOE, other federal agencies, and private companies since the late 1970s to evaluate complex decision problems**
- **The five-step process for implementing multi-attribute utility analysis:**
  - Define the objectives of the decision-maker(s), and develop metrics to measure performance against those objectives
  - Evaluate how each alternative performs against each objective
  - Assess tradeoffs: value functions and weights
  - Combine value functions and technical evaluation to estimate the overall value of each alternative
  - Use the combined evaluation results to support decision making (consider the appropriate decision rule, the quality of information, the comprehensiveness of the analysis, etc).

# Parameter evaluation criteria

- **At an initial Workshop (Aug 26, 2002), an expanded core team developed three criteria to be used in developing technical judgments of the potential impact of a performance confirmation activity on the performance confirmation program:**
  - Barrier capability & system performance sensitivity to the parameter
  - Confidence in the current representation of the parameter
  - Accuracy with which the proposed activity measures or estimates the parameter

- **Workshop participants included**
  - Technical investigators with various areas of expertise
  - Performance assessment analysts and managers
  - DOE staff

# Estimating the utility of a specific activity



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# A detailed set of questions was developed around each of the criteria

- **The goal of the questionnaire was to elicit technical input on how well proposed parameters and activities meet the three criteria**
  - Detailed questions and "scales" are also necessary to allow managerial value judgments to be applied consistently to the technical judgments
- **The goal of questionnaire was improve consistency across model areas**
  - Technical judgments about sensitivity, confidence, and accuracy must be made by the relevant technical experts most familiar with the model areas
  - Unaided or ad hoc evaluation of parameters by different individuals typically result in vastly different interpretations of the criteria
  - A single consistent set of questions reduces inter-individual variations in interpretation

# Workshops were held to develop candidate activities and distribute the questionnaire

Technical judgments

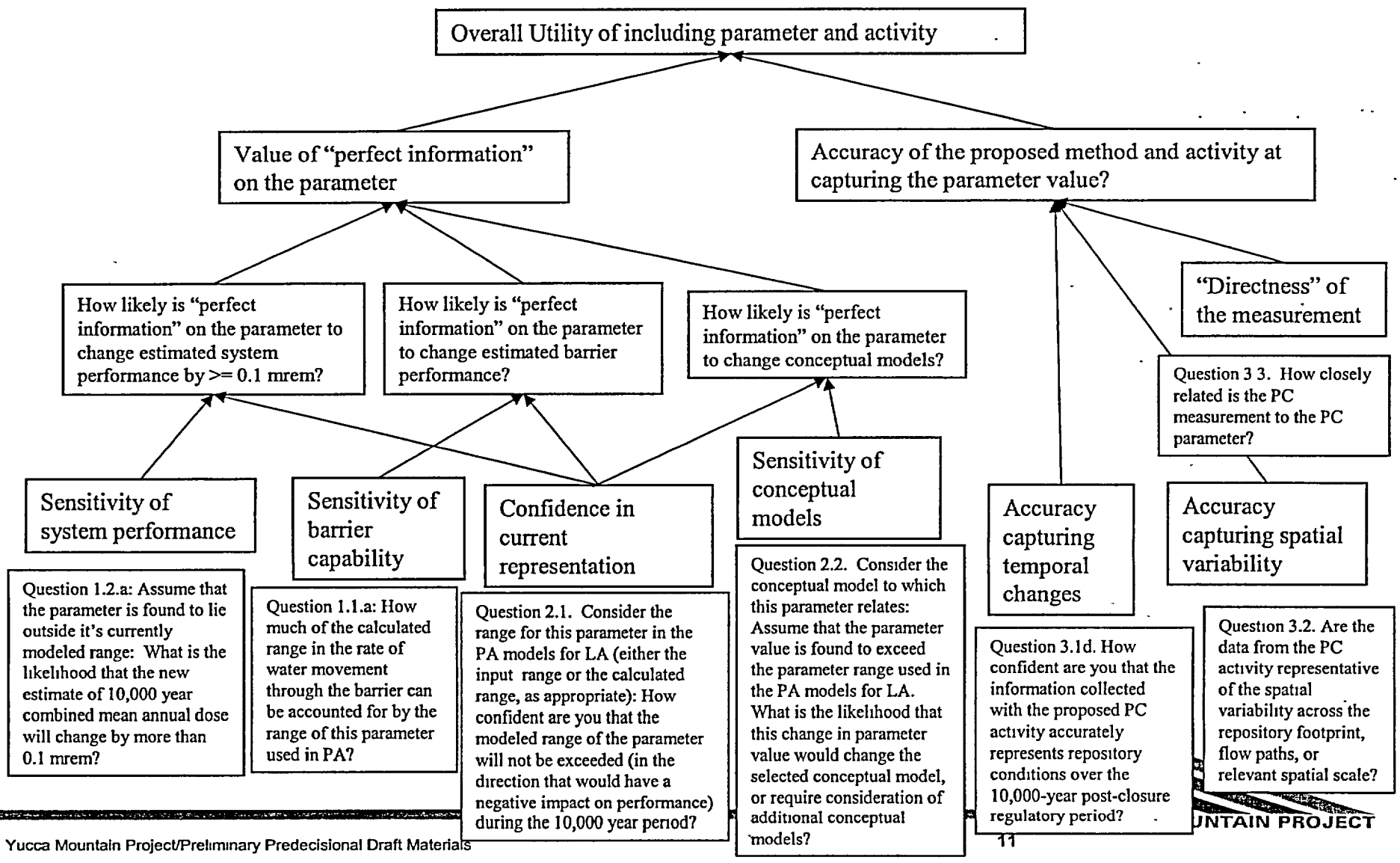
- **Workshops were held in September 2002 with each group of technical experts**
  - Technical investigators and TSPA modelers familiar with each barrier, with total system evaluations, and with disruptive events analyses
- **During the workshops**
  - Each group developed a comprehensive list of parameters to be considered
  - For each parameter identified, the group defined one or more data acquisition methods that could be implemented to provide information on that parameter
  - Several activities were evaluated in each workshop by the group, using the questionnaire

# Parameters were evaluated in small group meetings

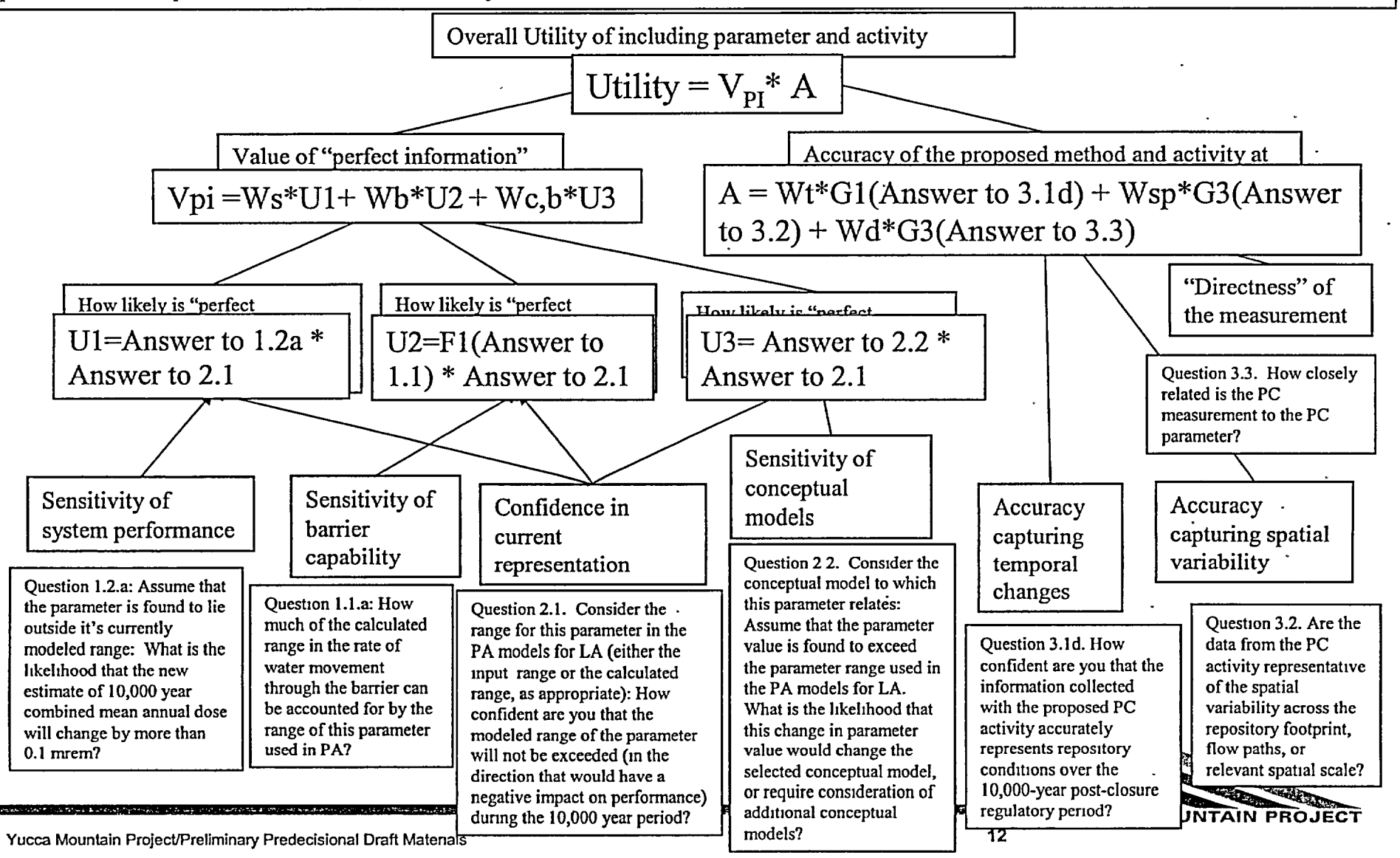
Technical judgments

- **After the workshops (Oct-Dec 2002)**
  - The technical experts used the questionnaire to specify their technical judgments on each activity within their area of expertise
  - A subset of the core team specified their technical judgments on each proposed activity across all model areas, to provide a consistency check
- **Differences in the technical judgments by the two groups were identified and then reconciled**
  - When differences in "utility scores" calculated from the evaluations differed significantly, individual scores were discussed and reconciled until the differences in the evaluations were relatively small
    - "significant" differences in utility were defined as differences larger than 10% of the difference in score between the highest and the lowest scored activities
  - The few differences which could not be resolved during discussions were reviewed and resolved by a knowledgeable senior manager

# Technical judgments: use of the questionnaire



F1 extrapolates answer to question 1.1 to estimate the likelihood that information a parameter value outside the currently modeled range would impact barrier capability
W's are management weights, Ws is the weight for total system impact, Wb for barrier, Wc,b for conceptual model impact (barrier specific), Wt for temporal changes, Wsp for spatial representativeness, and Wd for directness of measurement
G1, G2, and G3 are management value functions, translating the answers to questions 3.1, 3.2, and 3.3 to values
Vpi = the value of "perfect information, A = accuracy



# Performance Assessment managers provided the necessary management value judgments

Management value judgments

- Two elicitation workshops were held
- Managers reviewed the overall process and endorsed the specific criteria being used to evaluate parameters and methods
- Managers answered a series of tradeoff questions, designed around the technical questions used in the questionnaire, to establish management value judgments about the relative importance of the criteria
- Management value judgment used in conjunction with the technical judgments to establish the overall utility for each activity

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# Example management value judgment for the technical judgment question on spatial variability (1 of 2)

Management value judgments

- **Participants reviewed the descriptions of the degree of confidence technical investigators may have that the measurements capture the spatial variability of the parameter - that is, the choices available for "technical judgment" of this question**

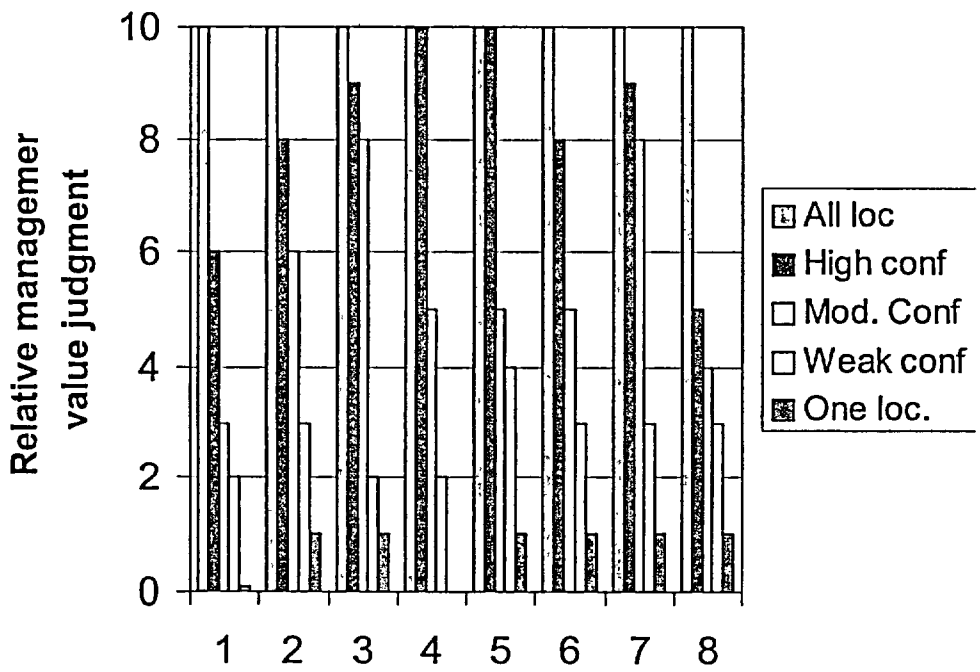
3.2.a. Are the data from the PC activity representative of the spatial variability across the repository footprint, flow paths, or relevant spatial scale?

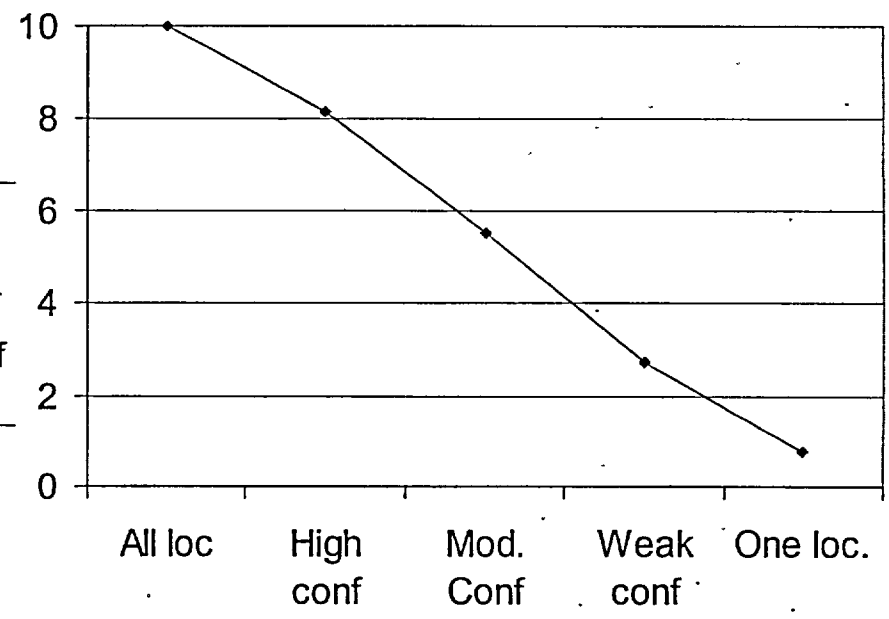
| | |
|---|---|
| A | The data measure a parameter over all locations across the relevant spatial scale. |
| B | The data measure a parameter over representative locations we are *highly confident* represent the spatial variability across the relevant spatial scale. |
| C | The data measure a parameter over representative locations we are *moderately confident* represent the spatial variability across the relevant spatial scale. |
| D | The data measure a parameter over representative locations we are *weakly confident* represent the spatial variability across the relevant spatial scale. |
| E | The measurement give no information on the known spatial variability of the parameter across the relevant spatial scale and only measures a single (or non-representative few) location(s) |

# Example management value judgment for the technical judgment question on spatial variability (2 of 2)

Management value judgments

- Participants discussed the scale and assigned each of the five levels a weight indicative of relative accuracy of the measurement
  - 8 participants
  - Rankings highly consistent
  - Average of the relative weights of the 8 participants used



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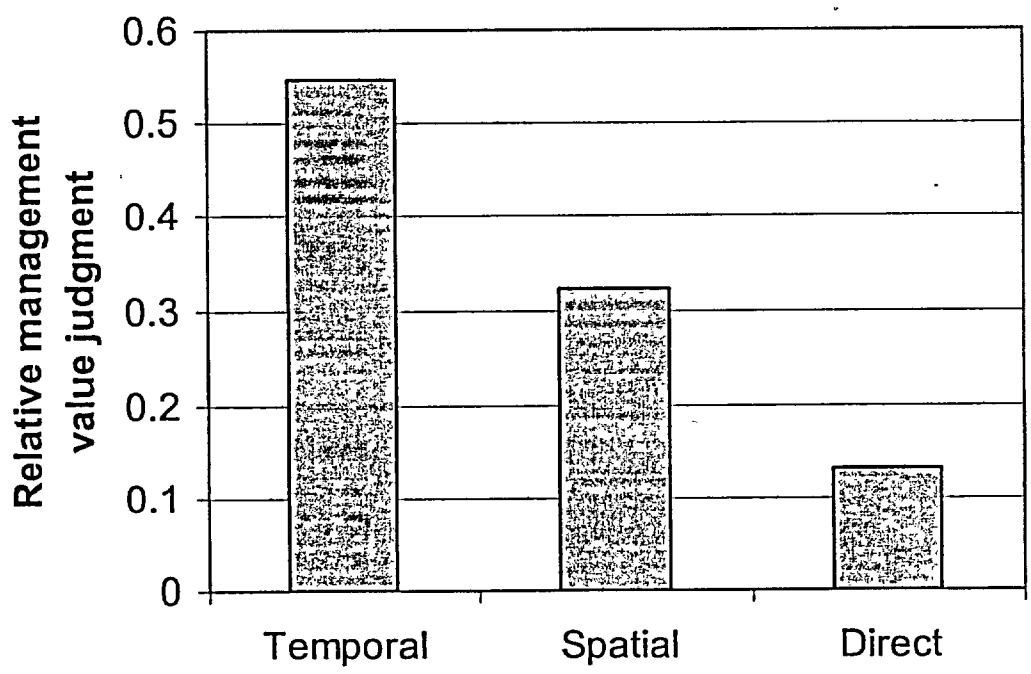
# Example management value judgment : Accuracy

Management value judgments

- "Value of perfect information" on a parameter was scaled by the estimated accuracy of the activity
- The three technical judgment aspects of accuracy were weighted by the management value judgements shown below:

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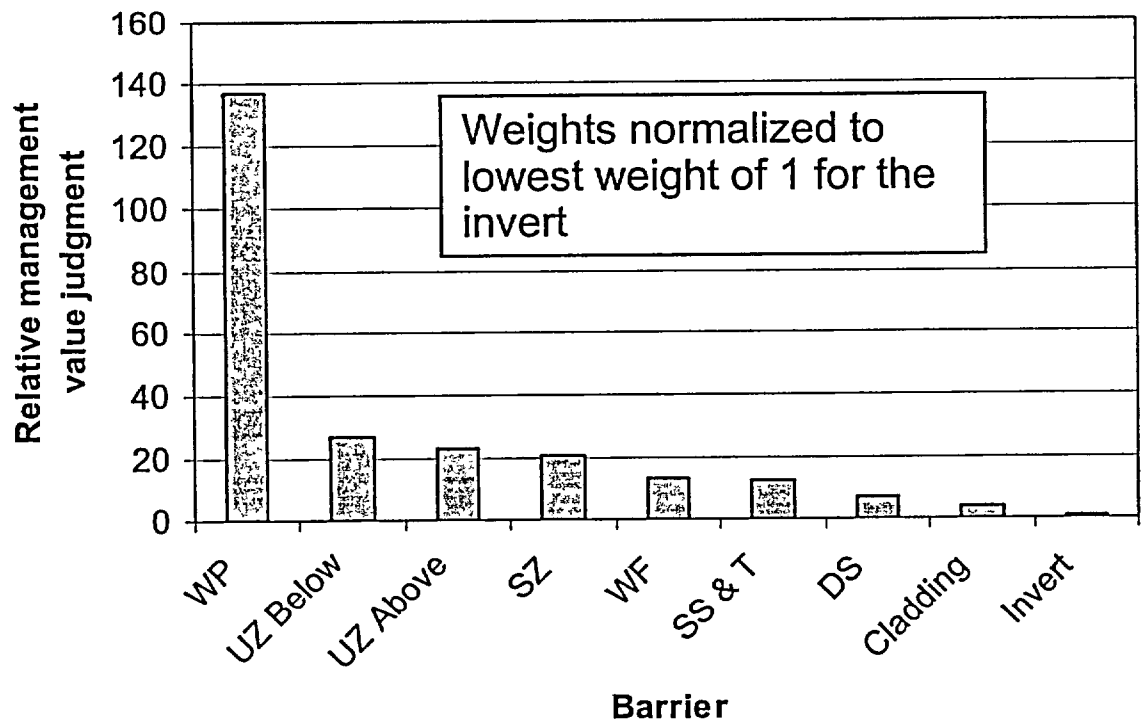
# Management value judgments related to barrier capability

Management value judgments

- The contribution of "sensitivity to barrier capability" to total utility depends in part on the relative value assigned to each of the nine barriers
- Performance assessment managers assigned weights to each of the barriers, based on judgment:




- Informed by the risk prioritization report and the "one on" analyses
- Informed by discussions of barrier capabilities

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Cost estimation

# Costs for each activity

- **Understanding both the benefits and the costs of a candidate activity is an essential component of the decision making process**
  - Including activities based solely on maximizing "benefit" may result in a highly cost-ineffective program
  - Including activities based solely on minimizing costs may leave highly valuable activities out
- **Costs are a consideration in developing portfolios, for example**
  - Cost synergies may make combinations of activities more attractive
  - Costs can be a factor in deciding between otherwise equal activities

# Review

- 237 parameters and a total of 360 activities initially identified
- After discussion and evaluation, 204 parameters and 287 total activities remained
- A review meeting was held with representatives of the technical experts who provided input
- Technical experts indicated where they thought the results did not reflect their technical opinions, and comments were carried forward to the portfolio development phase

# Example parameters and activities

| Parameter | Activity | Barrier (B) |
|---|---|---|
| Perforated fraction of Cladding at closure | Stay abreast of literature | Cladding |
| Waste Form dissolved concentration limits Tc dissolv. conc. limits/ Tc | Lab tests | WF |
| Composition and physical characteristics of the invert (incl mineralogy) | Testing On-site, prior to WP emplacement | Invert |
| Composition and physical charact.of the invert (incl mineralogy) | Off-footprint activities (lab tests) | Invert |
| Temperature/RH of Waste Package | Temp/RH of exit air at exits to regular drifts | WP |
| Temperature/RH of Waste Package | Using instruments within regular emplacement drifts | WP |
| Temperature/RH of Waste Package | Using instruments within an accelerated thermal drift | WP |
| Temperature/RH of Waste Package | Using an ROV to take periodic measurements within an accelerated thermal drift | WP |
| Temperature/RH of Waste Package | Using an ROV to take periodic measurements within regular emplacement drifts | WP |
| Temperature/RH of Waste Package | Temp/RH of exit air at an accelerated thermal drift | WP |
| Hydrologic Properties of Fractures, TSw (porosity, permeability) | Air-permeability testing in different repository areas, gas tracer testing in a few locations, liquid release tests in different locations above drifts, laboratory testing of moisture retention, testing after drift construction, but before emplacement | UZ Above, UZ Below |

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# Path Forward and Documentation

Presented to:
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February 26, 2003
Las Vegas, Nevada

Presented by:
Deborah Barr, DOE
Office of Repository Development, Office of License Application and Strategy

# Path forward

- **Choose a Portfolio for the Performance Confirmation Program to carry forward to Licensing**
  - March 2003
- **Update the Performance Confirmation Plan**
  - Rev. 2, May 2003
  - Rev. 3, January 2004

# Performance Confirmation Plan, Rev. 2

- **Rev. 2 will contain:**
  - Process used to evaluate candidate parameters and portfolios
  - Parameter list and activities evaluated
  - Portfolios developed and evaluated
  - Selected portfolio
  - Mapping of parameters and activities to 10 CFR 63, Subpart F
  - Appendices will contain some supporting technical detail

# Performance Confirmation Plan, Rev. 3

- **Rev. 3 will contain:**
  - Development of the monitoring or testing details for each activity
  - Preliminary information on:
    - Compliance ranges
    - Deficiency reporting
    - Expected ranges for test parameters
  - Additional information on the program management and administration topics (procedures and data management)

# Summary

- **DOE is in the process of restructuring the Performance Confirmation Program to:**
  - address barriers important to waste isolation
  - reflect a risk-informed, performance-based approach
- **A rigorous decision analysis process is being used**
- **A number of possible Performance Confirmation programs (portfolios) were developed using this method**
- **DOE is in the process of selecting the Performance Confirmation program for Licensing**
- **Revisions of the Performance Confirmation Plan are scheduled**

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# PC Parameter Evaluation Questionnaire

(updated 9/26/02)

NOTE: This questionnaire is intended for use by subject matter experts who have participated in the interactive PC Parameter Evaluation workshops September 18, 20, 24, and 25, 2002 at the BSC offices in Summerlin, Nevada. It is not meant as a stand-alone document, and can not be used effectively without the accompanying verbal discussion and group interaction planned at the meetings. Some revisions and refinements have been made to the questionnaire in response to comments received during those workshops. Future documentation will expand the detailed discussion of each of these questions.

## Developing a list of candidate PC parameters and methods

The first step in this process is to identify the candidate PC parameters, and the potential PC methods and activities associated with those parameters. The first goal of the meetings in late September is to develop a list of candidate parameters.

For the purposes of these workshops, *parameters* are "things that can be measured or observed" which are candidates for inclusion in the PC program (e.g., they can be model inputs, model outputs, intermediate results, etc...). *PC methods or activities* are the individual monitoring or testing activities, focused on a specific parameter (or parameters). Every PC method or activity is expected to fall roughly into one of the following five categories:

- Pre-emplacement mapping, sampling, and inspection
- Continuous monitoring of preclosure evolution
- Dedicated thermal drift with accelerated thermal cycle
- Mobile-based monitoring (e.g., remotely operated vehicle)
- Off-footprint testing and monitoring (i.e., laboratory testing of corrosion rate and monitoring of industry trends for reported cladding condition).

A matrix of candidate parameters and potential PC methods was compiled during each of the meetings in late September – the final version of that matrix from each meeting has been distributed to the workshop participants. Every parameter/method combination on that matrix is to be evaluated using this questionnaire. Note that in some workshops, only the parameter lists were discussed in detail, without a complete set of associated methods or activities. Participants will need to identify one or more activities suitable for those parameters where activities were not yet identified.

During the evaluation process, if you find you need to make changes, refinements, or clarifications to either the parameter definition or the specification of the PC activity, please document that change.

## Purpose of the questionnaire

The "value" of including a specific parameter/method in the PC Program is a function of

- The *sensitivity* of barrier capability and system performance to the parameter
- The level of *confidence* you have in the current parameter representation
- The *accuracy* of the proposed PC method at measuring or estimating the parameter value
- The *cost* of implementing the PC method

The questions herein ask you to evaluate each parameter and method according to these four attributes. Those evaluations will be combined with managerial value judgements about the importance of each of those attributes to determine the overall technical value of using the PC method/activity to measure or estimate the parameter. However, these are not the only things that are important or that will be considered in developing that Program; a number of other higher level criteria have been and are being identified that are important to consider when developing the PC Program. For example, tests explicitly mentioned in 10 CFR 63 must be included, at least one method to address each barrier will be included, and so on. Ultimately, the technical value defined by the answers to these questions will be combined with the higher-level criteria to develop the PC program.

## Instructions for completing the questionnaire

The questions below are organized in the manner of a "flow chart," so that you are guided to answer only those questions that are relevant for the parameter/method being considered. At the back of this form is an "Evaluation summary sheet" for recording your answers to the questions.

The questions are organized so that questions about the parameter come first (Part A) and questions about the PC activity come second (Part B). It is much easier to answer the questions if you are very clear about what parameter and what PC activity you are evaluating. If there are several viable and promising PC activities that could address a specific parameter, you can answer the questions in Part B several times, once for each PC activity. Use as many summary sheets as you need to.

If after completing the evaluation you feel that the questionnaire and your answers do not accurately reflect the potential value of including a PC parameter, please add any text comments that you believe are relevant to the value of including the parameter. You can use the back of the evaluation summary sheet or a separate document.

## Part A. Questions about the parameter

What parameter is being considered? (fill in on summary sheet)

| |
|---|
| |

For disruptive events, skip to question A2.

**A1.** What barrier(s) does the parameter relate to?

| | |
|---|---|
| 1 | Surficial Soils and Topography |
| 2 | Unsaturated Rock Units Above the Repository |
| 3 | Unsaturated Rock Units Below the Repository |
| 4 | Saturated Zone Rock Units |
| 5 | Drip Shield |
| 6 | Waste Package |
| 7 | Cladding |
| 8 | Waste Form |
| 9 | Invert |
| 10 | Parameter does not relate to a barrier → Go to A2 |

**A2.** If the parameter does not relate to a specific barrier, does it relate to any of the following?

| | |
|---|---|
| A | Biosphere |
| B | Igneous activity |
| C | Seismic activity |
| D | Radionuclide inventory |

### Section 1. Sensitivity of barrier capability and system performance to the parameter

For disruptive events, skip to Question 1.2.a.

1.1. Does the candidate parameter relate to the capability of a specific barrier to limit movement of water or radionuclides?

- ☐ No → Go to Question 1.2
- ☐ Yes → Continue below

Each question on the following page asks you to think about the impact of the candidate parameter on one of the fundamental capabilities of a barrier. The questions ask how much of the current uncertainty in barrier capability can be tied to uncertainty or variability in the candidate parameter.

The following table provides a guideline to help determine which questions are relevant for each barrier; use this table to determine which questions you need to answer.

10 CFR 63.102(h) requires natural and engineered barriers

| | | Natural Barrier | Engineered Barrier |
|---|---|---|---|
| 10 CFR 63.2 defines barrier attributes | **Substantially reduce water flow (Question 1.1.a.)** | Surficial Soils<br>UZ Above<br>UZ Below<br>SZ | Drip Shield<br>Waste Package<br>Cladding |
| | **Substantially reduce rad. transport (Question 1.1.b)** | UZ Below<br>SZ | Waste Package<br>Cladding<br>Invert |
| | **Substantially reduce rad. release rate (Question 1.1.c.)** | UZ Above (chemistry set by rock minerals) | Cladding<br>Waste Form |

Use the scale to the right to answer whichever of the following three questions is relevant (from the table on the previous page). If the question does not apply to the parameter, enter a score of "A" on the Evaluation Summary Sheet or leave it blank.

1.1.a. How much of the calculated range in the rate of water movement through the barrier[1] can be accounted for by the range of this parameter[2] used in PA[3]?

1.1.b. Consider the retardation of radionuclide movement within this barrier: How much of the calculated range in the rate of radionuclide movement *relative to water movement*[4] through the barrier can be accounted for by the range of this parameter[2] used in PA[3]? (i.e., the range in the calculated retardation factor)

1.1.c. How much of the calculated range in the radionuclide release rate[5] can be accounted for by the range of this parameter[2] used in PA[3]?

Scale for recording the sensitivity of barrier capability to the parameter

| | |
|---|---|
| **A** | NA or no change (parameter is not related to the barrier capability) |
| **B** | 90% to 100% of the full calculated range in PA |
| **C** | About 75% of the full calculated range in PA |
| **D** | About 50% of the full calculated range in PA |
| **E** | About 25% of the full calculated range in PA |
| **F** | 10% or less of the full calculated range in PA |

[1] Water flow at the barrier exit integrated over a time step and spatial grid block in the TSPA.
[2] For bounded parameters, the parameter range is the full range used in PA; for unbounded parameters (e g , Normal or other distribution) the parameter range is defined as the 5th to 95th percentiles.
[3] PA includes all the performance assessment models, and for the purposes of this questionnaire, refers to the PA models that will be used to support the license application
[4] Transit time across the barrier for a significant fraction of the radionuclides divided by transit time of a significant fraction of the water
[5] For a significant fraction (in terms of dose potential) of the radionuclides Include dose potential of radionuclides that would contribute dose if they were not retained by the barrier.

1.2.a. *Assume the parameter value is found to lie outside it's currently modeled range.* Use the scale below to estimate the likelihood that the new estimate of 10,000-year combined (nominal plus disruptive) mean annual dose changes **more than 0.1 mrem.**

Note: For disruptive events, estimate the likelihood that changes in the value of the candidate parameter could result in an increase in the estimated 10,000-year combined mean annual dose of more than 0.1 mrem

| | |
|---|---|
| **A** | More than 1 chance in 10 |
| **B** | Between 1 chance in 100 and 1 chance in 10 |
| **C** | Between 1 chance in 1000 and 1 chance in 100 |
| **D** | Between 1 chance in 10,000 and 1 chance in 1000 |
| **E** | Between 1 chance in 100,000 and 1 chance in 10,000 |
| **F** | Less than 1 chance in 100,000 |

## Section 2. Confidence in parameter representation

2.1. Consider the range for this parameter in the PA models for LA (either the input range or the calculated range, as appropriate): How confident are you that the modeled range of the parameter will not be exceeded (in the direction that would have a negative impact on performance) during the 10,000-year period?

| | |
|---|---|
| **A** | <10% confident |
| **B** | <50% confident, but >10% confident |
| **C** | <90% confident, but >50% confident |
| **D** | >90% confident |

2.2. Consider the conceptual model(s) to which this parameter relates*: Assume the parameter value is found to exceed the parameter range used in the PA models for LA*: what is the likelihood that this change in the parameter value would change the selected conceptual model, or require consideration of additional conceptual models?

| | |
|---|---|
| **A** | More than 1 chance in 5 |
| **B** | Between 1 chance in 10 and 1 chance in 5 |
| **C** | Between 1 chance in 100 and 1 chance in 10 |
| **D** | Between 1 chance in 1000 and 1 chance in 100 |
| **E** | Between 1 chance in 10000 and 1 chance in 1000 |
| **F** | Less than 1 chance in 10000 |

## Part B. Questions about the PC activity/method for this parameter

If there is more than one potential PC activity that addresses this parameter, answer the questions in Part B separately for each activity Use additional evaluation summary sheets as needed.

***Briefly* describe the proposed PC activity being evaluated? (on the summary sheet)**

**B1.** What is the degree of ease of obtaining relevant data using this approach?

| | |
|---|---|
| **A** | Can be obtained in a single measurement, in a shirtsleeve environment |
| **B** | Can be obtained by automated equipment accessible in a shirtsleeve environment |
| **C** | Can be obtained in intermittent long-term measurements, in a shirtsleeve environment |
| **D** | Can be obtained in a single measurement, by humans wearing PPE |
| **E** | Can be obtained by automated equipment accessible by humans wearing PPE |
| **F** | Can be obtained in intermittent long-term measurements, by humans wearing PPE |
| **G** | Can be obtained by ROV using current instrumentation technology |
| **H** | Can be obtained by ROV using instrumentation to be developed during the PC program |
| **I** | Cannot be obtained using existing technologies |

**B2.** How long will the proposed PC activity take? For PC activities that involve several iterations of a test or measurement over a time period, we need two estimates (using the same scale).

*B2a How long will a single test or measurement take?*

*B2b Over what time period will the testing/measuring continue?*

For example a PC activity that involves taking simple measurements annually over the entire performance confirmation period would be evaluated as an "A" for the first part and "E" for the second part.

For PC activities where a single test or measurement continues for the entire duration of the activity, the answers to these two questions will be the same.

| | |
|---|---|
| **A** | Less than 6 months |
| **B** | 6 months to 1 year |
| **C** | 1 to 3 years |
| **D** | 3 to 10 years |
| **E** | more than 10 years |

## Section 3. Accuracy of the proposed method in verifying the parameter

3.1. The four questions below ask about the temporal evolution of the parameter and the ability of the proposed activity to track and/or predict that evolution.

3.1.a. How is the parameter value expected to change or vary over the pre-closure period (due to natural evolution or characterization, construction, operations, or emplacement of wastes)?

| | |
|---|---|
| A | Parameter is static during the pre-closure period → Go to Question 3.1.c. |
| B | Parameter is expected to evolve during the pre-closure period due to natural evolution alone→ Continue below |
| C | Parameter is expected to evolve during the pre-closure period due to repository activities alone → Continue below |
| D | Parameter is expected to evolve during the pre-closure period due to both natural evolution and repository activities → Continue below |

3.1.b. Will the proposed PC activity track the changes in the parameter value during the pre-closure period?

- ☐ No
- ☐ Yes

3.1.c. How is the parameter value expected to change or vary during the 10,000 year post-closure period (due to natural evolution or characterization, construction, operations, or the presence of wastes)?

| | |
|---|---|
| A | Parameter is static during the 10,000 year post-closure regulatory period → Go to Question 3.2 |
| B | Parameter is expected to evolve during the 10,000 year post-closure regulatory period due to natural evolution alone→ Continue below |
| C | Parameter is expected to evolve during the 10,000 year post-closure regulatory period due to repository activities alone→ Continue below |
| D | Parameter is expected to evolve during the 10,000 year post-closure regulatory period due to both natural evolution and repository activities→ Continue below |

3.1.d. How confident are you that the information collected with the proposed PC activity accurately represents repository conditions over the 10,000-year post-closure regulatory period?

| | |
|---|---|
| **A** | We have *high confidence* that relevant time-dependent processes for the repository are captured in the measurement. Examples that would indicate high confidence include: (a) the PC measurement captures data from a closely related analogue system over time frames on the order of 10,000 years, (b) the PC measurement estimates the parameter changes by accelerating the time history, and that acceleration captures the relevant changes. |
| **B** | We have *moderate confidence* that relevant time-dependent processes for the repository are captured in the measurement. Examples that would indicate moderate confidence include: (a) the PC measurement captures data from loosely related analogue systems over time frames on the order of 10,000 years, (b) the PC measurement captures data from a closely related analogue system, but over time frames much greater than or much less than 10,000 years, (c) the PC measurement estimates the parameter changes by accelerating the time history, which causes the candidate parameter to change in a similarly representative manner to how it is expected to evolve in the repository environment. |
| **C** | We have *weak confidence* that relevant time-dependent processes for the repository are captured in the measurement. Examples that would indicate weak confidence include: (a) the PC measurement captures data from loosely related analogue system over time frames not representative of the 10,000 regulatory period, (b) the PC measurement estimates the parameter changes by accelerating time history, which causes the candidate parameter to change significantly differently than it is expected to evolve in the repository environment. |
| **D** | The PC measurement is designed to estimate post-closure changes through simple extrapolation of pre-closure measurement. |

3 2. Is the parameter value expected to vary over the repository footprint, the SZ flow paths, or other relevant spatial scale?

- ☐ No → Go to question 3.3
- ☐ Yes → Continue below

3.2 a Are the data from the PC activity representative of the spatial variability across the repository footprint, flow paths, or relevant spatial scale?

| | |
|---|---|
| **A** | The data measure a parameter over all locations across the relevant spatial scale. |
| **B** | The data measure a parameter over representative locations we are *highly confident* represent the spatial variability across the relevant spatial scale |
| **C** | The data measure a parameter over representative locations we are *moderately confident* represent the spatial variability across the relevant spatial scale. |
| **D** | The data measure a parameter over representative locations we are *weakly confident* represent the spatial variability across the relevant spatial scale. |
| **E** | The measurement give no information on the known spatial variability of the parameter across the relevant spatial scale and only measures a single (or non-representative few) location(s) |

3 3. How closely related is the PC measurement to the PC parameter?

| | |
|---|---|
| **A** | The proposed measurement directly measures the parameter |
| **B** | The proposed measurement is a widely-accepted and accurate surrogate for the parameter. Small uncertainties, noise, or errors in the measurement lead to an equally small range in the calculated parameter value. |
| **C** | The proposed measurement is closely related to the parameter of interest. Small uncertainties, noise, or errors in the measurement lead to a somewhat larger range in the estimated parameter value. |
| **D** | The proposed measurement is indirectly related to the parameter, and is several calculations removed from the parameter of interest. Small uncertainties, noise, or errors in the measurement lead to a large range in the calculated parameter value. |