

**ITERATIVE PERFORMANCE ASSESSMENT (IPA)
PHASE 2.5**

**EXPERT JUDGMENT ELICITATION
FUTURE CLIMATE AT YUCCA MOUNTAIN**

**Center for Nuclear Waste Regulatory Analyses
Aaron DeWispelare**

**Presented to
NWTRB—January 11, 1996**



OVERVIEW

- **Motivation**
- **Description of Elicitation Process**
- **Summary of Results**
- **Observations and Lessons Learned**

MOTIVATION

- **NRC Expects Use of Expert Elicitation in HLW Repository Program because**
 - **For Selected Areas, it Will Be a Significant Source of Some Information**
 - **State of Science**
 - **Complexity of Issues**
 - **Data Otherwise not Obtainable**
 - **For Other Areas, it May Complement Other Information**

OBJECTIVES

- **Acquire Expertise in the Expert Elicitation Process to aid in Reviews of DOE's use of Expert Elicitation and Contribute to the Development of Guidance**
- **Apply Formal Expert Elicitation Techniques for Estimation of Future Climate in the Yucca Mountain Vicinity**
- **Investigate Techniques for Aggregation of Opinion for Expert Panels**
- **Provide Information for Potential Use in Future NRC Iterative Performance Assessment Analyses**

A FORMAL EXPERT ELICITATION WAS SELECTED FOR FUTURE CLIMATE

- **The Current State of Climate Science and Modeling Provide Limited Sub-Regional Long-Term Projections Based on Historic or Current Meteorologic Data**
- **The Uncertainties Associated with Future Climate are Large Considering Climate Variance During the Quaternary Period, and the Climate Impact on Infiltration can Potentially Dominate Repository Performance**
- **There are Many Conceptual Approaches Extant; Ranging From General Circulation Models Conditioned with Combinations of Past and Present Meteorologic Data, to Energy Balance Models Based on Current Physical Data, to Empirical Historic Data Used to Establish Past Conditions**
- **The Published Record Contains a Variety of Data and Opinion That Establish Various Bounding Limits, Some of Which Have Been Interpreted to be Conservative**

● STEPS IN FORMAL EXPERT JUDGMENT ELICITATION ● PROCEDURE USED

- 1. Determine the Objectives and Goals of the Elicitation**
- 2. Recruit/Select the Subject-Matter Experts**
- 3. Identify the Issues and Information Needs**
- 4. Provide Information to the Subject-Matter Experts**
- 5. Discuss and Refine the Issues**
- 6. Provide a Multi-Week Study Period**
- 7. Conduct the Elicitation Training Session**
- 8. Conduct the Elicitations**
- 9. Provide Post-Elicitation Feedback to the Subject-Matter Experts**
- 10. Aggregate the Experts' Judgements**
- 11. Document the Process and Results**

ELICITATION TEAM MEMBERSHIP

- **NRC Lead:** — **Jim Park (NMSS)**
- **Principle Investigator:** — **Aaron DeWispelare (CNWRA)**
- **Normative Experts:** — **Robert Clemen (University of Oregon),
Tandy Herren (SwRI)**
- **Generalists:** — **Mike Miklas (CNWRA),
Jim Norwine (Texas A&I),
Berge Gureghian (CNWRA)**
- **Subject-Matter Experts:** — **Randall Cerveney (ASU),
Henry Diaz (NOAA),
Peter Robinson (UNC),
Tom Wigley (UCAR),
Cort Willmott (UD)**

SUBJECT-MATTER EXPERT SELECTION PROCESS

- **Nominations From Professional, Academic Societies**
 - **National Academy of Science, National Center for Atmospheric Research, Sigma XI Scientific Research Society, American Meteorological Society, American Quaternary Association, American Geophysical Union, Friends of the Pleistocene, Association of American Geographers**
 - **Received 42 Nominations**
- **Screen Nominees**
- **Nominees Rated Each Other**
- **Correlated Responses**
 - **Consensus of Rating for First Eight Candidates**
- **Panel of Five Selected out of First Eight Candidates**

ELICITATION PROCESS

- **Issue Statement Developed Through Interactions Among Staffs and Management at NRC/CNWRA, IPA Modelers, Climatology Consultants, Elicitation Team**
- **Expectations Defined**
 - **Documented Individual Projections From Each Expert With Associated Rationale**
 - **Probability Distributions for Precipitation, Temperature, Storm Intensity, and Wettest Decade in the Vicinity of Yucca Mountain, Nevada at 100, 300, 1,000, 3,000, 5,000, 7,500, and 10,000 Years in the Future and Included Seasonal Variation, and Incident Solar Radiation Projections**

ELICITATION TRAINING

- **Discussed Decision Making Under Uncertainty**
- **Described Objective Versus Subjective Probabilities**
- **Demonstrated Possible Cognitive Biases**
- **Practiced Making Probability Judgements Using Fractile Method**

RESULTS

- **“Rain Shadow” is Dominant Control for Yucca Mountain Area (Currently and in Next 10000 Years)**
- **Near Term (100–1000 Years) Dominated by Anthropogenic Effects**
 - **Warmer by 20 Percent**
 - **Wetter by 20 Percent**
- **Far Term (5000–10000 Years) Dominated by Solar Radiation (Milankovitch Forcing)**
 - **Cooler by 20 Percent**
 - **Wetter by 100 Percent**
 - **Seasonal Characteristics Continue (Most Precipitation in Winter, Continued Dry Hot Summers)**
- **Some Disagreement on the Long-Term Significance and Duration of the “Greenhouse Effect”**

OBSERVATIONS

- **Individual Elicitations Were Successful**
- **The Fractile Method Was an Effective Technique for Eliciting the Subjective Probability Distributions to Encode Expected Future Climate and Associated Uncertainty**
- **Consensus/Aggregation Session Conducted**
- **Participants Indicated That a Trip to the Site Was Valuable**
- **Participants Indicated That They Had Never Participated in a Formal Elicitation Before, but That They Were Very Impressed With the Rigor and Effectiveness of the Process**
- **Although a Variety of Data and Modeling Techniques Were Used, all Experts Said the Area Will Remain Semi-Arid Over the Next 10,000 Years**

LESSONS LEARNED

- **The Quality of the Resulting Judgments is Strongly Dependent on the Conduct and Consistency of the Elicitations and the Expertise of the Subject-Matter Experts'**
- **A Defensible Process for Selection of the Subject-Matter Experts is Feasible**
- **Training of the Subject-Matter Experts is Essential to a Smooth Elicitation**
- **A Mechanical Aggregation of the Subject-Matter Experts' Judgments Was Easier to Implement Than a Behavioral Aggregation**
- **A Site Visit by the Subject-Matter Experts is Valuable to Facilitate the Interpretation of Data and Research Done in Preparation for the Elicitation**
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