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

YUCCA MOUNTAIN PROJECT

Plans to Address NRC Key Technical Issues

Presented to:
Nuclear Waste Technical Review Board

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Overview

- **Process for resolution of NRC Key Technical Issues (KTIs)**
- **Status of DOE-NRC agreements**
- **Plans to address NRC KTIs**

NRC Sufficiency Review

- **Nuclear Waste Policy Act (NWPA) requires the Secretary's site recommendation to the President to include**
  - **"preliminary comments of the Commission concerning the extent to which the at-depth site characterization analysis and the waste form proposal for such site seem to be sufficient for inclusion in any [license] application to be submitted by the Secretary"**
- **DOE formally requested by letter that NRC provide its sufficiency comments by November 1 (Barrett to Travers, July 3, 2001)**
- **NRC has indicated that its sufficiency review will be based on proposed 10 CFR Part 63, and the available Issue Resolution Status Reports (IRSRs) and acceptance criteria for each KTI**

NRC Key Technical Issues

- **NRC pre-licensing focus is on topics important to evaluation of postclosure repository performance for licensing decisions**
  - **Topics characterized as KTIs**
  - **Progress toward resolution of issues for licensing is reported in IRSRs for each KTI**
- **KTIs cover areas DOE considered during site characterization**
  - **Igneous activity (IRSR Rev 2, 7/99)**
  - **Structural deformation and seismicity (IRSR Rev 2, 9/99)**
  - **Evolution of the near-field environment (IRSR Rev 3, 8/00)**

NRC Key Technical Issues
(Continued)

- Container life and source term (IRSR Rev 3, 1/01)
- Thermal effects on flow (IRSR Rev 3, 11/00)
- Repository design and thermal-mechanical effects (IRSR Rev 3, 9/00)
- Unsaturated and saturated flow under isothermal conditions (IRSR Rev 2, 6/99)
- Radionuclide transport (IRSR Rev 2, 9/00)
- Total system performance assessment and integration (IRSR Rev 3, 9/00)

NRC/DOE Approach to KTI Resolution

- **Technical issues related to each KTI are discussed and agreements for resolution are reached and documented in writing at public Technical Exchanges/Management Meetings**
- **Each KTI is split into sub-issues; the status of sub-issue resolution is determined by NRC**
  - **Closed - DOE approach and available information acceptably address NRC questions (i.e., information likely to be adequate for a license application)**

NRC/DOE Approach to KTI Resolution
(Continued)

- Closed Pending - DOE proposed approach together with additional information DOE agrees to provide acceptably addresses NRC questions (subject to NRC review of additional information); or
- Open - DOE has not yet acceptably addressed NRC questions or agreed to provide necessary additional information identified by NRC

- **Resolution at NRC staff level does not preclude issue being raised in licensing review**

Measure of Success for KTI Resolution and Sufficiency Review

- **Determine whether sufficient information is currently available for DOE to prepare an adequate license application**
- **Identify additional information needed if sufficient information is not currently available**
- **Assess progress against plans and agreements to provide needed information by license application submittal**

KTI Resolution Status

- **Agreements reached with NRC define a path forward for closure of all 37 KTI sub-issues**
  - **Five sub-issues are closed; 32 sub-issues are closed-pending**
- **The 292 KTI agreements reached identify about 240 documents to be submitted and other work to be completed prior to submittal of a possible license application**
  - **67 documents have been formally provided to date**
  - **Total number of documents depends on definition of the appropriate document structure to support a possible license application**
  - **NRC is periodically appraised of progress via formal correspondence and quarterly management/KTI-status meetings**
  - **DOE expects to provide an adequate response to all NRC issues by the time a possible license application is submitted to support a possible licensing proceeding**

Categories of KTI Agreements

- **Provide additional documentation/clarification**
- **Provide additional technical justification**
  - **Additional analysis of existing data**
  - **Additional testing and analysis needed**
- **Each agreement is tied to a specific technical product with a date for completion**

Examples of Work to Support KTI Closure

- **Two potential mechanisms identified that result in calculated dose during the 10,000-year compliance period**
  - **Early waste package failures due to defects - nominal scenario**
  - **Igneous events - disruptive scenario**
- **Examples of additional work DOE agreed to complete to support closure of selected sub-issues for relevant KTIs**
  - **KTI - Container life and source term**
    - **Effects of corrosion processes on container lifetime - focus on testing and analysis activities**
    - **Effects of phase instability and initial defects on mechanical failure and container lifetime - focus on testing and analysis activities**
  - **KTI - Igneous activity**
    - **Consequences of igneous activity**

Example - Container Life and Source Term

- **Sub-issue on effects of corrosion processes on container lifetime - focus on testing and analysis activities**
  - **Corrosion mechanisms and rates**
  - **Fabrication related testing**
- **Sub-issue on effects of phase instability and initial defects on mechanical failure and container lifetime - focus on testing and analysis activities**
  - **Prepare rockfall calculations considering point loading and multiple rock blocks**
  - **Prepare analyses to justify current bounding fracture mechanics approach to calculating mechanical failure of the drip shield**
  - **Perform aging and phase instability studies of Alloy 22, including testing and analysis of solution annealed and induction annealed weld and base-metal samples**

Example - Igneous Activity

- **Two subissues, probability and consequences, both closed-pending**
- **Consistent with proposed 10 CFR part 63, consequences of igneous activity must be evaluated since the probability of an igneous event is greater than 10^{-8}/year**
  - **Mean approximately 1.6×10^{-8}/year**
- **Focus of interactions with NRC is on consequence analysis for a low-probability event**
  - **Potential igneous event currently controls calculated dose during 10,000-year regulatory period**
  - **NRC-proposed event scenarios for magma/waste-package interactions and redistribution of volcanic ash could increase calculated dose to the public**

Example - Igneous Activity
(Continued)

- **Soil suspension effects**
  - **Evaluate conclusion that risk effects due to eolian and fluvial remobilization are bounded by modeling assumptions**
  - **Evaluate whether assumption that concentration of radionuclides on soil particles in air is equivalent to that on the ground underestimates dose**
- **Effects of repository and contents on magma flow, including stress distribution and strain response**
  - **Evaluate how repository structures may affect magma ascent, conduit localization, and evolution of the conduit/flow system**
  - **Evaluate how repository structures could affect magma flow for the duration of an event**
- **Response of waste packages to magmatic conditions**
- **Incorporation of high-level waste in magma**

Plans to Address NRC Key Technical Issues

- **To support NRC's sufficiency review for a possible site recommendation, DOE will need to demonstrate**
  - **Adequate progress toward completion of KTI agreements to provide confidence that the additional information needed for licensing will be available, and**
  - **Adequate plans and progress for resolution of quality assurance implementation issues**
- **Completion of KTI agreements prior to submittal of a possible license application is intended to ensure a complete application and to facilitate NRC acceptance and review of that application**

Summary

- **Process for resolution of KTIs has provided a useful framework for pre-licensing interactions with NRC**
- **It is a public process that has resulted in a clear understanding of NRC's expectations for the information needed to support a potential license application**
- **DOE is committed to address all agreements prior to submittal of a potential license application**

Backup

KTI Meetings

KTI Meeting Subject	Meeting Date
Unsaturated and Saturated Flow	August 16-17, 2000 and Oct 31-Nov 2, 2000
Igneous Activity	August 29-31, 2000 June 21-22, 2001 and September 5, 2001
Container Life and Source Term	September 12-13, 2000
Structural Deformation and Seismicity	October 11-12, 2000
Criticality Issues in all KTIs	October 23-24, 2000
Radionuclide Transport	December 5-7, 2000
Thermal Effects on Flow	January 8-9, 2001
Near-Field Environment	January 9-11, 2001
Repository Design and Thermal-Mechanical Effects	February 6-8, 2001
Total System Performance Assessment & Integration	May 15-17, 2001 and August 6-10, 2001
Range of Repository Operating Temperatures	August 2, 2001 and scheduled September 13-14, 2001
Preclosure Issues	July 24-26, 2001

KTI and Preclosure Sub-Issues and Status

KTI Title (IRSR Revision)	Sub-issue	Status
Igneous Activity (Rev 2)	Probability of future igneous activity	Closed-pending
	Consequences of future igneous activity	**Closed-pending**
Structural Deformation and Seismicity (Rev 2)	Faulting	Closed-pending
	Seismicity	Closed-pending
	Fracturing	Closed-pending
	Tectonic Framework	Closed
Evolution of the Near-Field Environment (Rev 3)	Effects of coupled thermal-hydrologic-chemical processes on seepage and flow	Closed-pending
	Effects of coupled thermal-hydrologic-chemical processes on waste package chemical environment	Closed-pending
	Effects of coupled thermal-hydrologic-chemical processes on chemical environment for radionuclide release	Closed-pending
	Effects of coupled thermal-hydrologic-chemical processes on radionuclide transport through engineered and natural barriers	Closed-pending
	Effects of coupled thermal-hydrologic-chemical processes on potential nuclear criticality in the near field	Closed-pending
Container Life And Source term (Rev 3)	Effects of corrosion processes on the lifetime of the containers	Closed-pending
	Effects of phase instability and initial defects on the mechanical failure and lifetime of the containers	Closed-pending
	The rate at which radionuclides in spent nuclear fuel are released from the engineered barrier subsystem through the oxidation and dissolution of spent nuclear fuel	Closed-pending
	The rate at which radionuclides in high-level waste glass are released from the engineered barrier	Closed-pending
	The effects of in-package criticality on waste package and engineered barrier subsystem performance	Closed-pending
	The effects of alternate engineered barrier subsystem design features on container lifetime and radionuclide release from the engineered barrier subsystem	Closed-pending

KTI and Preclosure Sub-Issues and Status

(Continued)

KTI Title (IRSR Revision)	Sub-issue	Status
Thermal Effects on Flow (Rev 3)	Features, events, and processes related to thermal effects on flow	Closed-pending
	Thermal effects on temperature, humidity, saturation, and flux	Closed-pending
Repository Design and Thermal-Mechanical Effects (Rev 3)	Implementation of an effective design control process within the overall quality assurance program	Closed
	Design of the geologic repository operations area for the effects of seismic vents and direct fault disruption	Closed-pending
	Thermal-mechanical effects on underground facility design and performance	Closed-pending
	Design and long-term contribution of repository seals in meeting post-closure performance objectives	Closed
Unsaturated and Saturated Flow under Isothermal Conditions (Rev 2)	Climate change	Closed
	Hydrologic effects of climate change	Closed
	Present-day shallow infiltration	Closed-pending
	Deep percolation	Closed-pending
	Saturated zone ambient flow conditions and dilution processes	Closed-pending
	Matrix diffusion	Closed-pending
Radionuclide Transport (Rev 2)	Radionuclide transport through porous rock	Closed-pending
	Radionuclide transport through alluvium	Closed-pending
	Radionuclide transport through fractured rock	Closed-pending
	Nuclear criticality in the far field	Closed-pending
Total System Performance Assessment and Integration (Rev 3)	System description and demonstration of multiple barriers	Closed-pending
	Scenario analysis	Closed-pending
	Model abstraction	Closed-pending
	Demonstration of the overall performance objective	Closed-pending

KTI and Preclosure Sub-Issues and Status

(Continued)

KTI Title (IRSR Revision)	Sub-issue	Status**
Preclosure Issues (not KTI but treated similarly by NRC)	Site description	TBD
	Description of structures, systems, components, equipment, and operational process activities	TBD*
	Identification of hazards and initiating events	TBD*
	Identification of event sequences	TBD*
	Consequence analysis	TBD*
	Identification of structures, systems and components important to safety; safety controls; and measures to ensure availability of the safety systems	TBD*
	Design of structures, systems and components important to safety and safety controls	TBD*
	Meeting the 10 CFR part 20 as low as is reasonably achievable requirements for normal operation and Category 1 event sequences	TBD
	Plans for retrieval and alternate storage of radioactive wastes	TBD
	Plans for permanent closure and decontamination, or decontamination and dismantlement of surface facilities	TBD

* Aspects of this sub-issue discussed at July 24-26 technical exchange

** Status of preclosure issues not discussed at meeting