[12]

KEY TECHNICAL ISSUE (KTI)

REPOSITORY DESIGN AND THERMAL MECHANICAL EFFECTS (RDTME)

RDTME TEAM:

R. Chen[2]	rchen@swri.edu
A. Chowdhury[2]	achowdhury@swri.edu
B. DasGupta[2]	bdasgupta@swri.edu
A. Ghosh[2]	aghosh@swri.edu
D. Gute[2]	dgute@swri.edu
S. Hsiung[2]	shsiung@swri.edu
B. Jagannath[1]	bnj@nrc.gov
M. Nataraja[1,3]	msn1@nrc.gov
G. Ofoegbu[2]	gofoegbu@swri.edu

[1] U.S. Nuclear Regulatory Commission (NRC)
[2] Center for Nuclear Waste Regulatory Analyses (CNWRA)
[3] Presenter, NRC Technical Lead

NRC/DOE TECHNICAL EXCHANGE
PRE-LICENSING ISSUE RESOLUTION STATUS
APRIL 25-26, LAS VEGAS, NV

Legacy/main - nc

RDTME KTI SUBISSUES AND RESOLUTION STATUS

Subissue 1: Implementation of an effective design control process within the overall quality assurance program: CLOSED

Subissue 2: Design of the geologic repository operations area for the effects of seismic events and direct fault disruption: CLOSED PENDING CONFIRMATORY INFORMATION

Subissue 3: Thermal-mechanical effects on underground facility design and performance: OPEN

Subissue 4: Design and long-term contribution of seals to performance: CLOSED PENDING CONFIRMATORY INFORMATION

PATH TO RESOLUTION (SUBISSUE 1)

Component 1: Design Control Process for the ESF: (CLOSED)

Component 2: Design control process for the GROA: (CLOSED)

Need for Continued Evaluation

- NRC staff to evaluate DOE implementation of design control process through audit observations
- DOE to inform NRC of any changes to its Design Control Process

Progress in Implementation:

- Document Hierarchy Simplified and In Place
- Design Control Process Appears to be Transparent and Traceable
- Effectiveness of Implementation Monitored Through Periodic Audit Observations and design reviews

PATH TO RESOLUTION (SUBISSUE 2)

Component 1: Seismic Hazard Assessment Methodology: (CLOSED -- SEE SDS IRSR)
Component 2: Seismic Design Methodology: (CLOSED -- SEE RDTME IRSR)

Component 3: Seismic and Fault Displacement Inputs for Design and Performance Assessment: (CLOSED PCI i.e., TR-3 OR OTHER ALTERNATIVE)

- DOE Repository Safety Strategy (RSS) Principal Factors:
  - — Seepage Into Drifts
  - — Performance of Drip Shield
  - — Performance of Waste Package

- NRC Abstractions:
  - — Mechanical Disruption of Engineered Barriers
  - — Spatial and Temporal Distribution of Flow
  - — Quantity and Chemistry of Water Contacting Waste Packages and Waste Forms
  - — Degradation of Engineered Barriers

Need for Additional Data/Rationale

- Seismic and Fault Displacement input data that are consistent with the seismic design methodology and Performance Assessment Methodology along with technical bases.

TR-3 should also discuss inputs for PA

PATH TO RESOLUTION (SUBISSUE 3)

Thermal-mechanical (TM) effects on underground facility design and performance

- DOE RSS Principal Factors:
  - — Seepage Into Drifts
  - — Performance of Drip Shield
  - — Performance of Waste Package
  - — Coupled Processes-Effects on Seepage
  - — Environments on the Drip Shield and on/within Waste Package

- NRC Abstractions:
  - — Mechanical Disruption of Engineered Barriers
  - — Spatial and Temporal Distribution of Flow
  - — Quantity and Chemistry of Water Contacting Waste Packages and Waste Forms
  - — Degradation of Engineered Barriers
  - — Radionuclide Release Rates and Solubility Limits

PATH TO RESOLUTION (SUBISSUE 3)

Component 1: Consideration of TM effects on Underground Facility Design/Performance (OPEN)

Need for Additional Data

- Intact-rock thermal and mechanical properties for TSw2 lithophysal unit
- Rock-mass properties for TSw2 lithophysal unit

Need for Additional Analysis

- Applicability of available empirical equations → may not be applicable to YM site
- Degradation of rock properties under repository environment friction angle
- Design analysis of emplacement drift stability needs to:
  - Consider appropriate combination of models
  - Consider site-specific fracture patterns in discontinuum analysis
  - Use site-specific frequency content and duration of ground motion data
  - Consider effects of lithophysae on rock bolt performance/effectiveness

PATH TO RESOLUTION (SUBISSUE 3)

Component 2: Consideration of TM effects and Resulting Rock-fall on the Design and Performance of Engineered Barriers (OPEN)

Need for Additional Analysis (SEE CLST KTI PRESENTATION)

don't know details of design

- Rock-fall impact analysis needs to consider the following:
  - Appropriate mechanical properties for the EB component materials (consistent with emplacement drift conditions, e.g., temperature effects)
  - Effects of flaws and cracks that are created during the fabrication process when assessing the capability of the EB component to withstand rock block impact(s)
  - Integrity of waste package pedestal support
  - Thermal load and ground motion on predicting rock-fall
  - Design and fabrication details for the Individual EB components
  - Appropriate failure criteria for the different EB components
  - Effects of seismic ground motion on the relative velocity between the EB component and rock block during impact
  - Effects of residual stresses and potential loss of material ductility in the region of the closure welds
  - Effect of multiple rock blocks falling in unison
  - Potential creep rupture of the Titanium (Grade 7) drip shield due to the sustained load of supporting a seismically dislodged rock block after impact

PATH TO RESOLUTION (SUBISSUE 3)

Component 3: Consideration of TM effects in Estimating Quantities of Seepage and Dripping Characteristics into Emplacement Drifts (OPEN)

Need for Additional Analysis

- Evaluation of long-term TM effects should consider:
  - — Changes in geometry of emplacement drifts
  - — Changes in permeability around emplacement drifts

PATH TO RESOLUTION (SUBISSUE 4)

Design and contribution of seals to long-term performance (CLOSED PCI)

- No specific design/performance requirements for Borehole/Shaft/Ramp Seals in Part 63
- DOE to establish criteria for Seal Design to meet long-term performance needs
- DOE to establish material/construction specifications to meet its design goals
- DOE to evaluate contribution of Seals to overall repository performance
- NRC to review Seal Design in the context of repository long-term performance

SUMMARY

SUBISSUE 1

DESIGN CONTROL PROCESS FOR THE GROA TO BE MONITORED BY NRC THROUGH PERIODIC OBSERVATIONS OF DOE AUDITS AND DESIGN REVIEWS

SUBISSUE 2

DOE SUBMITS TR-3, NRC REVIEWS TR-3 AND CONSIDERS TR-1, TR-2 AND TR-3 IN PREPARING SER, TR's WILL BECOME AN ACCEPTED REFERENCE TO DOE'S LA.

SUBISSUE 3

DOE TO RESPOND TO NRC QUESTIONS ON DATA AND ANALYSES, NRC TO REVIEW AND CONSIDER NEW INFORMATION IN SUBSEQUENT REVISIONS TO RDTME KTI IRSR.

DOE'S

SUBISSUE 4

RISK-INFORMED PERFORMANCE-BASED PART 63 APPROACH RESULTS IN RETHINKING OF SEALS SUBISSUE. DOE TO PROVIDE AN EVALUATION OF SEAL DESIGN AND ITS CONTRIBUTION TO LONG-TERM PERFORMANCE. NRC TO REVIEW SEAL DESIGN IN THE CONTEXT OF LONG-TERM PERFORMANCE