KEY TECHNICAL ISSUE (KTI)

CONTAINER LIFE AND SOURCE TERM (CLST)

CLST TEAM:

Tae Ahn[1,3]	T. Bloomer[1]
S. Brossia[2]	R. Codell[1]
G. Cragnolino[2]	D. Dunn[2]
C. Greene[1]	V. Jain[2]
B. Leslie[1]	O. Moghisi[2]
Y.-M. Pan[2]	M. Rahimi[1]
N. Sridhar[2]	L. Yang[2]

[1] U.S. Nuclear Regulatory Commission (NRC)
[2] Center for Nuclear Waste Regulatory Analyses (CNWRA)
[3] Presenter, NRC Lead, (301) 415-5812, tma@nrc.gov

NRC/DOE TECHNICAL EXCHANGE
PRE-LICENSING ISSUE RESOLUTION STATUS
APRIL 25 - 26, 2000, LAS VEGAS, NV

Legacy/main - x-d

CLST KTI SUBISSUES AND STATUS OF RESOLUTION

Subissue 1: The effects of corrosion processes on the lifetime of the containers
OPEN

Subissue 2: The effects of phase instability and initial defects on the mechanical failure and lifetime of the containers
CLOSED PENDING CONFIRMATORY INFORMATION

Subissue 3: 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 CONFIRMATORY INFORMATION

Subissue 4: The rate at which radionuclides in high-level waste glass are released from the engineered barrier subsystem
CLOSED PENDING CONFIRMATORY INFORMATION

Subissue 5: The effects of in-package criticality on waste package and engineered barrier subsystem performance
OPEN

Subissue 6: The effects of alternate engineered barrier subsystem design features on container lifetime and radionuclide release from the engineered barrier subsystem

CLOSED PENDING CONFIRMATORY INFORMATION

Subissue 1: The effects of corrosion processes on the lifetime of the containers

- DOE Repository Safety Strategy (RSS) Principal Factors: Performance of the Waste Package

- NRC Abstractions: Engineered Barrier Degradation

STATUS: OPEN

A-Need for additional analysis

Likelihood of localized corrosion, microbially influenced corrosion, and (internal or inter-granular) dry-air oxidation

- Provide data and justification for inclusion or exclusion taking into consideration uncertainties in the definition of in-drift environmental conditions

Long-term behavior of Alloy 22 considering ASTM Standard C-1174-97 and relevant analogue data

- Provide justification on selection of analogues considered

B-Need for additional data and analysis

Long-term uniform corrosion rates of Alloy 22

- Apply technically acceptable methods to determine rates eliminating uncertainties related to the deposition of silica and corrosion products as well as other experimental factors affecting test results
- Provide qualified range of values and distributions derived from experimental measurements

Susceptibility of Alloy 22 to stress corrosion cracking (SCC)

- Determine with technically acceptable and sensitive SCC test methods applicable to the range of in-drift environmental conditions
- Provide qualified range of values and distributions for crack growth rates and SCC stress intensity thresholds derived from experimental measurements

Corrosion environment in contact with containers

- Include effects of gamma radiolysis, maximum estimated concentration of anions, and acceptable determination of temperature and redox conditions considering temporal and spatial variations

Effects of fabrication, welding (with and without post-weld heat treatment), compositional variations, and thermal aging on corrosion of Alloy 22

- Provide adequate evaluation of the effect on localized corrosion, corrosion rates and SCC considering the variability associated with fabrication processes

<u>Subissue 2: The effects of phase instability and initial defects on the mechanical failure and lifetime of the containers</u> (partially covered by Repository Design and Thermal-Mechanical Effects KTI)

- DOE RSS Principal Factors: Performance of the Waste Package
- NRC Abstractions: Mechanical Disruption of Engineered Barriers

STATUS: CLOSED PENDING CONFIRMATORY INFORMATION

Confirmatory information needed

- Provide information on ultimate tensile strength or linear-elastic (or elastic-plastic) fracture toughness parameters to estimate mechanical failure of Alloy 22
- Provide acceptable database, and estimates of initial failure probabilities for Alloy 22 and 316 stainless steel welded containers
- Provide information on the effect of post-weld heat treatment and thermal aging on the parameters governing mechanical failure of Alloy 22 and 316 stainless steel welded containers

<u>Subissue 3: 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</u>

- DOE RSS Principal Factors: Solubility Limits of Dissolved Radionuclides in Yucca Mountain Water

- NRC Abstractions: Radionuclide Release Rates and Solubility Limits

STATUS: CLOSED PENDING CONFIRMATORY INFORMATION

Confirmatory information needed

- Provide information on radionuclide release from partially failed waste package including parameter values, assumed ranges, probability distributions and bounding assumptions

- Provide updated information and justification for using dissolution rate of spent nuclear fuel from accelerated flow-through tests including appropriate consideration of drip scenarios

- Provide information on radionuclide solubility limit including parameters values,assumed ranges, probability distributions and bounding assumptions, in particular for Np species

- Provide information on failure rate of cladding (including hydride embrittlement, and localized corrosion and SCC caused by in-package environment) considering both PWR and BWR fuel cladding materials and conditions

- Provide information on in-package chemistry including effects of gamma radiolysis and internal waste package materials, interaction of spent nuclear fuel and high-level waste glass and redox conditions considering temporal and spatial variations

<u>Subissue 4: The rate at which radionuclides in high-level waste glass are released from the engineered barrier subsystem</u>

- DOE RSS Principal Factors: Solubility Limits of Dissolved Radionuclides in Yucca Mountain Water

- NRC Abstractions: Radionuclide Release Rates and Solubility Limits

STATUS: CLOSED PENDING CONFIRMATORY INFORMATION

Confirmatory Information needed

- Provide information on radionuclide release from partially failed waste package including parameters values, assumed ranges, probability distributions and bounding assumptions

- Provide information on the effect of in-package corrosion products such as ferrous and ferric ions on glass dissolution rates and the significance of the radionuclide release rates in dose calculations

<u>Subissue 5: The effects of in-package criticality on waste package and engineered barrier subsystem performance</u>

- DOE RSS Principal Factors: not included

- NRC Abstractions: Engineered Barrier Degradation, Mechanical Disruption of Engineered Barriers

STATUS: OPEN

A-Need for additional analysis

- Multi-parameter trending analysis for developing code biases and uncertainties
- Verification of k_{eff} regression equation or look-up tables

B-Need for additional data and analysis

Methodology and modeling

- Provide the analysis methodology and modeling for initial and post-closure radionuclide inventory (e.g., SAS2H adequacy, bias on depletion code) and other types of moderators

- Provide the modeling validation approach for steady-state criticality consequence and isotopic depletion
- Measure spent nuclear fuel burnup on each assembly
- Develop criticality margin

C-Aspect of the subissue that has not been addressed

- Effects of radionuclide migration through pinholes and cracks in cladding
- Potential of igneous-induced criticalities
- Transient criticality consequences
- Criticality input to Total System Performance Assessment
- Methodology, modeling, and validation for the criticality assessment of Navy and DOE-owned spent nuclear fuel, and Plutonium-bearing high-level waste glass

Subissue 6: The effects of alternate engineered barrier subsystem design features on container lifetime and radionuclide release from the engineered barrier subsystem

- DOE RSS Principal Factors: Performance of the Drip Shield
- NRC Abstractions: Engineered Barrier Degradation, Mechanical Disruption of Engineered Barriers, Radionuclide Release Rates and Solubility Limits

STATUS: CLOSED PENDING CONFIRMATORY INFORMATION

Confirmatory information needed

statements in PHRs weak

- Provide information on temperature and the chemical environment in contact with drip shields, including the effects of gamma radiolysis and in-drift materials, and the maximum estimated concentration of anions
- Provide information on long-term uniform corrosion rates of Ti Grade 7, including range of values and distributions derived from experimental measurements
- Provide information on source and database used to estimate initial failure probability of Ti Grade 7 drip shield

- Provide information on ultimate tensile strength or linear-elastic (or elastic-plastic) fracture toughness parameters to estimate mechanical failure of Ti Grade 7
- Provide information on the effect of post-weld heat treatment and thermal aging on the parameters governing mechanical failure of Ti Grade 7 drip shield