APPENDIX 7: CONTAINER LIFE AND SOURCE TERM

July 7-8, 1999, LLNL (and Video Conference)

PURPOSES:

(1) present CLST IRSR and related topics
(2) obtain DOE feedback
(3) obtain DOE progress and present NRC evaluation in the performance of waste package (WP) and waste form

PRESENTATIONS: agenda and list of attendees are attached.

CONCLUDING REMARKS:

(1) DOE agrees with the acceptance criteria;
(2) DOE addresses most of the issues that have been raised;
(3) The topic of alloy-22 stress corrosion cracking needs to be evaluated;
(4) NRC would like to obtain welded materials for confirmatory tests;
(5) NRC needs to know about performance confirmation;
(6) NRC, especially ACNW, is interested in the system's approach; and
(7) NRC and DOE may issue a letter closing open items such as WP materials stability and spent fuel performance in general.

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Lawrence Livermore National Laboratory Bldg. 543

Tentative Agenda

July 7, 1999:		
8:15	Opening Remarks	NRC/DOE
8:30	Overview of NRC CLST IRSR	NRC
9:00	Subisssue 1: Container Corrosion	NRC
9:30	DOE Feedback	DOE
9:45	**Break**	
10:00	Subissue 2: Materials Stability and Mechanical Failure of Container	NRC
10:30	DOE Feedback	DOE
10:45	Testing and modeling of Container Corrosion (General overview of materials issues, testing program strategies, perf. Confirmation)	David Stahl
11:00	LADS process and EDAII Design	James Blink
11:15	Fabrication of waste package	Jerry Cogar
11:35	Process model report	Pasu Pasupathi
11:45	General overview of modeling of container corrosion	Joe Farmer
12:15	**Lunch**	
1:15	Chemistry on waste package materials surface	Greg Gdowski
1:45	Phase stability and aging	Tammy Summers
2:15	Stress corrosion cracking and HIC	Gerald Gordon
2:45	General and localized corrosion	Joe Farmer
3:15	**Break**	
3:30	Testing and Modeling of Container Corrosion	NRC
4:30	Tour of Corrosion Test Facilities	
5:30	Adjourn for the Day	

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July 8, 1999:		
8:00	Subissue 3: Spent Fuel Degradation and Radionuclide Release	NRC
8:30	DOE Feedback	DOE
8:45	Subissue 4: HLW Glass Degradation and Radionuclide Release	NRC
9:15	DOE Feedback	DOE
9:30	**Break**	
9:45	Other Subissues: Criticality and Alternative Design Features	NRC
10:15	DOE Feedback	DOE
10:30	Overview of waste form (WF) issues, testing of WF and cladding, performance confirmation plans	Christine Stockman
10:50	Commercial spent fuel tests at ANL	James Cunnane
11:20	Commercial spent fuel tests at PNN	Brady Hanson
11:40	HLW glass testing	James Cunnane
12:15	**Lunch**	
1:15	Complete Tour of Corrosion Test Facilities	
2:15	Intrinsic dissolution rate	Steve Steward
2:30	Cladding wet and dry unzipping, crack response	Ray Stout
3:00	Alteration layer and flow concentration limits	Ray Stout
3:15	**Break**	
3:30	Modeling of Waste Forms and Cladding	NRC
4:30	Concluding Remarks	NRC/DOE
5:00	Adjourn	

Sign-in Sheet
APPENDIX 7: CONTAINER LIFE AND SOURCE TERM
Lawrence Livermore National Laboratory
July 7 and 8, 1999

Name: Last	Name: First	Affiliation	Signature
Ahn	Tae	US NRC	
Barnard	William	US NWTRB	
Blink	Jim	LLNL	
Bullen	Daniel	US NWTRB	
Clarke	Bill	LLNL	
~~Cogar~~	~~Jerry~~	~~M&O~~	
Cragnolino	Gustavo A.	CNWRA	
Cunnane	James	ANL	
Dunn	Darrell S.	CNWRA – SRI	
Estill	John	LLNL	
Farmer	Joe	LLNL	
Gdowski	Greg	LLNL	
Gordon	Gerald	M&O	
Greene	Charles A.	US NRC	
Haghi	Ali	US DOE	
Hanson	Brady		
~~Haught~~	~~David~~	~~US DOE~~	
Jones	Denny	LLNL	
Lo	Henry	Idaho Falls	
McCright	Dan	LLNL	
Parizek	Richard	US NWTRB	
Pasupathi	Pasu	M&O	
Roy	Ajit	LLNL	
Shaber	Eric	Idaho Falls	
Solomon	Prof. Alvin	Purdue University	
Sridhar	Narasi	CNWRA	
Stahl	David	M&O	
Steward	Steve	LLNL	
Stockman	Christine	M&O	

Sign-in Sheet
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Name: Last	Name: First	Affiliation	Signature
Stout	Ray	LLNL	Ray B Stout Wednesday July 7, 99 (PUARTA)
Summers	Tammy	LLNL	Tammy Summers
Wang	Fancis	LLNL	
GUNTER	TIM	DOE/YMSCO	Timothy S Gunter
WONG	FRANK	MTS/YMSCO	F. Wong
LEE	JOON	M&O/PAO	Joon Lee
MAN	KEVIN	M&O/PAO	Kevin Man
HOWARD	ROBERT	M&O/PAO	Robert Howard
VALENTINE	MICHAEL	DOE/YMSCO	Michael Valentine
Haught	Dave	DOE/YMSCO	Dave Haught
Snyder	JAMES	NR	James Snyder
COCAR	JERRY	WPO/M&O	Jerry Cocar
TURCHI	Patrice	LLNL	Patrice Turchi
BENTON	HUGH	M&O/WPO	Hugh A. Benton
Sevougian	Dave	M&O/DES/PAO	S.D. Sevougian
MCRIGHT	DANIEL	LLNL	Daniel McCright
ROY	AJIT	FCF	Ajit Roy
HORN	JOANNE	LLNL	Joanne Horn
Wood	HOWARD	LLNL	Howard Wood
Daniel	Paul	MTS/YM	Paul Daniel
~~BLINK~~	~~James~~	~~LLNL M&O~~	~~James Blink~~
Hardin	Ernest	LLNL	Ernest Hardin

Process Models

- The Waste Package PMR will include nine process models and associated abstraction reports
- Process models being developed are:
  - Surface environment on drip shield and waste package
  - Juvenile failures
  - Aging and phase stability of Alloy 22
  - Mechanical failures due to rockfall
  - General and localized corrosion of Alloy 22

Process Models

(Continued)

- General and localized corrosion of titanium drip shield
- Stress corrosion cracking of Alloy 22, titanium and stainless steel
- Hydrogen induced cracking of titanium drip shield
- Degradation of stainless steel structural material

- For each of the process models an abstraction analysis will be prepared for use with the Waste Package Degradation (WAPDEG) code

Environmental Conditions on Waste Package Materials Surfaces; Water Chemistry and Salt/Mineral Scale

- **Liquid water can be present on material surfaces above the boiling point of pure water due to hygroscopic salts**
  - **Oxygen concentration is a function of the salt content and oxygen partial pressure**
- **Water chemistry is a function of temperature and relative humidity**
  - **Equilibrium and non-equilibrium chemistries can exist**
- **Work is continuing on characterizing the water chemistries**
- **Scale formation on the surfaces is likely**
- **Drip tests on candidate materials to characterize scale**

EDA II Underground Facility

- Line Loading and blending
  - Reduce axial temperature variations
- Aggressive pre-closure ventilation
  - Reduces peak temperatures
- Wide drift spacing (81 m) facilitates shedding
  - Only a small fraction of the pillar is heated above boiling
- Limited duration and volume of rock heated above boiling (50 yr closure)
  - Reduces uncertainty associated with altered flow paths and water chemistry
  - Additional thermal management (later closure, higher ventilation, wider drift spacing, etc.) can result in no rock heated above boiling

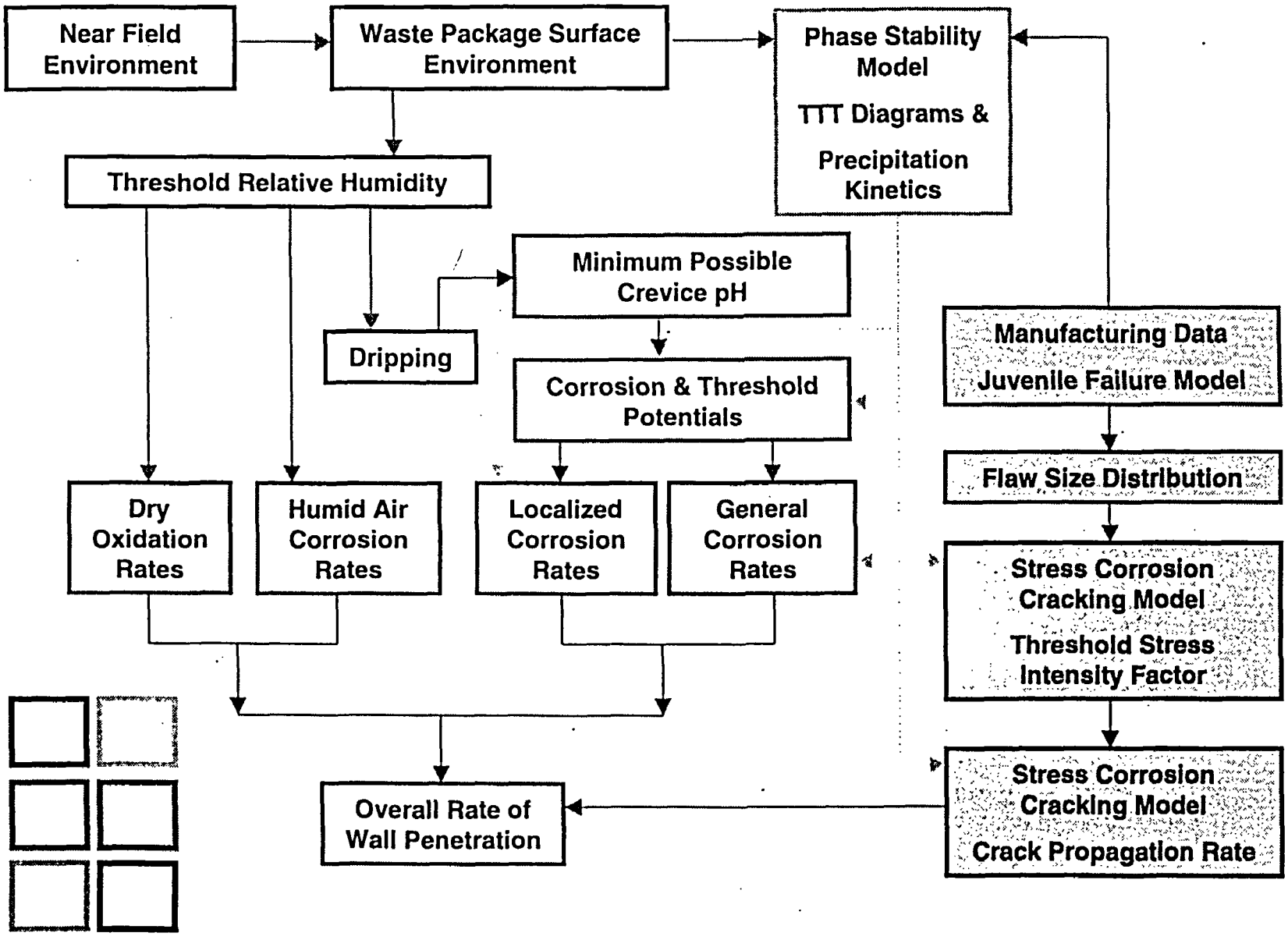
EDA II Waste Package

- 2 cm of Alloy 22 corrosion resistant material over 5 cm of stainless steel structural material
  - No oxide wedging uncertainty from confined carbon steel
  - Structural strength for the life of the CRM (>10^5 yr) compared to carbon steel lifetime (< 10^4 yr) for the VA WP
  - Thermal management (ventilation, blending, areal mass loading) avoids the Alloy 22 crevice corrosion window of susceptibility

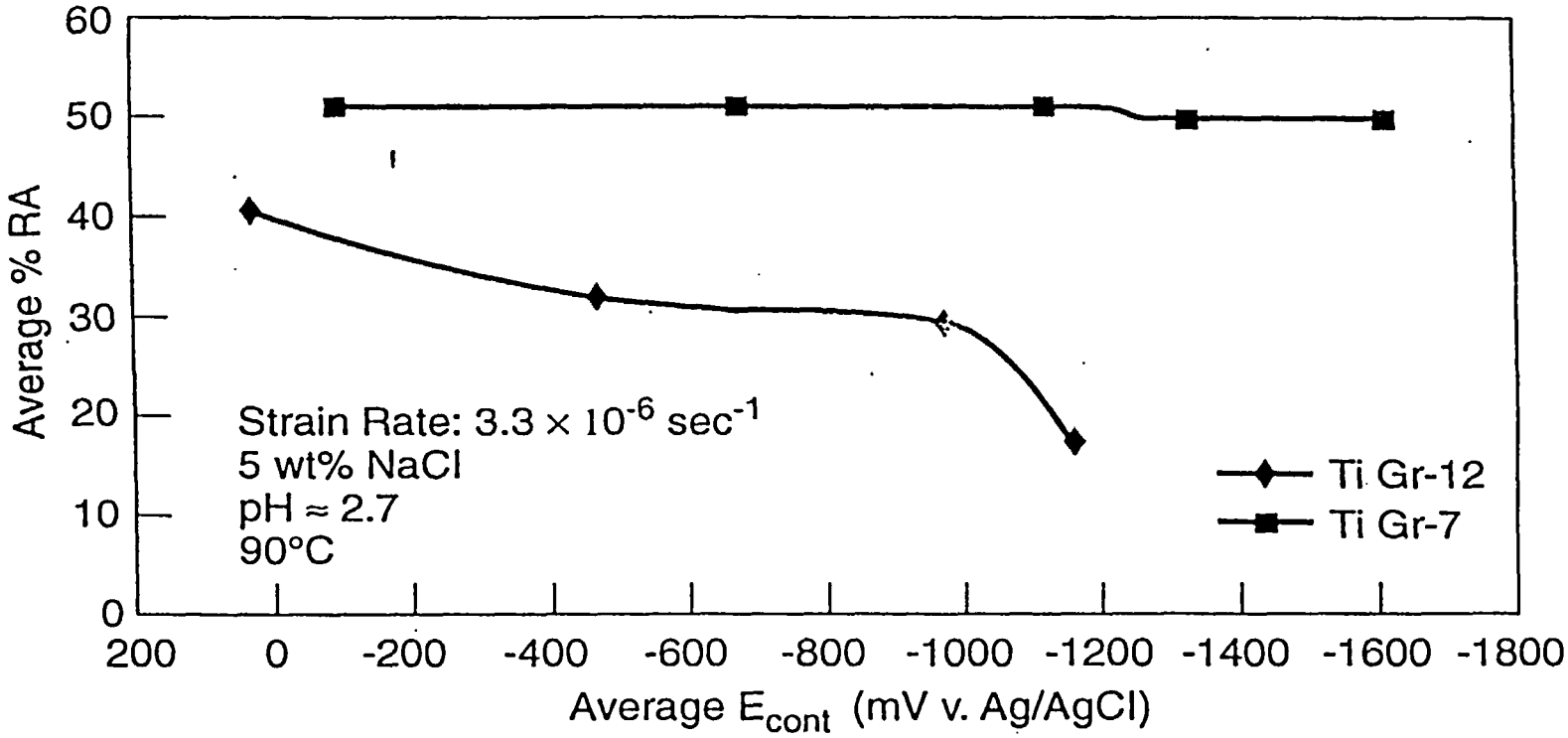
Fabrication and Inspection Sequence

- Material ordering
  - ASME B&PV Code, Section III, Division 1, Article NB-2000 material
- NDE
  - 100% ultrasonic inspection at vendor ASME B&PV Code, Section V, Article 5
  - Acceptance criteria ASME B&PV Code, Section III, Division 1, Article NB-5330

Abstracted Model for Waste Package Degradation

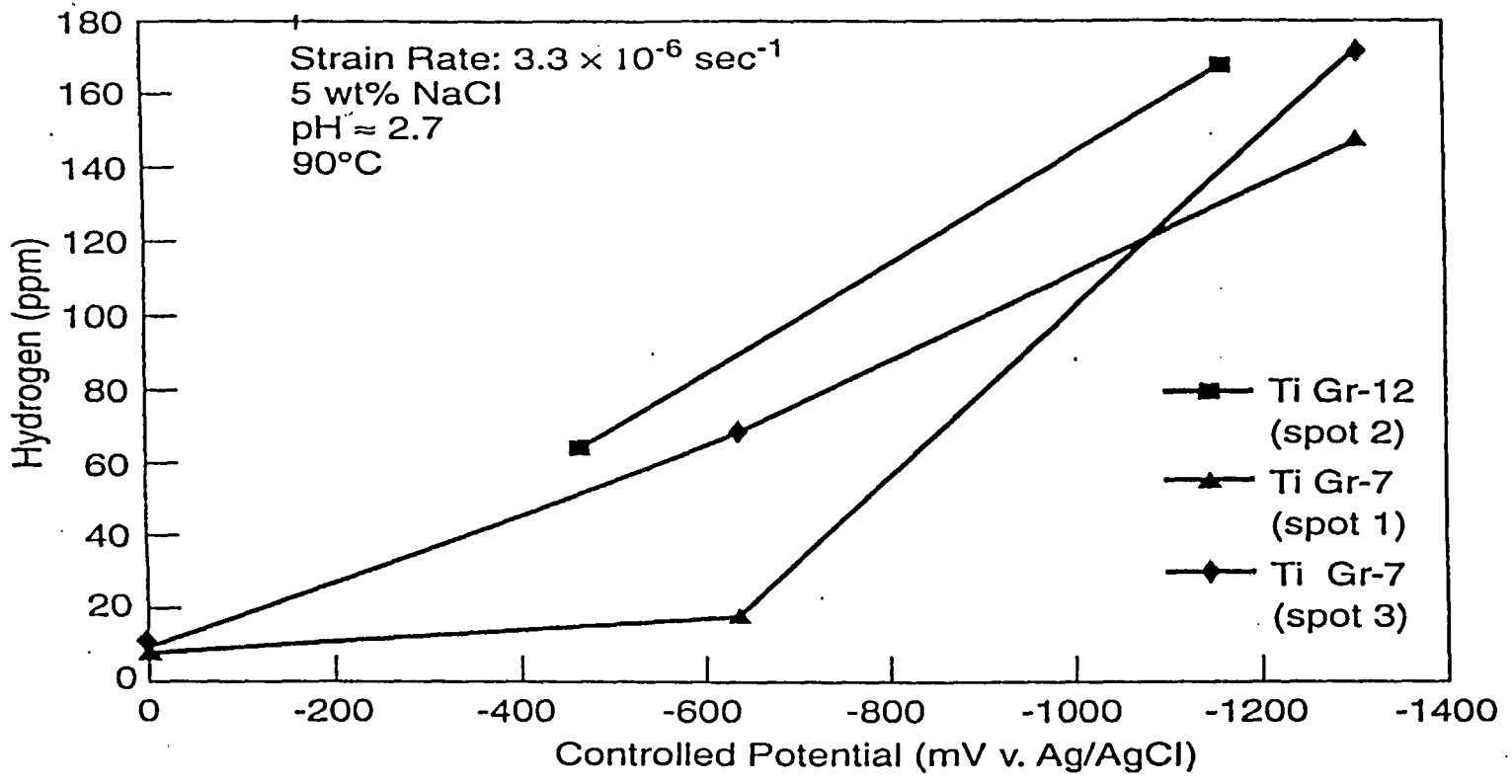


Controlled Potential SSRT Ductility



% RA versus E_{cont}

Hydrogen Pickup During SSRT

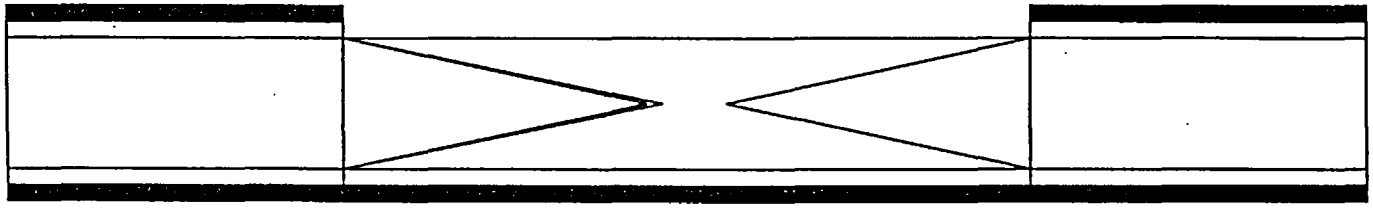


Hydrogen Concentration versus E_{cont} at Locations away from the Primary Fracture.

Issues: Waste Form Process Model Report Outline

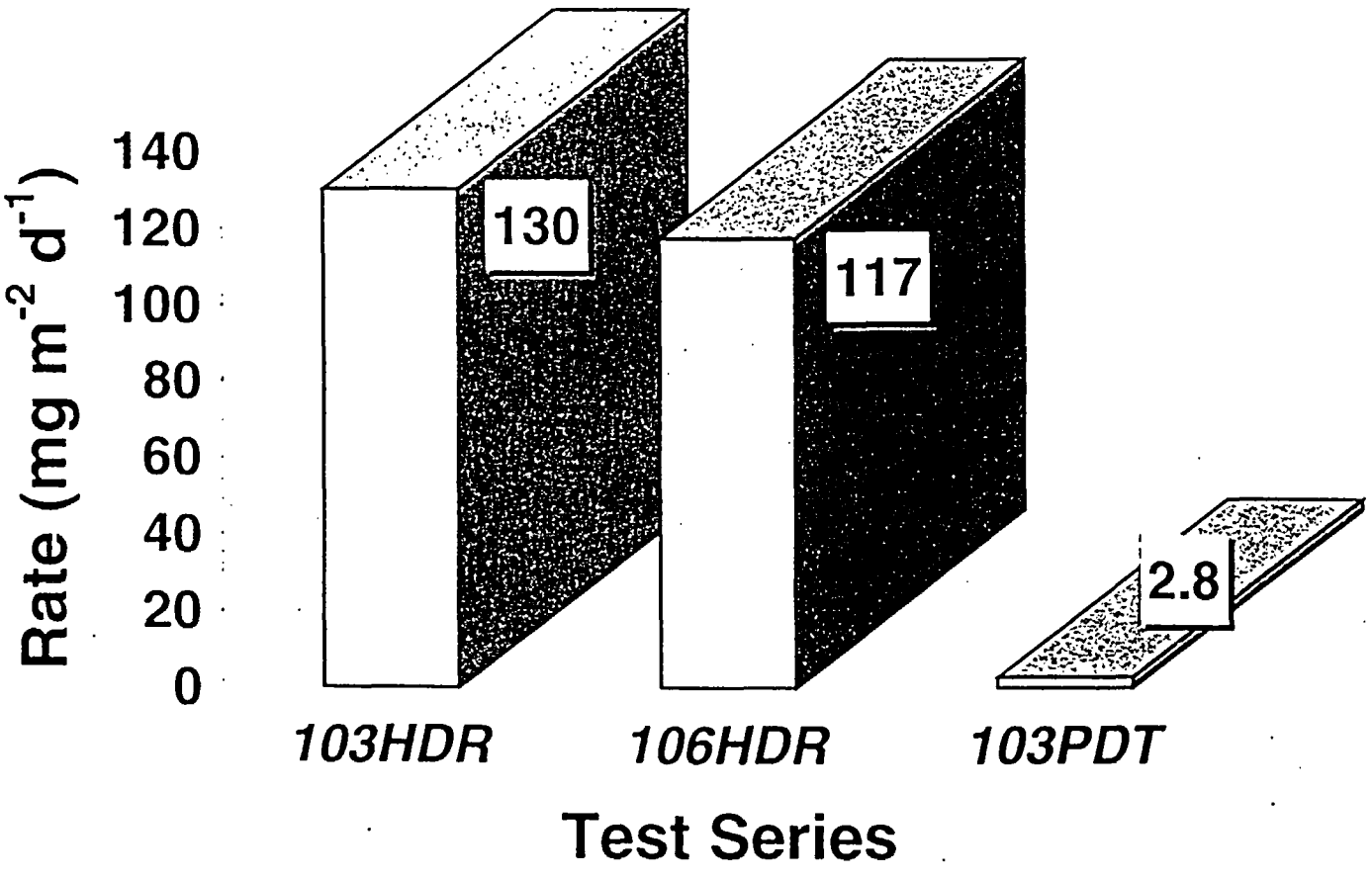
1. Radionuclide Inventory
2. Commercial Spent Nuclear Fuel (CSNF) Clad Degradation
3. CSNF Waste Form Degradation
4. Other Waste Form Degradation
5. High Level Waste Glass Degradation
6. Dissolved Radionuclide (RN) Concentration Limits
7. Colloid RN Concentration Limits
8. In-Package Chemistry
9. In-Package Transport

Stage 3. Estimated Potential Aqueous Unzipping Parameters



Dissolution Rate VD ~10mg/m/m/d = 0.365 microns/yr
Crack speed v2 ~ m/s VD ~ 100 VD = 36.5 microns/yr
Cone length Lc = (m/s) R ~ 40cm
(Order of magnitude numbers)

Area-Normalized Dissolution Rates (based on Tc release)



Overview

- Test Types
  - Unsaturated "Drip" Tests (N2, N3)
  - Vapor Hydration Tests
  - PCT and MCC-1 Tests
- For each Test Type
  - Test Configuration and Operation
  - Objectives and Scope
  - Results