

Used Fuel Disposition Campaign

Task 1: Screening Tools for Repository Decisions

Palmer Vaughn: *Sandia National Laboratories (SNL)*

ROK – US Joint Fuel Cycle Study

UFD Fuel Cycle Alternative Working Group (FCAWG)

June 5-7, 2012

Prepared by:

Sandia National Laboratories

Albuquerque, New Mexico 87185 and Livermore, California 94550

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Task 1: Staffing

■ Duration: October 2011 – December 2012 – June 2014

■ Leads:

- | | | |
|------------------|-------|--|
| – Haeryong JUNG | KRMC | nohul@krmc.or.kr |
| – Jeongtae Jeong | KAERI | jtjeong@kaeri.re.kr |
| – Palmer Vaughn | SNL | pvaughn@sandia.gov |

■ Support:

- | | | | |
|----------------|--------------------------|------|--|
| – Geoff Freeze | Disposal System Modeling | SNL | gafreez@sandia.gov |
| – Shaoping Chu | Generic Granite Modeling | LANL | spchu@lanl.gov |
| – Ralph Rogers | Database | NRSS | ralroge@sandia.gov |

Task 1: Goals and Purpose

- **Develop and apply capability for the analysis of potential disposal sites for used nuclear fuel.**
 - The Korean Radioactive Waste Management Corporation (KRMCC) has launched an R&D program for potential site investigation and selection .
 - *Develop a tool for the analysis of potential disposal sites for used nuclear fuel.*
 - *First stage of this program: Implementation plan for developing preliminary safety assessments of the potential disposal sites.*
 - *Second stage KRMCC and KAERI: Develop a general performance assessment program (TSPA) for disposal site selection of used nuclear fuel. The TSPA program development includes exposure dose assessment both deterministically and probabilistically for operating scenarios including normal operations, well intrusions, earthquakes, and the early failure of waste packages.*
 - US DOE/UFDC is reevaluating disposal options for the fate of nuclear fuels. A number of potential repository host rock types, waste forms, and engineered barrier system concepts are proposed for investigation.
 - *GDSM is developing generic performance assessment models for disposal in Granite, Salt, Clay, and Deep Borehole to support technical and programmatic decisions.*
 - *Develop disposal system model in a flexible fashion to meet the evolving needs of the DOE NE/UFDC mission by providing the capability to produce risk information throughout the potential future phases of the mission and that facilitates incorporating new knowledge as it becomes available and necessary.*
 - *First iteration probabilistic disposal system models have been developed.*

Task 1: Deliverables

- **12/15/2012: A draft report “Gap Analysis: Data and Modeling Needs for Korean Reference Geologic Media Site Selection Performance Assessment Modeling.”** Document results of collaboration with ROK staff. Conceptual models, numerical implementation, and data needs relevant to Korean reference geologic media modeling will be identified. Current data availability and gaps to support the modeling will be documented, including waste form, engineered barriers, inventory, and characterization of the natural system.
- **6/30/2014 : Report titled “Comparative Analysis of GPAM and ROK TSPA Safety Assessment of a Potential ROK Granite Repository.”** Utilize the data and conceptual models resulting from the collaboration and implement in the GPAM and the ROK TSPA. Document description of the models and results of the safety assessment, and provide logical explanations for any differences in results.

Task 1: Supporting Efforts

- **Develop a mutual understanding of disposal system modeling needs relevant to disposal of Used Nuclear Fuel in ROK granite. FEPS, System Conceptualization, Numerical implementation, Supporting data.**
- **Perform initial comparative safety assessment using currently available models and data and evaluate results. (e.g. ROK TSPA and DOE UFD GPAM)**
- **Identify gaps in models and supporting data. 12/31/2012 Report**
- **Make recommendations for stage 2 efforts**
- **Develop stage 2 plan**
- **Implement stage 2 plan**

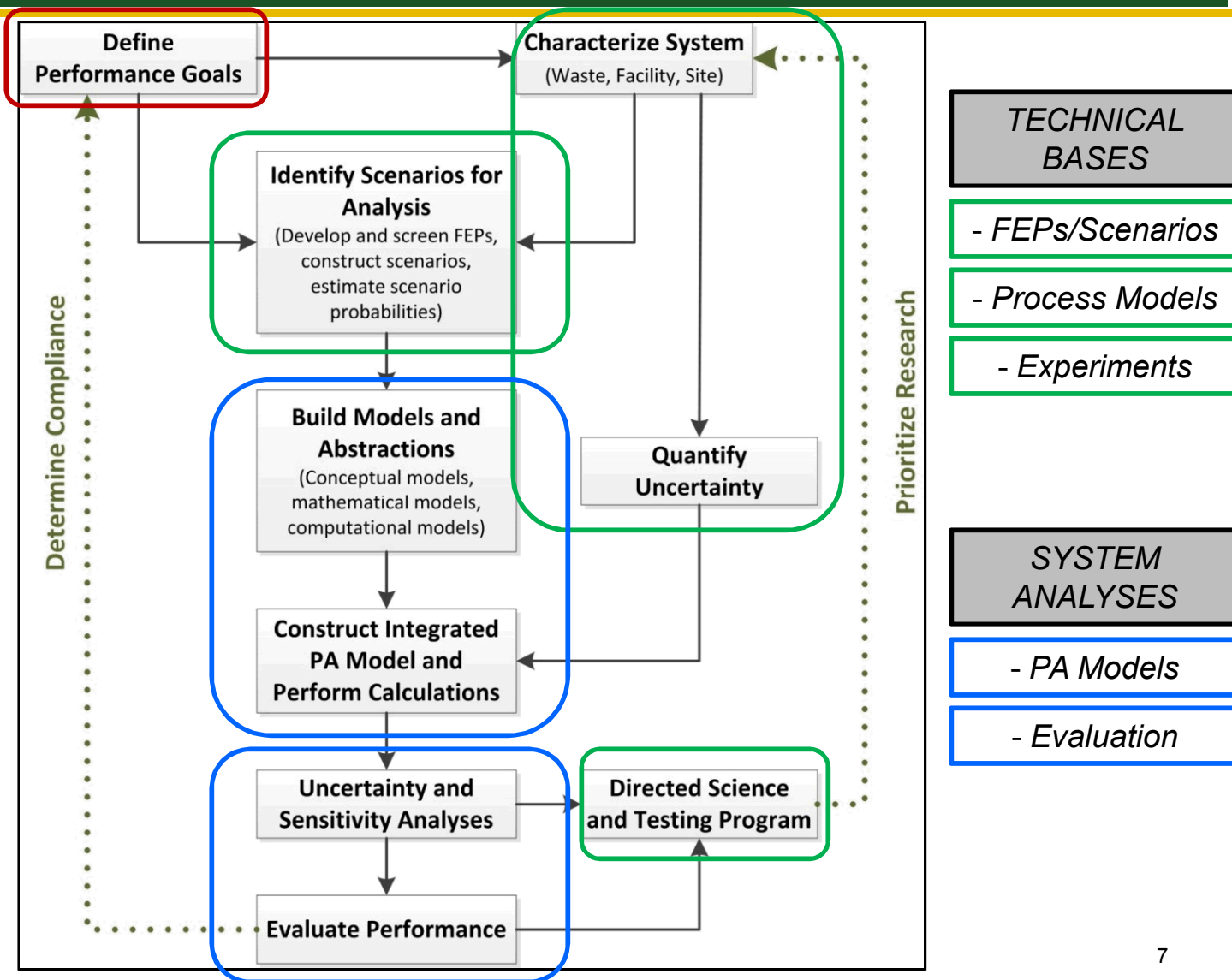
■ Initial technical contact December 2011

- Sent UFD FEPs Report
- Sent GDSM FY11 milestone report
- Request info on current state of safety assessment model, FEPs analysis.
- Requested info on ROK requirements, conceptualizations, data, and sub-models for various system components (e.g. Inventory, waste form characteristics, waste package characteristic, characterization of the natural system, repository loading, etc)

■ 2nd technical contact April 2012

- Sent UFD Generic Granite Model. A GoldSim “player” file. This will allow ROK counterparts to examine, the UFD model as well as see how the parameters are used, and investigate changes to parameter values .
- Sent an Excel spreadsheet, which identifies the parameters with descriptions , values, and use that are currently being used in the generic granite disposal system model.
- Sent a word document, which provides some additional information and an overview of the modeling and the data.
- Requested critique and suggestions to better reflect ROK specific needs in the GPAM model. Inventory, waste form, waste package, host rock characteristics.
- Requested dialog and ideas on how ROK counterparts would like to proceed.

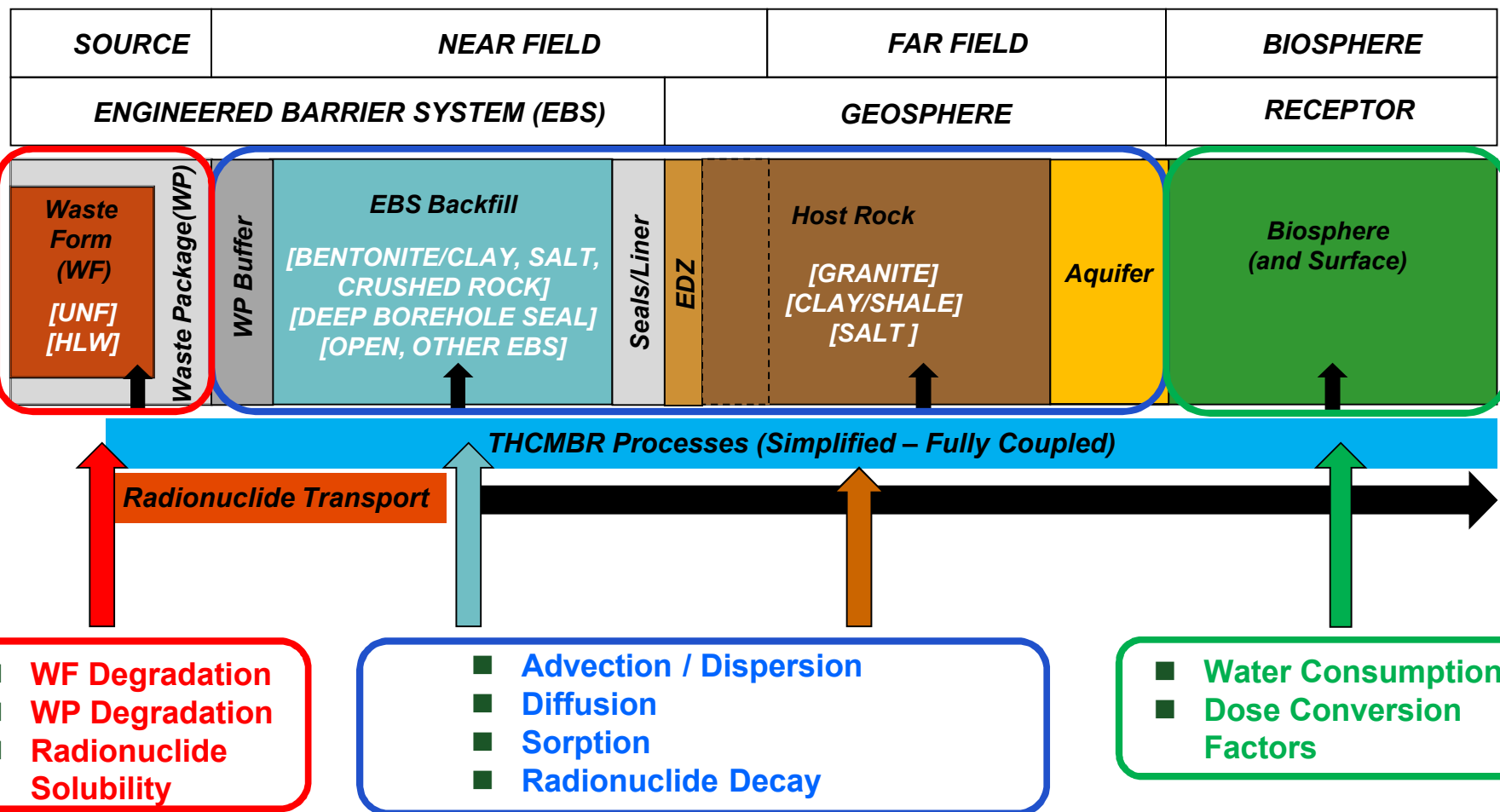
PA Methodology – Overview



Used Fuel Disposition

GPAM: Conceptualization

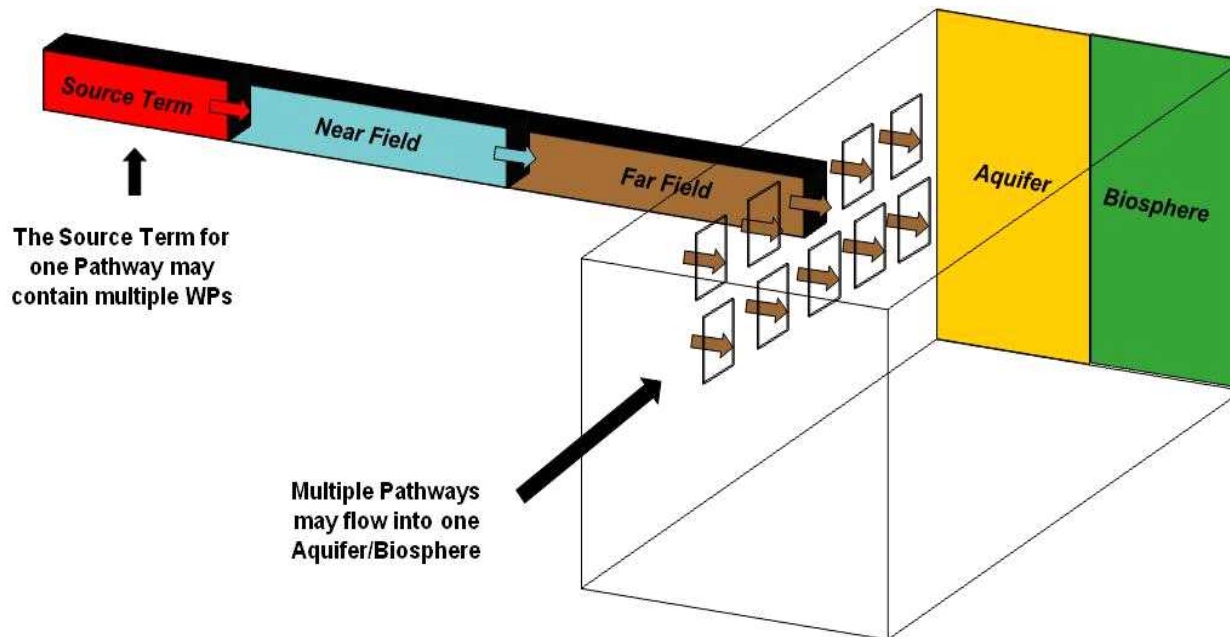
- Conceptual Model and supporting “high-level” FEPs
- Not all Model Domains need to be utilized (e.g., “active”) in a specific model application



GPAM: Conceptualization

A GPAM Disposal System may be conceptualized to contain multiple identical Pathways that all feed into the Aquifer and Biosphere

A GPAM Disposal System may also be conceptualized to contain a fast pathway that bypasses some of the Model Domains.



■ Major components:

- The near field (waste form, waste package the EBS, and bentonite buffer).
- The far field (Advection, diffusion, 5km to Biosphere).
- Stylized Aquifer and water well.
- Reference biosphere (IAEA ERB 1B model).

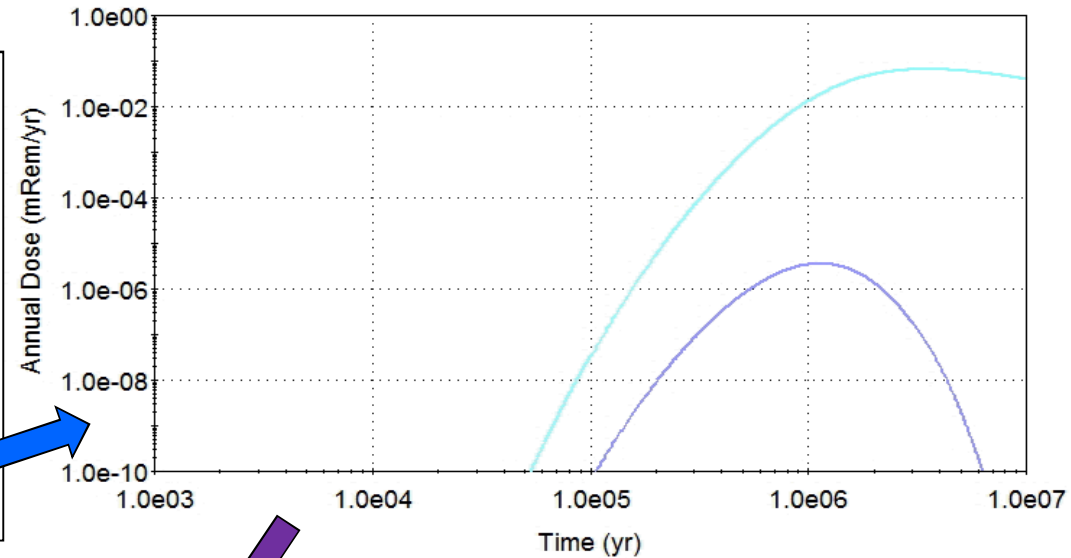
■ Assumptions

- Undisturbed scenario only.
- Isothermal conditions.
- Waste package failure occurs at the time of emplacement.
- Specified Fraction of WP that release to fractures. (Matrix F&T is negligible).
- Constant waste form degradation rate is used, no gap release.
- Flow is at steady state and fixed.
- Transport is calculate in 1-D using the GoldSim series of pipes as the pathway. (Dissolved species, decay and ingrowth, reversible linear sorption, solubility limits).

GoldSim Granite Safety Case Model – Deterministic Nominal Scenario

Inputs

- Inventory ~ 70,000 MTHM
- WF degr = 2×10^{-5} yr⁻¹
- WP degr = instant
- EBS bentonite = diffusive transport with sorption
- FF fractured granite = advective transport (5 km) with sorption and matrix diffusion



Important Processes

- **Slow transport through EBS bentonite buffer**
 - Diffusion-dominated
 - Sorption
 - No defects
- **Minimal direct connection from EBS to FF fractures**
 - Only 1% failed WPs connect to FF fractures
- **Delay in FF granite**
 - Sorption, matrix diffusion, 5 km length
- **WF degradation / WP degradation**

- Bullets, Numbers, Text, Pictures