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Cc: Andy Campbell; Marissa Bailey; Richard Codell; Dennis Galvin; Jack Guttmann; Randall Fedors; Bret Leslie
Subject: ENG3 TSPA barrier analysis session summary

Attached please find a bulleted summary of the ENG3 TSPA barrier analysis session. If anyone has any questions or comments please let me know...

1) Scope of ENG3
The following TSPA components are likely to be within the purview of ENG3:
PCE_TOUGHREACT
PCE_EQ3/6
PCE_In Drift Chemistry Abstraction
Flux Splitting??

The status of the EBS Flux splitting model was not clear. It belongs with either UZ2, ENG3, or ENG4; joint agreement would be needed to determine who would take ownership of it. Based on the workload of both UZ2 and ENG4, and on the fact that crack dripping proactive work experiments are being conducted under ENG3, it was agreed that ENG3 may be the appropriate candidate. This would need confirmation from UZ2 and ENG4.

2) Barrier Identification
DOE-Identified Barriers likely to be relevant to ENG3 (from EBS RTA, Table 6.7-1):
As far as we could see, there are no barriers for which ENG3 would be directly responsible. Instead, ENG3 outputs determine the performance of the barriers reviewed by other teams, primarily ENG1 and ENG4. The following summary will identify the ENG1/4 barriers impacted by ENG3 outputs.

Drip Shield around the Waste Packages (ENG1): Prevent water contacting the waste package and waste form by diverting water flow around the waste package, limiting advective flow through the invert.
ENG3 is related to this barrier in that localized corrosion of the drip shield is a function of seepage water chemistry and in-drift chemical conditions.
ENG3 is related to this barrier in that localized corrosion of the waste package is a function of in-drift chemical conditions.
In addition, the choice of an appropriate approach for modeling general corrosion is dependent on the formation of a passive chemical layer, which is a function of the chemical conditions on the exposed surfaces of the drip shield. Selection of an appropriate model for stress corrosion cracking of the drip shield would also be dependent on the chemical environment. ENG3 would provide input to ENG1 as to the suitability of the approaches for modeling general corrosion and stress corrosion cracking.

Waste Package (ENG1): Prevent water from contacting the waste form for the effective life of the package
ENG3 is related to this barrier in that localized corrosion of the waste package is a function of in-drift chemical conditions.
In addition, the choice of an appropriate approach for modeling general corrosion is dependent on the formation of a passive chemical layer, which is a function of the chemical conditions on the exposed surface of the waste package. Selection of an appropriate model for stress corrosion cracking of the waste package would also be dependent on the chemical environment. ENG3 would provide input to ENG1 as to the suitability of the approaches for modeling general corrosion and stress corrosion cracking.

Waste Package (ENG4): Limit advective and diffusive transport of radionuclides from failed waste packages by sorption onto steel internal component corrosion products Waste Form (ENG4): Limit radionuclide release rates as a result of low degradation rates for the waste forms, and low radionuclide solubilities

ENG3 is related to these barriers in that in-package chemistry is a function of the in-drift chemical environment and the chemical composition of seepage water and these phenomena are a function of in-package chemistry.

Invert (ENG4): Limit diffusive transport of engineered barriers out of the engineered barriers by maintaining unsaturated conditions under the waste package. Limit advective and diffusive transport of radionuclides by sorption onto crushed tuff
ENG3 is related to these barriers in that these phenomena are a function of the invert chemical environment. Note: It is not clear if this barrier includes nuclide solubity in the invert, which is a function of the invert chemical environment (primarily pH)

NRC Risk Insights for ENG3
High: Chemistry of Seepage Water

3) Information to support an understanding of barrier performance General Information Recall that the EBS transport abstraction has one source term domain and three transport domains: waste form, corrosion product, and invert. The radionuclide mass can be in the following locations:

Source Term Domain
- Bound within waste form matrix in non-failed waste packages
- Bound within waste form matrix in intact cladding in packages that have failed
- Bound within waste form matrix in degraded cladding in packages that have failed

Waste Form Domain: Released into the WF domain and present as either
1) a precipitated mass;
2) a dissolved mass;
3) associated with suspended colloids; or
4) associated with destabilized colloids.

Corrosion Product Domain: Released into the corrosion product domain and present as either
1) a precipitated mass;
2) a dissolved mass;
3) associated with suspended colloids;
4) associated with destabilized colloids;
5) reversibly sorbed to corrosion products; or
6) irreversibly sorbed to corrosion products

Invert Domain: Released from the WP into the Invert and present as either
1) a precipitated mass;
2) a dissolved mass;
3) associated with suspended colloids;
4) associated with destabilized colloids;

Unsaturated Zone

Saturated Zone

Biosphere

Each of these locations is potentially associated with a barrier. A mass balance that accounted for all of these locations would yield information on where activity was retained within the system. Identifying where the mass is located in the system may provide an indication of the effectiveness of the associated barrier. Mass balances and mass fluxes are saved in the TSPA results section, and these mass balances may therefore provide an indication of the effectiveness of the different barriers for different nuclides.

Specific Information:

WPDS Degradation (ENG1):
Failure rate (fraction of packages/shields that have some degree of corrosion failure) and failure extent (average extent of damage per failed waste package/drip shield) of waste packages and drip shields are outputs from WAPDEG and can be saved. Because average dripping fluxes, average drip shield fluxes, and average waste package fluxes can be saved, computations of diverted water can yield insights into the barrier performance of partially failed WP/DS.

- In-Package Chemistry (ENG4): time histories of pH and ionic strength can be saved. In package chemistry does not represent a barrier in and of itself; however, it determines the performance of other barriers (e.g., solubility, colloidal stability, waste form degradation, etc.). The impact of the in-drift chemistry on the in-package chemistry can be examined. Mass balances on source term and transport domains in the WP can yield insights into degree of the performance of barriers internal to the WP.

- Invert Chemistry (ENG3/4): Time histories of invert pH, ionic strength, and carbonate concentration can be saved. The impact of invert chemistry on sorption, solubility, and colloid stability can be examined by examining the extent to which radionuclide mass accumulates in the invert as a result of precipitation, colloid destabilization, and sorption. Note: Flux-dependent chemistries may need integration with UZ2 to ensure that the heterogeneity in water flow rates is appropriately accounted for.

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