From: Osvaldo Pensado
Sent: Thursday, February 15, 2007 6:38 PM
To: Andy Jung
Cc: Pavan Shukla; '[redacted]'; Ronald Janetzke; Xihua He; Luis Ibarra; Yi-Ming Pan
Subject: Revised value of DripShieldCorrosionRate[m/yr]
Attachments: parameters.wpd

This is a revised value of the DS corrosion rate. This parameter is rather important, because it affects MECHFAIL. I hope we can put it in the next beta version.

Ron, this same text is available at s:\opensado\parameters.wpd

DripShieldCorrosionRate[m/yr]	logTriangular 2E-8, 2.98E-7, 6.4E-7	**Drip Shield Corrosion Rate** Based on data in the report CNWRA 2001-03, a likely value of the anodic current grade 7 is 10^{-8} A/cm^2. Such current density is equivalent to a corrosion rate of 8.7 Based on 1-year crevice sample data by the DOE (General Corrosion and Localiz Corrosion of the Drip Shield, ANL-EBS-MD-000004 REV 02, September 2004), a the Ti corrosion rate of 3.2×10^{-7} m/yr is assumed. The low bound for the corrosio report is 0 (actually, weight loss experiments resulted in negative corrosion rates) Instead, based on observations of long-term corrosion rates reported in the literat reasonable to assume a low bound in the corrosion rate of 10^{-8} m/yr (order of ma guess). Corrosion rates are doubled to account for corrosion on both sides of the drip shie **Other literature data**: Blackwood et al. (1988) reported a maximum rate of $10–20\times10^{-7}$ m/yr for a pH = solution and < $1–2\times10^{-7}$ m/yr for pH ~ 2 solution. It is very unlikely to get solution low pH in Yucca Mountain Repository. Thus, these data are ignored. In Metal's handbook, 9th Edition, Volume 13, the reported titanium grade 7 gener rates in 62% $CaCl_2$ at 150°C, 10% and 30% FeCl3, and saturated $MgCl_2$ boiling s nil (pp. 705-706). These solutions are very aggressive. For titanium grade 24/29 supports, Schutz (2003) reported that the general corros 5 times of that of titanium grade 7. German data for titanium Grade 7 after 3.5 yrs exposure to Q-brine 90°C — 6×10^{-8} m/yr 170°C — 4×10^{-8} m/yr 200°C — 1.5×10^{-7} m/yr The data at 90°C and 170°C are consistent with corrosion rates reported in CNW

		References: Bechtel SAIC. General and Localized Corrosion of the Drip Shield. Rev. 2, 2004 Blackwood, D.J., L.M. Peter, and D.E. Williams. "Stability and Open Circuit Break Passive Oxide Film on Titanium." Electrochimica Acta, 33, pp. 1143-1149. 1988. Scuutz, R.W. "Platinum Group Metal Additions to Titanium: a Highly Effective Stra Enhancing Corrosion Resistance." Corrosion. Vol. 59. pp. 1043-1057. 2003.

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Hearing Identifier: HLW_YuccaMountain_Hold_EX
Email Number: 1671

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Subject: Revised value of DripShieldCorrosionRate[m/yr]
Sent Date: 2/15/2007 6:38:08 PM
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From: Osvaldo Pensado

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Files	Size	Date & Time
MESSAGE	2710	2/15/2007 6:38:18 PM
parameters.wpd	4865581	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

Parameter	Distribution	Justification
Probability Parameters		
Probability_WPWaterContact_GC-Flt-Ig	1.0	Dec 18, 2006, presentation symbol: $P_{contact}$, general corrosion, faulting, igneous WPs Drip shield eventually fails by general corrosion (mean failure time ~ 30,000 years). High probability that compromised WPs will be eventually contacted by water.
Probability_WPWaterAllowance_GC-Flt-Ig	1.0	Dec 18, 2006, presentation symbol: $P_{allowance}$, general corrosion, faulting, igneous WPs Assume extensive damage on WP by general corrosion, faulting, or igneous events
Probability_WPWaterContact_InitialDefects	1.0	Dec 18, 2006, presentation symbol: $P_{contact}$, initially defective WPs Drip shield eventually fails by general corrosion (mean failure time ~ 30,000 years). High probability that compromised WPs will be eventually contacted by water.

Probability_WPWaterAllowance_InitialDefects	~~loguniform~~ ~~10^{-3}, 0.1~~ Uniform 10^{-3}, 0.1	Dec 18, 2006, presentation symbol: $P_{allowance}$, initially defective WPs Initially defective WPs can be affected by localized corrosion and mechanical damage. Thus, it is proposed to compute $P_{allowance}$ as a weighted average of the allowance values for LC and mechanically damages WPs. [1] Probability_WPWaterAllowance_InitialDefects = (1 – probability of LC – probability of mechanical failure) ε + (probability of LC) Probability_WPWaterAllowance_LC + (probability of mechanical failure) Probability_WPWaterAllowance_MechFail [2] probability of LC ~ 0.3 × Probability_WPWaterAllowance_LC × Probability_WPWaterContact_LC [3] probability of mechanical failure ~ 0.1 × Probability_WPWaterAllowance_MechFail × Probability_WPWaterContact_MechFail If ε = uniform(10^{-3}, 10^{-2}), then Eq. [1] spans from approximately from 10^{-3} to 0.1. The distribution for Probability_WPWaterAllowance_InitialDefects is a log-distribution. To keep consistency with other Probability distributions a loguniform distribution is proposed (to avoid implying that detailed information is available). Feedback: distribution should be revised to account for revised distributions of $P_{contact}$ and $P_{allowance}$ for LC and MECH. Resolution: If new distributions are used, the Pcontact distribution for initially defective WPs is well spread between 5×10^{-3} and 0.1. Since the interest is in order of magnitude estimates, a distribution uniform(10^{-3}, 0.1) is proposed.
Probability_WPWaterContact_MechFail	1.0	Dec 18, 2006, presentation symbol: $P_{contact}$, mechanically breached WPs Drip shield eventually fails by general corrosion (mean failure time ~ 30,000 years). High probability that compromised WPs will be eventually contacted by water.

Probability_WPWaterAllowance_MechFail	~~loguniform~~ ~~10^{-3}, 1.0~~ Uniform 10^{-2}, 1.0	Dec 18, 2006, presentation symbol: $P_{allowance}$, mechanically breached WPs ContactLengthSubarea_1[m]=normal{0.192, 0.808} Assume a 0.15-m flange and 5 ribs on the DS (all of them assumed to contact the WP). Thus, the total contact area is ~ {0.0288, 0.1212} m^2. Projected WP surface: (WPLength[m]=5.165; WPDiameter[m]=1.659) = 8.56874 m^2 Damaged fraction: {0.0168053, 0.0707222} The damaged fraction may be overestimated. On the other hand, it can be argued that seepage could run along the WP causing higher seepage capture. It is reasonable to lower the low bound by a factor of 10 and increase the upper bound by a factor of 10, and assume a log-uniform distribution. WPs could open with time, making more inventory available for release (there is a chance that WPs could open up with later seismic events increasing the size of the WP damaged area, and increase the "allowance" probability). Thus, an upper bound of 1 is reasonable. ENG2 feedback: low bound of 10^{-3} is too low, the capture area could be high thus ENG2 disagrees that emphasis should be on lower values of the distribution. **Resolution**: increase the low bound in a factor of 10 and use a uniform distribution.

Probability_WPWaterContact_LC	~~loguniform~~ ~~10^{-}, 10^{-2}~~ uniform 10^{-3}, 0.1	Dec 18, 2006, presentation symbol: $P_{contact}$, localized corrosion WPs **Damaged DS surface** Assumed damage area on drip shield ~ 0.5 m^2 (strip 0.5-m wide and 1-m long) Projected DS surface: 2.75 m × 5.165 m = 14.2 m^2 Damaged projected fraction ~ 0.5/14 = 0.03 ~ 0.01 If the damaged area on the drip shield is in the form of cracks, then a 0.01 fraction is clearly an overestimation. **Probability that seepage will land on crevice areas appropriate for LC, p_c** Approximately 0.01 of the total surface is comprised of welds. There is a 3% probability that localized corrosion will happen on the body and welded areas. There is a 23% probability that LC will occur on welded areas only. If p is the probability that seepage lands in crevices, then the probability that seeps land on crevices with welds is 0.01 p, and on crevices without welds (1−0.01) p. p_c can be computed as a weighted average: $p_c = (0.23/0.26)\ 0.01\ p + (0.03/0.26)\ (1-0.01)\ p = 0.12\ p \sim 0.1\ p$ Multiplying the damaged DS surface times p_c: Probability_WPWaterContact_LC = 0.001 p It is reasonable to assume Probability_WPWaterContact_LC ~ loguniform[10^{-4}, 10^{-2}] The low end derives from assuming p=0.1. The upper recognizes that the drip shield could capture a higher proportion of seepage than the dictated by the damaged DS surface fraction. It is reasonable to emphasize lower values of the distribution; thus the selection of a log-distribution. Mean(loguniform[10^{-4}, 10^{-2}]) = 0.002 Interpretation: if drip shields collapse, only 2/1000 WPs will be contacted by seepage with the potential to induce localized corrosion. ENG2 feedback: low bound of 10^{-3} is too low, the capture area could be high thus ENG2 disagrees that emphasis should be on lower values of the distribution. **Resolution**: increase bounds in a factor of 10 and use a uniform distribution. T. Ahn: heat affected zone is also more susceptible to LC than mill annealed material. Up to 10% of the WP surface could be HAZ (extreme case). **Resolution**: considering 10% weld surface changes p_c from 0.1 p to 0.2 p. Thus, this observation does not significantly impact the parameter value.

Probability_WPWaterAllowance_LC	1.0	Dec 18, 2006, presentation symbol: $P_{allowance}$, localized corrosion WPs If localized corrosion occurs, it is because seepage contacts appropriate crevice regions. Thus, there is a high chance that such water may infiltrate the WP.
Seepage Factors		
InitialSeepageReductionFractionByMechFailedDS	~~Uniform 0.01, 0.1~~ loguniform 0.01, 1.0	Dec 18, 2006, presentation symbol: term to define step in seepage factor f_D Assumed damage area on drip shield ~ 0.5 m^2 (strip 0.5-m wide and 1-m long) Projected DS surface: 2.75 m × 5.165 m = 14.2 m^2 Damaged projected fraction ~ 0.5/14 = 0.03 Assume 5 seepage points impinging on the DS, fixed in space. Then, the probability that one of the seepage points will coincide with the opening on the DS is 5 × 0.03 ~ 0.1 A factor of 10 decrease, due to an smaller DS damaged area (likely to be in the form of cracks) is a reasonable assumption for a low bound on the distribution. It is considered that 0.1 upper bound value may be overestimated given that the damaged area on the DS may be much smaller. Probably assuming 5 seepage points per DS is also an overestimation. Mean(uniform[0.01, 0.1]) = 0.05 **Interpretation**: only 5 percent of the seepage impinging on damaged drip shields, infiltrates those. ENG2 feedback: the possibility of full water capture should be considered. Catchment area on DS may be higher that the 10% fraction initially estimated as upped bound. **Resolution**: range extended to 100%, but loguniform distribution selected to reflect opinion that catchment area could be small.
DSSeepageProtectionDegradationRate[1/yr]	0.0	Dec 18, 2006, presentation symbol: term to define slope in seepage factor f_D This parameters was proposed to allow for openings on the DS to grow (linearly) in time, capturing more and more seepage as time elapses. There is no information to propose a value for the degradation rate. This parameter is not too important if the parameter InitialSeepageReductionFractionByMechFailedDS is relatively large. Also, eventually the DS fails by general corrosion; at that time, it is assumed that 100% of the seepage infiltrates the DS. Thus, this parameter is not relevant for long-term simulations.

InitialSeepageReductionFractionByMechFailedWP	~~loguniform 0.01, 1.0~~ Uniform 0.01, 1.0	Dec 18, 2006, presentation symbol: term to define step in seepage factor f_W The breached DS area may be close to the breached area on the WP. As an extreme case, it is considered that all of the seepage impinging on the WP, infiltrates the WP (although this scenario appears unlikely). Since a correlation could exist between the impinging point of seepage on the WP and the location of the breached area on the WP, geometrical arguments to estimate parameter InitialSeepageReductionFractionByMechFailedWP are of limited value. A 0.01 and 1 bound values are (arbitrarily) assumed. A log-distribution is proposed, since it is considered that low-values are more likely than high values. General feedback: no good justification on why low values should be highlighted by the distribution. Resolution: use uniform distribution.
WPSeepageProtectionDegradationRate[1/yr]	0.0	Dec 18, 2006, presentation symbol: term to define slope in seepage factor f_W This parameter is not important if InitialSeepageReductionFractionByMechFailedWP is sampled at high values. It is not clear the mechanism for which a mechanically breached WP could further open the WP as a function of time. Probably seismic events could lead to further opening, but it unknown the frequency of those events (are events with a recurrence rate of 10^{-3}/yr or higher sufficient to induce opening of initial fractures?). If we assume that only 10^{-4}/yr events could further open mechanically damaged waste packages; then, the following distributions could be used: 1 later event to induce complete opening: lognormal(4.2×10^{-6}, 0.006) 1/yr 2 later events for complete opening: lognormal(5.8×10^{-6}, 0.00066) 1/yr 3 later events for complete opening: lognormal(5.86×10^{-6}, 0.00025) 1/yr 4 later events for complete opening: lognormal(5.57×10^{-6}, 0.00014) 1/yr Mechanisms for gradual opening are entirely hypothetical. A zero value for the degradation rate is recommended.

InitialSeepageReductionFractionLC	loguniform 0.001, 0.1	Dec 18, 2006, presentation symbol: term to define step in seepage factor f_W It is uncertain the fraction of the seepage infiltrating the WP to the impinging on the WP. However, it appears that the fraction should be small, because of the following observations: 1) Localized corrosion is in the form of crevice corrosion. Crevices must be tight for crevice corrosion to propagate (opening of crevices causes arrest of localized corrosion). If crevices are tight, water will not flow freely but rather diffuse into the crevice area. 2) Pits in the crevice area are a few microns in diameter, and full with corrosion products, further restricting the flow of water. For those reasons, it is reasonable to assume that the infiltrated seepage is a small fraction (1/1000 or greater) of the seepage impinging on the waste package. It is not recommended to make the fraction smaller than 1/1000 as the advective release model implemented in the TPA code may cease to be meaningful (the advective release model is an appropriate description in the limit when there is a significant flow in and out of the WP). The upper bound of 0.1 is selected as a reasonable value. A log-distribution is proposed because it is considered that lower values are more likely. X. He feedback: Only 1% to 10% of the crevice corroding area will be developed into active corrosion area that may lead to penetration through the WP. Resolution: no change was recommended.
WeldAdvectiveFraction[] **to be renamed as** InitialSeepageReductionFractionWeldLC	loguniform 0.001, 0.1	Dec 18, 2006, presentation symbol: term to define step in seepage factor f_W Propose to use the same distribution as InitialSeepageReductionFractionLC
InitialSeepageReductionFractionInitiallyDefWP	loguniform 0.001, 0.1	Dec 18, 2006, presentation symbol: term to define step in seepage factor f_W (initially defective WPs) Propose to use the same distribution as InitialSeepageReductionFractionLC
~~InitialDefWPSeepageProtectionDegradationRate[1/yr]~~ WPSeepageProtectionDegradationRateInitiallyDefWP[1/yr]	0.0	Dec 18, 2006, presentation symbol: term to define slope in seepage factor f_W (initially defective WPs) Parameter added to enhance flexibility, defaulted at 0.0. No clear mechanism is envisioned by which initially defective WPs may open as time elapses.

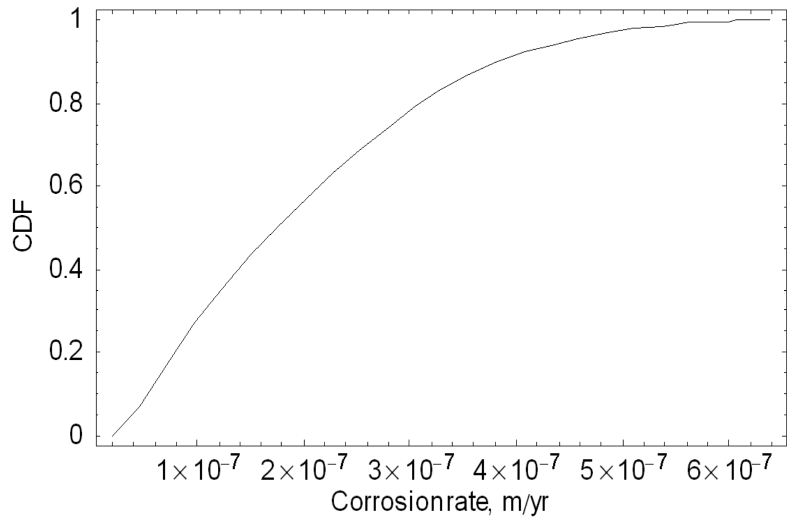
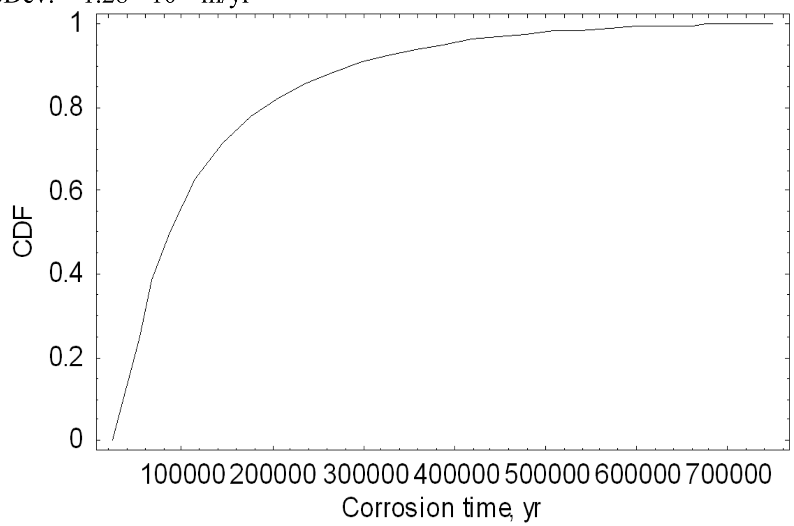
Waste Form Dissolution		
FractionOfWPsWithDiffusionTilt[]	0.0	The net effect of this parameter is to eliminate diffusion from release computations.
WaterContactMode_Initial(0=BathTub,1=FlowThrough) WaterContactMode_Faulting(0=BathTub,1=FlowThrough) WaterContactMode_Volcanic(0=BathTub,1=FlowThrough) WaterContactMode_SeismicInterval1(0=BathTub,1=FlowThrough) WaterContactMode_SeismicInterval2(0=BathTub,1=FlowThrough) WaterContactMode_SeismicInterval3(0=BathTub,1=FlowThrough) WaterContactMode_SeismicInterval4(0=BathTub,1=FlowThrough) WaterContactMode_Corrosion(0=BathTub,1=FlowThrough)	1	Set flow-through as default water contact mode. Flow-through produces earlier releases of radionuclides in solution and in colloidal form compared to bathtub. In bathtub, advective and colloidal releases only occur after the bathtub overflow. Probably earlier releases could occur in the form of diffusion; however, existing diffusion model in TPA was not designed to address that scenario (existing model may overestimate diffusive releases). It is recommended to default the water contact mode to flow-through.

SFWettedFraction_Initial_X X=1, 2, ..., 10	loguniform 0.001, 0.1	Propose to use the same distribution as InitialSeepageReductionFractionInitiallyDefWP. **Propose using a rank correlation coefficient equal to 0.7**. The justification is that if seepage is significantly decreased, then only a small fraction of the waste form will be contacted by seepage. T. McCartin proposed to increase the SFWettedFraction when general corrosion fails WPs. This increase is not relevant, as the general corrosion WP source will shadow any previous releases. Thus, it is proposed to preserve the current approach of constant SFWettedFraction value. In the TPA code, the set of initially defective WPs is treated as a disjoint set of the LC WPs or mech WPs. Such an approach is conservative. Thus, there is no need to consider the scenario where initially defective WPs could also experience LC or mechanical breaching.
SFWettedFraction_FAULT O	uniform 0.0, 1.0	No change with respect to previous TPA code versions.
SFWettedFraction_VOLCA NO	uniform 0.0, 1.0	No change with respect to previous TPA code versions.
SFWettedFraction_SEISM O1_X SFWettedFraction_SEISM O2_X X=1, 2, ..., 10	~~loguniform~~ ~~0.01, 1~~ uniform 0.01, 1.0	Propose to use the same distribution as InitialSeepageReductionFractionByMechFailedWP. Propose using a rank **correlation coefficient equal to 0.7.** The justification is that if seepage is significantly decreased, then only a small fraction of the waste form will be contacted by seepage. T. McCartin proposed to increase the SFWettedFraction when general corrosion fails WPs. This increase is not relevant, as the general corrosion WP source will shadow any previous releases. Thus, it is proposed to preserve the current approach of constant SFWettedFraction value. Mechanically failed WPs could also experience localized corrosion at earlier times than the time of mechanical breaching. Increases due to WP localized corrosion on the SFWettedFraction are negligible, because the probability that a WP is mechanically breached and also affected by localized corrosion and also capture water to mobilize the waste form is negligible (computations documented in the file RevisedParameters.nb). ENG2 feedback: change distribution to reflect change in InitialSeepageReductionFractionByMechFailedWP. Resolution: distribution changed for consistency.

SFWettedFraction_SEISMO3_X X=1, 2, ..., 10	uniform 0, 1	This parameter is not used. Consider removing.
SFWettedFraction_SEISMO4_X X=1, 2, ..., 10 To be renamed as SFWettedFraction_LC_X	loguniform 0.001, 0.1	Propose to use the same distribution as InitialSeepageReductionFractionLC. **Propose using a rank correlation coefficient equal to 0.7.** The justification is that if seepage is significantly decreased, then only a small fraction of the waste form will be contacted by seepage. T. McCartin proposed to increase the SFWettedFraction when general corrosion fails WPs. This increase is not relevant, as the general corrosion WP source will shadow any previous releases. Thus, it is proposed to preserve the current approach of constant SFWettedFraction value.
SFWettedFraction_Corrosion_X X=1, 2, ..., 10	uniform 0.0, 1.0	No change with respect to previous TPA code versions. This parameter will be applied to waste packages failed by general corrosion.
FuelRodHalfLength[m]	0.0	Value selected to allow for instantaneous unzipping. Alternatively, CladdingVelocityEnhancementFactor[] = 10^6. O. Pensado proposed to modify the cladding model to allow for gradual exposure of the WF. However, it is not clear the meaning of such a gradual exposure (the same exposure parameters would be used for all of the WP failure modes). Therefore, it is recommended to leave the cladding model as is, but make FuelRodHalfLength[m]=0.0 to allow for instantaneous unzipping (no credit for gradual exposure of the waste form).
FractionOfWPsWithDiffusionTilt[]	0.0	Setting this parameter as 0 causes de-activation of diffusive releases. The diffusion model, and its parameters, should be re-evaluated if activated.

Remove old parameters		Remove the following block from tpa.inp as it could cause confusion. Interval 4 is now used for localized corrosion. iconstant NumberOfSEISMOWPFailureIntervals 4 constant BeginningOfSEISMOWPFailureInterval1[yr] 0.0 constant BeginningOfSEISMOWPFailureInterval2[yr] 2000.0 constant BeginningOfSEISMOWPFailureInterval3[yr] 5000.0 constant BeginningOfSEISMOWPFailureInterval4[yr] 10000.0
Miscellaneous		
DefectiveFractionOfWPs/cell	loguniform 10^{-4}, 10^{-2}	Distribution in TPA 4.0: uniform[10^{-4}, 10^{-2}] . No clear justification on the distribution selection is available. Selection of "uniform" was arbitrary. The probability of the presence of waste packages sufficiently defective to allow immediate release as soon as contacted by water should be small given inspection procedures in place. Recommend replacing uniform by loguniform. T. Ahn feedback: upper bound of 10^{-2} is too high. Resolution: agree with selection of loguniform distribution.
DripShieldCorrosionRate[m/yr]	logTriangular 2×10^{-8} , 2.98×10^{-7}, 6.4×10^{-7}	**Drip Shield Corrosion Rate** Based on data in the report CNWRA 2001-03, a likely value of the anodic current density of Ti grade 7 is 10^{-8} A/cm^2. Such current density is equivalent to 8.7×10^{-8} m/yr. Based on 1-year crevice sample data by the DOE (General Corrosion and Localized Corrosion of the Drip Shield, ANL-EBS-MD-000004 REV 02, September 2004), an upper in the Ti corrosion rate of 3.2×10^{-7} m/yr is assumed. The low bound for the corrosion rate in this report is 0 (actually, weight loss experiments resulted in negative corrosion rates). Instead, based on observations of long-term corrosion rates reported in the literature, it is reasonable to assume a low bound in the corrosion rate of 10^{-8} m/yr (order of magnitude guess). **Other literature data**: Blackwood et al. (1988) reported a maximum rate of 10–20×10^{-7} m/yr for a pH = 1 acidified solution and < 1–2×10^{-7} m/yr for pH ~ 2 solution. It is very unlikely to get solution with such low pH in Yucca Mountain Repository. Thus, these data are ignored.

		In Metal's handbook, 9th Edition, Volume 13, the reported titanium grade 7 general corrosion rates in 62% $CaCl_2$ at 150°C, 10% and 30% FeCl3, and saturated $MgCl_2$ boiling solutions are nil (pp. 705-706). These solutions are very aggressive. Hua and Gordon (2004) reported the corrosion rate of titanium Grade 7 in BSW-12 at 60°C to 105 °C is 2.03×10^{-7} to 6.6×10^{-7} m/yr. Such data are based on short-term weight loss, which data are known less precise than electrochemical methods, tending to overestimate corrosion rates. Thus, these data are ignored to define a corrosion rate distribution. For titanium grade 24/29 supports, Schutz (2003) reported that the general corrosion rate is 4-5 times of that of titanium grade 7. German data for titanium Grade 7 after 3.5 yrs exposure to Q-brine 90°C — 6×10^{-8} m/yr 170°C — 4×10^{-8} m/yr 200°C — 1.5×10^{-7} m/yr The data at 90°C and 170°C are consistent with corrosion rates reported in CNWRA 2001-03. **References**: Bechtel SAIC. General and Localized Corrosion of the Drip Shield. Rev. 2, 2004 Blackwood, D.J., L.M. Peter, and D.E. Williams. "Stability and Open Circuit Breakdown of the Passive Oxide Film on Titanium." Electrochimica Acta, 33, pp. 1143-1149. 1988. Hua, F. and G. Gordon. "Corrosion Behavior of Alloy 22 and Ti Grade 7 in a Nuclear Waste Repository Environment." Corrosion, Vol. 60. pp. 764-777. 2004. Scuutz, R.W. "Platinum Group Metal Additions to Titanium: a Highly Effective Strategy for Enhancing Corrosion Resistance." Corrosion. Vol. 59. pp. 1043-1057. 2003.

		 Median: 1.74×10^{-7} m/yr Mean: 2×10^{-7} m/yr SDev: 1.28×10^{-7} m/yr 

		Min: 23,438 yr Max: 750,000 yr Mean: 129,185 yr Median: 86,207 yr SDev: 113,356 yr
Ebsflo.def		Adjust fwet column to 1.0 values
OuterOverpackErpIntercept	triangular 1541.2, 1591.2, 1641.2	mV_{SHE} Reference: CNWRA 2005-02, Table 5-2
TempCoefOfOuterPackErpIntercept	constant -13.1	mV/°C Reference: CNWRA 2005-02, Table 5-2
OuterOverpackErpSlope	constant -362.7	mV Reference: CNWRA 2005-02, Table 5-2
TempCoefOfOuterPackErpSlope	constant 2.3	mV/°C Reference: CNWRA 2005-02, Table 5-2
CritChlorideConcForFirstLayer[mol/L]	constant 1.0E-4	mol/L Reference: CNWRA 2005-02 Note that Table 5-2 recommends a value of 0.5. However, Figure 4-6 reports localized corrosion at $[Cl^-]$=0.05 mol/L at 95 °C in mill annealed material. Since critical chloride threshold does not appear to be well defined, D. Dunn and O. Pensado recommend to disregard such a threshold (setting the concentration to a small value is equivalent to disregarding a threshold). Note that the minimum chloride concentration in Figure 5-4 is 4 mol/L; thus, this parameter change has no effect in the total system results.
WeldCritChlorideConc[mol/L]	constant 1.0E-4	mol/L Reference: CNWRA 2005-02 Table 5-2 recommends a value of loguniform(0.01, 0.25). Allowing the threshold value to be a distribution may artificially disregard situations where the corrosion potential exceeds the repassivation potential. Figure 4-6 reports localized corrosion at $[Cl^-]$ as low as 10^{-3} mol/L in welded+solution annealed material at 95 °C. . Since critical chloride threshold does not appear to be well defined, D. Dunn and O. Pensado recommend to disregard such a threshold (setting the concentration to a small value is equivalent to disregarding a threshold). Note that the minimum chloride concentration in Figure 5-4 is 4 mol/L; thus, this parameter change has no

		effect in the total system results.
AA_1_1[C/m2/yr]	Triangular 1600.0, 2133.33, 6400.0	**Alloy 22 corrosion rate** The range (1600.0, 6400.0) is based on passive current rate measurements reported in CNWRA 2003-01, 2004-01, 2005-02. The steady anodic current density at 95 °C is expected to be 10^{-8} A/cm^2 [or 3200 Coul/(m^{2}yr)]. The mode of the distribution, 2133.33 Coul/(m^{2}yr), is selected to make the median 3200 Coul/(m^{2}yr). In other words, the triangular distribution is designed so that half of the realizations are sampled with an anodic current density greater than 10^{-8} A/cm^2 and the other half, with a value less than 10^{-8} A/cm^2. The mean of the proposed triangular distribution is 3377.8 Coul/(m^{2}yr), corresponding to $1.07*10^{-8}$ A/cm^2 (i.e., the mean and the median of the distribution are close).
InitialRadiusOfSFParticle[m]	logbeta 7.2E-4, 6.02E-3, 3.573, 8.889	Radius of SF particle [m] used to compute the specific area [m^2/mg]. According to CSNF Waste Form Degradation: Summary Abstraction, ANL-EBS-MD-000015 REV 02, August 2004, the expected value of the specific area is 2.2×10^{-7} m^2/mg, with a low bound of 4.7×10^{-8} m^2/mg. It was assumed that the specific area follows a normal distribution with a mean value of 2.2×10^{-7} m^2/mg, and a 0.001 quantile value of 4.7×10^{-8} m^2/mg. The radius, *r*, as function of the specific area can be defined as r=3/(sa ρ), where ρ is the spent fuel density (currently 10,600 kg/m^3). A logbeta is an appropriate fit to the resulting distribution.