SCR - 552

TPA 5.0.0e

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): PA-SCR-552	**2. Software Title and Version:** TPA 5.0.0e	**3. Project No:** 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *tpa.inp, tefkti.inp, mechfail.def, dsfailt.def, drythick.dat, coefkdeq.dat, climato2.dat, burnup.dat, codes/Makefile4.2*

Finalize modifications to the data set for *tpa.inp*.

5. Change Requested by: S. Mohanty	**6. Change Authorized by** (*Software Developer*): R. Janetzke Date: 1-21-05

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

Part I: *Tpa.inp* was modified according the input from the data questionnaires sent out to subject matter experts in 2004. *Tpa.inp* changes from this review will be implemented with this SCR.

Nfenv.f - change parmeter name *TortuosityOfBackfill* to *TortuosityOfNaturalBackfill*

Dcagw.f - change parameter name *AquiferThickness5km* to *AquiferThickness*

Volcano.f - change parameter name *ExtrusiveEventFlag(0=no,1=yes)* to *ExtrusiveEventFlag(extrusive=1,intrusive=0)*

Ashremob.f - change parameter name *PostEruptionYieldVolumeFluvialAsh[m/event]* to *PostEruptionFluvialAshYieldVolumePerAreaPerEvent[m/event]*

change parameter name *AmbientSedimentYieldVolumeFromBasin[m/event]* to *AmbientSedimentYieldVolumePerBasinAreaPerEvent[m/event]*

Makefile4.2 for the codes subdirectory was modified for *snllhs.e* to allow the code to handle the new beta distributions. Otherwise, the code would hang in **SNLLHS** if the code was compiled using *Makefile4.2*.The range checks for **SeedForRandomNumber** and **SeedForRandomNumberForSEISMO** were modified in *ran.f*, *reader.f*, and *sampler.f* were modified to check for a number in the range of 2^{30} - 2^{31} instead of in the range 10^9 - 10^{10}. The new values for the seeds were outside the previous range.

8. Implemented by: Part I: C. Scherer Part II: B. Winfrey	**Date:** 2-10-2005 through 5-13-2005

9. Description of Acceptance Tests:

See Attachment A.

10. Tested by: N/A	**Date:**

CNWRA Form TOP-5 (05/2000)

Status (ADD, DELETE, MODIFY TO, MODIFY FROM)	Module	Parameter Name	Description 1. definition of parameter in terms of its funciton in TPA code (calculated from ..., used for calculating..., used to relate... etc)	Distribution	Range	Justificaiton 1. site references (journals, sci. notebooks, publishings) 2. is uncertainty covered by the distribution / range ? 3. explain why you chose this range / distribution vs. other possible values / methods / distributions	Source (Initials)
MODIFY FROM	EBSFILT	InvertThickness[m]	Invert thickness (m)	constant	0.75	Data possibly based on Snell (1997)	J. Winterle
MODIFY TO	EBSFILT	InvertThickness[m]	Invert thickness (m)	constant	0.606	Max thickness of invert, as described in the DOE EBS Transport Abstraction (Bechtel SAIC Company, LLC, 2001a).	J. Winterle
MODIFY FROM	UZFLOW	MeanAnnualPrecipitationMultiplierAtGlacialMaximum	Mean annual precipitation (MAP) multiplier at glacial maximum.	uniform	2.0, 3.0	Best estimate by USFIC team (Issue Resolution Status Report on climate, Nuclear Regulatory Commission, 1997, 1999). CRWMS M&O (2000a,b).	G. Walter

MODIFY TO	UZFLOW	MeanAnnualPrecipitationMultiplierAtGlacialMaximum	Mean annual precipitation (MAP) multiplier at glacial maximum	uniform	1.5, 3.3	Approximatly consistent with DOE "Future Climate Analysis --10,000 years to 1,000,000 years after present"	G. Walter
MODIFY FROM	SETUP	AverageCalendarYearAssumedForEmplacement[A.D.]	Calendar year in which the spent fuel is emplaced in the repository.	constant	2034.0		O. Povetko
MODIFY TO	SETUP	AverageCalendarYearAssumedForEmplacement[A.D.]	Calendar year in which the spent fuel is emplaced in the repository.	constant	2033.0	References for an input value of 2033 for emplacement year: 1. BWR Source Term Generation and Evaluation, BBAC00000-01717-0210-0010REV 01 1999 2. PWR Source Term Generation and Evaluation, BBAC00000-01717-0210-0010 REV 01 1999	O. Povetko
MODIFY FROM	DCAGW	AquiferThicknes s5km[m]	Aquifer thickness (m)	uniform	300.0, 700.0	Parameter not required based on specifications in 10 CFR Part §63.102. Still in code for possible future use. Luckey et al (1996)	G. Wittmeyer

MODIFY TO	DCAGW	AquiferThicknes s[m]	Aquifer thickness (m)	uniform	300.0, 700.0	Parameter not required based on specifications in 10 CFR Part §63.102. Still in code for possible future use. Luckey et al (1996)	G. Wittmey er
MODIFY FROM	NFENV	TortuosityOfBac kfill[]		uniform	1.25, 3.0	CNWRA best estimate. Sensitivity analysis needed to determine effects on performance.	S. Mohanty
MODIFY TO	NFENV	TortuosityOfNat uralBackfill[]	[unitless]	uniform	1.25, 3.0		S. Mohanty
MODIFY FROM	UZFT	UZFractureForce FactorForKdtoR d	UZFFFFKTR=0.->Rd= 1.,else Rd=calculated	constant	0.0	User option. Program control switch used to investigate retardation effects	R. Janetzke
MODIFY TO	UZFT	UZFractureForce FactorForKdtoR d[0 or 1; 0 implies Rd=1]	User option to turn sorption on/off in fractures for Am, Np, Pu, Th, U. If UZFFFKTR = 0 then Rd = 1 (no sorption).	constant	0.0	The only values that should be used are 0.0 (no sorption, Rd =1) and 1.0 (sorption allowed; Rd calculated from surface response function)	R. Janetzke
DELETE	SETUP	ComponentInver tStudy	If (ImportanceAnalysisFla g = 1) and (ComponentInvertStudy = 1), then parameters related to the Invert are studied.	iflag	0		BLW

DELETE	SETUP	BarrierInvertStudy	If (ImportanceAnalysisFlag = 1) and (BarrierInvertStudy = 1), then parameters related to ENGINEERED/INVERT are studied.	iflag	0		BLW
DELETE	SETUP	ComponentDripShieldStudy	If (ImportanceAnalysisFlag = 1) and (ComponentDripShieldStudy = 1), then parameters related to the Drip Shield are studied.	iflag	0		BLW
DELETE	SETUP	ComponentBackfillStudy	If (ImportanceAnalysisFlag = 1) and (ComponentBackfillStudy = 1), then parameters related to Backfill are studied.	iflag	0		BLW
DELETE	SETUP	BarrierDriftStudy	If (ImportanceAnalysisFlag = 1) and (BarrierDriftStudy = 1), then parameters related to ENGINEERED/DRIFT/BACKFILL and DRIP SHIELD are studied.	iflag	0		BLW

DELETE	SETUP	SubsystemEngineeringStudy	If (ImportanceAnalysisFlag = 1) and (SubsystemEngineeringStudy = 1), then parameters related to Engineered barriers are studied.	iflag	0		BLW
DELETE	SETUP	ComponentWellWaterStudy	If (ImportanceAnalysisFlag = 1) and (ComponentWellWaterStudy = 1), then parameters related to Well Water are studied.	iflag	0		BLW
DELETE	SETUP	BarrierReceptorGroupStudy	If (ImportanceAnalysisFlag = 1) and (BarrierReceptorGroupStudy = 1), then the prameters related to Natural/Receptor Group/Well Water are studied.	iflag	0		BLW
DELETE	SETUP	Component_STFF_SAV_Study	If (ImportanceAnalysisFlag = 1) AND (Component_STFF_SAV_Study = 1), THEN parameters related to STFF/SAV layer are studied.	iflag	0		BLW

DELETE	SETUP	BarrierSaturated ZoneStudy	If (ImportanceAnalysisFlag = 1) and (BarrierSaturatedZoneStudy = 1), then the parameters related to Natural/Saturated Zone/STFF_SAV are studied.	iflag	0		BLW
DELETE	SETUP	ComponentBFw Study	If (ImportanceAnalysisFlag = 1) and (ComponentBFwStudy = 1), then parameters related to BFw layer are studied.	iflag	0		BLW
DELETE	SETUP	ComponentUCF Study	If (ImportanceAnalysisFlag = 1) and (ComponentUCFStudy = 1), then parameters related to the UCF layer are studied.	iflag	0		BLW
DELETE	SETUP	ComponentPPwS tudy	If (ImportanceAnalysisFlag = 1) and (ComponentPPwStudy = 1), then parameters related to the PPw layer are studied.	iflag	0		BLW

DELETE	SETUP	ComponentCHnz Study	If (ImportanceAnalysisFlag = 1) and (ComponentCHnzStudy = 1), then parameters related to CHnz layer are studied.	iflag	0		BLW
DELETE	SETUP	ComponentCHnv Study	If (ImportanceAnalysisFlag = 1) and (ComponentCHnvStudy = 1), then parameters related to CHnv layer are studied.	iflag	0		BLW
DELETE	SETUP	ComponentTSw Study	If (ImportanceAnalysisFlag = 1) and (ComponentTSwStudy = 1), then parameters related to the TSw layer are studied.	iflag	0		BLW
DELETE	SETUP	BarrierLowerUnsaturatedZoneStudy	If (ImportanceAnalysisFlag = 1) and (BarrierLowerUnsaturatedZoneStudy = 1), then parameters related to NATURAL/LOWER UNSATURATED ZONE/TSw,CHnv,CHnz,PPw,UCF and BFw are studied.	iflag	0		BLW

DELETE	SETUP	ComponentTiva CanyonStudy	If (ImportanceAnalysisFla g = 1) and (ComponentTivaCanyo nStudy = 1), then parameters related to Tiva Canyon are studied.	iflag	0		BLW
DELETE	SETUP	BarrierUpperUns aturatedZoneStu dy	If (ImportanceAnalysisFla g = 1) and (BarrierUpperUnsaturat edZoneStudy = 1), then the parameters related to Natural / Upper Unsaturated Zone are studied.	Iflag	0		BLW
DELETE	SETUP	ComponentPreci pitationStudy	If (ImportanceAnalysisFla g = 1) and (ComponentPrecipitatio nStudy = 1), then parameters related to Precipitation are studied.	iflag	0		BLW

DELETE	SETUP	BarrierBiosphere Study	If (ImportanceAnalysisFlag = 1) and (BarrierBiosphereStudy = 1), then parameters related to NATURAL/BIOSPHERE are studied.	iflag	0		BLW
DELETE	SETUP	SubsystemNaturalStudy	If (ImportanceAnalysisFlag = 1) and (SubsystemNaturalStudy = 1), then parameters related to Natural barriers are studied.	iflag	0		BLW
DELETE	DSFAIL	MaximumFluoride[mol/L]	max fluoride used for calculation for enhancing factor of TICorrosionRate vs Fluoride			OPR: This value corresponds to the maximum floride concentration above which no further fluoride enhancement on the corrosion rate is noticed. This fluoride concentration has nothing to do with the environment. OPR: Recommended to default this parameter to 2.0E-3 in dsfail.def and remove from tpa.inp.	O. Pensado

DELETE	DSFAIL	TiCorrosionRate VsFluorideSlope []	relation used in calculation for enhancing factor for TI corrosion Rate as function of Fl.			OPR: This value corresponds to the minimum floride concentration below which no fluoride enhancement on the current density or corrosion rate is discernible. This fluoride concentration is not related to the existing environment. OPR: Recommended to default this parameter to 1.0E-4 in dsfail.def and remove from tpa.inp.	O. Pensado

DELETE	DSFAIL	MinimumFluoride[mol/L]	min fluoride used for calculation for enhancing factor of TICorrosionRate vs Fluoride			CNWRA 2001-003. XH. OPR: Assumed an enhancement factor of 1 at MinimumFluoride[mol/L] and an enhancement factor of 5000 at MaximumFluoride[mol/L]. A linear relationship was assumed between the log(enhancement factor) and log(fluoride concentration). The corrosion rate is computed as the product of the enhancement factor times a base corrosion rate (corrosion rate measured at a low or zero fluoride concentration). OPR: Recommended to default this parameter to 2.84 in dsfail.def and remove from tpa.inp.	

Attachment A

No testing is required since no significant codes changes were made.

SCR - 552–1

TPA 5.0.2d

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 552-1	**2. Software Title and Version:** TPA 5.0.2d	**3. Project No:** 20.06002.01.354
4. Affected Software Module(s), Description of Problem(s): *tpa.inp* The *tpa.inp* file does not have the latest Kd values from P. Bertetti.		
5. Change Requested by: Paul Bertetti Date: 12-20-05	**6. Change Authorized by** (*Software Developer*): Ron Janetzke Date: 12-20-05	
7. Description of Change(s) or Problem Resolution: See Attachment A.		
8. Implemented by: Ron Janetzke	**Date:** 12/08/2005	
9. Description of Acceptance Tests: No testing is required since there are no significant coding changes.		
10. Tested by:	**Date:**	

CNWRA Form TOP-5 (05/2000)

UPDATE REQUIREMENTS for TPA.INP

SCR 552-1

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
(ADD, DELETE, MODIFY TO, MODIFY FROM)			*(Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.)* Distribution, Range			*1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	
MODIFY FROM	DCAGW	KD_Soil_Cm[cm3/g]		lognormal	1.5, 1.1e7		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	DCAGW	KD_Soil_Cm[cm3/g]		usersupplied pwise cdf	11 7666.0, 0.0 7785.4, 0.115 9604.6, 0.184 11849.0, 0.274 14617.9, 0.382 18033.7, 0.500 22247.8, 0.618 27446.7, 0.726 33860.4, 0.816 41772.8, 0.885 44260.0, 1.0		
MODIFY FROM	DCAGW	KD_Soil_Pu[cm3/g]		lognormal	2.0, 1.5e5		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	DCAGW	KD_Soil_Pu[cm3/g]		usersupplied pwise cdf	12 316.0, 0.0 395.4, 0.115 742.5, 0.184 1394.1, 0.274 2617.6, 0.382 4914.8, 0.500 9228.0, 0.618 17326.6, 0.726 32532.7, 0.816 61083.7, 0.885 114691.4, 0.933 190000.0, 1.0		
MODIFY FROM	DCAGW	KD_Soil_U[cm3/g]		lognormal	9.3e-4, 1.3e6		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	DCAGW	KD_Soil_U[cm3/g]		usersupplied pwise cdf	13 0.17, 0.0 0.27, 0.067 0.71, 0.115 1.86, 0.184 4.85, 0.274 12.7, 0.382 33.1, 0.500 86.5, 0.618 225.9, 0.726 589.9, 0.816 1540.7, 0.885 4023.9, 0.933 6000.0, 1.0		
MODIFY FROM	DCAGW	KD_Soil_Am[cm3/g]		lognormal	3.7e-1, 9.9e6		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	DCAGW	KD_Soil_Am[cm3/g]		usersupplied pwise cdf	12 100.0, 0.0 192.5, 0.184 419.9, 0.274 916.0, 0.382 1998.2, 0.500 4359.0, 0.618 9509.1, 0.726 20743.7, 0.816 45251.9, 0.885 98715.8, 0.933 215345.7, 0.964 300000.0, 1.0		
MODIFY FROM	DCAGW	KD_Soil_Np[cm3/g]		lognormal	1.9e-2, 1.3e3		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	DCAGW	KD_Soil_Np[cm3/g]		usersupplied pwise cdf	13 1.30, 0.0 1.92, 0.067 3.19, 0.115 5.31, 0.184 8.85, 0.274 14.7, 0.382 24.5, 0.500 40.9, 0.618 68.0, 0.726 113.3, 0.816 188.7, 0.885 314.2, 0.933 400.0, 1.0		
MODIFY FROM	DCAGW	KD_Soil_Th[cm3/g]		lognormal	3.2, 3.2e6		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	DCAGW	KD_Soil_Th[cm3/g]		usersupplied pwise cdf	9 1700.0, 0.0 2981.0, 0.500 5597.1, 0.618 10509.1, 0.726 19732.1, 0.816 37049.1, 0.885 69563.8, 0.933 130613.8, 0.964 170000.0, 1.0		
MODIFY FROM	DCAGW	KD_Soil_Ra[cm3/g]		lognormal	1.3e-2, 1.9e7		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	DCAGW	KD_Soil_Ra[cm3/g]		usersupplied pwise cdf	8 1262.0, 0.0 2230.5, 0.184 5653.3, 0.274 14328.4, 0.382 36315.5, 0.500 92042.0, 0.618 233281.2, 0.726 530000.0, 1.0		
MODIFY FROM	DCAGW	KD_Soil_Pb[cm3/g]		lognormal	1.4e-1, 5.2e5		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	DCAGW	KD_Soil_Pb[cm3/g]		usersupplied pwise cdf	8 800.0, 0.0 955.0, 0.274 2187.8, 0.382 5011.9, 0.500 11481.5, 0.618 26302.7, 0.726 60256.0, 0.816 100000.0, 1.0		
MODIFY FROM	DCAGW	KD_Soil_Cs[cm3/g]		lognormal	7.5e-2, 1.0e6		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	DCAGW	KD_Soil_Cs[cm3/g]		usersuppliedpwise cdf	12 1000.0, 0.0 1380.2, 0.184 2038.6, 0.274 3010.9, 0.382 4447.1, 0.500 6568.2, 0.618 9701.2, 0.726 14328.4, 0.816 21162.8, 0.885 31257.0, 0.933 46166.1, 0.964 61287.0, 1.0		
MODIFY FROM	DCAGW	KD_Soil_I[cm3/g]		lognormal	7.2e-4, 1.4e3		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	DCAGW	KD_Soil_I[cm3/g]		usersupplied pwise cdf	12 0.1, 0.0 0.12, 0.036 0.22, 0.067 0.41, 0.115 0.74, 0.184 1.35, 0.274 2.46, 0.382 4.48, 0.500 8.17, 0.618 14.88, 0.726 27.11, 0.816 43.0, 1.0		
MODIFY FROM	DCAGW	KD_Soil_Tc[cm3/g]		lognormal	2.7e-4, 3.7e1		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	DCAGW	KD_Soil_Tc[cm3/g]		usersupplied pwise cdf	15 0.01, 0.0 0.016, 0.115 0.027, 0.184 0.046, 0.274 0.079, 0.382 0.135, 0.500 0.232, 0.618 0.399, 0.726 0.684, 0.816 1.174, 0.885 2.014, 0.933 3.456, 0.964 5.930, 0.982 10.176, 0.992 16.0, 1.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY FROM	DCAGW	KD_Soil_Ni[cm3/g]		lognormal	2.9, 5.6e4		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	DCAGW	KD_Soil_Ni[cm3/g]		usersupplied pwise cdf	16 60.0, 0.0 100.0, 0.036 141.3, 0.067 199.5, 0.115 281.8, 0.184 398.1, 0.274 562.3, 0.382 794.3, 0.500 1122.0, 0.618 1584.9, 0.726 2238.7, 0.816 3162.3, 0.885 4466.8, 0.933 6309.6, 0.964 8912.5, 0.982		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY FROM	DCAGW	KD_Soil_Cl[cm3/g]		constant	0.25		
MODIFY TO	DCAGW	KD_Soil_Cl[cm3/g]		usersupplied pwise cdf	14 0.0, 0.0 0.010, 0.018 0.014, 0.036 0.019, 0.067 0.027, 0.115 0.037, 0.184 0.052, 0.274 0.072, 0.382 0.100, 0.500 0.139, 0.618 0.194, 0.726 0.270, 0.816 0.375, 0.885 0.4, 1.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY FROM	DCAGW	KD_Soil_C[cm3/g]		lognormal	3.6e-1, 7.0e1		
MODIFY TO	DCAGW	KD_Soil_C[cm3/g]		usersupplied pwise cdf	13 1.12, 0.0 1.42, 0.067 2.36, 0.115 3.94, 0.184 6.6, 0.274 10.9, 0.382 18.2, 0.500 30.3, 0.618 50.4, 0.726 83.9, 0.816 139.8, 0.885 232.8, 0.933 299.0, 1.0		
MODIFY FROM	DCAGW	KD_Soil_Se[cm3/g]		lognormal	1.5e1, 2.1e2		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	DCAGW	KD_Soil_Se[cm3/g]		usersupplied pwise cdf	11 36.0, 0.0 38.1, 0.184 42.9, 0.274 48.4, 0.382 54.6, 0.500 61.6, 0.618 69.4, 0.726 78.3, 0.816 88.2, 0.885 99.5, 0.933 100.0, 1.0		
MODIFY FROM	DCAGW	KD_Soil_Nb[cm3/g]		constant	160.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	DCAGW	KD_Soil_Nb[cm3/g]		usersupplied pwise cdf	13 33.0, 0.0 42.5, 0.067 70.8, 0.115 117.9, 0.184 196.4, 0.274 327.0, 0.382 544.6, 0.500 906.9, 0.618 1510.2, 0.726 2514.9, 0.816 4188.1, 0.885 6974.4, 0.933 8500.0, 1.0		
MODIFY FROM	ASHRMOVO	KdOfUraniumInVolcanicAsh[cm3/g]		constant	35.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRMOVO	KdOfUraniumInVolcanicAsh[cm3/g]		usersupplied pwise cdf	13 0.17, 0.0 0.27, 0.067 0.71, 0.115 1.86, 0.184 4.85, 0.274 12.7, 0.382 33.1, 0.500 86.5, 0.618 225.9, 0.726 589.9, 0.816 1540.7, 0.885 4023.9, 0.933 6000.0, 1.0		
MODIFY FROM	ASHRMOVO	KdOfCuriumInVolcanicAsh[cm3/g]		constant	4000.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRMOVO	KdOfCuriumInVolcanicAsh[cm3/g]		usersuppliedpwisecdf	11 7666.0, 0.0 7785.4, 0.115 9604.6, 0.184 11849.0, 0.274 14617.9, 0.382 18033.7, 0.500 22247.8, 0.618 27446.7, 0.726 33860.4, 0.816 41772.8, 0.885 44260.0, 1.0		
MODIFY FROM	ASHRMOVO	KdOfPlutoniumInVolcanicAsh[cm3/g]		constant	550.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRM OVO	KdOfPlutoniumInVolcanicAsh[cm3/g]		usersupplied pwise cdf	12 316.0, 0.0 395.4, 0.115 742.5, 0.184 1394.1, 0.274 2617.6, 0.382 4914.8, 0.500 9228.0, 0.618 17326.6, 0.726 32532.7, 0.816 61083.7, 0.885 114691.4, 0.933 190000.0, 1.0		
MODIFY FROM	ASHRM OVO	KdOfAmericiumInVolcanicAsh[cm3/g]		constant	1900.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRM OVO	KdOfAmericiumInVolcanicAsh[cm3/g]		usersupplied pwise cdf	12 100.0, 0.0 192.5, 0.184 419.9, 0.274 916.0, 0.382 1998.2, 0.500 4359.0, 0.618 9509.1, 0.726 20743.7, 0.816 45251.9, 0.885 98715.8, 0.933 215345.7, 0.964 300000.0, 1.0		
MODIFY FROM	ASHRM OVO	KdOfThoriumInVolcanicAsh[cm3/g]		constant	3200.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRMOVO	KdOfThoriumInVolcanicAsh[cm3/g]		usersuppliedpwisecdf	9 1700.0, 0.0 2981.0, 0.500 5597.1, 0.618 10509.1, 0.726 19732.1, 0.816 37049.1, 0.885 69563.8, 0.933 130613.8, 0.964 170000.0, 1.0		
MODIFY FROM	ASHRMOVO	KdOfRadiumInVolcanicAsh[cm3/g]		constant	500.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRM OVO	KdOfRadiumInVolcanicAsh[cm3/g]		usersupplied pwise cdf	8 1262.0, 0.0 2230.5, 0.184 5653.3, 0.274 14328.4, 0.382 36315.5, 0.500 92042.0, 0.618 233281.2, 0.726 530000.0, 1.0		
MODIFY FROM	ASHRM OVO	KdOfLeadInVolcanicAsh[cm3/g]		constant	270.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRM OVO	KdOfLeadInVolcanicAsh[cm3/g]		usersupplied pwise cdf	8 800.0, 0.0 955.0, 0.274 2187.8, 0.382 5011.9, 0.500 11481.5, 0.618 26302.7, 0.726 60256.0, 0.816 100000.0, 1.0		
MODIFY FROM	ASHRM OVO	KdOfProtactiniumInVolcanicAsh[cm3/g]		constant	550.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRM OVO	KdOfProtactiniumInVolcanicAsh[cm3/g]		usersupplied pwise cdf	13 110.0, 0.0 141.2, 0.067 235.1, 0.115 391.5, 0.184 652.0, 0.274 1085.7, 0.382 1808.0, 0.500 3010.9, 0.618 5014.1, 0.726 8349.9, 0.816 13904.9, 0.885 23155.8, 0.933 29000.0, 1.0		
MODIFY FROM	ASHRM OVO	KdOfActiniumInVolcanicAsh[cm3/g		constant	450.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRM OVO	KdOfActiniumInVolcanicAsh[cm3/g		usersupplied pwise cdf	12 100.0, 0.0 192.5, 0.115 320.5, 0.184 533.8, 0.274 888.9, 0.382 1480.3, 0.500 2465.1, 0.618 4105.2, 0.726 6836.3, 0.816 11384.4, 0.885 18958.4, 0.933 24300.0, 1.0		
MODIFY FROM	ASHRM OVO	KdOfNeptuniumInVolcanicAsh[cm3/g]		constant	5.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRM OVO	KdOfNeptuniumInVolcanicAsh[cm3/g]		usersupplied pwise cdf	13 1.30, 0.0 1.92, 0.067 3.19, 0.115 5.31, 0.184 8.85, 0.274 14.7, 0.382 24.5, 0.500 40.9, 0.618 68.0, 0.726 113.3, 0.816 188.7, 0.885 314.2, 0.933 400.0, 1.0		
MODIFY FROM	ASHRM OVO	KdOfSamariumInVolcanicAsh[cm3/g]		constant	245.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRM OVO	KdOfSamariumInVolcanicAsh[cm3/g]		usersupplied pwise cdf	5 14000.0, 0.0 22925.4, 0.382 38177.4, 0.500 63576.6, 0.618 104000.0, 1.0		
MODIFY FROM	ASHRM OVO	KdOfCesiumInVolcanicAsh[cm3/g]		constant	280.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRM OVO	KdOfCesiumInVolcanicAsh[cm3/g]		usersupplied pwise cdf	12 1000.0, 0.0 1380.2, 0.184 2038.6, 0.274 3010.9, 0.382 4447.1, 0.500 6568.2, 0.618 9701.2, 0.726 14328.4, 0.816 21162.8, 0.885 31257.0, 0.933 46166.1, 0.964 61287.0, 1.0		
MODIFY FROM	ASHRM OVO	KdOfIodineInVolcanicAsh [cm3/g]		constant	1.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRMOVO	KdOfIodineInVolcanicAsh [cm3/g]		usersupplied pwise cdf	12 0.1, 0.0 0.12, 0.036 0.22, 0.067 0.41, 0.115 0.74, 0.184 1.35, 0.274 2.46, 0.382 4.48, 0.500 8.17, 0.618 14.88, 0.726 27.11, 0.816 43.0, 1.0		
MODIFY FROM	ASHRMOVO	KdOfTinInVolcanicAsh[cm3/g]		constant	130.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRMOVO	KdOfTinInVolcanicAsh[cm3/g]		usersupplied pwise cdf	11 125.9, 0.0 190.5, 0.274 309.0, 0.382 501.2, 0.500 812.8, 0.618 1318.3, 0.726 2138.0, 0.816 3467.4, 0.885 5623.4, 0.933 9120.1, 0.964 10000.0, 1.0		
MODIFY FROM	ASHRMOVO	KdOfSilverInVolcanicAsh[cm3/g]		constant	90.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRMOVO	KdOfSilverInVolcanicAsh[cm3/g]		usersuppliedpwisecdf	16 10.0, 0.0 14.5, 0.036 25.1, 0.067 43.7, 0.115 75.9, 0.184 131.8, 0.274 229.1, 0.382 398.1, 0.500 691.8, 0.618 1202.3, 0.726 2089.3, 0.816 3630.8, 0.885 6309.6, 0.933 10964.8, 0.964 19054.6,		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY FROM	ASHRM OVO	KdOfPaladiumInVolcanic Ash[cm3/g]		constant	55.0		
MODIFY TO	ASHRM OVO	KdOfPaladiumInVolcanic Ash[cm3/g]		usersupplied pwise cdf	13 11.0, 0.0 14.2, 0.067 23.6, 0.115 39.3, 0.184 65.4, 0.274 108.9, 0.382 181.3, 0.500 301.9, 0.618 502.7, 0.726 837.1, 0.816 1394.1, 0.885 2321.6, 0.933 2850.0, 1.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY FROM	ASHRMOVO	KdOfTechnetiumInVolcanicAsh[cm3/g]		constant	0.1		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRMOVO	KdOfTechnetiumInVolcanicAsh[cm3/g]		usersuppliedpwisecdf	15 0.01, 0.0 0.016, 0.115 0.027, 0.184 0.046, 0.274 0.079, 0.382 0.135, 0.500 0.232, 0.618 0.399, 0.726 0.684, 0.816 1.174, 0.885 2.014, 0.933 3.456, 0.964 5.930, 0.982 10.176, 0.992 16.0, 1.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY FROM	ASHRMOVO	KdOfMolybdenumInVolcanicAsh[cm3/g]		constant	10.0		
MODIFY TO	ASHRMOVO	KdOfMolybdenumInVolcanicAsh[cm3/g]		usersuppliedpwisecdf	13 7.4, 0.0 9.5, 0.067 15.8, 0.115 26.3, 0.184 43.8, 0.274 73.0, 0.382 121.5, 0.500 202.4, 0.618 337.0, 0.726 561.2, 0.816 934.5, 0.885 1556.2, 0.933 2000.0, 1.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY FROM	ASHRMOVO	KdOfNiobiumInVolcanicAsh[cm3/g]		constant	160.0		
MODIFY TO	ASHRMOVO	KdOfNiobiumInVolcanicAsh[cm3/g]		usersupplied pwise cdf	13 33.0, 0.0 42.5, 0.067 70.8, 0.115 117.9, 0.184 196.4, 0.274 327.0, 0.382 544.6, 0.500 906.9, 0.618 1510.2, 0.726 2514.9, 0.816 4188.1, 0.885 6974.4, 0.933 8500.0, 1.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY FROM	ASHRM OVO	KdOfZirconiumInVolcanicAsh[cm3/g]		constant	600.0		
MODIFY TO	ASHRM OVO	KdOfZirconiumInVolcanicAsh[cm3/g]		usersuppliedpwisecdf	13 135.0, 0.0 172.4, 0.067 287.1, 0.115 478.2, 0.184 796.3, 0.274 1326.1, 0.382 2208.3, 0.500 3677.5, 0.618 6124.2, 0.726 10198.5, 0.816 16983.5, 0.885 28282.5, 0.933 34550.0, 1.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY FROM	ASHRM OVO	KdOfStrontiumInVolcanic Ash[cm3/g]		constant	15.0		
MODIFY TO	ASHRM OVO	KdOfStrontiumInVolcanic Ash[cm3/g]		usersupplied pwise cdf	13 3.0, 0.0 4.1, 0.067 6.8, 0.115 11.2, 0.184 18.7, 0.274 31.2, 0.382 51.9, 0.500 86.5, 0.618 144.0, 0.726 239.8, 0.816 399.4, 0.885 665.1, 0.933 900.0, 1.0		
MODIFY FROM	ASHRM OVO	KdOfSeleniumInVolcanic Ash[cm3/g]		constant	150.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRM OVO	KdOfSeleniumInVolcanicAsh[cm3/g]		usersupplied pwise cdf	11 36.0, 0.0 38.1, 0.184 42.9, 0.274 48.4, 0.382 54.6, 0.500 61.6, 0.618 69.4, 0.726 78.3, 0.816 88.2, 0.885 99.5, 0.933 100.0, 1.0		
MODIFY FROM	ASHRM OVO	KdOfNickelInVolcanicAsh [cm3/g]		constant	400.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY TO	ASHRMOVO	KdOfNickelInVolcanicAsh [cm3/g]		usersupplied pwise cdf	16 60.0, 0.0 100.0, 0.036 141.3, 0.067 199.5, 0.115 281.8, 0.184 398.1, 0.274 562.3, 0.382 794.3, 0.500 1122.0, 0.618 1584.9, 0.726 2238.7, 0.816 3162.3, 0.885 4466.8, 0.933 6309.6, 0.964 8912.5, 0.982		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY FROM	ASHRMOVO	KdOfChlorineInVolcanicAsh[cm3/g]		constant	0.25		
MODIFY TO	ASHRMOVO	KdOfChlorineInVolcanicAsh[cm3/g]		usersuppliedpwisecdf	14 0.0, 0.0 0.010, 0.018 0.014, 0.036 0.019, 0.067 0.027, 0.115 0.037, 0.184 0.052, 0.274 0.072, 0.382 0.100, 0.500 0.139, 0.618 0.194, 0.726 0.270, 0.816 0.375, 0.885 0.4, 1.0		

Status	Module	Parameter Name	Description	Distribution	Range	Justification	Source
MODIFY FROM	ASHRMOVO	KdOfCarbonInVolcanicAsh[cm3/g]		constant	5.0		
MODIFY TO	ASHRMOVO	KdOfCarbonInVolcanicAsh[cm3/g]		usersupplied pwise cdf	13 1.12, 0.0 1.42, 0.067 2.36, 0.115 3.94, 0.184 6.6, 0.274 10.9, 0.382 18.2, 0.500 30.3, 0.618 50.4, 0.726 83.9, 0.816 139.8, 0.885 232.8, 0.933 299.0, 1.0		

ATTACHMENT A

1. Several recent data sets were reviewed in an effort to update, as much as possible, the Kd values used in the DCAGW and ASHRMOVO modules. Keeping in mind the nature of conservatism applied when determining Kd parameters (values used for transport calculations tend to be lower, while values used to estimate leaching tend to be higher), distributions from more recent publications were used when available.

2. For several radionuclides, Sheppard and Thibault (1990) remained the only reasonable reference. However, in several cases the distributions were taken from the loamy soil data rather then the sandy soil data (used previously). This is consistent with the methodology used in the recent DOE AMR Soil-Related Input Parameters for the Biosphere Model (Rev 02, 2004) and is consistent with the probability of sandy-loam type soil in the region.

3. For the soil Kds, log normal distributions using data from Sheppard and Thibault (1990) have been replaced by user supplied piecewise distributions that simulate truncated log normal distributions. To create the user supplied distributions, I used the example spreadsheet method provided by Osvaldo. Where defined minimum and maximum data were available for a nuclide, those values were used as the truncation points for the distribution. Where no specific data were available, the specified distributions were truncated at approximately the 2-sigma bounds (i.e., 5% and 95%) for the log normal distribution. Multiple data sources were used to determine appropriate min and max values.

4. The ash Kds (formerly constants) were replaced with the same user supplied piecewise distributions used for the soil radionuclides. Similar to the soil data, new data were used when available and loamy soils were assumed when a difference was apparent.

The "changes" are not particularly significant for the most part. Several distributions are revised upward (higher Kds), but given the low sensitivity of TPA results to the broad distributions used previously in DCAGW, I would not expect any significant changes in TPA estimates of dose as a result of these changes. In several cases, the changes simply restrict the range of Kds sampled (truncation of the distribution). However, the specific values for each nuclide (i) are now pinned to the most recent available data, (ii) remain appropriately conservative for their use while being updated to be consistent (or at least not completely out of whack) with Kd values used in the transport modules, and (iii) are internally consistent between the DCAGW and ASHRMOVO modules.

For DCAGW:

```
**
usersuppliedpwisecdf
KD_Soil_Cm[cm3/g]
11
7666.0,  0.0
7785.4,  0.115
9604.6,  0.184
11849.0, 0.274
14617.9, 0.382
18033.7, 0.500
22247.8, 0.618
27446.7, 0.726
33860.4, 0.816
41772.8, 0.885
44260.0, 1.0
**
usersuppliedpwisecdf
KD_Soil_Pu[cm3/g]
12
316.0,    0.0
395.4,    0.115
742.5,    0.184
1394.1,   0.274
2617.6,   0.382
4914.8,   0.500
9228.0,   0.618
17326.6,  0.726
32532.7,  0.816
61083.7,  0.885
114691.4, 0.933
190000.0, 1.0
**
usersuppliedpwisecdf
KD_Soil_U[cm3/g]
13
0.17,   0.0
0.27,   0.067
0.71,   0.115
1.86,   0.184
4.85,   0.274
12.7,   0.382
33.1,   0.500
86.5,   0.618
225.9,  0.726
589.9,  0.816
1540.7, 0.885
4023.9, 0.933
6000.0, 1.0
**
usersuppliedpwisecdf
```

```
KD_Soil_Am[cm3/g]
12
100.0,     0.0
192.5,     0.184
419.9,     0.274
916.0,     0.382
1998.2,    0.500
4359.0,    0.618
9509.1,    0.726
20743.7,   0.816
45251.9,   0.885
98715.8,   0.933
215345.7,  0.964
300000.0,  1.0
**
usersuppliedpwisecdf
KD_Soil_Np[cm3/g]
13
1.30,  0.0
1.92,  0.067
3.19,  0.115
5.31,  0.184
8.85,  0.274
14.7,  0.382
24.5,  0.500
40.9,  0.618
68.0,  0.726
113.3, 0.816
188.7, 0.885
314.2, 0.933
400.0, 1.0
**
usersuppliedpwisecdf
KD_Soil_Th[cm3/g]
9
1700.0,    0.0
2981.0,    0.500
5597.1,    0.618
10509.1,   0.726
19732.1,   0.816
37049.1,   0.885
69563.8,   0.933
130613.8,  0.964
170000.0,  1.0
**
usersuppliedpwisecdf
KD_Soil_Ra[cm3/g]
8
1262.0,    0.0
2230.5,    0.184
5653.3,    0.274
14328.4,   0.382
```

```
36315.5,  0.500
92042.0,  0.618
233281.2, 0.726
530000.0, 1.0
**
usersuppliedpwisecdf
KD_Soil_Pb[cm3/g]
8
800.0,    0.0
955.0,    0.274
2187.8,   0.382
5011.9,   0.500
11481.5,  0.618
26302.7,  0.726
60256.0,  0.816
100000.0, 1.0
**
usersuppliedpwisecdf
KD_Soil_Cs[cm3/g]
12
1000.0,  0.0
1380.2,  0.184
2038.6,  0.274
3010.9,  0.382
4447.1,  0.500
6568.2,  0.618
9701.2,  0.726
14328.4, 0.816
21162.8, 0.885
31257.0, 0.933
46166.1, 0.964
61287.0, 1.0
**
usersuppliedpwisecdf
KD_Soil_I[cm3/g]
12
0.1,   0.0
0.12,  0.036
0.22,  0.067
0.41,  0.115
0.74,  0.184
1.35,  0.274
2.46,  0.382
4.48,  0.500
8.17,  0.618
14.88, 0.726
27.11, 0.816
43.0,  1.0
**
usersuppliedpwisecdf
KD_Soil_Tc[cm3/g]
15
```

```
0.01,    0.0
0.016,   0.115
0.027,   0.184
0.046,   0.274
0.079,   0.382
0.135,   0.500
0.232,   0.618
0.399,   0.726
0.684,   0.816
1.174,   0.885
2.014,   0.933
3.456,   0.964
5.930,   0.982
10.176,  0.992
16.0,    1.0
**
usersuppliedpwisecdf
KD_Soil_Ni[cm3/g]
16
60.0,    0.0
100.0,   0.036
141.3,   0.067
199.5,   0.115
281.8,   0.184
398.1,   0.274
562.3,   0.382
794.3,   0.500
1122.0,  0.618
1584.9,  0.726
2238.7,  0.816
3162.3,  0.885
4466.8,  0.933
6309.6,  0.964
8912.5,  0.982
6309.6,  1.0
**
usersuppliedpwisecdf
KD_Soil_Cl[cm3/g]
14
0.0,     0.0
0.010,   0.018
0.014,   0.036
0.019,   0.067
0.027,   0.115
0.037,   0.184
0.052,   0.274
0.072,   0.382
0.100,   0.500
0.139,   0.618
0.194,   0.726
0.270,   0.816
0.375,   0.885
```

```
0.4,   1.0
**
usersuppliedpwisecdf
KD_Soil_C[cm3/g]
13
1.12,  0.0
1.42,  0.067
2.36,  0.115
3.94,  0.184
6.6,   0.274
10.9,  0.382
18.2,  0.500
30.3,  0.618
50.4,  0.726
83.9,  0.816
139.8, 0.885
232.8, 0.933
299.0, 1.0
**
usersuppliedpwisecdf
KD_Soil_Se[cm3/g]
11
36.0,  0.0
38.1,  0.184
42.9,  0.274
48.4,  0.382
54.6,  0.500
61.6,  0.618
69.4,  0.726
78.3,  0.816
88.2,  0.885
99.5,  0.933
100.0, 1.0
**
usersuppliedpwisecdf
KD_Soil_Nb[cm3/g]
13
33.0,   0.0
42.5,   0.067
70.8,   0.115
117.9,  0.184
196.4,  0.274
327.0,  0.382
544.6,  0.500
906.9,  0.618
1510.2, 0.726
2514.9, 0.816
4188.1, 0.885
6974.4, 0.933
8500.0, 1.0
**
```

For ASHRMOVO:

```
**
usersuppliedpwisecdf
KdOfUraniumInVolcanicAsh[cm3/g]
13
0.17,   0.0
0.27,   0.067
0.71,   0.115
1.86,   0.184
4.85,   0.274
12.7,   0.382
33.1,   0.500
86.5,   0.618
225.9,  0.726
589.9,  0.816
1540.7, 0.885
4023.9, 0.933
6000.0, 1.0
**
usersuppliedpwisecdf
KdOfCuriumInVolcanicAsh[cm3/g]
11
7666.0,  0.0
7785.4,  0.115
9604.6,  0.184
11849.0, 0.274
14617.9, 0.382
18033.7, 0.500
22247.8, 0.618
27446.7, 0.726
33860.4, 0.816
41772.8, 0.885
44260.0, 1.0
**
usersuppliedpwisecdf
KdOfPlutoniumInVolcanicAsh[cm3/g]
12
316.0,    0.0
395.4,    0.115
742.5,    0.184
1394.1,   0.274
2617.6,   0.382
4914.8,   0.500
9228.0,   0.618
17326.6,  0.726
32532.7,  0.816
61083.7,  0.885
114691.4, 0.933
190000.0, 1.0
**
```

```
usersuppliedpwisecdf
KdOfAmericiumInVolcanicAsh[cm3/g]
12
100.0,    0.0
192.5,    0.184
419.9,    0.274
916.0,    0.382
1998.2,   0.500
4359.0,   0.618
9509.1,   0.726
20743.7,  0.816
45251.9,  0.885
98715.8,  0.933
215345.7, 0.964
300000.0, 1.0
**
usersuppliedpwisecdf
KdOfThoriumInVolcanicAsh[cm3/g]
9
1700.0,   0.0
2981.0,   0.500
5597.1,   0.618
10509.1,  0.726
19732.1,  0.816
37049.1,  0.885
69563.8,  0.933
130613.8, 0.964
170000.0, 1.0
**
usersuppliedpwisecdf
KdOfRadiumInVolcanicAsh[cm3/g]
8
1262.0,   0.0
2230.5,   0.184
5653.3,   0.274
14328.4,  0.382
36315.5,  0.500
92042.0,  0.618
233281.2, 0.726
530000.0, 1.0
**
usersuppliedpwisecdf
KdOfLeadInVolcanicAsh[cm3/g]
8
800.0,    0.0
955.0,    0.274
2187.8,   0.382
5011.9,   0.500
11481.5,  0.618
26302.7,  0.726
60256.0,  0.816
100000.0, 1.0
```

```
**
usersuppliedpwisecdf
KdOfProtactiniumInVolcanicAsh[cm3/g]
13
110.0,   0.0
141.2,   0.067
235.1,   0.115
391.5,   0.184
652.0,   0.274
1085.7,  0.382
1808.0,  0.500
3010.9,  0.618
5014.1,  0.726
8349.9,  0.816
13904.9, 0.885
23155.8, 0.933
29000.0, 1.0
**
usersuppliedpwisecdf
KdOfActiniumInVolcanicAsh[cm3/g]
12
100.0,   0.0
192.5,   0.115
320.5,   0.184
533.8,   0.274
888.9,   0.382
1480.3,  0.500
2465.1,  0.618
4105.2,  0.726
6836.3,  0.816
11384.4, 0.885
18958.4, 0.933
24300.0, 1.0
**
usersuppliedpwisecdf
KdOfNeptuniumInVolcanicAsh[cm3/g]
13
1.30,  0.0
1.92,  0.067
3.19,  0.115
5.31,  0.184
8.85,  0.274
14.7,  0.382
24.5,  0.500
40.9,  0.618
68.0,  0.726
113.3, 0.816
188.7, 0.885
314.2, 0.933
400.0, 1.0
**
usersuppliedpwisecdf
```

```
KdOfSamariumInVolcanicAsh[cm3/g]
5
14000.0,  0.0
22925.4,  0.382
38177.4,  0.500
63576.6,  0.618
104000.0, 1.0
**
usersuppliedpwisecdf
KdOfCesiumInVolcanicAsh[cm3/g]
12
1000.0,  0.0
1380.2,  0.184
2038.6,  0.274
3010.9,  0.382
4447.1,  0.500
6568.2,  0.618
9701.2,  0.726
14328.4, 0.816
21162.8, 0.885
31257.0, 0.933
46166.1, 0.964
61287.0, 1.0
**
usersuppliedpwisecdf
KdOfIodineInVolcanicAsh[cm3/g]
12
0.1,   0.0
0.12,  0.036
0.22,  0.067
0.41,  0.115
0.74,  0.184
1.35,  0.274
2.46,  0.382
4.48,  0.500
8.17,  0.618
14.88, 0.726
27.11, 0.816
43.0,  1.0
**
usersuppliedpwisecdf
KdOfTinInVolcanicAsh[cm3/g]
11
125.9,   0.0
190.5,   0.274
309.0,   0.382
501.2,   0.500
812.8,   0.618
1318.3,  0.726
2138.0,  0.816
3467.4,  0.885
5623.4,  0.933
```

```
9120.1,  0.964
10000.0, 1.0
**
usersuppliedpwisecdf
KdOfSilverInVolcanicAsh[cm3/g]
16
10.0,    0.0
14.5,    0.036
25.1,    0.067
43.7,    0.115
75.9,    0.184
131.8,   0.274
229.1,   0.382
398.1,   0.500
691.8,   0.618
1202.3,  0.726
2089.3,  0.816
3630.8,  0.885
6309.6,  0.933
10964.8, 0.964
19054.6, 0.982
31622.8, 1.0
**
usersuppliedpwisecdf
KdOfPaladiumInVolcanicAsh[cm3/g]
13
11.0,   0.0
14.2,   0.067
23.6,   0.115
39.3,   0.184
65.4,   0.274
108.9,  0.382
181.3,  0.500
301.9,  0.618
502.7,  0.726
837.1,  0.816
1394.1, 0.885
2321.6, 0.933
2850.0, 1.0
**
usersuppliedpwisecdf
KdOfTechnetiumInVolcanicAsh[cm3/g]
15
0.01,   0.0
0.016,  0.115
0.027,  0.184
0.046,  0.274
0.079,  0.382
0.135,  0.500
0.232,  0.618
0.399,  0.726
0.684,  0.816
```

```
1.174,  0.885
2.014,  0.933
3.456,  0.964
5.930,  0.982
10.176, 0.992
16.0,   1.0
**
usersuppliedpwisecdf
KdOfMolybdenumInVolcanicAsh[cm3/g]
13
7.4,    0.0
9.5,    0.067
15.8,   0.115
26.3,   0.184
43.8,   0.274
73.0,   0.382
121.5,  0.500
202.4,  0.618
337.0,  0.726
561.2,  0.816
934.5,  0.885
1556.2, 0.933
2000.0, 1.0
**
usersuppliedpwisecdf
KdOfNiobiumInVolcanicAsh[cm3/g]
13
33.0,   0.0
42.5,   0.067
70.8,   0.115
117.9,  0.184
196.4,  0.274
327.0,  0.382
544.6,  0.500
906.9,  0.618
1510.2, 0.726
2514.9, 0.816
4188.1, 0.885
6974.4, 0.933
8500.0, 1.0
**
usersuppliedpwisecdf
KdOfZirconiumInVolcanicAsh[cm3/g]
13
135.0,   0.0
172.4,   0.067
287.1,   0.115
478.2,   0.184
796.3,   0.274
1326.1,  0.382
2208.3,  0.500
3677.5,  0.618
```

```
6124.2,  0.726
10198.5, 0.816
16983.5, 0.885
28282.5, 0.933
34550.0, 1.0
**
usersuppliedpwisecdf
KdOfStrontiumInVolcanicAsh[cm3/g]
13
3.0,   0.0
4.1,   0.067
6.8,   0.115
11.2,  0.184
18.7,  0.274
31.2,  0.382
51.9,  0.500
86.5,  0.618
144.0, 0.726
239.8, 0.816
399.4, 0.885
665.1, 0.933
900.0, 1.0
**
usersuppliedpwisecdf
KdOfSeleniumInVolcanicAsh[cm3/g]
11
36.0,  0.0
38.1,  0.184
42.9,  0.274
48.4,  0.382
54.6,  0.500
61.6,  0.618
69.4,  0.726
78.3,  0.816
88.2,  0.885
99.5,  0.933
100.0, 1.0
**
usersuppliedpwisecdf
KdOfNickelInVolcanicAsh[cm3/g]
16
60.0,   0.0
100.0,  0.036
141.3,  0.067
199.5,  0.115
281.8,  0.184
398.1,  0.274
562.3,  0.382
794.3,  0.500
1122.0, 0.618
1584.9, 0.726
2238.7, 0.816
```

```
3162.3, 0.885
4466.8, 0.933
6309.6, 0.964
8912.5, 0.982
6309.6, 1.0
**
usersuppliedpwisecdf
KdOfChlorineInVolcanicAsh[cm3/g]
14
0.0,   0.0
0.010, 0.018
0.014, 0.036
0.019, 0.067
0.027, 0.115
0.037, 0.184
0.052, 0.274
0.072, 0.382
0.100, 0.500
0.139, 0.618
0.194, 0.726
0.270, 0.816
0.375, 0.885
0.4,   1.0
**
usersuppliedpwisecdf
KdOfCarbonInVolcanicAsh[cm3/g]
13
1.12,  0.0
1.42,  0.067
2.36,  0.115
3.94,  0.184
6.6,   0.274
10.9,  0.382
18.2,  0.500
30.3,  0.618
50.4,  0.726
83.9,  0.816
139.8, 0.885
232.8, 0.933
299.0, 1.0
**
```

SCR - 5632

TPA 5.1/ Beta V

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 563	2. Software Title and Version: TPA 5.1BetaV	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f, dcagw.f*

See Appendix A for the initiating e-mail from T. McCartin. See Appendix B for proposed format from P. LaPlante.

5. Change Requested by: T. McCartin	Date: 3-14-2007
6. Change Authorized by (*Software Developer*): R. Janetzke	Date: 3-20-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

1) Modify the groundwater protection calculation output file headers for files *epa_ave.out* and *epapktim.out* to clearly explain what is calculated in the file (See redline/strikeout edits for each file in Appendix B)

2) Update and clarify the header for data file *organdf.dat* to clarify what dose coefficients are included in the file. Remove the obsolete data entries referring to "proposed rule" and "scaling factors" (see redline/strikeout edits for this file in Appendix B).

3) Remove the total dose output column from *epa_ave.out* and *epapktim.out* files by modifying write statements for *epadosetotal* and *epadosetotalsum* in *dcagw.f*.. Programmer should verify/ensure the specific change to code does not impact other calculations.

4) Change the output file name for *epa_ave.out* to *gwp_ave.res* and *epapktim.out* to *gwp_pktim.res*

See Appendix C for final format for *gwp_ave.res*; see Appendix D for final format for *gwppktim.res*.

8. Implemented by: R. Janetzke	Date: 4-11-07

9. Code Review Needed (see TOP-018, 5.4.7) Yes ☐ No ☒
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution *(If no errors are found, indicate with **"None"**.)*:

Code review accomplished by:	Date:

10. Description of Acceptance Tests:

1. Verify that corrected file names and headers appear following code execution
2. Verify total dose column does not appear in groundwater protection output files
3. Verify correct execution of peak groundwater protection calculations for a mean value run using spreadsheet calculation
4. Verify correct execution of average groundwater protection calculations for 3 realization run using spreadsheet from #3 with computed average

11. Tested by: P. LaPlante	Date: 5/04/07

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for *TPA.INP*

SCR 563

Status (***ADD, DELETE, MODIFY TO, MODIFY FROM***)	**Module**	**Parameter Name**	**Description** (***Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.***)	**Distribution**	**Range**	**Justification** ***1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.***	**Source**
No Changes to tpa.inp parameters							

Appendix A

(text of e-mail from T. McCartin, NRC)

I am aware of two output files that provide information for comparison with the ground water protection requirements in Part 63. These files are epa_ave.out and epapktim.out (I believe these should be designated ".res" files if these are the only files that give us the information on compliance with GW protection - but the name of the file is a relatively minor issue). The issues I have are:

The information provided in the header of the file is not very useful in determining what the values represent (the user's manual is not much better - see page 17-48). Although organ doses are reported, it is not clear whether or not these doses (reported as mrem/yr) are weighted by the organ weighting factors - I assume they are but there is not explicit statement to this effect. Confusion arises, in part, due to an additional value added that is labeled "total dose," which also has the units of mrem/yr - this dose is most likely calculated using the organ weighting factors - a TEDE dose, which is not part of GW protection.

Suggestions:

1) clearly explain what is calculated in the file (e.g., organ doses with not weighting factors used) both in the header and the user guide

2) remove the total dose calculation - this is not part of GW protection and does not serve any type of useful comparison as mentioned in the user guide - comparison to what and for what purpose? It is certainly very confusing if this is a dose calculated with the organ weighting factors

3) change the extension on the files from .out to .res - these are the only files produced to allow evaluation of GW protection thus they should have an extension commensurate with the significance of the output

4) the file names that start with "epa" are not very helpful (the overall dose limit is an epa specification also) - it would be more helpful to use "GWP" as in Ground Water Protection or "GWprot."

5) It is difficult to determine if the values in these output files are correct until there is a better description of what the values actually represent.

Appendix B

REDLINE/STRIKEOUT EDITS FOR TPA DATA FILE
ORGANDF.DAT

TITLE: ~~TPA 4.1 Intake to~~ Organ and whole body ingestion dose coefficients ~~equivalent conversion factors~~
TITLE: ~~for ingestion~~ from Federal Guidance Report No. 11 (Sv/Bq) used for groundwater protection calculations

** maximum values selected from Table 2.2 of Federal Guidance Report No. 11 ~~received from~~ were compiled by P. LaPlante and ~~modified~~
** reformatted by R.Rice to match the TPA data file format and to include only the
** 43 radionuclides in the same sequence as nuclides.dat (9/6/00)
** Whole Body column contains coefficients that represent the committed effective dose equivalent per unit intake of radionuclide as
** described on Page 6 of Federal Guidance Report No. 11, the whole body coefficients were computed by the authors of that report using
** organ/tissue weighting factors listed in Federal Guidance Report 11, Page 6 (3/29/07)
** Organ/Tissue-specific columns contain coefficients that represent the committed organ/tissue dose equivalent per unit intake of
** radionuclide, computed as described in Federal Guidance Report No. 11, Page 7 (3/29/07)
** Reference: Environmental Protection Agency. EPA-5201/1-88-020, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion
** Factors for Inhalation, Submersion, and Ingestion." Federal Guidance Report No. 11. Washington, DC: EPA. 1988.

** ~~note: this file alos includes the EPA proposed rules which used as scaling factors~~

** Nuclide	Gonad	Breast	Lung	R Marrow	B Surface	Thyroid	Remainder	Whole Body
U238	2.31E-09	2.31E-09	2.30E-09	6.80E-08	1.01E-06	2.30E-09	9.69E-08	6.88E-08
Cm246	2.77E-07	3.91E-11	2.67E-11	1.48E-06	1.85E-05	1.87E-11	6.76E-07	1.00E-06
Pu242	2.51E-07	8.00E-12	7.88E-12	1.34E-06	1.67E-05	7.29E-12	6.10E-07	9.08E-07
Am242m	2.66E-07	1.22E-11	1.65E-11	1.41E-06	1.76E-05	3.77E-12	6.20E-07	9.50E-07
Pu238	2.33E-07	8.41E-12	8.49E-12	1.27E-06	1.58E-05	7.99E-12	6.00E-07	8.65E-07
U234	2.59E-09	2.58E-09	2.58E-09	7.21E-08	1.13E-06	2.58E-09	1.09E-07	7.66E-08
Th230	6.82E-10	6.80E-10	6.80E-10	2.89E-07	3.60E-06	6.80E-10	1.54E-08	1.48E-07
Ra226	9.16E-08	9.17E-08	9.16E-08	5.98E-07	6.83E-06	9.15E-08	1.03E-07	3.58E-07
Pb210	1.25E-07	1.25E-07	1.25E-07	1.48E-06	2.16E-05	1.25E-07	1.85E-06	1.45E-06
Cm243	1.73E-07	6.96E-11	7.73E-11	9.81E-07	1.23E-05	3.15E-11	4.97E-07	6.79E-07
Am243	2.71E-07	1.41E-10	1.95E-10	1.44E-06	1.80E-05	6.80E-11	6.61E-07	9.79E-07
Pu239	2.64E-07	7.69E-12	7.74E-12	1.41E-06	1.76E-05	7.49E-12	6.43E-07	9.56E-07
U235	2.67E-09	2.49E-09	2.46E-09	6.81E-08	1.05E-06	2.45E-09	1.03E-07	7.19E-08
Pa231	1.21E-10	7.81E-11	6.80E-11	5.78E-06	7.22E-05	6.33E-11	1.71E-08	2.86E-06
Ac227	8.31E-07	1.41E-10	2.20E-10	5.40E-06	6.73E-05	7.55E-11	3.08E-06	3.80E-06
Cm245	2.80E-07	6.80E-11	8.34E-11	1.49E-06	1.86E-05	3.02E-11	6.79E-07	1.01E-06
Pu241	5.66E-09	2.52E-13	4.45E-13	2.78E-08	3.48E-07	1.01E-13	1.10E-08	1.85E-08
Am241	2.70E-07	2.62E-11	3.36E-11	1.45E-06	1.81E-05	1.32E-11	6.66E-07	9.84E-07
Np237	2.46E-07	1.45E-10	1.53E-10	2.18E-06	2.72E-05	1.10E-10	2.10E-07	1.20E-06
U233	2.62E-09	2.62E-09	2.62E-09	7.36E-08	1.16E-06	2.62E-09	1.10E-07	7.81E-08
Th229	4.69E-09	4.57E-09	4.56E-09	1.91E-06	2.38E-05	4.55E-09	2.80E-08	9.54E-07
Cm244	1.33E-07	8.82E-12	8.81E-12	7.82E-07	9.77E-06	8.44E-12	4.15E-07	5.45E-07
Pu240	2.64E-07	7.97E-12	8.07E-12	1.41E-06	1.76E-05	7.51E-12	6.43E-07	9.56E-07
U236	2.45E-09	2.45E-09	2.45E-09	6.83E-08	1.07E-06	2.45E-09	1.03E-07	7.26E-08
U232	8.27E-09	8.33E-09	8.29E-09	4.19E-07	6.63E-06	8.11E-09	3.35E-07	3.54E-07
Sm151	2.12E-14	1.03E-15	6.52E-16	2.76E-11	3.45E-10	3.27E-17	3.04E-10	1.05E-10
Cs137	1.39E-08	1.24E-08	1.27E-08	1.32E-08	1.26E-08	1.26E-08	1.45E-08	1.35E-08
Cs135	1.91E-09	1.91E-09	1.91E-09	1.91E-09	1.91E-09	1.91E-09	1.91E-09	1.91E-09
I129	1.38E-10	3.31E-10	1.65E-10	2.21E-10	2.17E-10	2.48E-06	1.99E-10	7.46E-08

Sn126	2.41E-09	7.96E-10	5.99E-10	2.72E-09	5.06E-09	5.51E-10	1.33E-08	5.27E-09
Sn121m	4.31E-11	2.95E-11	2.90E-11	2.32E-10	6.12E-10	2.86E-11	1.18E-09	4.19E-10
Ag108m	1.93E-09	5.14E-10	6.03E-10	6.63E-10	3.55E-10	1.30E-10	4.44E-09	2.06E-09
Pd107	9.91E-15	9.91E-15	9.91E-15	5.36E-14	1.43E-13	9.91E-15	1.35E-10	4.04E-11
Tc99	6.04E-11	6.04E-11	6.04E-11	6.04E-11	6.04E-11	1.62E-09	1.02E-09	3.95E-10
Mo93	1.27E-10	9.96E-11	1.06E-10	2.82E-10	1.15E-09	9.42E-11	7.79E-10	3.64E-10
Nb94	1.80E-09	3.47E-10	1.72E-10	7.39E-10	7.65E-10	1.23E-10	4.30E-09	1.93E-09
Zr93	9.23E-14	1.97E-13	1.15E-13	7.42E-10	9.14E-09	7.31E-14	2.83E-10	4.48E-10
Sr90	1.51E-09	1.51E-09	1.51E-09	1.94E-07	4.19E-07	1.51E-09	6.14E-09	3.85E-08
Se79	9.06E-10	9.06E-10	9.06E-10	9.06E-10	9.06E-10	9.06E-10	5.73E-09	2.35E-09
Ni63	8.50E-11	8.50E-11	8.50E-11	8.50E-11	8.50E-11	8.50E-11	3.20E-10	1.56E-10
Ni59	3.83E-11	3.58E-11	3.50E-11	3.66E-11	3.62E-11	3.90E-11	1.03E-10	5.67E-11
Cl36	7.99E-10	7.99E-10	7.99E-10	7.99E-10	7.99E-10	7.99E-10	8.61E-10	8.18E-10
C14	5.64E-10	5.64E-10	5.64E-10	5.64E-10	5.64E-10	5.64E-10	5.64E-10	5.64E-10

~~1.50E+01 !gross alpha proposed rule or scaling factor (pCi/L)~~
~~2.00E+01 !total uranium proposed rule or scaling factor (pCi/L)~~
~~5.00E+00 !Ra 226 proposed rule or scaling factor (pCi/L)~~
~~4.00E+00 !organ and whole body proposed rule or scaling factor (mrem/yr)~~
~~1.50E+01 !total dose proposed rule or scaling factor (mrem/yr)~~

REDLINE/STRIKEOUT of HEADER INFORMATION FOR OUTPUT FILE
EPA_AVG.OUT

!! ~~epa_ave.out~~ gwp_ave.res
!!
!! Input file tpa.inp as supplied with TPA Version 5.1betaT Code.
!! Validation nominal scenario reference case. 3-11-07
!! Created by: TPA 5.1betaT
!! Module: EXEC
!! Job started: Thu Mar 29 12:12:26 2007
!!
!! PURPOSE:
!! Output file for groundwater protection calculations: Including average groundwater concentrations (gross alpha activity, radium226),
!! average organ/tissue doses (for combined beta and photon emitting radionuclides), and average whole body doses (for combined beta and photon emitting radionuclides).
!! Averages ~~Dose~~ computed over all realizations for each time step

!! This file has one section.
!!
!! SECTION 1
!!
!! time = time following start of simulation in years
!! Gross Alpha Concentration = all realization average concentration of all alpha-
!! emitting radionuclides in pico-
!! curies per liter.
!! Radium 226 Concentration = all realization average concentration of Radium 226 in
!! pico-curies per liter.
!! Gonad Dose = all realization average gonad committed dose equivalent for combined beta and photon emitting radionuclides in millirem per year.
!! Breast Dose = all realization average breast committed dose equivalent for combined beta and photon emitting radionuclides in millirem per year.
!! Lung Dose = all realization average lung committed dose equivalent for combined beta and photon emitting radionuclides in millirem per year.
!! R Marrow Dose = all realization average red bone marrow committed dose equivalent for combined beta and photon emitting radionuclides in millirem per year.
!! B Surface Dose = all realization average bone surface committed dose equivalent for combined beta and photon emitting radionuclides in millirem per year.
!! Thyroid Dose = all realization average thyroid committed dose equivalent for combined beta and photon emitting radionuclides in millirem per year.
!! Remainder Dose = all realization average committed dose equivalent for combined beta and photon emitting radionuclides to remaining organs in millirem per year.
!! Whole Body Dose = all realization average committed effective dose equivalent for combined beta and photon emitting radionuclides in millirem per year.

~~!! Determined Using the EPA Standard~~

time yr	gross alpha conc(pCi/L)	radium226 conc(pCi/L)	Gonad dose(mrem/yr)	Breast dose(mrem/yr)	Lung dose(mrem/yr)	R Marrow dose(mrem/yr)	B Surface dose(mrem/yr)	Thyroid dose(mrem/yr)	Remainder dose(mrem/yr)	Whole Body dose(mrem/yr)	~~Total Dose dose(mrem/yr)~~
0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2.31016E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4.67440E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
7.09399E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
9.57023E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
1.21044E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
1.46980E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
1.73522E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2.00686E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2.28486E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2.56937E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2.86054E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3.15852E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3.46349E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3.77559E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4.09499E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4.42188E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4.75642E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5.09879E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5.44917E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5.80776E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
6.17474E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
6.55032E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
6.93469E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
7.32805E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
7.73063E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
8.14263E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
8.56428E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
8.99579E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
9.43741E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
9.88937E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
1.03519E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
1.08253E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

REDLINE/STRIKEOUT of HEADER INFORMATION FOR OUTPUT FILE
EPAPKTIM.OUT

!! ~~epapktim.out~~ gwp_pktim.res
!!
!! Input file tpa.inp as supplied with TPA Version 5.1betaT Code.
!! Validation nominal scenario reference case. 3-11-07
!! Created by: TPA 5.1betaT
!! Module: EXEC
!! Job started: Thu Mar 29 12:12:26 2007
!!
!! *PURPOSE:*
~~!! Peak Concentration/Dose and Time of the Peak~~
~~!! for Each Realization Using the EPA Standard~~
~~!! This file records the peak concentration of gross alpha and~~
~~!! radium226 and peak dose for several organs. The time of~~
~~!! each peak is also recorded. One peak for each item is~~
~~!! recorded for each realization processed by the executive.~~
!!
!! Output file for groundwater protection calculations: For each realization, peak groundwater concentrations and time of peak concentration (gross alpha, radium226),
!! peak organ/tissue doses and time of peak doses (for combined beta and photon emitting radionuclides), and peak whole body doses
!! and time of peak doses for combined beta and photon emitting radionuclides). Peak values are selected among all timesteps for each realization.
!!
!! This file has one section~~s~~.
!!
!! SECTION 1

!! Realization = realization number !!
!! Gross Alpha Concentration = peak concentration over the simulation period of all alpha-
!! emitting radionuclides in pico-
!! curies per liter.
!! Gross Alpha Time = time of peak gross alpha concentration in years
!! Radium 226 Concentration = peak concentration over the simulation period of Radium 226 in
!! pico-curies per liter.
!! *Radium 226 Time = time of peak Radium 226 concentration in years*
!! Gonad Dose = peak gonad committed dose equivalent over the simulation period for combined beta and photon emitting radionuclides in millirem per year.
!! Gonad Time = time of peak gonad dose in years
!! Breast Dose = peak breast committed dose equivalent over the simulation period for combined beta and photon emitting radionuclides in millirem per year.
!! Breast Time = time of peak breast dose in years
!! Lung Dose = peak lung committed dose equivalent over the simulation period for combined beta and photon emitting radionuclides in millirem per year.
!! Lung Time = time of peak lung dose in years
!! R Marrow Dose = peak red bone marrow committed dose equivalent over the simulation period for combined beta and photon emitting radionuclides in millirem per year.
!! R Marrow Time = time of peak red marrow dose in years
!! B Surface Dose = peak bone surface committed dose equivalent over the simulation period for combined beta and photon emitting radionuclides in millirem per year.
!! B Surface Time = time of peak bone surface dose in years
!! Thyroid Dose = peak thyroid committed dose equivalent over the simulation period for combined beta and photon emitting radionuclides in millirem per year.
!! Thyroid Time = time of peak thyroid dose in years
!! Remainder Dose = peak committed dose equivalent to remaining organs over the simulation period for combined beta and photon emitting radionuclides in millirem per year.
!! Remainder Time = time of peak remaining organ dose in years
!! Whole Body Dose = peak committed effective dose equivalent over the simulation period for combined beta and photon emitting radionuclides in millirem per year.
!! Whole Body Time = time of peak whole body dose in years

~~!! Gross Alpha Concentration = Total concentration of alpha~~
~~!! emitting radionuclides in pico~~
~~!! curies per liter.~~
~~!! Gross Alpha Time = time of peak concentration.~~
~~!! Radium 226 Concentration = concentration of Radium 226 in~~
~~!! pico-curies per liter.~~
~~!! Radium 226 Time = time of peak concentration.~~
~~!! Gonad Dose = dose in millirem per year.~~
~~!! Gonad Time = time of peak dose.~~
~~!! Breast Dose = dose in millirem per year.~~
~~!! Breast Time = time of peak dose.~~
~~!! Lung Dose = dose in millirem per year.~~
~~!! Lung Time = time of peak dose.~~
~~!! Red Marrow Dose = dose in millirem per year.~~
~~!! Red Marrow Time = time of peak dose.~~
~~!! Bone Surface Dose = dose in millirem per year.~~
~~!! Bone Surface Time = time of peak dose.~~
~~!! Thyroid Dose = dose in millirem per year.~~
~~!! Thyroid Time = time of peak dose.~~
~~!! Remainder Dose = dose in millirem per year.~~
~~!! Remainder Time = time of peak dose.~~

~~!! Whole Body Dose = dose in millirem per year.~~
~~!! Whole Body Time = time of peak dose.~~
~~!! Total Dose = dose in millirem per year.~~
~~!! Total Dose Time = time of peak dose.~~

Realization Number (unitless)	Thyroid Dose (mrem/yr)	Gross Alpha Thyroid Concentration (pCi/L)	Gross Alpha Thyroid Time (yr)	Gross Alpha Remainder Dose (mrem/yr)	Radium 226 Remainder Concentration (pCi/L)	Radium 226 Remainder Time (yr)	Radium 226 Whole Body Dose (mrem/yr)	Radium 226 Whole Body Time (yr)	Gonad Whole Body Dose (mrem/yr)	Gonad Total Dose (mrem/yr)	Gonad Total Time (yr)	Breast Total Dose (mrem/yr)	Breast Total Time (yr)	Lung Dose (mrem/yr)	Lung Time (yr)	Red Marrow Dose (mrem/yr)	Red Marrow Time (yr)	Bone Surface Dose (mrem/yr)	Bone Surface Time (yr)
1	2.10164E-01	1.08596E-05	2.25149E+03	1.00000E+04	2.85621E-02	1.13324E-10	3.38432E+03	1.00000E+04	1.58979E-02	1.74419E-03	3.30464E+03	3.46586E+03	1.75664E-03	3.30464E+03	3.46586E+03	1.74593E-03	3.46586E+03	1.74954E-03	3.46586E+03
2	2.94080E-02	1.08369E-02	1.00000E+04	1.00000E+04	3.32754E-03	3.62725E-09	1.00000E+04	1.00000E+04	2.02035E-03	2.08395E-04	1.00000E+04	1.00000E+04	2.10279E-04	1.00000E+04	1.00000E+04	2.08658E-04	1.00000E+04	2.09212E-04	1.00000E+04
3	1.29346E+01	0.00000E+00	7.55132E+03	1.00000E+04	1.91256E+00	0.00000E+00	7.55132E+03	1.00000E+04	1.03998E+00	1.16806E-01	7.55132E+03	7.73042E+03	1.17578E-01	7.73042E+03	7.73042E+03	1.16914E-01	7.73042E+03	1.17138E-01	7.73042E+03

Appendix C

```
!! gwp_ave.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1betaW Code.
!!  Validation disruptive scenario reference case.  cfsv2r10a10y
!! Created by: TPA 5.1betaV
!! Module: EXEC
!! Job started: Wed Apr 11 16:46:30 2007
!!
!! PURPOSE:
!!
!!
!! This file contains output for groundwater protection
!! calculations: including average groundwater concentrations
!! (gross alpha activity, radium226), average organ/tissue
!! doses (for combined beta and photon emitting radionuclides),
!! and average whole body doses (for combined beta and photon
!! emitting redionuclides). Averages computed over all
!! realizations for each time step.
!!
!! SECTION 1
!!
!! time = time following start of simulation in years
!! Gross Alpha Concentration = all realization average
!!      concentration of all alpha emitting radionuclides in
!!      pico-curies per liter.
!! Radium 226 Concentration = all realization average
!!      concentration of Radium 226 in pico-curies per liter.
!! Gonad Dose = all realization average gonad committed dose
!!      equivalent for combined beta and photon emitting
!!      radionuclides in millirem per year.
!! Breast Dose = all realization average breast committed dose
!!      equivalent for combined beta and photon emitting
!!      radionuclides in millirem per year.
!! Lung Dose = all realization average lung committed dose
!!      equivalent for combined beta and photon emitting
!!      radionuclides in millirem per year.
!! Red Marrow Dose = all realization average red marrow i
!!      committed dose equivalent for combined beta and photon
!!      emitting radionuclides in millirem per year.
!! Bone Surface Dose = all realization average bone surface
!!      committed dose equivalent for combined beta and photon
!!      emitting radionuclides in millirem per year.
!! Thyroid Dose = all realization average thyroid committed
!!      dose equivalent for combined beta and photon emitting
!!      radionuclides in millirem per year.
!! Remainder Dose = all realization average remainder committed
!!      dose equivalent for combined beta and photon emitting
!!      radionuclides in millirem per year.
!! Whole Body Dose = all realization average whole body
!!      committed dose equivalent for combined beta and photon
!!      emitting radionuclides in millirem per year.
```

Time (year)	Gross Alpha Concentration (pCi/L)	Radium 226 Concentration (pCi/L)	Gonad Dose (mrem/yr)	Breast Dose (mrem/yr)	Lung Dose (mrem/yr)	Red Marrow Dose (mrem/yr)	Bone Surface Dose (mrem/yr)	Thyroid Dose (mrem/yr)	Remainder Dose (mrem/yr)	Whole Body Dose (mrem/yr)

Appendix D

```
!! gwppktim.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1betaW Code.
!!  Validation disruptive scenario reference case.  cfsv2r10a10y
!! Created by: TPA 5.1betaV
!! Module: EXEC
!! Job started: Wed Apr 11 16:46:30 2007
!!
!! PURPOSE:
!!
!!
!! This file contains output for groundwater protection
!! calculations: for each realization, peak groundwater
!! concentrations and time of peak concentration
!! calculations: for each realization, peak groundwater
!! (gross alpha, radium226), peak organ/tissue doses and,
!! time of peak doses (for combined beta and photon emitting
!! raionuclides), and peak whole body doses and time of peak
!! doses for combined beta and photon emitting radionuclides).
!! Peak values are selected among all time steps for each
!! realization.
!!
!! SECTION 1
!!
!! Realization = realization number
!! Gross Alpha Concentration = Peak concentration over the
!!             simulation period of all alpha-emitting
!!             radionuclides in pico-curies per liter.
!! Gross Alpha Time = time of peak gross alpha concentration in
!!             years.
!! Radium 226 Concentration  = peak concentration over the
!!             simulation period of Radium 226 in pico-curies
!!             per liter.
!! Radium 226 Time = time of peak Radium 226 concentration in
!!             years.
!! Gonad Dose = peak gonad committed dose equivalent over the
!!             simulation period for combined beta and photon
!!             emitting radionuclides in millirem per year.
!! Gonad Time = time of peak gonad dose in years.
!! Breast Dose = peak breast committed dose equivalent over the
!!             simulation period for combined beta and photon
!!             emitting radionuclides in millirem per year.
!! Breast Time = time of peak breast dose in years.
!! Lung Dose = peak lung committed dose equivalent over the
!!             simulation period for combined beta and photon
!!             emitting radionuclides in millirem per year.
!! Lung Time = time of peak lung dose in years.
!! Red Marrow Dose = peak red marrow committed dose equivalent
!!             over the simulation period for combined beta
!!             and photon emitting radionuclides in millirem
!!             per year.
!! Red Marrow Time = time of peak red marrow dose in years.
!! Bone Surface Dose = peak bone surface committed dose
!!             equivalent over the simulation period for
!!             combined beta and photon emitting radionuclides
!!             in millirem per year.
!! Bone Surface Time = time of peak bone surface dose in years.
!! Thyroid Dose = peak thyroid committed dose equivalent over
!!             the simulation period for combined beta and
!!             photon emitting radionuclides in millirem per
!!             year.
!! Thyroid Time = time of peak thyroid dose in years.
!! Remainder Dose = peak remainder committed dose equivalent
!!             over the simulation period for combined beta and
!!             photon emitting radionuclides in millirem per
!!             year.
!! Remainder Time = time of peak remainder dose in years.
!! Whole Body Dose = peak whole body committed dose equivalent
```

```
!!            over the simulation period for combined beta and
!!            photon emitting radionuclides in millirem per
!!            year.
!! Whole Body Time = time of peak whole body dose in years.
```

Realization Number (unitless)	Gross Alpha Concentration (pCi/L)	Gross Alpha Time (yr)	Radium 226 Concentration (pCi/L)	Radium 226 Time (yr)	Gonad Dose (mrem/yr)	Gonad Time (yr)	Breast Dose (mrem/yr)	Breast Time (yr)	Lung Dose (mrem/yr)	Lung Time (yr)	Red Marrow Dose (mrem/yr)	Red Marrow Time (yr)	Bone Surface Dose (mrem/yr)	Bone Surface Time (yr)
1	3.24535E-04	1.00000E+04	4.70296E-09	1.00000E+04	1.62915E-03	1.00000E+04	1.63666E-03	1.00000E+04	1.63020E-03	1.00000E+04	1.63239E-03	1.00000E+04	1.63238E-03	1.00000E+04
2	0.00000E+00	1.00000E+04	0.00000E+00	1.00000E+04	4.20478E-02	1.00000E+04	4.26636E-02	1.00000E+04	4.21339E-02	1.00000E+04	4.23126E-02	1.00000E+04	4.22998E-02	1.00000E+04

Right side truncated text from above.

Thyroid Dose (mrem/yr)	Thyroid Time (yr)	Remainder Dose (mrem/yr)	Remainder Time (yr)	Whole Body Dose (mrem/yr)	Whole Body Time (yr)
1.39585E-01	1.00000E+04	2.71817E-02	1.00000E+04	1.34336E-02	1.00000E+04
8.97806E+00	1.00000E+04	6.78141E-01	1.00000E+04	5.01060E-01	1.00000E+04

Appendix E

Acceptance Test Plan and Results for TPA SCR#563 Changes

Test Plan Name: Acceptance Test for Changes to Groundwater Protection Calculations

Tested By: P. LaPlante

Date: 5/03/07

Host Machine: Froggy (PC)

Host OS: Windows XP Professional, V2002, Service Pack 2

Baseline Version: TPA5.1BetaW

Test Version: TPA5.1BetaW

Process Level (PL) Tests

PL-1. Name: Verification of Changes to Groundwater Protection Input and Output Files
Path for run directory: c:\TPA51BetaW\
Path for archive of results: CD
Environment variables:

Basecase TPA_DATA=c:\tpa51BetaW\
TPA_DATA=c:\tpa51BetaW\

Testcase TPA_DATA=c:\tpa51BetaW\
TPA_DATA=c:\tpa51BetaW\

Special input files or modifications to input files required:

Run an unmodified base case *tpa.inp* and rename the file *tpameans.out* to *tpa.inp*, change

OutputMode(0=None,1=All,2=UserDefined) to 1.
NumberOfRealizations to 1
DSFractionThicknessPenetratedForFailureByCorrosion[] to 0
WPFractionThicknessPenetratedForFailureByCorrosion[] to 0

(Note: an initial test run verified no releases to groundwater for a mean value reference case run so DS and WP inputs above were modified to force early waste package failure so groundwater computations can be verified in test PL-2)

Special diagnostic code modifications required : None
Program modes to be used (append flags, scenario/model switches, etc.): No further changes
Utility scripts needed to perform the test: None
Utility codes needed in the analysis of the test data: MS Excel 2002 SP-2

Test description:

Objective:

1) Verify the groundwater protection calculation output file headers for files *gwp_ave.res* and *gwppktim.res* to clearly explain what is calculated in the file (based on redline/strikeout edits for each file provided in Appendix B and the draft headers in Appendix C and D)

2) Verify the header for data file *organdf.dat* clarifies what dose coefficients are included in the file based on the redline/strikeout edits provided in Appendix B). Verify removal of obsolete data entries referring to "proposed rule" and "scaling factors" (see redline/strikeout edits for this file in Appendix B) .

3) Verify the total dose output column from *gwp_ave.res* and *gwppktim.res* files have been removed.

4) Verify the output file name for prior version files *epa_ave.out* and *epapktim.out* have been changed to *gwp_ave.res* and *gwppktim.res,* respectively.

Assumptions: None
Constraints: None
Output files to compare or examine
organdf.dat
gwp_ave.res
gwppktim.res

Step by step test procedure to be used

1. Run an unmodified base case *tpa.inp* and rename the file *tpameans.out* to *tpa.inp*, change

   OutputMode(0=None,1=All,2=UserDefined) parameter to 1,
   NumberOfRealizations to 1

2. Run the "mean value" tpa.inp file created in Step 1 and copy output files from the run directory to a uniqely named file archive directory (\SCR563\p1).

3. Verify by inspection that the groundwater protection calculation output file headers for files *gwp_ave.out* and *gwppktim.res* are consistent with the redline/strikeout edits for each file provided in Appendix B and the draft headers in Appendix C and D of this SCR.

4. Verify by inspection the header for data file *organdf.dat* is consistent with the redline/strikeout edits provided for that file in Appendix B. Verify by inspection removal of obsolete data entries referring to "proposed rule" and "scaling factors" as noted in the redline/strikeout edits for this file in Appendix B.

5. Verify by inspection the total dose output column from *gwp_ave.res* and *gwppktim.res* files has been removed.

6. Verify by inspection the output file name for prior version files *epa_ave.out* and *epapktim.out* have been changed to *gwp_ave.res* and *gwppktim.res,* respectively.

Pass/fail criteria

Criterion 1: output file headers for files *gwp_ave.out* and *gwppktim.res* are consistent with the redline/strikeout edits for each file provided in Appendix B and drafts provided in Appendix C and D.

Criterion 2: header for data file *organdf.dat* is consistent with the redline/strikeout edits provided for that file in Appendix B

Criterion 3: obsolete data entries referring to "proposed rule" and "scaling factors" have been removed as noted in the redline/strikeout edits for this file in Appendix B

Criterion 4: the total dose output column from *gwp_ave.res* and *gwppktim.res* files has been removed

Criterion 5: output file name for prior version files *epa_ave.out* and *epapktim.out* have been changed to

gwp_ave.res and *gwppktim.res,* respectively.

Test Results:

Files referenced herein including code run and post processing are included in attached CD \SCR563\p1

Criterion 1: **FAIL**

Explanation of results: gwp_ave.res file, SECTION 1, Whole Body Dose definition should have the word "effective" before "dose equivalent" to read "....average whole body committed effective dose equivalent ....". As presently written the metric as described is inconsistent with a "whole body" dose metric and therefore should be corrected.

Criterion 2: **PASSED**
Criterion 3: **PASSED**
Criterion 4: **PASSED**
Criterion 5: **PASSED**

Overall test status: **FAIL**. This will be addressed in SCR689.

PL-2. Name: Verification of Groundwater Protection Calculation Results After SCR Changes
Path for run directory: c:\TPA51BetaW\
Path for archive of results: CD
Environment variables:

Basecase	TPA_DATA=c:\tpa51BetaW\ TPA_DATA=c:\tpa51BetaW\
Testcase	TPA_DATA=c:\tpa51BetaW\ TPA_DATA=c:\tpa51BetaW\

Special input files or modifications to input files required:

Run an unmodified base case *tpa.inp* and rename the file *tpameans.out* to *tpa.inp*, change

OutputMode(0=None,1=All,2=UserDefined) to 1.
NumberOfRealizations to 1
DSFractionThicknessPenetratedForFailureByCorrosion[] to 0
WPFractionThicknessPenetratedForFailureByCorrosion[] to 0

(Note: an initial test run verified no releases to groundwater for a mean value reference case run so DS and WP inputs above were modified to force early waste package failure so groundwater computations can be verified in this test. Same run is used for test PL-1)

Special diagnostic code modifications required : None
Program modes to be used (append flags, scenario/model switches, etc.): No further changes
Utility scripts needed to perform the test: None
Utility codes needed in the analysis of the test data: MS Excel 2002 SP-2

Test description:

Objective:

1. Verify correct execution of peak groundwater protection calculations for a mean value run using spreadsheet calculation

- Groundwater concentrations at the receptor well head are calculated as intended using the saturated zone release estimates and the pumping rate specified in *tpa.inp*

- Input parameters in *tpa.inp* and information in data files *nuclides.dat* (categorization of radionuclides into groups) and *organdf.dat* (organ and whole body dose coefficients) are used as intended in concentration and dose calculations for groundwater protection

- TPA output in files *dcagw.ech*, *gwppktim.res*, *gwp_ave.res* contain correct results that are verified by comparison with spreadsheet calculations

Assumptions:

The test reproduces the calculations done by the TPA5.1BetaW DCAGW module on a spreadsheet. This calculation converts saturated zone (groundwater) release estimates for 20 radionuclides to concentrations and doses of the types that are required by 10 CFR Part 63 groundwater protection limits. One timestep of a deterministic single realization run is verified and assumed to be representative of all timesteps since the same equations are applied to each timestep. Thus, the time-stepping nor stochastic operation are not specifically tested, however, the TPA output from the

calculations will be reviewed to check for anomalous behavior across timesteps. The current test cannot be applied to stochastic operation due to limitations of code output, however, it does directly verify the computations related to groundwater protection in DCAGW and therefore provides confidence in code operation when results agree with test runs.

Constraints: None
Output files to compare or examine

nuclides.dat
dcagw.ech
organdf.dat
gwp_ave.res
gwp_pktim.res

Step by step test procedure to be used

1. Use deterministic mean value code run results from test PL-1.

2. Open the output file *dcagw.ech* in MS Excel, reformat to a single row of columns for each realization and copy the final annual SZ release (flux) values for the 10,000 yr time step into the highlighted bottom row of the spreadsheet (filename *tpa51.validation.gwprot.xls*) labeled "Copied TPA Output from *dcagw.ech* (SZ release at 10 kyr)". Enter by hand into the spreadsheet column labeled *[ciperyrallsafromsz]* the same annual saturated zone flux values from the 10 kyr timestep for each radionuclide from *dcagw.ech*.

3. The spreadsheet was designed to compute the same groundwater protection calculations as TPA. The spreadsheet is populated with parameters and data from the TPA base case run (*tpa.inp* and supporting data files *nuclides.dat*, and *organdf.dat*). The calculations in the spreadsheet are simple and expected to be understood by a competent analyst without recourse to the originator. Using the tools/options menu in Excel to reveal formulas can provide transparency of the information flow on the spreadsheet. The spreadsheet takes saturated zone release estimates in TPA output (copied from *dcagw.ech* file) and:

- estimates groundwater concentrations by dividing the release rates of radionuclides by the pumping volume,
- estimates the human intake of radionclides from drinking the water at the estimated concentration,
- converts the human intake to organ and whole body doses using factors contained in TPA input data file *organdf.dat*
- sums the concentration and dose results to categories that match TPA code output in files gwp_ave.res and gwppktim.res.

4. Open the output file *gwp_ave.res* in MS Excel and copy the values for the 10,000 yr timestep into the aforementioned spreadsheet (filename *tpa51.validation.gwprot.xls*) in the yellow highlighted areas under the relevant headings (i.e., gross alpha and radium concentrations, doses to various organs and whole body).

5. Verify by visual inspection the ratios of spreadsheet calculated values with the TPA output on the spreadsheet equal 1.0 +- 0.05.

6. Visually inspect the output of *gwppktim.res* file and verify that results are consistent with results reported in *gwp_ave.res* (e.g., for a single realization run the *gwp_ave.res* output results are provided for each timestep and *gwppktim.res* provides only the peak result among all timesteps for each realization so the visual inspection will check whether the *gwppktim.res* shows the true maximum values and correct time step for each result computed for the single realization that was run that are found in *gwp_ave.res)*.

Pass fail criteria

Criterion 1: Test is passed if spreadsheet computed alpha concentration, Ra226 concentration, and organ and whole body doses match test run code output values.

Criterion 2: Test is passed if all the output results of *gwppktim.res* file are consistent with results reported in *gwp_ave.res*.

Test Results:

Files referenced herein including code run and post processing are included in attached CD \SCR563\p1

-Criterion 1: **PASSED**
-Criterion 2: **PASSED**

Overall test status (**PASS**):

PL-3. Name: Verification of Stochastic Groundwater Protection Calculation Results After SCR Changes
Path for run directory: c:\TPA51BetaW\
Path for archive of results: CD
Environment variables:

Basecase TPA_DATA=c:\tpa51BetaW\
TPA_DATA=c:\tpa51BetaW\

Testcase TPA_DATA=c:\tpa51BetaW\
TPA_DATA=c:\tpa51BetaW\

Special input files or modifications to input files required:
Modify a reference case *tpa.inp* file as follows:

OutputMode(0=None,1=All,2=UserDefined) to 1.
NumberOfRealizations to 3
DSFractionThicknessPenetratedForFailureByCorrosion[] to 0
WPFractionThicknessPenetratedForFailureByCorrosion[] to 0

(Note: an initial test run verified no releases to groundwater for a mean value reference case run so DS and WP inputs above were modified to force early waste package failure so groundwater computations can be verified in this test.)

Special diagnostic code modifications required : None
Program modes to be used (append flags, scenario/model switches, etc.): No further changes
Utility scripts needed to perform the test: None
Utility codes needed in the analysis of the test data: MS Excel 2002 SP-2

Test description:

Objective:

1. Verify correct execution of peak groundwater protection calculations for a stochastic run using a spreadsheet calculation

- Groundwater concentrations at the receptor well head are calculated as intended using the saturated zone release estimates and the pumping rate specified in *tpa.inp*

- Input parameters in *tpa.inp* and information in data files *nuclides.dat* (categorization of radionuclides into groups) and *organdf.dat* (organ and whole body dose coefficients) are used as intended in concentration and dose calculations for groundwater protection

- TPA output in files *dcagw.ech*, *gwppktim.res*, *gwp_ave.res* contain correct results that are verified by comparison with spreadsheet calculations

Assumptions:
The test reproduces the calculations done by the TPA5.1BetaW DCAGW module on a spreadsheet. This calculation converts saturated zone (groundwater) release estimates for 20 radionuclides to concentrations and doses of the types that are required by 10 CFR Part 63 groundwater protection limits. One timestep of a 3 realization run is verified and assumed to be representative of all timesteps

since the same equations are applied to each timestep. Thus, the time-stepping is not specifically tested. The current test verifies the computations related to groundwater protection in DCAGW for stochastic operation are being conducted as designed and therefore provides confidence in code operation when results agree with test runs.

Constraints: None
Output files to compare or examine

nuclides.dat
dcagw.ech
organdf.dat
gwp_ave.res
gwp_pktim.res

Step by step test procedure to be used

(Note, this test follows closely the same procedure as test PL-2, with the addition of 3 realization run conducted to check the average output instead of the mean value run used in PL-2)

1. Use stochastic 3 realization code run with input modifications as previously described.

2. Modify the spreadsheet used to verify a single realization in PL-2 to accommodate 3 realizations of code output. This is done by block copying/pasting the computations on spreadsheet to produce 3 blocks of the same computations (one for each realization). An additional computation to calculate average spreadsheet results for the 3 realizations is also added at the bottom of the spreadsheet.

3. Open the output file *dcagw.ech* in MS Excel, reformat to a single row of columns for each realization (*dcagw.ech.xls*) and copy the final annual SZ release (flux) values for the 10,000 yr time step for each realization into the highlighted portions of the spreadsheet (filename *tpa51.validation.gwprot.pl3.xls*) labeled "Copied TPA Output from *dcagw.ech* (SZ release at 10 kyr)". Enter by hand into the spreadsheet column labeled *[ciperyrallsafromsz]* the same annual saturated zone flux values from the 10 kyr timestep for each radionuclide from *dcagw.ech*. Repeat for each realization of code output.

3. The spreadsheet was designed to compute the same groundwater protection calculations as TPA. The spreadsheet is populated with parameters and data from the TPA base case run (*tpa.inp* and supporting data files *nuclides.dat*, and *organdf.dat*). The calculations in the spreadsheet are simple and expected to be understood by a competent analyst without recourse to the originator. Using the tools/options menu in Excel to reveal formulas can provide transparency of the information flow on the spreadsheet. The spreadsheet takes saturated zone release estimates in TPA output (copied from *dcagw.ech* file) and:

- estimates groundwater concentrations for each realization by dividing the release rates of radionuclides by the pumping volume,
- estimates the human intake of radionclides for each realization from drinking the water at the estimated concentration,
- converts the human intake to organ and whole body doses for each realization using factors contained in TPA input data file *organdf.dat*
- sums and averages the concentration and dose results for each realization to categories that match TPA code output in files gwp_ave.res and gwppktim.res.

4. Open the output file *gwppktim.res* in MS Excel and copy the values for the 10,000 yr timestep into the aforementioned spreadsheet (filename *tpa51.validation.gwprot.pl3.xls*) in the yellow highlighted areas under the relevant headings (i.e., gross alpha and radium concentrations).

5. Verify by visual inspection the ratios of spreadsheet calculated values (values of alpha and radium

concentrations for each realization, and the values for alpha and radium concentrations and organ and whole body doses averaged over all realizations) with the TPA output on the spreadsheet equal 1.0 +- 0.05.

Pass fail criteria

Criterion 1: Test is passed if spreadsheet computed values match test run TPA51BetaW code output for:

i) gross alpha and Ra226 concentrations by realization and
ii) average alpha concentration, Ra226 concentration, and organ and whole body doses

Test Results:

Files referenced herein including code run and post processing are included in attached CD \SCR563\p3

Criterion 1: **PASSED**

Overall test status (**PASS**):

SCR - 596

TPA 5.1/ Beta I

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 596	**2. Software Title and Version:** TPA 5.0.1betal	**3. Project No:** 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f*

When the TPA gives a message that all the waste packages have failed there is a discrepancy between the number that have failed and the number of waste packages in the subarea.

5. Change Requested by: R. Rice Date: 11-14-05	**6. Change Authorized by** (*Software Developer*): R. Janetzke Date: 11-15-05

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):
This condition exists when more than one failure type occurs during the same time step. The number of waste packages failed may exceed the number available by one because of rounding.

See Attachment A for the changes made to the *exec.f* file.

8. Implemented by: R. Rice	**Date:** 11-21-05

9. Description of Acceptance Tests:

See Attachment B.

10. Tested by: J. Menchaca	**Date:** 6-21-06

CNWRA Form TOP-5 (05/2000)

UPDATE REQUIREMENTS for TPA.INP

SCR 596

Status (***ADD, DELETE, MODIFY TO, MODIFY FROM***)	**Module**	**Parameter Name**	**Description** (***Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.***)	**Distribution**	**Range**	**Justification** ***1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.***	**Source**
No Change to any TPA.INP parameter							

ATTACHMENT A

```
Comparing files exec.f and EXEC.F.ORIGINAL
***** exec.f
      nwpdiff = iabs(nsafailed-numberofwpsinsa)

cc rwr 11-21-05; SCR596; decrease tolerance
cc      ntol = 1
      ntol = 0

      if (nwpdiff .le. ntol ) then
***** EXEC.F.ORIGINAL
      nwpdiff = iabs(nsafailed-numberofwpsinsa)
      ntol = 1
      if (nwpdiff .le. ntol ) then

***** exec.f
     &    numberofwpsinsa,' ***'
cc rwj 6-20-06; SCR 596
        if (nsafailed .gt. numberofwpsinsa) then
          print *,' *** In the event of 2 failure types occurring at'
          print *,'     the same time step, the number failed may'
          print *,'     exceed the number available by one, due to'
          print *,'     rounding.'
        endif

      endif
***** EXEC.F.ORIGINAL
     &    numberofwpsinsa,' ***'
      endif
*****

***** exec.f
     &    numberofwpsinsa,' ***'
cc rwj 6-20-06; SCR 596
        if (nsafailed .gt. numberofwpsinsa) then
          print *,' *** In the event of 2 failure types occurring at'
          print *,'     the same time step, the number failed may'
          print *,'     exceed the number available by one, due to'
          print *,'     rounding.'
        endif

***** EXEC.F.ORIGINAL
     &    numberofwpsinsa,' ***'
      endif
      ntotalfailed = ntotalfailed + nsafailed

*****

***** exec.f
      endif
      ntotalfailed = ntotalfailed + nsafailed

cccccccccc
```

Attachment B

Test Plan for TPA SCR#596

Test Plan Name: Check Report of Number of Waste Packages Failed.

Tested By: J. Menchaca **Date:** June 21, 2006

Host Machine: SUN Ultra-4 server: Spock **Host OS:** Sun Solaris 5.8

Baseline Version: 5.1betaA **Test Version:** 5.1betaC

System Level (SL) Tests

SL-1. Name: Check Report of Number of Waste Packages Failed

Path for run directory: ~/jmench/tpa51betaA/SCR596 and ~/jmench/tpa51betaC/SCR596

Path for archive of results: CD named "SCR#596 Testing".

Environment variables: TPA_TEST= ~jmench/tpa51betaC
TPA_DATA= ~jmench/tpa51betaC

Special input files or modifications to input files required: *tpa.inp*

VolcanismDisruptiveScenarioFlag =1
FaultingDisruptiveScenarioFlag =1
NumberOfRealizations = 444
StartAtRealization = 6
StopAtRealization = 6
OuterWPThickness[m] = 0.00002
CriticalRelativeHumidityHumidAirCorrosion = 0.1
CriticalRelativeHumidityAqueousCorrosion = 0.2
UseTimesOrSEISMOIntervals = 1
TimeOfNextFaultingEventinRegionOfInterest[yr] = 100.0, 1000.0, 2.0e-5
TimeOfNextVolcanicEventinRegionOfInterest[yr] = 100.0, 1000.0, 1.0e-7

Special diagnostic code modifications required : None

Program modes to be used (append flags, scenario/model switches, etc.):

OutputMode = 2 (UserDefined)
UserDefinedLowerRealizationAppended = 6
UserDefinedUpperRealizationAppended = 6
SelectAppendFiles = 6 (volcano.ech and volcano.rlt only)

Utility scripts needed to perform the test: None

Utility codes needed in the analysis of the test data: None

Test description: When the TPA gives a message that all the waste packages have failed, occasionally there is a discrepancy between the number that have failed and the number of waste packages in the subarea.

- **Objective:** Compare the results from the test code with that of a know failure in the baseline code.

- **Assumptions:** None.

- **Constraints:** None

- Output files to compare or examine: *tpa.out*

- Step by step test procedure to be used:

1. Create baseline and test "run" subdirectories in the SCR596 directory.
2. In each of these run directories, copy the respective *tpa.inp* file to the run directory.
3. Execute the TPA Versions 5.1betaC and 5.1betaA code using their respective modified base case *tpa.inp* files and capture the screen print in *tpa.out* files.
4. Scan the *tpa.out* files.
5. Verify that "rounding"warning message appears in the TPA Version 5.1betaC output.

- Pass/Fail criteria:

Criterion 1: For the TPA 5.1betaC code, the following message appears:
In the event of 2 failure types occurring at the same time step, the number failed may exceed the number available by one, due to rounding.

Test Results: PASS

- Overall test status: <u>PASS</u>

SCR - 627

TPA 5.1/ Beta A

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 627	**2. Software Title and Version:** TPA 5.1betaA	**3. Project No:** 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *mechfail.f, mechdrive.f, exec.f, ebsrel.f, codes/Makefile, codes/mechfail.fig, driftfail.f*

1) In MECHFAIL, messages are incorrectly formatted for the error handler. This causes the code to stop before executing the error handler and displaying the message. Also, within *mechdrive.f*, the drift degradation flag is not used, and references to it should be removed.

2) The following files should be removed at the start of execution: *ebspacsf.nuc, ebspacglass.nuc, ebsrelsf.inp, ebsrelglass.inp, mechfail_wp.out, mechfail_ds.out*

3) In DRIFTFAIL, the backfill outer diameter exceeds the rock wall diameter for thermal model 2. These values can be observed in the file *driftfail.rlt*.

4) In EBSREL, there is an error in the print statement for copying *ebspac.nuc* to *ebspacglass.nuc* (version TPA 5.1betaA).

5. Change Requested by: G. Adams Date: 4/26/2006	**6. Change Authorized by** (*Software Developer*): R. Janetzke Date: 4/26/2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

1) *Mechdrive.f, Mechfail.f*: Corrected the formatting of the write statements for the error handler to remove the line returns as part of the format string. Removed code involving the drift degradation flag.

2) *Exec.f*: Updated subroutine *setfiles()* within *exec.f* to remove *ebspacglass.nuc, ebspacsf.nuc, ebsrelglass.inp,* and *ebsrelsf.inp, mechfail_wp.out*, and *mechfail_ds.out.*

3) *Driftfail.f*: The backfill outer diameter is limited to not exceed the rock wall diameter for thermal model 2. For thermal model 1, the limit was already in place.

4) *Ebsrel.f*: Added code to generate files *ebspacsf.nuc* and *ebspacglass.nuc.*

8. Implemented by: G. Adams	**Date:** 4/26/2006

9. Description of Acceptance Tests:
See Attachment A

10. Tested by: J. Mancillas	**Date:** 6-22-06

CNWRA Form TOP-5 (05/2000)

UPDATE REQUIREMENTS for TPA.INP

SCR 627

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM)*	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.)*	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
none							

Attachment A
Test Plan for TPA SCR627

Test Plan Name: SCR 627 Testing

Tested By: J. Mancillas | Date: June 22, 2006

Host Machine: TPA | Host OS: Windows XP SP2

Baseline Version: TPA51betaA | Test Version: TPA51betaB

System Level (SL) Tests

SL-1. Name: Remove drift degradation flag

Path for run directory:
Baseline: [TPA] D:\Public\Mancillas\SCR627\run1A
Test : [TPA] D:\Public\Mancillas\SCR627\run1B

Path for archive of results:
Baseline: [CD: titled SCR627 testing] \ SCR627\run1A
Test : [CD: titled SCR628 testing] \SCR627\run1B

Environment variables:
Baseline: TPA_TEST= ..\tpa51betaA\
TPA_DATA= ..\tpa51betaA\

Test : TPA_TEST= ..\tpa51betaB\
TPA_DATA=..\tpa51betaB\

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): NONE

Utility scripts needed to perform the test: DOS command fc

Utility codes needed in the analysis of the test data: NONE

Test description: Changes being tested in mechdrive.f and mechfail.f are mostly cosmetic in nature. Format changes were made to error print statements, these statements in general are not accessible through the normal operation of the TPA code because most error generating conditions are intercepted prior to the mechfail module. In addition to the format changes, a parameter, a drift degradation flag, which was included as an input but was not employed in any mechfail calculations was

removed. These changes should have no impact on the normal operation of the TPA code.

- objective The objective of this test is to verify that the changes made to the TPA code, within the mechfail module are consistent with those described by SCR627.

- assumptions None other than those made within the TPA code

- constraints NONE

- output files to compare or examine the general output of the TPA code

- step by step test procedure to be used
  1) examine the changes in the source code for the baseline (TPA 51betaA) and test version (TPA 51betaB) modules *mechfail.f* and *mechdrive.f*
  2) execute a basecase realization for both the baseline and test version of the TPA code
  3) examine the results of the basecase realizations

- pass fail criteria
  1) the changes in the source code should be logical and consistent with the intended changes of SCR627
  2) the basecase and test versions of the TPA code should both execute properly and generate the same Peak Mean doses and times.

Test Results: The mechfail module is executed in two steps. The first is a function call within the TPA executive module to either mechdriver_ds or mechdriver_wp. The source code for these functions are contained in the file *mechdrive.f*. They prepare input files and retrieve output files from the standalone codes mechfail_ds and mechfail_wp, whose source codes is contained in the file *mechfail.f*. The mechdrivers perform some error checking of input data as they generate the input files and the mechfail functions again perform error checking of the input data as they read the input files. An examination the code changes show that the format of the output has been changed and that the statement strings have been cleared prior to setting the error message. In addition the variable idegradation flag has been omitted from the mechdrive functions.

- criterion 1
The following excerpts are from the file comparisons between the baseline and test versions of the files *mechdrive.f* and *mechfail.f*.

The following excerpt is from the file *mechdrive_fc*, which was generated using the DOS file compare command " fc tpa51betaA\mechdrive.f tpa51betaB\mechdrive.f > mechdrive_fc ". This file is archived to CD *\SCR627\diff_files\mechdrive_fc*

```
*****************************************************************************
Comparing files TPA51BETAB\mechdrive.f and TPA51BETAA\MECHDRIVE.F
***** TPA51BETAB\mechdrive.f
```

```
c     Input file declarations
c     GADAMS SCR627 4-26-2006: Drift degradation flag is not used
c      INTEGER iseismicity_flag, idegradation_flag,
c     &  istart_time, ifraction_rock1(maxnsubarea),
c     &  ihor_to_vert1(maxnsubarea), ihor_to_vert2(maxnsubarea),
c     &  icreep_threshold, idyn_amp_factor
      INTEGER iseismicity_flag,
     &  istart_time, ifraction_rock1(maxnsubarea),
***** TPA51BETAA\MECHDRIVE.F

c     Input file declarations
      INTEGER iseismicity_flag, idegradation_flag,
     &  istart_time, ifraction_rock1(maxnsubarea),
*****

***** TPA51BETAB\mechdrive.f
     &  ihor_to_vert1(maxnsubarea), ihor_to_vert2(maxnsubarea),
     &  icreep_threshold, idyn_amp_factor

c      SAVE    iseismicity_flag, idegradation_flag,
c     &  istart_time, ifraction_rock1,
c     &  ihor_to_vert1,              ihor_to_vert2,
c     &  icreep_threshold, idyn_amp_factor
      SAVE    iseismicity_flag,
     &  istart_time, ifraction_rock1,
***** TPA51BETAA\MECHDRIVE.F
     &  ihor_to_vert1(maxnsubarea), ihor_to_vert2(maxnsubarea),
     &  icreep_threshold, idyn_amp_factor

      SAVE    iseismicity_flag, idegradation_flag,
     &  istart_time, ifraction_rock1,
*****

***** TPA51BETAB\mechdrive.f
     &  icreep_threshold, idyn_amp_factor
c     GADAMS SCR627 4-26-2006: End of change

c     End static declarations
***** TPA51BETAA\MECHDRIVE.F
     &  icreep_threshold, idyn_amp_factor
c     End static declarations
*****

***** TPA51BETAB\mechdrive.f
c     Check the number of subareas
      IF(maxnsubarea .LT. numSubareas) THEN

c       GADAMS SCR627 4-13-2006: Updated error string
        CALL clearchar(180, cerror_message)
c        WRITE(cerror_message, FMT = '(a,\a,i,\a,i)')
c     &    'Number of subareas exceeds maximum',
c     &    'Number of subareas: ', numSubareas,
c     &    'Maximum number of subareas: ', maxnsubarea
        WRITE(cerror_message, FMT = '(a,a1,a,i10,a1,a,i10)')
     &    'Number of subareas exceeds maximum', char(10),
     &    'Number of subareas: ', numSubareas, char(10),
     &    'Maximum number of subareas: ', maxnsubarea
c       GADAMS SCR627 4-13-2006: End of change
```

```
        call errorHandler(cerror_message, 'mechdriver_ds')
***** TPA51BETAA\MECHDRIVE.F
c     Check the number of subareas
      IF(maxnsubarea .LT. numSubareas) THEN
        WRITE(cerror_message, FMT = '(a,\a,i,\a,i)')
     &    'Number of subareas exceeds maximum',
     &    'Number of subareas: ', numSubareas,
     &    'Maximum number of subareas: ', maxnsubarea
        call errorHandler(cerror_message, 'mechdriver_ds')
*****

***** TPA51BETAB\mechdrive.f
        IF(isconstant(iseismicity_flag) .NE. 1) THEN

c         GADAMS SCR627 4-13-2006: Updated error string
          CALL clearchar(180, cerror_message)
c          WRITE(cerror_message, FMT = '(a/a)')
c     &      'Problem with SeismicDisruptiveScenarioFlag(yes=1,no=0)',
c     &      'Should be specified as iflag'
          WRITE(cerror_message, FMT = '(a,a1,a)')
     &      'Problem with SeismicDisruptiveScenarioFlag(yes=1,no=0)',
     &      char(10), 'Should be specified as iflag'
c         GADAMS SCR627 4-13-2006: End of change

          CALL errorHandler(cerror_message, 'mechdriver')
***** TPA51BETAA\MECHDRIVE.F
        IF(isconstant(iseismicity_flag) .NE. 1) THEN
          WRITE(cerror_message, FMT = '(a/a)')
     &      'Problem with SeismicDisruptiveScenarioFlag(yes=1,no=0)',
     &      'Should be specified as iflag'
          CALL errorHandler(cerror_message, 'mechdriver')
*****

***** TPA51BETAB\mechdrive.f
        IF((ISeismicity .LT. 0) .OR. (ISeismicity .GT. 1) ) THEN

c         GADAMS SCR627 4-13-2006: Updated error string
          CALL clearchar(180, cerror_message)
c          WRITE(cerror_message, FMT = '(a/a)')
c     &      'Problem with SeismicDisruptiveScenarioFlag(yes=1,no=0)',
c     &      'Should be either a 0 or a 1'
          WRITE(cerror_message, FMT = '(a,a1,a)')
     &      'Problem with SeismicDisruptiveScenarioFlag(yes=1,no=0)',
     &      char(10), 'Should be either a 0 or a 1'
c         GADAMS SCR627 4-13-2006: End of change

          CALL errorHandler(cerror_message, 'mechdriver')
***** TPA51BETAA\MECHDRIVE.F
        IF((ISeismicity .LT. 0) .OR. (ISeismicity .GT. 1) ) THEN
          WRITE(cerror_message, FMT = '(a/a)')
     &      'Problem with SeismicDisruptiveScenarioFlag(yes=1,no=0)',
     &      'Should be either a 0 or a 1'
          CALL errorHandler(cerror_message, 'mechdriver')
*****

***** TPA51BETAB\mechdrive.f
```

```
c       GADAMS SCR627 4-26-2006: Drift degradation flag is not used
c        CALL clearchar(60, cname)
c        cname = 'DriftDegradationScenarioFlag(yes=1,no=0)'
c        idegradation_flag = ispquery(cname)
c        IF(isconstant(idegradation_flag) .NE. 1) THEN
c          WRITE(cerror_message, FMT = '(a,a1,a)')
c     &      'Problem with DriftDegradationScenarioFlag(yes=1,no=0)',
c     &      'Should be specified as iflag'
c          CALL errorHandler(cerror_message, 'mechdriver')
c        ENDIF
c        GADAMS SCR627 4-26-2006: Drift degradation flag is not used
c       End of control flags
***** TPA51BETAA\MECHDRIVE.F

        CALL clearchar(60, cname)
        cname = 'DriftDegradationScenarioFlag(yes=1,no=0)'
        idegradation_flag = ispquery(cname)
        IF(isconstant(idegradation_flag) .NE. 1) THEN
          WRITE(cerror_message, FMT = '(a/a)')
     &      'Problem with DriftDegradationScenarioFlag(yes=1,no=0)',
     &      'Should be specified as iflag'
          CALL errorHandler(cerror_message, 'mechdriver')
        ENDIF
c       End of control flags
*****

***** TPA51BETAB\mechdrive.f
        IF(istatus .NE. 0) THEN

c         GADAMS SCR627 4-13-2006: Added call to clearchar
          CALL clearchar(180, cerror_message)

          WRITE(cerror_message, FMT = '(a)')'Failure to copy mechfail.e'
***** TPA51BETAA\MECHDRIVE.F
        IF(istatus .NE. 0) THEN
          WRITE(cerror_message, FMT = '(a)')'Failure to copy mechfail.e'
*****

***** TPA51BETAB\mechdrive.f
        IF(istatus .NE. 0) THEN

c         GADAMS SCR627 4-13-2006: Added call to clearchar
          CALL clearchar(180, cerror_message)

          WRITE(cerror_message, FMT = '(a)')
***** TPA51BETAA\MECHDRIVE.F
        IF(istatus .NE. 0) THEN
          WRITE(cerror_message, FMT = '(a)')
*****

***** TPA51BETAB\mechdrive.f
        IF(istatus .NE. 0) THEN

c         GADAMS SCR627 4-13-2006: Added call to clearchar
          CALL clearchar(180, cerror_message)

          WRITE(cerror_message, FMT = '(a)')
***** TPA51BETAA\MECHDRIVE.F
```

```
        IF(istatus .NE. 0) THEN
          WRITE(cerror_message, FMT = '(a)')
*****

***** TPA51BETAB\mechdrive.f
      IF(istatus .NE. 0) THEN

c       GAADMS SCR627 4-13-2006: Added call to clearchar
        CALL clearchar(180, cerror_message)

        WRITE(cerror_message, FMT = '(a)')
     &    'Failed to invoke command: rm mechfail_ds.dat'
        CALL errorHandler(cerror_message, 'mechdriver_ds')
      ENDIF
***** TPA51BETAA\MECHDRIVE.F
      IF(istatus .NE. 0) THEN
          WRITE(cerror_message, FMT = '(a)')
     &      'Failed to invoke command: rm mechfail_ds.dat'
          CALL errorHandler(cerror_message, 'mechdriver_ds')
      ENDIF
*****

***** TPA51BETAB\mechdrive.f
      IF(istatus .NE. 0) THEN

c       GADAMS SCR627 4-13-2006: Added call to clearchar
        CALL clearchar(180, cerror_message)

        WRITE(cerror_message, FMT = '(a)')
     &    'Failed to invoke: mechfail.e > mechfail_ds.out'
        CALL errorHandler(cerror_message, 'mechdriver_ds')
      ENDIF
***** TPA51BETAA\MECHDRIVE.F
      IF(istatus .NE. 0) THEN
          WRITE(cerror_message, FMT = '(a)')
     &      'Failed to invoke: mechfail.e > mechfail_ds.out'
          CALL errorHandler(cerror_message, 'mechdriver_ds')
      ENDIF
*****

***** TPA51BETAB\mechdrive.f

c     Input file declarations
c     GADAMS SCR627 4-26-2006: Drift degradation flag is not used
c      INTEGER iseismicity_flag, idegradation_flag,
c     &  icontact_angle(maxnsubarea), icontact_length(maxnsubarea),
c     &  itributary_area,
c     &  istart_time, ifraction_rock1(maxnsubarea), idyn_amp_factor
      INTEGER iseismicity_flag,
     &  icontact_angle(maxnsubarea), icontact_length(maxnsubarea),
***** TPA51BETAA\MECHDRIVE.F

c     Input file declarations
      INTEGER iseismicity_flag, idegradation_flag,
     &  icontact_angle(maxnsubarea), icontact_length(maxnsubarea),
*****

***** TPA51BETAB\mechdrive.f
```

```
     &  istart_time, ifraction_rock1(maxnsubarea), idyn_amp_factor

c      SAVE    iseismicity_flag, idegradation_flag,
c     &  icontact_angle,              icontact_length,
c     &  itributary_area,
c     &  istart_time, ifraction_rock1, idyn_amp_factor
      SAVE    iseismicity_flag,
     &  icontact_angle,              icontact_length,
***** TPA51BETAA\MECHDRIVE.F
     &  istart_time, ifraction_rock1(maxnsubarea), idyn_amp_factor
      SAVE    iseismicity_flag, idegradation_flag,
     &  icontact_angle,              icontact_length,
*****

***** TPA51BETAB\mechdrive.f
     &  istart_time, ifraction_rock1, idyn_amp_factor
c     GADAMS SCR627 4-26-2006: End of change

c     End static declarations
***** TPA51BETAA\MECHDRIVE.F
     &  istart_time, ifraction_rock1, idyn_amp_factor
c     End static declarations
*****

***** TPA51BETAB\mechdrive.f
      IF(maxnsubarea .LT. numSubareas) THEN

c       GADAMS SCR627 4-13-2006: Updated error string
        CALL clearchar(180, cerror_message)
c        WRITE(cerror_message, FMT = '(a,\a,i,\a,i)')
c     &    'Number of subareas exceeds maximum',
c     &    'Number of subareas: ', numSubareas,
c     &    'Maximum number of subareas: ', maxnsubarea
        WRITE(cerror_message, FMT = '(a,a1,a,i10,a1,a,i10)')
     &    'Number of subareas exceeds maximum', char(10),
     &    'Number of subareas: ', numSubareas, char(10),
     &    'Maximum number of subareas: ', maxnsubarea
c       GADAMS SCR627 4-13-2006: End of change

        call errorHandler(cerror_message, 'mechdriver_wp')
***** TPA51BETAA\MECHDRIVE.F
      IF(maxnsubarea .LT. numSubareas) THEN
        WRITE(cerror_message, FMT = '(a,\a,i,\a,i)')
     &    'Number of subareas exceeds maximum',
     &    'Number of subareas: ', numSubareas,
     &    'Maximum number of subareas: ', maxnsubarea
        call errorHandler(cerror_message, 'mechdriver_wp')
*****

***** TPA51BETAB\mechdrive.f
        IF(isconstant(iseismicity_flag) .NE. 1) THEN

c         GADAMS SCR627 4-13-2006: Updated error string
          CALL clearchar(180, cerror_message)
c          WRITE(cerror_message, FMT = '(a/a)')
c     &      'Problem with SeismicDisruptiveScenarioFlag(yes=1,no=0)',
c     &      'Should be specified as iflag'
          WRITE(cerror_message, FMT = '(a,a1,a)')
```

```
     &       'Problem with SeismicDisruptiveScenarioFlag(yes=1,no=0)',
     &       char(10), 'Should be specified as iflag'
c          GADAMS SCR627 4-13-2006: End of change

           CALL errorHandler(cerror_message, 'mechdriver')
***** TPA51BETAA\MECHDRIVE.F
         IF(isconstant(iseismicity_flag) .NE. 1) THEN
           WRITE(cerror_message, FMT = '(a/a)')
     &       'Problem with SeismicDisruptiveScenarioFlag(yes=1,no=0)',
     &       'Should be specified as iflag'
           CALL errorHandler(cerror_message, 'mechdriver')
*****

***** TPA51BETAB\mechdrive.f
         IF((ISeismicity .LT. 0) .OR. (ISeismicity .GT. 1) ) THEN

c          GADAMS SCR627 4-13-2006: Updated error string
           CALL clearchar(180, cerror_message)
c           WRITE(cerror_message, FMT = '(a/a)')
c     &       'Problem with SeismicDisruptiveScenarioFlag(yes=1,no=0)',
c     &       'Should be either a 0 or a 1'
           WRITE(cerror_message, FMT = '(a,a1,a)')
     &       'Problem with SeismicDisruptiveScenarioFlag(yes=1,no=0)',
     &       char(10), 'Should be either a 0 or a 1'
c          GADAMS SCR627 4-13-2006: End of change

           CALL errorHandler(cerror_message, 'mechdriver')
***** TPA51BETAA\MECHDRIVE.F
         IF((ISeismicity .LT. 0) .OR. (ISeismicity .GT. 1) ) THEN
           WRITE(cerror_message, FMT = '(a/a)')
     &       'Problem with SeismicDisruptiveScenarioFlag(yes=1,no=0)',
     &       'Should be either a 0 or a 1'
           CALL errorHandler(cerror_message, 'mechdriver')
*****

***** TPA51BETAB\mechdrive.f

c        GADAMS SCR627 4-26-2006: Drift degradation flag is not used
c         CALL clearchar(60, cname)
c         cname = 'DriftDegradationScenarioFlag(yes=1,no=0)'
c         idegradation_flag = ispquery(cname)
c         IF(isconstant(idegradation_flag) .NE. 1) THEN
c           WRITE(cerror_message, FMT = '(a/a)')
c     &       'Problem with DriftDegradationScenarioFlag(yes=1,no=0)',
c     &       'Should be specified as iflag'
c           CALL errorHandler(cerror_message, 'mechdriver')
c         ENDIF
c        GADAMS SCR627 4-26-2006: End of change

c        End of control flags
***** TPA51BETAA\MECHDRIVE.F

         CALL clearchar(60, cname)
         cname = 'DriftDegradationScenarioFlag(yes=1,no=0)'
         idegradation_flag = ispquery(cname)
         IF(isconstant(idegradation_flag) .NE. 1) THEN
           WRITE(cerror_message, FMT = '(a/a)')
     &       'Problem with DriftDegradationScenarioFlag(yes=1,no=0)',
```

```
     &       'Should be specified as iflag'
          CALL errorHandler(cerror_message, 'mechdriver')
        ENDIF
c       End of control flags
*****

***** TPA51BETAB\mechdrive.f
        istatus = zportsh(command)
        IF(istatus .NE. 0) THEN

c         GADAMS SCR627 4-13-2006: Added call to clearchar
          CALL clearchar(180, cerror_message)

          WRITE(cerror_message, FMT = '(a)')
***** TPA51BETAA\MECHDRIVE.F
        istatus = zportsh(command)
        IF(istatus .NE. 0) THEN
          WRITE(cerror_message, FMT = '(a)')
*****

***** TPA51BETAB\mechdrive.f
        istatus = zportsh(command)
        IF(istatus .NE. 0) THEN

c         GADAMS SCR627 4-13-2006: Added call to clearchar
          CALL clearchar(180, cerror_message)

          WRITE(cerror_message, FMT = '(a)')
***** TPA51BETAA\MECHDRIVE.F
        istatus = zportsh(command)
        IF(istatus .NE. 0) THEN
          WRITE(cerror_message, FMT = '(a)')
*****

***** TPA51BETAB\mechdrive.f
      IF(istatus .NE. 0) THEN

c       GADAMS SCR627 4-13-2006: Added call to clearchar
        CALL clearchar(180, cerror_message)

          WRITE(cerror_message, FMT = '(a)')
***** TPA51BETAA\MECHDRIVE.F
      IF(istatus .NE. 0) THEN
          WRITE(cerror_message, FMT = '(a)')
*****

***** TPA51BETAB\mechdrive.f
      IF(istatus .NE. 0) THEN

c       GADAMS SCR627 4-13-2006: Added call to clearchar
        CALL clearchar(180, cerror_message)

          WRITE(cerror_message, FMT = '(a)')
***** TPA51BETAA\MECHDRIVE.F
      IF(istatus .NE. 0) THEN
          WRITE(cerror_message, FMT = '(a)')
*****
*******************************************************************************
```

The changes shown in this excerpt depict the removal of the drift failure flag and its error checking and the clearing of the error message line before generating the error message and the change in the format of the error messages.

The following excerpt is from the file *mechfail_fc*, which was generated using the DOS file compare command " fc tpa51betaA\mechfail.f tpa51betaB\mechfail.f > mechfail_fc ". This file is archived to *CD \SCR627\diff_files\mechfail_fc*

```
*******************************************************************************
Comparing files TPA51BETAB\CODES\mechfail.f and TPA51BETAA\CODES\MECHFAIL.F
***** TPA51BETAB\CODES\mechfail.f
C File Name:            mechfail.f
C File Date:            05/17/06
C Release Version:      5.1
***** TPA51BETAA\CODES\MECHFAIL.F
C File Name:            mechfail.f
C File Date:            04/11/06
C Release Version:      5.1
*****

***** TPA51BETAB\CODES\mechfail.f
      IF(ntime_values .GT. maxntime) THEN

c       GADAMS SCR627 4-13-2006: Updated error string
        CALL clearchar(180, cerror_message)
c        WRITE(cerror_message, FMT='(a,/a,i,/a,i)')
c     &    'Number of time steps exceeds maximum',
c     &    'Number of time steps: ', ntime_values,
c     &    'Maximum number of time steps: ', maxntime
        WRITE(cerror_message, FMT='(a,a1,a,i10,a1,a,i10)')
     &    'Number of time steps exceeds maximum', char(10),
     &    'Number of time steps: ', ntime_values, char(10),
     &    'Maximum number of time steps: ', maxntime
c       GADAMS SCR627 4-13_2006: End of change

        CALL errorHandler(cerror_message, 'processFailure_ds')
***** TPA51BETAA\CODES\MECHFAIL.F
      IF(ntime_values .GT. maxntime) THEN
        WRITE(cerror_message, FMT='(a,/a,i,/a,i)')
     &    'Number of time steps exceeds maximum',
     &    'Number of time steps: ', ntime_values,
     &    'Maximum number of time steps: ', maxntime
        CALL errorHandler(cerror_message, 'processFailure_ds')
*****

***** TPA51BETAB\CODES\mechfail.f
      IF(nseismic_events .GT. maxseismic) THEN

c       GADAMS SCR627 4-13-2006: Updated error string
        CALL clearchar(180, cerror_message)
c        WRITE(cerror_message, FMT='(a,/a,i,/a,i)')
c     &    'Number of seismic events exceeds maximum',
c     &    'Number of seismic events: ', nseismic_events,
c     &    'Maximum number of seismic events: ', maxseismic
        WRITE(cerror_message, FMT='(a,a1,a,i10,a1,a,i10)')
     &    'Number of seismic events exceeds maximum', char(10),
     &    'Number of seismic events: ', nseismic_events, char(10),
     &    'Maximum number of seismic events: ', maxseismic
```

```
c       GADAMS SCR627 4-13-2006: End of change

        call errorHandler(cerror_message, 'processFailure_ds')
      ENDIF
***** TPA51BETAA\CODES\MECHFAIL.F
      IF(nseismic_events .GT. maxseismic) THEN
        WRITE(cerror_message, FMT='(a,/a,i,/a,i)')
     &    'Number of seismic events exceeds maximum',
     &    'Number of seismic events: ', nseismic_events,
     &    'Maximum number of seismic events: ', maxseismic
        call errorHandler(cerror_message, 'processFailure_ds')

      ENDIF
*****

***** TPA51BETAB\CODES\mechfail.f
      IF((ISeismicityFlag .NE. 0) .AND. (ISeismicityFlag .NE. 1)) THEN
c       GADAMS SCR627 4-13-2006: Added clearchar statement
        CALL clearchar(180, cerror_message)
        WRITE(cerror_message, FMT='(a)')
***** TPA51BETAA\CODES\MECHFAIL.F
      IF((ISeismicityFlag .NE. 0) .AND. (ISeismicityFlag .NE. 1)) THEN
        WRITE(cerror_message, FMT='(a)')
*****

***** TPA51BETAB\CODES\mechfail.f
      IF(ntime_values .GT. maxntime) THEN

c       GADAMS SCR627 4-13-2006: Updated error string
        CALL clearchar(180, cerror_message)
c        WRITE(cerror_message, FMT='(a,/a,i,/a,i)')
c     &    'Number of time steps exceeds maximum',
c     &    'Number of time steps: ', ntime_values,
c     &    'Maximum number of time steps: ', maxntime
        WRITE(cerror_message, FMT='(a,a1,a,i10,a1,a,i10)')
     &    'Number of time steps exceeds maximum', char(10),
     &    'Number of time steps: ', ntime_values, char(10),
     &    'Maximum number of time steps: ', maxntime
c       GADAMS SCR627 4-13-2006: End of change

        CALL errorHandler(cerror_message, 'processFailure_wp')
***** TPA51BETAA\CODES\MECHFAIL.F
      IF(ntime_values .GT. maxntime) THEN
        WRITE(cerror_message, FMT='(a,/a,i,/a,i)')
     &    'Number of time steps exceeds maximum',
     &    'Number of time steps: ', ntime_values,
     &    'Maximum number of time steps: ', maxntime
        CALL errorHandler(cerror_message, 'processFailure_wp')
*****

***** TPA51BETAB\CODES\mechfail.f
      IF(nseismic_events .GT. maxseismic) THEN

c       GADAMS SCR627 4-13-2006: Updated error string
        CALL clearchar(180, cerror_message)
c        WRITE(cerror_message, FMT='(a,/a,i,/a,i)')
c     &    'Number of seismic events exceeds maximum',
c     &    'Number of seismic events: ', nseismic_events,
```

```
c     &     'Maximum number of seismic events: ', maxseismic
        WRITE(cerror_message, FMT='(a,a1,a,i10,a1,a,i10)')
     &    'Number of seismic events exceeds maximum', char(10),
     &    'Number of seismic events: ', nseismic_events, char(10),
     &    'Maximum number of seismic events: ', maxseismic
c       GADAMS SCR627 4-13-2006: End of change
        call errorHandler(cerror_message, 'processFailure_wp')
***** TPA51BETAA\CODES\MECHFAIL.F
      IF(nseismic_events .GT. maxseismic) THEN
        WRITE(cerror_message, FMT='(a,/a,i,/a,i)')
     &    'Number of seismic events exceeds maximum',
     &    'Number of seismic events: ', nseismic_events,
     &    'Maximum number of seismic events: ', maxseismic
        call errorHandler(cerror_message, 'processFailure_wp')
*****

***** TPA51BETAB\CODES\mechfail.f
      IF((ISeismicityFlag .NE. 0) .AND. (ISeismicityFlag .NE. 1)) THEN

c       GADAMS SCR627 4-13-2006: Added call to clearchar
        CALL clearchar(180, cerror_message)

        WRITE(cerror_message, FMT='(a)')
***** TPA51BETAA\CODES\MECHFAIL.F
      IF((ISeismicityFlag .NE. 0) .AND. (ISeismicityFlag .NE. 1)) THEN
        WRITE(cerror_message, FMT='(a)')
*****

***** TPA51BETAB\CODES\mechfail.f
      IF((dindValue .LT. dlower) .OR. (dindValue .GT. dupper)) THEN

c       GADAMS SCR627 4-13-2006: Updated error string
        CALL clearchar(180, cerror_message)
c        WRITE(cerror_message, FMT='(a/a)')
c     &    'Independent variable outside of upper or lower bound for: ',
c     &    cname
        WRITE(cerror_message, FMT='(a,a1,a)')
     &    'Independent variable outside of upper or lower bound for: ',
     &    char(10),cname


        CALL errorHandler(cerror_message, 'dpolynomialValue')
      ENDIF
***** TPA51BETAA\CODES\MECHFAIL.F
      IF((dindValue .LT. dlower) .OR. (dindValue .GT. dupper)) THEN
        WRITE(cerror_message, FMT='(a/a)')
     &    'Independent variable outside of upper or lower bound for: ',
     &    cname
        CALL errorHandler(cerror_message, 'dsCapacity')
      ENDIF
*****
*******************************************************************************
```

This excerpt depicts the changes in error message formats and clearing the error meassage line prior to generating the error message.

The changes in the baseline and test versions of *mechfail.f* and *mechdrive.f* are logical and consistent

with the changes requested by SCR627. And these excerpts are presented as evidence that SCR627 has been properly implemented.

- criterion 2

The following are excerpts from the screen captured TPA general output

The following excerpt is from the screen capture of a basecase realization of the baseline TPA code (TPA51betaA). The full file is archived to CD: *\SCR627\run1A\out*

```
*****************************************************************************
exec: Peak Mean Dose is 3.07450E-03 rem/yr at    8896.6 yr, based on     1
realizations.

exec:  Run Successfully Completed
*****************************************************************************
```

The following excerpt is from the screen capture of a basecase realization of the test version TPA code (TPA51betaB). The full file is archived to CD: *\SCR627\run1B\out*

```
*****************************************************************************
exec: Peak Mean Dose is 3.07450E-03 rem/yr at    8896.6 yr, based on     1
realizations.

exec:  Run Successfully Completed
*****************************************************************************
```

A comparison between these two file show that they both executed successfully and that they generated the same released doses. This is presented as evidence that SCR627 was properly implemented

- overall test status: PASS

SL-2. Name: Removal of *ebspacsf.nuc, ebspacglass.nuc, ebsrelsf.inp, mechfail_wp.out, mechfail_ds.out* at the start of TPA execution.

Path for run directory:

Baseline: [TPA] D:\Public\Mancillas\SCR627\run1A & run2A
Test : [TPA] D:\Public\Mancillas\SCR627\run1B & run2B

Path for archive of results:

Baseline: [CD: titled SCR627 testing] \ SCR627\run1A & run2A
Test : [CD: titled SCR628 testing] \SCR627\run1B & run2B

Environment variables:

Baseline: TPA_TEST= ..\tpa51betaA\
TPA_DATA= ..\tpa51betaA\

Test : TPA_TEST= ..\tpa51betaB\
TPA_DATA=..\tpa51betaB\

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): NONE

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: To ensure proper operation of the TPA code the removal of data from previous realizations needs to be ensured (otherwise pre-existing data could mistakenly be incorporated into the current analysis).

- objective: Verify the removal of the files *ebspacsf.nuc, ebspacglass.nuc, ebsrelsf.inp, mechfail_wp.out, mechfail_ds.out* at the start of TPA execution.
- assumptions: None other than those made within the TPA code
- constraints: NONE
- output files to compare or examine: examine the list of files that exist in the run directory after the TPA begins to execute
- step by step test procedure to be used

1) Copy the contents of a completed TPA execution (run1A and run1B) into a new directory (run2A and run2B) and record a list of the directory contents.
2) Begin an execution of the baseline and test versions then terminate the execution manually (Ctrl -C)prior to the beginning of the analysis of any subareas.

3) Examine the contents of the run directory to determine if the appropriate files were removed during TPA initialization.

- pass fail criteria

1) Changes to the executive module should be consistent with the changes request by SCR627
2) the files *ebspacsf.nuc, ebspacglass.nuc, ebsrelsf.inp, mechfail_wp.out,* and *mechfail_ds.out* should not be present in the run directory after the TPA code has initialized.

Test Results: The changes in exec.f are logical and consistent with the changes requested in SCR627 and the appropriate files are removed prior to TPA subarea loop calculations.

-criterion 1

The executive module *exec.f* for the baseline (TPA51betaA) and the test version (TPA51betaB) of the TPA code were examined and their differences were compared using the DOS fc command, " fc tpa51betaA\exec.f tpa51betaB\exec.f >exec_fc ". The comparison file was archived to CD \SCR627\diff_files*exec_fc*.

The following text is an excerpt from exec_fc which pertains to SCR627.

```
*****************************************************************************
***** TPA51BETAB\exec.f

c       GADAMS SCR627 4-26-2006: Updated output files for
c       MECHFAIL module.  The updated files should be
c       removed (mechfail.out is no longer generated)
c        INQUIRE(FILE = 'mechfail.out', EXIST = lexist)
c        IF(lexist) istatus = zportsh('rm mechfail.out')

        INQUIRE(FILE = 'mechfail_ds.out', EXIST = lexist)
        IF(lexist) istatus = zportsh('rm mechfail_ds.out')

        INQUIRE(FILE = 'mechfail_wp.out', EXIST = lexist)
        IF(lexist) istatus = zportsh('rm mechfail_wp.out')
c       GADAMS SCR627 4-26-2006: End of change

***** TPA51BETAA\EXEC.F

        INQUIRE(FILE = 'mechfail.out', EXIST = lexist)
        IF(lexist) istatus = zportsh('rm mechfail.out')

*****

***** TPA51BETAB\exec.f
        IF(lexist) istatus = zportsh('rm ebsrel.cum')

c       GADAMS SCR627 4-26-2006: The stored versions
c       of input files are removed so that an old version
c       is not present for a different tpa run.
        inquire(FILE = 'ebsrelsf.inp', EXIST = lexist)
        if (lexist) istatus = zportsh('rm ebsrelsf.inp')

        inquire(FILE = 'ebsrelglass.inp', EXIST = lexist)
```

```
        if (lexist) istatus = zportsh('rm ebsrelglass.inp')

        inquire(FILE = 'ebspacsf.nuc', EXIST = lexist)
        if (lexist) istatus = zportsh('rm ebspacsf.nuc')

        inquire(FILE = 'ebspacglass.nuc', EXIST = lexist)
        if (lexist) istatus = zportsh('rm ebspacglass.nuc')
c       GADAMS SCR627 4-26-2006: End of change


***** TPA51BETAA\EXEC.F
        IF(lexist) istatus = zportsh('rm ebsrel.cum')

*******************************************************************************
```

This excerpt depicts the additional removal of the files *mechfail_wp.out* , *mechfail_ds.out, ebsrelsf.inp, ebsrelglass.inp, ebspacsf.nuc* and *ebspacglass.nuc* prior to TPA subarea execution and is presented as evidence that SCR627 has been properly implemented.

-criterion 2

The results of a single basecase realization for the baseline and test TPA codes which were performed in test 1 of this SCR testing were copied into the directories \SCR627\run2A and SCR627\run2B respectively. The contents of these directories were then recorded into the files named *list_full* (\SCR627\run2A*list_full* and \SCR627\run2B*list_full*) using the DOS command "dir >list_full". The TPA code was then executed and manually terminated in the run directories and the contents of the directories were recorded in the files named *list* again using the same DOS command "dir>list". \SCR627\run2A*list* and \SCR627\run2B*list*).

An examination of the files *list_full* in the run directories run2A and run2B show that they both contain the same files at the end of a TPA execution. And a comparison of the contents of the directories \SCR627\run2A and \SCR627\run2B after the TPA initialization and manual termination is shown in the following text which was generated by a DOS file comparison between the two *list* files, "fc \run2A\list \run2B\list >list_fc "

```
*******************************************************************************
Comparing files RUN2A\list and RUN2B\LIST
***** RUN2A\list
ebspac.nuc
ebspacglass.nuc
ebspacsf.nuc
ebsrel.def
***** RUN2B\LIST
ebspac.nuc
ebsrel.def
*****

***** RUN2A\list
ebsrel.inp
ebsrelglass.inp
ebsrelsf.inp
ebssf.dat
***** RUN2B\LIST
ebsrel.inp
ebssf.dat
*****
```

```
***** RUN2A\list
mechfail_ds.inp
mechfail_ds.out
mechfail_wp.dat
***** RUN2B\LIST
mechfail_ds.inp
mechfail_wp.dat
*****

***** RUN2A\list
mechfail_wp.inp
mechfail_wp.out
mv.tpa
***** RUN2B\LIST
mechfail_wp.inp
mv.tpa
*****
*******************************************************************************
```

The comparison between the two directories shows that the files *mechfail_wp.out* , *mechfail_ds.out, ebsrelsf.inp*, *ebsrelglass.inp, ebspacsf.nuc* and *ebspacglass.nuc* are deleted prior to subarea loop execution. These results are presented as evidence that SCR627 has been properly implemented.

- overall test status : PASS

SL-3. Name: In *driftfail.f* the backfill outer diameter exceeds the rock wall diameter for thermal model 2

Path for run directory:

Baseline: [TPA] D:\Public\Mancillas\SCR627\run3A
Test : [TPA] D:\Public\Mancillas\SCR627\run3B

Path for archive of results:

Baseline: [CD: titled SCR627 testing] \ SCR627\run3A
Test : [CD: titled SCR628 testing] \SCR627\run3B

Environment variables:

Baseline: TPA_TEST= ..\tpa51betaA\
TPA_DATA= ..\tpa51betaA\

Test : TPA_TEST= ..\tpa51betaB\
TPA_DATA=..\tpa51betaB\

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): Thermal model 2

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: DOS file compare 'fc'

Test description: The rubble backfill diameter exceeds the rock wall diameter in thermal model 2. This error results from implicit assumptions made within the equivalent diameter calculations and is within acceptable limits, but it produces non-physical results. To remedy this non physical result, the backfill diameter is limited to the rock wall diameter.

- objective Ensure that the backfill diameter does not exceed the rock wall diameter

- assumptions None other than those made within the TPA code

- constraints NONE

- output files to compare or examine *driftfail.dat*

- step by step test procedure to be used

1) Examine the source code changes between the baseline and test TPA *driftfail.f*
2) Execute a single realization for a single subarea (SA1) of the baseline and test TPA codes and examine the files *driftfail.dat*, which is generated by driftfail.f and contains the backfill and rock wall diameters.

- pass fail criteria

1) The changes in the file driftfail.f are consistent with the changes requested in SCR627
2) The backfill diameter does not exceed the rock wall diameter.

Test Results: The changes made to *driftfail.f* are logical and consistent with the requested changes in SCR627. And the backfill diameters are shown to be limited to less than or equal to the rock wall diameter.

- criterion 1

The baseline and test TPA versions of *driftfail.f* have been examined and compared. The following text was generated by the DOS command fc, 'fc \tpa51betaA\codes\driftfail.f \tpa51betaB\codes\driftfail.f >driftfail_fc " and is archived to CD \SCR627\diff_files\driftfail_fc. This text shows that the equivalent diameters for the backfill are limited to the rock wall diameters.

```
*****************************************************************************
Comparing files TPA51BETAB\CODES\driftfail.f and TPA51BETAA\CODES\DRIFTFAIL.F
***** TPA51BETAB\CODES\driftfail.f
C File Name:           driftfail.f
C File Date:           05/17/06
C Release Version:     5.1
***** TPA51BETAA\CODES\DRIFTFAIL.F
C File Name:           driftfail.f
C File Date:           04/11/06
C Release Version:     5.1
*****

***** TPA51BETAB\CODES\driftfail.f

c         GADAMS SCR627 4-26-2006: Limit the equivalent diameter of
c         the backfill to the equivalent diameter of the rock wall
          equivDiaBFA(index1) = min(equivDiaBFA(index1),
     &      equivDiaRWA(index1))
          equivDiaBFB(index1) = min(equivDiaBFB(index1),
     &      equivDiaRWB(index1))
c         GADAMS SCR627 4-26-2006: End of change

        end do
      else
***** TPA51BETAA\CODES\DRIFTFAIL.F

      end do
      else
*****
*****************************************************************************
```

These changes are logical and consistent with the changes requested in SCR627 and are presented as evidence that SCR627 has been properly implemented.

- criterion 2

The TPA code was executed using the baseline and test versions of the code. The file driftfail.dat generated by the driftfail module were compared and shown than the backfill diameter was limited to the rock wall diameter when in thermal model 2.
The following text is an excerpt from
\SCR627\run3A*driftfail.dat,* which was generated from the baseline TPA code.

****

: Time	Frac	Press1	Press2	eqRWA	eqRWB	eqBFA	eqBFB	height
7913.7100	1.00	420.7704	408.8566	14.7675	0.0000	14.9772	0.0000	24.3051
8101.2900	1.00	420.7704	408.8566	14.7675	0.0000	14.9772	0.0000	24.3051
8293.2700	1.00	420.7704	408.8566	14.7675	0.0000	14.9772	0.0000	24.3051
8489.7300	1.00	420.7704	408.8566	14.7675	0.0000	14.9772	0.0000	24.3051
8690.8000	1.00	420.7704	408.8566	14.7675	0.0000	14.9772	0.0000	24.3051
8896.5700	1.00	420.7704	408.8566	14.7675	0.0000	14.9772	0.0000	24.3051
9107.1600	1.00	420.7704	408.8566	14.7675	0.0000	14.9772	0.0000	24.3051
9322.6900	1.00	420.7704	408.8566	14.7675	0.0000	14.9772	0.0000	24.3051
9543.2500	1.00	420.7704	408.8566	14.7675	0.0000	14.9772	0.0000	24.3051
9768.9800	1.00	420.7704	408.8566	14.7675	0.0000	14.9772	0.0000	24.3051
10000.0000	1.00	420.7704	408.8566	14.7675	0.0000	14.9772	0.0000	24.3051

****

Here it is clearly visible that the backfill diameter (eqBFA) is larger than the rock wall diameter (eqRWA).

The following text is an excerpt from \SCR627\run3B*driftfail.dat*, which was generated from the test version TPA code.

****

: Time	Frac	Press1	Press2	eqRWA	eqRWB	eqBFA	eqBFB	height
7913.7100	1.00	420.7704	408.8566	14.7675	0.0000	14.7675	0.0000	24.3051
8101.2900	1.00	420.7704	408.8566	14.7675	0.0000	14.7675	0.0000	24.3051
8293.2700	1.00	420.7704	408.8566	14.7675	0.0000	14.7675	0.0000	24.3051
8489.7300	1.00	420.7704	408.8566	14.7675	0.0000	14.7675	0.0000	24.3051
8690.8000	1.00	420.7704	408.8566	14.7675	0.0000	14.7675	0.0000	24.3051
8896.5700	1.00	420.7704	408.8566	14.7675	0.0000	14.7675	0.0000	24.3051
9107.1600	1.00	420.7704	408.8566	14.7675	0.0000	14.7675	0.0000	24.3051
9322.6900	1.00	420.7704	408.8566	14.7675	0.0000	14.7675	0.0000	24.3051
9543.2500	1.00	420.7704	408.8566	14.7675	0.0000	14.7675	0.0000	24.3051
9768.9800	1.00	420.7704	408.8566	14.7675	0.0000	14.7675	0.0000	24.3051
10000.0000	1.00	420.7704	408.8566	14.7675	0.0000	14.7675	0.0000	24.3051

****

Here it is visible that the backfill diameter (eqBFA) is no larger than the rock wall diameter (eqRWA). These results are presented as evidence that SCR627 has been properly implemented.

- overall test status: PASS

SL-4. Name: In ebsrel, these is an error in the print statement for copying *ebspac.nuc* to *ebspacglass.nuc*

Path for run directory:

Baseline: [TPA] D:\Public\Mancillas\SCR627\run1A
Test : [TPA] D:\Public\Mancillas\SCR627\run1B

Path for archive of results:

Baseline: [CD: titled SCR627 testing] \ SCR627\run1A
Test : [CD: titled SCR628 testing] \SCR627\run1B

Environment variables:

Baseline: TPA_TEST= ..\tpa51betaA\
TPA_DATA= ..\tpa51betaA\

Test : TPA_TEST= ..\tpa51betaB\
TPA_DATA=..\tpa51betaB\

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): NONE

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: If either of the system commands 'cp ebspac.nuc ebspacsf.nuc' and 'cp ebspac.nuc ebspacglass.nuc' fail to function properly when called in ebsrel an error message is generated. These error messages have been changed to provide a more accurate and descriptive message to the user.

- objective examine the error message for these system call failures

- assumptions NONE

- constraints NONE

- output files to compare or examine NONE

- step by step test procedure to be used
  1) Examine the change in the error message by looking at the baseline and test versions of the TPA code *ebsrel.f.*

- pass fail criteria
  1) The new messages should more accurately describe the system failures.

Test Results: This cosmetic code change in which error messages have been changed to provide a more accurate and descriptive message to the user has been properly implemented.

- criterion 1

The following text are excerpts from the files \tpa51betaA\ebsrel.f and \tpa51betaB\ebsrel.f. These excerpts show the changed error messages to be more accurate descriptions of the error occurrences.

The following is an excerpt from the baseline *ebsrel.f* pertinent to SCR627.
\tpa51betaA*ebsrel.f*

```
*******************************************************************************
      if (iwasteform .eq. 1) then
        call clearchar(80,command)
        command = 'cp ebspac.nuc ebspacsf.nuc'
        istatus=zportsh(command)
        if( istatus .ne. 0 ) then
          print *, ' ***>>> Error in ebsrel <<<*** '
          print *, ' istatus .ne. 0 '
          print *, ' istatus = sh( ', command, ' )'
          print *, ' istatus = ', istatus
          STOP
        endif
      else
cc Save ebspac.nuc for glass wasteform, too
        call clearchar(80,command)
        command = 'cp ebspac.nuc ebspacglass.nuc'
        istatus=zportsh(command)
        if( istatus .ne. 0 ) then
          print *, ' ***>>> Error in ebsrel <<<*** '
          print *, ' error copying glass form of ebsrel.inp'
          print *, ' istatus .ne. 0 '
          print *, ' istatus = sh( ', command, ' )'
          print *, ' istatus = ', istatus
          STOP
        endif
      end if
*******************************************************************************
```

And the following text is an excerpt from the test version *ebsrel.f* pertinent to SCR627.
\tpa51betaB*ebsrel.f*

```
*******************************************************************************
      if (iwasteform .eq. 1) then
        call clearchar(80,command)
        command = 'cp ebspac.nuc ebspacsf.nuc'
        istatus=zportsh(command)
        if( istatus .ne. 0 ) then
          print *, ' ***>>> Error in ebsrel <<<*** '
          print *, ' error copying sf form of ebspac.nuc'
          print *, ' istatus .ne. 0 '
          print *, ' istatus = sh( ', command, ' )'
          print *, ' istatus = ', istatus
          STOP
        endif
      else
```

```
c      save ebspac.nuc for glass wasteform
         call clearchar(80,command)
         command = 'cp ebspac.nuc ebspacglass.nuc'
         istatus=zportsh(command)
         if( istatus .ne. 0 ) then
           print *, ' ***>>> Error in ebsrel <<<*** '
           print *, ' error copying glass form of ebspac.nuc'
           print *, ' istatus .ne. 0 '
           print *, ' istatus = sh( ', command, ' )'
           print *, ' istatus = ', istatus
           STOP
         endif
       end if
*****************************************************************************
```

The error message in the baseline code has no description of the error, only the istatus. This is augmented in the test version by providing the descriptive statement `' error copying sf form of ebspac.nuc'`. The second error message in the baseline code has the description `' error copying glass form of ebsrel.inp'` this is an inaccurate description and has been changed to the more accurate message `' error copying glass form of ebspac.nuc'` in the test version. These changes are presented as evidence that SCR627 has been properly implemented.

- overall test status : PASS

SCR - 628

TPA 5.1/ Beta

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 628	2. Software Title and Version: TPA 5.1beta	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *ebsrel.f* and *dsfail.f*

In *ebsrel.f*, there are three items.

(1) For the no seismic and no drift degradation case, release rates for initial defects are high, even though the drip shield is standing. It looks like the drip shield is not present either. In the *ebsflo.dat* file from the last realization, it appears that the drip shield failed at time 0, yet the file *dsfail.res* indicates no drip shield failure;

(2) The following error was received

```
>>> Error in set_Colloid <<<
Attempted divide by zero
Total Affinity x Concentration =  -7.458023527019681E-21    at timestep
143    for element PU239; and
```

(3) the RELEASET input *ebspac.nuc* file for spent fuel is overwritten by the *ebspac.nuc* data file for glass during a TPA code subarea calculation.

In *dsfail.f*, there is one item: two *tpa.inp* file parameters are written to *dsfailt.inp* with one and three decimal places. More decimal places are needed for *dsfailt.exe* corrosion alculations.

5. Change Requested by:	6. Change Authorized by (*Software Developer*):
O. Pensado, J. Menchaca Date: 4-17-06	R. Janetzke Date: 4-17-06

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

See Attachment A.

8. Implemented by:	Date:
R. Rice	4-18-06

9. Description of Acceptance Tests:

See Attachments B and C

10. Tested by:	Date:
J Mancillas	7-5-06

UPDATE REQUIREMENTS for TPA.INP

SCR 628

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM)*	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.)*	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source

ATTACHMENT A

Description of Problem Resolution for *ebsrel.f* and *dsfail.f*

For *ebsrel.f*

Item #1.) This case arises when the drip shield does not fail during the simulation period. The case become evident when the seismic flag and the drift degradation flag are changed from 1 (default value) to 0 in the *tpa.inp* file. In these cases, there are early and increasing releases although the drip shield is intact. Inspection of the drip shield seepage factor in *ebsflo.dat* reveals this factor has a value equal to 1.0 (meaning the drip shield has failed). This case is resolved by initializing a variable in the *ebsrel.f* file by setting it equal to the maximum simulation time.

Item #2.) RELEASET can give a negative release rate in the output file *ebsnef.dat*. Negative releases are already set equal to zero in another part of the *ebsrel.f* file; however, in this case when the spent fuel and glass *ebsnef.dat* files are read in *ebsrel.f*, any negative releases are not set equal to zero. For consistency within the *ebsrel.f* file, any negative releases are set equal to zero.

Item #3.) The RELEASET input file *ebspac.nuc* for spent fuel is overwritten when glass calculations are performed. The *ebsrel.f* file copies another RELEASET input file *ebsrel.inp* to *ebsrelsf.inp* and *ebsrelglass.inp*. For consistency with this *ebsrel.inp* file, modifications were made to the *ebsrel.f* file to copy the *ebspac.nuc* file to *ebspacsf.nuc* and *ebspacglass.nuc*.

The following information contains a file comparison between the modified and original *ebsrel.f* file (generated using the COMMAND PROMPT utility "fc") and illustrates the changes made address the above three items.

```
Comparing files ebsrel.f and EBSREL_ORIGINAL.F
***** ebsrel.f
cc (note that this time corresponding to the first nonzero value)
cc
cc rwr 4/18/06; SCR628; found in the TPA51beta version
cc (first, initialize "timedsmechfail" at tim(ntim) so that)
cc (if there is no drip shield failure "timedsmechfail" equals)
cc (the maximum simulation time)
      timedsmechfail  = tim(ntim)

      do iread = 1,ntim
***** EBSREL_ORIGINAL.F
cc (note that this time corresponding to the first nonzero value)
      do iread = 1,ntim
*****

***** ebsrel.f
     close(iebspacnuc)

cc rwr 4/18/06; SCR628; found in the TPA51beta version
```

```
cc Save ebspac.nuc for spent fuel wasteform because
cc otherwise, it will get overwritten when the glass
cc model is run
     if (iwasteform .eq. 1) then
       call clearchar(80,command)
       command = 'cp ebspac.nuc ebspacsf.nuc'
       istatus=zportsh(command)
       if( istatus .ne. 0 ) then
         print *, ' ***>>> Error in ebsrel <<<*** '
         print *, ' istatus .ne. 0 '
         print *, ' istatus = sh( ', command, ' )'
         print *, ' istatus = ', istatus
         STOP
       endif
     else
cc Save ebspac.nuc for glass wasteform, too
       call clearchar(80,command)
       command = 'cp ebspac.nuc ebspacglass.nuc'
       istatus=zportsh(command)
       if( istatus .ne. 0 ) then
         print *, ' ***>>> Error in ebsrel <<<*** '
         print *, ' error copying glass form of ebsrel.inp'
         print *, ' istatus .ne. 0 '
         print *, ' istatus = sh( ', command, ' )'
         print *, ' istatus = ', istatus
         STOP
       endif
     end if

c-----------------------------------------------------------------------
***** EBSREL_ORIGINAL.F
     close(iebspacnuc)
c-----------------------------------------------------------------------
*****

***** ebsrel.f
    &                          i_affected_flag2, qout2

cc rwr 4/18/06; SCR628; found in the TPA51beta version
cc
cc as noted above:
c
c   the release part of EBSPAC can produce negative release rates
c   If it goes below zero, we set to zero.
         ajval1 = dmax1( 0.0d0, ajval1 )
         ajval2 = dmax1( 0.0d0, ajval2 )

         write (iebsnefdat,  '(1x, 1pe12.4, 1x, 1pe12.4, 1x, i4,
***** EBSREL_ORIGINAL.F
    &                          i_affected_flag2, qout2
         write (iebsnefdat,  '(1x, 1pe12.4, 1x, 1pe12.4, 1x, i4,
*****
```

For *dsfail.f*

The format for the *dsfailt.exe* input file, *dsfail.inp*, in TPA code Version 51beta is as follows:

```
Input file for module DSfailt
This file is rewritten for each realization
==================================================
  fluoride.dat   fileIn, Input data file, fluoride concentr
   dsfailt.dat   fileOut, Output data file 1, tracking thic
   1.6E-07   CorrRate, m/yr, drip shield corrosion rate
   1.500E-02   DSThick, m, drip shield thickness : DripSh
        2.84   slope, dimensionless, slope of drip shield
     1.0e-04   minF, M, minimum fluoride concentration af
     2.0e-03   maxF, M, maximum fluoride concentration af
           0   FluorideEnh, (0 or 1). 0 : no fluoride enh
```

There are two *tpa.inp* parameters in the above file ("CorrRate" and "DSThick"). Corrosion calculations in *dsfailt.exe* utilize these two parameters and the failure time determination requires more precision than one decimal place. Therefore, the *dsfail.f* file was modified to write five decimal places for these two parameters in the *dsfailt.inp* file. Consequently, after modifications, the format for the *dsfailt.inp* file is as follows:

```
Input file for module DSfailt
This file is rewritten for each realization
==================================================
  fluoride.dat   fileIn, Input data file, fluoride concentr
   dsfailt.dat   fileOut, Output data file 1, tracking thic
   1.63982E-07   CorrRate, m/yr, drip shield corrosion rate
   1.50000E-02   DSThick, m, drip shield thickness : DripSh
        2.84   slope, dimensionless, slope of drip shield
     1.0e-04   minF, M, minimum fluoride concentration af
     2.0e-03   maxF, M, maximum fluoride concentration af
           0   FluorideEnh, (0 or 1). 0 : no fluoride enh
```

The following information contains a file comparison between the modified and original *dsfail.f* file (generated using the COMMAND PROMPT utility "fc") and illustrates the changes made address the above three items.

```
Comparing files dsfail.f and DSFAIL_ORIGINAL.F
***** dsfail.f
c  Retrieve the corrosion rate
cc rwr 4/20/06; SCR628; found in the TPA51beta version
cc (add more precision to this value)
cc      WRITE(line6(1:18), FMT = '(1PE15.1, 3x)') dripShieldCorrosionRate
      WRITE(line6(1:18), FMT = '(1PE15.5, 3x)') dripShieldCorrosionRate
      WRITE(iUnitFile, FMT='(A60)') line6
***** DSFAIL_ORIGINAL.F
c  Retrieve the corrosion rate
      WRITE(line6(1:18), FMT = '(1PE15.1, 3x)') dripShieldCorrosionRate
```

```
      WRITE(iUnitFile, FMT='(A60)') line6
*****

***** dsfail.f
c     WRITE(line7(1:18), FMT = '(F15.3, 3x)') drip_shield_thickness
cc rwr 4/20/06; SCR628; found in the TPA51beta version
cc (add more precision to this value)
cc       WRITE(line7(1:18), FMT = '(1PE15.3, 3x)') drip_shield_thickness*ds
cc      &penetration
      WRITE(line7(1:18), FMT = '(1PE15.5, 3x)') drip_shield_thickness*ds
     &penetration
***** DSFAIL_ORIGINAL.F
c     WRITE(line7(1:18), FMT = '(F15.3, 3x)') drip_shield_thickness
      WRITE(line7(1:18), FMT = '(1PE15.3, 3x)') drip_shield_thickness*ds
     &penetration
*****
```

Attachment B
Test Plan for TPA SCR628

Test Plan Name: *ebsrel.f* high release rate for non failed drip shield and *dsfail.f* data file precision

Tested By: J. Mancillas Date: 16 June 2006

Host Machine: Spock Host OS: SunOS 5.9

Baseline Version: TPA 5.1beta Test Version: TPA 5.1betaC

System Level (SL) Tests

SL-1. Name: *ebsrel.f* generates early releases when there is no drip shield failure

Path for run directory:
baseline: [spock]://home/jmancillas/TPA/SCR628/run1
test : [spock]://home/jmancillas/TPA/SCR628/runc1

Path for archive of results:
baseline: [CD titled: SCR628 testing]:/SCR628/run1
test : [CD titled: SCR628 testing]:/SCR628/runc1

Environment variables:
baseline: TPA_DATA=//home/jmancillas/TPA/tpa51beta/
TPA_TEST=//home/jmancillas/TPA/tpa51beta/

test : TPA_DATA=//home/jmancillas/TPA/tpa51betaC/
: TPA_TEST=//home/jmancillas/TPA/tpa51betaC/

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): Append # 7, Seismic flag and Degradation flag both set to 0

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: *ebsrel.f* uses the drip shield failure time passed to it to determine the drip shield (DS) failure status. However if the DS is not failed either mechanically or by corrosion (which are generally caused by seismic events and natural drift degradation), the drip shield failure time is 0.0. This misinterpretation of DS failure has been fixed by setting the drip shield failure time within *ebsrel.f* to the max simulation time or the shortest failure time (passed to this module) greater

than zero.

- objective This test is to verify that if the DS has not failed then *ebsrel.f* will not release Rns.

- assumptions NONE

- constraints NONE

- output files to compare or examine NONE

- step by step test procedure to be used
  1) compare the changes in *ebsrel.f* from the baseline to the test versions of TPA
  2) perform a single realization of the baseline and test versions of the TPA code with no seismic events and no drift degradation
  3) examine the TPA output for peak dose value and time and the data file *ebsflo.dat*

- pass fail criteria
  1) changes in code between baseline and test versions are logical and consistent with the intended code repairs.
  2) The ebsflo.dat files values for Fd (flow diversion for drip shield failure) should be consistent with the DS status.
  3) If the DS has not failed there are no RN releases (no dose to REMI)

Test Results:

- criterion 1 The following text show the differences between the baseline and test versions of the *ebsrel.f*. These differences were generated by using the Unix file comparison command *diff*. This file is saved to the archive CD in the location //SCR628/diff_files/*ebsrel_diff*.

```
*****************************************************************************
3c3
< c File Date:            06/14/06
---
> c File Date:            04/11/06
1200,1206d1199
< cc
< cc rwr 4/18/06; SCR628; found in the TPA51beta version
< cc (first, initialize "timedsmechfail" at tim(ntim) so that)
< cc (if there is no drip shield failure "timedsmechfail" equals)
< cc (the maximum simulation time)
<          timedsmechfail  = tim(ntim)
<
*****************************************************************************
```

This excerpt shows that the default value for the variable timedsmechfail has been set to the maximum simulation time. If the DS is not failed by either a seismic event or natural degradation, then the failure time of the DS will remain at the maximum simulation time. If the DS is failed by a seismic event or

natural degradation then the time of that failure will be used as the DS failure time. This code change is submitted as evidence that SCR628 has been properly implemented.

-criterion 2

The following text excerpts are from the files ebsflo.dat.

In the baseline TPA code the *ebsflo.dat* contains Fd (seventh column) values which are non zero when the DS is not failed. These results are inconsistent with the idea that if the DS is not failed there should be no flow through the DS.

\SCR628\run1\ebsflo.dat

```
*******************************************************************************
 8.4897321499E+03 2.6407817356E-01 8.9974300000E-01 9.7724000000E-01
1.0000000000E+00 1.0000000000E+00 1.7051000000E-01 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
 8.6907988407E+03 2.6407817356E-01 8.9974200000E-01 9.7627600000E-01
1.0000000000E+00 1.0000000000E+00 1.7252100000E-01 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
 8.8965727848E+03 2.6407817356E-01 8.9974100000E-01 9.7529000000E-01
1.0000000000E+00 1.0000000000E+00 1.7457900000E-01 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
 9.1071641854E+03 2.6407817356E-01 8.9974000000E-01 9.7428000000E-01
1.0000000000E+00 1.0000000000E+00 1.7668400000E-01 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
 9.3226858259E+03 2.6407817356E-01 8.9973900000E-01 9.7324700000E-01
1.0000000000E+00 1.0000000000E+00 1.7884000000E-01 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
 9.5432531302E+03 2.6407817356E-01 8.9973700000E-01 9.7219000000E-01
1.0000000000E+00 1.0000000000E+00 1.8104500000E-01 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
 9.7689842244E+03 2.6407817356E-01 8.9973600000E-01 9.7110700000E-01
1.0000000000E+00 1.0000000000E+00 1.8330300000E-01 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
 1.0000000000E+04 2.6407817356E-01 1.0000000000E+00 9.7000000000E-01
1.0000000000E+00 1.0000000000E+00 1.8561300000E-01 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
*******************************************************************************
```

In the test version of the TPA code the values for Fd are observed to be zero which is consistent with a non failed DS. The following is an excerpt from the generated file *ebsflo.dat*.

\SCR628\run1c\ebsflo.dat

```
*******************************************************************************
8.4897321499E+03 2.6408204065E-01 8.9990700000E-01 9.7724000000E-01
1.0000000000E+00 1.0000000000E+00 0.0000000000E+00 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
 8.6907988407E+03 2.6408204065E-01 8.9990700000E-01 9.7627600000E-01
1.0000000000E+00 1.0000000000E+00 0.0000000000E+00 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
 8.8965727848E+03 2.6408204065E-01 8.9990600000E-01 9.7529000000E-01
1.0000000000E+00 1.0000000000E+00 0.0000000000E+00 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
```

```
 9.1071641854E+03 2.6408204065E-01 8.9990600000E-01 9.7428000000E-01
1.0000000000E+00 1.0000000000E+00 0.0000000000E+00 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
 9.3226858259E+03 2.6408204065E-01 8.9990600000E-01 9.7324700000E-01
1.0000000000E+00 1.0000000000E+00 0.0000000000E+00 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
 9.5432531302E+03 2.6408204065E-01 8.9990500000E-01 9.7219000000E-01
1.0000000000E+00 1.0000000000E+00 0.0000000000E+00 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
 9.7689842244E+03 2.6408204065E-01 8.9990500000E-01 9.7110700000E-01
1.0000000000E+00 1.0000000000E+00 0.0000000000E+00 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
 1.0000000000E+04 2.6408204065E-01 1.0000000000E+00 9.7000000000E-01
1.0000000000E+00 1.0000000000E+00 0.0000000000E+00 0.0000000000E+00
0.0000000000E+00 0.0000000000E+00
*******************************************************************************
```

The test version of the TPA code (TPA51betaC) generated results which are consistent with the abstractions expected results. These results are presented as evidence that SCR628 has been properly implemented.

- criterion 3

The release of RN from failed WP can not occur until the failure of the drip shield, either by mechanical means or by corrosion of the DS. And in a 10,000 yr simulation with seismic events and natural degradation turned off, there should be no release of RN (the earliest possible failure time by corrosion is ~57,000 yrs).
The TPA code was tested under these conditions for both the baseline and test versions.

Running the baseline and test versions of the code for a 10,000 yr simulation with the seismic flag and the degradation flags turned off resulted in an erroneous dose calculation for the baseline version but a correct dose for the test version. A screen capture of the TPA general output show the following:

excerpt from the TPA baseline version
[CD]/SCR628/run1/tpa.out

```
*******************************************************************************
exec: Peak Mean Dose is 1.68540E-03 rem/yr at    3549.3 yr, based on     1
realizations
*******************************************************************************
```

excerpt from the TPA test version
[CD]/SCR628/run1c/tpa.out

```
*******************************************************************************
exec: Peak Mean Dose is 0.00000E+00 rem/yr at       0.0 yr, based on     1
realizations.
*******************************************************************************
```

The test version shows that the peak mean dose, which should be zero, is zero, while the baseline version of the TPA had generated an anomalously high release value. These results are presented as evidence that SCR628 has been properly implemented.

- overall test status: PASS

SL-2. Name: Negative Colloidal Releases

Path for run directory:

baseline: [spock]://home/jmancillas/TPA/SCR628/run4
test : [spock]://home/jmancillas/TPA/SCR628/runc4

Path for archive of results:

baseline: [CD titled: SCR628 testing]:/SCR628/run4
test : [CD titled: SCR628 testing]:/SCR628/runc4

Environment variables:

baseline: TPA_DATA=//home/jmancillas/TPA/tpa51beta/
TPA_TEST=//home/jmancillas/TPA/tpa51beta/

test : TPA_DATA=//home/jmancillas/TPA/tpa51betaC/
: TPA_TEST=//home/jmancillas/TPA/tpa51betaC/

Special input files or modifications to input files required : None

Special diagnostic code modifications required : None

Program modes to be used (append flags, scenario/model switches, etc.): None

Utility scripts needed to perform the test: None

Utility codes needed in the analysis of the test data: UNIX system command 'diff'

Test description: Examine the changes to TPA code in *ebsrel.f*

- objective Examine the changes to ebsrel.f and ensure that these changes are logical and consistent with the intent of SCR628

- assumptions None other than those made with in the TPA code

- constraints None

- output files to compare or examine Output screen capture

- step by step test procedure to be used

1) compare the differences between the baseline and test versions of *ebsrel.f*
2) execute a basecase realization for both the baseline and test versions of the TPA code

- pass fail criteria

1) The differences between the versions of the *ebsrel.f* files should contain changes which set any negative colloidal release values to zero.
2) The TPA codes should successfully execute.

Test Results:

- criterion 1

The following text was generated using the UNIX system command 'diff' to compare the baseline and test versions of the file *ebsrel.f*, 'diff tpa51beta/ebsrel.f tpa51betaC/ebsrel.f >ebsrel_diff'. The results of the file comparison is saved in the following directory
SCR628/diff_files/*ebsrel_diff*

```
*******************************************************************************
cc rwr 4/18/06; SCR628; found in the TPA51beta version
cc
cc as noted above:
c
c  the release part of EBSPAC can produce negative release rates
c  If it goes below zero, we set to zero.
      ajval1 = dmax1( 0.0d0, ajval1 )
      ajval2 = dmax1( 0.0d0, ajval2 )

      write (iebsnefdat, '(1x, 1pe12.4, 1x, 1pe12.4, 1x, i4,
   &                 1pe12.4)')
   &        ajtim2, ajval1 + ajval2, i_affected_flag1,
   &        qout1 + qout2
*******************************************************************************
```

The differences in the two files depicts the evaluation of the parameters "ajval1 " and "ajval2 " which hold the release values. In the evaluation of these values, if the values are less than zero the values are set to zero. These changes are consistent with SCR628 and are presented as evidence that SCR628 has been successfully implemented.

- criterion 2 evidence

A basecase realization was executed for the baseline and testcase TPA codes. Both versions of the TPA code executed properly. Their generated files and screen captures are saved in the following locations
Baseline saved directory , SCR628/run4/ and within this directory is the file 'out' which contains the executions screen capture.
Test version saved directory , SCR628/runc4/ and within this directory is the file 'out' which contains the executions screen capture

The successful execution of the test version of the TPA code is presented as further evidence that SCR628 has been properly implemented.

- overall test status: PASS

SL-3. Name: *ebsrel.f* should copy *ebspac.nuc* to *ebspacfs.nuc* and *ebspacglass.nuc*

Path for run directory:
baseline: [spock]://home/jmancillas/TPA/SCR628/run2
test : [spock]://home/jmancillas/TPA/SCR628/runc2 & runc3

Path for archive of results:
baseline: [CD titled: SCR628 testing]:/SCR628/run2
test : [CD titled: SCR628 testing]:/SCR628/runc2 & runc3

Environment variables:
baseline: TPA_DATA=//home/jmancillas/TPA/SCR628/tpa51beta/
TPA_TEST=//home/jmancillas/TPA/SCR628/tpa51beta/

test : TPA_DATA=//home/jmancillas/TPA/SCR628/tpa51betaC/
: TPA_TEST=//home/jmancillas/TPA/SCR628/tpa51betaC/

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): Basecase

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: UNIX command diff

Test description: The module *ebsrel.f* has been enhanced to preserve the nuclide inventory of both the spent fuel and glass form waste in the data files *ebspacsf.nuc* and *ebspacglass.nuc*, respectively.

- objective Verify that the files *ebspacsf.nuc* and *ebspacglass.nuc* are properly generated.

- assumptions NONE

- constraints None other than those made within the TPA abstractions

- output files to compare or examine *ebspac.nuc*, *ebspacsf.nuc*, and *ebspacglass.nuc*

- step by step test procedure to be used
  1) run a basecase realization for both the baseline and test versions of the TPA code.
  2) examine the contents of the data files ebspac.nuc and ebspacglass.nuc.
  3) Modify the ebsrel.f module to stop after the spent fuel waste form has been evaluated.
  4) examine the contents of the data files ebspac.nuc and ebspacsf.nuc.

- pass fail criteria

1) The test version of the TPA code should have generated the data files ebspacsf.nuc and ebspacglass.nuc

2) The unmodified test TPA code should have generated the file ebspacglass.nuc which has the same contents as the file ebspac.nuc.

3) Using the modified test TPA code the files ebspac.nuc and ebspacsf.nuc should have the same contents.

Test Results:

- criterion 1

A basecase realization for the baseline (TPA51beta) and the test version (TPA51betaC) TPA codes both executed successfully, with the TPA screen output captured to the files *\SCR628\run2\out* (baseline) and *\SCR628\run2c\out* (test). The list of the run directories contents were created in their respective run directories using the command 'ls >directory'. A comparison between the two directory lists show that the test version TPA code generated two additional files : *ebspacsf.nuc* and *ebspacglass.nuc*.

The following text was generated using the UNIX file comparison command 'diff run2/*directory* run2c/*directory* >*directory_diff* '. The file *directory_diff* is archived in the following location */SCR628/diff_files/directory_diff.*, and shows the differing contents between the baseline and test versions of the TPA code.

```
*******************************************************************************
40a41,42
> ebspacglass.nuc
> ebspacsf.nuc
*******************************************************************************
```

These are the expected results and are presented as evidence that SCR628 has been properly implemented.

- criterion 2

In the normal operation of the TPA code *ebsrel.f.* an *ebspac.nuc* file is generated for each waste form and is overwritten as the next waste form is processed. The first waste form is the spent fuel and the second is the glass form. As a result, after the normal completion of a TPA realization the files *ebspac.nuc* and *ebspacglass.nuc* should contain the same data.

Using the UNIX diff command 'diff ebspacglass.nuc ebspac.nuc > ebspac1_diff ' a comparison between the two files was made, which showed no differences between the files /SCR628/run2c/*ebspacglass.nuc* and /SCR628/run2c/*ebspac.nuc* This file is saved in the following /SCR628/diff_files/ebspac1_diff. These are the expected results and are presented as evidence that SCR628 has been properly implemented.

- criterion 3

The normal operation of the TPA code was interrupted to allow the comparison between the transient contents of the data file *ebspac.nuc* with the contents of *ebspacsf.nuc*. The modified TPA code used to perform this test is saved in the following /SCR628/TPA51betaC_mod. The only file modified in the TPA code was the *ebsrel.f* file. In this code the normal operation of the module was halted after the completion of the first waste form (spent fuel). This allows a comparison between the *ebspac.nuc* which is copied to the *ebspacsf.nuc* data file. Running a basecase realization in the following directory /SCR628/run3c, the TPA code exited prior to proper completion, as expected, while generating the files ebspac.nuc and ebspacsf.nuc for comparison.

Using the UNIX diff command 'diff ebspacsf.nuc ebspac.nuc > ebspac2_diff ' a comparison between the two files was made, which showed no differences between the files /SCR628/run3c/*ebspacsf.nuc* and /SCR628/run3c/*ebspac.nuc*. This file is saved in the following /SCR628/diff_files/ebspac2_diff. These are the expected results and are presented as evidence that SCR628 has been properly implemented

- overall test status: PASS

SL-4. Name: dsfailt.inp data format change

Path for run directory:
baseline: [spock]://home/jmancillas/TPA/SCR628/run1
test : [spock]://home/jmancillas/TPA/SCR628/runc1

Path for archive of results:
baseline: [CD titled: SCR628 testing]:/SCR628/run1
test : [CD titled: SCR628 testing]:/SCR628/runc1

Environment variables:
baseline: TPA_DATA=//home/jmancillas/TPA/tpa51beta/
TPA_TEST=//home/jmancillas/TPA/tpa51beta/

test : TPA_DATA=//home/jmancillas/TPA/tpa51betaC/
: TPA_TEST=//home/jmancillas/TPA/tpa51betaC/

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): Append All, Seismic flag and Degradation flag both set to 0

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: The data format of two data entries in the file *dsfailt.inp* have been changed to provide a more accurate representation of the values for corrosion rate and the drip shield thickness, with five decimal places.

- objective Verify that the values for corrosion rate and DS thickness in *dsfailt.inp* are written to five decimal places of precision.

- assumptions NONE

- constraints NONE

- output files to compare or examine *dsfailt.inp*

- step by step test procedure to be used
1) run a single realization of the baseline and test versions of the TPA code.
2) compare the *dsfailt.inp* files generated by both TPA code versions

- pass fail criteria
1) the *dsfailt.inp* file for the test version of the TPA code should have five decimal places for the parameters corrosion rate and drip shield thicknesses.

Test Results:
- criterion 1

The *dsfailt.inp* files generated by the baseline and test versions of the TPA code are show bellow.

baseline TPA generated *dsfailt.inp*
[CD]SCR628/run1/*dsfailt.inp*

```
*****************************************************************************
Input file for module DSfailt
This file is rewritten for each realization
==================================================
   fluoride.dat   fileIn, Input data file, fluoride concentr
    dsfailt.dat   fileOut, Output data file 1, tracking thic
        2.0E-07   CorrRate, m/yr, drip shield corrosion rate
      1.500E-02   DSThick, m, drip shield thickness : DripSh
           2.84   slope, dimensionless, slope of drip shield
        1.0e-04   minF, M, minimum fluoride concentration af
        2.0e-03   maxF, M, maximum fluoride concentration af
              0   FluorideEnh, (0 or 1). 0 : no fluoride enh
*****************************************************************************
```

test version TPA generated *dsfailt.inp*
[CD]SCR628/runc1/*dsfailt.inp*

```
*****************************************************************************
Input file for module DSfailt
This file is rewritten for each realization
==================================================
   fluoride.dat   fileIn, Input data file, fluoride concentr
    dsfailt.dat   fileOut, Output data file 1, tracking thic
    2.00261E-07   CorrRate, m/yr, drip shield corrosion rate
    1.50000E-02   DSThick, m, drip shield thickness : DripSh
           2.84   slope, dimensionless, slope of drip shield
        1.0e-04   minF, M, minimum fluoride concentration af
        2.0e-03   maxF, M, maximum fluoride concentration af
              0   FluorideEnh, (0 or 1). 0 : no fluoride enh
*****************************************************************************
```

The dsfail.inp file generated by the TPA test version shows that the variables CorrRate and DSThick are written to five decimal places. This results are submitted as evidence that SCR628 has been properly implemented.

- overall test status : PASS

Attachment C
Test Plan for TPA SCR628

Test Plan Name: Comparison between Unix and Windows TPA 51betaC basecase execution

Tested By: J. Mancillas Date: 5 July 2006

Unix Machine: Spock Unix Host OS: SunOS 5.9
Window Machine: TPA Window OS : Windows XP SP2

Unix Version: TPA 5.1betaC
Windows Version: TPA 5.1betaC

System Level (SL) Tests

SL-1. Name:

Path for run directory:
Unix: [spock]://home/jmancillas/TPA/SCR628/runc4
Window [TPA]:D:\Public\Mancillas\SCR628\run1

Path for archive of results:
Unix: [CD titled: SCR628 testing]:/SCR628/runc4
Window: [CD titled: SCR628 testing]:Win\SCR628\run1

Environment variables:
Unix : TPA_DATA=//home/jmancillas/TPA/tpa51betaC/
TPA_TEST=//home/jmancillas/TPA/tpa51betaC/

Window : TPA_DATA=D: ..\tpa51betaC
: TPA_TEST=D: ..\tpa51betaC

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): NONE

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: The TPA code is released on two OS platforms the Unix platform and the Windows platform, to ensure both versions of the code have been updated a comparison of the TPA results is made

- objective The results of the Windows and Unix TPA versions of TPA 51betaC should generate the same release results.

- assumptions NONE

- constraints NONE

- output files to compare or examine Screen capture

- step by step test procedure to be used
  1) execute a basecase realization of the TPA code on both operating platforms

- pass fail criteria
  1) The TPA results of both platforms should both be within machine precision of each others results.

Test Results:

- criterion 1

The following excerpts are from the screen captures of the TPA general results.

The Unix TPA execution generated the following Peak Mean Dose and time /SCR628/runc4/out .

```
*****************************************************************************

 exec: Peak Mean Dose is 8.47540E-03 rem/yr at    8896.6 yr, based on     1
realizations.

 exec:  Run Successfully Completed
*****************************************************************************
```

The Window TPA execution generated the following Peak Mean Dose and time Win\SCR628\run1\out.

```
*****************************************************************************
exec: Peak Mean Dose is 8.47540E-03 rem/yr at    8896.6 yr, based on     1
realizations.

exec:  Run Successfully Completed
*****************************************************************************
```

The two versions of the TPA code generated the same results. This is presented as evidence that both versions of the TPA code have been properly updated.

-Overall test status: PASS

SCR - 629

TPA 5.1/ Beta A

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR629	2. Software Title and Version: TPA51betaA	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f, sampler.f*

Seismic events prior to repository closure are being generated. Because it is assumed that damage to the repository prior to closure will be repaired and that these events will have no long term affect on repository performance, these events should be neglected.

5. Change Requested by:	6. Change Authorized by (*Software Developer*):
J. Mancillas Date: 4-25-06	R. Janeztke Date: 4-25-06

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

Seismic events which occur prior to repository closure have had their PGA, PGV, CF and MAPEs set to zero to nullify their impact on repository performance.

8. Implemented by:	Date:
J. Mancillas	04-25-06

9. Description of Acceptance Tests:

See Attachment A for PC Acceptance Testing and Attachment B for UNIX Acceptance Testing.

10. Tested by:	Date:
R. Rice	7-11-06

CNWRA Form TOP-5 (05/2000)

UPDATE REQUIREMENTS for TPA.INP

SCR 629

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	**Module**	**Parameter Name**	**Description** (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	**Distribution**	**Range**	**Justification** *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	**Source**

Attachment A

PC Acceptance Testing

Test Plan for TPA SCR#629

Test Plan Name: PC Testing of Nullifying Seismic Effects Prior to Repository Closure

Tested By: R. Rice

Date: July 11, 2006

Host Machine: Toshiba Laptop

Host OS: XP Professional

Baseline Version: 51betaA

Test Version: 51betaB

System Level (SL) Tests

SL-1. Name: Verify Nullification of Seismic Effects - Basecase

Path for run directory:
c:\SCR629\tpa51betaA\run\test1
c:\SCR629\tpa51betaB\run\test1

Path for archive of results:
\SCR629\PC\tpa51betaA\run\test1 (archived on CD "SCR#629 Testing")
\SCR629\PC\tpa51betaB\run\test1 (archived on CD "SCR#629 Testing")

Environment variables:

Baseline case
TPA_DATA=c:\SCR629\tpa51betaA
TPA_TEST=c:\SCR629\tpa51betaA

and

Test Case
TPA_DATA=c:\SCR629\tpa51betaB
TPA_TEST=c:\SCR629\tpa51betaB

Special input files or modifications to input files required: *tpa.inp* (modify this file to run Subarea 1 of 10 and Realization 1 of 2; activate APPEND file flag; and decrease the magnitudes of all five recurrence periods for the Seismic Hazard Curve by three orders of magnitude)

Special diagnostic code modifications required : None

Program modes to be used (append flags, scenario/model switches, etc.): None

Utility scripts needed to perform the test: None

Utility codes needed in the analysis of the test data: None

Test description: Using the basecase *tpa.inp* file with the modifications described above, the test verifies that the TPA code correctly nullifies the effects of seismic activity prior to the basecase repository closure time of 100 years. These effects are nullified by zeroing out the values of PGA, PGV, CF, and MAPE prior to repository closure.

- **Objective:** Verify PGA, PGV, CF, and MAPE are zeroed out prior to the basecase repository closure time of 100 years in the TPA Version 51betaB code.

- **Assumptions:** None, other than assumptions made in the TPA code

- **Constraints:** None

- **Output files to compare or examine:** *driftfail.ech*

- **Step by step test procedure to be used:**
  1. Create "run\test1" subdirectories in both the TPA Versions 51betaA and 51betaB main source code directories.
  2. Modify the *tpa.inp* file for the TPA Version 51betaA code according to the "Special input files or modifications to input files required" given above.
  3. Copy the *tpa.inp* file created in #2 above into the subdirectories created in #1 above (i.e., use the same *tpa.inp* file for both the TPA Versions 51 betaA and 51betaB code executions).
  4. Execute the TPA Versions 51betaA and 51betaB code in the subdirectories created in #1.
  5. Compare the contents of the file *driftfail.ech* for both the TPA Versions 51betaA and 51betaB using the "fc" command.

- **Pass/Fail criteria:**

  Criterion 1: In the file *driftfail.ech* of the TPA Version 51betaB code, the values for PGA, PGV, CF, and MAPE should be zeroed out prior to the basecase repository closure time of 100 years and in the TPA Versions 51betaA and 51betaB code, the values for PGA, PGV, CF, and MAPE should be equal after the basecase repository closure time of 100 years.

Test Results: The files in the \SCR629\PC\tpa51betaA\run\test1 and \SCR629\PC\tpa51betaB\run\test1 subdirectories on the CD contain the files from this test.

For Criterion 1, the contents of the file *fc_test1_driftfail.ech* , which is a file comparison between the contents of *driftfail.ech* from the TPA Versions 51betaA and 51betaB code execution, is provided below.

```
Comparing files TPA51BETAB\RUN\TEST1\driftfail.ech and
TPA51BETAA\RUN\TEST1\DRIFTFAIL.ECH
***** TPA51BETAB\RUN\TEST1\driftfail.ech
Base case.
TPA 5.1betaB, Job started: Wed Jul 12 13:07:04 2006
Echo of DRIFTFAIL Input Values
***** TPA51BETAA\RUN\TEST1\DRIFTFAIL.ECH
Base case.
TPA 5.1betaA, Job started: Wed Jul 12 12:59:08 2006
Echo of DRIFTFAIL Input Values
*****

***** TPA51BETAB\RUN\TEST1\driftfail.ech
```

	Time[yr]	MAPE	PGV[m/s]	PGA[g]	CF
1	4.61143E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	6.08034E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	6.39852E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	1.08348E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5	2.86684E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
6	3.09825E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
7	3.27498E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
8	4.15981E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
9	4.62383E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
10	5.51233E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
11	6.70994E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
12	7.94628E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
13	8.69112E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
14	1.03784E+02	7.61665E-05	5.40942E-01	7.16703E-01	1.45680E-01

***** TPA51BETAA\RUN\TEST1\DRIFTFAIL.ECH

	Time[yr]	MAPE	PGV[m/s]	PGA[g]	CF
1	4.61143E+00	9.84954E-05	4.73951E-01	7.52375E-01	1.15903E-01
2	6.08034E+00	3.72269E-05	7.27486E-01	8.65207E-01	1.79128E-01
3	6.39852E+00	6.04687E-05	6.01082E-01	2.31687E+00	1.01348E-01
4	1.08348E+01	4.91906E-06	1.49212E+00	3.03487E+00	2.99961E-01
5	2.86684E+01	9.32927E-05	4.88091E-01	7.09952E-01	1.24846E-01
6	3.09825E+01	8.10633E-05	5.24705E-01	3.78419E-01	1.87631E-01
7	3.27498E+01	2.05271E-05	8.82603E-01	3.10126E+00	1.09064E-01
8	4.15981E+01	7.85977E-05	5.32754E-01	6.99765E-01	1.44552E-01
9	4.62383E+01	1.25139E-05	1.01156E+00	1.46173E+00	1.78993E-01
10	5.51233E+01	6.36417E-05	5.87755E-01	1.00690E+00	1.32593E-01
11	6.70994E+01	7.71042E-06	1.22470E+00	1.51787E+00	3.73454E-01
12	7.94628E+01	5.71142E-06	1.40326E+00	4.30500E+00	2.40832E-01
13	8.69112E+01	4.06251E-05	7.04723E-01	1.38633E+00	1.35488E-01
14	1.03784E+02	7.61665E-05	5.40942E-01	7.16703E-01	1.45680E-01

*****

From the file comparison between the *drifttpa.out* files for TPA Versions 51betaA and 51betaB above, the values for PGA, PGV, CF, and MAPE are zeroed out prior to 100 years (basecase repository closure) and are equal afterwards.

Therefore, Criterion 1 is passed.

- Overall test status: PASS

SL-2. Name: Verify Nullification of Seismic Effects - Repository Closure at 70 years

Path for run directory: c:\SCR629\tpa51betaA\run\test2
c:\SCR629\tpa51betaB\run\test2

Path for archive of results: \SCR629\PC\tpa51betaA\run\test2(archived on CD "SCR#629 Testing")
\SCR629\PC\tpa51betaB\run\test2(archived on CD "SCR#629 Testing")

Environment variables:

Baseline case
TPA_DATA=c:\SCR629\tpa51betaA
TPA_TEST=c:\SCR629\tpa51betaA

and

Test Case
TPA_DATA=c:\SCR629\tpa51betaB
TPA_TEST=c:\SCR629\tpa51betaB

Special input files or modifications to input files required: *tpa.inp* (modify this file to run Subarea 1 of 10 and Realization 1 of 2; activate APPEND file flag; decrease the magnitudes of all five recurrence periods for the Seismic Hazard Curve by three orders of magnitude; and set the time of repository closure at 70 years)

Special diagnostic code modifications required : None

Program modes to be used (append flags, scenario/model switches, etc.): None

Utility scripts needed to perform the test: None

Utility codes needed in the analysis of the test data: None

Test description: Using the *tpa.inp* file with the modifications described above, the test verifies that the TPA code correctly nullifies the effects of seismic activity prior to the repository closure time of 70 years. These effects are nullified by zeroing out the values of PGA, PGV, CF, and MAPE prior to repository closure.

- **Objective:** Verify PGA, PGV, CF, and MAPE are zeroed out prior to the repository closure time of 70 years in the TPA Version 51betaB code.

- **Assumptions:** None, other than assumptions made in the TPA code

- **Constraints:** None

- Output files to compare or examine: *driftfail.ech*

- Step by step test procedure to be used:

1. Create "run\test2" subdirectories in both the TPA Versions 51betaA and 51betaB main source code directories.
2. Modify the *tpa.inp* file for the TPA Version 51betaA code according to the "Special input files or modifications to input files required" given above.
3. Copy the *tpa.inp* file created in #2 above into the subdirectories created in #1 above (i.e., use the same *tpa.inp* file for both the TPA Versions 51 betaA and 51betaB code executions).
4. Execute the TPA Versions 51betaA and 51betaB code in the subdirectories created in #1.
5. Compare the contents of the file *driftfail.ech* for both the TPA Versions 51betaA and 51betaB using the "fc" command.

- Pass/Fail criteria:

Criterion 1: In the file *driftfail.ech* of the TPA Version 51betaB code, the values for PGA, PGV, CF, and MAPE should be zeroed out prior to the repository closure time of 70 years and in the TPA Versions 51betaA and 51betaB code, the values for PGA, PGV, CF, and MAPE should be equal after the repository closure time of 70 years.

Test Results: The files in the \SCR629\PC\tpa51betaA\run\test2 and \SCR629\PC\tpa51betaB\run\test2 subdirectories on the CD contain the files from this test.

For Criterion 1, the contents of the file *fc_test2_driftfail.ech* , which is a file comparison between the contents of *driftfail.ech* from the TPA Versions 51betaA and 51betaB code execution, is provided below.

```
Comparing files TPA51BETAB\RUN\TEST2\driftfail.ech and
TPA51BETAA\RUN\TEST2\DRIFTFAIL.ECH
***** TPA51BETAB\RUN\TEST2\driftfail.ech
 Base case.
 TPA 5.1betaB, Job started: Wed Jul 12 13:17:17 2006
 Echo of DRIFTFAIL Input Values
***** TPA51BETAA\RUN\TEST2\DRIFTFAIL.ECH
 Base case.
 TPA 5.1betaA, Job started: Wed Jul 12 13:02:33 2006
 Echo of DRIFTFAIL Input Values
*****

***** TPA51BETAB\RUN\TEST2\driftfail.ech
        Time[yr]      MAPE      PGV[m/s]      PGA[g]        CF
   1  4.61143E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
   2  6.08034E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
   3  6.39852E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
   4  1.08348E+01  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
   5  2.86684E+01  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
   6  3.09825E+01  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
   7  3.27498E+01  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
```

8	4.15981E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
9	4.62383E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
10	5.51233E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
11	6.70994E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
12	7.94628E+01	5.71142E-06	1.40326E+00	4.30500E+00	2.40832E-01

***** TPA51BETAA\RUN\TEST2\DRIFTFAIL.ECH

	Time[yr]	MAPE	PGV[m/s]	PGA[g]	CF
1	4.61143E+00	9.84954E-05	4.73951E-01	7.52375E-01	1.15903E-01
2	6.08034E+00	3.72269E-05	7.27486E-01	8.65207E-01	1.79128E-01
3	6.39852E+00	6.04687E-05	6.01082E-01	2.31687E+00	1.01348E-01
4	1.08348E+01	4.91906E-06	1.49212E+00	3.03487E+00	2.99961E-01
5	2.86684E+01	9.32927E-05	4.88091E-01	7.09952E-01	1.24846E-01
6	3.09825E+01	8.10633E-05	5.24705E-01	3.78419E-01	1.87631E-01
7	3.27498E+01	2.05271E-05	8.82603E-01	3.10126E+00	1.09064E-01
8	4.15981E+01	7.85977E-05	5.32754E-01	6.99765E-01	1.44552E-01
9	4.62383E+01	1.25139E-05	1.01156E+00	1.46173E+00	1.78993E-01
10	5.51233E+01	6.36417E-05	5.87755E-01	1.00690E+00	1.32593E-01
11	6.70994E+01	7.71042E-06	1.22470E+00	1.51787E+00	3.73454E-01
12	7.94628E+01	5.71142E-06	1.40326E+00	4.30500E+00	2.40832E-01

*****

From the file comparison between the *drifttpa.out* files for TPA Versions 51betaA and 51betaB above, the values for PGA, PGV, CF, and MAPE are zeroed out prior to 70 years (repository closure) and are equal afterwards.

Therefore, Criterion 1 is passed.

- Overall test status: PASS

Attachment B

UNIX Acceptance Testing

Test Plan for TPA SCR#629

Test Plan Name: UNIX Testing of Nullifying Seismic Effects Prior to Repository Closure

Tested By: R. Rice

Date: July 11, 2006

Host Machine: SPOCK

Host OS: Version 5.9
(SUNW, Ultra-4,sparc, sun4u)

Baseline Version: 51betaA

Test Version: 51betaB

System Level (SL) Tests

SL-1. Name: Verify Nullification of Seismic Effects - Basecase

Path for run directory:
/home/rrice/scr629/tpa51betaA/run/test1
/home/rrice/scr629/tpa51betaB/run/test1

Path for archive of results:
\SCR629\UNIX\tpa51betaA\run\test1
\SCR629\UINIX\tpa51betaB\run\test1
(archived on CD "SCR#629 Testing")

Environment variables:

Baseline case
TPA_DATA is /home/rrice/scr629/tpa51betaA/
TPA_TEST is /home/rrice/scr629/tpa51betaA/

and

Test Case
TPA_DATA is /home/rrice/scr629/tpa51betaB/
TPA_TEST is /home/rrice/scr629/tpa51betaB/

Special input files or modifications to input files required: *tpa.inp* (modify this file to run Subarea 1 of 10 and Realization 1 of 2; activate APPEND file flag; and decrease the magnitudes of all five recurrence periods for the Seismic Hazard Curve by three orders of magnitude)

Special diagnostic code modifications required : None

Program modes to be used (append flags, scenario/model switches, etc.): None

Utility scripts needed to perform the test: None

Utility codes needed in the analysis of the test data: None

Test description: Using the basecase *tpa.inp* file with the modifications described above, the test verifies that the TPA code correctly nullifies the effects of seismic activity prior to basecase repository closure time of 100 years. These effects are nullified by zeroing out the values of PGA, PGV, CF, and MAPE prior to repository closure.

- Objective: Verify PGA, PGV, CF, and MAPE are zeroed out prior to the basecase repository closure time of 100 years in the TPA Version 51betaB code.

- Assumptions: None, other than assumptions made in the TPA code

- Constraints: None

- Output files to compare or examine: *driftfail.ech*

- Step by step test procedure to be used:

1. Create "run/test1" subdirectories in both the TPA Versions 51betaA and 51betaB main source code directories.
2. Modify the *tpa.inp* file for the TPA Version 51betaA code according to the "Special input files or modifications to input files required" given above.
3. Copy the *tpa.inp* file created in #2 above into the subdirectories created in #1 above (i.e., use the same *tpa.inp* file for both the TPA Versions 51 betaA and 51betaB code executions).
4. Execute the TPA Versions 51betaA and 51betaB code in the subdirectories created in #1.
5. Compare the contents of the file *driftfail.ech* for both the TPA Versions 51betaA and 51betaB using the "diff" command.

- Pass/Fail criteria:

Criterion 1: In the file *driftfail.ech* of the TPA Version 51betaB code, the values for PGA, PGV, CF, and MAPE should be zeroed out prior to the basecase repository closure time of 100 years and in the TPA Versions 51betaA and 51betaB code, the values for

PGA, PGV, CF, and MAPE should be equal after the basecase repository closure time of 100 years.

Test Results: The files in the \SCR629\UNIX\tpa51betaA\run\test1 and \SCR629\UNIX\tpa51betaB\run\test1 subdirectories on the CD contain the files from this test.

For Criterion 1, the contents of the file *diff_test1_driftfail.ech* , which is a file comparison between the contents of *driftfail.ech* from the TPA Versions 51betaA and 51betaB code execution, is provided below.

```
3c3
< TPA 5.1betaB, Job started: Wed Jul 12 14:21:14 2006
---
> TPA 5.1betaA, Job started: Wed Jul 12 14:16:38 2006
223,235c223,235
<   1  4.61143E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
<   2  6.08034E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
<   3  6.39852E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
<   4  1.08348E+01  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
<   5  2.86684E+01  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
<   6  3.09825E+01  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
<   7  3.27498E+01  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
<   8  4.15981E+01  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
<   9  4.62383E+01  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
<  10  5.51233E+01  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
<  11  6.70994E+01  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
<  12  7.94628E+01  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
<  13  8.69112E+01  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
---
>   1  4.61143E+00  9.84954E-05  4.73951E-01  7.52375E-01  1.15903E-01
>   2  6.08034E+00  3.72269E-05  7.27486E-01  8.65207E-01  1.79128E-01
>   3  6.39852E+00  6.04687E-05  6.01082E-01  2.31687E+00  1.01348E-01
>   4  1.08348E+01  4.91906E-06  1.49212E+00  3.03487E+00  2.99961E-01
>   5  2.86684E+01  9.32927E-05  4.88091E-01  7.09952E-01  1.24846E-01
>   6  3.09825E+01  8.10633E-05  5.24705E-01  3.78419E-01  1.87631E-01
>   7  3.27498E+01  2.05271E-05  8.82603E-01  3.10126E+00  1.09064E-01
>   8  4.15981E+01  7.85977E-05  5.32754E-01  6.99765E-01  1.44552E-01
>   9  4.62383E+01  1.25139E-05  1.01156E+00  1.46173E+00  1.78993E-01
>  10  5.51233E+01  6.36417E-05  5.87755E-01  1.00690E+00  1.32593E-01
>  11  6.70994E+01  7.71042E-06  1.22470E+00  1.51787E+00  3.73454E-01
>  12  7.94628E+01  5.71142E-06  1.40326E+00  4.30500E+00  2.40832E-01
>  13  8.69112E+01  4.06251E-05  7.04723E-01  1.38633E+00  1.35488E-01
```

From the file comparison between the *drifttpa.out* files for TPA Versions 51betaA and 51betaB above, the values for PGA, PGV, CF, and MAPE are zeroed out prior to 100 years (basecase repository closure) and are equal afterwards.

Therefore, Criterion 1 is passed.

- Overall test status: PASS

SL-2. Name: Verify Nullification of Seismic Effects - Repository Closure at 70 years

Path for run directory: /home/rrice/scr629/tpa51betaA/run/test2
/home/rrice/scr629/tpa51betaB/run/test2

Path for archive of results: \SCR629\UNIX\tpa51betaA\run\test2
\SCR629\UINIX\tpa51betaB\run\test2
(archived on CD "SCR#629 Testing")

Environment variables:

Baseline case
TPA_DATA is /home/rrice/scr629/tpa51betaA/
TPA_TEST is /home/rrice/scr629/tpa51betaA/

and

Test Case
TPA_DATA is /home/rrice/scr629/tpa51betaB/
TPA_TEST is /home/rrice/scr629/tpa51betaB/

Special input files or modifications to input files required: *tpa.inp* (modify this file to run Subarea 1 of 10 and Realization 1 of 2; activate APPEND file flag; decrease the magnitudes of all five recurrence periods for the Seismic Hazard Curve by three orders of magnitude; and set the time of repository closure at 70 years)

Special diagnostic code modifications required : None

Program modes to be used (append flags, scenario/model switches, etc.): None

Utility scripts needed to perform the test: None

Utility codes needed in the analysis of the test data: None

Test description: Using the basecase *tpa.inp* file with the modifications described above, the test verifies that the TPA code correctly nullifies the effects of seismic activity prior to the repository closure time of 70 years. These effects are nullified by zeroing out the values of PGA, PGV, CF, and MAPE prior to repository closure.

- Objective: Verify PGA, PGV, CF, and MAPE are zeroed out prior to the repository closure time of 70 years in the TPA Version 51betaB code.

- Assumptions: None, other than assumptions made in the TPA code

- Constraints: None

- Output files to compare or examine: *driftfail.ech*

- Step by step test procedure to be used:

1. Create "run/test2" subdirectories in both the TPA Versions 51betaA and 51betaB main source code directories.
2. Modify the *tpa.inp* file for the TPA Version 51betaA code according to the "Special input files or modifications to input files required" given above.
3. Copy the *tpa.inp* file created in #2 above into the subdirectories created in #1 above (i.e., use the same *tpa.inp* file for both the TPA Versions 51 betaA and 51betaB code executions).
4. Execute the TPA Versions 51betaA and 51betaB code in the subdirectories created in #1.
5. Compare the contents of the file *driftfail.ech* for both the TPA Versions 51betaA and 51betaB using the "diff" command.

- Pass/Fail criteria:

Criterion 1: In the file *driftfail.ech* of the TPA Version 51betaB code, the values for PGA, PGV, CF, and MAPE should be zeroed out prior to the repository closure time of 70 years and in the TPA Versions 51betaA and 51betaB code, the values for PGA, PGV, CF, and MAPE should be equal after the repository closure time of 70 years.

Test Results: The files in the \SCR629\UNIX\tpa51betaA\run\test2 and \SCR629\UNIX\tpa51betaB\run\test2 subdirectories on the CD contain the files from this test.

For Criterion 1, the contents of the file *diff_test2_driftfail.ech* , which is a file comparison between the contents of *driftfail.ech* from the TPA Versions 51betaA and 51betaB code execution, is provided below.

```
3c3
< TPA 5.1betaB, Job started: Wed Jul 12 14:22:27 2006
---
> TPA 5.1betaA, Job started: Wed Jul 12 14:17:56 2006
223,233c223,233
<   1  4.61143E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
<   2  6.08034E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
<   3  6.39852E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
```

```
<   4   1.08348E+01   0.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
<   5   2.86684E+01   0.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
<   6   3.09825E+01   0.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
<   7   3.27498E+01   0.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
<   8   4.15981E+01   0.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
<   9   4.62383E+01   0.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
<   10   5.51233E+01   0.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
<   11   6.70994E+01   0.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
---
>   1   4.61143E+00   9.84954E-05   4.73951E-01   7.52375E-01   1.15903E-01
>   2   6.08034E+00   3.72269E-05   7.27486E-01   8.65207E-01   1.79128E-01
>   3   6.39852E+00   6.04687E-05   6.01082E-01   2.31687E+00   1.01348E-01
>   4   1.08348E+01   4.91906E-06   1.49212E+00   3.03487E+00   2.99961E-01
>   5   2.86684E+01   9.32927E-05   4.88091E-01   7.09952E-01   1.24846E-01
>   6   3.09825E+01   8.10633E-05   5.24705E-01   3.78419E-01   1.87631E-01
>   7   3.27498E+01   2.05271E-05   8.82603E-01   3.10126E+00   1.09064E-01
>   8   4.15981E+01   7.85977E-05   5.32754E-01   6.99765E-01   1.44552E-01
>   9   4.62383E+01   1.25139E-05   1.01156E+00   1.46173E+00   1.78993E-01
>   10   5.51233E+01   6.36417E-05   5.87755E-01   1.00690E+00   1.32593E-01
>   11   6.70994E+01   7.71042E-06   1.22470E+00   1.51787E+00   3.73454E-01
```

From the file comparison between the *drifttpa.out* files for TPA Versions 51betaA and 51betaB above, the values for PGA, PGV, CF, and MAPE are zeroed out prior to 70 years (repository closure) and are equal afterwards.

Therefore, Criterion 1 is passed.

- Overall test status: PASS

SCR - 651

TPA 5.1/ Beta C

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 651	**2. Software Title and Version:** TPA 5.1betaC	**3. Project No:** 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *corrfail.f*, *ebsfail.f*, *ebsrel.f*, *exec.f*, *failt.f*, *failt.fig*, *nfenv.f*, *releaset.f*, *samplerx.i*, *corrosn.f*, *tpa.inp*, and *tpanames.dbs*.

First, no partial protection against seepage is applied if the WP fails by localized corrosion. Second, the time of WP failure by general corrosion only is not computed. Third, the TPA code computations estimate all drifts are fully degrade longitudinally after 1,000 years; the approach is conservative, as only a fraction of the drift length may experience degradation. Fourth, seepage is not allowed until the drift wall temperature drops below a threshold value even for degraded drifts, in which case the drift shield temperature would be more appropriate to use. Fifth, the chemistry for Environment II is the same for the entire repository and there is no subarea dependent/spatial variability. Sixth, the file *wpsfail.res* does not track the number of WPs affected by weld corrosion. Lastly, the flow of water into and out of a WP is not reported in *infilper.res*.

5. Change Requested by:	**6. Change Authorized by** (*Software Developer*):
O. Pensado Date: 6-16-2006	R. Janetzke Date: 6-16-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*): The following changes were implemented in the TPA code: (a) seepage factors modified to account for weld and localized corrosion ***(ebsrel.f)***; (b) failure time by general corrosion only computed ***(failt.f, ebsfail.f, corrfail.f, ebsrel.f)***; (c) new parameter added for the maximum drift degradation extent ***(exec.f)***; (d) drift shield temperature used to define the onset of seepage ***(nfenv.f)***; (e) subarea dependent chemical conditions added for Environment II ***(ebsfail.f)*** ; (f) track the number of WPs affected by weld corrosion in *wpsfail.res* ***(exec.f, ebsrel.f)*** ; and (g) weighted average of the water entering and leaving the WP added to last two columns of *infilper.res* ***(exec.f, releaset.f)*** . Also, parameters were added and updated, in addition to correlations added, to the *tpa.inp* file; see the following table. And also *corrosn.f* was updated to correct the equation for variable **piv2.** Note: the file *weldfail.f* was replaced with *corrfail.f*.

8. Implemented by:	**Date:**
R. Rice	6/30/06

9. Description of Acceptance Tests: See Attachment A for detailed test description.
Note: test of drip shield temperature used to define the onset of seepage (part (d) of changes) failed (testSL-2), correction of this issue will be addressed in SCR658.
Test of weighted average of the water entering and leaving the WP (part (g) of the changes) failed (testSL-6), correction of this issue will be addressed in SCR658.
All other changes were successfully tested.
Failed tests will be addressed by SCR663.

10. Tested by:	**Date:**
J. Mancillas	7/31/06

CNWRA Form TOP-5 (05/2000)

UPDATE REQUIREMENTS for TPA.INP
SCR 651

Status (***ADD, DELETE, MODIFY TO, MODIFY FROM***)	**Module**	**Parameter Name**	**Description** (***Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.***)	**Distribution**	**Range**	**Justification** ***1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.***	**Source**
ADD	EBSREL	InitialSeepageReductionFractionLC	Fraction of seepage that enters a WP as a result of localized corrosion	uniform	1.0e-3, 2.0e	Same as for the parameter "InitialSeepageReductionFractionByMechFailedDS"	See left
ADD	EXEC	DriftDegradationFraction[]	Fraction of the drift that has degraded for the entire repository	constant	1.0	Conservative value. Distribution may be developed in the future.	Best estimate
MODIFY FROM	EBSREL	SolubilityPu[kg/m3]	Pu solubility	uniform	2.4e-6, 2.4e-4	Previous distribution	See left

MODIFY TO	EBSREL	SolubilityPu[kg/m3]	Pu solubility	usersuppliedpwisecdf	23 7.11E-07, 0 3.79E-06, 0.05 6.27E-06, 0.1 8.41E-06, 0.15 1.07E-05, 0.2 1.37E-05, 0.25 1.68E-05, 0.3 2.02E-05, 0.35 2.42E-05, 0.4 2.86E-05, 0.45 3.36E-05, 0.5 4.01E-05, 0.55 4.61E-05, 0.6 5.53E-05, 0.65 6.73E-05, 0.7 8.22E-05,	Update Pu solubility	Scientific Notebook 172, pp. 104-110 by D. Pickett and 318E by S. Painter

DELETE	NFENV	EnvironmentII_Fl[mol/L]	These six deleted parameters describe the Environment II chemistry for the entire repository. Note that the same distribution that was used for the repository will be used for each subarea and the same correlations will be used.	usersuppliedp wisecdf	25 1.68E-06, 0.0 8.14E-06, 0.041666667 1.11355E-05, 0.083333333 1.79965E-05, 0.125 5.97035E-05, 0.166666667 0.00019405, 0.208333333 0.00034545, 0.25 0.00049711, 0.291666667 0.00887261, 0.333333333 0.034946554, 0.375	Define Environment II chemistry on a subarea basis to allow for spatial variability (instead of a single chemistry for the entire repository)	See left

DELETE	NFENV	EnvironmentII_Cl[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
DELETE	NFENV	EnvironmentII_pH[]	Same as above	Same as above	Same as above	Same as above	Same as above
DELETE	NFENV	EnvironmentII_NO3[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
DELETE	NFENV	EnvironmentII_CO3[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
DELETE	NFENV	EnvironmentII_SO4[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Fl_Subarea_1[mol/L]	These added parameters are the Environment II chemistry parameters for Fl, Cl, pH, NO_3, CO_3, and SO_4 by subarea	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_1[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_1[]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_NO3_Subarea_1[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above

ADD	NFENV	EnvironmentII_CO3_Subarea_1[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_SO4_Subarea_1[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Fl_Subarea_2[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_2[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_2[]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_NO3_Subarea_2[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_CO3_Subarea_2[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_SO4_Subarea_2[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Fl_Subarea_3[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_3[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_3[]	Same as above	Same as above	Same as above	Same as above	Same as above

ADD	NFENV	EnvironmentII_NO3_Subarea_3[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_CO3_Subarea_3[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_SO4_Subarea_3[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Fl_Subarea_4[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_4[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_4[]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_NO3_Subarea_4[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_CO3_Subarea_4[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_SO4_Subarea_4[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Fl_Subarea_5[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_5[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above

ADD	NFENV	EnvironmentII_pH_Subarea_5[]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_NO3_Subarea_5[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_CO3_Subarea_5[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_SO4_Subarea_5[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Fl_Subarea_6[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_6[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_6[]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_NO3_Subarea_6[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_CO3_Subarea_6[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_SO4_Subarea_6[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Fl_Subarea_7[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above

ADD	NFENV	EnvironmentII_Cl_Subarea_7[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_7[]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_NO3_Subarea_7[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_CO3_Subarea_7[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_SO4_Subarea_7[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Fl_Subarea_8[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_8[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_8[]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_NO3_Subarea_8[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_CO3_Subarea_8[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_SO4_Subarea_8[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above

ADD	NFENV	EnvironmentII_Fl_Subarea_9[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_9[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_9[]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_NO3_Subarea_9[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_CO3_Subarea_9[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_SO4_Subarea_9[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Fl_Subarea_10[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_10[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_10[]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_NO3_Subarea_10[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
ADD	NFENV	EnvironmentII_CO3_Subarea_10[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above

ADD	NFENV	EnvironmentII_SO4_Subarea_10[mol/L]	Same as above	Same as above	Same as above	Same as above	Same as above
DELETE	NFENV	EnvironmentII_pH[] and EnvironmentII_CO3[mol/L]	Parameters have been described above	correlateinputs	0.9	Same as above	Same as above
DELETE	NFENV	EnvironmentII_Cl[mol/L] and EnvironmentII_pH[]	Same as above	correlateinputs	-0.8	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_1[] and EnvironmentII_CO3_Subarea_1[mol/L]	Same as above	correlateinputs	0.9	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_1[mol/L] and EnvironmentII_pH_Subarea_1[]	Same as above	correlateinputs	-0.8	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_2[] and EnvironmentII_CO3_Subarea_2[mol/L]	Same as above	correlateinputs	0.9	Same as above	Same as above

ADD	NFENV	EnvironmentII_Cl_Subarea_2[mol/L] and EnvironmentII_pH_Subarea_2[]	Same as above	correlateinputs	-0.8	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_3[] and EnvironmentII_CO3_Subarea_3[mol/L]	Same as above	correlateinputs	0.9	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_3[mol/L] and EnvironmentII_pH_Subarea_3[]	Same as above	correlateinputs	-0.8	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_4[] and EnvironmentII_CO3_Subarea_4[mol/L]	Same as above	correlateinputs	0.9	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_4[mol/L] and EnvironmentII_pH_Subarea_4[]	Same as above	correlateinputs	-0.8	Same as above	Same as above

ADD	NFENV	EnvironmentII_pH_Subarea_5[] and EnvironmentII_CO3_Subarea_5[mol/L]	Same as above	correlateinputs	0.9	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_5[mol/L] and EnvironmentII_pH_Subarea_5[]	Same as above	correlateinputs	-0.8	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_6[] and EnvironmentII_CO3_Subarea_6[mol/L]	Same as above	correlateinputs	0.9	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_6[mol/L] and EnvironmentII_pH_Subarea_6[]	Same as above	correlateinputs	-0.8	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_7[] and EnvironmentII_CO3_Subarea_7[mol/L]	Same as above	correlateinputs	0.9	Same as above	Same as above

ADD	NFENV	EnvironmentII_Cl_Subarea_7[mol/L] and EnvironmentII_pH_Subarea_7[]	Same as above	correlateinputs	-0.8	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_8[] and EnvironmentII_CO3_Subarea_8[mol/L]	Same as above	correlateinputs	0.9	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_8[mol/L] and EnvironmentII_pH_Subarea_8[]	Same as above	correlateinputs	-0.8	Same as above	Same as above
ADD	NFENV	EnvironmentII_pH_Subarea_9[] and EnvironmentII_CO3_Subarea_9[mol/L]	Same as above	correlateinputs	0.9	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_9[mol/L] and EnvironmentII_pH_Subarea_9[]	Same as above	correlateinputs	-0.8	Same as above	Same as above

ADD	NFENV	EnvironmentII_pH_Subarea_10[] and EnvironmentII_CO3_Subarea_10[mol/L]	Same as above	correlateinputs	0.9	Same as above	Same as above
ADD	NFENV	EnvironmentII_Cl_Subarea_10[mol/L] and EnvironmentII_pH_Subarea_10[]	Same as above	correlateinputs	-0.8	Same as above	Same as above

ATTACHMENT A

Test Plan for TPA SCR651

Test Plan Name: SCR651 testing

Tested By:	J. Mancillas	Date:	31 July 2006
Host Machine:	TPA	Host OS:	MS WinXP SP2
Baseline Version:	tpa51betaC	Test Version:	tpa51betaD

System Level (SL) Tests

SL-1. Name: Test implementation of **DriftDegradationFraction[]**

Path for run directory:

Baseline Version	[TPA]D\Mancillas\SCR651\runC1
Test Version:	[TPA]D:\Mancillas\SCR651\runD1 ,runD2, runD3, runD4, runD5, runD6, runD7

Path for archive of results:

Baseline Version	CD [titled: SCR651 testing] :SCR651\testSL1\runC1
Test Version:	CD [titled: SCR651 testing] :SCR651\testSL1\runD1, runD2, runD3, runD4, runD5, runD6, runD7

Environment variables:

Baseline Version	TPA_DATA=..\tpa51betaC TPA_TEST =..\tpa51betaC
Test Version	TPA_DATA=..\tpa51betaD TPA_TEST =..\tpa51betaD

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): Append 7, Volcanism & Faulting scenarios

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: DOS command fc

Test description: The TPA code has been modified to include a parameter **DriftDegradationFraction[]**. This factor is used to rescale the number of WP which are damaged due to mechanical interactions. This is to account for the presence of un-degraded areas within a drift that has failed. Because mechanical interactions result directly in WP mechanical failures, Localized corrosion and Weld failures these failures should also be scaled, with the exception of juvenile failures. This should also not affect releases due to Faulting or Volcanism.

- objective Verify that the **DriftDegradationFraction[]** parameter has been implemented as intented.

- assumptions None, other that those made within the TPA code

- constraints None

- output files to compare or examine Screen captures of TPA execution

- step by step test procedure to be used

1) perform a test version basecase realization with **DriftDegradationFraction[ ]**=1
2) perform a test version basecase realization with **DriftDegradationFraction[ ]**=0.5
3) perform a test version basecase realization with **DriftDegradationFraction[ ]**=0.333
4) perform a test version basecase realization with **DriftDegradationFraction[]**=1 and **Volcanism flag** set to 1
5) perform a test version basecase realization with **DriftDegradationFraction[]**=0.5 and **Volcanism flag** set to 1

- pass fail criteria

1) test version should execute successfully with proper TPA input parameters
2) The number of WP failures in subareas should properly reflect the drift degradation fraction for that realization (ie if Wpfailed=500 w/ fraction =1 then; Wpfailed=250 w/ fraction =0.5; and Wpfailed = 167 w/ fraction=0.333). The amount of released RN should be consistent with fraction drift degradation
3) Initial WP Failures should not scale with the degradation fraction
4) The drift degradation fraction should have no affect on WP failures by Faulting or Volcanism

Test Results: During the evaluation of this test the simulation time was extended to 100,000 yrs and 20 realizations were performed to find individual realizations which had mechanical failures. In realization 16 and 17 adequate conditions were found to evaluate the performance of SCR651 SL-1.

- criterion 1

In the run directory [TPA]D:\Mancillas\SCR651\runD1 the tpa.inp was modified to run for 100,000 yrs and to perform 20 realizations (from 16 to 17) with the **DriftDegradationFraction[]** set to 1.00. The TPA code executed successfully.
The following text excerpt is from the archived screen capture of the TPA execution
[CD]:\SCR651\testSL1\runD1*out*

```
*******************************************************************************
exec: Peak Mean Dose is 1.33927E-01 rem/yr at   41500.0 yr, based on     2
realizations.

exec:  Run Successfully Completed
*******************************************************************************
```

The following excerpt shows the new parameter added to the *tpa.inp* file.
[CD]:\SCR651\tpa51betaD\ *tpa.inp*

```
*******************************************************************************
constant
DriftDegradationFraction[]
1.0
*******************************************************************************
```

This is presented as evidence that SCR651 has been properly implemented.

- criterion 2

In the run directories [TPA]D:\Mancillas\SCR651\runD2 and [TPA]D:\Mancillas\SCR651\runD3 additional realizations were performed, 20 realizations (from 16 to 17) with the **DriftDegradationFraction[]** set to 0.5 and 0.33, for 100,000yrs. In subarea 5 of realization 17 of 20 mechanical failures occurred.

The following text excerpts are from the append file *ebsrel.rlt* for these realizations and show the number of mechanically failed WPs in subarea 5 of realization 17 of 20.

[CD]:\SCR651\testSL1\runD1*ebsrel.rlt* (NOTE: default value of **DriftDegradationFraction**=1.0)

```
*******************************************************************************
SUBAREA    5

 Release information taken from relcumsf.out & relcumglass.out

     1.00000E+05     Simulation Time

     Type# Failed    Start SF Wet[yr]       Fill Time[yr]       Fill Start[yr]       Fill Stop[yr]
       1       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       2       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       3       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       4     888         1.1307E+03          2.5589E+02          1.1595E+03          1.4154E+03
       5     157         1.1307E+03          4.0273E+02          1.1595E+03          1.5622E+03
       6       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       7       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       8       0         1.1307E+03          0.0000E+00          0.0000E+00          0.0000E+00
*******************************************************************************
```

[CD]:\SCR651\testSL1\runD2\ebsrel.rlt ,(**DriftDegradationFraction**=0.50)

```
*******************************************************************************
SUBAREA    5

 Release information taken from relcumsf.out & relcumglass.out

     1.00000E+05     Simulation Time

     Type# Failed    Start SF Wet[yr]       Fill Time[yr]      Fill Start[yr]       Fill Stop[yr]
       1       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       2       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       3       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       4     444         1.1307E+03          2.5589E+02          1.1595E+03          1.4154E+03
       5      78         1.1307E+03          4.0273E+02          1.1595E+03          1.5622E+03
       6       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       7       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       8       0         1.1307E+03          0.0000E+00          0.0000E+00          0.0000E+00
*******************************************************************************
```

[CD]:\SCR651\testSL1\runD3*ebsrel.rlt*,(**DriftDegradationFraction**=0.333)

```
*******************************************************************************
SUBAREA    5

 Release information taken from relcumsf.out & relcumglass.out

     1.00000E+05     Simulation Time

     Type# Failed    Start SF Wet[yr]       Fill Time[yr]      Fill Start[yr]       Fill Stop[yr]
       1       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       2       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       3       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       4     296         1.1307E+03          2.5589E+02          1.1595E+03          1.4154E+03
       5      53         1.1307E+03          4.0273E+02          1.1595E+03          1.5622E+03
       6       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       7       0         1.0483E+03          0.0000E+00          0.0000E+00          0.0000E+00
       8       0         1.1307E+03          0.0000E+00          0.0000E+00          0.0000E+00
*******************************************************************************
```

An inspection of the number of failed WP (column two) shows that mechanically failed WPs are properly scaled by the **DriftDegradationFraction[]**.

- criterion 3

The number of initially failed (juvenile failures) should be unaffected by the **DriftDegradationFraction[]**, by examining the *ebsrel.rlt* results of subarea 10 of realization 16 of 20, the number of initially failed Wps can be observed to be unchanged with 12 juvenile failures, when the DriftDegradationFraction[] has values of 1.0, 0.5 and 0.333 (runD1, runD2 and runD3 respectively). Note also that row eight column two contains the number of Wps that are failed by corrosion. These corrosion failures are a direct result of mechanical failure of the DS and should scale by the **DriftDegradationFraction[]**

The following text is an excerpt from [CD]:\SCR651\testSL1\runD1*ebsrel.rlt,* row one, column two depicts the number of juvenile failures (**DriftDegradationFraction**=1.0)

```
*******************************************************************************
SUBAREA   10

 Release information taken from relcumsf.out & relcumglass.out
```

```
     1.00000E+05     Simulation Time

     Type# Failed    Start SF Wet[yr]       Fill Time[yr]      Fill Start[yr]       Fill Stop[yr]
       1      12         2.0939E+03          5.2532E+01          2.1452E+03          2.1977E+03
       2       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       3       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       4       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       5       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       6       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       7       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       8    1246         2.1515E+03          6.7202E+04          2.1977E+03          6.9400E+04
*****************************************************************************************************
```

The following text is an excerpt from
[CD]:\SCR651\testSL1\runD2*ebsrel.rlt*, row one, column two depicts the number of juvenile failures
(**DriftDegradationFraction**=0.50)

```
*****************************************************************************************************
SUBAREA   10

 Release information taken from relcumsf.out & relcumglass.out

     1.00000E+05     Simulation Time

     Type# Failed    Start SF Wet[yr]       Fill Time[yr]      Fill Start[yr]       Fill Stop[yr]
       1      12         2.0939E+03          5.2532E+01          2.1452E+03          2.1977E+03
       2       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       3       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       4       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       5       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       6       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       7       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       8     623         2.1515E+03          6.7202E+04          2.1977E+03          6.9400E+04
*****************************************************************************************************
```

The following text is an excerpt from
[CD]:\SCR651\testSL1\runD3*ebsrel.rlt*, row one, column two depicts the number of juvenile failures
(**DriftDegradationFraction**=0.333)

```
*****************************************************************************************************
SUBAREA   10

 Release information taken from relcumsf.out & relcumglass.out

     1.00000E+05     Simulation Time

     Type# Failed    Start SF Wet[yr]       Fill Time[yr]      Fill Start[yr]       Fill Stop[yr]
       1      12         2.0939E+03          5.2532E+01          2.1452E+03          2.1977E+03
       2       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       3       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       4       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       5       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       6       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       7       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       8     415         2.1515E+03          6.7202E+04          2.1977E+03          6.9400E+04
*****************************************************************************************************
```

These results depict the expected behavior of the TPA code with differing **DriftDegradataionFraction[]** values, and are presented as evidence that SCR651 has been properly implemented.

- criterion 4

Two basecase realizations (10,000 yrs) with the Volcanism flag set to 1 were run, one with the **DriftDegradationFraction[]** set to 1.0 (runD4) and the other set to 0.5 (runD5). The Append file

ebsrel.rlt was examined to ensure that the number of Wps failed by Volcanism was not scaled by the **DriftDegradationFraction[].** In realization one of one in subarea 4 Volcanism failures were observed.

The following excerpt is from *ebsrel.rlt* in archive directory
[CD]:\SCR651\testSL1\runD4*ebsrel.rlt* (**DriftDegradationFraction[]**=1.0, Volcanism=1)

```
*****************************************************************************************
SUBAREA    4

 Release information taken from relcumsf.out & relcumglass.out

     1.00000E+04     Simulation Time

     Type# Failed    Start SF Wet[yr]       Fill Time[yr]      Fill Start[yr]       Fill Stop[yr]
       1       9         2.0939E+03          0.0000E+00          2.1452E+03          2.1452E+03
       2       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       3    1024         2.0939E+03          0.0000E+00          2.1452E+03          2.1452E+03
       4       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       5       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       6       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       7       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       8       0         1.0000E+04          0.0000E+00          0.0000E+00          0.0000E+00
*****************************************************************************************
```

Row 3, column 2 shows that in subarea 4 there were 1024 Wps failed by volcanism.

The following excerpt is from *ebsrel.rlt* in archive directory
[CD]:\SCR651\testSL1\runD5*ebsrel.rlt* (**DriftDegradationFraction[]**=0.5, Volcanism=1)

```
*****************************************************************************************
SUBAREA    4

 Release information taken from relcumsf.out & relcumglass.out

     1.00000E+04     Simulation Time

     Type# Failed    Start SF Wet[yr]       Fill Time[yr]      Fill Start[yr]       Fill Stop[yr]
       1       9         2.0939E+03          0.0000E+00          2.1452E+03          2.1452E+03
       2       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       3    1024         2.0939E+03          0.0000E+00          2.1452E+03          2.1452E+03
       4       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       5       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       6       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       7       0         2.0939E+03          0.0000E+00          0.0000E+00          0.0000E+00
       8       0         1.0000E+04          0.0000E+00          0.0000E+00          0.0000E+00
*****************************************************************************************
```

Row 3, column 2 shows that in subarea 4 there were 1024 Wps failed by volcanism.

In both cases (**DriftDegradationFraction[]**=1.0 and 0.5), the number of Wps failed by Volcanism is 1024 and is not affected by the **DriftDegradationFraction**. This is the expected behavior of the TPA model and these results are presented as evidence that SCR651 has be properly implemented.

- criterion 5 evidence

Two basecase realizations (10,000 yrs) with the Faulting flag set to 1 were run, one with the **DriftDegradationFraction[]** set to 1.0 (runD6) and the other set to 0.5 (runD7). The Append file ebsrel.rlt was examined to ensure that the number of Wps failed by a Faulting event was not scaled by the **DriftDegradationFraction[].** In realization one of one in subarea 5 Faulting failures were observed.

The following excerpt is from **ebsrel.rlt** in archive directory
[CD]:\SCR651\testSL1\runD6*ebsrel.rlt* (**DriftDegradationFraction[]**=1.0, Faulting scenario =1)

```
*****************************************************************************************
SUBAREA    5

 Release information taken from relcumsf.out & relcumglass.out

     1.00000E+04     Simulation Time

     Type# Failed    Start SF Wet[yr]       Fill Time[yr]      Fill Start[yr]       Fill Stop[yr]
       1       7         1.6409E+03          1.7266E+02          1.6816E+03          1.8543E+03
       2       8         1.6409E+03          0.0000E+00          1.6816E+03          1.6816E+03
       3       0         1.6409E+03          0.0000E+00          0.0000E+00          0.0000E+00
       4       0         1.6409E+03          0.0000E+00          0.0000E+00          0.0000E+00
       5       0         1.6409E+03          0.0000E+00          0.0000E+00          0.0000E+00
       6       0         1.6409E+03          0.0000E+00          0.0000E+00          0.0000E+00
       7       0         1.6409E+03          0.0000E+00          0.0000E+00          0.0000E+00
       8    1030         1.7005E+03          8.2767E+03          1.7233E+03          1.0000E+04
*****************************************************************************************
```

Row 2, column 2 shows that in subarea 5 there were 8 Wps failed by a faulting scenario.

The following excerpt is from *ebsrel.rlt* in archive directory
[CD]:\SCR651\testSL1\runD7*ebsrel.rlt* (**DriftDegradationFraction[]**=0.5, Faulting scenario =1)

```
*****************************************************************************************
SUBAREA    5

 Release information taken from relcumsf.out & relcumglass.out

     1.00000E+04     Simulation Time

     Type# Failed    Start SF Wet[yr]       Fill Time[yr]      Fill Start[yr]       Fill Stop[yr]
       1       7         1.6409E+03          1.7266E+02          1.6816E+03          1.8543E+03
       2       8         1.6409E+03          0.0000E+00          1.6816E+03          1.6816E+03
       3       0         1.6409E+03          0.0000E+00          0.0000E+00          0.0000E+00
       4       0         1.6409E+03          0.0000E+00          0.0000E+00          0.0000E+00
       5       0         1.6409E+03          0.0000E+00          0.0000E+00          0.0000E+00
       6       0         1.6409E+03          0.0000E+00          0.0000E+00          0.0000E+00
       7       0         1.6409E+03          0.0000E+00          0.0000E+00          0.0000E+00
       8     515         1.7005E+03          8.2767E+03          1.7233E+03          1.0000E+04
*****************************************************************************************
```

Row 2, column 2 shows that in subarea 5 there were 8 Wps failed by a faulting scenario.

In both cases (**DriftDegradationFraction[]**=1.0 and 0.5), the number of Wps failed by a faulting scenario is 8 and is not affected by the **DriftDegradationFraction**. This is the expected behavior of the TPA model and these results are presented as evidence that SCR651 has be properly implemented.

- overall test status: PASS

SL-2. Name: Drip shield temperature used to define the onset of seepage.

Path for run directory:

Baseline Version	[TPA]D\Mancillas\SCR651\runC1
Test Version:	[TPA]D:\Mancillas\SCR651\runD1

Path for archive of results:

Baseline Version	CD [titled: SCR651 testing] :SCR651\testSL2\runC1
Test Version:	CD [titled: SCR651 testing] :SCR651\testSL2\runD1

Environment variables:

Baseline Version	TPA_DATA=..\tpa51betaC TPA_TEST =..\tpa51betaC
Test Version	TPA_DATA=..\tpa51betaD TPA_TEST =..\tpa51betaD

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): Append All

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: The subroutine nfenvFl has been modified to use the drip shield temperature to determine the seepage onto the WPs when the drift has degraded and covered the DS.

- objective: Verify that the DS temperature is used for seepage calculations when the drift has degraded and rubble has accumulated on top of the DS.

- assumptions: None other than those made within the TPA code

- constraints: NONE

- output files to compare or examine: *driftfail.rlt, infilper.res* and *nfenv.rlt*

- step by step test procedure to be used

1) Perform a mean value basecase realization of the TPA and using the append all flag.

2) Examine the logic used in the selection of the temperature comparison for seepage.
3) Compare the time and temperature of the drip shield and repository (*nfenv.rlt)* with the flow rates into the WPs.

- pass fail criteria

1) The logic used to select the seepage threshold temperature should be consistent with the intended change of SCR651
2) The time of WP inflow should be consistent with the time the DS or repository temperature reaches the seepage threshold temperature.

Test Results:

The following text is an excerpt from the test version of *nfenv.f.*
D:\SCR651\tpa51betaD\ *nfenv.f*

```
*****************************************************************************
cc rwr 6/16/06; SCR651; determine waste package general corrosion
cc                      failure time, in addition to the time of
cc                      weld failure
cc (when the drift has degraded, use drip shield temperature instead
cc  of "temprep")
cc            if (temprep(it) .GT. ThrSeepage) then
cc                 qm3peryrperwpinsamisswp(it) =
cc      &             qm3peryrperwpinsamisswp(it) +
cc      &             qm3peryrperwpinsahitwp(it)
cc                 qm3peryrperwpinsahitwp(it)=0.0
cc              endif
            if (eqBFDiaB(it) .ge. driftdia) then
              if (temprep(it) .GT. ThrSeepage) then
                qm3peryrperwpinsamisswp(it) =
     &               qm3peryrperwpinsamisswp(it) +
     &               qm3peryrperwpinsahitwp(it)
                qm3peryrperwpinsahitwp(it)=0.0
              endif
            else
              if (tempdsoB(it) .GT. ThrSeepage) then
                qm3peryrperwpinsamisswp(it) =
     &               qm3peryrperwpinsamisswp(it) +
     &               qm3peryrperwpinsahitwp(it)
                qm3peryrperwpinsahitwp(it)=0.0
              endif
            endif
*****************************************************************************
```

An examination of this logic loop shows that the repository temp (temprep(it)) is selected when the DS has been covered in rubble (eqBFDiaB(it) .ge. driftdia), and that the drip shield temperature (tempdsoB) is used otherwise for comparison against the seepage threshold temperature. This is inconsistent with the intended change defined in section 7 of SCR651.

In addition, after performing a mean value basecase realization of the TPA code an examination of the files: *nfenv.rlt*, *infilper.res* and *driftfail.rlt* shows that the repository temperature is erroneously selected for seepage calculations.

It is suggested that the line

```
*******************************************************************************
          if (eqBFDiaB(it) .ge. driftdia) then
*******************************************************************************
```

be modified to

```
*******************************************************************************
          if (eqBFDiaB(it) .lt. driftdia) then
*******************************************************************************
```

to correct this issue.

- overall test status: FAIL

Correction of this issue will be addressed in SCR658.

SL-3. Name: Environment II chemistry defined on a subarea basis

Path for run directory:

Baseline Version: [TPA]D\Mancillas\SCR651\runC1
Test Version: [TPA]D:\Mancillas\SCR651\runD1

Path for archive of results:

Baseline Version: CD [titled: SCR651 testing] :SCR651\testSL3\runC1
Test Version: CD [titled: SCR651 testing] :SCR651\testSL3\runD1

Environment variables:

Baseline Version: TPA_DATA=..\tpa51betaC
TPA_TEST =..\tpa51betaC

Test Version: TPA_DATA=..\tpa51betaD
TPA_TEST =..\tpa51betaD

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): NONE

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: The TPA code has been modified to sample Environment II on a subarea basis. This requires the modification of the *tpa.inp* and the *ebsfail.f* files

- objective Verify that the tpa.inp file has been modified to include Environment II parameters on a subarea basis and that they are used in the calculation of corrosion rates on a subarea basis.

- assumptions None other than those made within the TPA code.

- constraints None

- output files to compare or examine

- step by step test procedure to be used
  1) perform a test version realization of the TPA code for 100,000 yrs with drift

degradation and Seismic events turned off.
2) The CO3, NO3, SO4, Fl and Cl concentrations should vary by subarea as recorded in the *nfenv.rlt*.

- pass fail criteria
  1) Environment II parameters have been altered to a subarea basis in the *tpa.inp* file.
  2) *ebsfail.f* has been modified to used Environment II parameters on a subarea basis.

Test Results:

-criterion 1

An examination of *tpa.inp* in the test version of the TPA code shows that the parameters: **EnvironmentII_pH[]**, **EnvironmentII_CO3[mol/L]**, **EnvironmentII_Cl[mol/L]**, and **EnvironmentII_pH[]** have been commented out and have been replaced by the subarea specific parameters: **EnvironmentII_pH_Subarea_1... 10[]**, **EnvironmentII_CO3_Subarea_1 ... 10[mol/L]**, **EnvironmentII_Cl_Subarea_1 ... 10[mol/L]**, and **EnvironmentII_pH_Subarea_1 ... 10[]**. The correlation of these parameters has been retained on a subarea basis and the previous value distributions have been retained for these parameters on a subarea basis.

The following text is an excerpt from the test version of the tpa.inp file
[CD]:\SCR651\tpa51betaD\ *tpa.inp*

```
*******************************************************************************
** rwr 6/16/06; SCR651; determine waste package general corrosion
**                      failure time, in addition to the time of
**                      weld failure
** (define the chemistry parameters for EnvironmentII on a subarea
**  basis to allow for spatial variability)
**usersuppliedpwisecdf
**EnvironmentII_Fl[mol/L]
**25
**1.68E-06,       0.0
**8.14E-06,     0.041666667
**1.11355E-05, 0.083333333
**1.79965E-05, 0.125
**5.97035E-05, 0.166666667
**0.00019405,  0.208333333
**0.00034545,  0.25
**0.00049711,  0.291666667
**0.00887261,  0.333333333
**0.034946554, 0.375
**0.045923167, 0.416666667
**0.050417268, 0.458333333
**0.062505976, 0.5
**0.06994287,  0.541666667
**0.07103854,  0.583333333
**0.074881871, 0.625
**0.078999899, 0.666666667
**0.08071957,  0.708333333
**0.081644782, 0.75
**0.081850946, 0.791666667
**0.08847118,  0.833333333
**0.1238553,   0.875
**0.2375897,   0.916666667
**0.368547279, 0.958333333
**0.509481015, 1.0
```

```
****
**usersuppliedpwisecdf
**EnvironmentII_Cl[mol/L]
**25,
**3.964578,       0.0
**4.052321471, 0.041666667
**4.115,        0.083
**4.263,        0.125
**4.455,        0.167
**4.674,        0.208
**4.725,        0.250
**4.852,        0.292
**5.301,        0.333
**5.602,        0.375
**5.624,        0.417
**5.745,        0.458
**5.907,        0.500
**6.174,        0.542
**6.387,        0.583
**6.393,        0.625
**6.538,        0.667
**6.810,        0.708
**6.942,        0.750
**7.039,        0.792
**7.116,        0.833
**7.310,        0.875
**7.473,        0.917
**9.088,        0.958
**10.185,       1.000
****
**usersuppliedpwisecdf
**EnvironmentII_pH[]
**25
**5.8,       0.0
**6.14875,  0.041666667
**6.434,    0.083
**6.887,    0.125
**7.510,    0.167
**8.193,    0.208
**8.446,    0.250
**8.596,    0.292
**9.019,    0.333
**10.139,   0.375
**10.519,   0.417
**10.564,   0.458
**10.631,   0.500
**10.683,   0.542
**10.714,   0.583
**10.725,   0.625
**10.736,   0.667
**10.773,   0.708
**10.803,   0.750
**10.827,   0.792
**10.830,   0.833
**10.844,   0.875
**10.900,   0.917
**10.932,   0.958
**10.950,   1.000
****
**usersuppliedpwisecdf
**EnvironmentII_NO3[mol/L]
**25
**0.00265, 0.0
**0.022,   0.042
**0.062,   0.083
**0.112,   0.125
**0.152,   0.167
**0.176,   0.208
**0.221,   0.250
**0.271,   0.292
**0.294,   0.333
**0.315,   0.375
```

```
**0.332,   0.417
**0.336,   0.458
**0.351,   0.500
**0.440,   0.542
**0.492,   0.583
**0.501,   0.625
**0.796,   0.667
**1.156,   0.708
**1.804,   0.750
**2.440,   0.792
**2.795,   0.833
**3.160,   0.875
**3.356,   0.917
**3.672,   0.958
**4.109,   1.000
****
**usersuppliedpwisecdf
**EnvironmentII_CO3[mol/L]
**25
**2.54E-09,   0.0
**4.69E-08,   0.042
**1.69E-07,   0.083
**9.1815E-07, 0.125
**3.756E-06,  0.167
**1.912E-05,  0.208
**0.0000421,  0.250
**0.000065,   0.292
**0.058,      0.333
**0.238,      0.375
**0.324,      0.417
**0.369,      0.458
**0.448,      0.500
**0.552,      0.542
**0.690,      0.583
**0.785,      0.625
**0.856,      0.667
**0.862,      0.708
**0.868,      0.750
**0.873,      0.792
**0.955,      0.833
**1.033,      0.875
**1.077,      0.917
**1.141,      0.958
**1.217,      1.000
****
****
**usersuppliedpwisecdf
**EnvironmentII_SO4[mol/L]
**25
**7.43E-06, 0.0
**0.000277, 0.042
**0.00117,  0.083
**0.0027,   0.125
**0.003,    0.167
**0.0048,   0.208
**0.0073,   0.250
**0.0086,   0.292
**0.00985,  0.333
**0.011,    0.375
**0.012,    0.417
**0.0125,   0.458
**0.013,    0.500
**0.0135,   0.542
**0.014,    0.583
**0.015,    0.625
**0.016,    0.667
**0.018,    0.708
**0.021,    0.750
**0.071,    0.792
**0.123,    0.833
**0.154,    0.875
**0.160,    0.917
```

```
**0.166,     0.958
**0.263,     1.000
usersuppliedpwisecdf
EnvironmentII_Fl_Subarea_1[mol/L]
25
1.68E-06,       0.0
8.14E-06,     0.041666667
1.11355E-05, 0.083333333
1.79965E-05, 0.125
5.97035E-05, 0.166666667
0.00019405,  0.208333333
0.00034545,  0.25
0.00049711,  0.291666667
0.00887261,  0.333333333
0.034946554, 0.375
0.045923167, 0.416666667
0.050417268, 0.458333333
0.062505976, 0.5
0.06994287,  0.541666667
0.07103854,  0.583333333
0.074881871, 0.625
0.078999899, 0.666666667
0.08071957,  0.708333333
0.081644782, 0.75
0.081850946, 0.791666667
0.08847118,  0.833333333
0.1238553,   0.875
0.2375897,   0.916666667
0.368547279, 0.958333333
0.509481015, 1.0
**
usersuppliedpwisecdf
EnvironmentII_Cl_Subarea_1[mol/L]
25,
3.964578,       0.0
4.052321471, 0.041666667
4.115,       0.083
4.263,       0.125
4.455,       0.167
4.674,       0.208
4.725,       0.250
4.852,       0.292
5.301,       0.333
5.602,       0.375
5.624,       0.417
5.745,       0.458
5.907,       0.500
6.174,       0.542
6.387,       0.583
6.393,       0.625
6.538,       0.667
6.810,       0.708
6.942,       0.750
7.039,       0.792
7.116,       0.833
7.310,       0.875
7.473,       0.917
9.088,       0.958
10.185,      1.000
**
usersuppliedpwisecdf
EnvironmentII_pH_Subarea_1[]
25
5.8,       0.0
6.14875,   0.041666667
6.434,     0.083
6.887,     0.125
7.510,     0.167
8.193,     0.208
8.446,     0.250
8.596,     0.292
9.019,     0.333
```

```
10.139,   0.375
10.519,   0.417
10.564,   0.458
10.631,   0.500
10.683,   0.542
10.714,   0.583
10.725,   0.625
10.736,   0.667
10.773,   0.708
10.803,   0.750
10.827,   0.792
10.830,   0.833
10.844,   0.875
10.900,   0.917
10.932,   0.958
10.950,   1.000
**
usersuppliedpwisecdf
EnvironmentII_NO3_Subarea_1[mol/L]
25
0.00265, 0.0
0.022,   0.042
0.062,   0.083
0.112,   0.125
0.152,   0.167
0.176,   0.208
0.221,   0.250
0.271,   0.292
0.294,   0.333
0.315,   0.375
0.332,   0.417
0.336,   0.458
0.351,   0.500
0.440,   0.542
0.492,   0.583
0.501,   0.625
0.796,   0.667
1.156,   0.708
1.804,   0.750
2.440,   0.792
2.795,   0.833
3.160,   0.875
3.356,   0.917
3.672,   0.958
4.109,   1.000
**
usersuppliedpwisecdf
EnvironmentII_CO3_Subarea_1[mol/L]
25
2.54E-09,   0.0
4.69E-08,   0.042
1.69E-07,   0.083
9.1815E-07, 0.125
3.756E-06,  0.167
1.912E-05,  0.208
0.0000421,  0.250
0.000065,   0.292
0.058,      0.333
0.238,      0.375
0.324,      0.417
0.369,      0.458
0.448,      0.500
0.552,      0.542
0.690,      0.583
0.785,      0.625
0.856,      0.667
0.862,      0.708
0.868,      0.750
0.873,      0.792
0.955,      0.833
1.033,      0.875
1.077,      0.917
```

```
1.141,       0.958
1.217,       1.000
**
usersuppliedpwisecdf
EnvironmentII_SO4_Subarea_1[mol/L]
25
7.43E-06, 0.0
0.000277, 0.042
0.00117,  0.083
0.0027,   0.125
0.003,    0.167
0.0048,   0.208
0.0073,   0.250
0.0086,   0.292
0.00985,  0.333
0.011,    0.375
0.012,    0.417
0.0125,   0.458
0.013,    0.500
0.0135,   0.542
0.014,    0.583
0.015,    0.625
0.016,    0.667
0.018,    0.708
0.021,    0.750
0.071,    0.792
0.123,    0.833
0.154,    0.875
0.160,    0.917
0.166,    0.958
0.263,    1.000
**
usersuppliedpwisecdf
EnvironmentII_Fl_Subarea_2[mol/L]
25
1.68E-06,       0.0
8.14E-06,     0.041666667
1.11355E-05, 0.083333333
1.79965E-05, 0.125
5.97035E-05, 0.166666667
0.00019405,  0.208333333
0.00034545,  0.25
0.00049711,  0.291666667
0.00887261,  0.333333333
0.034946554, 0.375
0.045923167, 0.416666667
0.050417268, 0.458333333
0.062505976, 0.5
0.06994287,  0.541666667
0.07103854,  0.583333333
0.074881871, 0.625
0.078999899, 0.666666667
0.08071957,  0.708333333
0.081644782, 0.75
0.081850946, 0.791666667
0.08847118,  0.833333333
0.1238553,   0.875
0.2375897,   0.916666667
0.368547279, 0.958333333
0.509481015, 1.0
**
usersuppliedpwisecdf
EnvironmentII_Cl_Subarea_2[mol/L]
25,
3.964578,       0.0
4.052321471, 0.041666667
4.115,       0.083
4.263,       0.125
4.455,       0.167
4.674,       0.208
4.725,       0.250
4.852,       0.292
```

```
5.301,        0.333
5.602,        0.375
5.624,        0.417
5.745,        0.458
5.907,        0.500
6.174,        0.542
6.387,        0.583
6.393,        0.625
6.538,        0.667
6.810,        0.708
6.942,        0.750
7.039,        0.792
7.116,        0.833
7.310,        0.875
7.473,        0.917
9.088,        0.958
10.185,       1.000
**
usersuppliedpwisecdf
EnvironmentII_pH_Subarea_2[]
25
5.8,       0.0
6.14875,   0.041666667
6.434,     0.083
6.887,     0.125
7.510,     0.167
8.193,     0.208
8.446,     0.250
8.596,     0.292
9.019,     0.333
10.139,    0.375
10.519,    0.417
10.564,    0.458
10.631,    0.500
10.683,    0.542
10.714,    0.583
10.725,    0.625
10.736,    0.667
10.773,    0.708
10.803,    0.750
10.827,    0.792
10.830,    0.833
10.844,    0.875
10.900,    0.917
10.932,    0.958
10.950,    1.000
**
usersuppliedpwisecdf
EnvironmentII_NO3_Subarea_2[mol/L]
25
0.00265, 0.0
0.022,   0.042
0.062,   0.083
0.112,   0.125
0.152,   0.167
0.176,   0.208
0.221,   0.250
0.271,   0.292
0.294,   0.333
0.315,   0.375
0.332,   0.417
0.336,   0.458
0.351,   0.500
0.440,   0.542
0.492,   0.583
0.501,   0.625
0.796,   0.667
1.156,   0.708
1.804,   0.750
2.440,   0.792
2.795,   0.833
3.160,   0.875
```

```
3.356,    0.917
3.672,    0.958
4.109,    1.000
**
usersuppliedpwisecdf
EnvironmentII_CO3_Subarea_2[mol/L]
25
2.54E-09,    0.0
4.69E-08,    0.042
1.69E-07,    0.083
9.1815E-07, 0.125
3.756E-06,  0.167
1.912E-05,  0.208
0.0000421,  0.250
0.000065,   0.292
0.058,      0.333
0.238,      0.375
0.324,      0.417
0.369,      0.458
0.448,      0.500
0.552,      0.542
0.690,      0.583
0.785,      0.625
0.856,      0.667
0.862,      0.708
0.868,      0.750
0.873,      0.792
0.955,      0.833
1.033,      0.875
1.077,      0.917
1.141,      0.958
1.217,      1.000
**
usersuppliedpwisecdf
EnvironmentII_SO4_Subarea_2[mol/L]
25
7.43E-06, 0.0
0.000277, 0.042
0.00117,  0.083
0.0027,   0.125
0.003,    0.167
0.0048,   0.208
0.0073,   0.250
0.0086,   0.292
0.00985,  0.333
0.011,    0.375
0.012,    0.417
0.0125,   0.458
0.013,    0.500
0.0135,   0.542
0.014,    0.583
0.015,    0.625
0.016,    0.667
0.018,    0.708
0.021,    0.750
0.071,    0.792
0.123,    0.833
0.154,    0.875
0.160,    0.917
0.166,    0.958
0.263,    1.000
**
usersuppliedpwisecdf
EnvironmentII_Fl_Subarea_3[mol/L]
25
1.68E-06,       0.0
8.14E-06,     0.041666667
1.11355E-05, 0.083333333
1.79965E-05, 0.125
5.97035E-05, 0.166666667
0.00019405,  0.208333333
0.00034545,  0.25
```

```
0.00049711,  0.291666667
0.00887261,  0.333333333
0.034946554, 0.375
0.045923167, 0.416666667
0.050417268, 0.458333333
0.062505976, 0.5
0.06994287,  0.541666667
0.07103854,  0.583333333
0.074881871, 0.625
0.078999899, 0.666666667
0.08071957,  0.708333333
0.081644782, 0.75
0.081850946, 0.791666667
0.08847118,  0.833333333
0.1238553,   0.875
0.2375897,   0.916666667
0.368547279, 0.958333333
0.509481015, 1.0
**
usersuppliedpwisecdf
EnvironmentII_Cl_Subarea_3[mol/L]
25,
3.964578,      0.0
4.052321471, 0.041666667
4.115,       0.083
4.263,       0.125
4.455,       0.167
4.674,       0.208
4.725,       0.250
4.852,       0.292
5.301,       0.333
5.602,       0.375
5.624,       0.417
5.745,       0.458
5.907,       0.500
6.174,       0.542
6.387,       0.583
6.393,       0.625
6.538,       0.667
6.810,       0.708
6.942,       0.750
7.039,       0.792
7.116,       0.833
7.310,       0.875
7.473,       0.917
9.088,       0.958
10.185,      1.000
**
usersuppliedpwisecdf
EnvironmentII_pH_Subarea_3[]
25
5.8,      0.0
6.14875,  0.041666667
6.434,    0.083
6.887,    0.125
7.510,    0.167
8.193,    0.208
8.446,    0.250
8.596,    0.292
9.019,    0.333
10.139,   0.375
10.519,   0.417
10.564,   0.458
10.631,   0.500
10.683,   0.542
10.714,   0.583
10.725,   0.625
10.736,   0.667
10.773,   0.708
10.803,   0.750
10.827,   0.792
10.830,   0.833
```

```
10.844,   0.875
10.900,   0.917
10.932,   0.958
10.950,   1.000
**
usersuppliedpwisecdf
EnvironmentII_NO3_Subarea_3[mol/L]
25
0.00265, 0.0
0.022,   0.042
0.062,   0.083
0.112,   0.125
0.152,   0.167
0.176,   0.208
0.221,   0.250
0.271,   0.292
0.294,   0.333
0.315,   0.375
0.332,   0.417
0.336,   0.458
0.351,   0.500
0.440,   0.542
0.492,   0.583
0.501,   0.625
0.796,   0.667
1.156,   0.708
1.804,   0.750
2.440,   0.792
2.795,   0.833
3.160,   0.875
3.356,   0.917
3.672,   0.958
4.109,   1.000
**
usersuppliedpwisecdf
EnvironmentII_CO3_Subarea_3[mol/L]
25
2.54E-09,   0.0
4.69E-08,   0.042
1.69E-07,   0.083
9.1815E-07, 0.125
3.756E-06,  0.167
1.912E-05,  0.208
0.0000421,  0.250
0.000065,   0.292
0.058,      0.333
0.238,      0.375
0.324,      0.417
0.369,      0.458
0.448,      0.500
0.552,      0.542
0.690,      0.583
0.785,      0.625
0.856,      0.667
0.862,      0.708
0.868,      0.750
0.873,      0.792
0.955,      0.833
1.033,      0.875
1.077,      0.917
1.141,      0.958
1.217,      1.000
**
usersuppliedpwisecdf
EnvironmentII_SO4_Subarea_3[mol/L]
25
7.43E-06, 0.0
0.000277, 0.042
0.00117,  0.083
0.0027,   0.125
0.003,    0.167
0.0048,   0.208
```

```
0.0073,   0.250
0.0086,   0.292
0.00985,  0.333
0.011,    0.375
0.012,    0.417
0.0125,   0.458
0.013,    0.500
0.0135,   0.542
0.014,    0.583
0.015,    0.625
0.016,    0.667
0.018,    0.708
0.021,    0.750
0.071,    0.792
0.123,    0.833
0.154,    0.875
0.160,    0.917
0.166,    0.958
0.263,    1.000
**
usersuppliedpwisecdf
EnvironmentII_Fl_Subarea_4[mol/L]
25
1.68E-06,      0.0
8.14E-06,    0.041666667
1.11355E-05, 0.083333333
1.79965E-05, 0.125
5.97035E-05, 0.166666667
0.00019405,  0.208333333
0.00034545,  0.25
0.00049711,  0.291666667
0.00887261,  0.333333333
0.034946554, 0.375
0.045923167, 0.416666667
0.050417268, 0.458333333
0.062505976, 0.5
0.06994287,  0.541666667
0.07103854,  0.583333333
0.074881871, 0.625
0.078999899, 0.666666667
0.08071957,  0.708333333
0.081644782, 0.75
0.081850946, 0.791666667
0.08847118,  0.833333333
0.1238553,   0.875
0.2375897,   0.916666667
0.368547279, 0.958333333
0.509481015, 1.0
**
usersuppliedpwisecdf
EnvironmentII_Cl_Subarea_4[mol/L]
25,
3.964578,      0.0
4.052321471, 0.041666667
4.115,       0.083
4.263,       0.125
4.455,       0.167
4.674,       0.208
4.725,       0.250
4.852,       0.292
5.301,       0.333
5.602,       0.375
5.624,       0.417
5.745,       0.458
5.907,       0.500
6.174,       0.542
6.387,       0.583
6.393,       0.625
6.538,       0.667
6.810,       0.708
6.942,       0.750
7.039,       0.792
```

```
7.116,       0.833
7.310,       0.875
7.473,       0.917
9.088,       0.958
10.185,      1.000
**
usersuppliedpwisecdf
EnvironmentII_pH_Subarea_4[]
25
5.8,       0.0
6.14875,   0.041666667
6.434,     0.083
6.887,     0.125
7.510,     0.167
8.193,     0.208
8.446,     0.250
8.596,     0.292
9.019,     0.333
10.139,    0.375
10.519,    0.417
10.564,    0.458
10.631,    0.500
10.683,    0.542
10.714,    0.583
10.725,    0.625
10.736,    0.667
10.773,    0.708
10.803,    0.750
10.827,    0.792
10.830,    0.833
10.844,    0.875
10.900,    0.917
10.932,    0.958
10.950,    1.000
**
usersuppliedpwisecdf
EnvironmentII_NO3_Subarea_4[mol/L]
25
0.00265, 0.0
0.022,   0.042
0.062,   0.083
0.112,   0.125
0.152,   0.167
0.176,   0.208
0.221,   0.250
0.271,   0.292
0.294,   0.333
0.315,   0.375
0.332,   0.417
0.336,   0.458
0.351,   0.500
0.440,   0.542
0.492,   0.583
0.501,   0.625
0.796,   0.667
1.156,   0.708
1.804,   0.750
2.440,   0.792
2.795,   0.833
3.160,   0.875
3.356,   0.917
3.672,   0.958
4.109,   1.000
**
usersuppliedpwisecdf
EnvironmentII_CO3_Subarea_4[mol/L]
25
2.54E-09,    0.0
4.69E-08,    0.042
1.69E-07,    0.083
9.1815E-07, 0.125
3.756E-06,  0.167
```

```
1.912E-05,  0.208
0.0000421,  0.250
0.000065,   0.292
0.058,      0.333
0.238,      0.375
0.324,      0.417
0.369,      0.458
0.448,      0.500
0.552,      0.542
0.690,      0.583
0.785,      0.625
0.856,      0.667
0.862,      0.708
0.868,      0.750
0.873,      0.792
0.955,      0.833
1.033,      0.875
1.077,      0.917
1.141,      0.958
1.217,      1.000
**
usersuppliedpwisecdf
EnvironmentII_SO4_Subarea_4[mol/L]
25
7.43E-06, 0.0
0.000277, 0.042
0.00117,  0.083
0.0027,   0.125
0.003,    0.167
0.0048,   0.208
0.0073,   0.250
0.0086,   0.292
0.00985,  0.333
0.011,    0.375
0.012,    0.417
0.0125,   0.458
0.013,    0.500
0.0135,   0.542
0.014,    0.583
0.015,    0.625
0.016,    0.667
0.018,    0.708
0.021,    0.750
0.071,    0.792
0.123,    0.833
0.154,    0.875
0.160,    0.917
0.166,    0.958
0.263,    1.000
**
usersuppliedpwisecdf
EnvironmentII_Fl_Subarea_5[mol/L]
25
1.68E-06,      0.0
8.14E-06,    0.041666667
1.11355E-05, 0.083333333
1.79965E-05, 0.125
5.97035E-05, 0.166666667
0.00019405,  0.208333333
0.00034545,  0.25
0.00049711,  0.291666667
0.00887261,  0.333333333
0.034946554, 0.375
0.045923167, 0.416666667
0.050417268, 0.458333333
0.062505976, 0.5
0.06994287,  0.541666667
0.07103854,  0.583333333
0.074881871, 0.625
0.078999899, 0.666666667
0.08071957,  0.708333333
0.081644782, 0.75
```

```
0.081850946, 0.791666667
0.08847118,  0.833333333
0.1238553,   0.875
0.2375897,   0.916666667
0.368547279, 0.958333333
0.509481015, 1.0
**
usersuppliedpwisecdf
EnvironmentII_Cl_Subarea_5[mol/L]
25,
3.964578,      0.0
4.052321471, 0.041666667
4.115,       0.083
4.263,       0.125
4.455,       0.167
4.674,       0.208
4.725,       0.250
4.852,       0.292
5.301,       0.333
5.602,       0.375
5.624,       0.417
5.745,       0.458
5.907,       0.500
6.174,       0.542
6.387,       0.583
6.393,       0.625
6.538,       0.667
6.810,       0.708
6.942,       0.750
7.039,       0.792
7.116,       0.833
7.310,       0.875
7.473,       0.917
9.088,       0.958
10.185,      1.000
**
usersuppliedpwisecdf
EnvironmentII_pH_Subarea_5[]
25
5.8,       0.0
6.14875,   0.041666667
6.434,     0.083
6.887,     0.125
7.510,     0.167
8.193,     0.208
8.446,     0.250
8.596,     0.292
9.019,     0.333
10.139,    0.375
10.519,    0.417
10.564,    0.458
10.631,    0.500
10.683,    0.542
10.714,    0.583
10.725,    0.625
10.736,    0.667
10.773,    0.708
10.803,    0.750
10.827,    0.792
10.830,    0.833
10.844,    0.875
10.900,    0.917
10.932,    0.958
10.950,    1.000
**
usersuppliedpwisecdf
EnvironmentII_NO3_Subarea_5[mol/L]
25
0.00265, 0.0
0.022,   0.042
0.062,   0.083
0.112,   0.125
```

```
0.152,   0.167
0.176,   0.208
0.221,   0.250
0.271,   0.292
0.294,   0.333
0.315,   0.375
0.332,   0.417
0.336,   0.458
0.351,   0.500
0.440,   0.542
0.492,   0.583
0.501,   0.625
0.796,   0.667
1.156,   0.708
1.804,   0.750
2.440,   0.792
2.795,   0.833
3.160,   0.875
3.356,   0.917
3.672,   0.958
4.109,   1.000
**
usersuppliedpwisecdf
EnvironmentII_CO3_Subarea_5[mol/L]
25
2.54E-09,   0.0
4.69E-08,   0.042
1.69E-07,   0.083
9.1815E-07, 0.125
3.756E-06,  0.167
1.912E-05,  0.208
0.0000421,  0.250
0.000065,   0.292
0.058,      0.333
0.238,      0.375
0.324,      0.417
0.369,      0.458
0.448,      0.500
0.552,      0.542
0.690,      0.583
0.785,      0.625
0.856,      0.667
0.862,      0.708
0.868,      0.750
0.873,      0.792
0.955,      0.833
1.033,      0.875
1.077,      0.917
1.141,      0.958
1.217,      1.000
**
usersuppliedpwisecdf
EnvironmentII_SO4_Subarea_5[mol/L]
25
7.43E-06, 0.0
0.000277, 0.042
0.00117,  0.083
0.0027,   0.125
0.003,    0.167
0.0048,   0.208
0.0073,   0.250
0.0086,   0.292
0.00985,  0.333
0.011,    0.375
0.012,    0.417
0.0125,   0.458
0.013,    0.500
0.0135,   0.542
0.014,    0.583
0.015,    0.625
0.016,    0.667
0.018,    0.708
```

```
0.021,    0.750
0.071,    0.792
0.123,    0.833
0.154,    0.875
0.160,    0.917
0.166,    0.958
0.263,    1.000
**
usersuppliedpwisecdf
EnvironmentII_Fl_Subarea_6[mol/L]
25
1.68E-06,      0.0
8.14E-06,    0.041666667
1.11355E-05, 0.083333333
1.79965E-05, 0.125
5.97035E-05, 0.166666667
0.00019405,  0.208333333
0.00034545,  0.25
0.00049711,  0.291666667
0.00887261,  0.333333333
0.034946554, 0.375
0.045923167, 0.416666667
0.050417268, 0.458333333
0.062505976, 0.5
0.06994287,  0.541666667
0.07103854,  0.583333333
0.074881871, 0.625
0.078999899, 0.666666667
0.08071957,  0.708333333
0.081644782, 0.75
0.081850946, 0.791666667
0.08847118,  0.833333333
0.1238553,   0.875
0.2375897,   0.916666667
0.368547279, 0.958333333
0.509481015, 1.0
**
usersuppliedpwisecdf
EnvironmentII_Cl_Subarea_6[mol/L]
25,
3.964578,      0.0
4.052321471, 0.041666667
4.115,       0.083
4.263,       0.125
4.455,       0.167
4.674,       0.208
4.725,       0.250
4.852,       0.292
5.301,       0.333
5.602,       0.375
5.624,       0.417
5.745,       0.458
5.907,       0.500
6.174,       0.542
6.387,       0.583
6.393,       0.625
6.538,       0.667
6.810,       0.708
6.942,       0.750
7.039,       0.792
7.116,       0.833
7.310,       0.875
7.473,       0.917
9.088,       0.958
10.185,      1.000
**
usersuppliedpwisecdf
EnvironmentII_pH_Subarea_6[]
25
5.8,      0.0
6.14875,  0.041666667
6.434,    0.083
```

```
6.887,    0.125
7.510,    0.167
8.193,    0.208
8.446,    0.250
8.596,    0.292
9.019,    0.333
10.139,   0.375
10.519,   0.417
10.564,   0.458
10.631,   0.500
10.683,   0.542
10.714,   0.583
10.725,   0.625
10.736,   0.667
10.773,   0.708
10.803,   0.750
10.827,   0.792
10.830,   0.833
10.844,   0.875
10.900,   0.917
10.932,   0.958
10.950,   1.000
**
usersuppliedpwisecdf
EnvironmentII_NO3_Subarea_6[mol/L]
25
0.00265, 0.0
0.022,   0.042
0.062,   0.083
0.112,   0.125
0.152,   0.167
0.176,   0.208
0.221,   0.250
0.271,   0.292
0.294,   0.333
0.315,   0.375
0.332,   0.417
0.336,   0.458
0.351,   0.500
0.440,   0.542
0.492,   0.583
0.501,   0.625
0.796,   0.667
1.156,   0.708
1.804,   0.750
2.440,   0.792
2.795,   0.833
3.160,   0.875
3.356,   0.917
3.672,   0.958
4.109,   1.000
**
usersuppliedpwisecdf
EnvironmentII_CO3_Subarea_6[mol/L]
25
2.54E-09,   0.0
4.69E-08,   0.042
1.69E-07,   0.083
9.1815E-07, 0.125
3.756E-06,  0.167
1.912E-05,  0.208
0.0000421,  0.250
0.000065,   0.292
0.058,      0.333
0.238,      0.375
0.324,      0.417
0.369,      0.458
0.448,      0.500
0.552,      0.542
0.690,      0.583
0.785,      0.625
0.856,      0.667
```

```
0.862,      0.708
0.868,      0.750
0.873,      0.792
0.955,      0.833
1.033,      0.875
1.077,      0.917
1.141,      0.958
1.217,      1.000
**
usersuppliedpwisecdf
EnvironmentII_SO4_Subarea_6[mol/L]
25
7.43E-06, 0.0
0.000277, 0.042
0.00117,  0.083
0.0027,   0.125
0.003,    0.167
0.0048,   0.208
0.0073,   0.250
0.0086,   0.292
0.00985,  0.333
0.011,    0.375
0.012,    0.417
0.0125,   0.458
0.013,    0.500
0.0135,   0.542
0.014,    0.583
0.015,    0.625
0.016,    0.667
0.018,    0.708
0.021,    0.750
0.071,    0.792
0.123,    0.833
0.154,    0.875
0.160,    0.917
0.166,    0.958
0.263,    1.000
**
usersuppliedpwisecdf
EnvironmentII_Fl_Subarea_7[mol/L]
25
1.68E-06,      0.0
8.14E-06,    0.041666667
1.11355E-05, 0.083333333
1.79965E-05, 0.125
5.97035E-05, 0.166666667
0.00019405,  0.208333333
0.00034545,  0.25
0.00049711,  0.291666667
0.00887261,  0.333333333
0.034946554, 0.375
0.045923167, 0.416666667
0.050417268, 0.458333333
0.062505976, 0.5
0.06994287,  0.541666667
0.07103854,  0.583333333
0.074881871, 0.625
0.078999899, 0.666666667
0.08071957,  0.708333333
0.081644782, 0.75
0.081850946, 0.791666667
0.08847118,  0.833333333
0.1238553,   0.875
0.2375897,   0.916666667
0.368547279, 0.958333333
0.509481015, 1.0
**
usersuppliedpwisecdf
EnvironmentII_Cl_Subarea_7[mol/L]
25,
3.964578,      0.0
4.052321471, 0.041666667
```

```
4.115,       0.083
4.263,       0.125
4.455,       0.167
4.674,       0.208
4.725,       0.250
4.852,       0.292
5.301,       0.333
5.602,       0.375
5.624,       0.417
5.745,       0.458
5.907,       0.500
6.174,       0.542
6.387,       0.583
6.393,       0.625
6.538,       0.667
6.810,       0.708
6.942,       0.750
7.039,       0.792
7.116,       0.833
7.310,       0.875
7.473,       0.917
9.088,       0.958
10.185,      1.000
**
usersuppliedpwisecdf
EnvironmentII_pH_Subarea_7[]
25
5.8,       0.0
6.14875,   0.041666667
6.434,     0.083
6.887,     0.125
7.510,     0.167
8.193,     0.208
8.446,     0.250
8.596,     0.292
9.019,     0.333
10.139,    0.375
10.519,    0.417
10.564,    0.458
10.631,    0.500
10.683,    0.542
10.714,    0.583
10.725,    0.625
10.736,    0.667
10.773,    0.708
10.803,    0.750
10.827,    0.792
10.830,    0.833
10.844,    0.875
10.900,    0.917
10.932,    0.958
10.950,    1.000
**
usersuppliedpwisecdf
EnvironmentII_NO3_Subarea_7[mol/L]
25
0.00265, 0.0
0.022,   0.042
0.062,   0.083
0.112,   0.125
0.152,   0.167
0.176,   0.208
0.221,   0.250
0.271,   0.292
0.294,   0.333
0.315,   0.375
0.332,   0.417
0.336,   0.458
0.351,   0.500
0.440,   0.542
0.492,   0.583
0.501,   0.625
```

```
0.796,    0.667
1.156,    0.708
1.804,    0.750
2.440,    0.792
2.795,    0.833
3.160,    0.875
3.356,    0.917
3.672,    0.958
4.109,    1.000
**
usersuppliedpwisecdf
EnvironmentII_CO3_Subarea_7[mol/L]
25
2.54E-09,    0.0
4.69E-08,    0.042
1.69E-07,    0.083
9.1815E-07,  0.125
3.756E-06,   0.167
1.912E-05,   0.208
0.0000421,   0.250
0.000065,    0.292
0.058,       0.333
0.238,       0.375
0.324,       0.417
0.369,       0.458
0.448,       0.500
0.552,       0.542
0.690,       0.583
0.785,       0.625
0.856,       0.667
0.862,       0.708
0.868,       0.750
0.873,       0.792
0.955,       0.833
1.033,       0.875
1.077,       0.917
1.141,       0.958
1.217,       1.000
**
usersuppliedpwisecdf
EnvironmentII_SO4_Subarea_7[mol/L]
25
7.43E-06,  0.0
0.000277,  0.042
0.00117,   0.083
0.0027,    0.125
0.003,     0.167
0.0048,    0.208
0.0073,    0.250
0.0086,    0.292
0.00985,   0.333
0.011,     0.375
0.012,     0.417
0.0125,    0.458
0.013,     0.500
0.0135,    0.542
0.014,     0.583
0.015,     0.625
0.016,     0.667
0.018,     0.708
0.021,     0.750
0.071,     0.792
0.123,     0.833
0.154,     0.875
0.160,     0.917
0.166,     0.958
0.263,     1.000
**
usersuppliedpwisecdf
EnvironmentII_Fl_Subarea_8[mol/L]
25
1.68E-06,      0.0
```

```
8.14E-06,     0.041666667
1.11355E-05, 0.083333333
1.79965E-05, 0.125
5.97035E-05, 0.166666667
0.00019405,  0.208333333
0.00034545,  0.25
0.00049711,  0.291666667
0.00887261,  0.333333333
0.034946554, 0.375
0.045923167, 0.416666667
0.050417268, 0.458333333
0.062505976, 0.5
0.06994287,  0.541666667
0.07103854,  0.583333333
0.074881871, 0.625
0.078999899, 0.666666667
0.08071957,  0.708333333
0.081644782, 0.75
0.081850946, 0.791666667
0.08847118,  0.833333333
0.1238553,   0.875
0.2375897,   0.916666667
0.368547279, 0.958333333
0.509481015, 1.0
**
usersuppliedpwisecdf
EnvironmentII_Cl_Subarea_8[mol/L]
25,
3.964578,       0.0
4.052321471, 0.041666667
4.115,       0.083
4.263,       0.125
4.455,       0.167
4.674,       0.208
4.725,       0.250
4.852,       0.292
5.301,       0.333
5.602,       0.375
5.624,       0.417
5.745,       0.458
5.907,       0.500
6.174,       0.542
6.387,       0.583
6.393,       0.625
6.538,       0.667
6.810,       0.708
6.942,       0.750
7.039,       0.792
7.116,       0.833
7.310,       0.875
7.473,       0.917
9.088,       0.958
10.185,      1.000
**
usersuppliedpwisecdf
EnvironmentII_pH_Subarea_8[]
25
5.8,      0.0
6.14875,  0.041666667
6.434,    0.083
6.887,    0.125
7.510,    0.167
8.193,    0.208
8.446,    0.250
8.596,    0.292
9.019,    0.333
10.139,   0.375
10.519,   0.417
10.564,   0.458
10.631,   0.500
10.683,   0.542
10.714,   0.583
```

```
10.725,   0.625
10.736,   0.667
10.773,   0.708
10.803,   0.750
10.827,   0.792
10.830,   0.833
10.844,   0.875
10.900,   0.917
10.932,   0.958
10.950,   1.000
**
usersuppliedpwisecdf
EnvironmentII_NO3_Subarea_8[mol/L]
25
0.00265, 0.0
0.022,   0.042
0.062,   0.083
0.112,   0.125
0.152,   0.167
0.176,   0.208
0.221,   0.250
0.271,   0.292
0.294,   0.333
0.315,   0.375
0.332,   0.417
0.336,   0.458
0.351,   0.500
0.440,   0.542
0.492,   0.583
0.501,   0.625
0.796,   0.667
1.156,   0.708
1.804,   0.750
2.440,   0.792
2.795,   0.833
3.160,   0.875
3.356,   0.917
3.672,   0.958
4.109,   1.000
**
usersuppliedpwisecdf
EnvironmentII_CO3_Subarea_8[mol/L]
25
2.54E-09,   0.0
4.69E-08,   0.042
1.69E-07,   0.083
9.1815E-07, 0.125
3.756E-06,  0.167
1.912E-05,  0.208
0.0000421,  0.250
0.000065,   0.292
0.058,      0.333
0.238,      0.375
0.324,      0.417
0.369,      0.458
0.448,      0.500
0.552,      0.542
0.690,      0.583
0.785,      0.625
0.856,      0.667
0.862,      0.708
0.868,      0.750
0.873,      0.792
0.955,      0.833
1.033,      0.875
1.077,      0.917
1.141,      0.958
1.217,      1.000
**
usersuppliedpwisecdf
EnvironmentII_SO4_Subarea_8[mol/L]
25
```

```
7.43E-06, 0.0
0.000277, 0.042
0.00117,  0.083
0.0027,   0.125
0.003,    0.167
0.0048,   0.208
0.0073,   0.250
0.0086,   0.292
0.00985,  0.333
0.011,    0.375
0.012,    0.417
0.0125,   0.458
0.013,    0.500
0.0135,   0.542
0.014,    0.583
0.015,    0.625
0.016,    0.667
0.018,    0.708
0.021,    0.750
0.071,    0.792
0.123,    0.833
0.154,    0.875
0.160,    0.917
0.166,    0.958
0.263,    1.000
**
usersuppliedpwisecdf
EnvironmentII_Fl_Subarea_9[mol/L]
25
1.68E-06,      0.0
8.14E-06,    0.041666667
1.11355E-05, 0.083333333
1.79965E-05, 0.125
5.97035E-05, 0.166666667
0.00019405,  0.208333333
0.00034545,  0.25
0.00049711,  0.291666667
0.00887261,  0.333333333
0.034946554, 0.375
0.045923167, 0.416666667
0.050417268, 0.458333333
0.062505976, 0.5
0.06994287,  0.541666667
0.07103854,  0.583333333
0.074881871, 0.625
0.078999899, 0.666666667
0.08071957,  0.708333333
0.081644782, 0.75
0.081850946, 0.791666667
0.08847118,  0.833333333
0.1238553,   0.875
0.2375897,   0.916666667
0.368547279, 0.958333333
0.509481015, 1.0
**
usersuppliedpwisecdf
EnvironmentII_Cl_Subarea_9[mol/L]
25,
3.964578,      0.0
4.052321471, 0.041666667
4.115,       0.083
4.263,       0.125
4.455,       0.167
4.674,       0.208
4.725,       0.250
4.852,       0.292
5.301,       0.333
5.602,       0.375
5.624,       0.417
5.745,       0.458
5.907,       0.500
6.174,       0.542
```

```
6.387,        0.583
6.393,        0.625
6.538,        0.667
6.810,        0.708
6.942,        0.750
7.039,        0.792
7.116,        0.833
7.310,        0.875
7.473,        0.917
9.088,        0.958
10.185,       1.000
**
usersuppliedpwisecdf
EnvironmentII_pH_Subarea_9[]
25
5.8,       0.0
6.14875,   0.041666667
6.434,     0.083
6.887,     0.125
7.510,     0.167
8.193,     0.208
8.446,     0.250
8.596,     0.292
9.019,     0.333
10.139,    0.375
10.519,    0.417
10.564,    0.458
10.631,    0.500
10.683,    0.542
10.714,    0.583
10.725,    0.625
10.736,    0.667
10.773,    0.708
10.803,    0.750
10.827,    0.792
10.830,    0.833
10.844,    0.875
10.900,    0.917
10.932,    0.958
10.950,    1.000
**
usersuppliedpwisecdf
EnvironmentII_NO3_Subarea_9[mol/L]
25
0.00265, 0.0
0.022,   0.042
0.062,   0.083
0.112,   0.125
0.152,   0.167
0.176,   0.208
0.221,   0.250
0.271,   0.292
0.294,   0.333
0.315,   0.375
0.332,   0.417
0.336,   0.458
0.351,   0.500
0.440,   0.542
0.492,   0.583
0.501,   0.625
0.796,   0.667
1.156,   0.708
1.804,   0.750
2.440,   0.792
2.795,   0.833
3.160,   0.875
3.356,   0.917
3.672,   0.958
4.109,   1.000
**
usersuppliedpwisecdf
EnvironmentII_CO3_Subarea_9[mol/L]
```

```
25
2.54E-09,   0.0
4.69E-08,   0.042
1.69E-07,   0.083
9.1815E-07, 0.125
3.756E-06,  0.167
1.912E-05,  0.208
0.0000421,  0.250
0.000065,   0.292
0.058,      0.333
0.238,      0.375
0.324,      0.417
0.369,      0.458
0.448,      0.500
0.552,      0.542
0.690,      0.583
0.785,      0.625
0.856,      0.667
0.862,      0.708
0.868,      0.750
0.873,      0.792
0.955,      0.833
1.033,      0.875
1.077,      0.917
1.141,      0.958
1.217,      1.000
**
usersuppliedpwisecdf
EnvironmentII_SO4_Subarea_9[mol/L]
25
7.43E-06, 0.0
0.000277, 0.042
0.00117,  0.083
0.0027,   0.125
0.003,    0.167
0.0048,   0.208
0.0073,   0.250
0.0086,   0.292
0.00985,  0.333
0.011,    0.375
0.012,    0.417
0.0125,   0.458
0.013,    0.500
0.0135,   0.542
0.014,    0.583
0.015,    0.625
0.016,    0.667
0.018,    0.708
0.021,    0.750
0.071,    0.792
0.123,    0.833
0.154,    0.875
0.160,    0.917
0.166,    0.958
0.263,    1.000
**
usersuppliedpwisecdf
EnvironmentII_Fl_Subarea_10[mol/L]
25
1.68E-06,      0.0
8.14E-06,    0.041666667
1.11355E-05, 0.083333333
1.79965E-05, 0.125
5.97035E-05, 0.166666667
0.00019405,  0.208333333
0.00034545,  0.25
0.00049711,  0.291666667
0.00887261,  0.333333333
0.034946554, 0.375
0.045923167, 0.416666667
0.050417268, 0.458333333
0.062505976, 0.5
```

```
0.06994287,  0.541666667
0.07103854,  0.583333333
0.074881871, 0.625
0.078999899, 0.666666667
0.08071957,  0.708333333
0.081644782, 0.75
0.081850946, 0.791666667
0.08847118,  0.833333333
0.1238553,   0.875
0.2375897,   0.916666667
0.368547279, 0.958333333
0.509481015, 1.0
**
usersuppliedpwisecdf
EnvironmentII_Cl_Subarea_10[mol/L]
25,
3.964578,       0.0
4.052321471, 0.041666667
4.115,       0.083
4.263,       0.125
4.455,       0.167
4.674,       0.208
4.725,       0.250
4.852,       0.292
5.301,       0.333
5.602,       0.375
5.624,       0.417
5.745,       0.458
5.907,       0.500
6.174,       0.542
6.387,       0.583
6.393,       0.625
6.538,       0.667
6.810,       0.708
6.942,       0.750
7.039,       0.792
7.116,       0.833
7.310,       0.875
7.473,       0.917
9.088,       0.958
10.185,      1.000
**
usersuppliedpwisecdf
EnvironmentII_pH_Subarea_10[]
25
5.8,       0.0
6.14875,   0.041666667
6.434,     0.083
6.887,     0.125
7.510,     0.167
8.193,     0.208
8.446,     0.250
8.596,     0.292
9.019,     0.333
10.139,    0.375
10.519,    0.417
10.564,    0.458
10.631,    0.500
10.683,    0.542
10.714,    0.583
10.725,    0.625
10.736,    0.667
10.773,    0.708
10.803,    0.750
10.827,    0.792
10.830,    0.833
10.844,    0.875
10.900,    0.917
10.932,    0.958
10.950,    1.000
**
usersuppliedpwisecdf
```

```
EnvironmentII_NO3_Subarea_10[mol/L]
25
0.00265, 0.0
0.022,   0.042
0.062,   0.083
0.112,   0.125
0.152,   0.167
0.176,   0.208
0.221,   0.250
0.271,   0.292
0.294,   0.333
0.315,   0.375
0.332,   0.417
0.336,   0.458
0.351,   0.500
0.440,   0.542
0.492,   0.583
0.501,   0.625
0.796,   0.667
1.156,   0.708
1.804,   0.750
2.440,   0.792
2.795,   0.833
3.160,   0.875
3.356,   0.917
3.672,   0.958
4.109,   1.000
**
usersuppliedpwisecdf
EnvironmentII_CO3_Subarea_10[mol/L]
25
2.54E-09,   0.0
4.69E-08,   0.042
1.69E-07,   0.083
9.1815E-07, 0.125
3.756E-06,  0.167
1.912E-05,  0.208
0.0000421,  0.250
0.000065,   0.292
0.058,      0.333
0.238,      0.375
0.324,      0.417
0.369,      0.458
0.448,      0.500
0.552,      0.542
0.690,      0.583
0.785,      0.625
0.856,      0.667
0.862,      0.708
0.868,      0.750
0.873,      0.792
0.955,      0.833
1.033,      0.875
1.077,      0.917
1.141,      0.958
1.217,      1.000
**
usersuppliedpwisecdf
EnvironmentII_SO4_Subarea_10[mol/L]
25
7.43E-06, 0.0
0.000277, 0.042
0.00117,  0.083
0.0027,   0.125
0.003,    0.167
0.0048,   0.208
0.0073,   0.250
0.0086,   0.292
0.00985,  0.333
0.011,    0.375
0.012,    0.417
0.0125,   0.458
```

```
0.013,    0.500
0.0135,   0.542
0.014,    0.583
0.015,    0.625
0.016,    0.667
0.018,    0.708
0.021,    0.750
0.071,    0.792
0.123,    0.833
0.154,    0.875
0.160,    0.917
0.166,    0.958
0.263,    1.000
**


** rwr 6/16/06; SCR651; determine waste package general corrosion
**                      failure time, in addition to the time of
**                      weld failure
** (define the chemistry parameters for EnvironmentII on a subarea
**  basis to allow for spatial variability)
** correlateinputs
** EnvironmentII_pH[]
** EnvironmentII_CO3[mol/L]
** 0.9
** **
** correlateinputs
** EnvironmentII_Cl[mol/L]
** EnvironmentII_pH[]
** -0.8
**
correlateinputs
EnvironmentII_pH_Subarea_1[]
EnvironmentII_CO3_Subarea_1[mol/L]
0.9
**
correlateinputs
EnvironmentII_Cl_Subarea_1[mol/L]
EnvironmentII_pH_Subarea_1[]
-0.8
**
correlateinputs
EnvironmentII_pH_Subarea_2[]
EnvironmentII_CO3_Subarea_2[mol/L]
0.9
**
correlateinputs
EnvironmentII_Cl_Subarea_2[mol/L]
EnvironmentII_pH_Subarea_2[]
-0.8
**
correlateinputs
EnvironmentII_pH_Subarea_3[]
EnvironmentII_CO3_Subarea_3[mol/L]
0.9
**
correlateinputs
EnvironmentII_Cl_Subarea_3[mol/L]
EnvironmentII_pH_Subarea_3[]
-0.8
**
correlateinputs
EnvironmentII_pH_Subarea_4[]
EnvironmentII_CO3_Subarea_4[mol/L]
0.9
**
correlateinputs
EnvironmentII_Cl_Subarea_4[mol/L]
EnvironmentII_pH_Subarea_4[]
-0.8
**
correlateinputs
```

```
EnvironmentII_pH_Subarea_5[]
EnvironmentII_CO3_Subarea_5[mol/L]
0.9
**
correlateinputs
EnvironmentII_Cl_Subarea_5[mol/L]
EnvironmentII_pH_Subarea_5[]
-0.8
**
correlateinputs
EnvironmentII_pH_Subarea_6[]
EnvironmentII_CO3_Subarea_6[mol/L]
0.9
**
correlateinputs
EnvironmentII_Cl_Subarea_6[mol/L]
EnvironmentII_pH_Subarea_6[]
-0.8
**
correlateinputs
EnvironmentII_pH_Subarea_7[]
EnvironmentII_CO3_Subarea_7[mol/L]
0.9
**
correlateinputs
EnvironmentII_Cl_Subarea_7[mol/L]
EnvironmentII_pH_Subarea_7[]
-0.8
**
correlateinputs
EnvironmentII_pH_Subarea_8[]
EnvironmentII_CO3_Subarea_8[mol/L]
0.9
**
correlateinputs
EnvironmentII_Cl_Subarea_8[mol/L]
EnvironmentII_pH_Subarea_8[]
-0.8
**
correlateinputs
EnvironmentII_pH_Subarea_9[]
EnvironmentII_CO3_Subarea_9[mol/L]
0.9
**
correlateinputs
EnvironmentII_Cl_Subarea_9[mol/L]
EnvironmentII_pH_Subarea_9[]
-0.8
**
correlateinputs
EnvironmentII_pH_Subarea_10[]
EnvironmentII_CO3_Subarea_10[mol/L]
0.9
**
correlateinputs
EnvironmentII_Cl_Subarea_10[mol/L]
EnvironmentII_pH_Subarea_10[]
-0.8
**
**********************************************************************************************
```

This is submitted as evidence that SCR651 has be properly implemented

- criterion 2

In the file *nfenv.f*, Environmental parameters have been altered from a realization basis to a subarea basis. The following excerpts show how these per realization parameters were commented out and replaced by per subarea parameters.

[CD]:\SCR651\tpa51betaD\ *nfenv.f*

```
*******************************************************************************
cc rwr 6/16/06; SCR651; determine waste package general corrosion
cc                      failure time, in addition to the time of
cc                      weld failure
cc (define the chemistry parameters for EnvironmentII on a subarea
cc  basis to allow for spatial variability)
cc         call clearchar( 60, name )
cc         name = 'EnvironmentII_Fl[mol/L]'
cc         iEnvII_Fl= ispquery( name )
*******************************************************************************
```

```
*******************************************************************************
cc rwr 6/16/06; SCR651; determine waste package general corrosion
cc                      failure time, in addition to the time of
cc                      weld failure
cc (define the chemistry parameters for EnvironmentII on a subarea
cc  basis to allow for spatial variability)
cc         call clearchar( 60, name )
cc         name = 'EnvironmentII_Cl[mol/L]'
cc         iEnvII_Cl= ispquery( name )
cc
cc         call clearchar( 60, name )
cc         name = 'EnvironmentII_pH[]'
cc         iEnvII_pH= ispquery( name )
cc
cc         call clearchar( 60, name )
cc         name = 'EnvironmentII_NO3[mol/L]'
cc         iEnvII_NO3= ispquery( name )
cc
cc         call clearchar( 60, name )
cc         name = 'EnvironmentII_CO3[mol/L]'
cc         iEnvII_CO3= ispquery( name )
cc
cc         call clearchar( 60, name )
cc         name = 'EnvironmentII_SO4[mol/L]'
cc         iEnvII_SO4= ispquery( name )
*******************************************************************************
```

The Environmental II parameters defined on a subarea basis are read in on a subarea basis.

```
*******************************************************************************
      write (temp,'(i2)') isa
      if (isa.lt.10) then
        call clearchar( 60, name )
        name = 'EnvironmentII_Fl_Subarea_'//temp(2:2)//'[mol/L]'
        iEnvII_Fl= ispquery( name )
        EnvII_Fl= valuesp( iEnvII_Fl )
      else if (isa.lt.100) then
        call clearchar( 60, name )
        name = 'EnvironmentII_Fl_Subarea_'//temp//'[mol/L]'
        iEnvII_Fl= ispquery( name )
        EnvII_Fl= valuesp( iEnvII_Fl )
      end if
*******************************************************************************
```

```
*******************************************************************************
      write (temp,'(i2)') isa
```

```
      if (isa.lt.10) then
        call clearchar( 60, name )
        name = 'EnvironmentII_Cl_Subarea_'//temp(2:2)//'[mol/L]'
        iEnvII_Cl= ispquery( name )
        EnvII_Cl= valuesp( iEnvII_Cl )

        call clearchar( 60, name )
        name = 'EnvironmentII_pH_Subarea_'//temp(2:2)//'[]'
        iEnvII_pH= ispquery( name )
        EnvII_pH= valuesp( iEnvII_pH )

        call clearchar( 60, name )
        name = 'EnvironmentII_NO3_Subarea_'//temp(2:2)//'[mol/L]'
        iEnvII_NO3= ispquery( name )
        EnvII_NO3= valuesp( iEnvII_NO3 )

        call clearchar( 60, name )
        name = 'EnvironmentII_CO3_Subarea_'//temp(2:2)//'[mol/L]'
        iEnvII_CO3= ispquery( name )
        EnvII_CO3= valuesp( iEnvII_CO3 )

        call clearchar( 60, name )
        name = 'EnvironmentII_SO4_Subarea_'//temp(2:2)//'[mol/L]'
        iEnvII_SO4= ispquery( name )
        EnvII_SO4= valuesp( iEnvII_SO4 )
      else if (isa.lt.100) then
        call clearchar( 60, name )
        name = 'EnvironmentII_Cl_Subarea_'//temp//'[mol/L]'
        iEnvII_Cl= ispquery( name )
        EnvII_Cl= valuesp( iEnvII_Cl )

        call clearchar( 60, name )
        name = 'EnvironmentII_pH_Subarea_'//temp//'[]'
        iEnvII_pH= ispquery( name )
        EnvII_pH= valuesp( iEnvII_pH )

        call clearchar( 60, name )
        name = 'EnvironmentII_NO3_Subarea_'//temp//'[mol/L]'
        iEnvII_NO3= ispquery( name )
        EnvII_NO3= valuesp( iEnvII_NO3 )

        call clearchar( 60, name )
        name = 'EnvironmentII_CO3_Subarea_'//temp//'[mol/L]'
        iEnvII_CO3= ispquery( name )
        EnvII_CO3= valuesp( iEnvII_CO3 )

        call clearchar( 60, name )
        name = 'EnvironmentII_SO4_Subarea_'//temp//'[mol/L]'
        iEnvII_SO4= ispquery( name )
        EnvII_SO4= valuesp( iEnvII_SO4 )
      end if
*******************************************************************************
```

These results are presented as evidence that SCR651 has be properly implemented.

NOTE: The parameter **EnvironmentII_Wastepackage_DeltaCrit[VHSE]**, which is a Environment II parameter was not extended to a subarea basis in either the *tpa.inp* or the *nfenv.f* files. However this parameter is not actively used within the TPA code.

-criterion 3

A baseline and test version of the TPA code was performed for 100,000 yrs with the drip shield thickness of 0.00001m (to ensure an early DS failure). An examination of the *nfenv.rlt* file shows that while Environment II exists, each subarea had concentrations of Fl, Cl, SO4, CO3 and NO3 that varied by subarea in the test version of the TPA code, while in the baseline version these concentrations were the same in all subareas.

The following tables shows the concentrations of Fl, Cl, SO4, CO3 and NO3 for the first 3 subareas as evidence of this behavior.

Table 1. Chemistry Concentrations for Test Version TPA code
Summary of [CD]:\SCR651\SL3\runD1*nfenv.rlt*

Subarea	Fl conc.	Cl conc.	SO4 conc.	CO3 conc.	NO3
1	7.481 E-2	5.62	1.3055E-2	2.2562E-5	1.6609E-1
2	6.1641E-2	6.5812	2.422E-4	8.5666E-1	2.5299E 0
3	7.9401E-2	6.6152	1.4396E-2	8.5615E-1	1.9837E-1

Table 2. Chemistry Concentrations for Baseline Version TPA code
Summary of [CD]:\SCR651\SL3\runC1*nfenv.rlt*

Subarea	Fl conc.	Cl conc.	SO4 conc.	CO3 conc.	NO3
1	7.481 E-2	5.62	1.3055E-2	2.2562E-5	1.6609E-1
2	7.481 E-2	5.62	1.3055E-2	2.2562E-5	1.6609E-1
3	7.481 E-2	5.62	1.3055E-2	2.2562E-5	1.6609E-1

These results are presented as evidence that SCR651 has been properly implemented.

- overall test status: PASS

SL-4. Name: Seepage factors modified to account for weld and localized corrosion

Path for run directory:

Test Version: [TPA]D:\Mancillas\SCR651\runD1, runD2 and runD3

Path for archive of results:

Test Version: CD [titled: SCR651 testing] :SCR651\testSL4\runD1,runD2 and runD3

Environment variables:

Test Version TPA_DATA=..\tpa51betaD_mod1
TPA_TEST =..\tpa51betaD_mod1

Special input files or modifications to input files required : The run file *ebstrh.dat* which contains the corrosion failure times for the WPs was manually copied into the file *my_ebstrh.dat*

Special diagnostic code modifications required : The subroutine ebsrel was modified to read input data from *my_ebstrh.dat* instead of the locally generated *ebstrh.dat*. In addition, the mechanical failure time for WP was hardwired into the subroutine at 10,000 yrs.

Program modes to be used (append flags, scenario/model switches, etc.): Append All

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: The TPA code ebsrel module has been modified to incorporate seepage factors to account for weld and localized corrosion. The time dependent events : WP weld failure by corrosion, WP mechanical failure, WP failure by Localized corrosion and WP failure by general corrosion result in a cumulative change in the fraction of seepage allowed to enter into the WP.

- objective The objective of this test is to verify the proper accumulation in value of the seepage factor during the three possible conditions of accumulated failure events
  (1) mechanical, weld corrosion, localized corrosion, general corrosion
  (2) weld corrosion, mechanical, localized corrosion, general corrosion
  (3) weld corrosion, localized corrosion, mechanical, general corrosion

  To derive the conditions to examine these three scenarios would require an exhaustive trial and error search for the proper failure sequences and conditions. Instead a direct method of controlling the failure times of each of these events

was employed, in which the data file which contains the failure times is manually manipulated to produce the proper failure sequences for testing.

- assumptions None other than those made within the TPA code.

- constraints The time for mechanical failure has been hard wired into the modified TPA51betaD_mod1 *ebsrel.f* module, at 10,000 yrs.

- output files to compare or examine *wpflow.dat, ebstrh.dat* and *ebsrel.rlt*

- step by step test procedure to be used

1) Modify the module ebsrel.f to read the file *my_ebstrh.dat* instead of *ebstrh.dat*, and hard wire in mechanical failure time of 10,000 yrs.
2) Compile the modified TPA code and execute a mean value case for one subarea (SA 1), with the append all flag on and with a Maximum time set to 100,000 yrs
3) Copy the generated file *ebstrh.dat* to *my_ebstrh.dat* within each run directory.
4) Modify the corrosion failure times in *my_ebstrh.dat* to allow for the examination of the three possible failure cases.

- pass fail criteria

1) The resulting accumulation in the seepage factor calculation should be consistent with the expected accumulation in the seepage factor for each of the three failure cases.

Test Results:
The subroutine ebsrel was modified to read input data from *my_ebstrh.dat* instead of the locally generated *ebstrh.dat*. In addition, the mechanical failure time for WP was hardwired into the subroutine at 10,000 yrs. This modified code was then compiled and executed in the normal manner. The modified code is contained in the following location.
[CD]:\SCR651\tpa51betaD_mod1

An unmodified version of the TPA code (tpa51betaD) was then executed using a mean value realization of one subarea for 100,000 yrs, in the run directories. The files *ebstrh.dat* was then copied to the file *my_ebstrh.dat* and the failure times were modified to produce the three desired failure sequences. The modified TPA code was then run in the same run directories. The results of these TPA runs are in the following locations
Case 1: [CD]:\SCR651\SL4\runD1
Case 2: [CD]:\SCR651\SL4\runD2
Case 3: [CD]:\SCR651\SL4\runD3

At the time of each of the failure events the seepage factor should increase by a specific amount:

Mechanical failure should have an increase set by the tpa.inp parameter **InitialSeepageReductionFractionByMechFailuedWP** followed by in increase in the seepage fraction at a rate set by the parameter **WPSeepageProtectionDegradationRate[1/yr]** until the end of the realization or until the seepage fraction reaches 1, for these mean value realizations these values are

1.005E-3 and 1.0E-6 respectively.

Weld corrosion failure should have an increase set by the tpa.inp parameter **WeldAdvectiveFraction[]**, for these mean value realizations this value is 1.000E-3

Localized corrosion failure should have an increase set by the tpa.inp parameter **InitialSeepageReductionFractionLC**, for these mean value realizations this value is 0.100500

General corrosion failure should result in the seepage fraction being set to 1.00.

-criteria 1

In case 1 the failure sequence is: mechanical failure followed by weld failure followed by localized corrosion failure and lastly general corrosion failure. The failure times were set respectively at 10,000 yrs, 40,000 yrs, 60,000 yrs and 90,000 yrs within the file *my_ebstrh.dat* (mechanical failure time was hard wired).

An examination of the file [CD]:\SCR651\SL4\runD1*wpflow.dat* (column 1&8, time and seepage fraction) shows that at the seepage fraction has increased properly (and as expected) throughout the entire simulation period.
From 0 to 10,000 yrs the fraction is 0.00
At 10,000 yrs the fraction steps up to a value of 1.005E-3
From 10,000 yrs to 40,000 yrs the fraction increases by a rate of 1.0E-6 to a value of 3.1005E-2
At 40,000 yrs the fraction steps up by 1.000E-3 to a value of 3.2005E-2
From 40,000 yrs to 60,000 yrs the fraction increases at a rate of 1.0E-6 to a value of 5.2005E-2
At 60,000 yrs the fraction steps up by 0.1005 to a value of 0.152505
From 60,000 to 90,000 yrs the fraction increases at a rate of 1.0E-6 to a value of 0.182505
At 90,000 the fraction steps up to a value of 1.00 and persists until the end of the simulation period.
This is the expected behavior for this failure case.

In case 2 the failure sequence is: weld failure followed by mechanical failure followed by localized corrosion failure and lastly general corrosion failure. The failure times were set respectively at 2000 yrs, 10,000 yrs, 60,000 yrs and 80,000 yrs within the file *my_ebstrh.dat* (mechanical failure time was hard wired).
An examination of the file [CD]:\SCR651\SL4\runD2*wpflow.dat* (column 1&8, time and seepage fraction) shows that at the seepage fraction has increased properly (and as expected) throughout the entire simulation period.
From 0 to 2000 yrs the fraction is 0.00
At 2000 yrs the fraction steps up to 1.00E-3
From 2000 to 10,000 yrs the fraction remains constant at 1.00E-3
At 10,000 yrs the fraction steps up by 1.005E-3 to a value of 2.005E-3
From 10,000 to 60,000 yrs the fraction increase at a rate of 1.0E-6 to a value of 5.2005E-2
At 60,000 yrs the fraction steps up by 0.1005 to a value of 0.152505
From 60,000 to 80,000 yrs the fraction increases at a rate of 1.0E-6 to a value of 0.182505
At 80,000 the fraction steps up to a value of 1.0 and persists until the end of the simulation period.
This is the expected behavior for this failure case.

In case 3 the failure sequence is: weld failure followed by localized corrosion failure followed by mechanical failure and lastly general corrosion failure. The failure times were set respectively at 2000 yrs, 8,000 yrs, 10,000 yrs and 70,000 yrs within the file *my_ebstrh.dat* (mechanical failure time was hard wired).
An examination of the file [CD]:\SCR651\SL4\runD3*wpflow.dat* (column 1&8, time and seepage fraction) shows that at the seepage fraction has increased properly (and as expected) throughout the entire simulation period.
From 0 to 2000 yrs the fraction is 0.0
At 2000 yrs the fraction steps up to a value of 1.00E-3
From 2000 to 8000 yrs the fraction remains constant at a value of 1.00E-3
At 8000 yrs the fraction steps by a 0.1005 to a value of 0.1015
From 8000 to 10,000 yrs the fraction remains constant at a value of 0.1015
At 10,000 yrs the fraction steps up by 1.005E-3 to a value of 0.102505
From 10,000 to 70,000 yrs the fraction increases at a rate of 1.0E-6 to a value of 0.162505
At 70,000 yrs the fraction steps up to a value of 1.00 and persists until the end of the simulation period
This is the expected behavior for this failure case.

These results are presented as evidence that SCR651 has been properly implemented.

- overall test status: PASS

SL-5. Name: Failure time by general corrosion calculated by failt.f

Path for run directory:

Baseline Version:	[TPA]D:\Mancillas\SCR651\runC1
Test Version:	[TPA]D:\Mancillas\SCR651\runD1

Path for archive of results:

Baseline Version:	CD [titled: SCR651 testing] :SCR651\testSL5\runC1
Test Version:	CD [titled: SCR651 testing] :SCR651\testSL5\runD1

Environment variables:

Baseline Version	TPA_DATA=..\tpa51betaC TPA_TEST =..\tpa51betaC
Test Version	TPA_DATA=..\tpa51betaD TPA_TEST =..\tpa51betaD

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): Append All

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: The *failt.f* module has been modified to include a calculation of the general corrosion failure time for WPs. The subroutine weldfail has been renamed as corrfail and has been modified to calculate weld failure corrosion failure time and general corrosion failure time for WPs.

- objective The objective of this test is to verify that the general corrosion failure calculation has been properly implemented and that this time is recorded for use in the file *ebstrh.dat*.

- assumptions None, other than those made within the TPA code

- constraints NONE

- output files to compare or examine *ebstrh.dat*

- step by step test procedure to be used

1) perform a basecase realization of baseline TPA code in the run directory \SCR651\runC1
2) perform a realization of the test version TPA code in the run directory \SCR651\runD1
3) examine the remaining data file *ebstrh.dat* contained in the two run directories
4) examine the changes in the files: *failt.f, corrfail.f*

- pass fail criteria

1) The data file *ebstrh.dat* should include the time of failure by general corrosion for WPs.
2) The changes made within *failt.f* and *corrfail.f* should be logical and consistent with the changes requested by O. Pensado.

Test Results: A basecase realization of the baseline TPA code was run and a realization of the test version of the TPA code was performed : 100,000 yrs , two subareas (1 and 2), **WPWeldFractionThicknessPenetratedForFailureByCorrosion[]**=0.05, **WPFractionThicknessPenetratedForFailureByCorrosion[]**=0.05, **DSFractionThicknessPenetratedForFailureByCorrosion[]**=0.001. These conditions were set to allow for WP failures to occur within the simulation period.

- criterion 1

The following text are excerpts from the files *ebstrh.dat*. This file contains the corrosion failure times of the WPs for the last subarea of the last realization.

[CD]:\SCR651\testSL5\runC1*ebstrh.dat*

```
*******************************************************************************
     1   1.7820164655E+03      | Weld Failure Flag (1 = failure), Weld Failure Time[yr]
     0   1.0000000000E+04      | WP Failure Flag (1 = failure), WP Failure Time[yr]
*******************************************************************************
```

[CD]:\SCR651\testSL5\runD1*ebstrh.dat*

```
*******************************************************************************
     1   1.6876868206E+03      | Weld Failure Flag (1 = failure), Weld Failure Time[yr]
     1   5.6067765267E+04      | General Corrosion Only Failure Flag (1 = failure),
General Corrosion Only Failure Time[yr]
     1   5.5000000000E+04      | WP Localized Corrosion Failure Flag (1 = failure), WP
Localized Corrosion Failure Time[yr]
*******************************************************************************
```

In the test version of the TPA code the *ebstrh.dat* contains an extra entry which is the general corrosion failure time. This is presented as evidence that SCR651 has been properly implemented.

- criterion 2

In the module *failt.f*, corrosion failure time is calculated by the function 'calculateCorrFailure'. This function has been altered to return the general corrosion failure flag and time.
The following text is an excerpt from
[CD]\SCR651\tpa51betaD*failt.f*

```
*******************************************************************************
cc       SUBROUTINE calculateWeldFailure(timr, tcan, humd, pHvec,
```

```
cc      &  deltaEcritOL, chlorideConcentration, inhConcentration, nhist,
cc      &  weldFailureFlag, weldFailureTime)
c     ****************************************************************
c     calculateCorrFailure:  This subroutine is an interface module to *
c     corrfail.                                                       *
c     ****************************************************************
      SUBROUTINE calculateCorrFailure(timr, tcan, humd, pHvec,
     &  deltaEcritOL, chlorideConcentration, inhConcentration, nhist,
     &  weldFailureFlag, weldFailureTime,
     &  gencorrFailureFlag, gencorrFailureTime)
 ******************************************************************************
```

The major change in this function is the inclusion of the determination of the general corrosion failure times. To perform this calculation the function corrfail has replaced the function weldfail.

The following text excerpt shows the weld failure calculation and general failure calculation calls in the function 'calcluateCorrFailure'.
[CD]: \SCR651\tpa51betaD*failt.f*

```
******************************************************************************
cc rwr 6/16/06; SCR651; determine both weld and WP general corrosion
cc                      failure times
cc c
cc c     Calculate the weld failure time and weld thickness versus
cc c     time.
cc       CALL weldfail(nhist, time, temperature,
cc      &  relative_humidity, pH, chloride, inhibitor, deltaECrit,
cc      &  weldFailureFlag, weldFailureTime)
cc
cc first, do calculations for the weld
cc (note in the call to "corrfail" that 0=weld and 1=WP for the corrosion
cc  calculation type, i.e. "icorrcalctype" can be either "0" or "1")
      icorrcalctype = 0
      CALL corrfail(icorrcalctype,nhist, time, temperature,
     &  relative_humidity, pH, chloride, inhibitor, deltaECrit,
     &  weldFailureFlag, weldFailureTime)
cc then, do calculations for the WP
      icorrcalctype = 1
cc the following two parameters are to reset to thickness of the WP
cc outer overpack and the critical chloride equal to a value that
cc will prevent localized corrosion from occurring (i.e., there
cc is only general corrosion - note that these values are passed in
cc common blocks)
cc store these values (will be restored below following the "corrfail" call)
      WeldThicknessStore = WeldThickness
      CritChlorideStore = CritChloride
cc reset values
      WeldThickness = cthick1
      CritChloride = 1.0d2
      CALL corrfail(icorrcalctype,nhist, time, temperature,
     &  relative_humidity, pH, chloride, inhibitor, deltaECrit,
     &  gencorrFailureFlag, gencorrFailureTime)
cc restore variables to stored values
      WeldThickness = WeldThicknessStore
      CritChloride = CritChlorideStore
******************************************************************************
```

In this excerpt the first call of the function 'corrfail' calculates the weld failure time.
The variable **WeldThickness** is set to the outer barrier thickness of the WP. And the variable **CritChloride** is set to 100. The **CritChloride** value is set high to eliminate the possibility of localized corrosion from occurring during this function call. Both of these parameters are passed through common status.

The subroutine corrfail is contained in the file *corrfail.f* and replaces the subroutine weldfail in the previous version of the TPA code (tpa51betaC). These subroutines are the same with the exception of an additional input parameter **icorrcalctype**. This parameter is used to control the write statements from this subroutine for the files *weldfail.out* and *corrfail.out*.
An examination of the *ebstrh.dat* file generated by the test version of the TPA code shown previously in criterion 1, shows that the weld corrosion failure and general corrosion failure times differ, and that the general corrosion failure time is significantly longer than the weld corrosion failure time. These are the expected results and are presented as evidence that SCR651 has been properly implemented.

- overall test status: PASS

SL-6. Name: Weighted average of the water entering and leaving the WP added to last two columns of *infilper.res*. The equation for variable piv2 was updated in *corrosn.f*.

Path for run directory:

Basecase :	[TPA]D:\Mancillas\SCR651\runC1
Test Version:	[TPA]D:\Mancillas\SCR651\runD1

Path for archive of results:

Base case :	CD [titled: SCR651 testing] :SCR651\testSL6\runC1
Test Version:	CD [titled: SCR651 testing] :SCR651\testSL6\runD1

Environment variables:

Baseline Version	TPA_DATA=..\tpa51betaC TPA_TEST =..\tpa51betaC
Test Version	TPA_DATA=..\tpa51betaD TPA_TEST =..\tpa51betaD

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): Append ALL

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: The output file *infilper.res* has been modified to include in the last two columns the average water entering and leaving the WP.

- objective The objective of this test is to verify that the data included in the last two columns of the file *infilper.res* contain the correct data.

- assumptions None other than those made within the TPA code.

- constraints NONE

- output files to compare or examine *infilper.res*

- step by step test procedure to be used
  1) examine the changes made to the TPA code that affect the writing of the data reported in *infilper.res*.
  2) perform a basecase realization of the baseline and test version of the TPA code.

3) examine the differences in the *infilper.res* files

- pass fail criteria

1) The changes made to the *exec.f* and *releaset.f* should be logical and consistent with the intent of including the average flow into and out of the WP in the *infilper.res* file.
2) The *infilper.res* should reflect the changes made within *exec.f.*

Test Results:

- criterion 1

In the file *releaset.f,* the parameter **nwpstotal** accumulates the total number of failed waste packages from each type of failure. Currently this parameter is exposed to a time loop and accumulates values on each time step. This is a logic error and needs to be corrected. In addition, the values for **qin** and **qout** in *ebsrel.f* have suspected incorrect values. **qin** has a value greater than zero assigned to it on the time step immediately prior to flow being able to reach a failed WP.

- overall test status: Failed

Correction of this issue will be addressed in SCR658.

SL-7. Name: Track the number of WPs affected by weld corrosion in *wpsfail.res*.

Path for run directory:

Basecase :	[TPA]D:\Mancillas\SCR651\runC1
Test Version:	[TPA]D:\Mancillas\SCR651\runD1

Path for archive of results:

Base case :	CD [titled: SCR651 testing] :SCR651\testSL7\runC1
Test Version:	CD [titled: SCR651 testing] :SCR651\testSL7\runD1

Environment variables:

Baseline Version	TPA_DATA=..\tpa51betaC TPA_TEST =..\tpa51betaC
Test Version	TPA_DATA=..\tpa51betaD TPA_TEST =..\tpa51betaD

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): Append All.

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: The TPA *exec.f* module was modified to report the number of WP which fail by weld corrosion in the data file *wpsfail.res*.

- objective: Verify that the number of WP weld corrosion failures is recorded in the file *wpsfail.res*.

- assumptions: None, other than those made within the TPA code.

- constraints: NONE

- output files to compare or examine *wpsfail.res*

- step by step test procedure to be used
  1) examine the changes made to the test version of *exec.f*.
  2) perform a single realization for 100,000 yrs, with **WPWeldFractionThicknessPenetratedForFailureByCorrosion[]**=0.01 in both the test version and baseline version.

3) examine the *wpsfail.res* files generated
4) In the file *corrosn.f* the equation defining **piv2** should be updated to
piv2=piv*CO2bulk(ReferenceTemperature,pO2)/cO2bulk(T,pO2)

- pass fail criteria
  1) The *exec.f* file changes are logical and consistent with the changes requested by SCR651.
  2) The *wpsfail.res* file should properly reflect the *exec.f* changes.
  3) The variable **piv2** should be properly defined.

Test Results:

- criterion 1

The following text depicts the changes made to *exec.f* which deal with the change in the data reported in *wpsfail.f.*

[CD]:\SCR651\tpa51betaD\ *exec.f*

```
*******************************************************************************
cc rwr 6/16/06; SCR651; determine waste package general corrosion
cc                      failure time, in addition to the time of
cc                      weld failure
cc (set the number of corrosion failures in "field(8)" equal to
cc  the number of WPs affected by general corrosion, or localized
cc  corrosion, or weld corrosion only (i.e., these WPs never
cc  experience mechanical degradation, nor faulting, nor igneous)
cc           do iwpfail = 1, maxseismointervals+4
cc               if(releasewpfailedtimer(2,iwpfail,isa) .eq. tim(itime) .and.
cc      &           releasewpfailedtimer(1,iwpfail,isa) .gt. 0.0d0)      then
cc                  field(iwpfail) = releasewpfailedtimer(1,iwpfail,isa)
cc                  lprint = .TRUE.
cc               endif
cc           enddo
          do iwpfail = 1, maxseismointervals+4
            if(iwpfail .ne. 8) then
              if(releasewpfailedtimer(2,iwpfail,isa).eq.tim(itime) .and.
     &          releasewpfailedtimer(1,iwpfail,isa) .gt. 0.0d0) then
               field(iwpfail) = releasewpfailedtimer(1,iwpfail,isa)
               lprint = .TRUE.
              endif
            else
              if (ifield8set(isa) .eq. 1) then
                call gsanwp( isa, nwpinsa )
                if (field8set(isa) .eq. tim(itime) ) then
                  field(8) = nwpinsa - nwpsopensave(isa) - field(1) -
     &              field(2) - field(3) - field(4) - field(5) -
     &              field(6) - field(7)
                  field(8) = max( 0.0d0, field(8) )
                endif
                if ( field(8) .gt. 0.0d0) then
                  lprint = .TRUE.
                endif
              endif
            endif
          enddo

c
cc        If print flag is set then add all seismic events together.
```

```
          if (lprint) then

            field(4) = field(4) + field(5) + field(6) + field(7)

            write(iunitwpsfail,'(x,i5,4x,i5,2x,6(1pe13.5,1x))')
     &          ir, isa, tim(itime), field(1), field(8),
     &          field(4), field(2), field(3)
            nprint = nprint + 1
            call flush(iunitwpsfail)
          end if
*****************************************************************************************
```

An examination of the code shows the **field(8)** records only those wp failed by weld corrosion. And that this field is written to the files *wpsfail.res* in column 5. These results are presented as evidence that SCR651 has been properly implemented.

-criterion 2

The parameter **WPWeldFractionThicknessPenetratedForFailureByCorrosion[]** was set to 0.01. This should result in the early failure of WP weld by corrosion. Performing a realization using the test version and the baseline TPA codes shows that the test version *wpsfail.res* records WP corrosion failures. The following text is from that file.

[CD]:\SCR651\testSL7\runD1\ *wpsfail.res*

```
*****************************************************************************************
Input file tpa.inp as supplied with TPA Version 5.1betaD Code.
 Preliminary testing case.
 TPA 5.1betaD, Job started: Fri Jul 28 14:28:38 2006
 Number of Failed WPs for GW by Type of Disruptive Event

 Including Time of Event and Subarea for Each Vector

vector  subarea      time        #initial      #corrode   #mechanical       #fault
 #ign_act
 unitless unitless      yr         unitless      unitless      unitless      unitless
   unitless
     1        1    0.00000E+00   4.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
     1        2    0.00000E+00   7.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
     1        3    0.00000E+00   2.00000E+01   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
     1        4    0.00000E+00   1.20000E+01   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
     1        5    0.00000E+00   1.00000E+01   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
     1        6    0.00000E+00   2.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
     1        7    0.00000E+00   5.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
     1        8    0.00000E+00   6.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
     1        9    0.00000E+00   5.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
     1       10    0.00000E+00   1.20000E+01   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
     1        7    1.41539E+03   0.00000E+00   6.96000E+02   0.00000E+00   0.00000E+00
 0.00000E+00
     1        2    1.48711E+03   0.00000E+00   1.06200E+03   0.00000E+00   0.00000E+00
 0.00000E+00
     1        4    1.48711E+03   0.00000E+00   1.79300E+03   0.00000E+00   0.00000E+00
 0.00000E+00
     1        5    1.48711E+03   0.00000E+00   1.45200E+03   0.00000E+00   0.00000E+00
 0.00000E+00
```

```
    1        6    1.48711E+03   0.00000E+00   3.43000E+02   0.00000E+00   0.00000E+00
 0.00000E+00
    1        8    1.48711E+03   0.00000E+00   9.31000E+02   0.00000E+00   0.00000E+00
 0.00000E+00
    1        9    1.48711E+03   0.00000E+00   7.23000E+02   0.00000E+00   0.00000E+00
 0.00000E+00
    1       10    1.48711E+03   0.00000E+00   1.74700E+03   0.00000E+00   0.00000E+00
 0.00000E+00
    1        1    1.52423E+03   0.00000E+00   5.26000E+02   0.00000E+00   0.00000E+00
 0.00000E+00
    1        3    1.52423E+03   0.00000E+00   2.90400E+03   0.00000E+00   0.00000E+00
 0.00000E+00
*******************************************************************************************
```

The following text shows the *wpsfail.res* generated by the baseline TPA code and it does not report any weld corrosion failues.

[CD]:\SCR651\testSL7\runC1\ *wpsfail.res*

```
*******************************************************************************************
Input file tpa.inp as supplied with TPA Version 5.1betaC Code.
 Preliminary testing case.
 TPA 5.1betaC, Job started: Fri Jul 28 14:40:54 2006
 Number of Failed WPs for GW by Type of Disruptive Event

 Including Time of Event and Subarea for Each Vector


  vector  subarea      time        #initial      #corrode   #mechanical       #fault
   #ign_act
 unitless unitless      yr         unitless      unitless     unitless       unitless
   unitless
    1        1    0.00000E+00   3.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
    1        2    0.00000E+00   7.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
    1        3    0.00000E+00   1.80000E+01   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
    1        4    0.00000E+00   1.10000E+01   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
    1        5    0.00000E+00   9.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
    1        6    0.00000E+00   2.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
    1        7    0.00000E+00   4.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
    1        8    0.00000E+00   6.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
    1        9    0.00000E+00   4.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
    1       10    0.00000E+00   1.10000E+01   0.00000E+00   0.00000E+00   0.00000E+00
 0.00000E+00
*******************************************************************************************
```

However, while the baseline *wpsfail.f* records no failures an examination of the TPA execution screen captures recorded in the following files, [CD]:\SCR651\testSL7\runD1*out* and [CD]:\SCR651\testSL7\runC1*out* shows that there were WP failures in both the baseline and test versions. Thus, both TPA versions have failed WPs, but only the test version of the TPA code reports the weld corrosion failures (in the file *wpsfail.res*). These results are presented as evidence that SCR651 was implemented properly.

-criterion 3

An examination of the file *corrosn.f* in the test version of the code shows that the variable **piv2** has been redefined as: piv2=piv*cO2bulk(ReferenceTemperature,pO2)/cO2bulk(T,pO2).

The following text is an excerpt from a file comparison made using the Windows DOS command 'fc tpa51betaD\codes\corrosn.f tpa51betaC\codes\corrosn.f >corrosn.f_fc

[CD]:\SCR651\files_fc\corrosn.f_fc

```
*****************************************************************************
 Comparing files TPA51BETAD\CODES\corrosn.f and TPA51BETAC\CODES\CORROSN.F
***** TPA51BETAD\CODES\corrosn.f
c File Name:            corrosn.f
c File Date:            07/14/06
c Release Version:      5.0
***** TPA51BETAC\CODES\CORROSN.F
c File Name:            corrosn.f
c File Date:            03/31/06
c Release Version:      5.0
*****

***** TPA51BETAD\CODES\corrosn.f
c                     Introduced action of inhibitors to localized corrosion
c           OPensado 7-13-06: SCR651 Correct piv2 for non-zero film thickness
case.
c
***** TPA51BETAC\CODES\CORROSN.F
c                     Introduced action of inhibitors to localized corrosion
c
*****

***** TPA51BETAD\CODES\corrosn.f

cc OP 7-13-06; SCR651; Correct in order to include the case when water
cc                     film thickness is non-zero.
cc    piv2=piv/cO2bulk(T,pO2)
      piv2=piv*cO2bulk(ReferenceTemperature,pO2)/cO2bulk(T,pO2)

***** TPA51BETAC\CODES\CORROSN.F

      piv2=piv/cO2bulk(T,pO2)

*****
*****************************************************************************
```

This excerpt shows that the variable **piv2** has been properly redefined in the test version of the TPA code. This is presented as evidence that SCR651 has been properly implemented.

- overall test status: PASS

Note the following excerpt.

[CD]:\SCR651\tpa51betaD\ *exec.f*

```
*******************************************************************************
cc field contents
```

```
cc field(1) = initial
cc field(2) = faulting
cc field(3) = igneaous
cc field(4) = seismic 1
cc field(5) = seismic 2
cc field(6) = seismic 3
cc field(7) = seismic 4
cc field(8) = corrosion
*******************************************************************************
```

SCR - 652

TPA 5.1/ Beta B

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 652	**2. Software Title and Version:** TPA 5.1betaB	**3. Project No:** 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *releaset.f*

TPA code results could be different when the maximum simulation time changes. For example, results from 10,000 yr TPA code execution could be different when compared to results in the first 10,000 yrs from a 100,000 yr TPA code execution. Also, a decrease in the release rates just following 10,000 yrs (could be described as a "blip") was observed in EBS release rate results.

5. Change Requested by: O. Pensado Date: 5-16-2006	**6. Change Authorized by** (*Software Developer*): R. Janetzke Date: 5-16-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

The dependence of TPA code results on the maximum simulation time and the decreases (or "bips") in the EBS release rates were removed by modifying *releaset.f*. The volume was set equal to the volume of water contained in the bathtub, just prior to overflowing and this volume was not reset as it was previously. Also, switches in the volume used in calculations were removed. These switches occurred at 10,000 yrs.

8. Implemented by: R. Rice	**Date:** 5/16/06

9. Description of Acceptance Tests:

See Attachment A

10. Tested by: James Mancillas	**Date:** 19 September 2006

CNWRA Form TOP-5 (05/2000)

UPDATE REQUIREMENTS for TPA.INP

SCR 652

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM)*	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.)*	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source

Attachment A
Test Plan for TPA SCR652

Test Plan Name: Test Plan for TPA SCR652

Tested By:	James Mancillas	Date:	19 September 2006
Host Machine:	TPA	Host OS:	Window XP SP2
Baseline Version:	TPA51betaB	Test Version:	TPA51betaC

System Level (PL) Tests

SL-1. Name: Remove simulation time dependence from the EBS release rate calculations

Path for run directory:

Baseline version	[TPA]D:\Mancillas\SCR652\test1\run1B & run2B
Test version	[TPA]D:\Mancillas\SCR652\test1\run1C & run2C

Path for archive of results:

Baseline version	[CD: titled: SCR652 Testing]:\SCR652\run1B & run2B
Test version	[CD: titled: SCR652 Testing]:\SCR652\run1C & run2C

Environment variables:

Baseline version	TPA_DATA=..\..\TPA51betaB TPA_TEST =..\..\TPA51betaB
Test version	TPA_DATA=..\..\TPA51betaC TPA_TEST =..\..\TPA51betaC

Special input files or modifications to input files required : None

Special diagnostic code modifications required : None

Program modes to be used (append flags, scenario/model switches, etc.): Append all

Utility scripts needed to perform the test: None

Utility codes needed in the analysis of the test data: None

Test description: The *releaset.f* module has been modified to remove simulation time dependencies from the release rate calculations. This was done to provide consistency between long simulations and short simulations. Such that given the same sampling of parameters, the results between two simulations are the same

for periods which they overlap.

- objective Verify that for TPA realizations when the simulation time is increased, the release rates are not dependent on the length of the simulation.

- assumptions None, other than those made within the TPA code.

- constraints None

- output files to compare or examine *ebsrel.rlt* , *cumrelse.out*, *totdose.res*

- step by step test procedure to be used

1) examine the changes between the basecase and test version of the TPA code which affect release rate calculations
2) perform a basecase realization for each version of the TPA code using two different simulation times, 10,000 and 100,000 yrs
3) examine the generated files: *cumrelse.out*, *ebsrel.rlt* and *totdose.res*

- pass fail criteria

1) The changes made to the TPA code should be logical and consistent with the intent stated by SCR652.
2) Data contained in the files *cumrelse.out*, *ebsrel.rlt* and *totdose.res* for the 10,000 yr simulation should be the same as the first 10,000 yrs of the 100,000 yr simulation, for the test case TPA code.

Test Results:

- criterion 1

An examination of the changes made to *releaset.f* were performed by simultaneously examining the test version and base line version of the TPA code and by performing a file comparison using the DOS command "fc tpa51betaC\codes*releaset.f* tpa51betaB\codes*releaset.f* > file_fc*releaset.f_fc*". The file *releaset.f_fc* has been archived in the following CD:\SCR652\files_fc.
The direct comparison between the two versions of the TPA code show that the changes made to *releaset.f* are logical and consistent with the stated intent of SCR652. The file releaset.f_fc is submitted as evidence that SCR652 has been properly implemented.

- criterion 2

In the baseline version of the TPA code the release rate calculations can be dependent on the simulation

time. An examination of the files *cumrelse.out ebsrel.rlt* and *totdose.res* for two different simulation times all show this phenomena. The following excerpts from *ebsrel.rlt* show this effect

A basecase realization for 10,000 yrs using the baseline code (tpa51betaB).
SCR652\test1\runB1*ebsrel.rlt*

```
*******************************************************************************
 All nuclides - ciperyrinsaintoloweruz
(Ci/yr for this subarea from the ebs)
 AF = Affected Flag: If this flag is set (1), then the release rate was affected by solubility.

        time        Cm246     AF    U238      AF    Cm245     AF    Am241     AF    Np237     AF

 ....
 102  9.2294E+02  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0
 103  9.4686E+02  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0
 104  9.7134E+02  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0
 105  9.9639E+02  1.1513E-09  0  7.8671E-14  0  3.5933E-09  0  1.2108E-06  0  3.1148E-10  0
 106  1.0220E+03  1.2649E-09  0  7.7829E-14  0  3.9541E-09  0  1.1902E-06  0  3.0816E-10  0
 107  1.0483E+03  1.2372E-09  0  7.6833E-14  0  3.8741E-09  0  1.1626E-06  0  3.0421E-10  0
 108  1.0751E+03  1.2260E-09  0  7.5852E-14  0  3.8455E-09  0  1.1352E-06  0  3.0033E-10  0
....

*******************************************************************************
```

A basecase realization for 100,000 yrs using the baseline code (tpa51betaB).
SCR652\test1\runB2*ebsrel.rlt*

```
*******************************************************************************

 All nuclides - ciperyrinsaintoloweruz
(Ci/yr for this subarea from the ebs)
 AF = Affected Flag: If this flag is set (1), then the release rate was affected by solubility.

        time        Cm246     AF    U238      AF    Cm245     AF    Am241     AF    Np237     AF
....
 106  1.0220E+03  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0
 107  1.0483E+03  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0
 108  1.0751E+03  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0
 109  1.1026E+03  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0
 110  1.1307E+03  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  1.0757E-25  0
 111  1.1595E+03  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  5.0133E-15  0
 112  1.1890E+03  8.3822E-10  0  5.2499E-14  0  2.6492E-09  0  7.4636E-07  0  2.0786E-10  0
 113  1.2191E+03  1.1311E-09  0  7.1040E-14  0  3.5807E-09  0  9.9803E-07  0  2.8127E-10  0
 114  1.2500E+03  1.1124E-09  0  7.0085E-14  0  3.5288E-09  0  9.7059E-07  0  2.7749E-10  0
 115  1.2815E+03  1.0942E-09  0  6.9149E-14  0  3.4780E-09  0  9.4333E-07  0  2.7379E-10  0
 116  1.3138E+03  1.0763E-09  0  6.8229E-14  0  3.4281E-09  0  9.1631E-07  0  2.7014E-10  0
 117  1.3469E+03  1.0587E-09  0  6.7324E-14  0  3.3793E-09  0  8.8948E-07  0  2.6656E-10  0
....
*******************************************************************************
```

These excerpts show that the simulation time affects the release rates and the times of the releases.

The following text excerpts from the test case generated *ebsrel.rlt* show that this dependance has been removed.

A basecase realization for 10,000 yrs using the test version code (tpa51betaC).
SCR652\test1\runC1*ebsrel.rlt*

```
*******************************************************************************
```

```
 All nuclides - ciperyrinsaintoloweruz
(Ci/yr for this subarea from the ebs)
 AF = Affected Flag: If this flag is set (1), then the release rate was affected by solubility.

        time         Cm246     AF    U238      AF    Cm245     AF    Am241     AF    Np237     AF
....
 101  8.9957E+02  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0
 102  9.2294E+02  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0
 103  9.4686E+02  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0
 104  9.7134E+02  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0
 105  9.9639E+02  1.2497E-09  0  7.8675E-14  0  3.9000E-09  0  1.2148E-06  0  3.1150E-10  0
 106  1.0220E+03  1.2654E-09  0  7.7829E-14  0  3.9556E-09  0  1.1902E-06  0  3.0816E-10  0
 107  1.0483E+03  1.2455E-09  0  7.6833E-14  0  3.9000E-09  0  1.1626E-06  0  3.0421E-10  0
 108  1.0751E+03  1.2260E-09  0  7.5852E-14  0  3.8455E-09  0  1.1352E-06  0  3.0033E-10  0
 109  1.1026E+03  1.2068E-09  0  7.4890E-14  0  3.7921E-09  0  1.1079E-06  0  2.9651E-10  0
 110  1.1307E+03  1.7755E-07  0  1.3141E-11  0  5.5901E-07  0  1.8300E-04  0  5.1936E-08  0

*******************************************************************************************
```

A basecase realization for 100,000 yrs using the test version code (tpa51betaC).
SCR652\test1\runC2*ebsrel.rlt*

```
*******************************************************************************************

 1 All nuclides - ciperyrinsaintoloweruz
(Ci/yr for this subarea from the ebs)
 AF = Affected Flag: If this flag is set (1), then the release rate was affected by solubility.

        time         Cm246     AF    U238      AF    Cm245     AF    Am241     AF    Np237     AF
....
 01   8.9957E+02  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0
 102  9.2294E+02  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0
 103  9.4686E+02  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0

 104  9.7134E+02  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0  0.0000E+00  0
 105  9.9639E+02  1.2497E-09  0  7.8675E-14  0  3.9000E-09  0  1.2148E-06  0  3.1150E-10  0
 106  1.0220E+03  1.2654E-09  0  7.7829E-14  0  3.9556E-09  0  1.1902E-06  0  3.0816E-10  0
 107  1.0483E+03  1.2455E-09  0  7.6833E-14  0  3.9000E-09  0  1.1626E-06  0  3.0421E-10  0
 108  1.0751E+03  1.2260E-09  0  7.5852E-14  0  3.8455E-09  0  1.1352E-06  0  3.0033E-10  0
 109  1.1026E+03  1.2068E-09  0  7.4890E-14  0  3.7921E-09  0  1.1079E-06  0  2.9651E-10  0
 110  1.1307E+03  1.7755E-07  0  1.3141E-11  0  5.5901E-07  0  1.8300E-04  0  5.1936E-08  0

*******************************************************************************************
```

An examination of these excerpts show that in the test version of the TPA code, the RN release rates have no dependence on the simulation time.

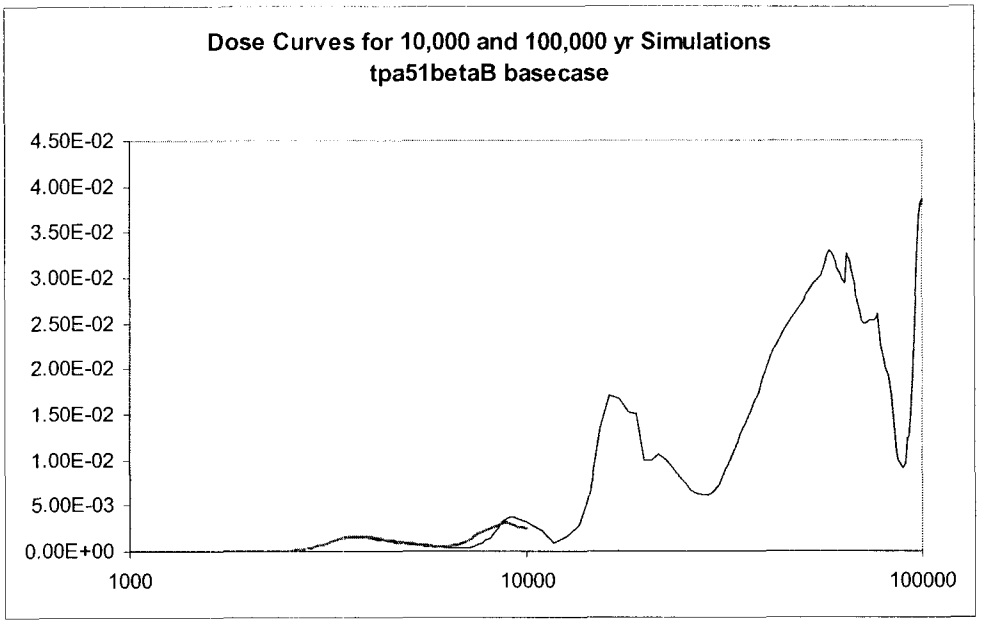


Figure 1 Dose curves for baseline TPA code, (SCR652\test1\runB1\totdose.res and SCR652\test1\runB2\totdose.res)

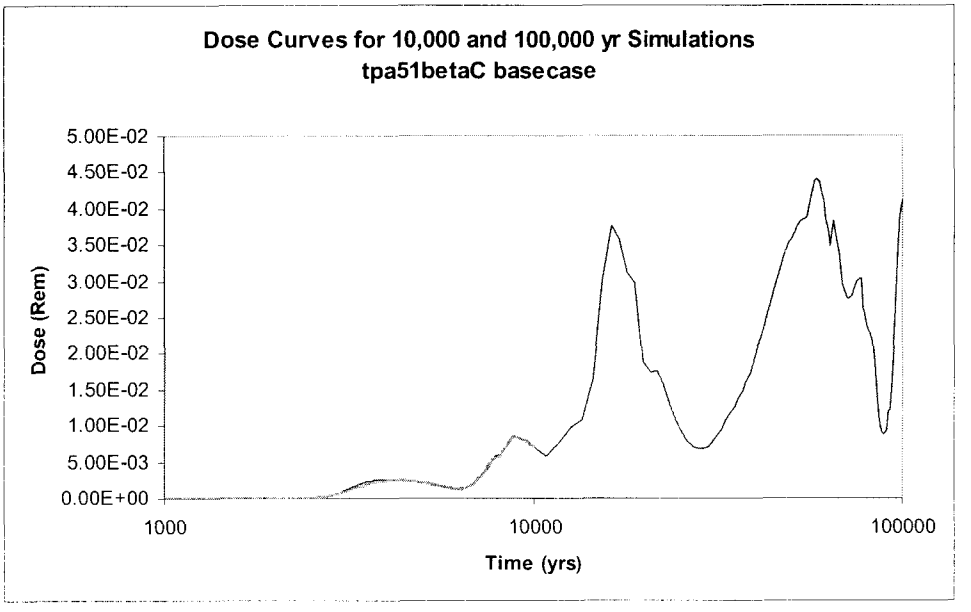


Figure 2 Dose curves for test version of the TPA code (SCR652\test1\runC1\totdose.res and SCR652\test1\runC2\totdose.res)

Figure 1 shows the total dose curves for basecase realizations run for two different simulation times. It is clear that in the baseline TPA code the releases and dose are affected by the simulation run times. Figure 2 shows the total dose curves for basecase realizations run for two different simulation times. In the test version of the TPA code, the total dose curves are independent of the simulation period. These results are presented as evidence that SCR652 has been properly implemented.

- overall test status : **PASS**

Notes: The files *cumrelse.out* and *totdose.res* also properly reflected the changes made to the *releaset.f* calculations.

SCR - 653

TPA 5.1/ Beta B

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 653	**2. Software Title and Version:** TPA 5.1betaB	**3. Project No:** 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *ebsrel.f* and *tpa.inp*
For the case having (a) zero WP failures and (b) weld failure, or (a) zero WP failures and (b) no weld failure (but with WP localized corrosion failure), the release rates passed from EBSREL to EXEC were zeroed out, except for the last time step. Also, update the distribution for the parameter "Preexponential_SFDissolutionModel2" in the *tpa.inp* file.

5. Change Requested by: O. Pensado Date: 5-30-2006	**6. Change Authorized by** (*Software Developer*): R. Janetzke Date: 5-30-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):
The problem resolution was modification of *ebsrel.f*, as described below. Note that there were two lines of code added, in addition to descriptive comment lines.

```
cc rwr 5/30/06; SCR653; account for time for weld failure in setting
cc                      the value of rminfailtime; also zero out all
cc                      releases if there are no failures
cc
cc first, set rminfailtime at minimum of weld failure time and the
cc failure times for all 8 scenario failure types
cc
cc rwr 10/5/06; SCR653 (continued); also, make sure rminfailtime
cc                                  is the minimum of the WP localized
cc                                  corrosion failure time
cc         rminfailtime =
cc      &    MIN(rminfailtime, timeweldfail)
        rminfailtime =
     &    MIN(rminfailtime, timeweldfail, timewpfail)
cc second, if this minimum failure time equals the maximum simulation
cc time (tim(ntim)), then the reset rminfailtime to be equal
cc to tim(ntim) + 1.0d0, so that all release rates, including the
cc release rate at the last time, are zeroed out
        if (rminfailtime .eq. tim(ntim))
     &    then rminfailtime = tim(ntim) + 1.0d0
```

Also, see the following table for the update to the distribution of the parameter "Preexponential_SFDissolutionModel2" in the *tpa.inp* file.

8. Implemented by: R. Rice	**Date:** 10/5/06

9. Description of Acceptance Tests:

See Attachment A.

10. Tested by: James Mancillas	**Date:** 11/07/06

CNWRA Form TOP-5 (05/2000)

UPDATE REQUIREMENTS for TPA.INP

SCR 653

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	**Module**	**Parameter Name**	**Description** (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	**Distribution**	**Range**	**Justification** *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	**Source**
MODIFY FROM	EBSREL	Preexponential_SF DissolutionModel 2	parameter used in the basecase fuel dissolution model (IMODEL 2)	logbeta	1.022e4, 1.022e7, 3.145, 2.07		O. Pensado and T. Ahn
MODIFY TO	EBSREL	Preexponential_SF DissolutionModel 2	parameter used in the basecase fuel dissolution model (IMODEL 2)	lognormal	1.022e4, 1.022e7		O. Pensado and T. Ahn

Attachment A
Test Plan for TPA SCR653

Test Plan Name: Test Plan for TPA SCR653

Tested By: James Mancillas Date: November 7, 2006

Host Machine: TPA Host OS: Windos XP SP2

Baseline Version: TPA51betaB Test Version: TPA51betaG

System Level (SL) Tests

SL-1. Name: Release rates zeroed when no WP failures occur.

Path for run directory:

Base case	[TPA]:D\Mancillas\SCR653\test1\runB1
Test Version	[TPA]:D\Mancillas\SCR653\test1\runG1 and runG2

Path for archive of results:

Base case	[CD: titled SCR653 Testing]:\SCR653\test1\runB1
Test Version	[CD: titled SCR653 Testing]:\SCR653\test1\runG1 and runG2

Environment variables:

Baseline Version	TPA_DATA=..\..\tpa51betaB TPA_TEST=..\..tpa51betaB
Test Version	TPA_DATA=..\..\tpa51betaG TPA_TEST=..\..\tpa51betaG

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): Append All

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: Evaluate that the release rates passed form EBSREL to EXEC were zeroed out. Previously it was possible that the last time step value was not zeroed out. This error could occur under two conditions: (1) WP failures by Localized corrosion

and release occurred in a subarea sequentially preceding a subarea which had no WP failures. value in the last time step. (2) WP failures by Weld failure and release occurred in a subarea sequentially preceding a subarea which had no WP failures. In both cases the subsequent subarea would have had an uninitialized value in the last time step. In addition the distribution of tpa.inp parameter **Preexpoential_SFDissolutionModel2** has been altered.

- objective Ensure that the final time step for release rates returned from the EBSREL module has been properly zeroed out when no release is possible. Ensure **Preexpoential_SFDissolutionModel2** has been properly modified.

- assumptions NONE

- constraints NONE

- output files to compare or examine *ebsrel.rlt*

- step by step test procedure to be used

1) Execute the test version twice for 10 realizations for 10 subareas per realization with the fraction of initial defective WP set to zero and with conditions which prevent WP mechanical failure. In the first execution of the TPA code set conditions which allow only weld failures to occur and in the second execution set condition which allow only localized corrosion failures to occur.
2) Examine the generated file *ebsrel.rlt* for instances in which the last time step of RN releases are erroneously non-zero.
3) Examine the change in the tpa.inp parameter **Preexpoential_SFDissolutionModel2**

- pass fail criteria

1) Changes made to the TPA code are logical and consistent with the description of changes for SCR653.

2) The file *ebsrel.rlt* should not contain any instances of erroneously non-zero values on the last time step of RN release rate calculations, as recorded in *ebsrel.rlt*.

3) The parameter **Preexpoential_SFDissolutionModel2** should have been properly modified in the *tpa.inp* file.

Test Results:

- criterion 1

The following text is an excerpt from the modified TPA module, *ebsrel.f*, which depicts the changes made to the module.

SCR653\tpa51betaG*ebsrel.f*

```
*******************************************************************************
cc rwr 5/30/06; SCR653; account for time for weld failure in setting
cc                      the value of rminfailtime; also zero out all
cc                      releases if there are no failures
cc
cc first, set rminfailtime at minimum of weld failure time and the
cc failure times for all 8 scenario failure types
cc  rwr 10/5/06; SCR653 (continued) also, make sure rminfailtime
cc                                  is the minimum of the WP localized
cc                                  corrosion failure time
cc        rminfailtime =
cc     &    MIN(rminfailtime, timeweldfail)
        rminfailtime =
     &    MIN(rminfailtime, timeweldfail, timewpfail)

*******************************************************************************
```

The modifications to the ebsrel.f module are logical and consistent with the stated intent of SCR653. The change includes an internal statement which reflects the logic implemented to ensure that the last time step is zeroed if no failures occur prior to the last time step. This is submitted as evidence that SCR653 has been properly implemented.

- criterion 2

First TPA run.
The *tpa.inp* file was modified prevent WP mechanical failure failures (by setting the **DripShieldBulkheadTributaryArea[m^2]** to 0.0023M), initial failures (by setting the **DefectiveFractionOfWPs/cell** to zero) and localized corrosion (by setting the **CritChlorideConcForFirstLayer[mol/L]** to 100.0). Thus only weld failures could occur. Performing 10 (of 500) realizations for all subareas for 10,000 yr, conditions which previously caused a improper release to be recorded occurred in realization 7. In this realization, subarea 7 had WP failures by Weld failure and RN releases and subarea 8 had no WP failures or releases. These results can be examined in the following files [CD]\SCR653\runG1*out* and *ebsrel.rlt*. These results are presented as evidence that SCR653 has been properly implemented.

Second TPA run
The *tpa.inp* file was modified prevent WP mechanical failure failures (by setting the **DripShieldBulkheadTributaryArea[m^2]** to 0.0023M), initial failures (by setting the **DefectiveFractionOfWPs/cell** to zero) and localized corrosion (by setting the **WeldCritChlorideConc[mol/L]** to 10.0 , 250.0). Thus only Localized corrosion failures could occur. Performing 10 (of 500) realizations for all subareas for 10,000 yr, conditions which previously caused a improper release to be recorded occurred in realization 1. In this realization, subarea 6 had WP failures by localized corrosion and RN releases and subarea 7 had no WP failures or releases. These results can be examined in the following files [CD]\SCR653\runG2*out* and *ebsrel.rlt*. These results are presented as evidence that SCR653 has been properly implemented.

- criterion 3

An examination of the changes made to the tpa.inp file show that the parameter **Preexpoential_SFDissolutionModel2** has been altered. The following text generated from a DOS file comparison command " fc tpa51betaG\tpa.inp tpa51betaB\tpa.inp >files_fc\tpa.inp_fc".
SCR653\files_fc*tpa.inp_fc*

```
*******************************************************************************
Comparing files TPA51BETAG\tpa.inp and TPA51BETAB\TPA.INP
***** TPA51BETAG\tpa.inp
title
 Input file tpa.inp as supplied with TPA Version 5.1betaC Code.
 Preliminary testing case.
***** TPA51BETAB\TPA.INP
title
 Input file tpa.inp as supplied with TPA Version 5.1betaB Code.
 Preliminary testing case.
*****

***** TPA51BETAG\tpa.inp
**   3 = ebsfail.ech and ebsfail.rlt only
**   4 = driftfail.ech, driftfail.rlt, mechfail.ech, and mechfail.rlt only'
**   5 = faulto.ech and faulto.rlt only
***** TPA51BETAB\TPA.INP
**   3 = ebsfail.ech and ebsfail.rlt only
**   4 = drftfail.ech, drftfail.rlt, mechfail.ech, and mechfail.rlt only'
**   5 = faulto.ech and faulto.rlt only
*****

***** TPA51BETAG\tpa.inp
**
** rwr 5/30/06; SCR653; per discussion between
**              O. Pensado and T. Ahn, change from
**              logbeta to lognormal distribution and
**              keep the same minimum and maximum values
** logbeta
** Preexponential_SFDissolutionModel2
** 1.022e4, 1.022e7, 3.145, 2.07
**
lognormal
Preexponential_SFDissolutionModel2
1.022e4, 1.022e7
**
***** TPA51BETAB\TPA.INP
**
logbeta
Preexponential_SFDissolutionModel2
1.022e4, 1.022e7, 3.145, 2.07
**
*****
*******************************************************************************
```

The change is consistent with the parameter values stated in SCR653 Update Requirements for *tpa.inp*. This is submitted as evidence that SCR653 has been properly implemented.

- overall test status : **PASS**

Notes: It is noted that an additional change was made to the *tpa.inp* file. In the append section of the *tpa.inp* file, the spelling for append files number 4 have been changed: *drftfail.ech* and *drftfail.rlt* have been changed to *driftfail.ech* and *driftfail.rlt*. This is a cosmetic change and does not affect TPA calculations.

SCR - 654

TPA 5.1/ Beta A

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 654	**2. Software Title and Version:** TPA 5.1betaA	**3. Project No:** 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *ashremob.f* and *tpa.inp*

1. Compared to DCAGS, a simplification in the airborne mass load modeling within ASHREMOB resulted in the removal of the long-term component of the outdoor airborne mass load for the initial deposit at the receptor location. This simplification produced undesirable results.

For 100% fluvial weighting, the indoor component of mass loading is increasing with time due to the fact that the airborne mass load for ash associated with an initial deposit at the receptor location is not zeroed out even when the initial mass of ash deposited at the receptor location is zero.

2. For consistency with the resolution of 1. above, change default values in tpa.inp for two input parameters to non-zero values.

3. The `reductionfactor` in *ashremob.f* is time dependent. ASHREMOB intermediate outputs **abnmassldinth** and **abnmassldintl** are time dependent, but their time dependence is not portrayed in the output file, named *ashremob.out*.

4. The values of the new lognormal distribution for the `WindSpeed[cm/s]` input parameter (see ASHPLUMO block in *tpa.inp*) were entered incorrectly.

5. Change Requested by: R. Benke and A. Simpkins Date: 5/24/2006, updated 7/20/2006	**6. Change Authorized by** (*Software Developer*): Ron Janetzke Date: 5-24-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):
See Attachment A for descriptions.
See Attachment B for files differences after implementation.

8. Implemented by: Jose M. Menchaca	**Date:** 08/02/2006

9. Description of Acceptance Tests:

See Attachment C for descriptions.

10. Tested by: Carol Scherer and Ali Simpkins	**Date:** 2/15/2007

CNWRA Form TOP-5 (05/2000)

UPDATE REQUIREMENTS for TPA.INP

SCR 654

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
Modify from	dcags	AirborneMassLoadOutsideHeavyDisturbance[g/m3]		constant	0.		

Modify to	dcags	AirborneMassLoadOutsideHeavyDisturbance[g/m3]	Maximum value in the range of airborne mass loads for outdoor activities assuming soil conditions	constant	7.0e-4		Mohanty et al., 2005, Table 5-4
Modify from	dcags	AirborneMassLoadOutsideLightDisturbance[g/m3]		constant	0.		
Modify to	dcags	AirborneMassLoadOutsideLightDisturbance[g/m3]	Minimum value in the range of airborne mass loads for outdoor activities assuming soil conditions	constant	1.0e-4		Mohanty et al., 2005, Table 5-4
Modify from	ashplumo	WindSpeed[cm/s]		lognormal	2.013, 3.909		

Modify to	ashplu mo	WindSpeed[cm/s]		lognormal	103., 8110		SN 88E page 413

Attachment A
Description of Change(s) or Problem Resolution

1. Modify the outdoor airborne mass load modeling in ASHREMOB for the initial deposit at the receptor location so that it is consistent with the DCAGS outdoor airborne mass load modeling for ash and soil.

Make the calculation of `reductionfactor` time dependent, so that `reductionfactor` becomes an array `reductionfactor(it)`.

Move the unmodified line
```
abnmassldintl = massloadashlight * reductionfactor
```
to a location that is above the calculation of `hlwgpm3intl(it)` and below the line
```
abnmassldinth =  massloadashheavy * reductionfactor.
```

Replace the two-line pair below
```
abnmassldinth =  massloadashheavy * reductionfactor
abnmassldintl = massloadashlight * reductionfactor
```
with
```
if (massashinit(iashplumerealindex) .eq. 0.d0) then
      abnmassldinth(it) = massloadoutheavy
      abnmassldintl(it) = massloadoutlight
   else
      abnmassldinth(it) = (massloadashheavy - massloadoutheavy) *
        reductionfactor(it) + massloadoutheavy
      abnmassldintl(it) = (massloadashlight - massloadoutlight) *
        reductionfactor(it)  + massloadoutlight
endif
```

Modify
```
  hlwgpm3inth(it) =  concentfactorinit * abnmassldinth *
     &                          resuspendiblefraction(it)
```
to
```
  hlwgpm3inth(it) =  concentfactorinit * abnmassldinth(it) *
     &                          resuspendiblefraction(it)
```

Modify
```
hlwgpm3intl(it) = wgtfactorinitial * concentfactorinit *
     &                       massloadashlight *
     &                       resuspendiblefraction(it) *
     &                       reductionfactor
```
to
```
hlwgpm3intl(it) = wgtfactorinitial * concentfactorinit *
     &                       abnmassldintl(it) *
     &                       resuspendiblefraction(it)
```

Modify the airborne mass load modeling for the eolian component to be consistent with the mass load modeling for the initial deposit at the receptor location.
Modify
```
partmassloadeoli(it) = massloadashlight * reductionfactor
```
to

```
partmassloadeoli(it) = (massloadashlight - massloadoutlight) *
reductionfactor(it)  + massloadoutlight
```

Add error checks in *ashremob.f* for situations where the quantities `(massloadashheavy - massloadoutheavy)` and `(massloadashlight - massloadoutlight)` may be less than zero, which would imply that the presence of ash results in a reduction in the mass load from the value for soil. Either prompt the user with a warning or simply not allow such negative contributions to the airborne mass load.

---

2. Assign non-zero default values to the two outdoor mass load parameters for soil.

Assign a constant default value of 7.0e-4 for
`AirborneMassLoadOutsideHeavyDisturbance[g/m3]` in *tpa.inp*.
Remarks: This value corresponds to the maximum value in the range of airborne mass loads for outdoor activities assuming soil conditions (Mohanty et al., 2005, Table 5-4).
For consistency, update the parameter value and remarks fields in the master spreadsheet of TPA code input parameters.

Assign a constant default value of 1.0e-4 for
`AirborneMassLoadOutsideLightDisturbance[g/m3]` in *tpa.inp*.
Remarks: This value corresponds to the minimum value in the range of airborne mass loads for outdoor activities assuming soil conditions (Mohanty et al., 2005, Table 5-4).
For consistency, update the parameter value and remarks fields in the master spreadsheet of TPA code input parameters.

---

3. Modify *ashremob.f* to include time dependency in the calculation of **abnmassldinth** and **abnmassldintl** as arrays, **abnmassldinth(it)** and **abnmassldintl(it)**, and report the time-dependent intermediate values for **abnmassldinth(it)** and **abnmassldintl(it)** in the appropriate columns of *ashremob.out*. (Note: The code changes in 1. above address time dependency to some extent.) Consistent with other intermediate outputs in *ashremob.out*, assign values of zero to **abnmassldinth(it)** and **abnmassldintl(it)** for time steps before the volcanic event.

---

4. Based on the rationale given on page 413 of Scientific Notebook 88E for a new lognormal distribution of wind speed, correct the input parameter values specified in *tpa.inp*. The lower value, in cm/s, should be changed to 103 (i.e., $10^{2.013} = 103$). The upper value, in cm/s, should be changed to 8110 (i.e., $10^{3.909} = 8110$).

In summary, modify
```
lognormal
WindSpeed[cm/s]
2.013, 3.909
```
to
```
lognormal
WindSpeed[cm/s]
103., 8110.
```

Reference

S. MOHANTY, R. BENKE, R. CODELL, K. COMPTON, D. ESH, D. GUTE, L. HOWARD, T. MCCARTIN, O. PENSADO, M. SMITH, G. ADAMS, T. AHN, P. BERTETTI, L. BROWNING, G. CRAGNOLINO, D. DUNN, R. FEDORS, B. HILL, D. HOOPER, P. LAPLANTE, B. LESLIE, R. NES, G. OFOEGBU, R. PABALAN, R. RICE, J. RUBENSTONE, J. TRAPP, B. WINFREY and L. YANG. "Risk Analysis for Risk Insights Progress Report." ML051580323. San Antonio, Texas: Center for Nuclear Waste Regulatory Analyses. May 2005.

Attachment B

Differences to tpa.inp

```
/home/jmench/tpa51betaD{144}>diff -C 1 tpa.inp origs
*** tpa.inp     Wed Aug  2 14:23:47 2006
--- origs/tpa.inp       Fri Jul 14 14:22:32 2006
***************
*** 2,4 ****
   Input file tpa.inp as supplied with TPA Version 5.1betaD Code.
!  Modifications implementing SCR654. Preliminary testing case.
  **
--- 2,4 ----
   Input file tpa.inp as supplied with TPA Version 5.1betaD Code.
!  Preliminary testing case.
  **
***************
*** 8254,8256 ****
  WindSpeed[cm/s]
! 103., 8110.
  **
--- 8254,8256 ----
  WindSpeed[cm/s]
! 2.013, 3.909
  **
***************
*** 8840,8842 ****
  AirborneMassLoadOutsideHeavyDisturbance[g/m3]
! 7.0e-4
  **
--- 8840,8842 ----
  AirborneMassLoadOutsideHeavyDisturbance[g/m3]
! 0.0
  **
***************
*** 8844,8846 ****
  AirborneMassLoadOutsideLightDisturbance[g/m3]
! 1.0e-4
  **
--- 8844,8846 ----
  AirborneMassLoadOutsideLightDisturbance[g/m3]
! 0.0
  **
/home/jmench/tpa51betaD{145}>
```

Differences toashremob.f file:

```
/home/jmench/tpa51betaD{153}>diff ashremob.f origs/ashremob.f
76,80d75
< c          07-27-06 jmm   SCR654; changes to mass loading.
< c                         SCR654 changes are embedded between the 2 lines below.
< cjmm 20060728 SCR654 for adding time dependence to several parameters
< cjmm end SCR654 modifications
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
298,301c293,294
< cjmm 20060728 SCR654 for adding time dependence to several parameters
<       double precision abnmassldinth(maxntime)
<       double precision abnmassldintl(maxntime)
< cjmm end SCR654 modifications
---
>       double precision abnmassldinth
>       double precision abnmassldintl
407,411c400
<
< cjmm 20060728 SCR654 for adding time dependence to several parameters
<       double precision reductionfactor(maxntime)
< cjmm  double precision reductionfactor
< cjmm end SCR654 modifications
---
>       double precision reductionfactor
495,501d483
< cjmm 20060728 SCR654 for adding time dependence to several parameters
<          do j=1,maxntime
<            abnmassldintl(j)=0.0d0
<            abnmassldinth(j)=0.0d0
<          end do
< cjmm end SCR654 modifications
<
1037,1041c1019
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
< cjmm 20060728 SCR654 for adding time dependence to several parameters
<          reductionfactor(it) = exp(-reductionrate* (tim(it)-tim(itoe)))
< cjmm     reductionfactor = exp(-reductionrate* (tim(it)-tim(itoe)))
< cjmm end SCR654 modifications
---
>          reductionfactor = exp(-reductionrate* (tim(it)-tim(itoe)))
1044,1074c1022,1023
< cjmm 20060728 SCR654 for adding time dependence to several parameters
< cjmm     abnmassldinth =  massloadashheavy * reductionfactor(it)
< cjmm     abnmassldinth =  massloadashheavy * reductionfactor
< cjmm     abnmassldintl = massloadashlight * reductionfactor(it)
<          if (massashinit(iashplumerealindex) .eq. 0.d0) then
<             abnmassldinth(it) = massloadoutheavy
<             abnmassldintl(it) = massloadoutlight
<          else
<             if (massloadoutheavy .gt. massloadashheavy) then
<                print *, 'WARNING: '//
<      &              'AirborneMassLoadOutsideHeavyDisturbance exceeds '
<                print *,
<      &            'AirborneMassLoadAboveFreshAshBlanketHeavyDisturbance'
<                print *, 'which will cause a negative contribrution to'//
<      &            ' the airborne mass load.'
<             end if
<             abnmassldinth(it) = (massloadashheavy - massloadoutheavy) *
<      &         reductionfactor(it) + massloadoutheavy
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
<             if (massloadoutheavy .gt. massloadashheavy) then
<                print *, 'WARNING: '//
<      &              'AirborneMassLoadOutsideLightDisturbance exceeds '
<                print *,
```

```
<      &            'AirborneMassLoadAboveFreshAshBlanketLightDisturbance'
<                print *, 'which will cause a negative contribrution to'//
<      &            ' the airborne mass load.'
<             end if
<             abnmassldintl(it) = (massloadashlight - massloadoutlight) *
<      &         reductionfactor(it) + massloadoutlight
<          endif
<          hlwgpm3inth(it) =  concentfactorinit * abnmassldinth(it) *
---
>          abnmassldinth =  massloadashheavy * reductionfactor
>          hlwgpm3inth(it) =  concentfactorinit * abnmassldinth *
1076,1077d1024
< cjmm     hlwgpm3inth(it) =  concentfactorinit * abnmassldinth *
< cjmm &                          resuspendiblefraction(it)
1081,1088c1028,1030
<      &                        abnmassldintl(it) *
<      &                        resuspendiblefraction(it)
< cjmm     hlwgpm3intl(it) = wgtfactorinitial * concentfactorinit *
< cjmm &                        massloadashlight *
< cjmm &                        resuspendiblefraction(it) *
< cjmm &                        reductionfactor(it)
< cjmm &                        reductionfactor
< cjmm end SCR654 modifications
---
>      &                        massloadashlight *
>      &                        resuspendiblefraction(it) *
>      &                        reductionfactor
1101,1106c1043
< cjmm 20060728 SCR654 for adding time dependence to several parameters
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
<          partmassloadeoli(it) = (massloadashlight - massloadoutlight) *
<      &                          reductionfactor(it) + massloadoutlight
< cjmm    partmassloadeoli(it) = massloadashlight * reductionfactor
< cjmm end SCR654 modifications
---
>          partmassloadeoli(it) = massloadashlight * reductionfactor
1119,1120c1056
< cjmm 20060728 SCR654 for adding time dependence to several parameters
<          hlwgmp3toth(it) = abnmassldinth(it) +
---
>          hlwgmp3toth(it) = abnmassldinth +
1123,1126d1058
< cjmm    hlwgmp3toth(it) = abnmassldinth +
< cjmm &                        wgtfactorfluvial * partmassloadfluv(it) +

< cjmm &                        wgtfactoreolian * partmassloadeoli(it)
< cjmm end SCR654 modifications
1133,1136c1065
< cjmm 20060728 SCR654 for adding time dependence to several parameters
<             portioninth = abnmassldinth(it) / hlwgmp3toth(it)
< cjmm        portioninth = abnmassldinth / hlwgmp3toth(it)
< cjmm end SCR654 modifications
---
>             portioninth = abnmassldinth / hlwgmp3toth(it)
1149,1153c1078,1079
< cjmm 20060728 SCR654 for adding time dependence to several parameters
< cjmm    abnmassldintl = massloadashlight * reductionfactor(it) "moved to line 1038
above"
< cjmm    abnmassldintl = massloadashlight * reductionfactor
< cjmm end SCR654 modifications
<          hlwgmp3totl(it) = wgtfactorinitial * abnmassldintl(it)  +
---
>          abnmassldintl = massloadashlight * reductionfactor
>          hlwgmp3totl(it) = wgtfactorinitial * abnmassldintl  +
```

```
1156,1159d1081
< cjmm    hlwgmp3totl(it) = wgtfactorinitial * abnmassldintl  +
< cjmm &                        wgtfactorfluvial * partmassloadfluv(it) +
< cjmm &                        wgtfactoreolian * partmassloadeoli(it)
< cjmm end SCR654 modifications
1166,1167c1088
< cjmm 20060728 SCR654 for adding time dependence to several parameters
<             portionintl = wgtfactorinitial * abnmassldintl(it) /
---
>             portionintl = wgtfactorinitial * abnmassldintl /
1169,1171d1089
< cjmm        portionintl = wgtfactorinitial * abnmassldintl /
< cjmm &                    hlwgmp3totl(it)
< cjmm end SCR654 modifications
1207d1124
< cjmm 20060728 SCR654 for adding time dependence to several parameters
1210,1212c1127
<      &                    reductionfactor(it)
< cjmm &                    reductionfactor
< cjmm end SCR654 modifications
---
>      &                    reductionfactor
1633,1634d1547
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
< cjmm 20060728 SCR654 for adding time dependence to several parameters
1636,1641c1549,1552
<      &  (tim(it), abnmassldinth(it), abnmassldintl(it),
<      &   partmassloadfluv(it), partmassloadeoli(it),
<      &   hlwgpm3inth(it), hlwgpm3intl(it),
<      &   hlwgpm3fluv(it), hlwgpm3eoli(it),
<      &   hlwgmp3toth(it), hlwgmp3totl(it),
<      &   hremiout(it), hremiin(it),
---
>      &  (tim(it), abnmassldinth, abnmassldintl, partmassloadfluv(it),
>      &   partmassloadeoli(it), hlwgpm3inth(it),
>      &   hlwgpm3intl(it), hlwgpm3fluv(it), hlwgpm3eoli(it),
>      &   hlwgmp3toth(it), hlwgmp3totl(it), hremiout(it), hremiin(it),
1644,1650d1554
< cjmm  write( ioutunit, '(15(1pe14.8,3x))')
< cjmm &  (tim(it), abnmassldinth, abnmassldintl, partmassloadfluv(it),
< cjmm &   partmassloadeoli(it), hlwgpm3inth(it),
< cjmm &   hlwgpm3intl(it), hlwgpm3fluv(it), hlwgpm3eoli(it),
< cjmm &   hlwgmp3toth(it), hlwgmp3totl(it), hremiout(it), hremiin(it),
< cjmm &   hremioff(it), hrmei(it), it=1,ntim)
< cjmm end SCR654 modifications
```

Attachment C
Description of Acceptance Test

All validation tests were performed with the following settings (unless otherwise noted):

- VolcanismDisruptiveScenarioFlag(yes=1,no=0) set to 1,
- DirectReleaseOnlyFlag(yes=1,no=0) set to 1,
- TimeOfNextVolcanicEventinRegionOfInterest[yr] set to a constant at 500.0,
- OutputMode(0=None,1=All,2=UserDefined) set to 1, and
- SelectAppendFiles set to 12.

Test 1a. (No initial deposit at receptor location, zero ash mass load)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ash remob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	1
AirborneMassLoadAboveFreshAshBlanketHeavyDisturbance[g/m3]	constant	0.0
AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3]	constant	0.0

Test Criteria: Check for error warning and look at output in *ashremob.out.* Test is passed if:
(1) **abnmassldinth** is zero for times before the volcanic event, and constant and equal to AirborneMassLoadOutsideHeavyDisturbance[g/m3] in all following time steps;
PASSED
(2) **abnmassldintl** is zero for times before the volcanic event, and constant and equal to AirborneMassLoadOutsideLightDisturbance[g/m3] in all following time steps;
PASSED
(3) If results are presented in *ashremob.out*, verify that **partmassloadeoli** does not increase with time and is positive (nonnegative and nonzero) at all time steps after the volcanic event.
FAILED - Program fixes will be made in SCR 682

Test 1b. (No initial deposit at receptor location, zero ash mass load, no erosion)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ash remob,1=ashremob]	–	1

AshPlumeRealizationIndex[]	iconstant	1
AirborneMassLoadAboveFreshAshBlanketHeavyDisturbance[g/m3]	constant	0.0
AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3]	constant	0.0
RelativeRateOfBlanketRemoval[1/yr]	–	0.0

Test Criteria: Check for error warning and look at output in *ashremob.out.* Test is passed if:
(1) **abnmassldinth** is zero for times before the volcanic event, and constant and equal to AirborneMassLoadOutsideHeavyDisturbance[g/m3] in all following time steps;
PASSED
(2) **abnmassldintl** is zero for times before the volcanic event, and constant and equal to AirborneMassLoadOutsideLightDisturbance[g/m3] in all following time steps;
PASSED
(3) If results are presented in *ashremob.out*, verify that **partmassloadeoli** does not increase with time and is positive (nonnegative and nonzero) for all time steps after the volcanic event.
FAILED - Program fixes will be made in SCR 682

Test 1c. (No initial deposit at receptor location, zero soil mass load)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ashremob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	1
AirborneMassLoadOutsideHeavyDisturbance[g/m3]	constant	0.0
AirborneMassLoadOutsideLightDisturbance[g/m3]	constant	0.0

Test Criteria: Check for error warning and look at output in *ashremob.out.* Test is passed if:
(1) both **abnmassldinth** and **abnmassldintl** (in *ashremob.out*) equal zero for all time steps and
PASSED
(2) both **hlwgpm3inth** and **hlwgpm3intl** (in *ashremob.out*) equal zero for all time steps.
PASSED
(3) If results are presented in *ashremob.out*, verify that **partmassloadeoli** does not increase with time and is positive (nonnegative and nonzero) in all time steps after the volcanic event.
FAILED - Program fixes will be made in SCR 682

Test 1d. (Initial deposit at receptor location, zero ash mass load)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ash remob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	2
AirborneMassLoadAboveFreshAshBlanketHeavyDisturbance[g/m3]	constant	0.0
AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3]	constant	0.0

Test Criteria: Check for error warning and look at output in *ashremob.out.* Test is passed if error/warning regarding negative mass load contribution is presented for both heavy- and light-disturbance mass loads. If results are presented in *ashremob.out*, verify that **abnmassldinth**, **abnmassldintl**, and **partmassloadeoli** do not increase with time and are positive (nonnegative and nonzero) in all time steps.
FAILED - Program fixes will be made in SCR 682

Test 1e. (Initial deposit at receptor location, no soil mass load, no mass load reduction)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ash remob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	2
AirborneMassLoadOutsideHeavyDisturbance[g/m3]	–	0.0
AirborneMassLoadOutsideLightDisturbance[g/m3]	–	0.0
RateOfReductionOfMassLoadingFactor[1/yr]	–	0.0

Test Criteria: Look at output in *ashremob.out.* Test is passed if:
(1) **abnmassldinth** is zero for times before the volcanic event, and constant and equal to AirborneMassLoadAboveFreshAshBlanketHeavyDisturbance[g/m3] in all following time steps
FAILED - Program fixes will be made in SCR 682;

(2) **abnmassldintl** is constant in time and equals AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3] in all following time steps;
FAILED - Program fixes will be made in SCR 682
(3) **hlwgpm3inth** is decreasing with time after the volcanic event;
PASSED
(4) **hlwgpm3intl** is decreasing with time; and
PASSED
(5) **partmassloadeoli** is zero for times before the volcanic event, and constant and equal to AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3] in all following time steps.
FAILED - Program fixes will be made in SCR 682

Test 1f. Initial deposit at receptor location, fast mass load reduction
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ash remob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	2
AirborneMassLoadOutsideHeavyDisturbance[g/m3]	–	0.0
AirborneMassLoadOutsideLightDisturbance[g/m3]	–	0.0
RateOfReductionOfMassLoadingFactor[1/yr]	–	0.693147

Test Criteria: Look at output (referred to generically as *massload(t)* in the equation below where *t* is time) in *ashremob.out* and compare results for the year of the event (t0) and the year (t1) corresponding to next time step. Calculate the reduction rate factor for each output below as

$$\left[\sqrt[(t1-t0)]{\frac{massload(t1)}{massload(t0)}}\right]^{-1}.$$

Test is passed if:
(1) **abnmassldinth** decreases by a factor between 1.9 and 2.1 per year; **PASSED**
(2) **abnmassldintl** decreases by a factor between 1.9 and 2.1 per year;**PASSED**
(3) **hlwgpm3inth** decreases by a factor between 1.9 and 2.1 per year;**PASSED**
(4) **hlwgpm3intl** decreases by a factor between 1.9 and 2.1 per year; and **PASSED**
(5) **partmassloadeoli** decreases by a factor between 1.9 and 2.1 per year. **PASSED**

Test 1g. (100% fluvial deposit)
Input: Perform the test by using the tpameans.out file and changing it to the tpa.inp file. Make the global changes as shown above as well as the following.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	1
AshEvolutionMode[0=no_ash remob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	97
WeightingFactorInitialDeposit[]	constant	0.0
WeightingFactorFluvial[]	constant	1.0
WeightingFactorEolian[]	constant	0.0

Test Criteria: Examine *ashremob.out*, verify that **H_RMEI indoor**, and **H_RMEI** do not increase with time and are positive (nonnegative and nonzero) in all time steps after the volcanic event.
PASSED

Test 1h. (No initial deposit at receptor location, zero ash mass load)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ash remob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	2
AirborneMassLoadAboveFreshAshBlanketHeavyDisturbance[g/m3]	constant	0.0
AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3]	constant	0.0

Test Criteria: Check for error warning and look at output in *ashremob.out.* Test is passed if:
(1) **hlwgpm3inth** is decreasing with time after the volcanic event and
FAILED - Program fixes will be made in SCR 682
(2) **hlwgpm3intl** is decreasing with time after the volcanic event.
FAILED - Program fixes will be made in SCR 682

Test 1i. (No initial deposit at receptor location, zero ash mass load, no erosion)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ash remob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	2
AirborneMassLoadAboveFre shAshBlanketHeavyDisturba nce[g/m3]	constant	0.0
AirborneMassLoadAboveFre shAshBlanketLightDisturban ce[g/m3]	constant	0.0
RelativeRateOfBlanketRemo val[1/yr]	–	0.0

Test Criteria: Check for error warning and look at output in *ashremob.out.* Test is passed if:
(1) **hlwgpm3inth** is nonzero and constant with time after the volcanic event and
FAILED - Program fixes will be made in SCR 682
(2) **hlwgpm3intl** is nonzero and constant with time after the volcanic event.
FAILED - Program fixes will be made in SCR 682

Test 1j. (Initial deposit at receptor location, zero ash mass load)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ash remob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	2
AirborneMassLoadAboveFre shAshBlanketHeavyDisturba nce[g/m3]	constant	0.0

Test Criteria: Check for error warning and look at output in *ashremob.out.* Test is passed if error/warning regarding negative mass load contribution is presented for heavy disturbance with no error/warning for light disturbance. If results are presented in *ashremob.out*, verify that **abnmassldinth**, **abnmassldintl**, and **partmassloadeoli** do not increase with time and are positive (nonnegative and nonzero) in all time steps.

Test 1k. (Initial deposit at receptor location, zero ash mass load)

Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ash remob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	2
AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3]	constant	0.0

Test Criteria: Check for error warning and look at output in *ashremob.out.* Test is passed if error/warning regarding negative mass load contribution is presented for light disturbance with no error/warning for heavy disturbance. If results are presented in *ashremob.out*, verify that **abnmassldinth**, **abnmassldintl**, and **partmassloadeoli** do not increase with time and are positive (nonnegative and nonzero) in all time steps.
FAILED - Program fixes will be made in SCR 682

Test 2
Verify the requested changes were made to input file.

Test 2 Results
The *tpa.inp* file provided with this SCR was accessed, and the inputs for the two input parameters are pasted below.

```
**
constant
AirborneMassLoadOutsideHeavyDisturbance[g/m3]
7.0e-4
**
constant
AirborneMassLoadOutsideLightDisturbance[g/m3]
1.0e-4
**
```

These inputs match the request, and therefore, this test **PASSED**

Test 3
Check time dependence of **abnmassldinth** and **abnmassldintl** in *ashremob.out.*
(1) Use the results of **Test 1f**, check that **abnmassldinth** and **abnmassldintl** are zero for times prior to the eruption event. Verify that **abnmassldinth** and **abnmassldintl** decrease with time after the event. **PASSED**
(2) Use the results of **Test 1e**. Verify that **abnmassldinth** and **abnmassldintl** are zero for times prior to the eruption event. **PASSED**

Test 4
Verify the requested changes were made to input file.

Test 4 Results
The *tpa.inp* file provided with this SCR was accessed, and the inputs for the input parameter of interest are pasted below.

```
**
lognormal
WindSpeed[cm/s]
103., 8110.
**
```

These inputs match the request, and therefore, this test **PASSED**

SCR - 656

TPA 5.1/ Beta D

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 656	**2. Software Title and Version:** TPA 5.1betaD	**3. Project No:** 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f, reader.f, maxchain.i, SIZE.INC, samplerv.i, mva.i, uzft.f, szft.f, maxclnuc.i, maxnnucl.i, ebsrel.f, nefmks.f, sampler.f, invent.f, dcagw.f.*

Testing has shown that the code does not accept the specification of every nuclide listed in *nuclides.dat* as a separate chain, for both regular and colloidal nuclides (as specified in the *tpa.inp* input file).

The *tpa.inp* file does not indicate that the source nuclide of a colloidal nuclide should not appear in any of the colloid chains, otherwise it will cause an error while creating *ebsnef.dat*. Regular nuclides not acting as a source for a colloidal nuclide may, however, appear.

5. Change Requested by: R. Janetzke Date: 7-26-06	**6. Change Authorized by** (*Software Developer*): R. Janetzke Date: 7-27-06

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

Many source files, header files and include files had inconsistent use of parameters used for dimensioning nuclide and nuclide chain arrays. The following limits were applied or maintained:

Maximum number of regular nuclides = 43
Maximum number of colloidal nuclides = 14
Maximum number of regular nuclide chains = 43
Maximum number of colloidal nuclide chains = 14
Maximum number of members of a regular nuclide chain = 7
Maximum number of members of a colloidal nuclide chain = 7
Maximum number of number of nuclides (all must be regular nuclides) participating in all of the regular nuclide chains = 43
Maximum number of number of nuclides (may be either colloidal nuclides, or regular nuclides not associated with a colloidal nuclide) participating in all of the colloidal nuclide chains = 28

8. Implemented by: R. Janetzke	**Date:** 7-27-06

9. Description of Acceptance Tests:

See attachment A.

10. Tested by: J. Menchaca	**Date:** 03-09-07

CNWRA Form TOP-5 (05/2000)

UPDATE REQUIREMENTS for TPA.INP

SCR 656

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
none							

Attachment A

Description of Acceptance Tests

Test Plan Name: Full Radionuclide Test

Tested By: Jose M. Menchaca | Date: 02/26/2007

Host Machine: "TPA" 64 bit Microsoft Windows Server | Host OS: Microsoft Windows Ver 5.2

Baseline Version: TPA51betaD | Test Version: TPA51betaE

Process Level (PL) Tests

PL-1 Name:

Path for run directory:

Path for archive directory:

Environment variable: TPA_TEST = L:\tpabetaE (L: is "Ladybug")
TPA_DATA = L:\tpabetaE (L: is "Ladybug")

Special input files or modifications to input files required: Two files were modified to run the special case with all radionuclides.

1. A modified tpa.inp that had element specific parameters or radionuclide specific parameters. Appendix B shows the results of doing a file comparison (fc in DOS) between the original and modified tpa.inp files.

2. A modified nuclides.dat file that assured there was no zero-inventory radionuclide. Appendix C show the results of doing a file comparison between the original and modified nuclides.dat file.

Special diagnostic code modifications required: NONE

Program modes to be used: STANDARD

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: DOS file comparison utility, fc.

Test Description: The objective of the test is to assure that the TPA code is able to execute with all radionuclides activated and that each radionuclide has some level of release.

For radionuclide specific or element specific parameters that were added to the tpa.inp file, values previously encountered for other radionuclide/element specific parameters were assumed with no verification from a module expert.

There were no constraints applied to the execution of this test.

The cumrel.res file will be used to assure that each radionuclide and its associated colloid (if one exists) has some level of release.

Using a modified tpa.inp file as specified in Appendix B and a modified nuclides.dat file as specified in Appendix C, execute a single vector run. Inspect the cumrel.res file and verify that each of the 43 radionuclides and each of the 14 colloids are present in the file. Additionally verify that there is some level of release in the ebscumrl column of the cumrel.res file.

The test passes if the conditions described in the above paragraph are met.

Test Results: Appendix D contains the output of the cumrel.res file. As can be seen from a visual inspection of Appendix D the conditions for passing are met.

PASS

Attachment B

tpa.inp modifications needed to carry out test

```
Comparing files SINGVEC04\tpa.inp and ..\..\TPA.INP
***** SINGVEC04\tpa.inp
 Input file tpa.inp as supplied with TPA Version 5.1betaE Code.
 Added Element specific parameters to test SCR656.
**
***** ..\..\TPA.INP
 Input file tpa.inp as supplied with TPA Version 5.1betaE Code.
 Preliminary testing case.
**
*****

***** SINGVEC04\tpa.inp
** 13
** jmm 20061004 SCR656 testing
** aqueousnuclides
** 21
** 12
aqueousnuclides
43
34
**
***** ..\..\TPA.INP
** 13
aqueousnuclides
21
12
**
*****

***** SINGVEC04\tpa.inp
Cl36
**   chain 14
1
Ac227
**   chain 15
1
Ag108m
**   chain 16
1
Am242m
**   chain 17
1
C14
**   chain 18
1
Cm243
**   chain 19
1
Cm244
**   chain 20
1
Cs137
**   chain 21
1
Mo93
**   chain 22
1
Ni63
**   chain 23
1
Pa231
**   chain 24
1
Pd107
**   chain 25
1
```

```
Pu238
**   chain 26
1
Pu241
**   chain 27
1
Pu242
**   chain 28
1
Sm151
**   chain 29
1
Sn121m
**   chain 30
1
Sn126
**   chain 31
1
Sr90
**   chain 32
1
U232
**   chain 33
1
U235
**   chain 34
1
U236
**   chain 35
1
Zr93
**
***** ..\..\TPA.INP
Cl36
**
*****

***** SINGVEC04\tpa.inp
**   number of colloidal nuclides (14 max)
**   SCR656 changes to run all colloids implemented by jmm
14
**   number of colloidal chains
14
**   colloidal chain 1
1
Jc246
**U238
**   colloidal chain 2
**3
**Jc245
***** ..\..\TPA.INP
**   number of colloidal nuclides (14 max)
11
**   number of colloidal chains
5
**   colloidal chain 1
2
Jc246
U238
**   colloidal chain 2
3
Jc245
Ja241
Np237
**5
**Jc245
*****

***** SINGVEC04\tpa.inp
**Np237
1
Jc245
```

```
**   colloidal chain 3
1
Ja241
**Np237
**U233
**   colloidal chain 4
***** ..\..\TPA.INP
**Np237
**U233
**Jt229
**   colloidal chain 3
2
Ja243
Jp239
**   colloidal chain 4
*****

***** SINGVEC04\tpa.inp
1
Jt229
**   colloidal chain 5
1
Ja243
**   colloidal chain 6
1
Jp239
**   colloidal chain 7
1
Jp240
**   colloidal chain 8
1
Jt230
**Ra226
**Pb210
**   colloidal chain 9
1
Ja242m
**   colloidal chain 10
1
Jc243
**   colloidal chain 11
1
Jc244
**   colloidal chain 12
1
Jp238
**   colloidal chain 13
1
Jp241
**   colloidal chain 14
1
Jp242
**
***** ..\..\TPA.INP
1
Jp240
**   colloidal chain 5
3
Jt230
Ra226
Pb210
**
*****

***** SINGVEC04\tpa.inp
NumberOfRealizations
1
**
***** ..\..\TPA.INP
NumberOfRealizations
500
**
```

```
*****

***** SINGVEC04\tpa.inp
StopAtRealization
0
**
***** ..\..\TPA.INP
StopAtRealization
1
**
*****

***** SINGVEC04\tpa.inp
constant
RD_Invert_Ac
1.0
**
***** ..\..\TPA.INP
constant
GapFractionForCM246
0.0
**
*****

***** SINGVEC04\tpa.inp
constant
RD_Invert_Ag
1.0
**
***** ..\..\TPA.INP
constant
GapFractionForU238
0.0
**
*****

***** SINGVEC04\tpa.inp
constant
RD_Invert_C
1.0
**
***** ..\..\TPA.INP
constant
GapFractionForCM245
0.0
**
*****

***** SINGVEC04\tpa.inp
constant
RD_Invert_Mo
1.0
**
***** ..\..\TPA.INP
constant
GapFractionForAM241
0.0
**
*****

***** SINGVEC04\tpa.inp
constant
RD_Invert_Pa
1.0
**
***** ..\..\TPA.INP
constant
GapFractionForNP237
0.0
**
*****
```

```
***** SINGVEC04\tpa.inp
constant
RD_Invert_Pd
1.0
**
***** ..\..\TPA.INP
constant
GapFractionForAM243
0.0
**
*****

***** SINGVEC04\tpa.inp
constant
RD_Invert_Sm
1.0
**
***** ..\..\TPA.INP
constant
GapFractionForPU239
0.0
**
*****

***** SINGVEC04\tpa.inp
constant
RD_Invert_Sn
1.0
**
***** ..\..\TPA.INP
constant
GapFractionForPU240
0.0
**
*****

***** SINGVEC04\tpa.inp
constant
RD_Invert_Sr
1.0
**
***** ..\..\TPA.INP
constant
GapFractionForU234
0.0
**
*****

***** SINGVEC04\tpa.inp
constant
RD_Invert_Zr
1.0
**
***** ..\..\TPA.INP
constant
GapFractionForTH230
0.0
**
*****

***** SINGVEC04\tpa.inp
constant
GapFractionForCM246
0.0
***** ..\..\TPA.INP
constant
GapFractionForRA226
0.0
*****

***** SINGVEC04\tpa.inp
constant
```

```
GapFractionForU238
0.0
***** ..\..\TPA.INP
constant
GapFractionForPB210
0.0
*****

***** SINGVEC04\tpa.inp
constant
GapFractionForCM245
0.0
***** ..\..\TPA.INP
constant
GapFractionForU233
0.0
*****

***** SINGVEC04\tpa.inp
constant
GapFractionForAM241
0.0
***** ..\..\TPA.INP
constant
GapFractionForTH229
0.0
*****

***** SINGVEC04\tpa.inp
**
constant
GapFractionForNP237
0.0
**
***** ..\..\TPA.INP
**
triangular
GapFractionForCS135
8.8e-3, 2.5e-2, 5.8e-2
**
triangular
GapFractionForI129
5.4e-3, 1.1e-1, 3.2e-1
**
triangular
GapFractionForTC99
5.0e-4, 1.3e-3, 2.8e-3
**
*****

***** SINGVEC04\tpa.inp
constant
GapFractionForAM243
0.0
***** ..\..\TPA.INP
constant
GapFractionForNI59
0.0
*****

***** SINGVEC04\tpa.inp
**
constant
GapFractionForPU239
0.0
**
***** ..\..\TPA.INP
**
triangular
GapFractionForCL36
5.4e-3, 1.1e-1, 3.2e-1
**
```

```
triangular
GapFractionForSE79
8.8e-3, 2.5e-2, 5.8e-2
**
*****

***** SINGVEC04\tpa.inp
constant
GapFractionForPU240
0.0
***** ..\..\TPA.INP
constant
GapFractionForNB94
0.0
*****

***** SINGVEC04\tpa.inp
constant
GapFractionForU234
0.0
***** ..\..\TPA.INP
constant
GapFractionForPU242
0.0
*****

***** SINGVEC04\tpa.inp
**
constant
GapFractionForTH230
0.0
**
***** ..\..\TPA.INP
**
logbeta
InitialRadiusOfSFParticle[m]
4.42e-4, 4.72e-3, 3.549, 9.664
**
*****

***** SINGVEC04\tpa.inp
constant
GapFractionForRA226
0.0
**
***** ..\..\TPA.INP
constant
CladdingCorrectionFactor
1.0
**
uniform
SolubilityAm[kg/m3]
2.4e-8,  2.4e-4
**
loguniform
SolubilityNp[kg/m3]
1.1e-4, 5.9e-1
**
*****

***** SINGVEC04\tpa.inp
constant
GapFractionForPB210
0.0
**
***** ..\..\TPA.INP
constant
Solubility_I[kg/m3]
1.29e2
**
*****
```

```
***** SINGVEC04\tpa.inp
constant
GapFractionForU233
0.0
**
***** ..\..\TPA.INP
constant
SolubilityTc[kg/m3]
9.93e1
**
*****

***** SINGVEC04\tpa.inp
constant
GapFractionForTH229
0.0
**
triangular
GapFractionForCS135
8.8e-3, 2.5e-2, 5.8e-2
**
triangular
GapFractionForI129
5.4e-3, 1.1e-1, 3.2e-1
**
triangular
GapFractionForTC99
5.0e-4, 1.3e-3, 2.8e-3
**
***** ..\..\TPA.INP
constant
SolubilityCl[kg/m3]
3.6e1
**
logtriangular
Solubility_U[kg/m3]
2.4e-6, 7.6e-3, 2.4e0
**
uniform
SolubilityCm[kg/m3]
2.4e-8,  2.4e-4
**
** rwr 6/16/06; SCR651; update Pu solubility
**               (see Scientific Notebook 172, pp. 104-110
**                by D. Pickett and 318E by S. Painter)
**uniform
**SolubilityPu[kg/m3]
**2.4e-6, 2.4e-4
usersuppliedpwisecdf
SolubilityPu[kg/m3]
23
7.11E-07, 0
3.79E-06, 0.05
6.27E-06, 0.1
8.41E-06, 0.15
1.07E-05, 0.2
1.37E-05, 0.25
1.68E-05, 0.3
2.02E-05, 0.35
2.42E-05, 0.4
2.86E-05, 0.45
3.36E-05, 0.5
4.01E-05, 0.55
4.61E-05, 0.6
5.53E-05, 0.65
6.73E-05, 0.7
8.22E-05, 0.75
1.00E-04, 0.8
1.25E-04, 0.85
1.68E-04, 0.9
2.55E-04, 0.95
3.23E-04, 0.97
```

```
5.15E-04, 0.99
1.32E-03, 1
**
loguniform
SolubilityTh[kg/m3]
2.3e-7, 2.3e-1
**
logtriangular
SolubilityRa[kg/m3]
2.3e-7, 2.3e-5, 2.3e-3
**
logtriangular
SolubilityPb[kg/m3]
2.1e-6, 6.6e-5, 2.1e-3
**
*****

***** SINGVEC04\tpa.inp
constant
GapFractionForNI59
0.0
**
triangular
GapFractionForCL36
5.4e-3, 1.1e-1, 3.2e-1
**
triangular
GapFractionForSE79
8.8e-3, 2.5e-2, 5.8e-2
**
***** ..\..\TPA.INP
constant
SolubilityCs[kg/m3]
1.35e2
**
logtriangular
SolubilityNi[kg/m3]
5.9e-5, 1.1e-1, 5.9e0
**
*****

***** SINGVEC04\tpa.inp
constant
GapFractionForNB94
0.0
**
constant
GapFractionForPU242
0.0
**
*jmm GapFraction additions for executing SCR656
**
constant
GapFractionForAC227
0.01
**
constant
GapFractionForAG108M
0.01
**
constant
GapFractionForAM242M
0.01
**
constant
GapFractionForC14
0.01
**
constant
GapFractionForCM243
0.01
**
```

```
constant
GapFractionForCM244
0.01
**
constant
GapFractionForCS137
0.01
**
constant
GapFractionForMO93
0.01
**
constant
GapFractionForNI63
0.01
**
constant
GapFractionForPA231
0.01
**
constant
GapFractionForPD107
0.01
**
constant
GapFractionForPU238
0.01
**
constant
GapFractionForPU241
0.01
**
constant
GapFractionForSM151
0.01
**
constant
GapFractionForSN121M
0.01
**
constant
GapFractionForSN126
0.01
**
constant
GapFractionForSR90
0.01
**
constant
GapFractionForU232
0.01
**
constant
GapFractionForU235
0.01
**
constant
GapFractionForU236
0.01
**
constant
GapFractionForZR93
0.01
**
*jmm end of GapFraction additions for executing SCR656
**
logbeta
InitialRadiusOfSFParticle[m]
4.42e-4, 4.72e-3, 3.549, 9.664
**
***** ..\..\TPA.INP
constant
```

```
SolubilitySe[kg/m3]
7.9e1
**
*****

***** SINGVEC04\tpa.inp
**
constant
CladdingCorrectionFactor
1.0
**
***** ..\..\TPA.INP
**
loguniform
SolubilityNb[kg/m3]
9.3e-8, 9.3e-6
**
*****

***** SINGVEC04\tpa.inp
uniform
SolubilityAm[kg/m3]
2.4e-8,  2.4e-4
**
loguniform
SolubilityNp[kg/m3]
1.1e-4, 5.9e-1
**
constant
Solubility_I[kg/m3]
1.29e2
**
constant
SolubilityTc[kg/m3]
9.93e1
**
constant
SolubilityCl[kg/m3]
3.6e1
**
logtriangular
Solubility_U[kg/m3]
2.4e-6, 7.6e-3, 2.4e0
**
***** ..\..\TPA.INP
uniform
SFWettedFraction_Initial_1
0.0, 1.0
**
*****

***** SINGVEC04\tpa.inp
uniform
SolubilityCm[kg/m3]
2.4e-8,  2.4e-4
**
***** ..\..\TPA.INP
uniform
SFWettedFraction_Initial_2
0.0, 1.0
**
uniform
SFWettedFraction_Initial_3
0.0, 1.0
**
uniform
SFWettedFraction_Initial_4
0.0, 1.0
**
uniform
SFWettedFraction_Initial_5
0.0, 1.0
```

```
**
uniform
SFWettedFraction_Initial_6
0.0, 1.0
**
uniform
SFWettedFraction_Initial_7
0.0, 1.0
**
uniform
SFWettedFraction_Initial_8
0.0, 1.0
**
uniform
SFWettedFraction_Initial_9
0.0, 1.0
**
uniform
SFWettedFraction_Initial_10
0.0, 1.0
**
uniform
SFWettedFraction_FAULTO
0.0, 1.0
**
uniform
SFWettedFraction_VOLCANO
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO1_1
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO1_2
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO1_3
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO1_4
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO1_5
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO1_6
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO1_7
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO1_8
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO1_9
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO1_10
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO2_1
0.0, 1.0
```

```
**
uniform
SFWettedFraction_SEISMO2_2
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO2_3
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO2_4
0.0, 1.0
**
*****

Resync Failed.  Files are too different.
***** SINGVEC04\tpa.inp
**
** rwr 6/16/06; SCR651; update Pu solubility
**               (see Scientific Notebook 172, pp. 104-110
**                by D. Pickett and 318E by S. Painter)
**uniform
**SolubilityPu[kg/m3]
**2.4e-6, 2.4e-4
usersuppliedpwisecdf
SolubilityPu[kg/m3]
23
7.11E-07, 0
3.79E-06, 0.05
6.27E-06, 0.1
8.41E-06, 0.15
1.07E-05, 0.2
1.37E-05, 0.25
1.68E-05, 0.3
2.02E-05, 0.35
2.42E-05, 0.4
2.86E-05, 0.45
3.36E-05, 0.5
4.01E-05, 0.55
4.61E-05, 0.6
5.53E-05, 0.65
6.73E-05, 0.7
8.22E-05, 0.75
1.00E-04, 0.8
1.25E-04, 0.85
1.68E-04, 0.9
2.55E-04, 0.95
3.23E-04, 0.97
5.15E-04, 0.99
1.32E-03, 1
**
loguniform
SolubilityTh[kg/m3]
2.3e-7, 2.3e-1
**
logtriangular
SolubilityRa[kg/m3]
2.3e-7, 2.3e-5, 2.3e-3
**
logtriangular
SolubilityPb[kg/m3]
2.1e-6, 6.6e-5, 2.1e-3
**
constant
SolubilityCs[kg/m3]
1.35e2
**
logtriangular
SolubilityNi[kg/m3]
5.9e-5, 1.1e-1, 5.9e0
**
constant
```

```
SolubilitySe[kg/m3]
7.9e1
**
loguniform
SolubilityNb[kg/m3]
9.3e-8, 9.3e-6
**
constant
SolubilityAc[kg/m3]
1.0
**
constant
SolubilityAg[kg/m3]
1.0
**
constant
Solubility_C[kg/m3]
1.0
**
constant
SolubilityMo[kg/m3]
1.0
**
constant
SolubilityPa[kg/m3]
1.0
**
constant
SolubilityPd[kg/m3]
1.0
**
constant
SolubilitySm[kg/m3]
1.0
**
constant
SolubilitySn[kg/m3]
1.0
**
constant
SolubilitySr[kg/m3]
1.0
**
constant
SolubilityZr[kg/m3]
***** ..\..\TPA.INP
**
uniform
SFWettedFraction_SEISMO2_5
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO2_6
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO2_7
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO2_8
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO2_9
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO2_10
0.0, 1.0
**
uniform
```

```
SFWettedFraction_SEISMO3_1
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO3_2
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO3_3
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO3_4
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO3_5
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO3_6
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO3_7
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO3_8
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO3_9
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO3_10
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO4_1
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO4_2
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO4_3
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO4_4
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO4_5
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO4_6
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO4_7
0.0, 1.0
**
uniform
SFWettedFraction_SEISMO4_8
0.0, 1.0
**
uniform
```

```
SFWettedFraction_SEISMO4_9
0.0, 1.0
*****
```

Attachment C

nuclides.dat modifications needed to carry out test

```
Comparing files nuclides.dat and ORIGS\NUCLIDES.DAT
***** nuclides.dat
   01     U238    U238     U238      U   238.0d0   4.468d9      0.10   3.32d-01   3.34d-01      4
   02    Cm246    Cm246    CM246     Cm   246.0d0   4.731d3      0.10   2.05d-01   1.00d+00      2
   03    Pu242    Pu242    PU242     Pu   242.0d0   3.869d5      0.10   3.77d+00   6.41d-02      2
   04   Am242m   Am242m   AM242M     Am   242.0d0   1.520d2      0.10   1.51d+01   1.00d+00      1
   05    Pu238    Pu238    PU238     Pu   238.0d0   8.774d1      0.10   3.22d+03   2.80d+03      2
***** ORIGS\NUCLIDES.DAT
   01     U238    U238     U238      U   238.0d0   4.468d9      0.10   3.32d-01   3.34d-01      4
   02    Cm246    Cm246    CM246     Cm   246.0d0   4.731d3      0.10   2.05d-01   0.00d+00      2
   03    Pu242    Pu242    PU242     Pu   242.0d0   3.869d5      0.10   3.77d+00   6.41d-02      2
   04   Am242m   Am242m   AM242M     Am   242.0d0   1.520d2      0.10   1.51d+01   0.00d+00      1
   05    Pu238    Pu238    PU238     Pu   238.0d0   8.774d1      0.10   3.22d+03   2.80d+03      2
*****

***** nuclides.dat
   07    Th230    Th230    TH230     Th   230.0d0   7.700d4      0.01   4.74d-04   7.02d-05      2
   08    Ra226    Ra226    RA226     Ra   226.0d0   1.600d3      0.10   1.00d+00   1.01d-04      3
   09    Pb210    Pb210    PB210     Pb   210.0d0   2.230d1      1.00   1.00d+00   1.09d-07      1
   10    Cm243    Cm243    CM243     Cm   243.0d0   2.850d1      0.10   2.23d+01   1.00d+00      2
   11    Am243    Am243    AM243     Am   243.0d0   7.380d3      0.10   3.21d+01   4.83d-01      2
***** ORIGS\NUCLIDES.DAT
   07    Th230    Th230    TH230     Th   230.0d0   7.700d4      0.01   4.74d-04   7.02d-05      2
   08    Ra226    Ra226    RA226     Ra   226.0d0   1.600d3      0.10   0.00d+00   1.01d-04      3
   09    Pb210    Pb210    PB210     Pb   210.0d0   2.230d1      1.00   0.00d+00   1.09d-07      1
   10    Cm243    Cm243    CM243     Cm   243.0d0   2.850d1      0.10   2.23d+01   0.00d+00      2
   11    Am243    Am243    AM243     Am   243.0d0   7.380d3      0.10   3.21d+01   4.83d-01      2
*****

***** nuclides.dat
   15    Ac227    Ac227    AC227     Ac   227.0d0   2.177d1      0.10   2.79d-05   5.79d-02      1
   16    Cm245    Cm245    CM245     Cm   245.0d0   8.499d3      0.10   6.00d-01   1.00d+00      2
   17    Pu241    Pu241    PU241     Pu   241.0d0   1.440d1   1000.00   1.72d+04   5.27d+02      1
***** ORIGS\NUCLIDES.DAT
   15    Ac227    Ac227    AC227     Ac   227.0d0   2.177d1      0.10   2.79d-05   5.79d-02      1
   16    Cm245    Cm245    CM245     Cm   245.0d0   8.499d3      0.10   6.00d-01   0.00d+00      2
   17    Pu241    Pu241    PU241     Pu   241.0d0   1.440d1   1000.00   1.72d+04   5.27d+02      1
*****

***** nuclides.dat
   20     U233    U233     U233      U   233.0d0   1.585d5      0.10   8.43d-05   7.86d-01      4
   21    Th229    Th229    TH229     Th   229.0d0   7.339d3      0.10   1.00d+00   2.96d-03      2
   22    Cm244    Cm244    CM244     Cm   244.0d0   1.811d1   1000.00   2.81d+03   1.00d+00      2
   23    Pu240    Pu240    PU240     Pu   240.0d0   6.537d3      0.10   5.91d+02   4.40d+01      2
***** ORIGS\NUCLIDES.DAT
   20     U233    U233     U233      U   233.0d0   1.585d5      0.10   8.43d-05   7.86d-01      4
   21    Th229    Th229    TH229     Th   229.0d0   7.339d3      0.10   0.00d+00   2.96d-03      2
   22    Cm244    Cm244    CM244     Cm   244.0d0   1.811d1   1000.00   2.81d+03   0.00d+00      2
   23    Pu240    Pu240    PU240     Pu   240.0d0   6.537d3      0.10   5.91d+02   4.40d+01      2
*****

***** nuclides.dat
   25     U232    U232     U232      U   232.0d0   7.200d1      0.10   2.77d-02   3.77d-02      4
   26    Sm151    Sm151    SM151     Sm   151.0d0   8.999d1      1.00   4.63d+02   1.00d+00      1
   27    Cs137    Cs137    CS137     Cs   137.0d0   3.000d1      1.00   5.76d+04   1.10d+05      1
***** ORIGS\NUCLIDES.DAT
   25     U232    U232     U232      U   232.0d0   7.200d1      0.10   2.77d-02   3.77d-02      4
   26    Sm151    Sm151    SM151     Sm   151.0d0   8.999d1      1.00   4.63d+02   0.00d+00      1
   27    Cs137    Cs137    CS137     Cs   137.0d0   3.000d1      1.00   5.76d+04   1.10d+05      1
*****

***** nuclides.dat
   30    Sn126    Sn126    SN126     Sn   126.0d0   1.000d5      1.00   9.00d-01   2.03d+00      1
   31   Sn121m   Sn121m   SN121M     Sn   121.0d0   4.997d1      1.00   3.86d+00   1.00d+00      1
   32   Ag108m   Ag108m   AG108M     Ag   108.0d0   4.180d2      1.00   1.49d-02   1.00d+00      1
   33    Pd107    Pd107    PD107     Pd   107.0d0   6.496d6      1.00   1.94d-01   1.00d+00      1
```

```
   34      Tc99    Tc99      TC99      Tc     99.0d0   2.130d5      10.00    1.62d+01    7.23d+01        1
   35      Mo93    Mo93      MO93      Mo     93.0d0   3.498d3       1.00    7.09d-02    1.00d+00        1
   36      Nb94    Nb94      NB94      Nb     94.0d0   2.030d4       1.00    1.46d+00    1.00d+00        1
   37      Zr93    Zr93      ZR93      Zr     93.0d0   1.530d6       1.00    2.17d+00    1.00d+00        1
   38      Sr90    Sr90      SR90      Sr     90.0d0   2.912d1       1.00    3.82d+04    1.00d+05        1
***** ORIGS\NUCLIDES.DAT
   30     Sn126   Sn126     SN126     Sn    126.0d0   1.000d5       1.00    9.00d-01    2.03d+00        1
   31    Sn121m  Sn121m    SN121M     Sn    121.0d0   4.997d1       1.00    3.86d+00    0.00d+00        1
   32    Ag108m  Ag108m    AG108M     Ag    108.0d0   4.180d2       1.00    1.49d-02    0.00d+00        1
   33     Pd107   Pd107     PD107     Pd    107.0d0   6.496d6       1.00    1.94d-01    0.00d+00        1
   34      Tc99    Tc99      TC99      Tc     99.0d0   2.130d5      10.00    1.62d+01    7.23d+01        1
   35      Mo93    Mo93      MO93      Mo     93.0d0   3.498d3       1.00    7.09d-02    0.00d+00        1
   36      Nb94    Nb94      NB94      Nb     94.0d0   2.030d4       1.00    1.46d+00    0.00d+00        1
   37      Zr93    Zr93      ZR93      Zr     93.0d0   1.530d6       1.00    2.17d+00    0.00d+00        1
   38      Sr90    Sr90      SR90      Sr     90.0d0   2.912d1       1.00    3.82d+04    1.00d+05        1
*****

***** nuclides.dat
   39      Se79    Se79      SE79      Se     79.0d0   1.100d6       1.00    1.08d-01    2.05d-01        1
   40      Ni63    Ni63      NI63      Ni     63.0d0   9.200d1       1.00    5.42d+02    1.00d+00        1
   41      Ni59    Ni59      NI59      Ni     59.0d0   8.000d4       1.00    4.52d+00    1.00d+00        1
   42      Cl36    Cl36      CL36      Cl     36.0d0   3.010d5       1.00    1.72d-02    1.00d+00        1
   43       C14     C14       C14       C     14.0d0   5.729d3       0.10    7.60d-01    1.00d+00        1
   44     Jc246   Jc246     JC246      Jc    246.0d0   4.731d3       0.00    0.00d+00    0.00d+00        2
***** ORIGS\NUCLIDES.DAT
   39      Se79    Se79      SE79      Se     79.0d0   1.100d6       1.00    1.08d-01    2.05d-01        1
   40      Ni63    Ni63      NI63      Ni     63.0d0   9.200d1       1.00    5.42d+02    0.00d+00        1
   41      Ni59    Ni59      NI59      Ni     59.0d0   8.000d4       1.00    4.52d+00    0.00d+00        1
   42      Cl36    Cl36      CL36      Cl     36.0d0   3.010d5       1.00    1.72d-02    0.00d+00        1
   43       C14     C14       C14       C     14.0d0   5.729d3       0.10    7.60d-01    0.00d+00        1
   44     Jc246   Jc246     JC246      Jc    246.0d0   4.731d3       0.00    0.00d+00    0.00d+00        2
*****
```

Appendix D

cumrel.res output file

Input file tpa.inp as supplied with TPA Version 5.1betaE Code.
Added Element specific parameters to test SCR656.
TPA 5.1betaE, Job started: Fri Mar 09 14:29:24 2007
Cumulative Releases from EBS, UZ, and SZ by Nuclide

Summed Over All Subareas - Values for Each Vector

vector unitless	nuclide unitless	ebscumrl Ci	uzcumrl Ci	szcumrl Ci
1	Cm246	2.3768E+00	0.0000E+00	0.0000E+00
1	U238	8.7056E-01	0.0000E+00	0.0000E+00
1	Cm245	7.4684E+00	0.0000E+00	0.0000E+00
1	Am241	3.5534E+02	0.0000E+00	0.0000E+00
1	Np237	4.5201E+02	5.9458E+01	1.4104E-07
1	U233	5.8526E-01	2.7768E-02	1.2614E-11
1	Th229	1.8243E+00	7.7537E-06	1.1371E-15
1	Am243	4.8240E+02	0.0000E+00	0.0000E+00
1	Pu239	1.4693E+02	0.0000E+00	0.0000E+00
1	Pu240	1.0886E+02	0.0000E+00	0.0000E+00
1	U234	3.0823E+00	0.0000E+00	0.0000E+00
1	Th230	2.3279E-01	0.0000E+00	0.0000E+00
1	Ra226	1.2164E+02	0.0000E+00	0.0000E+00
1	Pb210	3.0935E+02	0.0000E+00	0.0000E+00
1	Cs135	6.2638E+02	5.4391E+02	0.0000E+00
1	I129	3.1066E+01	3.0782E+01	2.8857E+01
1	Tc99	1.6072E+04	1.5923E+04	1.5007E+04
1	Ni59	1.5031E+03	1.3676E+02	0.0000E+00
1	Se79	8.2077E+01	8.0784E+01	6.9188E+01
1	Nb94	1.4939E+00	0.0000E+00	0.0000E+00
1	Cl36	9.7173E+01	9.6812E+01	9.5667E+01
1	Ac227	2.2130E-11	2.6720E-12	0.0000E+00
1	Ag108m	1.8101E+00	1.4349E+00	0.0000E+00
1	Am242m	9.3487E-04	0.0000E+00	0.0000E+00
1	C14	3.2135E+02	0.0000E+00	0.0000E+00
1	Cm243	1.4196E-13	0.0000E+00	0.0000E+00
1	Cm244	2.0783E-06	0.0000E+00	0.0000E+00
1	Cs137	9.6075E-07	5.2206E-11	0.0000E+00
1	Mo93	6.5102E+01	6.3210E+01	0.0000E+00
1	Ni63	6.3702E-03	5.8132E-14	0.0000E+00
1	Pa231	2.3798E+03	2.3675E+03	0.0000E+00
1	Pd107	2.0192E+02	2.0026E+02	0.0000E+00
1	Pu238	3.1077E-05	0.0000E+00	0.0000E+00
1	Pu241	5.9972E-15	0.0000E+00	0.0000E+00
1	Pu242	1.2929E+00	0.0000E+00	0.0000E+00
1	Sm151	1.5941E-02	6.3503E-03	0.0000E+00
1	Sn121m	2.1534E-07	3.6215E-08	0.0000E+00
1	Sn126	7.4290E+02	7.3511E+02	0.0000E+00
1	Sr90	3.5284E-07	1.8732E-08	0.0000E+00
1	U232	7.9392E-11	0.0000E+00	0.0000E+00
1	U235	4.1786E-02	0.0000E+00	0.0000E+00
1	U236	6.1911E-01	0.0000E+00	0.0000E+00
1	Zr93	1.3738E+03	1.3564E+03	0.0000E+00
1	Jc246	7.3805E-01	0.0000E+00	0.0000E+00
1	Jc245	2.0090E+00	0.0000E+00	0.0000E+00
1	Ja241	6.4421E+01	0.0000E+00	0.0000E+00
1	Jt229	6.4318E-01	0.0000E+00	0.0000E+00
1	Ja243	8.3868E+01	0.0000E+00	0.0000E+00
1	Jp239	2.6058E+00	0.0000E+00	0.0000E+00
1	Jp240	2.0251E+00	0.0000E+00	0.0000E+00
1	Jt230	8.3588E-02	0.0000E+00	0.0000E+00
1	Ja242m	1.3076E-04	0.0000E+00	0.0000E+00
1	Jc243	2.6781E-14	0.0000E+00	0.0000E+00
1	Jc244	2.3529E-06	0.0000E+00	0.0000E+00
1	Jp238	2.5322E-07	0.0000E+00	0.0000E+00
1	Jp241	2.2162E-16	0.0000E+00	0.0000E+00
1	Jp242	2.4224E-02	0.0000E+00	0.0000E+00

SCR - 658

TPA 5.1/ Beta D

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR658	**2. Software Title and Version:** TPA51betaD	**3. Project No:** 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *releaset.f,nfenv.f*
The flow into the waste package is not equal to the flow out of the waste package even though the bathtub is filled and flow out and flow in are set equal to each other in *releaset.f* (i.e., the RELEASET standalone code). These flows should be equal once the bathtub is filled or if the water contact mode is flow-through., The files *ebssf.dat*, *ebsglass.dat*, and *infilper.res* contain information showing the difference in flows.

Also, seepage should occur only if the temperature of the drift wall temperature (non-degraded drift) or the drip shield temperature (degraded drift) is less than the seepage threshold temperature.

5. Change Requested by: R. RIce Date: 8-18-06	**6. Change Authorized by** (*Software Developer*): R. Janetzke Date: 8-18-06

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):
Within *releaset.f*, the initialization of the array containing the flow rate out of the waste package was moved outside of the loop for the failure type. Also, counting the number of failed waste packages was done only for the first time step and the flow rate in and out of the waste package was written only for the first radionuclide of the first chain in the *ebsnef.dat* file (note that the *ebsnef.dat* file is renamed to *ebssf.dat* and *ebsglass.dat* in EBSREL).

In *nfenv.f*, set the following conditions: seepage should be set equal to zero if the temperature of the drift wall (for the non-degraded drift) or the drip shield (for the degraded drift) is greater than the seepage threshold; otherwise, seepage should not be reset.

8. Implemented by: R. Rice	**Date:** 8-18-06

9. Description of Acceptance Tests:

See Attachment A

10. Tested by: J. Mancillas	**Date:** 14 Sept 2006

CNWRA Form TOP-5 (05/2000)

UPDATE REQUIREMENTS for TPA.INP

SCR 658

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	**Module**	**Parameter Name**	**Description** (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	**Distribution**	**Range**	**Justification** *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	**Source**
(No Updates)							

Attachment A
Test Plan for TPA SCR658

Test Plan Name: Test Plan for SCR658

Tested By:	James Mancillas	Date:	14 September 2006
Host Machine:	TPA	Host OS:	Windows XP SP2
Baseline Version:	TPA51betaD	Test Version:	TPA51betaF

System Level (SL) Tests

SL-1. Name: Retest SCR651-- Drip shield temperature used to define the onset of seepage

Path for run directory:

Baseline	[TPA]D:\Mancillas\SCR658\test1\run1D
Test version	[TPA]D:\Mancillas\SCR658\test1\run1F & run2F

Path for archive of results:

Baseline	[CD: titled SCR658 Testing]: \SCR658\test1\run1D
Test version	[CD: titled SCR658 Testing]: \SCR658\test1\run1F & run2F

Environment variables:

Baseline	TPA_DATA=D:\Mancillas\SCR658\tpa51betaD TPA_TEST=D:\Mancillas\SCR658\tpa51betaD
Test version	TPA_DATA=D:\Mancillas\SCR658\tpa51betaF TPA_TEST=D:\Mancillas\SCR658\tpa51betaF

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): Append All

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: Seepage into WPs is determined by comparison of the seepage critical temperature to either the repository temperature or the DS temperature. When the DS is surrounded by rubble the DS temperature is used, otherwise the

repository temperature is used.

- objective Verify that the appropriate temperature comparison is used to establish the flow of seepage on to WPs.

- assumptions None, other than those made within the TPA code

- constraints None

- output files to compare or examine *driftfail.rlt, nfenv.rlt,*

- step by step test procedure to be used

1) Perform a mean value TPA realization for 10,000 yrs for 10 subareas, with and without seismicity and natural drift degradation.
2) Examine *driftfail.rlt* to determine state of rubble surrounding DS.
3) Examine *nfenv.rlt* to determine the time seepage hits the WP and the temperature of the repository and DS at that time.

- pass fail criteria

1) If the DS is surrounded by rubble (defined as when the equivalent backfill diameter B equals 5.5 m) the seepage to the WP should be determined by the time at which the DS temperature drops below the critical seepage temperature

2) If the DS is not surrounded by rubble, the seepage to the WP should be determined by the time a which the repository temperature drops below the critical seepage temperature.

Test Results: The test version of the TPA code was run with and without drift degradation and seismicity for 10,000 yrs, respectively named case 1 and case 2. In both cases the TPA code was run using mean values, with the critical seepage temperature set to 108.33 C.

-criterion 1

Case 1 Drift degradation and seismicity were active.

Under these conditions, rubble accumulation around the DS occurs very early, typically within the first several hundred years. The test version of the TPA code executed successfully and the screen output was captured in the file \SCR658\test1\run1F*out*.

An examination of the data for SA 1 in the append files *driftfail.rlt*, and *nfenv.rlt* located in \SCR658\test1\run1F, show that the equivalent backfill diameter reached 5.5 m at a time of 168 years and that the repository temperature and DS temperatures drop below the critical seepage temperature at the times 574.9 and 1313.8 years, respectfully.
Under these circumstances, the earliest time allowed for WP seepage is 1313.8 yrs. Further examination of *nfenv.rlt,* shows that the parameter **qm3hit**, which records the seepage hitting a WP, is zero until the time 1313.8 yrs, after which it remains a positive value . These results are consistent with the expected

TPA behavior, and are submitted as evidence that this SCR has been properly implemented.

-criterion 2

Case 1 Drift degradation and seismicity were not active.

Under these conditions, rubble never accumulates around the DS. The test version of the TPA code executed successfully and the screen output was captured in the file \SCR658\test1\run2F*out*.

An examination of the data for SA 1 in the append files *driftfail.rlt*, and *nfenv.rlt* located in \SCR658\test1\run2F, show that the equivalent backfill diameter never reaches 5.5 m and that the repository temperature and DS temperatures drop below the critical seepage temperature at the times 606.8 and 657.5 years, respectfully.
Under these circumstances, the earliest time allowed for WP seepage is 606.8 yrs. Further examination of *nfenv.rlt,* shows that the parameter **qm3hit**, which records the seepage hitting a WP, is zero until the time 606.8 yrs, after which it remains a positive value . These results are consistent with the expected TPA behavior, and are submitted as evidence that SCR658 has been properly implemented and that the failed tests of SCR651 have been properly addressed.

- overall test status: **PASS**

SL-2. Name: Retest SCR651-- Test of weighted average of the water entering and leaving the WP

Path for run directory:

Baseline	[TPA]D:\Mancillas\SCR658\test2\run1D & run2D
Test version	[TPA]D:\Mancillas\SCR658\test2\run1F & run2F

Path for archive of results:

Baseline	[CD: titled SCR658 Testing]: \SCR658\test2\run1D & run2D
Test version	[CD: titled SCR658 Testing]: \SCR658\test2\run1F & run2F

Environment variables:

Baseline	TPA_DATA=D:\Mancillas\SCR658\tpa51betaD TPA_TEST=D:\Mancillas\SCR658\tpa51betaD
Test version	TPA_DATA=D:\Mancillas\SCR658\tpa51betaF TPA_TEST=D:\Mancillas\SCR658\tpa51betaF

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): Append All, natural drift degradation deactivate

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: The average flow into and out of a WP has been included in the output of the file *infilper.res.* This change was implemented in SCR651, but the recorded flows were incorrectly calculated.

- objective The objective of this test is to verify the recorded average flow into and out of WP in the data file *infilper.res.*

- assumptions None, other than those made within the TPA code.

- constraints NONE

- output files to compare or examine *infilper.res, releaset.f*

- step by step test procedure to be used
1) examine the changes made to the TPA code file *releaset.f*
2) perform a mean value TPA realization of the test version and basecase TPA codes with natural

drift degradation turned off.
3) examine the WP average flows recorded in the output file *infilper.res*.

- pass fail criteria

1) The changes made to the file *releaset.f* should be logical and consistent with the intent of properly calculating the average flow of Wps.
2)The file *infilper.res* should reflect the changes made within the TPA code.

Test Results:

- criterion 1

In SCR651 the calculation and recording of the average WP flows was included into the TPA code. However, in the calculation of the average values in *releaset.f*, the parameter **nwptotal** was improperly "exposed" to a *do loop*, which resulted in a **nwptotal** value which was erroneously large. This error caused the average flow values to be erroneously small. The following excerpts show that this parameter has been protected from the *do loop* by a conditional statement. In addition, the initialization of the array containing the flow rate out of the WP was moved outside of the loop for failure.

The following text excerpt is from the file comparison of the baseline and test versions of the TPA code *releaset.f*. This file was generated using the MS command fc tpa51betaF\codes*releaset.f* tpa51betaD\codes*releaset.f* > *releaset.f_fc* and is saved in the following location [CD: titled SCR658 Testing]\SCR658\files_fc.

```
*****************************************************************************
***** TPA51BETAF\CODES\releaset.f
          qintotal(itime) = 0.0d0

cc rwr 8/18/06; SCR658; ensure qin and qout are consistent
cc initialize the "totqoutbyWPfailtype(lc,k)" array here
          do lc=1,9
            totqoutbyWPfailtype(lc,k) = 0.0d0
          end do

        enddo
***** TPA51BETAD\CODES\RELEASET.F
          qintotal(itime) = 0.0d0
        enddo
*****

***** TPA51BETAF\CODES\releaset.f
            qintotal(i) = qintotal(i) + qin(i) * dble(numwp)

cc rwr 8/18/06; SCR658; ensure qin and qout are consistent
cc accumulate WPs at the first time step
cc                nwpstotal = nwpstotal + numwp
            if (i .eq. 1) then
```

```
              nwpstotal = nwpstotal + numwp
            endif

***** TPA51BETAD\CODES\RELEASET.F
            qintotal(i) = qintotal(i) + qin(i) * dble(numwp)
            nwpstotal = nwpstotal + numwp

*****

***** TPA51BETAF\CODES\releaset.f
          flowrate_out(k) = 0.0

cc rwr 8/18/06; SCR658; ensure qin and qout are consistent
cc initialize the "totqoutbyWPfailtype(lc,k)" array above
cc c css 1/31/06 - SCR611; initialize totqoutbyWPfailtype array
cc           do lc=1,9
cc             totqoutbyWPfailtype(lc,k) = 0.0
cc           end do
cc c end change:  SCR611

        end do
***** TPA51BETAD\CODES\RELEASET.F
          flowrate_out(k) = 0.0
c css 1/31/06 - SCR611; initialize totqoutbyWPfailtype array
          do lc=1,9
             totqoutbyWPfailtype(lc,k) = 0.0
          end do
c end change:  SCR611
        end do
*****

***** TPA51BETAF\CODES\releaset.f

        DO itemp = 2, ntemp
***** TPA51BETAD\CODES\RELEASET.F

c  jwm        write(99,*) flowrate_in(itemp),flowrate_out(itemp)

        DO itemp = 2, ntemp
*****

***** TPA51BETAF\CODES\releaset.f
cc      IF ( waste_package_fill_start.ne.waste_package_fill_stop ) THEN
        IF ( bathflow .eq. 0 ) THEN
***** TPA51BETAD\CODES\RELEASET.F
cc      IF ( waste_package_fill_start.ne.waste_package_fill_stop ) THEN
cc jwm
        print*,'bathflow = ', bathflow, itype

        IF ( bathflow .eq. 0 ) THEN
*****

***** TPA51BETAF\CODES\releaset.f
cc c end change:  SCR611

cc rwr 8/18/06; SCR658; ensure qin and qout are consistent
cc only write here for the first nuclide of the first chain
cc               if (i .eq. 1) then
              if (k .eq. 1 .and. i .eq. 1) then
                if (nwpstotal .eq. 0) then
***** TPA51BETAD\CODES\RELEASET.F
cc c end change:  SCR611
              if (i .eq. 1) then
                if (nwpstotal .eq. 0) then
```

*****
****
This text and the baseline and test version of the TPA code *releaset.f* are presented as evidence that SCR658 has been properly implemented.

- criterion 2

The following text are from the test version and baseline version of the TPA code. Natural drift degradation deactivated so that the changes in critical seepage temperature do not affect the flow characteristics in to the WP (seismicity remained activate to ensure the DS would fail, thus allowing flow into the WP near field). The average flow into and out of SA 1 failed WPs is shown

Test version
\SCR658\test2\runF2\infilper.res
****

vector	subarea	time	infil	diver&ref	fow	fmult	fr	fd	waveflowin	waveflowout
unitless	unitless	yr	mm/yr	mm/yr	mm/yr	mm/yr	mm/yr	m/yr	mm/yr	mm/yr
1	1	4.4992E+03	4.8620E+01	4.8594E+01	4.7415E+01	4.2672E+01	4.2672E+01	0.0000E+00	0.0000E+00	0.0000E+00
1	1	4.6068E+03	4.8629E+01	4.8629E+01	4.7499E+01	4.2748E+01	4.2748E+01	0.0000E+00	0.0000E+00	0.0000E+00
1	1	4.7170E+03	4.8629E+01	4.8629E+01	4.7550E+01	4.7550E+01	4.7550E+01	4.7788E+00	4.7788E+00	0.0000E+00
1	1	4.8297E+03	4.8629E+01	4.8629E+01	4.7603E+01	4.7603E+01	4.7603E+01	4.8377E+00	4.8377E+00	4.8349E+00
1	1	4.9451E+03	4.8963E+01	4.8956E+01	4.7977E+01	4.7977E+01	4.7977E+01	4.9311E+00	4.9312E+00	4.9220E+00
1	1	5.0632E+03	4.9252E+01	4.9247E+01	4.8262E+01	4.8262E+01	4.8262E+01	5.0174E+00	5.0174E+00	5.0089E+00
1	1	5.1840E+03	4.9252E+01	4.9252E+01	4.8267E+01	4.8267E+01	4.8267E+01	5.0763E+00	5.0764E+00	5.0704E+00

****

Base case
\SCR658\test2\runD2\infilper.res
****

vector	subarea	time	infil	diver&ref	fow	fmult	fr	fd	waveflowin	waveflowout
unitless	unitless	yr	mm/yr	mm/yr	mm/yr	mm/yr	mm/yr	m/yr	mm/yr	mm/yr
1	1	4.4992E+03	4.8620E+01	4.8594E+01	4.7415E+01	4.2672E+01	4.2672E+01	0.0000E+00	0.0000E+00	0.0000E+00
1	1	4.6068E+03	4.8629E+01	4.8629E+01	4.7499E+01	4.2748E+01	4.2748E+01	0.0000E+00	0.0000E+00	0.0000E+00
1	1	4.7170E+03	4.8629E+01	4.8629E+01	4.7550E+01	4.7550E+01	4.7550E+01	4.7788E+00	2.3775E-02	0.0000E+00
1	1	4.8297E+03	4.8629E+01	4.8629E+01	4.7603E+01	4.7603E+01	4.7603E+01	4.8377E+00	2.4068E-02	2.4054E-02
1	1	4.9451E+03	4.8963E+01	4.8956E+01	4.7977E+01	4.7977E+01	4.7977E+01	4.9311E+00	2.4533E-02	2.4488E-02
1	1	5.0632E+03	4.9252E+01	4.9247E+01	4.8262E+01	4.8262E+01	4.8262E+01	5.0174E+00	2.4962E-02	2.4920E-02
1	1	5.1840E+03	4.9252E+01	4.9252E+01	4.8267E+01	4.8267E+01	4.8267E+01	5.0763E+00	2.5256E-02	2.5227E-0

****

An examination of the screen capture for both the baseline and test versions of the TPA code SCR658\test2\runF1*out*, SCR658\test2\runD1*out* show that the each version of the TPA code has generated 3 WP failures from initial defects. In the base line version of the TPA code the WP flows are 201 times smaller than the test version of the TPA code. This is because in the baseline version of the TPA code the parameter **nwptotal** is exposed to a do loop in time, where at each time step the number of failed WP increases by 3 (the number initially failed). For this realization there are 201 time steps, resulting in the final number of failed WP being 603 (201x 3) instead of 3. The average flow is determined by dividing the total flow by the number of failed WP. In the baseline version this division is erroneously by 603, in the test version the division is correctly by 3. These results are presented as evidence that SCR658 has been implemented properly, and that failed tests in SCR651 have been properly addressed.

Note: The average flow into and out of the WP do not need to be equal.

- overall test status: **PASS**

SCR - 659

TPA 5.1/ Beta M

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 659	**2. Software Title and Version:** TPA 5.1BetaM	**3. Project No:** 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *tpa.inp, mechfail_ds.def, codes/mechfail.f, mechdrive.f*

1. The BulkingFactorRockTypeOne{Two}Subarea_1{2..10} distribution has not been updated in accordance with the Drip Shield-Waste Package Mechanical Interaction report (Ibarra, L., et. al, 2006).

2. The drip shield temperature multiplier calculation is hardcoded.

3. The user may want to disable drip shield temperature multiplier calculation and/or disable creep multiplier calculation.

4. Some functions use hardcoded values to evaluate discontinuous polynomials.

5. Change Requested by: L. Ibarra	**Date:** 2-14-2007
6. Change Authorized by (*Software Developer*): R. Janetzke	**Date:** 2-14-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

1. Updated the BulkingFactorRockTypeOne{Two}Subarea_1{2..10} from a uniform distribution to a beta distribution.

2. Modified subroutine **dtempFactor()** to interpolate over a set of values supplied in *mechfail_ds.def*. Added an interpolation table to *mechfail_ds.def* in a new Section 3.

3. Added two flags to *tpa.inp*: `CalculateTemperatureMultiplierFlag(yes=1,no=0)` and `CalculateCreepMultiplierFlag(yes=1,no=0)`. These two flags were added to *mechfail_ds.def* in Section 4.

4. Removed hardcoded values from function **dsCorrosion()** and function **dwpCapacity()** in file *mechfail.f*.

8. Implemented by: G. Adams	**Date:** 2-27-2007

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

L. Ibarra reviewed modifications in *mechfail.f* to the routines **dtempFactor()**, **dsCorrosion()**, and **dwpCapacity()**, and to the input files *tpa.inp* and *mechfail_ds.def*.

Code review accomplished by: L. Ibarra	**Date:** 2-28-2007

10. Description of Acceptance Tests:

SUCCESSFULLY PASSED, SEE ATTACHMENT FOR DETAILS.

11. Tested by: R. Kazban	**Date:** 3-15-2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for *TPA.INP*

SCR 659

Status (***ADD, DELETE, MODIFY TO, MODIFY FROM***)	**Module**	**Parameter Name**	**Description** (***Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.***)	**Distribution**	**Range**	**Justification** ***1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.***	**Source**
MODIFY FROM	MECHFAIL	BulkingFactorRock TypeOneSubarea_1[ ]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeOneSubarea_ 1[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY FROM	MECHFAIL	BulkingFactorRo ck TypeOneSubare a_2[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRo ck TypeOneSubare a_2[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	

MODIFY FROM	MECHFAIL	BulkingFactorRock TypeOneSubarea_3[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeOneSubarea_3[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY FROM	MECHFAIL	BulkingFactorRock TypeOneSubarea_4[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeOneSubarea_4[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY FROM	MECHFAIL	BulkingFactorRock TypeOneSubarea_5[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeOneSubarea_5[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY FROM	MECHFAIL	BulkingFactorRock TypeOneSubarea_6[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeOneSubarea_6[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	

MODIFY FROM	MECHFAIL	BulkingFactorRock TypeOneSubarea_7[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeOneSubarea_7[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY FROM	MECHFAIL	BulkingFactorRock TypeOneSubarea_8[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeOneSubarea_8[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY FROM	MECHFAIL	BulkingFactorRock TypeOneSubarea_9[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeOneSubarea_9[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY FROM	MECHFAIL	BulkingFactorRock TypeOneSubarea_10[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeOneSubarea_10[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	

MODIFY FROM	MECHFAIL	BulkingFactorRock TypeTwoSubarea_1[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeTwoSubarea_1[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY FROM	MECHFAIL	BulkingFactorRock TypeTwoSubarea_2[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeTwoSubarea_2[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY FROM	MECHFAIL	BulkingFactorRock TypeTwoSubarea_3[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeTwoSubarea_3[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY FROM	MECHFAIL	BulkingFactorRock TypeTwoSubarea_4[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeTwoSubarea_4[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	

MODIFY FROM	MECHFAIL	BulkingFactorRock TypeTwoSubarea_5[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeTwoSubarea_5[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY FROM	MECHFAIL	BulkingFactorRock TypeTwoSubarea_6[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeTwoSubarea_6[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY FROM	MECHFAIL	BulkingFactorRock TypeTwoSubarea_7[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeTwoSubarea_7[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY FROM	MECHFAIL	BulkingFactorRock TypeTwoSubarea_8[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeTwoSubarea_8[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	

MODIFY FROM	MECHFAIL	BulkingFactorRock TypeTwoSubarea_9[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeTwoSubarea_9[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY FROM	MECHFAIL	BulkingFactorRock TypeTwoSubarea_10[]	To determine the degradation volume.	uniform	1.15, 1.25	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
MODIFY TO	**MECHFAIL**	BulkingFactorRock TypeTwoSubarea_10[]	To determine the degradation volume.	beta	1.0, 2.0, 23.1747, 92.6989	Ibarra et. al., Drip Shield - Waste Package Mechanical Interation, 2006	
ADD	MECHFAIL	`CalculateTemperatureMultiplierFlag(yes=1,no=0)`	If yes, perform temperature multiplier calculation	iflag	1		
ADD	MECHFAIL	`CalculateCreepMultiplierFlag(yes=1,no=0)`	If yes, perform creep multiplier calculation	iflag	1		

ATTACHMENT - Description of Acceptance Tests

1. Using tpa51betaM and tpa51betaT, it was verified that the same results were obtained for both codes when the BulkingFactorRockTypeOne{Two}Subare_1{2...10} was set to uniform 1.15, 1.25. A total of 5 verification runs were performed for a randomly selected realizations and subareas as follows:

- tpa51betaT *tpa.inp* file was modified to set the BulkingFactorRockTypeOne{Two}Subare_1{2...10} to uniform 1.15, 1.25;

- tpa51betaT *tpa.e* was executed on Spock to obtain *mechfail_ds{wp}.dat*, *mechfail_ds{wp}.dbg*, and *mechfail_ds{wp}.inp* files;

- tpa51betaM *mechfail.e* was executed on Spock using tpa51betaT *mechfail_ds{wp}.inp* as input files to generate new *mechfail_ds{wp}.dat* and *mechfail_ds{wp}.dbg* files;

- tpa51betaT *mechfail_ds{wp}.dat* and *mechfail_ds{wp}.dbg* were compared with tpa51betaM *mechfail_ds{wp}.dat* and *mechfail_ds{wp}.dbg*, and the comparison results were stored as *ds{wp}_dat{dbg}.out* files;

- *ds{wp}_dat{dbg}.out* files showed no difference between tpa51betaT and tpa51betaM *mechfail_ds{wp}.dat* and *mechfail_ds{wp}.dbg* files except the difference in the date and time data lines.

2. Using tpa51betaT, the code was executed on Spock with CalculateTemparatureMultiplierFlag(yes=1,no=0) set to 0. According to *mechfail_ds.dbg* and *mechfail_ds.dat* files, for this run the temperature multiplier was equal to 1.0 in *mechfail_ds.dbg* until the first failure was reported in *mechfail_ds.dat.*

3. Using tpa51betaT, the code was executed on Spock with CalculateCreepMultiplierFlag(yes=1,no=0) set to 0. According to *mechfail_ds.dbg* and *mechfail_ds.dat* files, for this run the creep multiplier was equal to 1.0 in *mechfail_ds.dbg* until the first failure was reported in *mechfail_ds.dat.*

SCR - 660

TPA 5.1/ Beta D

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 660	2. Software Title and Version: TPA 5.1BetaD	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f, mechdrive.f, mechfail.f, ebsfail.f, driftdrive.f,* and *SIZES.INC*

1) The MECHFAIL module is using the waste package outer layer thickness that includes localized corrosion. It should instead be using the waste package outer layer thickness for general corrosion.
2) Result files for waste package and drip shield mechanical failure need to be included to more easily track waste package and drip shield mechanical failures.
3) NEFTRAN fails for long simulation periods. Array variable, BF, dimensions are exceeded for one or more realizations.

5. Change Requested by:	6. Change Authorized by (*Software Developer*):
G. Adams Date: 8-15-2006	R. Janetzke Date: 8-15-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):
1) Modified file *ebsfail.f* to return the waste package outer layer thickness due to general corrosion.

2) Added mechanical failure result files *mechfail_wp.res* and *mechfail_ds.res*. These two files are used to track waste package and drip shield mechanical failure.

3) Modified file *SIZES.INC* to increase the array dimensions for variable BF from 1.5E6 to 6.0E6 to allow the analysis to take place for long simulation periods.

8. Implemented by:	Date:
G. Adams	9-25-2006

9. Description of Acceptance Tests:

See Attachment A

10. Tested by:	Date:
J. Mancillas	3-1-2007

CNWRA Form TOP-5 (05/2000)

UPDATE REQUIREMENTS for TPA.INP

SCR 660

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM)*	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.)*	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
No Changes to tpa.inp parameters							

Attachment A
Test Plan for TPA SCR660

Test Plan Name: SCR660 Test Plan

Tested By:	J. Mancillas	Date:	3-1-2007
Host Machine:	Manta	Host OS:	Windows XP SP2
Baseline Version:	TPA51BetaD	Test Version:	TPA51BetaG

System Level (SL) Tests

SL-1. Name: *ebsfail.f* modified to return waste package outer layer thickness due to general corrosion.

Path for run directory:

Basecase: Manta:D\SCR660\runD1
Test case: Manta:D\SCR660\runG1

Path for archive of results:

Basecase: CD[Titled:SCR660 Testing]:\SCR660\runD1
Test case: CD[Titled:SCR660 Testing]:\SCR660\runG1

Environment variables:

Basecase: TPA_DATA=..\tpa51betaD
TPA_TEST=..\tpa51betaD

Testcase: TPA_DATA=..\tpa51betaG
TPA_TEST=..\tpa51betaG

Special input files or modifications to input files required : None

Special diagnostic code modifications required : None

Program modes to be used (append flags, scenario/model switches, etc.): Append All

Utility scripts needed to perform the test: None

Utility codes needed in the analysis of the test data: None

Test description: The MECHFAIL module requires the time dependent thickness of the waste package outer barrier to evaluate the strength of the waste package. The waste package barrier thickness is calculated for two different corrosion types: localized corrosion and generalized corrosion.

- objective — Verify the thickness of the waste package passed to the MECHFAIL module is the generalized corrosion thickness.

- assumptions — None, other than those made within the TPA code

- constraints — None

- output files to compare or examine — *ebstrch.dat*, *gencorrfail.out* and *mechfail_wp.inp*

- step by step test procedure to be used

1) Perform one reference case TPA run for both the basecase and testcase TPA versions, with the file output option set to append all.
2) Examine the files *ebstrh.dat*, *gencorrfail.out* and *mechfail_wp.inp* for both versions of the TPA code.

- pass fail criteria

1) The basecase and the test case versions of the TPA code should successfully run.
2) The changes made to the files *exec.f*, *mechfail.f*, *driftdrive.f*, *size.inc* and *ebsfail.f* should be logical and consistent with the stated intent of SCR660.
3) The waste package thickness passed to the MECHFAIL module should be the thickness derived from the general corrosion calculations.

Test Results:

- criterion 1 evidence

The basecase and test case versions of the TPA code were executed for a single realization (of 500) with the *tpa.inp* file modified to append all files. Both versions of the TPA code successfully executed, and the screen outputs from this test and the results of these code executions are saved in the directory \SCR660\runD1 and \SCR660\runG1 and are presented as evidence that SCR660 has been properly implemented.

- criterion 2 evidence

An examination of the modified files in the test version of the TPA code (TPA51betaG) showed that the changes were logical and consistent with the stated intent of SCR660. In addition, file comparisons were made using the DOS command "fc" for each of the modified files and saved as *driftdrive.f_fc*, *ebsfail.f_fc*, *exec.f_fc*, *mechdrive.f_fc*, and *mechfail.f_fc* . These file comparisons were saved in the directory \SCR660\files_fc and are presented as evidence that SCR660 has been properly implemented.

-criterion 3 evidence

The file *ebsfail.f* has been modified to read in and return the waste package general corrosion thickness. A comparison of the WP thickness in the file *mechfail_wp.inp* and in the WP thickness in the file *gencorrfail.out*, which contains the WP general corrosion thickness, shows that in the test case version of the TPA code are the same. This is the expected result of SCR660. The files

\SCR660\runG1\gencorrfail.out and \SCR660\runG1\mechfail_wp.inp are presented as evidence that SCR660 has been properly implemented.

- overall test status : PASS

SL-2. Name: Two additional files *mechfail_wp.res* and *mechfail_ds.res* were added.

Path for run directory:

Test case: Manta:D\SCR660\runG2 & runG3

Path for archive of results:

Test case: CD[Titled:SCR660 Testing]:\SCR660\runG2 & runG3

Environment variables:

Testcase: TPA_DATA=..\tpa51betaG
TPA_TEST=..\tpa51betaG

Special input files or modifications to input files required : None

Special diagnostic code modifications required : None

Program modes to be used (append flags, scenario/model switches, etc.): Append All

Utility scripts needed to perform the test: None

Utility codes needed in the analysis of the test data: None

Test description: Two additional files have been added to the results files: *mechfail_wp.res* and *mechfail_ds.res*.

- objective Ensure that to two files are generated when mechanical degradation occurs.

- assumptions None, other than those made within the TPA code.

- constraints None

- output files to compare or examine: *mechfail_ds.res* and *mechfail_wp.res*

- step by step test procedure to be used

1) Execute the TPA code for the test version of the code, and examine the files *mechfail_ds.res* and *mechfail_wp.res*. The *tpa.inp* file has been modified to enhance the probability of WP mechanical failure, by changing the parameter **DripShieldBulkheadTributaryArea[m^2]** from 2.3 to 20.0, to increase the effective load on the WP. And the parameter **FractionDriftDegradationOccursByChimney** has been changed to 1 and 0, for runG2 and runG3 respectfully, to investigate the failure geometry as either chimney or trapezoidal.
2) Examine the output files *mechfail_ds.res* and *mechfail_wp.res*.

- pass fail criteria

1) The files *mechfail_ds.res* and *mechfail_wp.res* should be generated
2) The data reported in the files *mechfail_ds.res* should be consistent with other data output from the TPA code.
3) The data reported in the files *mechfail_wp.res* should be consistent with other data output from the TPA code

Test Results:

- criterion 1

The test version of the TPA code (TPA51BetaG) the file *mechfail_ds.res* and *mechfail_wp.res* are generated. These two files are not generated in the TPA51BetaD version of the TPA code. The files \SCR660\runG2\ *mechfail_ds.res* and \SCR660\runG2*mechfail_wp.res* are presented as evidence that SCR660 has been properly implemented.

- criterion 2

The file *mechfail_ds.res* reports the following time dependent data: Realization number, subarea number rock type (grid 1 and 2), time of DS failure, vertical pressure, the MAFE and PGA of the seismic event (if a seismic event caused the DS failure).DS temperature, Horizontal to vertical load ratio, the creep threshold, the DS thickness, DS static failure flag, DS dynamic failure flag and the failure mechanism of the drift (the failure geometry of the drift).

A comparison between the time and vertical pressures reported in SCR660\runG2*mechfail_ds.res* are consistent with time and pressures reported in the append file SCR660\runG2\ *driftfail.rlt*.
A comparison between the DS thicknesses reported in SCR660\runG2*mechfail_ds.res* are consistent with time and DS thicknesses reported in the append file SCR660\runG2*dsfail.rlt*.
A comparison of the DS temp, horizontal to vertical load ratio, creep threshold reported by the SCR660\runG2\ *mechfail_ds*.res are consistent with the file SCR660\runG2\ *mechfail_ds.inp*.

The Failure Mechanism reported in *mechfail_ds.res* was examined by altering the value of the parameter **FractionDriftDegradationOccursByChimney**. In the run directory runG2 the parameter was set to 1 to ensure that the drift would always degrade by the chimney geometry and in the run directory runG3 the parameter was set to 0 to ensure that the drift would always degrade by trapezoidal geometry. An examination of SCR660\runG2*mechfail_ds.res* and SCR660\runG3*mechfail_ds.res* show that the *mechfail_ds.res* properly reports the failure mechanism as 1 or 0 (chimney or trapezoidal).

The files *mechfail_ds.res, dsfail.rlt, driftfail.rlt* and *mechfail_ds.inp* in the directories SCR660\runG2 & runG3 are submitted as evidence that this SCR has been properly implemented.

- criterion 3

The file *mechfail_wp.res* reports the following time dependent data: The realization, the subarea the rock

type (grid 1 or 2) the vertical pressure, the WP outer barrier thickness, the contact angle, contact length, the PGA of a seismic event (if the event fails the WP), the WP static failure flag, the WP dynamic failure flag, and the failure mechanism (the failure geometry of the drift).

A comparison between the time and vertical pressures reported in SCR660\runG2*mechfail_wp.res* are consistent with time and pressures reported in the append file SCR660\runG2\ *driftfail.rlt*.
A comparison between the WP thicknesses reported in SCR660\runG2*mechfail_wp.res* are consistent with time and WP thicknesses reported in the append file SCR660\runG2*gencorrfail.out*.
The contact angle and contact lengths and PGA reported in SCR660\runG2*mechfail_wp.res* are consistent with the values reported in SCR660\runG2*mechfail_wp.inp* and *driftfail.rlt*.

The Failure Mechanism reported in mechfail_ds.res was examined by altering the value of the parameter **FractionDriftDegradationOccursByChimney**. In the run directory runG2 the parameter was set to 1 to ensure that the drift would always degrade by the chimney geometry and in the run directory runG3 the parameter was set to 0 to ensure that the drift would always degrade by trapezoidal geometry. An examination of SCR660\runG2*mechfail_wp.res* and SCR660\runG3*mechfail_wp.res* show that the *mechfail_wp.res* properly reports the failure mechanism as 1 or 0 (chimney or trapezoidal).

The files *mechfail_wp.res*, *driftfail.rlt*, *gencorrfail.out* and *mechfail_wp.inp* in directories SCR660\runG2 & runG3 are submitted as evidence that this SCR has been properly implemented.

- overall test status: PASS

Note: The file *mechfail_ds.res* report the Mean Annual Probability of Exceedence (MAPE) as the Mean Annual Frequency of Exceedence (MAFE). This is a minor change in terminology.

SL-3. Name: The file *size.inc* was modified to increase the dimension for the variable BF.

Path for run directory:

Base case: Manta:D\SCR660\runD4
Test case: Manta:D\SCR660\runG4

Path for archive of results:

Basecase: CD[Titled:SCR660 Testing]:\SCR660\runD4
Test case: CD[Titled:SCR660 Testing]:\SCR660\runG4

Environment variables:

Basecase: TPA_DATA=..\tpa51betaD
TPA_TEST=..\tpa51betaD

Testcase: TPA_DATA=..\tpa51betaG
TPA_TEST=..\tpa51betaG

Special input files or modifications to input files required : None

Special diagnostic code modifications required : None

Program modes to be used (append flags, scenario/model switches, etc.): None

Utility scripts needed to perform the test: None

Utility codes needed in the analysis of the test data: None

Test description: The parameter NDBF in *sizes.inc* controls the size of the array BF in the NEFMKS module. It has been observed that the size of this array affects the stability of the NEFTRAN code for long TPA simulations. NDBF has been increased to increase the stability of NEFTRAN runs during TPA runs.

- objective: Verify that increasing NDBF increases the stability of the TPA code for long simulation times.

- assumptions: None

- constraints: None

- output files to compare or examine: Screen captures from TPA code executions

- step by step test procedure to be used

1) Modify the tpa.inp file for basecase and test case TPA simulations to 1 million years.
2) Execute the basecase and test case of the TPA code
3) Evaluate the completion of the basecase and test case TPA codes for long realizations.

- pass fail criteria

1) The parameter NDGF has been increased in value from 1,500,000 to at least 3,000,000 in the file *sizes.inc*.
2) The change of the value for NDGF increases the stability of the TPA code by minimizing the likely hood of NEFTRAN crashing.

Test Results:

- criterion 1 evidence

The following text excerpt is from the tpa51betaG file *sizes.inc*, which shows the change in the size of the parameter NDBF from 1.5 million to 6.0 million.

SCR660\tpa51betaG\codes\sizes.inc

```
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
      PARAMETER (MXGRD=100000, NDDF=45500, NDSF=15500)
cc rwj 9-23-04; SCR482
c     PARAMETER (NDJPN=20000, NDBF=150000, MXELEM=30)
cc rwr 2-4-05; SCR 530
cc modified for long TPA simulations
cc (needed to increase after adding U233 and Th229)
cc    PARAMETER (NDJPN=20000, NDBF=300000, MXELEM=30)

c     GADAMS SCR660 9-15-2006 Increased value for NDBF to accomodate
c     long simulation periods
c      PARAMETER (NDJPN=20000, NDBF=1500000, MXELEM=30)
      PARAMETER (NDJPN=20000, NDBF=6000000, MXELEM=30)
c     GADAMS SCR660 9-15-2006 End of change
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
```

The parameter NDBF was changed from 1.5 million to 6.0 million. An examination of previous changes of NDBF shows that this parameter has been progressively increased because of NEFTRAN instabilities. The current increase NDBF is consistent with previous modifications. These results are presented as evidence that SCR660 has been properly implemented.

- criterion 2 evidence

The basecase and testcase versions of the TPA code were executed for 50 realizations with each realization set to run for 1 million years. The results of the simulations generated as screen outputs were captured in the files \SCR660\runD4*out* (basecase) and \SCR660\runG4*out* (testcase). An examination of these files shows that the basecase version of the TPA code crashed as a result of a NEFTRAN error, while the testcase version of the TPA code successfully completed the 50 realizations

The following excerpt if from \SCR660\runD4*out*

```
*****************************************************************************
exec: calling uzft
 ***>>> Error running NEFTRAN <<<***
 NEFTRAN failed to terminate normally
 check NEFTRAN files:
 nefii.inp, NEFII.VEL, and nefii.out
*****************************************************************************
```

From this excerpt, it is clear that the simulation crashed as a result of a NEFTRAN error.

The following excerpt is from \SCR660\runG4*out*

```
*****************************************************************************
exec: end realizations

exec: Peak Mean Dose is 5.16921E-03 rem/yr at   10000.0 yr, based on    50
realizations.

exec:  Run Successfully Completed
*****************************************************************************
```

From this excerpt, it is clear that the simulation successfully completed, calculating a peak mean dose of 5.1 mrem at 10,000 yr.

These results, and the files contained in the directories \SCR660\runD4 & runG4 are submitted as evidence that SCR660 has been properly implemented.

- overall test status : PASS

SCR - 662

TPA 5.1/ Beta W

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 662	2. Software Title and Version: TPA 5.1BetaW	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *driftsa.i*

The addition of glass waste form has increased the number of possible waste packages. The current maximum does not permit the single drift per WP scenario to complete successfully.

5. Change Requested by: R. Janetzke	**Date:** 5-2-2007
6. Change Authorized by (*Software Developer*): R. Janetzke Ron Janetzke	**Date:** 5-2-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

The value of the parameter 'maxnumdrifts' was changed form 10,000 to 14,000 in *driftsa.i.*

8. Implemented by: R. Janetzke Ron Janetzke	**Date:** 5-9-07

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

Visual inspection of *driftsa.i* from TPA5.1beta X verified that maxnumdrifts was changed from 10,000 to 14,000.

Code review accomplished by: C. Scherer Carol S. Scherer	**Date:** 5-25-2007

10. Description of Acceptance Tests:

Visual inspection of the source code file *driftsa.i* was carried out. The test PASSED.

11. Tested by: C. Scherer Carol S. Scherer	**Date:** 5-25-2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for *TPA.INP*

SCR 662

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
No Changes to *tpa.inp* parameters							

SCR - 663

TPA 5.1/ Beta H

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR663	**2. Software Title and Version:** TPA51betaH	**3. Project No:** 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *cumfail.h*, *ebsfail.f*, *ebsrel.f*, *exec.f*, *failt.f*, *lhs1.i*, *releaset.f*, *tpa.inp*, *tpanames.dat*, *wpflow.def*, and *uzft.f*

All seepage was allowed to enter initially defective WPs. Localized and general corrosion failures of the WP were treated as the same failure type in release calculations. Additionally, for a particular failure type, it was assumed that all WPs received seepage and it was observed that TPA code results were not necessarily consistent for different simulation times.

5. Change Requested by:	**6. Change Authorized by** (*Software Developer*):
O. Pensado Date: 12-18-06	R. Janeztke Date: 12-18-06

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

A seepage factor for initially defective WPs was implemented and added to *ebsflo.dat* and used in RELEASET. Also, RELEASET calculations were modified to separately compute releases from WPs failed by localized corrosion of the mill-annealed WP body and by general corrosion of the WP. Also, probability factors, used to determine the number of WPs not only contacted by water but allowing water to enter the WP, were employed to adjust the number of WPs considered in RELEASET calculations. The screenprint and input, output, and intermediate files were modified to more specifically state the type of corrosion (weld, localized, or general) and to state the reported times were "TPA times."

Additionally, (1) information in data files, input parameters names, distribution type, and values in *tpa.inp* were updated and/or deleted as described in the following table; (2) the determination of the seepage factors (which are written to *ebsflo.dat)* in EBSREL was streamlined and made more transparent; (3) comments and contents in input and output files (e.g., *ebsrel.inp*, *wpsfail.res*, *wpsfail2.res* (new file)) were modified to state "MECH" instead of "SEISMO" or added to show number of WPs available for release; and (4) UZFT was modified to yield consistent results for different simulation times (for example, simulation times of 10,000 yr and 100,000 yr).

8. Implemented by:	**Date:**
R. Rice	12-29-06

9. Description of Acceptance Tests:
Tested version: TPA 5.1 beta O
Test 1: Check waste package balance consulting data in wpsfail.res and wpsfail2.res
Test 2: Check seepage factors in file ebsflo.dat for a couple of realizations and subareas. Explain changes as function of drip shield and waste package breaching times (both mechanical and corrosion)
Test 3: Check system response in case general corrosion occurs within 1-million years (verify that an additional general corrosion source is considered in RELEASET computations).
Test 4: Compute a series of realizations with 10,000 and 100,000 year simulation times and verify that UZ and SZ releases are identical in both simulations in the first 10,000 years, provided that EBS releases from both simulations are identical.
Test 5: Inspect the input file tpa.inp and verify that all of the input parameters were properly implemented.

Test results: pass (see attached Mathematica notebook and electronic files attached to this SCR).

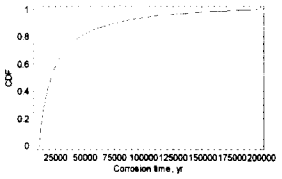
10. Tested by: Osvaldo Pensado	**Date: 3/7/2007**

CNWRA Form TOP-5 (05/2000)

UPDATE REQUIREMENTS for TPA.INP

SCR 663

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	**Module**	**Parameter Name**	**Description** (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	**Distribution**	**Range**	**Justification** *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	**Source**

MODIFY FROM	DSFAIL	DripShieldCorrosionRate[m/yr] **(NOTE THAT THIS IS <u>REPLACED</u> BY OTHER INFORMATION AND THE DISTRIBUTION IN THIS TABLE)**	corrosion rate of the drip shield	triangular	8.6e-8, 1.72e-7, 2.6e-7	 Minimum: 11,400 years Maximum: 197,000 years Mean: 34,400 years **Notes by X. He**: Corrosion rates in the range of 4.3E-8 and 8.6E-8 m/yr are reported in CNWRA 2001-03 (Figure 4-7 and 4-9). Corrosion rates decreased with time. Blackwood et al. (1988) reported a maximum rate of 10-20E-6 m/yr for a pH = 1 acidified solution and < 1-2E-6 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% CaCl2 at 150°C, 10% and 30% FeCl3, and saturated MgCl2 boiling solutions are nil (pp. 705-706). These solutions are very aggressive. DOE data including titanium grades 7 and 16 (General and Localized Corrosion of the Drip Shield. Rev. 2, 2004): 3.8E-8 m/yr to 3.2E-7 m/yr. For titanium grade 7 the corrosion rate is 3.8E-8 m/yr to 5.0E-8 m/yr Hua and Gordon (2004) reported the corrosion rate of titanium Grade 7 in BSW-12 at 60°C to 105 °C is 2.03E-7 to 6.6E-7 m/yr. 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 - 6E-8 m/yr 170°C - 4E-8 m/yr 200°C - 1.5E-7 m/yr Thus, based on the data in the literature, corrosion rate bounds of 3.8×10^{-8} and 6.6×10^{-7} m/yr were selected. Because corrosion happens in the underside of the drip shield, these bounds were multiplied by 2 and a uniform distribution was selected. An alternative is considering that the under and above drip shield corrosion rates are independent. The addition of two uniform distributions results in a triangular distribution: triangular[$2\times3.8\times10^{-8}$, $(66+3.8)\times10^{-8}$, $2\times6.6\times10^{-7}$] m/yr. The DS failure time for this distribution has a mean value of 26,000 years. Because selection of longer DS lifetimes is conservative with respect to mechanical breaching of the WP, a uniform distribution for the corrosion rate is preferred over a triangular distribution.	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. Schutz, R.W. "Platinum Group Metal Additions to Titanium: a Highly Effective Strategy for Enhancing Corrosion Resistance." Corrosion. Vol. 59. pp. 1043-1057. 2003.

MODIFY TO	DSFAIL	DripShieldCorrosionRate[m/yr]	(see above)	uniform	7.6×10^{-8}, 1.32×10^{-6}	(see above)	(see above)
MODIFY FROM	EBSREL	WeldAdvectiveFraction[]	fraction of WP surface area that is the weld; fraction is used to determine the seepage factor	loguniform	1.0e-4, 1.0e-2	Dec 18, 2006, presentation symbol: term to define step in seepage factor f_W Propose to use the same distribution as InitialSeepageReductionFractionLC	Email sent from O. Pensado to R. Rice on 12/18/06; the file names were "parameters.wpd" and "DriftDeg_recommendation_03.ppt"
MODIFY TO	EBSREL	InitialSeepageReductionFractionWeldLC	(see above)	loguniform	1.0d-3, 1.0e-1	(see above)	(see above)

MODIFY FROM	EBSFAIL	WeldCritChlorideConc[mol /L]	Minimum chloride concentration at which localized corrosion of the weld occurs	loguniform	0.01, 0.25	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.	CNWRA 2005-02, Table 5-2
MODIFY TO	EBSFAIL	WeldCritChlorideConc[mol /L]	(see above)	constant	1.0d-4	(see above)	(see above)

MODIFY FROM	EBSFAIL	CriticalRelativeHumidityAqueousCorrosion	Critical RH above which aqueous corrosion may initiate	constant	0.30	This parameter controls the onset of aqueous corrosion. It represents the equilibrium relative humidity for deliquescence. The TPA model assumes that localized corrosion cannot be supported by deliquescence environments due to the presence of localized corrosion inhibitors, such as nitrate, in dust. TPA results are relatively insensitive to the exact time for the onset of aqueous corrosion. The current parameter value is a reasonable selection for the deliquescence relative humidity based on experimental values at temperatures close to 100 °C. In general, experimental data are available to define the dependence of the deliquescence relative humidity on the temperature for various systems; see Scientific Notebook 464 (Yang, YEAR). However, a single value for this parameter is sufficient given the relative lack of sensitivity of TPA results on this parameter. The value was lowered from 0.3 to 0.2 because recent studies showed that aqueous corrosion can take place at lower RH (Yang, 2006). But the effect by the amount of solution is uncertain. Must be evaluated further.	Email from O. Pensado to R. Janetzke et al. on 2/02/07; the email subject line was "TPA Parameters ."
MODIFY TO	EBSFAIL	CriticalRelativeHumidityAqueousCorrosion	(see above)	constant	0.20	(see above)	(see above)

MODIFY FROM	EBSFAIL	CriticalRelativeHumidityHumidAirCorrosion	Critical relative humidity above which humid-air corrosion may initiate	constant	0.20	It is assumed that the rate of humid air oxidation is negligible in Alloy 22 in the basecase. TPA code results are independent of the value of the parameter CriticalRelativeHumidityHumidAirCorrosion, but this parameter must not exceed the CriticalRelativeHumidityAqueousCorrosion parameter. This value was lowered from 0.2 to 0.15 to be consistent with the change in CriticalRelativeHumidityAqueousCorrosion.	Email from O. Pensado to R. Janetzke et al. on 2/02/07; the email subject line was "TPA Parameters."
MODIFY TO	EBSFAIL	CriticalRelativeHumidityHumidAirCorrosion	(see above)	constant	0.15	(see above)	(see above)
MODIFY FROM	EBSFAIL	AA_1_1[C/m2/yr]	Alloy 22 corrosion rate	triangular	1.63e3, 3.2e3, 6.4e3	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 median value of the proposed distribution is precisely 3200 Coul/(m^{2}yr). The 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).	File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."

MODIFY TO	EBSFAIL	AA_1_1[C/m2/yr]	(see above)	triangular	1.60e3, 2.13e3, 6.40e3	(see above)	(see above)
MODIFY FROM	EBSFAIL	CritChlorideConcForFirstLayer[mol/L]		constant	0.5	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.	CNWRA 2005-02, Table 5-2; from file on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."
MODIFY TO	EBSFAIL	CritChlorideConcForFirstLayer[mol/L]	(see above)	constant	1.0d-4	(see above)	(see above)

MODIFY FROM	EBSREL	WaterContactMode_Initial(0=BathTub,1=FlowThrough)	Sets the water contact mode in RELEASET (either will be a bath tub model or a flow through model)	iflag	0	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.	CNWRA 2005-02, Table 5-2; from file on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."
MODIFY TO	EBSREL	WaterContactMode_Initial(0=BathTub,1=FlowThrough)	(see above)	iflag	1	(see above)	(see above)
MODIFY FROM	EBSREL	WaterContactMode_SeismicInterval1(0=BathTub,1=FlowThrough)	(see above)	iflag	0	(see above)	(see above)
MODIFY TO	EBSREL	WaterContactMode_Mechanical1(0=BathTub,1=FlowThrough)	(see above)	iflag	1	(see above) - also rename the parameter as "Mechanical" instead of "Seismic"	(see above)
MODIFY FROM	EBSREL	WaterContactMode_SeismicInterval2(0=BathTub,1=FlowThrough)	(see above)	iflag	0	(see above)	(see above)
MODIFY TO	EBSREL	WaterContactMode_Mechanical2(0=BathTub,1=FlowThrough)	(see above)	iflag	1	(see above) - also rename the parameter as "Mechanical" instead of "Seismic"	(see above)

DELETE	EBSREL	WaterContactMode_SeismicInterval3(0=BathTub,1=FlowThrough)	(see above)	iflag	0	This RELEASET failure type is not used.	This RELEASET failure type is not used.
MODIFY FROM	EBSREL	WaterContactMode_SeismicInterval4(0=BathTub,1=FlowThrough)	(see above)	iflag	0	Rename the parameter as "LC" (localized forrosion) instead of "Seismic" since this failure type is now "LC" Also, see discussion above for the parameter "WaterContactMode_Initial(0=BathTub,1=FlowThrough)".	(see left)
MODIFY TO	EBSREL	WaterContactMode_LocCorr(0=BathTub,1=FlowThrough)	(see above)	iflag	1	(see above)	(see above)
MODIFY FROM	EBSREL	WaterContactMode_Corrosion(0=BathTub,1=FlowThrough)	(see above)	iflag	0	See discussion above for the parameter "WaterContactMode_Initial(0=BathTub,1=FlowThrough)".	(see left)
MODIFY TO	EBSREL	WaterContactMode_Corrosion(0=BathTub,1=FlowThrough)	(see above)	iflag	1	(see above)	(see above)

MODIFY FROM	EBSREL	DefectiveFractionOfWPs/cell	In a subarea calculation, the fraction of WPs in that subarea that are considered to be defective and can have releases	uniform	1.0e-4, 1.0e-2	Distribution in TPA 4.0: uniform[1e-4, 1e-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 1e-2 is too high. Resolution: agree with selection of loguniform distribution.	File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."
MODIFY TO	EBSREL	DefectiveFractionOfWPs/cell	(see above)	loguniform	1.0e-4, 1.0e-2	(see above)	(see above)
DELETE	EBSREL	UseTimesOrSEISMOIntervals(0=Times,1=Intervals)	These six parameters were used to specify bins for assigning the number and times of WP failure by seismicity.	iflag	0	In the current TPA code, the four former "Seismic" WP failure types are now "mechanical" in two cases (MECH1 and MECH2) (formerly SEISMO1 and SEISMO2) and localized corrosion (LC) (formerly SEISMO4). Note that one of these types is not used (formerly SEISMO3).	File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."
DELETE	EBSREL	NumberOfSEISMOWPFailureIntervals	(see above)	iconstant	4	(see above)	(see above)
DELETE	EBSREL	BeginningOfSEISMOWPFailureInterval1[yr]	(see above)	constant	0.0	(see above)	(see above)

DELETE	EBSREL	BeginningOfSEISMOWPFailureInterval2[yr]	(see above)	constant	2000.0	(see above)	(see above)
DELETE	EBSREL	BeginningOfSEISMOWPFailureInterval3[yr]	(see above)	constant	5000.0	(see above)	(see above)
DELETE	EBSREL	BeginningOfSEISMOWPFailureInterval4yr]	(see above)	constant	10000.0	(see above)	(see above)
MODIFY FROM	EBSREL	SFWettedFraction_Initial_X, where X = subarea number = 1 to 10	Fraction of the waste form in an initially defective WP that can receive water (by subarea).	uniform	0.0, 1.0	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.	File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."

MODIFY TO	EBSREL	SFWettedFraction_Initial_X, where X = subarea number = 1 to 10	(see above)	loguniform	1.0d-3, 1.0d-1	(see above)	(see above)
ADD	EBSREL	SFWettedFraction_Initial_X, where X = subarea number = 1 to 10 and InitialSeepageReductionFractionInitiallyDefWP (i.e., add 10 separate correlations)	Correlate the SF wet fraction for initially defective WPs with the InitialSeepageReductionFractionInitiallyDefWP and use the same distribution (see above)	correlateinputs	0.7	(see above)	(see above)

MODIFY FROM	EBSREL	SFWettedFraction_SEISMO1_X, where X = subarea number = 1 to 10	Fraction of the waste form in WP failure type "MECH1" that can receive water (by subarea). Also, change parameter name from "SEISMO1" to "MECH1"	uniform	0.0, 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).	File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."

MODIFY TO	EBSREL	SFWettedFraction_MECH 1_X, where X = subarea number = 1 to 10	(see above)	uniform	1.0d-2, 1.0d0	(see above)	(see above)
MODIFY FROM	EBSREL	SFWettedFraction_SEISM O2_X, where X = subarea number = 1 to 10	Fraction of the waste form in WP failure type "MECH2" that can receive water (by subarea). Also, change parameter name from "SEISMO2" to "MECH2"	uniform	0.0, 1.0	(see above)	(see above)
MODIFY TO	EBSREL	SFWettedFraction_MECH 2_X, where X = subarea number = 1 to 10	(see above)	uniform	1.0d-2, 1.0d0	(see above)	(see above)
ADD	EBSREL	SFWettedFraction_MECH 1_X, where X = subarea number = 1 to 10 and InitialSeepageReductionFr actionByMechFailedWP (i.e., add 10 separate correlations)	Correlate the SF wet fraction for MECH 1 failed WPs with the InitialSeepageRed uctionFractionByM echFailedWP and use the same distribution (see above)	correlateinputs	0.7	(see above)	(see above)
ADD	EBSREL	SFWettedFraction_MECH 1_X, where X = subarea number = 1 to 10 and InitialSeepageReductionFr actionByMechFailedWP (i.e., add 10 separate correlations)	Correlate the SF wet fraction for MECH 2 failed WPs with the InitialSeepageRed uctionFractionByM echFailedWP and use the same distribution (see above)	correlateinputs	0.7	(see above)	(see above)

DELETE	EBSREL	SFWettedFraction_SEISMO3_X, where X = subarea number = 1 to 10	Fraction of the waste form in WP failure type "SEISMO3" that can receive water (by subarea).	uniform	0.0, 1.0	This failure type is not used in TPA code calculations (see above).	File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."
MODIFY FROM	EBSREL	SFWettedFraction_SEISMO4_X, where X = subarea number = 1 to 10	Fraction of the waste form in WP failure type "LC" (localized corrosion) that can receive water (by subarea). Also, change parameter name from "SEISMO4" to "LC"	uniform	0.0, 1.0	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.	File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."
MODIFY TO	EBSREL	SFWettedFraction_LC_X, where X = subarea number = 1 to 10	(see above)	loguniform	1.0d-3, 1.0d-1	(see above)	(see above)

ADD	EBSREL	SFWettedFraction_MECH1_X, where X = subarea number = 1 to 10 and InitialSeepageReductionFractionLC (i.e., add 10 separate correlations)	Correlate the SF wet fraction for LC failed WPs with the InitialSeepageReductionFractionLC and use the same distribution (see above)	correlateinputs	0.7	(see above)	(see above)
MODIFY FROM	EBSREL	FuelRodHalfLength[m]	Half-length of the waste form fuel rod; used in the cladding model to allow for gradual exposure of the waste form.	constant	2.0	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).	File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."
MODIFY TO	EBSREL	FuelRodHalfLength[m]	(see above)	constant	0.0	(see above)	(see above)
MODIFY FROM	EBSREL	FractionOfWPsWithDiffusionTilt[]	Fraction of WPs that can have diffusive releases	constant	0.1	Setting this parameter as 0 causes de-activation of diffusive releases. The diffusion model, and its parameters, should be re-evaluated if activated.	File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."

MODIFY TO	EBSREL	FractionOfWPsWithDiffusionTilt[]	(see above)	constant	0.0	(see above)	(see above)
MODIFY FROM	EBSREL	InitialSeepageReductionFractionByMechFailedDS	Seepage reduction fraction for mechanically failed drip shields	uniform	1.0e-3, 2.0e-1	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 (also, see cell to the right)	Dec 18, 2006, presentation symbol: term to define step in seepage factor f_D 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.

MODIFY TO	EBSREL	InitialSeepageReductionFractionByMechFailedDS	(see above)	loguniform	1.0d-2, 1.0d0	(see above)	(see above) and file on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."
MODIFY FROM	EBSREL	DSSeepageProtectionDegradationRate[1/yr]	Degradation rate of the drip shield. The degradation allows seepage to pass through the drip shield.	constant	1.0d-5	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.	File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."
MODIFY TO	EBSREL	DSSeepageProtectionDegradationRate[1/yr]	(see above)	constant	0.0	(see above)	(see above)

MODIFY FROM	EBSREL	InitialSeepageReductionFractionByMechFailedWP	Seepage reduction fraction for mechanically failed WPs.	uniform	1.0e-5, 2.0e-3	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.	File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."
MODIFY TO	EBSREL	InitialSeepageReductionFractionByMechFailedWP	(see above)	uniform	1.0d-2, 1.0d0	(see above)	(see above)

MODIFY FROM	EBSREL	WPSeepageProtectionDegradationRate[1/yr]	Degradation rate of the WP. The degradation allows seepage to pass through the WP.	constant	1.0e-6	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.	Dec 18, 2006, presentation symbol: term to define slope in seepage factor f_W File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."

MODIFY TO	EBSREL	WPSeepageProtectionDegradationRate[1/yr]	(see above)	constant	0.0	(see above)	(see above)
ADD	EBSREL	FlagPartialProtectionFromSeepageByInitialDefWP[1=yes,0=no]	Option (together with the following 2 new parameters below) to allow for partial protection of the initially defective WPs from seepage.	iflag	1		File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."
ADD	EBSREL	InitialSeepageReductionFractionInitiallyDefWP	See above and seepage reduction fraction for initially defective WPs.	loguniform	1.0d-3, 1.0d-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	(see above)
ADD	EBSREL	WPSeepageProtectionDegradationRateInitiallyDefWP[1/yr]	See above and degradation rate of the initially defective WPs. The degradation allows seepage to pass through those WPs.	constant	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.	(see above)

ADD	EBSREL	Probability_WPWaterContact_GC-Flt-Ig	Probability water contacts WPs failed by GC, Flt, and Ig events.	constant	1.0	Drip shield eventually fails by general corrosion (mean failure time ~ 30,000 years). High probability that compromised WPs will be eventually contacted by water.	File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd." Dec 18, 2006, presentation symbol: $P_{contact}$, general corrosion, faulting, igneous WPs
ADD	EBSREL	Probability_WPWaterAllowance_GC-Flt-Ig	Probability water enter WPs failed by GC, Flt, and Ig events.	constant	1.0	Assume extensive damage on WP by general corrosion, faulting, or igneous events	(see above) Dec 18, 2006, presentation symbol: $P_{allowance}$, general corrosion, faulting, igneous WPs

ADD	EBSREL	Probability_WPWaterContact_InitialDefects	Probability water contacts initially defective WPs.	constant	1.0	Drip shield eventually fails by general corrosion (mean failure time ~ 30,000 years). High probability that compromised WPs will be eventually contacted by water.	(see above) Dec 18, 2006, presentation symbol: $P_{contact}$, initially defective WPs

ADD	EBSREL	Probability_WPWaterAllowance_InitialDefects	Probability water enters 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) e + (probability of LC) Probability_WPWaterAllowance_LC + (probability of mechanical failure) Probability_WPWaterAllowance_MechFail (continued three cells to the right)	uniform	1.0d-3, 1.0d-1	(continued from the left) [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 e = 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.	(see above) Dec 18, 2006, presentation symbol: $P_{allowance}$, initially defective WPs

ADD	EBSREL	Probability_WPWaterContact_MechFail	Probability water contacts mechanically failed WPs.	constant	1.0	Drip shield eventually fails by general corrosion (mean failure time ~ 30,000 years). High probability that compromised WPs will be eventually contacted by water.	(see above) Dec 18, 2006, presentation symbol: $P_{contact}$, mechanically breached WPs
ADD	EBSREL	Probability_WPWaterAllowance_MechFail	Probability water enters mechanically failed 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} (continued three cells to the right)	uniform	1.0d-2, 1.0d0	(continued from the left) 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.	(see above) Dec 18, 2006, presentation symbol: $P_{allowance}$, mechanically breached WPs

ADD	EBSREL	Probability_WPWaterContact_LC	Probability water contacts WPs with localized corrosion. **Damaged DS surface** Assumed damage area on DS ~ 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. (continued three cells to the right)	uniform	1.0d-3, 1.0d-1	(continued from the left) 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 ~ 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. (continued below)	(see above) Dec 18, 2006, presentation symbol: $P_{contact}$, localized corrosion WPs

						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.	
ADD	EBSREL	Probability_WPWaterAllowance_LC	Probability water enters WPs with localized corrosion.	constant	1.0	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.	(see above) Dec 18, 2006, presentation symbol: $P_{allowance}$, localized corrosion WPs

ADD	EBSREL	InitialSeepageReductionFractionLC	Seepage reduction fraction for WPs with localized corrosion. 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. (continued three cells to the right)	loguniform	1.0d-3, 1.0d-1	(continued from the left) 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.	File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd." Dec 18, 2006, presentation symbol: term to define step in seepage factor f_W

MODIFY DATA FILE	EBSREL	Fwet	In *wpsflow.def,* Fwet is factor that is applied to the seepage.	Column with Fwet values	set all equal to 1.0	Set all values equal to 1.0 since other seepage factors are now being applied.	File on the S: drive from O. Pensado on 1/31/07 in a file titled "Parameters.wpd."
DELETE	EBSREL	`DriftDegradationFraction[]`	Factor that allowed for a fraction of the drift to be undegraded.	constant	1.0	The Pcontact and Pallowance factors account for drift degradation,	Email from O. Pensado to J. Winterle on 12/8/06 titled "parameter names and delete DriftDegradationFraction[] "

MODIFY FROM	MECHFAIL	DripShieldCorrosionRate[m/yr] **(NOTE THAT THIS <u>REPLACES</u> OTHER INFORMATION AND THE DISTRIBUTION IN THIS TABLE)**	Corrosion rate of the drip shield	uniform	7.6×10^{-8}, 1.32×10^{-6}	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/cm2. Such current density is equivalent to a corrosion rate of 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). Corrosion rates are doubled to account for corrosion on both sides of the drip shield.	Email from O. Pensado on 2/15/07 titled "Revised value of DripShield CorrosionRate[m/yr]."

						Other literature data: Blackwood et al. (1988) reported a maximum rate of $10—20\times\times10^{-7}$ m/yr for a pH = 1 acidified solution and < $1—2\times\times10^{-7}$ 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. 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. Scuutz, R.W. "Platinum Group Metal Additions to Titanium: a Highly Effective Strategy for Enhancing Corrosion Resistance." Corrosion. Vol. 59. pp. 1043-1057. 2003.	
MODIFY TO	MECHFAIL	DripShieldCorrosionRate[m/yr]	(see above)	logtriangular	2E-8, 2.98E-7, 6.4E-7	(see above)	(see above)

Please note the following parameter justification (these values were not changed in the *tpa.inp* file):

The correct parameters are

OuterOverpackErpIntercept ~ Triangular(1025.04,1180.76,1336.49)
TempCoefOfOuterPackErpIntercept=- 9.35026 mVSHE/°C
OuterOverpackErpSlope = -752.034 mVSHE
TempCoefOfOuterPackErpSlope = 5.20131 mVSHE/°C

Those parameters were proposed in the reference
Dunn, D.S., O. Pensado, Y.-M Pan, L.T. Yang, and X. He. "Modeling Corrosion Processes for Alloy 22 Waste Packages" in Scientific Basis for Nuclear Waste Management XXIX, edited by P. Van Isheghem. Mater. Res. Soc. Symp. Proc. 932, Warrendale, PA, pp. 853-860, 2006

The other parameters

OuterOverpackErpIntercept ~ Triangular(1541.2, 1591.2, 1641.2)
TempCoefOfOuterPackErpIntercept=- 13.1 mVSHE/°C
OuterOverpackErpSlope = -362.7 mVSHE
TempCoefOfOuterPackErpSlope = 2.3 mVSHE/°C

are from reference

Dunn, D.S., O. Pensado, Y.-M. Pan, R.T. Pabalan, L. Yang, X. He, and K.T. Chiang CNWRA 2005-02, Passive and Localized Corrosion of Alloy 22 -- Modeling and Experiments, Revision 1. Rev. 1 CNWRA 2005-02 December 2005 San Antonio, TX: Center for Nuclear Waste Regulatory Analyses: December 2005

which is older.

In[437]:=

```
SetDirectory["D:/Version5.1beta/beta0/"];
<< CommonPackages.m;
<< LeeDatos.m;
<< distributions.m;
<< rankMatrix.m;
<< CumWPFailed.m;
<< quantilesM.m;
```

SCR 663, validation testing

SCR No. SCR663

4. Affected Software Module(s), Description of Problem(s): *cumfail.h*, *ebsfail.f*, *ebsrel.f*, *exec.f*, *failt.f*, *lhs1.i*, *releaset.f*, *tpa.inp*, *tpanames.dat*, *wpflow.def*, and *uzft.f*

All seepage was allowed to enter initially defective WPs. Localized and general corrosion failures of the WP were treated as the same failure type in release calculations. Additionally, for a particular failure type, it was assumed that all WPs received seepage and it was observed that TPA code results were not necessarily consistent for different simulation times.

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):
A seepage factor for initially defective WPs was implemented and added to ebsflo.dat and used in RELEASET. Also, RELEASET calculations were modified to separately compute releases from WPs failed by localized corrosion of the mill-annealed WP body and by general corrosion of the WP. Also, probability factors, used to determine the number of WPs not only contacted by water but allowing water to enter the WP, were employed to adjust the number of WPs considered in RELEASET calculations. The screenprint and input, output, and intermediate files were modified to more specifically state the type of corrosion (weld, localized, or general) and to state the reported times were "TPA times."

Additionally, (1) information in data files, input parameters names, distribution type, and values in tpa.inp were updated and/or deleted as described in the following table; (2) the determination of the seepage factors (which are written to ebsflo.dat) in EBSREL was streamlined and made more transparent; (3) comments and contents in input and output files (e.g., ebsrel.inp, wpsfail.res, wpsfail2.res (new file)) were modified to state "MECH" instead of "SEISMO" or added to show number of WPs available for release; and (4) UZFT was modified to yield consistent results for different simulation times (for example, simulation times of 10,000 yr and 100,000 yr).

Test 1, WP scaling factors

Read data from the files wpsfail.res and wpsfail2.res.
Compute the number of failed WPs by correcting with the factors
1. Probability_WPWaterAllowance_InitialDefects
2. Probability_WPWaterAllowance_MechFail
3. Probability_WPWaterContact_LC

If the computations are correct, numbers in the files wpsfail.res and wpsfail2.res should be consistent. Check number for 2 subareas (e.g. subareas 3 and 9).

For few realizations with initially defective, LC, and mechanical breaching on the same subarea, perform a detailed check on the number of WPs breached. Check that the appropriate number of WPs is passed to RELEASET (consult data in the file ebsrel.ech).

Test result: PASS
Expected differences resulted, which were explained to the fact that corrosion WPs in wpsfail.res are double counted. This double counting is done on purpose and does not constitute a problem in the TPA code.
A detailed WP balance was performed for few realizations. The correct number of WPs are passed to RELEASET for release computations.

Input data and code version
TPA 5.1 betaO
600 realizations of the code were executed, with 401 timesteps.

The following changes were implemented in the input file (for consistency with a future nominal case definition):
loguniform
SFWettedFraction_Initial_X, X=1,2,...,10
0.007, 0.156
**
uniform
SFWettedFraction_MECH1_X, X=1,2,...,10
0.033, 1.0
**
uniform
SFWettedFraction_MECH2_X, X=1,2,...,10
0.033, 1.0
**
loguniform
SFWettedFraction_LC_X, X=1,2,...,10 (formerly SFWettedFraction_SEISMO4_X)
0.007, 0.156
**

```
constant
InitialRadiusOfSFParticle[m]
1.286E-3
**
loguniform
WastePackageFlowMultiplicationFactor
1.0, 4.0
**
loguniform
SubareaWetFraction
0.25, 1.0
**
***CORRELATIONS****
correlateinputs
SubAreaWetFraction
ArealAverageMeanAnnualInfiltrationAtStart[mm/yr]
0.7
**
correlateinputs
SubAreaWetFraction
WastePackageFlowMultiplicationFactor
-0.9999
**
correlateinputs
WastePackageFlowMultiplicationFactor
X0FmultCoefficient
-0.9
**
correlateinputs
InitialSeepageReductionFractionInitiallyDefWP
SFWettedFraction_Initial_X, X=1,2,...,10
0.9
**
correlateinputs
InitialSeepageReductionFractionByMechFailedWP
SFWettedFraction_MECH1_X, X=1,2,...,10
0.9
**
correlateinputs
InitialSeepageReductionFractionByMechFailedWP
SFWettedFraction_MECH2_X, X=1,2,...,10
0.9
**
correlateinputs
InitialSeepageReductionFractionLC
```

SFWettedFraction_LC_X, X=1,2,....10 (formerly SFWettedFraction_SEISMO4_X)
0.9
**

```
(*Number of WPs per subarea*)
NoWPs = {526, 1062, 2904, 1793, 1452, 343, 696, 931, 723, 1747}
```

```
{526, 1062, 2904, 1793, 1452, 343, 696, 931, 723, 1747}
```

```
(*Read sampled values, all parameters, from file samplpar.res*)
noParameters = 491;
samp = LeeDatos["00_samplpar.txt", 0, noParameters];
sampT = Transpose[dat];

(*Read parameter names*)
fileID = OpenRead["00_samplpar.hdr"];
Do[Read[fileID, Record, RecordSeparators → {"\n"}], {30}];
parameters = {};
Do[
  {piv1, wo1, wo2} = Read[fileID, {Number, Word, Word}];
  AppendTo[parameters, wo2],
  {i, 1, noParameters}];
Close[fileID];

(*Read data from wpsfail.res, data without scaling factors*)
datwp = LeeDatos["00_wpsfail.res", 34, 8];

(*Read data from wpsfail2.res, including scaling factors*)
datwp2 = LeeDatos["00_wpsfail2.res", 14, 9];
```

■ Subarea 3

```
SA = 3;  (*Subarea number*)
{inits, reaInits} = CumFailedSA[datwp, 3, 4, SA];
{corrs, reaCorrs} = CumFailedSA[datwp, 3, 5, SA];
{mechs, reaMechs} = CumFailedSA[datwp, 3, 6, SA];

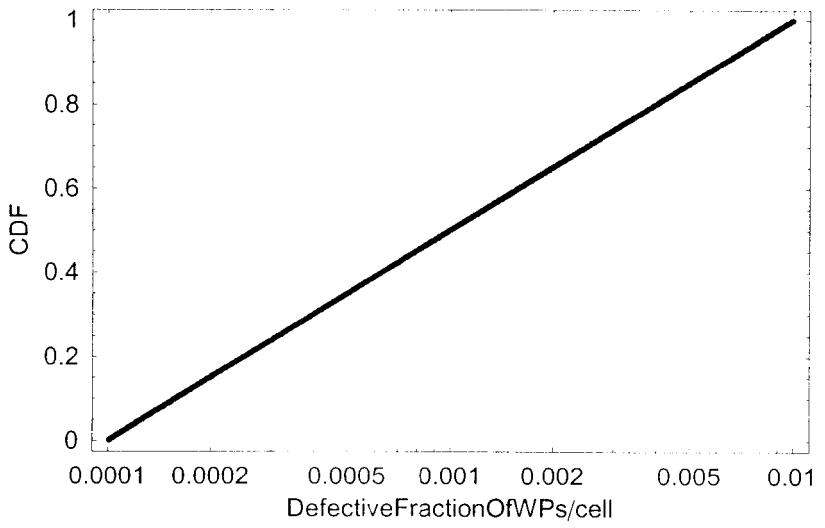
initsT = Transpose[inits];
corrsT = Transpose[corrs];
mechsT = Transpose[mechs];

{inits2, reaInits2} = CumFailedSA[datwp2, 3, 4, SA];
{corrs2, reaCorrs2} = CumFailedSA[datwp2, 3, 6, SA];
{mechs2, reaMechs2} = CumFailedSA[datwp2, 3, 7, SA];

inits2T = Transpose[inits2];
corrs2T = Transpose[corrs2];
mechs2T = Transpose[mechs2];
```

■ Initially defective WPs

```
a1 = Position[parameters, "DefectiveFractionOfWPs/cell"][[1, 1]];
initFractions = sampT[[a1]];
LogLinearListPlot[cdf2[sampT[[a1]]], Frame → True,
  FrameLabel → {"DefectiveFractionOfWPs/cell", "CDF", "", ""}];
```



Number of initially defective waste packages for multiple realizations (before adjusting):

```
defects = Round[Drop[inits[[1]], 1]]
```

```
{1, 8, 15, 2, 23, 3, 1, 1, 6, 1, 4, 11, 1, 3, 0, 3, 13, 1, 1, 5, 10, 1, 6, 1, 1, 0, 2, 7, 22, 3,
 4, 29, 8, 1, 1, 2, 1, 3, 4, 1, 1, 2, 13, 3, 1, 10, 13, 2, 1, 1, 18, 1, 3, 21, 1, 7, 1, 3,
 1, 1, 10, 16, 3, 11, 28, 14, 1, 3, 2, 8, 2, 1, 2, 29, 27, 1, 13, 0, 1, 1, 15, 26, 3, 5,
 8, 1, 21, 0, 3, 1, 3, 20, 9, 0, 1, 8, 2, 20, 6, 7, 7, 1, 1, 1, 2, 2, 9, 1, 27, 5, 21, 7,
 7, 3, 1, 1, 6, 2, 1, 6, 1, 1, 2, 11, 26, 17, 2, 3, 2, 0, 2, 25, 3, 2, 5, 16, 1, 8, 4, 1,
 1, 11, 2, 3, 12, 11, 1, 6, 1, 1, 3, 10, 1, 2, 5, 15, 8, 1, 2, 24, 3, 14, 7, 11, 5, 1, 7,
 5, 5, 1, 2, 5, 12, 9, 28, 11, 12, 12, 2, 2, 6, 3, 4, 2, 2, 12, 5, 2, 23, 18, 2, 19, 21,
 8, 1, 1, 1, 9, 5, 2, 2, 1, 8, 1, 16, 2, 1, 1, 10, 2, 4, 5, 1, 26, 4, 7, 16, 4, 7, 0, 1, 9,
 1, 9, 26, 1, 1, 8, 1, 5, 20, 1, 10, 5, 2, 1, 16, 24, 3, 6, 11, 5, 1, 2, 24, 2, 2, 2, 1,
 1, 4, 11, 5, 14, 16, 12, 28, 5, 1, 11, 5, 18, 11, 3, 13, 7, 1, 1, 2, 17, 1, 5, 11, 4, 22,
 2, 20, 9, 12, 2, 10, 1, 8, 1, 2, 5, 1, 10, 2, 1, 0, 1, 1, 3, 3, 1, 22, 4, 1, 1, 14, 1, 3,
 17, 1, 2, 12, 1, 1, 1, 28, 1, 4, 1, 0, 5, 3, 1, 7, 2, 10, 19, 1, 1, 2, 1, 14, 0, 20, 9, 6,
 19, 2, 1, 4, 2, 4, 2, 5, 13, 2, 1, 4, 6, 23, 1, 3, 3, 17, 23, 0, 10, 2, 4, 16, 8, 2, 18,
 15, 6, 1, 3, 21, 4, 13, 19, 14, 1, 24, 3, 2, 9, 6, 4, 6, 3, 0, 11, 1, 1, 16, 7, 9, 27, 1,
 25, 3, 19, 1, 13, 7, 22, 0, 5, 1, 9, 2, 4, 2, 14, 6, 0, 17, 1, 19, 6, 6, 17, 18, 5, 3,
 25, 4, 0, 1, 9, 6, 1, 3, 1, 1, 3, 21, 2, 1, 3, 0, 2, 18, 23, 15, 3, 25, 26, 4, 6, 2, 2,
 22, 1, 1, 3, 25, 1, 2, 1, 4, 1, 6, 1, 7, 7, 2, 27, 10, 3, 1, 1, 3, 23, 3, 1, 6, 5, 15, 0,
 4, 1, 1, 1, 0, 1, 4, 1, 22, 6, 20, 2, 13, 1, 3, 1, 2, 7, 4, 1, 1, 4, 1, 6, 1, 9, 1, 3, 1,
 0, 7, 4, 8, 2, 13, 18, 3, 1, 10, 9, 4, 21, 1, 29, 1, 4, 1, 2, 8, 24, 1, 12, 1, 0, 8, 16,
 7, 4, 26, 1, 4, 15, 5, 4, 17, 15, 1, 19, 12, 14, 13, 8, 1, 2, 14, 1, 2, 4, 1, 2, 1, 1, 9}
```

Number of initially defective WPs expected from the input parameters in tpa.inp

```
defectsTheo =
 Table[Round[initFractions[[reaInits[[i]]]] * NoWPs[[SA]]], {i, 1, Length[reaInits]}]
```

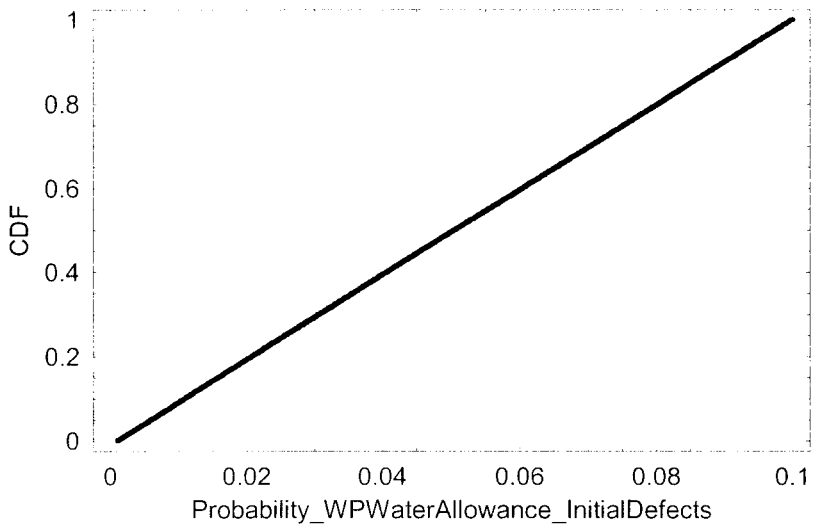
```
{1, 8, 15, 2, 23, 3, 1, 1, 6, 1, 4, 11, 1, 3, 0, 3, 13, 1, 1, 5, 10, 1, 6, 1, 1, 0, 2, 7, 22, 3,
 4, 29, 8, 1, 1, 2, 1, 3, 4, 1, 1, 2, 13, 3, 1, 10, 13, 2, 1, 1, 18, 1, 3, 21, 1, 7, 1, 3,
 1, 1, 10, 16, 3, 11, 28, 14, 1, 3, 2, 8, 2, 1, 2, 29, 27, 1, 13, 0, 1, 1, 15, 26, 3, 5,
 8, 1, 21, 0, 3, 1, 3, 20, 9, 0, 1, 8, 2, 20, 6, 7, 7, 1, 1, 1, 2, 2, 9, 1, 27, 5, 21, 7,
 7, 3, 1, 1, 6, 2, 1, 6, 1, 1, 2, 11, 26, 17, 2, 3, 2, 0, 2, 25, 3, 2, 5, 16, 1, 8, 4, 1,
 1, 11, 2, 3, 12, 11, 1, 6, 1, 1, 3, 10, 1, 2, 5, 15, 8, 1, 2, 24, 3, 14, 7, 11, 5, 1, 7,
 5, 5, 1, 2, 5, 12, 9, 28, 11, 12, 12, 2, 2, 6, 3, 4, 2, 2, 12, 5, 2, 23, 18, 2, 19, 21,
 8, 1, 1, 1, 9, 5, 2, 2, 1, 8, 1, 16, 2, 1, 1, 10, 2, 4, 5, 1, 26, 4, 7, 16, 4, 7, 0, 1, 9,
 1, 9, 26, 1, 1, 8, 1, 5, 20, 1, 10, 5, 2, 1, 16, 24, 3, 6, 11, 5, 1, 2, 24, 2, 2, 2, 1,
 1, 4, 11, 5, 14, 16, 12, 28, 5, 1, 11, 5, 18, 11, 3, 13, 7, 1, 1, 2, 17, 1, 5, 11, 4, 22,
 2, 20, 9, 12, 2, 10, 1, 8, 1, 2, 5, 1, 10, 2, 1, 0, 1, 1, 3, 3, 1, 22, 4, 1, 1, 14, 1, 3,
 17, 1, 2, 12, 1, 1, 1, 28, 1, 4, 1, 0, 5, 3, 1, 7, 2, 10, 19, 1, 1, 2, 1, 14, 0, 20, 9, 6,
 19, 2, 1, 4, 2, 4, 2, 5, 13, 2, 1, 4, 6, 23, 1, 3, 3, 17, 23, 0, 10, 2, 4, 16, 8, 2, 18,
 15, 6, 1, 3, 21, 4, 13, 19, 14, 1, 24, 3, 2, 9, 6, 4, 6, 3, 0, 11, 1, 1, 16, 7, 9, 27, 1,
 25, 3, 19, 1, 13, 7, 22, 0, 5, 1, 9, 2, 4, 2, 14, 6, 0, 17, 1, 19, 6, 6, 17, 18, 5, 3,
 25, 4, 0, 1, 9, 6, 1, 3, 1, 1, 3, 21, 2, 1, 3, 0, 2, 18, 23, 15, 3, 25, 26, 4, 6, 2, 2,
 22, 1, 1, 3, 25, 1, 2, 1, 4, 1, 6, 1, 7, 7, 2, 27, 10, 3, 1, 1, 3, 23, 3, 1, 6, 5, 15, 0,
 4, 1, 1, 1, 0, 1, 4, 1, 22, 6, 20, 2, 13, 1, 3, 1, 2, 7, 4, 1, 1, 4, 1, 6, 1, 9, 1, 3, 1,
 0, 7, 4, 8, 2, 13, 18, 3, 1, 10, 9, 4, 21, 1, 29, 1, 4, 1, 2, 8, 24, 1, 12, 1, 0, 8, 16,
 7, 4, 26, 1, 4, 15, 5, 4, 17, 15, 1, 19, 12, 14, 13, 8, 1, 2, 14, 1, 2, 4, 1, 2, 1, 1, 9}
```

Therefore, the number of initially defective waste packages is well computed (this is an additional test)

```
defects - defectsTheo
```

```
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}
```

```
b1 = Position[parameters, "Probability_WPWaterAllowance_InitialDefects"][[1, 1]];
probs = sampT[[b1]];
ListPlot[cdf2[probs], Frame → True,
  FrameLabel → {"Probability_WPWaterAllowance_InitialDefects", "CDF", "", ""}];
```



The following list is the number of initially defective WPs (rounded to an integer) after adjusting by the Pallowance factor

```
defectsAdjTheo = Table[
  Round[Round[initFractions[[reaInits[[i]]]] * NoWPs[[SA]]] * probs[[reaInits[[i]]]]],
  {i, 1, Length[reaInits]}]
```

```
{0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 2, 1,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1,
 1, 1, 0, 0, 0, 1, 0, 0, 0, 1, 2, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 2, 0, 0, 0, 0, 1, 1, 0, 0,
 1, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1,
 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
 0, 0, 2, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 2, 0, 0, 1, 0,
 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 2, 0, 0, 0,
 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0,
 1, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 2, 0, 0, 1, 0,
 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 1, 0, 0, 0, 0, 0, 0,
 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0,
 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 1, 2, 0, 2, 0, 1, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0,
 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0,
 1, 2, 1, 0, 2, 2, 0, 1, 0, 0, 1, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0,
 2, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 2, 0, 2, 0, 0, 0, 0, 0, 1, 0, 0, 0,
 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0}
```

The subarea of interes has fewer entries in wpsfail2.res than in wpsfail.res. In other words, for each subarea, fewer realizations are reported in wpsfail2.res than in wpsfail.res. With the following operation, the positions in the master realization vector (determined by data in wpsfail.res) corresponding to the realizations where WPs are reported in wpsfail2.res are determined:

```
mappedPos = Table[Position[reaInits, reaInits2[[i]]][[1, 1]], {i, 1, Length[reaInits2]}]
```

```
{5, 10, 12, 15, 19, 21, 24, 26, 29, 31, 32, 33, 34, 37, 42, 43, 46, 47, 48, 49, 51, 54, 55, 56,
 60, 61, 62, 64, 65, 66, 68, 70, 71, 74, 75, 77, 78, 81, 82, 87, 88, 92, 93, 94, 96, 97,
 98, 99, 100, 101, 105, 106, 107, 110, 111, 113, 115, 116, 117, 119, 120, 124, 125, 126,
 130, 132, 133, 136, 138, 144, 145, 150, 152, 153, 156, 160, 162, 163, 166, 168, 170,
 175, 176, 177, 184, 186, 189, 190, 191, 192, 193, 196, 197, 198, 202, 203, 205, 209,
 210, 213, 214, 217, 220, 224, 225, 228, 229, 230, 231, 233, 238, 240, 241, 245, 247,
 251, 252, 254, 255, 257, 260, 262, 263, 265, 267, 270, 275, 276, 277, 279, 280, 283,
 284, 286, 288, 289, 291, 294, 295, 297, 300, 303, 304, 305, 307, 311, 315, 318, 320,
 321, 324, 327, 328, 329, 332, 336, 338, 340, 343, 345, 350, 351, 352, 355, 356, 358,
 362, 363, 365, 367, 370, 372, 374, 375, 377, 378, 381, 383, 384, 385, 386, 388, 390,
 392, 393, 396, 400, 402, 403, 405, 406, 408, 409, 412, 414, 415, 416, 418, 421, 422,
 423, 424, 426, 427, 429, 430, 431, 433, 434, 435, 436, 439, 443, 445, 446, 448, 451,
 452, 454, 455, 460, 461, 464, 465, 466, 468, 469, 470, 471, 473, 474, 475, 477, 483,
 484, 490, 492, 493, 496, 497, 499, 501, 502, 506, 508, 510, 514, 516, 517, 520, 521,
 524, 525, 526, 528, 531, 532, 533, 534, 535, 536, 537, 540, 541, 542, 544, 545, 548}
```

The vector of WPs (number of WPs failed for partcular realizations) from data in wpsfail.res and the sampled probability is the following

```
defectsAdjTheoMapped =
 Table[defectsAdjTheo[[ mappedPos[[i]] ]], {i, 1, Length[reaInits2]}]
```

```
{1, 0, 1, 0, 0, 1, 0, 0, 2, 0, 2, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 0,
 1, 0, 1, 2, 0, 0, 0, 1, 2, 0, 1, 1, 0, 1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 2, 0, 0, 0, 0, 0, 0,
 1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 0, 1, 0, 0, 2, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 1, 0, 1, 1,
 0, 0, 0, 0, 1, 0, 1, 0, 0, 2, 1, 0, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1, 2, 0, 0, 1, 1, 0, 1, 1,
 0, 1, 1, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 2, 0, 0, 2, 0, 1, 1, 0, 0, 0, 0, 0,
 0, 0, 2, 1, 0, 0, 1, 0, 1, 1, 0, 0, 1, 1, 1, 0, 2, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 2, 0, 2,
 1, 1, 1, 0, 1, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 2, 0, 0, 0, 1, 2, 1, 2, 2, 0,
 1, 1, 2, 0, 0, 0, 1, 1, 1, 1, 2, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0,
 1, 1, 1, 1, 0, 2, 2, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 1, 1, 1, 1, 0, 1, 0, 0, 0, 0}
```

The vector of WPs (number of WPs failed for partcular realizations) from data in wpsfail2.res is the following

```
defectsAdj = Round[Drop[inits2[[1]], 1]]
```

```
{1, 0, 1, 0, 0, 1, 0, 0, 2, 0, 2, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 0,
 1, 0, 1, 2, 0, 0, 0, 1, 2, 0, 1, 1, 0, 1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 2, 0, 0, 0, 0, 0, 0,
 1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 0, 1, 0, 0, 2, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 1, 0, 1, 1,
 0, 0, 0, 0, 1, 0, 1, 0, 0, 2, 1, 0, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1, 2, 0, 0, 1, 1, 0, 1, 1,
 0, 1, 1, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 2, 0, 0, 2, 0, 1, 1, 0, 0, 0, 0, 0,
 0, 0, 2, 1, 0, 0, 1, 0, 1, 1, 0, 0, 1, 1, 1, 0, 2, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 2, 0, 2,
 1, 1, 1, 0, 1, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 2, 0, 0, 0, 1, 2, 1, 2, 2, 0,
 1, 1, 2, 0, 0, 0, 1, 1, 1, 1, 2, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0,
 1, 1, 1, 1, 0, 2, 2, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 1, 1, 1, 1, 0, 1, 0, 0, 0, 0}
```

Since both vectors are identical, it is concluded that the factor Probability_WPWaterAllowance_InitialDefects is properly applied

```
defectsAdjTheoMapped - defectsAdj
```

```
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}
```

■ LC WPs

LC waste packages for multiple realizations (before adjusting); i.e., data in wpsfail.res

Note that the number of WPs tracked in wpsfail.res is always the number of WPs in the subarea. It is assumed that all of the WPs can experience localized corrosion, even initially defective WPs, mechanical WPs, faulting and igneous WPs. Therefore, the WP count in wpsfail.res exceeds the total number of WPs (some WPs can be double counted). The file wpsfail.res is intended for information only (it is not used in the TPA computations).

On the other hand, the file wpsfail2.res includes a detailed WP balance. It is infrequent to have initially defective WPs, LC WPs and mechanical WPs in the same subarea, in the same realization. When those cases appear, the WP count in wpsfail.res is inconsistent with the count in wpsfail2.res. Those differences in WP count can be explained.

```
defects = Round[Drop[corrs[[75]], 1]]
```

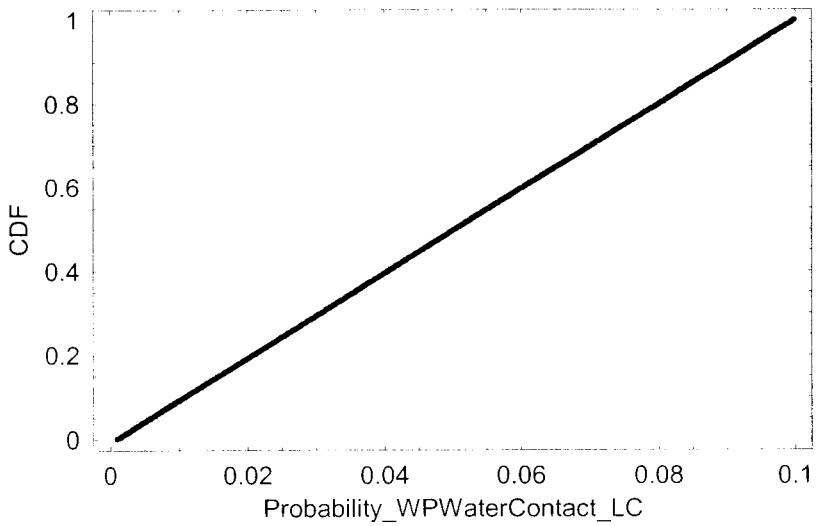
```
{0, 0, 0, 0, 0, 0, 0, 0, 0, 2904, 0, 2904, 0, 0, 2904, 0, 0, 0, 2904, 0, 0, 0, 0, 0, 0, 2904, 0,
 0, 0, 0, 2904, 0, 2904, 2904, 0, 0, 2904, 0, 0, 0, 0, 2904, 0, 0, 0, 2904, 2904, 2904,
 2904, 0, 0, 0, 0, 0, 2904, 0, 0, 0, 0, 2904, 0, 0, 0, 0, 2904, 0, 0, 2904, 0, 2904,
 2904, 0, 0, 0, 0, 0, 2904, 2904, 0, 0, 2904, 2904, 0, 0, 0, 0, 0, 2904, 0, 0, 0, 0, 0,
 0, 0, 2904, 2904, 2904, 2904, 0, 2904, 0, 0, 0, 2904, 2904, 2904, 0, 0, 2904, 0, 0, 0,
 0, 2904, 0, 0, 0, 2904, 2904, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 2904, 0, 0, 0, 0, 0, 2904, 0, 0, 2904, 0, 0, 2904, 0, 0, 0, 2904, 0, 2904,
 0, 0, 0, 2904, 0, 2904, 0, 2904, 0, 0, 0, 0, 2904, 0, 0, 0, 0, 0, 0, 0, 0, 2904, 0, 0,
 0, 0, 2904, 0, 2904, 0, 0, 0, 0, 2904, 2904, 2904, 0, 0, 0, 0, 2904, 0, 2904, 0, 0, 0,
 0, 2904, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2904, 0, 0, 0, 0, 0, 0, 0, 0, 2904, 0, 0, 0, 0, 0,
 0, 0, 0, 2904, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2904, 0, 0, 2904, 2904, 0, 0, 0, 0,
 2904, 0, 0, 0, 0, 0, 0, 2904, 0, 0, 0, 0, 0, 0, 0, 2904, 2904, 2904, 0, 2904, 2904, 0,
 0, 0, 2904, 0, 2904, 0, 0, 2904, 0, 2904, 0, 0, 2904, 0, 0, 0, 0, 0, 2904, 0, 0, 2904,
 0, 2904, 0, 0, 0, 0, 0, 2904, 0, 0, 0, 2904, 0, 0, 2904, 0, 2904, 2904, 0, 0, 2904, 0,
 0, 0, 2904, 2904, 0, 0, 0, 0, 0, 0, 2904, 0, 2904, 0, 2904, 0, 0, 2904, 0, 0, 0, 0, 0,
 0, 0, 2904, 2904, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2904, 2904, 0, 2904, 0, 0, 0, 0, 2904, 0,
 2904, 0, 2904, 2904, 0, 2904, 0, 0, 0, 0, 0, 0, 0, 2904, 2904, 0, 0, 0, 0, 0, 2904,
 2904, 0, 0, 0, 0, 0, 0, 2904, 0, 2904, 2904, 0, 2904, 2904, 0, 2904, 2904, 0, 0, 0, 0,
 2904, 2904, 0, 0, 2904, 0, 0, 2904, 2904, 2904, 2904, 0, 2904, 2904, 0, 0, 0, 0, 0, 0,
 0, 2904, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2904, 2904, 0, 2904, 0, 0, 2904, 0, 0, 0, 0, 0, 0,
 0, 0, 2904, 0, 0, 0, 2904, 0, 2904, 0, 2904, 0, 2904, 2904, 0, 0, 2904, 0, 0, 0, 0, 0,
 0, 0, 0, 2904, 2904, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2904, 0, 0, 2904, 0, 0, 0, 0, 0, 0,
 2904, 0, 0, 0, 0, 0, 0, 0, 2904, 0, 0, 2904, 0, 0, 2904, 0, 0, 0, 2904, 0, 2904, 0, 0,
 0, 0, 0, 2904, 0, 2904, 2904, 0, 0, 0, 0, 2904, 0, 2904, 0, 2904, 2904, 0, 0, 2904, 0}
```

The number of WPs in the subarea of interest is

```
NoWPs[[SA]]
```

```
2904
```

```
b1 = Position[parameters, "Probability_WPWaterContact_LC"][[1, 1]];
probs = sampT[[b1]];
ListPlot[cdf2[probs], Frame → True,
  FrameLabel → {"Probability_WPWaterContact_LC", "CDF", "", ""}];
```



The following list is the number of failed WPs (rounded to an integer) after adjusting by the Pcontact factor

```
defectsAdjTheo =
 Table[Round[defects[[i]] * probs[[ reaCorrs[[i]] ]] ],  {i, 1, Length[reaCorrs]}]
```

```
{0, 0, 0, 0, 0, 0, 0, 0, 0, 233, 0, 51, 0, 0, 277, 0, 0, 0, 161, 0, 0, 0, 0, 0, 0, 59, 0, 0,
 0, 0, 92, 0, 78, 132, 0, 0, 14, 0, 0, 0, 0, 62, 0, 0, 0, 150, 23, 279, 273, 0, 0, 0,
 0, 0, 82, 0, 0, 0, 0, 93, 0, 0, 0, 0, 225, 0, 0, 89, 0, 222, 257, 0, 0, 0, 0, 0, 168,
 251, 0, 0, 242, 65, 0, 0, 0, 0, 0, 225, 0, 0, 0, 0, 0, 0, 0, 246, 213, 222, 158, 0,
 270, 0, 0, 0, 198, 244, 50, 0, 0, 39, 0, 0, 0, 0, 31, 0, 0, 0, 26, 226, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 279, 0, 0, 0, 0, 0, 73, 0, 0,
 153, 0, 0, 146, 0, 0, 0, 27, 0, 58, 0, 0, 0, 172, 0, 209, 0, 179, 0, 0, 0, 0, 113, 0,
 0, 0, 0, 0, 0, 0, 0, 96, 0, 0, 0, 0, 178, 0, 9, 0, 0, 0, 0, 139, 118, 83, 0, 0, 0, 0,
 156, 0, 53, 0, 0, 0, 0, 90, 0, 0, 0, 0, 0, 0, 0, 0, 0, 263, 0, 0, 0, 0, 0, 0, 0, 0, 290,
 0, 0, 0, 0, 0, 0, 0, 0, 23, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 264, 0, 0, 70, 195, 0,
 0, 0, 0, 194, 0, 0, 0, 0, 0, 0, 74, 0, 0, 0, 0, 0, 0, 0, 162, 66, 191, 0, 85, 33, 0,
 0, 0, 68, 0, 59, 0, 0, 54, 0, 15, 0, 0, 285, 0, 0, 0, 0, 0, 147, 0, 0, 79, 0, 74, 0,
 0, 0, 0, 0, 213, 0, 0, 0, 148, 0, 0, 271, 0, 273, 153, 0, 0, 72, 0, 0, 0, 31, 97, 0,
 0, 0, 0, 0, 0, 142, 0, 275, 0, 185, 0, 0, 69, 0, 0, 0, 0, 0, 0, 0, 53, 260, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 222, 135, 0, 51, 0, 0, 0, 0, 236, 0, 268, 0, 186, 36, 0, 279, 0, 0,
 0, 0, 0, 0, 0, 223, 175, 0, 0, 0, 0, 0, 10, 160, 0, 0, 0, 0, 0, 0, 146, 0, 163, 108,
 0, 289, 221, 0, 72, 128, 0, 0, 0, 0, 224, 108, 0, 0, 265, 0, 0, 99, 278, 205, 232,
 0, 103, 46, 0, 0, 0, 0, 0, 0, 0, 24, 0, 0, 0, 0, 0, 0, 0, 0, 0, 288, 140, 0, 152, 0,
 0, 116, 0, 0, 0, 0, 0, 0, 0, 0, 125, 0, 0, 0, 55, 0, 22, 0, 153, 0, 120, 214, 0, 0,
 24, 0, 0, 0, 0, 0, 0, 0, 0, 81, 48, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 157, 0, 0, 130,
 0, 0, 0, 0, 0, 0, 90, 0, 0, 0, 0, 0, 0, 0, 159, 0, 0, 259, 0, 0, 225, 0, 0, 0, 199, 0,
 111, 0, 0, 0, 0, 0, 36, 0, 256, 149, 0, 0, 0, 0, 120, 0, 64, 0, 20, 196, 0, 0, 156, 0}
```

The subarea of interes has fewer entries in wpsfail2.res than in wpsfail.res. In other words, for each subarea, fewer realizations are reported in wpsfail2.res than in wpsfail.res. With the following operation, the positions in the master realization vector (determined by data in wpsfail.res) corresponding to the realizations where WPs are reported in wpsfail2.res are determined:

```
mappedPos = Table[Position[reaCorrs, reaCorrs2[[i]]][[1, 1]], {i, 1, Length[reaCorrs2]}]
```

```
{5, 10, 12, 15, 19, 21, 24, 26, 29, 31, 32, 33, 34, 37, 42, 43, 46, 47, 48, 49, 51, 54, 55, 56,
 60, 61, 62, 64, 65, 66, 68, 70, 71, 74, 75, 77, 78, 81, 82, 87, 88, 92, 93, 94, 96, 97,
 98, 99, 100, 101, 105, 106, 107, 110, 111, 113, 115, 116, 117, 119, 120, 124, 125, 126,
 130, 132, 133, 136, 138, 144, 145, 150, 152, 153, 156, 160, 162, 163, 166, 168, 170,
 175, 176, 177, 184, 186, 189, 190, 191, 192, 193, 196, 197, 198, 202, 203, 205, 209,
 210, 213, 214, 217, 220, 224, 225, 228, 229, 230, 231, 233, 238, 240, 241, 245, 247,
 251, 252, 254, 255, 257, 260, 262, 263, 265, 267, 270, 275, 276, 277, 279, 280, 283,
 284, 286, 288, 289, 291, 294, 295, 297, 300, 303, 304, 305, 307, 311, 315, 318, 320,
 321, 324, 327, 328, 329, 332, 336, 338, 340, 343, 345, 350, 351, 352, 355, 356, 358,
 362, 363, 365, 367, 370, 372, 374, 375, 377, 378, 381, 383, 384, 385, 386, 388, 390,
 392, 393, 396, 400, 402, 403, 405, 406, 408, 409, 412, 414, 415, 416, 418, 421, 422,
 423, 424, 426, 427, 429, 430, 431, 433, 434, 435, 436, 439, 443, 445, 446, 448, 451,
 452, 454, 455, 460, 461, 464, 465, 466, 468, 469, 470, 471, 473, 474, 475, 477, 483,
 484, 490, 492, 493, 496, 497, 499, 501, 502, 506, 508, 510, 514, 516, 517, 520, 521,
 524, 525, 526, 528, 531, 532, 533, 534, 535, 536, 537, 540, 541, 542, 544, 545, 548}
```

The vector of WPs (number of WPs failed for partcular realizations) from data in wpsfail.res and the sampled probability is the following

```
defectsAdjTheoMapped =
 Table[defectsAdjTheo[[ mappedPos[[i]] ]], {i, 1, Length[reaCorrs2]}]
```

```
{0, 233, 51, 277, 161, 0, 0, 59, 0, 92, 0, 78, 132, 14, 62, 0, 150, 23, 279, 273, 0, 0, 82, 0,
 93, 0, 0, 0, 225, 0, 89, 222, 257, 0, 0, 168, 251, 242, 65, 0, 225, 0, 0, 0, 246, 213,
 222, 158, 0, 270, 198, 244, 50, 39, 0, 0, 31, 0, 0, 26, 226, 0, 0, 0, 0, 0, 0, 0, 0, 279,
 0, 73, 0, 153, 146, 27, 58, 0, 172, 209, 179, 113, 0, 0, 96, 0, 178, 0, 9, 0, 0, 139,
 118, 83, 0, 156, 53, 0, 90, 0, 0, 0, 263, 0, 0, 0, 290, 0, 0, 0, 23, 0, 0, 0, 0, 264,
 0, 70, 195, 0, 194, 0, 0, 0, 74, 0, 162, 66, 191, 85, 33, 0, 68, 59, 0, 54, 15, 285, 0,
 0, 147, 79, 0, 74, 0, 213, 148, 271, 273, 153, 72, 0, 31, 97, 0, 142, 275, 185, 69, 0,
 0, 53, 260, 0, 0, 0, 222, 135, 51, 0, 236, 268, 186, 36, 279, 0, 0, 0, 0, 223, 175, 0,
 0, 10, 160, 0, 146, 163, 108, 289, 221, 72, 128, 0, 224, 108, 0, 265, 99, 278, 205,
 232, 103, 46, 0, 0, 0, 0, 0, 24, 0, 0, 0, 288, 140, 152, 116, 0, 0, 0, 125, 0, 55, 0,
 22, 153, 0, 120, 214, 0, 24, 0, 0, 81, 48, 0, 0, 0, 157, 0, 130, 0, 0, 90, 0, 0, 159,
 0, 259, 225, 0, 199, 0, 111, 0, 0, 36, 0, 256, 149, 0, 0, 120, 0, 64, 20, 196, 156}
```

The vector of WPs (number of WPs failed for partcular realizations) from data in wpsfail2.res is the following

```
Dimensions[corrs2]
```

```
{75, 269}
```

```
defectsAdj = Round[Drop[corrs2[[75]], 1]]
```

```
{0, 233, 51, 277, 161, 0, 0, 59, 0, 92, 0, 77, 132, 14, 62, 0, 150, 23, 0, 273, 0, 0, 82, 0,
 93, 0, 0, 0, 222, 0, 89, 0, 257, 0, 0, 167, 251, 240, 65, 0, 225, 0, 0, 0, 246, 213,
 221, 158, 0, 269, 198, 244, 50, 39, 0, 0, 31, 0, 0, 26, 226, 0, 0, 0, 0, 0, 0, 0, 0,
 278, 0, 72, 0, 153, 145, 27, 58, 0, 172, 209, 179, 112, 0, 0, 96, 0, 176, 0, 9, 0, 0,
 139, 118, 83, 0, 156, 53, 0, 90, 0, 0, 0, 263, 0, 0, 0, 0, 0, 0, 0, 23, 0, 0, 0, 0, 264,
 0, 70, 194, 0, 193, 0, 0, 0, 74, 0, 160, 66, 189, 85, 33, 0, 68, 59, 0, 0, 15, 284, 0,
 0, 147, 79, 0, 74, 0, 211, 148, 271, 273, 153, 72, 0, 31, 97, 0, 142, 275, 184, 69,
 0, 0, 53, 0, 0, 0, 0, 222, 134, 51, 0, 236, 0, 158, 36, 279, 0, 0, 0, 0, 223, 174, 0,
 0, 10, 160, 0, 146, 163, 107, 287, 221, 71, 128, 0, 224, 108, 0, 265, 99, 278, 173,
 232, 102, 46, 0, 0, 0, 0, 0, 24, 0, 0, 0, 288, 140, 152, 115, 0, 0, 0, 124, 0, 55, 0,
 22, 153, 0, 120, 214, 0, 24, 0, 0, 81, 48, 0, 0, 0, 157, 0, 0, 0, 0, 90, 0, 0, 159,
 0, 259, 225, 0, 198, 0, 111, 0, 0, 36, 0, 254, 149, 0, 0, 120, 0, 64, 20, 196, 156}
```

There are some apparent inconsistencies:

```
defectsAdjTheoMapped - defectsAdj
```

```
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 279, 0, 0, 0, 0, 0, 0, 0, 0, 0, 3, 0, 0,
 222, 0, 0, 0, 1, 0, 2, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 2, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 290, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1,
 0, 0, 0, 0, 0, 2, 0, 2, 0, 0, 0, 0, 0, 0, 54, 0, 1, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 260, 0, 0, 0, 0, 1, 0, 0, 0, 268, 28, 0, 0, 0, 0, 0, 0,
 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 2, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 32, 0, 1, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 130, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0}
```

There are differences in realizations 36, 53, 72, 79, and so on. This happened because initially defective WPs or mechanical WPs occurred in the same realization, in the same subarea. For example, the following data are contained in ebsfail.ech:

```
36 !! Realization
```

3 !! Subarea

type of event	number wps failed	time of event
INITIAL	1.0000E+00	0.0000E+00
FAULTING	0.0000E+00	0.0000E+00
VOLCANO	0.0000E+00	0.0000E+00
MECH 1	0.0000E+00	0.0000E+00
MECH 2	0.0000E+00	0.0000E+00
NOT USED	0.0000E+00	0.0000E+00
LOC CORR	7.7000E+01	2.5398E+03
GEN CORR	0.0000E+00	1.0000E+05
EXTRUSIVE	0.0000E+00	0.0000E+00

The 1 initial explains the difference.

53 !! Realization
3 !! Subarea

type of event	number wps failed	time of event
INITIAL	0.0000E+00	0.0000E+00
FAULTING	0.0000E+00	0.0000E+00
VOLCANO	0.0000E+00	0.0000E+00
MECH 1	6.3800E+02	8.2450E+04
MECH 2	0.0000E+00	0.0000E+00
NOT USED	0.0000E+00	0.0000E+00
LOC CORR	0.0000E+00	2.5398E+03
GEN CORR	0.0000E+00	1.0000E+05
EXTRUSIVE	0.0000E+00	0.0000E+00

There are 638 mechanicals. It is conservatively assumed that all of the mechanicals experience also localized corrosion. However, for practical reasons these WPs are classified ad MECHANICALS.

72 !! Realization
3 !! Subarea

type of event	number wps failed	time of event
INITIAL	1.0000E+00	0.0000E+00
FAULTING	0.0000E+00	0.0000E+00
VOLCANO	0.0000E+00	0.0000E+00
MECH 1	0.0000E+00	0.0000E+00
MECH 2	0.0000E+00	0.0000E+00
NOT USED	0.0000E+00	0.0000E+00
LOC CORR	2.2200E+02	2.4204E+03
GEN CORR	0.0000E+00	1.0000E+05
EXTRUSIVE	0.0000E+00	0.0000E+00

The 1 initial explains the difference.

79 !! Realization

```
                    3 !! Subarea
type of event     number wps failed     time of event
   INITIAL           1.0000E+00          0.0000E+00
   FAULTING          0.0000E+00          0.0000E+00
   VOLCANO           0.0000E+00          0.0000E+00
   MECH 1            1.4440E+03          3.5493E+03
   MECH 2            0.0000E+00          0.0000E+00
   NOT USED          0.0000E+00          0.0000E+00
   LOC CORR          0.0000E+00          2.0437E+03
   GEN CORR          0.0000E+00          1.0000E+05
   EXTRUSIVE         0.0000E+00          0.0000E+00
```

There are 1444 mechanicals. It is conservatively assumed that all of the mechanicals experience also localized corrosion. However, for practical reasons these WPs are classified ad MECHANICALS.

Therefore, the results in wpsfail2.res are consistent with the expectations. Also, the number of WPs is correctly passed to RELEASET (verified through data in the file ebsrel.ech)

The following is a WP balance for few realizations.

Realization 36

```
                   36 !! Realization
                    3 !! Subarea
type of event     number wps failed     time of event
   INITIAL           1.0000E+00          0.0000E+00
   FAULTING          0.0000E+00          0.0000E+00
   VOLCANO           0.0000E+00          0.0000E+00
   MECH 1            0.0000E+00          0.0000E+00
   MECH 2            0.0000E+00          0.0000E+00
   NOT USED          0.0000E+00          0.0000E+00
   LOC CORR          7.7000E+01          2.5398E+03
   GEN CORR          0.0000E+00          1.0000E+05
   EXTRUSIVE         0.0000E+00          0.0000E+00
```

```
NoWPs[[SA]]
```

```
2904
```

```
rea = 36;
a1 = Position[parameters, "DefectiveFractionOfWPs/cell"][[1, 1]];
f1 = sampT[[a1, rea]];

a2 = Position[parameters, "Probability_WPWaterAllowance_InitialDefects"][[1, 1]];
f2 = sampT[[a2, rea]];
Print["Number of WPs initially breached contributing to release = ",
  Round[f2 * Round[f1 * NoWPs[[SA]]]]];

a3 = Position[parameters, "Probability_WPWaterContact_LC"][[1, 1]];
f3 = sampT[[a3, rea]];
Print["Number of LC WPs contributing to release = ",
  Round[f3 * (NoWPs[[SA]] - Round[f1 * NoWPs[[SA]]])]];
```

```
Number of WPs initially breached contributing to release = 1

Number of LC WPs contributing to release = 77
```

The above numbers are consistent with data in ebsrel.ech.

Realization 79

```
                    79 !! Realization
                     3 !! Subarea
type of event     number wps failed     time of event
   INITIAL           1.0000E+00          0.0000E+00
   FAULTING          0.0000E+00          0.0000E+00
   VOLCANO           0.0000E+00          0.0000E+00
   MECH 1            1.4440E+03          3.5493E+03
   MECH 2            0.0000E+00          0.0000E+00
   NOT USED          0.0000E+00          0.0000E+00
   LOC CORR          0.0000E+00          2.0437E+03
   GEN CORR          0.0000E+00          1.0000E+05
   EXTRUSIVE         0.0000E+00          0.0000E+00
```

```
rea = 79;
a1 = Position[parameters, "DefectiveFractionOfWPs/cell"][[1, 1]];
f1 = sampT[[a1, rea]];

a2 = Position[parameters, "Probability_WPWaterAllowance_InitialDefects"][[1, 1]];
f2 = sampT[[a2, rea]];
Print["Number of WPs initially breached contributing to release = ",
  Round[f2 * Round[f1 * NoWPs[[SA]]]]];

a3 = Position[parameters, "Probability_WPWaterContact_LC"][[1, 1]];
f3 = sampT[[a3, rea]];
Print["Number of LC WPs contributing to release = ",
  Round[f3 * (NoWPs[[SA]] - Round[f1 * NoWPs[[SA]]])]];

a4 = Position[parameters, "Probability_WPWaterAllowance_MechFail"][[1, 1]];
f4 = sampT[[a4, rea]];
Print["Number of MECH WPs contributing to release = ",
  Round[f4 * (NoWPs[[SA]] - Round[f1 * NoWPs[[SA]]])]];
```

```
Number of WPs initially breached contributing to release = 1

Number of LC WPs contributing to release = 222

Number of MECH WPs contributing to release = 1444
```

By TPA design, it is assumed that all of the MECH WPs also experience LC (conservative approach). Those dual WPs are classified as MECH. Thus, the data in ebsfail.ech are consistent with expectations.

TEST RESULT: PASS

```
MatrixForm[Prepend[Transpose[
   {reaCorrs2, defectsAdjTheoMapped - defectsAdj, defectsAdj, defectsAdjTheoMapped}],
  {"Rea", "Diff", "wpsfail2.res", "wpsfail.res"}]]
```

Rea	Diff	wpsfail2.res	wpsfail.res
6	0	0	0
11	0	233	233
13	0	51	51
16	0	277	277
21	0	161	161
23	0	0	0
26	0	0	0
29	0	59	59
32	0	0	0
34	0	92	92
35	0	0	0
36	1	77	78
37	0	132	132
40	0	14	14
46	0	62	62
47	0	0	0
50	0	150	150
51	0	23	23
53	279	0	279

54	0	273	273
56	0	0	0
59	0	0	0
60	0	82	82
61	0	0	0
67	0	93	93
68	0	0	0
69	0	0	0
71	0	0	0
72	3	222	225
73	0	0	0
77	0	89	89
79	222	0	222
80	0	257	257
84	0	0	0
86	0	0	0
88	1	167	168
89	0	251	251
92	2	240	242
93	0	65	65
100	0	0	0
101	0	225	225
106	0	0	0
107	0	0	0
108	0	0	0
110	0	246	246
111	0	213	213
112	1	221	222
113	0	158	158
114	0	0	0
115	1	269	270
119	0	198	198
120	0	244	244
122	0	50	50
125	0	39	39
126	0	0	0
129	0	0	0
131	0	31	31
132	0	0	0
133	0	0	0
135	0	26	26
136	0	226	226
140	0	0	0
141	0	0	0
142	0	0	0
146	0	0	0
148	0	0	0
149	0	0	0
153	0	0	0
156	0	0	0
162	1	278	279
163	0	0	0
168	1	72	73
170	0	0	0
171	0	153	153

174	1	145	146
178	0	27	27
180	0	58	58
181	0	0	0
184	0	172	172
186	0	209	209
188	0	179	179
193	1	112	113
194	0	0	0
195	0	0	0
202	0	96	96
204	0	0	0
208	2	176	178
209	0	0	0
210	0	9	9
211	0	0	0
212	0	0	0
216	0	139	139
217	0	118	118
218	0	83	83
222	0	0	0
223	0	156	156
225	0	53	53
229	0	0	0
230	0	90	90
233	0	0	0
234	0	0	0
237	0	0	0
240	0	263	263
244	0	0	0
245	0	0	0
248	0	0	0
249	290	0	290
250	0	0	0
251	0	0	0
253	0	0	0
258	0	23	23
260	0	0	0
262	0	0	0
266	0	0	0
268	0	0	0
272	0	264	264
273	0	0	0
275	0	70	70
276	1	194	195
280	0	0	0
283	1	193	194
286	0	0	0
287	0	0	0
289	0	0	0
291	0	74	74
294	0	0	0
300	2	160	162
301	0	66	66
302	2	189	191

304	0	85	85
305	0	33	33
308	0	0	0
309	0	68	68
311	0	59	59
313	0	0	0
315	54	0	54
317	0	15	15
320	1	284	285
321	0	0	0
323	0	0	0
326	0	147	147
329	0	79	79
332	0	0	0
333	0	74	74
335	0	0	0
340	2	211	213
345	0	148	148
348	0	271	271
350	0	273	273
351	0	153	153
354	0	72	72
359	0	0	0
360	0	31	31
361	0	97	97
364	0	0	0
368	0	142	142
370	0	275	275
372	1	184	185
376	0	69	69
379	0	0	0
384	0	0	0
385	0	53	53
386	260	0	260
389	0	0	0
390	0	0	0
392	0	0	0
396	0	222	222
398	1	134	135
400	0	51	51
402	0	0	0
405	0	236	236
407	268	0	268
409	28	158	186
410	0	36	36
412	0	279	279
413	0	0	0
416	0	0	0
418	0	0	0
419	0	0	0
420	0	223	223
421	1	174	175
423	0	0	0
425	0	0	0
427	0	10	10

428	0	160	160
431	0	0	0
435	0	146	146
437	0	163	163
438	1	107	108
441	2	287	289
442	0	221	221
444	1	71	72
445	0	128	128
448	0	0	0
450	0	224	224
451	0	108	108
452	0	0	0
454	0	265	265
458	0	99	99
459	0	278	278
460	32	173	205
461	0	232	232
463	1	102	103
465	0	46	46
467	0	0	0
468	0	0	0
469	0	0	0
471	0	0	0
472	0	0	0
473	0	24	24
474	0	0	0
477	0	0	0
482	0	0	0
484	0	288	288
485	0	140	140
487	0	152	152
490	1	115	116
491	0	0	0
493	0	0	0
494	0	0	0
499	1	124	125
500	0	0	0
504	0	55	55
506	0	0	0
507	0	22	22
509	0	153	153
510	0	0	0
512	0	120	120
513	0	214	214
515	0	0	0
516	0	24	24
517	0	0	0
519	0	0	0
526	0	81	81
527	0	48	48
533	0	0	0
535	0	0	0
536	0	0	0
539	0	157	157

540	0	0	0
542	130	0	130
546	0	0	0
548	0	0	0
552	0	90	90
554	0	0	0
556	0	0	0
560	0	159	159
562	0	0	0
563	0	259	259
566	0	225	225
568	0	0	0
572	1	198	199
573	0	0	0
574	0	111	111
576	0	0	0
579	0	0	0
580	0	36	36
581	0	0	0
582	2	254	256
583	0	149	149
584	0	0	0
585	0	0	0
588	0	120	120
589	0	0	0
590	0	64	64
594	0	20	20
595	0	196	196
598	0	156	156

■ MECH WPs

Mechanically breached WPs. Data in wpsfail.res must be consistent with data in wpsfail2.res

```
Dimensions[mechs]
```

```
{75, 550}
```

```
defects = Round[Drop[mechs[[75]], 1]]
```

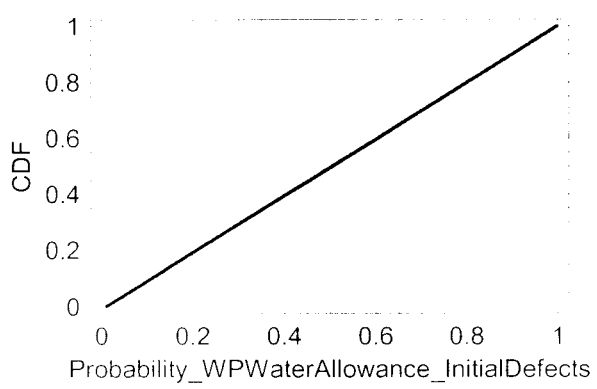
```
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2903, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2902, 0, 0, 0, 0, 0, 2883, 0, 0, 0,
 0, 0, 0, 2894, 0, 0, 0, 0, 0, 0, 0, 0, 2896, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 2904, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 2897, 0, 0, 2903, 2898, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2904, 0, 0, 2901, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2892, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 2903, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2903, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 2903, 2899, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2902, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2886, 2893, 0, 0, 0, 0, 0, 0, 2887, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2894, 2902, 0, 0, 0, 0, 0, 2901, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2890, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2894, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2890, 0, 0, 0, 0, 2895, 0, 435, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 432, 0, 0, 0, 0, 0, 2886, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 435, 0, 0, 0, 2889, 0, 0, 0,
 2903, 0, 0, 0, 2900, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2463, 0, 0, 2903,
 0, 0, 0, 0, 0, 2896, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 2889, 0, 0, 0, 0, 2903, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}
```

The number of WPs in the subarea of interest is

```
NoWPs[[SA]]
```

```
2904
```

```
b1 = Position[parameters, "Probability_WPWaterAllowance_MechFail"][[1, 1]];
probs = sampT[[b1]];
ListPlot[cdf2[probs], Frame → True,
  FrameLabel → {"Probability_WPWaterAllowance_InitialDefects", "CDF", "", ""}];
```



The following list is the number of Mech WPs (rounded to an integer) after adjusting by the Pallowance factor

```
defectsAdjTheo =
 Table[Round[defects[[i]] * probs[[ reaMechs[[i]] ]] ], {i, 1, Length[reaMechs]}]
```

```
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 354, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 638, 0, 0, 0, 0, 0, 2314, 0, 0, 0, 0,
 0, 0, 1336, 0, 0, 0, 0, 0, 0, 0, 0, 1444, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 179, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 436,
 0, 0, 1477, 2355, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 700, 0, 0, 1657, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 56, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 1566, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1889, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 725, 261, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 835, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1165, 547, 0, 0, 0, 0, 0, 0, 268, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2429, 185, 0, 0, 0, 0, 0, 995, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 713, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1028, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 2785, 0, 0, 0, 0, 1162, 0, 186, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 278, 0, 0, 0, 0, 0, 1913, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 102, 0, 0, 0, 2150, 0, 0, 0, 2531,
 0, 0, 0, 1622, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1574, 0, 0, 2393, 0,
 0, 0, 0, 0, 2247, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 731, 0, 0, 0, 0, 1557, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}
```

The subarea of interest only has entries for fewer realizations than the total. Fewer realizations are reported in wpsfail2.res where the subarea of interest has WP entries. With the following operation, the positions in the master realization vector (determined by data in wpsfail.res) corresponding to the realizations where WPs are reported in wpsfail2.res are determined

```
mappedPos = Table[Position[reaMechs, reaMechs2[[i]]][[1, 1]], {i, 1, Length[reaMechs2]}]
```

```
{5, 10, 12, 15, 19, 21, 24, 26, 29, 31, 32, 33, 34, 37, 42, 43, 46, 47, 48, 49, 51, 54, 55, 56,
 60, 61, 62, 64, 65, 66, 68, 70, 71, 74, 75, 77, 78, 81, 82, 87, 88, 92, 93, 94, 96, 97,
 98, 99, 100, 101, 105, 106, 107, 110, 111, 113, 115, 116, 117, 119, 120, 124, 125, 126,
 130, 132, 133, 136, 138, 144, 145, 150, 152, 153, 156, 160, 162, 163, 166, 168, 170,
 175, 176, 177, 184, 186, 189, 190, 191, 192, 193, 196, 197, 198, 202, 203, 205, 209,
 210, 213, 214, 217, 220, 224, 225, 228, 229, 230, 231, 233, 238, 240, 241, 245, 247,
 251, 252, 254, 255, 257, 260, 262, 263, 265, 267, 270, 275, 276, 277, 279, 280, 283,
 284, 286, 288, 289, 291, 294, 295, 297, 300, 303, 304, 305, 307, 311, 315, 318, 320,
 321, 324, 327, 328, 329, 332, 336, 338, 340, 343, 345, 350, 351, 352, 355, 356, 358,
 362, 363, 365, 367, 370, 372, 374, 375, 377, 378, 381, 383, 384, 385, 386, 388, 390,
 392, 393, 396, 400, 402, 403, 405, 406, 408, 409, 412, 414, 415, 416, 418, 421, 422,
 423, 424, 426, 427, 429, 430, 431, 433, 434, 435, 436, 439, 443, 445, 446, 448, 451,
 452, 454, 455, 460, 461, 464, 465, 466, 468, 469, 470, 471, 473, 474, 475, 477, 483,
 484, 490, 492, 493, 496, 497, 499, 501, 502, 506, 508, 510, 514, 516, 517, 520, 521,
 524, 525, 526, 528, 531, 532, 533, 534, 535, 536, 537, 540, 541, 542, 544, 545, 548}
```

The vector of WPs (number of WPs failed for partcular realizations) from data in wpsfail.res and the sampled probability is the following

```
defectsAdjTheoMapped =
 Table[defectsAdjTheo[[ mappedPos[[i]] ]], {i, 1, Length[reaMechs2]}]
```

```
{0, 0, 0, 0, 0, 0, 354, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 638, 0, 0, 2314, 0, 0, 0, 1336, 0, 0, 0,
 0, 0, 1444, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 179, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 436, 0,
 1477, 2355, 0, 0, 0, 0, 0, 700, 0, 1657, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 56, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1566, 0, 0, 0, 0, 1889, 0, 0, 0, 0, 0, 0, 725, 261, 0,
 0, 0, 0, 0, 0, 835, 0, 0, 0, 0, 0, 0, 1165, 547, 0, 0, 268, 0, 0, 0, 0, 0, 0, 0, 0, 2429,
 185, 0, 0, 995, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 713, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 1028, 0, 0, 0, 0, 0, 0, 2785, 0, 1162, 186, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 278, 0, 0, 0, 1913, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 102, 0, 2150, 0, 0, 2531, 0, 0, 1622, 0, 0, 0, 0, 0, 1574, 0, 2393, 0, 0,
 2247, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 731, 0, 0, 1557, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}
```

The vector of WPs (number of WPs failed for partcular realizations) from data in wpsfail2.res is the following

```
Dimensions[mechs2]
```

```
{75, 269}
```

```
defectsAdj = Round[Drop[mechs2[[75]], 1]]
```

```
{0, 0, 0, 0, 0, 0, 354, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 638, 0, 0, 2314, 0, 0, 0, 1336, 0, 0, 0,
 0, 0, 1444, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 179, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 436, 0,
 1477, 2355, 0, 0, 0, 0, 0, 700, 0, 1657, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 56, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1566, 0, 0, 0, 0, 1889, 0, 0, 0, 0, 0, 0, 725, 261, 0,
 0, 0, 0, 0, 0, 835, 0, 0, 0, 0, 0, 0, 1165, 547, 0, 0, 268, 0, 0, 0, 0, 0, 0, 0, 0, 2429,
 185, 0, 0, 995, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 713, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 1028, 0, 0, 0, 0, 0, 0, 2785, 0, 1162, 186, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 278, 0, 0, 0, 1913, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 102, 0, 2150, 0, 0, 2531, 0, 0, 1622, 0, 0, 0, 0, 0, 1574, 0, 2393, 0, 0,
 2247, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 731, 0, 0, 1557, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}
```

Therefore, data in the files wpsfail.res and wpsfail2.res are consistent

```
defectsAdjTheoMapped - defectsAdj
```

```
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}
```

■ Subarea 9

```
SA = 9;
(*Data from wpsfail.res*)
{inits, reaInits} = CumFailedSA[datwp, 3, 4, SA];
{corrs, reaCorrs} = CumFailedSA[datwp, 3, 5, SA];
{mechs, reaMechs} = CumFailedSA[datwp, 3, 6, SA];

initsT = Transpose[inits];
corrsT = Transpose[corrs];
mechsT = Transpose[mechs];

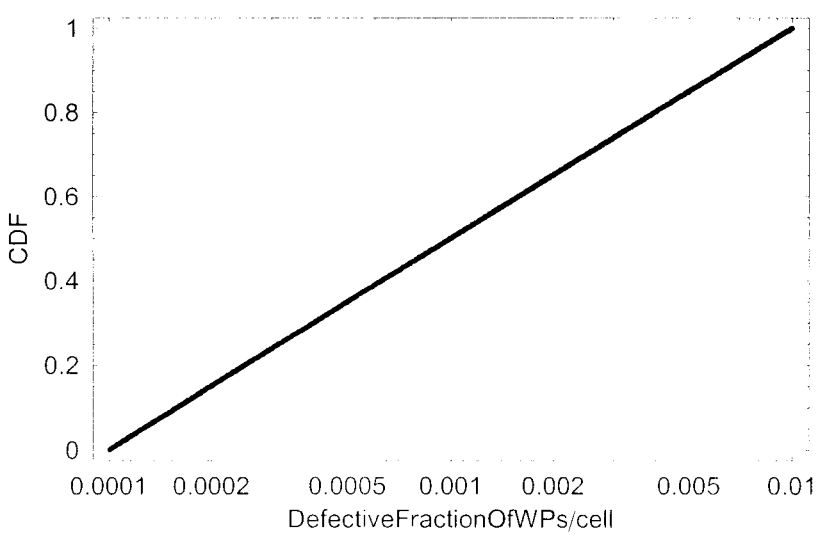
(*Data from wpsfail2.res*)
{inits2, reaInits2} = CumFailedSA[datwp2, 3, 4, SA];
{corrs2, reaCorrs2} = CumFailedSA[datwp2, 3, 6, SA];
{mechs2, reaMechs2} = CumFailedSA[datwp2, 3, 7, SA];

inits2T = Transpose[inits2];
corrs2T = Transpose[corrs2];
mechs2T = Transpose[mechs2];
```

■ Initially defective WPs

Data in wpsfail.res must be consistent with data in wpsfail2.res

```
a1 = Position[parameters, "DefectiveFractionOfWPs/cell"][[1, 1]];
initFractions = sampT[[a1]];
LogLinearListPlot[cdf2[sampT[[a1]]], Frame → True,
  FrameLabel → {"DefectiveFractionOfWPs/cell", "CDF", "", ""}];
```



Initially defective waste packages for multiple realizations (before adjusting)

```
defects = Round[Drop[inits[[1]], 1]]
```

```
{0, 2, 4, 0, 1, 6, 1, 0, 0, 1, 1, 3, 1, 1, 3, 0, 0, 1, 3, 0, 2, 0, 0, 1, 2, 6, 1, 1, 7, 2, 0,
 1, 1, 1, 0, 3, 1, 0, 3, 3, 0, 0, 4, 1, 5, 2, 1, 0, 2, 4, 1, 3, 7, 3, 0, 1, 1, 2, 1, 7, 7,
 3, 4, 6, 1, 1, 2, 5, 0, 1, 1, 5, 2, 2, 1, 5, 1, 2, 2, 0, 1, 0, 2, 7, 1, 5, 2, 2, 1, 1, 1,
 1, 3, 6, 4, 1, 1, 1, 0, 6, 1, 1, 4, 0, 2, 1, 3, 1, 3, 3, 2, 0, 1, 3, 1, 1, 4, 2, 0, 6, 1,
 3, 2, 3, 1, 2, 1, 1, 1, 1, 3, 2, 7, 3, 3, 3, 1, 1, 1, 1, 1, 3, 1, 1, 0, 6, 4, 0, 5, 5, 2,
 2, 1, 1, 0, 2, 4, 0, 2, 1, 1, 1, 7, 1, 2, 4, 1, 2, 0, 2, 2, 7, 0, 2, 0, 1, 5, 2, 1, 4, 6,
 1, 2, 3, 1, 6, 1, 1, 1, 0, 1, 3, 1, 3, 4, 3, 7, 1, 0, 3, 1, 5, 3, 1, 3, 2, 1, 4, 0, 1, 3,
 1, 5, 5, 2, 3, 2, 2, 1, 2, 0, 0, 1, 1, 5, 1, 3, 0, 1, 0, 4, 0, 3, 0, 0, 0, 7, 0, 1, 0, 0,
 1, 1, 0, 2, 0, 2, 5, 0, 0, 4, 5, 2, 2, 5, 0, 1, 1, 1, 3, 1, 1, 6, 1, 1, 4, 6, 3, 1, 1, 4,
 2, 5, 4, 2, 1, 0, 5, 1, 3, 5, 4, 6, 1, 1, 2, 1, 1, 2, 1, 3, 0, 4, 2, 2, 7, 6, 1, 5, 3,
 2, 6, 1, 2, 1, 1, 4, 1, 0, 4, 5, 1, 2, 4, 4, 1, 1, 6, 1, 0, 2, 1, 1, 0, 1, 5, 1, 1, 0,
 4, 6, 4, 1, 6, 7, 1, 2, 1, 0, 6, 1, 6, 1, 0, 2, 2, 2, 7, 3, 1, 0, 1, 6, 1, 1, 1, 0, 4,
 1, 0, 0, 1, 5, 1, 5, 3, 1, 2, 1, 0, 1, 2, 2, 0, 1, 0, 2, 1, 2, 0, 3, 5, 1, 2, 2, 1, 5,
 7, 1, 1, 2, 6, 3, 2, 4, 2, 1, 6, 0, 1, 4, 1, 1, 4, 4, 0, 5, 3, 4, 3, 2, 0, 4, 1, 1, 2}
```

Number of initially defective WPs expected from the input parameters in tpa.inp

```
defectsTheo =
 Table[Round[initFractions[[reaInits[[i]]]] * NoWPs[[SA]]], {i, 1, Length[reaInits]}]
```

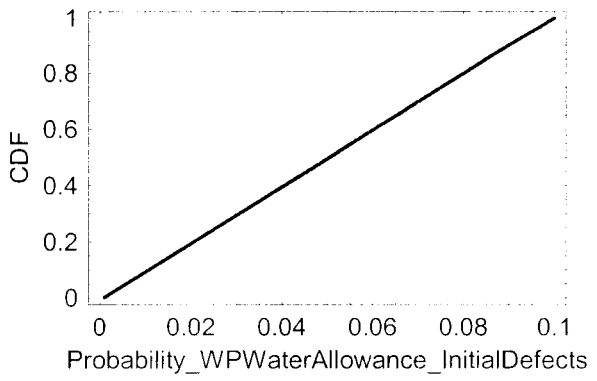
```
{0, 2, 4, 0, 1, 6, 1, 0, 0, 1, 1, 3, 1, 1, 3, 0, 0, 1, 3, 0, 2, 0, 0, 1, 2, 6, 1, 1, 7, 2, 0,
 1, 1, 1, 0, 3, 1, 0, 3, 3, 0, 0, 4, 1, 5, 2, 1, 0, 2, 4, 1, 3, 7, 3, 0, 1, 1, 2, 1, 7, 7,
 3, 4, 6, 1, 1, 2, 5, 0, 1, 1, 5, 2, 2, 1, 5, 1, 2, 2, 0, 1, 0, 2, 7, 1, 5, 2, 2, 1, 1, 1,
 1, 3, 6, 4, 1, 1, 1, 0, 6, 1, 1, 4, 0, 2, 1, 3, 1, 3, 3, 2, 0, 1, 3, 1, 1, 4, 2, 0, 6, 1,
 3, 2, 3, 1, 2, 1, 1, 1, 1, 3, 2, 7, 3, 3, 3, 1, 1, 1, 1, 1, 3, 1, 1, 0, 6, 4, 0, 5, 5, 2,
 2, 1, 1, 0, 2, 4, 0, 2, 1, 1, 1, 7, 1, 2, 4, 1, 2, 0, 2, 2, 7, 0, 2, 0, 1, 5, 2, 1, 4, 6,
 1, 2, 3, 1, 6, 1, 1, 1, 0, 1, 3, 1, 3, 4, 3, 7, 1, 0, 3, 1, 5, 3, 1, 3, 2, 1, 4, 0, 1, 3,
 1, 5, 5, 2, 3, 2, 2, 1, 2, 0, 0, 1, 1, 5, 1, 3, 0, 1, 0, 4, 0, 3, 0, 0, 0, 7, 0, 1, 0, 0,
 1, 1, 0, 2, 0, 2, 5, 0, 0, 4, 5, 2, 2, 5, 0, 1, 1, 1, 3, 1, 1, 6, 1, 1, 4, 6, 3, 1, 1, 4,
 2, 5, 4, 2, 1, 0, 5, 1, 3, 5, 4, 6, 1, 1, 2, 1, 1, 2, 1, 3, 0, 4, 2, 2, 7, 6, 1, 5, 3,
 2, 6, 1, 2, 1, 1, 4, 1, 0, 4, 5, 1, 2, 4, 4, 1, 1, 6, 1, 0, 2, 1, 1, 0, 1, 5, 1, 1, 0,
 4, 6, 4, 1, 6, 7, 1, 2, 1, 0, 6, 1, 6, 1, 0, 2, 2, 2, 7, 3, 1, 0, 1, 6, 1, 1, 1, 0, 4,
 1, 0, 0, 1, 5, 1, 5, 3, 1, 2, 1, 0, 1, 2, 2, 0, 1, 0, 2, 1, 2, 0, 3, 5, 1, 2, 2, 1, 5,
 7, 1, 1, 2, 6, 3, 2, 4, 2, 1, 6, 0, 1, 4, 1, 1, 4, 4, 0, 5, 3, 4, 3, 2, 0, 4, 1, 1, 2}
```

Therefore, the number of initially defective waste packages is well computed (this is an additional test)

```
defects - defectsTheo
```

```
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}
```

```
b1 = Position[parameters, "Probability_WPWaterAllowance_InitialDefects"][[1, 1]];
probs = sampT[[b1]];
ListPlot[cdf2[probs], Frame → True,
  FrameLabel → {"Probability_WPWaterAllowance_InitialDefects", "CDF", "", ""}];
```



The following list is the number of initially defective WPs (rounded to an integer) after adjusting by the Pallowance factor

```
defectsAdjTheo = Table[
  Round[Round[initFractions[[reaInits[[i]]]] * NoWPs[[SA]]] * probs[[reaInits[[i]]]]],
  {i, 1, Length[reaInits]}]
```

```
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}
```

The subarea of interes has fewer entries in wpsfail2.res than in wpsfail.res. In other words, for each subarea, fewer realizations are reported in wpsfail2.res than in wpsfail.res. With the following operation, the positions in the master realization vector (determined by data in wpsfail.res) corresponding to the realizations where WPs are reported in wpsfail2.res are determined:

```
mappedPos = Table[Position[reaInits, reaInits2[[i]]][[1, 1]], {i, 1, Length[reaInits2]}]
```

```
{1, 3, 4, 8, 9, 10, 15, 16, 17, 20, 21, 22, 23, 29, 30, 31, 34, 35, 38, 41, 42, 44, 48,
 49, 51, 53, 55, 58, 59, 62, 65, 69, 70, 72, 73, 76, 80, 81, 82, 86, 88, 90, 94, 99,
 101, 104, 112, 116, 117, 119, 122, 126, 128, 129, 130, 132, 135, 136, 138, 143, 145,
 147, 148, 149, 153, 155, 158, 163, 164, 165, 167, 169, 170, 173, 175, 176, 179, 184,
 188, 189, 190, 192, 194, 196, 199, 205, 206, 209, 211, 213, 214, 217, 219, 220, 221,
 222, 228, 230, 232, 234, 235, 236, 237, 238, 240, 241, 244, 246, 249, 250, 255, 256,
 258, 268, 275, 277, 278, 279, 281, 286, 288, 290, 292, 293, 296, 297, 298, 299, 302,
 304, 305, 306, 309, 310, 315, 316, 320, 321, 322, 323, 324, 325, 327, 329, 331, 334,
 335, 339, 344, 349, 351, 355, 357, 358, 360, 361, 362, 368, 370, 372, 373, 374, 376,
 378, 380, 383, 385, 388, 390, 391, 399, 401, 402, 406, 407, 410, 411, 412, 415, 416}
```

The vector of WPs (number of WPs failed for partcular realizations) from data in wpsfail.res and the sampled probability is the following

```
defectsAdjTheoMapped =
 Table[defectsAdjTheo[[ mappedPos[[i]] ]], {i, 1, Length[reaInits2]}]
```

```
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}
```

The vector of WPs (number of WPs failed for partcular realizations) from data in wpsfail2.res is the following

```
defectsAdj = Round[Drop[inits2[[1]], 1]]
```

```
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}
```

Since both vectors are identical, it is concluded that the factor Probability_WPWaterAllowance_InitialDefects is properly applied

```
defectsAdjTheoMapped - defectsAdj
```

```
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}
```

■ LC WPs

LC waste packages for multiple realizations (before adjusting); i.e., data in wpsfail.res

Note that the number of WPs tracked in wpsfail.res is always the number of WPs in the subarea. It is assumed that all of the WPs can experience localized corrosion, even initially defective WPs, mechanical WPs, faulting and igneous WPs. Therefore, the WP count in wpsfail.res exceeds the total number of WPs (some WPs can be double counted). The file wpsfail.res is intended for information only (it is not used in the TPA computations).

On the other hand, the file wpsfail2.res includes a detailed WP balance. It is infrequent to have initially defective WPs, LC WPs and mechanical WPs in the same subarea, in the same realization. When those cases appear, the WP count in wpsfail.res is inconsistent with the count in wpsfail2.res. Those differences in WP count can be easily explained.

```
Dimensions[corrs]
```

```
{70, 417}
```

```
defects = Round[Drop[corrs[[70]], 1]]
```

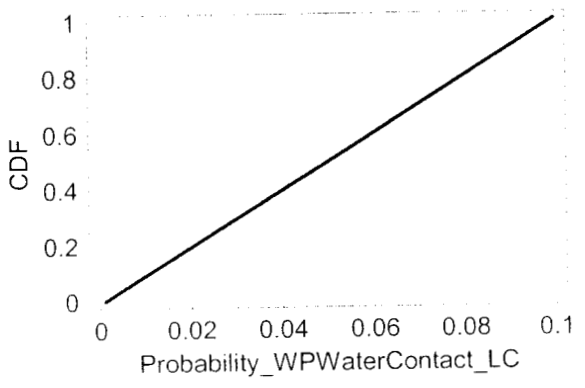
```
{723, 0, 723, 723, 0, 0, 0, 723, 723, 0, 0, 0, 0, 0, 723, 723, 723, 0, 0, 723, 723, 723,
 723, 0, 0, 0, 0, 0, 0, 723, 0, 0, 0, 723, 723, 0, 0, 723, 0, 0, 0, 723, 0, 723, 0, 0,
 0, 723, 0, 0, 723, 0, 723, 0, 723, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 723, 723, 0,
 723, 0, 0, 0, 0, 0, 0, 0, 723, 723, 723, 0, 0, 0, 723, 0, 0, 0, 0, 0, 0, 0, 723, 0,
 0, 0, 0, 723, 0, 0, 0, 0, 723, 0, 0, 0, 0, 0, 0, 0, 723, 0, 0, 0, 723, 723, 0, 723,
 0, 0, 0, 0, 0, 0, 723, 0, 0, 723, 0, 0, 723, 0, 0, 0, 723, 0, 723, 0, 0, 0, 0, 723,
 0, 723, 0, 723, 723, 723, 0, 0, 0, 723, 0, 723, 0, 0, 723, 0, 0, 0, 0, 0, 723, 0, 0,
 723, 0, 723, 0, 0, 0, 0, 0, 0, 0, 0, 0, 723, 0, 0, 0, 0, 723, 0, 0, 0, 723, 723, 723,
 0, 723, 0, 723, 0, 723, 0, 0, 723, 0, 0, 0, 0, 0, 723, 723, 0, 0, 723, 0, 723, 0, 723,
 723, 0, 0, 723, 0, 723, 723, 0, 723, 0, 0, 0, 0, 0, 723, 0, 723, 0, 723, 0, 723, 723,
 723, 723, 723, 0, 723, 723, 0, 0, 723, 0, 723, 0, 0, 723, 723, 0, 0, 0, 0, 723, 0,
 0, 723, 0, 0, 0, 0, 0, 0, 0, 0, 0, 723, 0, 0, 0, 0, 0, 0, 723, 0, 723, 723, 723, 0,
 723, 0, 0, 0, 0, 723, 0, 723, 0, 0, 0, 723, 723, 0, 0, 0, 723, 723, 723, 0, 0, 723,
 0, 723, 723, 723, 0, 0, 723, 723, 0, 0, 0, 0, 723, 723, 0, 0, 0, 723, 723, 723, 723,
 723, 723, 0, 723, 0, 723, 0, 723, 0, 0, 723, 0, 0, 0, 0, 723, 0, 0, 0, 0, 723, 0, 0,
 0, 0, 723, 0, 723, 0, 0, 0, 723, 0, 723, 0, 0, 723, 0, 723, 0, 0, 0, 0, 0, 723, 0,
 723, 0, 0, 723, 723, 0, 723, 0, 0, 0, 723, 0, 0, 723, 0, 0, 0, 0, 0, 0, 723, 723, 0,
 0, 0, 0, 0, 0, 0, 723, 0, 0, 723, 0, 0, 0, 0, 723, 0, 0, 723, 723, 0, 0, 0, 723, 723}
```

The number of WPs in the subarea of interest is

```
NoWPs[[SA]]
```

```
723
```

```
b1 = Position[parameters, "Probability_WPWaterContact_LC"][[1, 1]];
probs = sampT[[b1]];
ListPlot[cdf2[probs], Frame → True,
  FrameLabel → {"Probability_WPWaterContact_LC", "CDF", "", ""}];
```



The following list is the number of failed WPs (rounded to an integer) after adjusting by the Pcontact factor

```
defectsAdjTheo =
 Table[Round[defects[[i]] * probs[[ reaCorrs[[i]] ]] ], {i, 1, Length[reaCorrs]}]
```

```
{25, 0, 7, 9, 0, 0, 0, 38, 34, 0, 0, 0, 0, 0, 19, 35, 40, 0, 0, 62, 27, 53, 4, 0, 0, 0, 0,
 0, 0, 19, 0, 0, 0, 34, 3, 0, 0, 33, 0, 0, 0, 68, 0, 22, 0, 0, 0, 23, 0, 0, 10, 0, 56,
 0, 27, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 56, 48, 0, 17, 0, 0, 0, 0, 0, 0, 0, 46,
 61, 55, 0, 0, 0, 54, 0, 0, 0, 0, 0, 0, 0, 18, 0, 0, 0, 0, 44, 0, 0, 0, 0, 59, 0, 0, 0,
 0, 0, 0, 0, 18, 0, 0, 0, 61, 36, 0, 48, 0, 0, 0, 0, 0, 0, 59, 0, 0, 30, 0, 0, 47, 0,
 0, 0, 47, 0, 14, 0, 0, 0, 0, 9, 0, 46, 0, 15, 2, 70, 0, 0, 0, 27, 0, 50, 0, 0, 41, 0,
 0, 0, 0, 0, 26, 0, 0, 29, 0, 66, 0, 0, 0, 0, 0, 0, 0, 0, 0, 9, 0, 0, 0, 0, 37, 0, 0, 0,
 57, 66, 24, 0, 54, 0, 18, 0, 16, 0, 0, 22, 0, 0, 0, 0, 0, 15, 62, 0, 0, 11, 0, 61, 0,
 40, 47, 0, 0, 46, 0, 15, 17, 0, 21, 0, 0, 0, 0, 0, 38, 0, 18, 0, 18, 0, 23, 49, 50,
 53, 6, 0, 33, 37, 0, 0, 67, 0, 68, 0, 0, 18, 70, 0, 0, 0, 0, 17, 0, 0, 60, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 65, 0, 0, 0, 0, 0, 0, 43, 0, 14, 34, 20, 0, 45, 0, 0, 0, 0, 67, 0, 46,
 0, 0, 0, 5, 27, 0, 0, 0, 44, 17, 13, 0, 0, 2, 0, 52, 57, 54, 0, 0, 41, 27, 0, 0, 0,
 0, 32, 1, 0, 0, 0, 56, 68, 35, 40, 11, 69, 0, 58, 0, 11, 0, 70, 0, 0, 55, 0, 0, 0, 0,
 59, 0, 0, 0, 0, 38, 0, 0, 0, 0, 12, 0, 69, 0, 0, 0, 33, 0, 8, 0, 0, 38, 0, 66, 0, 0,
 0, 0, 0, 12, 0, 15, 0, 0, 56, 26, 0, 39, 0, 0, 0, 45, 0, 0, 60, 0, 0, 0, 0, 0, 0, 40,
 63, 0, 0, 0, 0, 0, 0, 0, 28, 0, 0, 30, 0, 0, 0, 0, 64, 0, 0, 70, 10, 0, 0, 0, 26, 41}
```

The subarea of interes has fewer entries in wpsfail2.res than in wpsfail.res. In other words, for each subarea, fewer realizations are reported in wpsfail2.res than in wpsfail.res. With the following operation, the positions in the master realization vector (determined by data in wpsfail.res) corresponding to the realizations where WPs are reported in wpsfail2.res are determined:

```
mappedPos = Table[Position[reaCorrs, reaCorrs2[[i]]][[1, 1]], {i, 1, Length[reaCorrs2]}]
```

```
{1, 3, 4, 8, 9, 10, 15, 16, 17, 20, 21, 22, 23, 29, 30, 31, 34, 35, 38, 41, 42, 44, 48,
 49, 51, 53, 55, 58, 59, 62, 65, 69, 70, 72, 73, 76, 80, 81, 82, 86, 88, 90, 94, 99,
 101, 104, 112, 116, 117, 119, 122, 126, 128, 129, 130, 132, 135, 136, 138, 143, 145,
 147, 148, 149, 153, 155, 158, 163, 164, 165, 167, 169, 170, 173, 175, 176, 179, 184,
 188, 189, 190, 192, 194, 196, 199, 205, 206, 209, 211, 213, 214, 217, 219, 220, 221,
 222, 228, 230, 232, 234, 235, 236, 237, 238, 240, 241, 244, 246, 249, 250, 255, 256,
 258, 268, 275, 277, 278, 279, 281, 286, 288, 290, 292, 293, 296, 297, 298, 299, 302,
 304, 305, 306, 309, 310, 315, 316, 320, 321, 322, 323, 324, 325, 327, 329, 331, 334,
 335, 339, 344, 349, 351, 355, 357, 358, 360, 361, 362, 368, 370, 372, 373, 374, 376,
 378, 380, 383, 385, 388, 390, 391, 399, 401, 402, 406, 407, 410, 411, 412, 415, 416}
```

The vector of WPs (number of WPs failed for partcular realizations) from data in wpsfail.res and the sampled probability is the following

```
defectsAdjTheoMapped =
 Table[defectsAdjTheo[[ mappedPos[[i]] ]], {i, 1, Length[reaCorrs2]}]
```

```
{25, 7, 9, 38, 34, 0, 19, 35, 40, 62, 27, 53, 4, 0, 19, 0, 34, 3, 33, 0, 68, 22, 23, 0,
 10, 56, 27, 0, 0, 0, 0, 56, 48, 17, 0, 0, 46, 61, 55, 54, 0, 0, 18, 44, 0, 59, 18,
 61, 36, 48, 0, 59, 0, 30, 0, 47, 0, 47, 14, 9, 46, 15, 2, 70, 27, 50, 41, 0, 26, 0,
 29, 66, 0, 0, 0, 0, 9, 37, 57, 66, 24, 54, 18, 16, 22, 15, 62, 11, 61, 40, 47, 46,
 15, 17, 0, 21, 38, 18, 18, 23, 49, 50, 53, 6, 33, 37, 67, 68, 18, 70, 17, 0, 60,
 65, 43, 14, 34, 20, 45, 67, 46, 0, 5, 27, 0, 44, 17, 13, 2, 52, 57, 54, 41, 27, 32,
 1, 56, 68, 35, 40, 11, 69, 58, 11, 70, 55, 0, 59, 38, 12, 69, 33, 8, 0, 38, 0, 66,
 12, 15, 0, 56, 26, 39, 0, 45, 60, 0, 0, 40, 63, 28, 0, 30, 0, 64, 70, 10, 0, 26, 41}
```

The vector of WPs (number of WPs failed for partcular realizations) from data in wpsfail2.res is the following

```
Dimensions[corrs2]
```

```
{69, 181}
```

```
defectsAdj = Round[Drop[corrs2[[69]], 1]]
```

```
{0, 7, 9, 38, 34, 0, 19, 35, 40, 62, 27, 53, 4, 0, 19, 0, 34, 3, 33, 0, 68, 22, 23,
 0, 10, 55, 27, 0, 0, 0, 0, 56, 48, 17, 0, 0, 46, 61, 55, 54, 0, 0, 18, 44, 0, 59,
 18, 61, 36, 48, 0, 58, 0, 30, 0, 47, 0, 47, 14, 9, 46, 14, 2, 70, 27, 50, 41, 0,
 26, 0, 29, 66, 0, 0, 0, 0, 9, 37, 57, 66, 24, 0, 17, 16, 22, 0, 62, 11, 61, 40, 47,
 45, 15, 0, 0, 21, 38, 18, 18, 23, 49, 50, 52, 6, 33, 37, 67, 68, 18, 70, 16, 0, 60,
 64, 43, 14, 33, 20, 45, 66, 46, 0, 5, 27, 0, 43, 17, 13, 2, 52, 57, 54, 41, 27, 32,
 1, 56, 68, 35, 40, 11, 69, 58, 11, 69, 54, 0, 59, 38, 12, 69, 33, 8, 0, 38, 0, 0,
 12, 15, 0, 56, 0, 39, 0, 45, 60, 0, 0, 40, 63, 28, 0, 30, 0, 63, 70, 10, 0, 26, 41}
```

There are some apparent inconsistencies:

```
defectsAdjTheoMapped - defectsAdj
```

```
{25, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 54, 1, 0, 0, 15, 0, 0, 0, 0, 0,
 1, 0, 17, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0,
 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 66, 0, 0, 0, 0, 26, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0}
```

There are differences in realizations 1, 72, and so on. The reason is because initially defective WPs or mechanical WPs occurred in the same realization, in the same subarea. For example, the following data are contained in ebsfail.ech:

```
                        1 !! Realization
                        9 !! Subarea
type of event      number wps failed     time of event
   INITIAL            0.0000E+00          0.0000E+00
   FAULTING           0.0000E+00          0.0000E+00
   VOLCANO            0.0000E+00          0.0000E+00
   MECH 1             5.2300E+02          3.1150E+04
   MECH 2             0.0000E+00          0.0000E+00
   NOT USED           0.0000E+00          0.0000E+00
   LOC CORR           0.0000E+00          1.7660E+03
   GEN CORR           0.0000E+00          1.0000E+05
   EXTRUSIVE          0.0000E+00          0.0000E+00

There are 523 mechanicals.  It is conservatively assumed that all of the mechani-
cals experience also localized corrosion.  However, for practical reasons these
WPs are classified ad MECHANICALS.

 Realization      Subarea                      Number of      Number of     Number of
Number of     Number of
    Number        Number                Time  Initial        Corrosion     Mechanical
Faulting      Igneous Activity
```

```
  (unitless)    (unitless)              (yr)   (unitless)      (unitless)    (unitless)
(unitless)    (unitless)
The following information is available in wpsfail.res
    72         1    0.00000E+00   5.00000E+00   0.00000E+00   0.00000E+00   0.00000-
E+00   0.00000E+00
    72         2    0.00000E+00   1.00000E+01   0.00000E+00   0.00000E+00   0.00000-
E+00   0.00000E+00
    72         3    0.00000E+00   2.80000E+01   0.00000E+00   0.00000E+00   0.00000-
E+00   0.00000E+00
    72         4    0.00000E+00   1.70000E+01   0.00000E+00   0.00000E+00   0.00000-
E+00   0.00000E+00
    72         5    0.00000E+00   1.40000E+01   0.00000E+00   0.00000E+00   0.00000-
E+00   0.00000E+00
    72         6    0.00000E+00   3.00000E+00   0.00000E+00   0.00000E+00   0.00000-
E+00   0.00000E+00
    72         7    0.00000E+00   7.00000E+00   0.00000E+00   0.00000E+00   0.00000-
E+00   0.00000E+00
    72         8    0.00000E+00   9.00000E+00   0.00000E+00   0.00000E+00   0.00000-
E+00   0.00000E+00
    72         9    0.00000E+00   7.00000E+00   0.00000E+00   0.00000E+00   0.00000-
E+00   0.00000E+00
    72        10    0.00000E+00   1.70000E+01   0.00000E+00   0.00000E+00   0.00000-
E+00   0.00000E+00
    72         1    1.60111E+03   0.00000E+00   5.26000E+02   0.00000E+00   0.00000-
E+00   0.00000E+00
    72         9    1.94681E+03   0.00000E+00   7.23000E+02   0.00000E+00   0.00000-
E+00   0.00000E+00
    72         7    2.14520E+03   0.00000E+00   6.96000E+02   0.00000E+00   0.00000-
E+00   0.00000E+00
    72         3    2.42045E+03   0.00000E+00   2.90400E+03   0.00000E+00   0.00000-
E+00   0.00000E+00
```

There are 7 initially defective WPs in subarea 9. Those 7 are excluded from the count of WPs that can be affected by LC only.

The 7 initials are also assumed to undergo LC (conservatiev approach). However, when applying the pAllowance factor, none of these WPs actually allows water in. Thus, none contributes to release.

On the other hard, the complement of the WPs could potentially exhibit LC. This number times the Pcontact factor determines the number of WPs experiencing LC and contributing to release.

Because of the initials in subarea 9, data derived from wpsfail.res and wpsfail2.res are off by 1 waste package. This result is expected.

The following is a WP balance for few realizations.

Realization 1

```
                    1 !! Realization
                    9 !! Subarea
type of event     number wps failed     time of event
   INITIAL           0.0000E+00          0.0000E+00
   FAULTING          0.0000E+00          0.0000E+00
   VOLCANO           0.0000E+00          0.0000E+00
   MECH 1            5.2300E+02          3.1150E+04
   MECH 2            0.0000E+00          0.0000E+00
   NOT USED          0.0000E+00          0.0000E+00
   LOC CORR          0.0000E+00          1.7660E+03
   GEN CORR          0.0000E+00          1.0000E+05
   EXTRUSIVE         0.0000E+00          0.0000E+00
```

```
NoWPs[[SA]]
```

```
723
```

```
rea = 1;
a1 = Position[parameters, "DefectiveFractionOfWPs/cell"][[1, 1]];
f1 = sampT[[a1, rea]];

a2 = Position[parameters, "Probability_WPWaterAllowance_InitialDefects"][[1, 1]];
f2 = sampT[[a2, rea]];
Print["Number of WPs initially breached contributing to release = ",
  Round[f2 * Round[f1 * NoWPs[[SA]]]]];

a3 = Position[parameters, "Probability_WPWaterContact_LC"][[1, 1]];
f3 = sampT[[a3, rea]];
Print["Number of LC WPs contributing to release = ",
  Round[f3 * (NoWPs[[SA]] - Round[f1 * NoWPs[[SA]]])]];

a4 = Position[parameters, "Probability_WPWaterAllowance_MechFail"][[1, 1]];
f4 = sampT[[a4, rea]];
Print["Number of MECH WPs contributing to release = ",
  Round[f4 * (NoWPs[[SA]] - Round[f1 * NoWPs[[SA]]])]];
```

```
Number of WPs initially breached contributing to release = 0

Number of LC WPs contributing to release = 25

Number of MECH WPs contributing to release = 523
```

By TPA design, it is assumed that all of the MECH WPs also experience LC (conservative approach). Those dual WPs are classified as MECH. Thus, the data in ebsfail.ech are consistent with expectations.

TEST RESULT: PASS

```
MatrixForm[Prepend[Transpose[
   {reaCorrs2, defectsAdjTheoMapped - defectsAdj, defectsAdj, defectsAdjTheoMapped}],
  {"Rea", "Diff", "wpsfail2.res", "wpsfail.res"}]]
```

Rea	Diff	wpsfail2.res	wpsfail.res
1	25	0	25
3	0	7	7
4	0	9	9
8	0	38	38
9	0	34	34
10	0	0	0
18	0	19	19
19	0	35	35
21	0	40	40
24	0	62	62
25	0	27	27
26	0	53	53
27	0	4	4
35	0	0	0
36	0	19	19
38	0	0	0
43	0	34	34
45	0	3	3
49	0	33	33
53	0	0	0
54	0	68	68
58	0	22	22
67	0	23	23
68	0	0	0
70	0	10	10
72	1	55	56
74	0	27	27
79	0	0	0
82	0	0	0
88	0	0	0
94	0	0	0
101	0	56	56
102	0	48	48
106	0	17	17
107	0	0	0
112	0	0	0
117	0	46	46
120	0	61	61
121	0	55	55
126	0	54	54
129	0	0	0
133	0	0	0
141	0	18	18
147	0	44	44
149	0	0	0
155	0	59	59
168	0	18	18
173	0	61	61
174	0	36	36
176	0	48	48

180	0	0	0
185	1	58	59
187	0	0	0
189	0	30	30
190	0	0	0
192	0	47	47
195	0	0	0
196	0	47	47
199	0	14	14
205	0	9	9
207	0	46	46
209	1	14	15
210	0	2	2
211	0	70	70
219	0	27	27
221	0	50	50
226	0	41	41
234	0	0	0
235	0	26	26
236	0	0	0
238	0	29	29
240	0	66	66
242	0	0	0
246	0	0	0
249	0	0	0
250	0	0	0
254	0	9	9
262	0	37	37
268	0	57	57
269	0	66	66
271	0	24	24
273	54	0	54
275	1	17	18
277	0	16	16
282	0	22	22
289	15	0	15
290	0	62	62
295	0	11	11
298	0	61	61
300	0	40	40
302	0	47	47
306	1	45	46
311	0	15	15
313	17	0	17
316	0	0	0
318	0	21	21
328	0	38	38
330	0	18	18
333	0	18	18
336	0	23	23
338	0	49	49
339	0	50	50
340	1	52	53
341	0	6	6
344	0	33	33

345	0	37	37
348	0	67	67
350	0	68	68
354	0	18	18
356	0	70	70
364	1	16	17
366	0	0	0
369	0	60	60
386	1	64	65
394	0	43	43
397	0	14	14
398	1	33	34
399	0	20	20
401	0	45	45
407	1	66	67
409	0	46	46
411	0	0	0
414	0	5	5
416	0	27	27
419	0	0	0
421	1	43	44
422	0	17	17
423	0	13	13
427	0	2	2
431	0	52	52
432	0	57	57
433	0	54	54
437	0	41	41
438	0	27	27
445	0	32	32
446	0	1	1
450	0	56	56
452	0	68	68
453	0	35	35
456	0	40	40
457	0	11	11
459	0	69	69
461	0	58	58
465	0	11	11
468	1	69	70
471	1	54	55
472	0	0	0
476	0	59	59
487	0	38	38
494	0	12	12
496	0	69	69
503	0	33	33
505	0	8	8
506	0	0	0
509	0	38	38
510	0	0	0
515	66	0	66
527	0	12	12
529	0	15	15
533	0	0	0

535	0	56	56
536	26	0	26
539	0	39	39
541	0	0	0
545	0	45	45
549	0	60	60
552	0	0	0
556	0	0	0
560	0	40	40
561	0	63	63
574	0	28	28
576	0	0	0
577	0	30	30
581	0	0	0
582	1	63	64
585	0	70	70
586	0	10	10
587	0	0	0
596	0	26	26
600	0	41	41

■ MECH WPs

Mechanically breached WPs. Data in wpsfail.res must be consistent with data in wpsfail2.res

```
Dimensions[mechs]
```

```
{70, 417}
```

```
defects = Round[Drop[mechs[[70]], 1]]
```

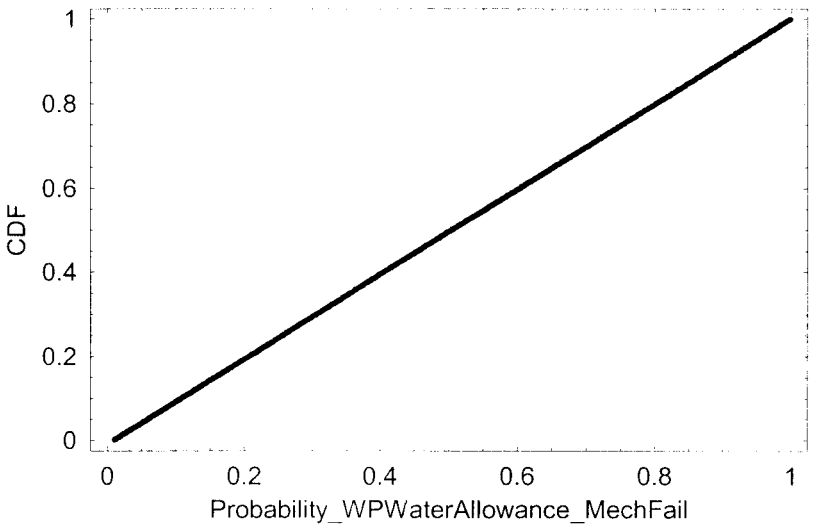
```
{723, 0, 0, 0, 0, 0, 0, 0, 0, 722, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 716,
 0, 723, 0, 0, 0, 0, 0, 0, 0, 0, 0, 723, 0, 0, 0, 0, 0, 0, 0, 721, 0, 0, 0, 0, 0, 0, 0, 0,
 613, 722, 0, 0, 720, 0, 0, 614, 0, 0, 0, 0, 0, 0, 0, 721, 0, 0, 718, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 721, 0, 722, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 722, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 720, 0, 0, 0, 0, 0, 722, 0, 722, 0, 0, 0, 0, 720, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 613, 0,
 0, 0, 0, 721, 0, 0, 723, 0, 723, 722, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 720,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 720, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 721,
 723, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 723, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 108, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 719, 0, 0, 723, 722, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 721, 0, 723, 0, 0, 0, 722, 0, 0, 0, 0, 0, 0, 721, 0, 0, 716, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 719, 0, 0, 0, 0, 723, 0, 0, 0, 0, 0, 723, 0, 0, 0, 0}
```

The number of WPs in the subarea of interest is

```
NoWPs[[SA]]
```

```
723
```

```
b1 = Position[parameters, "Probability_WPWaterAllowance_MechFail"][[1, 1]];
probs = sampT[[b1]];
ListPlot[cdf2[probs], Frame → True,
  FrameLabel → {"Probability_WPWaterAllowance_MechFail", "CDF", "", ""}];
```



The following list is the number of Mech WPs (rounded to an integer) after adjusting by the Pallowance factor

```
defectsAdjTheo =
 Table[Round[defects[[i]] * probs[[ reaMechs[[i]] ]] ], {i, 1, Length[reaMechs]}]
```

```
{523, 0, 0, 0, 0, 0, 0, 0, 0, 55, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 60, 0,
 566, 0, 0, 0, 0, 0, 0, 0, 0, 0, 159, 0, 0, 0, 0, 0, 0, 0, 333, 0, 0, 0, 0, 0, 0, 0, 0,
 306, 610, 0, 0, 482, 0, 0, 337, 0, 0, 0, 0, 0, 0, 0, 57, 0, 0, 350, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 108, 0, 587, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 412, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 152, 0, 0, 0, 0, 0, 487, 0, 241, 0, 0, 0, 0, 14, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 86,
 0, 0, 0, 0, 612, 0, 0, 25, 0, 180, 65, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 406,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 422, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 605,
 428, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 522, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 66, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 535, 0, 0, 630, 404, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 461, 0, 596, 0, 0, 0, 398, 0, 0, 0, 0, 0, 0, 73, 0, 0, 675, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 182, 0, 0, 0, 0, 388, 0, 0, 0, 0, 0, 288, 0, 0, 0, 0}
```

The subarea of interes has fewer entries in wpsfail2.res than in wpsfail.res. In other words, for each subarea, fewer realizations are reported in wpsfail2.res than in wpsfail.res. With the following operation, the positions in the master realization vector (determined by data in wpsfail.res) corresponding to the realizations where WPs are reported in wpsfail2.res are determined:

```
mappedPos = Table[Position[reaMechs, reaMechs2[[i]]][[1, 1]], {i, 1, Length[reaMechs2]}]
```

```
{1, 3, 4, 8, 9, 10, 15, 16, 17, 20, 21, 22, 23, 29, 30, 31, 34, 35, 38, 41, 42, 44, 48,
 49, 51, 53, 55, 58, 59, 62, 65, 69, 70, 72, 73, 76, 80, 81, 82, 86, 88, 90, 94, 99,
 101, 104, 112, 116, 117, 119, 122, 126, 128, 129, 130, 132, 135, 136, 138, 143, 145,
 147, 148, 149, 153, 155, 158, 163, 164, 165, 167, 169, 170, 173, 175, 176, 179, 184,
 188, 189, 190, 192, 194, 196, 199, 205, 206, 209, 211, 213, 214, 217, 219, 220, 221,
 222, 228, 230, 232, 234, 235, 236, 237, 238, 240, 241, 244, 246, 249, 250, 255, 256,
 258, 268, 275, 277, 278, 279, 281, 286, 288, 290, 292, 293, 296, 297, 298, 299, 302,
 304, 305, 306, 309, 310, 315, 316, 320, 321, 322, 323, 324, 325, 327, 329, 331, 334,
 335, 339, 344, 349, 351, 355, 357, 358, 360, 361, 362, 368, 370, 372, 373, 374, 376,
 378, 380, 383, 385, 388, 390, 391, 399, 401, 402, 406, 407, 410, 411, 412, 415, 416}
```

The vector of WPs (number of WPs failed for partcular realizations) from data in wpsfail.res and the sampled probability is the following

```
defectsAdjTheoMapped =
 Table[defectsAdjTheo[[ mappedPos[[i]] ]], {i, 1, Length[reaMechs2]}]
```

```
{523, 0, 0, 0, 0, 55, 0, 0, 0, 0, 0, 0, 0, 60, 0, 566, 0, 0, 0, 159, 0, 0, 0, 333, 0, 0, 0,
 306, 610, 482, 337, 0, 0, 0, 57, 350, 0, 0, 0, 0, 108, 587, 0, 0, 412, 0, 0, 0, 0, 0,
 152, 0, 487, 0, 241, 0, 14, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 86, 0, 0, 612, 25, 180,
 65, 0, 0, 0, 0, 0, 406, 0, 0, 0, 422, 0, 0, 0, 0, 0, 0, 0, 605, 428, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 522, 0, 0, 0, 0, 0, 0, 0, 0, 0, 66, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 535, 0, 630, 404,
 0, 0, 461, 0, 596, 0, 398, 0, 0, 73, 675, 0, 0, 0, 182, 0, 388, 0, 0, 0, 288, 0, 0}
```

The vector of WPs (number of WPs failed for partcular realizations) from data in wpsfail2.res is the following

```
Dimensions[mechs2]
```

```
{69, 181}
```

```
defectsAdj = Round[Drop[mechs2[[69]], 1]]
```

```
{523, 0, 0, 0, 0, 55, 0, 0, 0, 0, 0, 0, 0, 60, 0, 566, 0, 0, 0, 159, 0, 0, 0, 333, 0, 0, 0,
 306, 610, 482, 337, 0, 0, 0, 57, 350, 0, 0, 0, 0, 108, 587, 0, 0, 413, 0, 0, 0, 0, 0,
 152, 0, 487, 0, 241, 0, 14, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 86, 0, 0, 612, 25, 180,
 65, 0, 0, 0, 0, 0, 406, 0, 0, 0, 422, 0, 0, 0, 0, 0, 0, 0, 605, 428, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 522, 0, 0, 0, 0, 0, 0, 0, 0, 0, 66, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 535, 0, 630, 404,
 0, 0, 461, 0, 596, 0, 398, 0, 0, 73, 675, 0, 0, 0, 182, 0, 388, 0, 0, 0, 288, 0, 0}
```

Therefore, data in the files wpsfail.res and wpsfail2.res are consistent

```
Transpose[
 {reaMechs, Table[defects[[i]] * probs[[ reaMechs[[i]] ]] ,  {i, 1, Length[reaMechs]}]}]
```

```
{{1, 522.708}, {2, 0}, {3, 0}, {4, 0}, {5, 0}, {6, 0}, {7, 0}, {8, 0}, {9, 0}, {10, 55.4263},
 {12, 0}, {13, 0}, {15, 0}, {17, 0}, {18, 0}, {19, 0}, {21, 0}, {22, 0}, {23, 0}, {24, 0},
 {25, 0}, {26, 0}, {27, 0}, {30, 0}, {31, 0}, {32, 0}, {33, 0}, {34, 0}, {35, 59.7579},
 {36, 0}, {38, 565.948}, {39, 0}, {42, 0}, {43, 0}, {45, 0}, {47, 0}, {48, 0}, {49, 0},
 {50, 0}, {51, 0}, {53, 158.929}, {54, 0}, {56, 0}, {58, 0}, {59, 0}, {61, 0}, {63, 0},
 {67, 0}, {68, 332.735}, {69, 0}, {70, 0}, {71, 0}, {72, 0}, {73, 0}, {74, 0}, {77, 0},
 {78, 0}, {79, 305.557}, {82, 610.319}, {84, 0}, {86, 0}, {88, 481.768}, {92, 0},
 {93, 0}, {94, 336.694}, {96, 0}, {97, 0}, {100, 0}, {101, 0}, {102, 0}, {105, 0},
 {106, 0}, {107, 56.9068}, {110, 0}, {111, 0}, {112, 350.127}, {113, 0}, {114, 0},
 {115, 0}, {117, 0}, {120, 0}, {121, 0}, {122, 0}, {124, 0}, {125, 0}, {126, 0}, {127, 0},
 {129, 108.479}, {130, 0}, {133, 586.814}, {136, 0}, {139, 0}, {140, 0}, {141, 0},
 {142, 0}, {143, 0}, {144, 0}, {145, 0}, {147, 0}, {148, 0}, {149, 412.27}, {152, 0},
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 {576, 181.924}, {577, 0}, {578, 0}, {579, 0}, {580, 0}, {581, 387.831}, {582, 0}, {583, 0},
 {584, 0}, {585, 0}, {586, 0}, {587, 287.79}, {589, 0}, {594, 0}, {596, 0}, {600, 0}}
```

```
defectsAdjTheoMapped - defectsAdj
```

```
{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
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 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}
```

The only difference in in realization 149. This difference is due to the way the rounding is applied, as next explained

```
 Realization      Subarea                      Number of       Number of     Number of
Number of     Number of
    Number        Number                Time   Initial         Corrosion     Mechanical
Faulting      Igneous Activity
  (unitless)    (unitless)              (yr)   (unitless)      (unitless)    (unitless)
(unitless)    (unitless)
149          1     0.00000E+00    1.00000E+00    0.00000E+00    0.00000E+00    0.00000-
E+00    0.00000E+00
   149          2     0.00000E+00    1.00000E+00    0.00000E+00    0.00000E+00    0.00000-
E+00    0.00000E+00
   149          3     0.00000E+00    3.00000E+00    0.00000E+00    0.00000E+00    0.00000-
E+00    0.00000E+00
   149          4     0.00000E+00    2.00000E+00    0.00000E+00    0.00000E+00    0.00000-
E+00    0.00000E+00
   149          5     0.00000E+00    2.00000E+00    0.00000E+00    0.00000E+00    0.00000-
E+00    0.00000E+00
   149          7     0.00000E+00    1.00000E+00    0.00000E+00    0.00000E+00    0.00000-
E+00    0.00000E+00
   149          8     0.00000E+00    1.00000E+00    0.00000E+00    0.00000E+00    0.00000-
E+00    0.00000E+00
   149          9     0.00000E+00    1.00000E+00    0.00000E+00    0.00000E+00    0.00000-
E+00    0.00000E+00
   149         10     0.00000E+00    2.00000E+00    0.00000E+00    0.00000E+00    0.00000-
E+00    0.00000E+00
   149          5     1.60111E+03    0.00000E+00    1.45200E+03    0.00000E+00    0.00000-
E+00    0.00000E+00
   149          7     1.60111E+03    0.00000E+00    6.96000E+02    0.00000E+00    0.00000-
E+00    0.00000E+00
   149          2     1.72331E+03    0.00000E+00    1.06200E+03    0.00000E+00    0.00000
E+00    0.00000E+00
   149          9     3.00375E+03    0.00000E+00    0.00000E+00    6.14000E+02    0.00000-
E+00    0.00000E+00
   149          1     3.54931E+03    0.00000E+00    0.00000E+00    5.25000E+02    0.00000-
E+00    0.00000E+00
   149          2     3.54931E+03    0.00000E+00    0.00000E+00    1.06100E+03    0.00000-
E+00    0.00000E+00
   149          3     3.54931E+03    0.00000E+00    0.00000E+00    2.90100E+03    0.00000-
```

```
E+00   0.00000E+00
   149        4    3.54931E+03   0.00000E+00   0.00000E+00   1.79100E+03   0.00000-
E+00   0.00000E+00
   149        5    3.54931E+03   0.00000E+00   0.00000E+00   1.45000E+03   0.00000-
E+00   0.00000E+00
   149        6    3.54931E+03   0.00000E+00   0.00000E+00   3.43000E+02   0.00000-
E+00   0.00000E+00
   149        7    3.54931E+03   0.00000E+00   0.00000E+00   6.95000E+02   0.00000-
E+00   0.00000E+00
   149        8    3.54931E+03   0.00000E+00   0.00000E+00   9.30000E+02   0.00000-
E+00   0.00000E+00
   149        9    3.54931E+03   0.00000E+00   0.00000E+00   1.08000E+02   0.00000-
E+00   0.00000E+00
```

```
NoWPs[[SA]]
```

```
723
```

In the TPA, the rounding is applied in two parts. The MECH WPs fail in two times. First, 614 are breached, and then 108. The Pallowance factor is applied in two instances:

```
Round[6.14000*^02*probs[[149]]] + Round[1.08000*^02*probs[[149]]]
```

```
413
```

However, if the WPs are added and then the rounding is applied, then the number of WPs is 1 less:

```
Round[(6.14000*^02 + 1.08000*^02) * probs[[149]]]
```

```
412
```

Consequently the difference is expected.

Test result: PASS

Test 02, Seepage factors

Test 02
(i) Check the seepage factors for a couple of realizations and compare seepage factors to known times or failure (drip shield corrosion, drip shield mechanical, waste package corrosion, and waste package mechanical).
(ii) Compare values of the seepage factors to sampled data in the file samplpar.res.
(iii) Explain inflexions in EBS release rates as changes in the seepage factors.

Repeat the test for a couple of representative subareas realizations

■ Realization 79, subarea 3

```
CopyFile["run/tpa.inp", "02_01_tpa.inp"];
CopyFile["run/ebsflo.dat", "02_01_ebsflo.dat"];
CopyFile["run/dsfailt.dat", "02_01_dsfail.dat"];
CopyFile["run/dsfail.res", "02_01_dsfail.res"];

Run["ebsrel.exe"]; (*Script to abstract data
  from ebsrel.rlt and write it in matrix from in output files*)
CopyFile["run/ebsrel_nucAverage.txt", "02_01_ebsrel_nucAverage.txt"];
CopyFile["run/ebsrel_realizations.txt", "02_01_ebsrel_realizations.txt"];
CopyFile["run/ebsrel_subAverage.txt", "02_01_ebsrel_subAverage.txt"];
CopyFile["run/wpsfail2.res", "02_01_wpsfail2.res"];
CopyFile["run/wpsfail.res", "02_01_wpsfail.res"];

!! "02_01_dsfail.dat"
```

```
GENERATING MODULE: dsfailt
Uniform corrosion of drip shield
Thickness of drip shield vs time
1  Failure Flag (=1 if failed, 0 otherwise)
39334  yrs :  Drip shield failure time
267  Number of time steps in this file
 Time[yr]       Thickness[m]
 0.0000E+00     1.5000E-02
 2.3102E+00     1.4999E-02
 4.6744E+00     1.4998E-02
 7.0940E+00     1.4997E-02
 9.5702E+00     1.4996E-02
 1.2104E+01     1.4995E-02
 1.4698E+01     1.4994E-02
 1.7352E+01     1.4993E-02
 2.0069E+01     1.4992E-02
 2.2849E+01     1.4991E-02
 2.5694E+01     1.4990E-02
 2.8605E+01     1.4989E-02
 3.1585E+01     1.4988E-02
 3.4635E+01     1.4987E-02
 3.7756E+01     1.4986E-02
 4.0950E+01     1.4984E-02
 4.4219E+01     1.4983E-02
 4.7564E+01     1.4982E-02
 5.0988E+01     1.4981E-02
 5.4492E+01     1.4979E-02
 5.8078E+01     1.4978E-02
 6.1747E+01     1.4976E-02
 6.5503E+01     1.4975E-02
 6.9347E+01     1.4974E-02
 7.3281E+01     1.4972E-02
 7.7306E+01     1.4971E-02
 8.1426E+01     1.4969E-02
 8.5643E+01     1.4967E-02
 8.9958E+01     1.4966E-02
 9.4374E+01     1.4964E-02
 9.8894E+01     1.4962E-02
 1.0352E+02     1.4961E-02
 1.0825E+02     1.4959E-02
 1.1310E+02     1.4957E-02
 1.1806E+02     1.4955E-02
 1.2313E+02     1.4953E-02
 1.2832E+02     1.4951E-02
```

1.3364E+02	1.4949E-02
1.3908E+02	1.4947E-02
1.4464E+02	1.4945E-02
1.5034E+02	1.4943E-02
1.5617E+02	1.4940E-02
1.6213E+02	1.4938E-02
1.6824E+02	1.4936E-02
1.7449E+02	1.4933E-02
1.8088E+02	1.4931E-02
1.8743E+02	1.4929E-02
1.9413E+02	1.4926E-02
2.0098E+02	1.4923E-02
2.0800E+02	1.4921E-02
2.1518E+02	1.4918E-02
2.2252E+02	1.4915E-02
2.3004E+02	1.4912E-02
2.3774E+02	1.4909E-02
2.4562E+02	1.4906E-02
2.5368E+02	1.4903E-02
2.6193E+02	1.4900E-02
2.7037E+02	1.4897E-02
2.7901E+02	1.4894E-02
2.8785E+02	1.4890E-02
2.9690E+02	1.4887E-02
3.0616E+02	1.4883E-02
3.1564E+02	1.4880E-02
3.2534E+02	1.4876E-02
3.3526E+02	1.4872E-02
3.4542E+02	1.4868E-02
3.5582E+02	1.4864E-02
3.6646E+02	1.4860E-02
3.7735E+02	1.4856E-02
3.8849E+02	1.4852E-02
3.9990E+02	1.4847E-02
4.1157E+02	1.4843E-02
4.2352E+02	1.4838E-02
4.3574E+02	1.4834E-02
4.4825E+02	1.4829E-02
4.6106E+02	1.4824E-02
4.7416E+02	1.4819E-02
4.8757E+02	1.4814E-02
5.0130E+02	1.4809E-02
5.1535E+02	1.4803E-02
5.2972E+02	1.4798E-02
5.4443E+02	1.4792E-02
5.5949E+02	1.4787E-02
5.7490E+02	1.4781E-02
5.9067E+02	1.4775E-02
6.0680E+02	1.4769E-02
6.2332E+02	1.4762E-02
6.4022E+02	1.4756E-02
6.5752E+02	1.4749E-02
6.7523E+02	1.4742E-02
6.9334E+02	1.4736E-02
7.1189E+02	1.4729E-02
7.3086E+02	1.4721E-02
7.5028E+02	1.4714E-02
7.7016E+02	1.4706E-02
7.9050E+02	1.4699E-02
8.1132E+02	1.4691E-02
8.3262E+02	1.4682E-02
8.5442E+02	1.4674E-02
8.7674E+02	1.4666E-02
8.9957E+02	1.4657E-02
9.2294E+02	1.4648E-02
9.4686E+02	1.4639E-02
9.7134E+02	1.4630E-02
9.9639E+02	1.4620E-02

1.0220E+03	1.4610E-02
1.0483E+03	1.4600E-02
1.0751E+03	1.4590E-02
1.1026E+03	1.4580E-02
1.1307E+03	1.4569E-02
1.1595E+03	1.4558E-02
1.1890E+03	1.4547E-02
1.2191E+03	1.4535E-02
1.2500E+03	1.4523E-02
1.2815E+03	1.4511E-02
1.3138E+03	1.4499E-02
1.3469E+03	1.4486E-02
1.3808E+03	1.4473E-02
1.4154E+03	1.4460E-02
1.4508E+03	1.4447E-02
1.4871E+03	1.4433E-02
1.5242E+03	1.4419E-02
1.5622E+03	1.4404E-02
1.6011E+03	1.4389E-02
1.6409E+03	1.4374E-02
1.6816E+03	1.4359E-02
1.7233E+03	1.4343E-02
1.7660E+03	1.4327E-02
1.8096E+03	1.4310E-02
1.8543E+03	1.4293E-02
1.9000E+03	1.4275E-02
1.9468E+03	1.4258E-02
1.9947E+03	1.4239E-02
2.0437E+03	1.4221E-02
2.0939E+03	1.4201E-02
2.1452E+03	1.4182E-02
2.1977E+03	1.4162E-02
2.2515E+03	1.4141E-02
2.3065E+03	1.4120E-02
2.3628E+03	1.4099E-02
2.4204E+03	1.4077E-02
2.4794E+03	1.4054E-02
2.5398E+03	1.4031E-02
2.6015E+03	1.4008E-02
2.6648E+03	1.3984E-02
2.7295E+03	1.3959E-02
2.7957E+03	1.3934E-02
2.8634E+03	1.3908E-02
2.9328E+03	1.3882E-02
3.0038E+03	1.3855E-02
3.0764E+03	1.3827E-02
3.1507E+03	1.3798E-02
3.2268E+03	1.3769E-02
3.3046E+03	1.3740E-02
3.3843E+03	1.3709E-02
3.4659E+03	1.3678E-02
3.5493E+03	1.3646E-02
3.6347E+03	1.3614E-02
3.7221E+03	1.3581E-02
3.8116E+03	1.3546E-02
3.9031E+03	1.3512E-02
3.9968E+03	1.3476E-02
4.0927E+03	1.3439E-02
4.1908E+03	1.3402E-02
4.2912E+03	1.3364E-02
4.3940E+03	1.3324E-02
4.4992E+03	1.3284E-02
4.6068E+03	1.3243E-02
4.7170E+03	1.3201E-02
4.8297E+03	1.3158E-02
4.9451E+03	1.3114E-02
5.0632E+03	1.3069E-02
5.1840E+03	1.3023E-02

5.3077E+03	1.2976E-02
5.4343E+03	1.2928E-02
5.5638E+03	1.2878E-02
5.6964E+03	1.2828E-02
5.8321E+03	1.2776E-02
5.9709E+03	1.2723E-02
6.1130E+03	1.2669E-02
6.2584E+03	1.2613E-02
6.4073E+03	1.2557E-02
6.5596E+03	1.2498E-02
6.7154E+03	1.2439E-02
6.8750E+03	1.2378E-02
7.0382E+03	1.2316E-02
7.2053E+03	1.2252E-02
7.3763E+03	1.2187E-02
7.5513E+03	1.2120E-02
7.7304E+03	1.2052E-02
7.9137E+03	1.1982E-02
8.1013E+03	1.1911E-02
8.2933E+03	1.1837E-02
8.4897E+03	1.1762E-02
8.6908E+03	1.1686E-02
8.8966E+03	1.1607E-02
9.1072E+03	1.1527E-02
9.3227E+03	1.1445E-02
9.5433E+03	1.1361E-02
9.7690E+03	1.1275E-02
1.0000E+04	1.1186E-02
1.0450E+04	1.1015E-02
1.0900E+04	1.0843E-02
1.1350E+04	1.0672E-02
1.1800E+04	1.0500E-02
1.2250E+04	1.0328E-02
1.2700E+04	1.0157E-02
1.3150E+04	9.9852E-03
1.3600E+04	9.8136E-03
1.4050E+04	9.6420E-03
1.4500E+04	9.4704E-03
1.4950E+04	9.2988E-03
1.5400E+04	9.1271E-03
1.5850E+04	8.9555E-03
1.6300E+04	8.7839E-03
1.6750E+04	8.6123E-03
1.7200E+04	8.4407E-03
1.7650E+04	8.2691E-03
1.8100E+04	8.0975E-03
1.8550E+04	7.9259E-03
1.9000E+04	7.7543E-03
1.9450E+04	7.5827E-03
1.9900E+04	7.4111E-03
2.0350E+04	7.2394E-03
2.0800E+04	7.0678E-03
2.1250E+04	6.8962E-03
2.1700E+04	6.7246E-03
2.2150E+04	6.5530E-03
2.2600E+04	6.3814E-03
2.3050E+04	6.2098E-03
2.3500E+04	6.0382E-03
2.3950E+04	5.8666E-03
2.4400E+04	5.6950E-03
2.4850E+04	5.5234E-03
2.5300E+04	5.3517E-03
2.5750E+04	5.1801E-03
2.6200E+04	5.0085E-03
2.6650E+04	4.8369E-03
2.7100E+04	4.6653E-03
2.7550E+04	4.4937E-03
2.8000E+04	4.3221E-03

```
2.8450E+04    4.1505E-03
2.8900E+04    3.9789E-03
2.9350E+04    3.8073E-03
2.9800E+04    3.6357E-03
3.0250E+04    3.4640E-03
3.0700E+04    3.2924E-03
3.1150E+04    3.1208E-03
3.1600E+04    2.9492E-03
3.2050E+04    2.7776E-03
3.2500E+04    2.6060E-03
3.2950E+04    2.4344E-03
3.3400E+04    2.2628E-03
3.3850E+04    2.0912E-03
3.4300E+04    1.9196E-03
3.4750E+04    1.7479E-03
3.5200E+04    1.5763E-03
3.5650E+04    1.4047E-03
3.6100E+04    1.2331E-03
3.6550E+04    1.0615E-03
3.7000E+04    8.8990E-04
3.7450E+04    7.1829E-04
3.7900E+04    5.4668E-04
3.8350E+04    3.7507E-04
3.8800E+04    2.0346E-04
3.9250E+04    3.1855E-05
3.9700E+04   -1.3975E-04
```

!! "02_01_dsfail.res"

```
!! dsfail.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1beta0 Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1beta0
!! Module: EXEC
!! Job started: Mon Mar 05 13:36:20 2007
!!
!! PURPOSE:
!!  Number of Failed Drip Shields by Type of Event
!!  Including Time of Event - Values for Each Vector
!!  SECTION: Dripshield and drift failure times
!!           This section reports the following
!!           The realization number, which is a unitless vector
!!           The time recorded for either a dripshield
!!             mechanical failure or drift failure (yr)
!!           The corrosion status of the Drip Shield at the
!!             time of mechanical failure, either
!!             uncorroded (0) or corroded (1)
!!           The number of drip shields that were reported
!!             failed at that time (cumulative)
!!           The repository wide drift failure fraction
```

Realization Vector unitless	TIME [yr]	DRIP SHIELD #CORRODE unitless	DRIP SHIELD #MECHANICAL unitless	DRIFT FRACTION unitless
79	3.0616E+02	0	436	0.0000E+00
79	3.9990E+02	0	2904	0.0000E+00
79	7.1189E+02	0	2904	1.5000E-01
79	9.4686E+02	0	2904	1.0000E+00

!! 02_01_wpsfail2.res

```
!! wpsfail2.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1beta0 Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1beta0
!! Module: EXEC
!! Job started: Mon Mar 05 13:36:20 2007
!!
!! PURPOSE:
!!  Number WPs Available for GW Release by Event Type
!!  Including Event Time and Subarea for Each Vector

  vector  subarea      time        #initial      #gencorr      #loccorr   #mechanical
#fault       #ign_act
 unitless unitless      yr         unitless      unitless      unitless      unitless
unitless      unitless
    79        3    0.00000E+00   1.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
0.00000E+00   0.00000E+00
    79        3    3.54931E+03   0.00000E+00   0.00000E+00   0.00000E+00   1.44400E+03
0.00000E+00   0.00000E+00
```

```
!! 02_01_wpsfail.res
```

```
!! wpsfail.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1beta0 Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1beta0
!! Module: EXEC
!! Job started: Mon Mar 05 13:36:20 2007
!!
!! PURPOSE:
!!  Number of WPs Identified by Event Type
!!  Including Event Time and Subarea for Each Vector
!! This file presents a table of five different waste package
!! failure modes in time order for each realization. The
!! subarea of failure is also noted.
!!
!! This file contains only one section.
!!
!! SECTION 1
!!
!! Realization Number = realization number; (ir)
!! Subarea Number = subarea number; (isa)
!! Time  = simulation time in years of failure event;
!!         (tim)
!! Number of Initial = number of initial failures.
!! Number of Corrosion = number of corrosion failures.
!! Number of Mechanical = number of mechanical failures.
!! Number of Faulting = number of failures due to faulting
!!                      event.
!! Number of Igneous Activity = number of indrift failures
!!                              due to volcanic event.

 Realization     Subarea                  Number of      Number of    Number of      Number of
Number of
    Number       Number              Time  Initial        Corrosion    Mechanical     Faulting
Igneous Activity
  (unitless)   (unitless)            (yr)  (unitless)     (unitless)   (unitless)
(unitless)   (unitless)
    79        3    0.00000E+00   8.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
0.00000E+00
    79        3    2.04371E+03   0.00000E+00   2.90400E+03   0.00000E+00   0.00000E+00
0.00000E+00
    79        3    3.54931E+03   0.00000E+00   0.00000E+00   2.89600E+03   0.00000E+00
0.00000E+00
```

According to data in dsfail.dat and dsfail.res

Drip shield corrosion failure time: 39334 yrs

Drip shield mechanical failure times: 306.16 (15% of the DS), and 399.9 (remaining 85% of the DS)

```
Round[0.15 NoWPs[[3]]]
```

```
436
```

```
seepData = LeeDatos["02_01_ebsflo.dat", 3, 11];
seepDataT = Transpose[seepData];
labels = {"time[yr]", "drip/wp[m^3/yr]", "fmult", "fow",
   "sawet", "frubble", "fDS", "fwcorr", "fwmech1", "fwmech2", "fidefects"};
```

```
(*Number of WPs per subarea*)
NoWPs = {526, 1062, 2904, 1793, 1452, 343, 696, 931, 723, 1747}
```

```
{526, 1062, 2904, 1793, 1452, 343, 696, 931, 723, 1747}
```

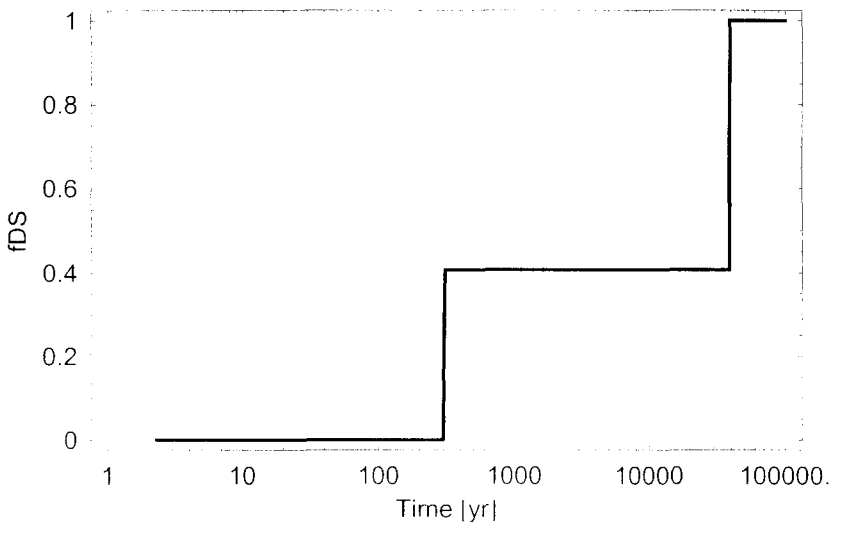
```
(*Read sampled values, all parameters, from file samplpar.res*)
noParameters = 491;
samp = LeeDatos["00_samplpar.txt", 0, noParameters];
sampT = Transpose[dat];

(*Read parameter names*)
fileID = OpenRead["00_samplpar.hdr"];
Do[Read[fileID, Record, RecordSeparators → {"\n"}], {30}];
parameters = {};
Do[
  {piv1, wo1, wo2} = Read[fileID, {Number, Word, Word}];
  AppendTo[parameters, wo2],
  {i, 1, noParameters}];
Close[fileID];

rea = 79 ;  (*Realization number*)
```

■ Drip shield factor

```
p1 = 7;
LogLinearListPlot[Transpose[{seepDataT[[1]], seepDataT[[p1]]}],
  PlotJoined → True, Frame → True, Axes → None,
  FrameLabel → {"Time [yr]", labels[[p1]], "", ""}, PlotStyle → AbsoluteThickness[2]];
```




```
a1 = Position[parameters, "InitialSeepageReductionFractionByMechFailedDS"][[1, 1]];
sampT[[a1, rea]]
```

```
0.408135
```

```
(*Heights of the seepage factor*)
heights = Union[seepDataT[[p1]]]
```

```
{0., 0.408135, 1.}
```

```
(*Get times of failure from the seepage factor*)
piv = Flatten[Position[seepDataT[[p1]], heights[[2]]]];
Print["Time of mechanical failure = ", seepDataT[[1, piv[[1]]]], " yr"]

piv = Flatten[Position[seepDataT[[p1]], heights[[3]]]];
Print["Time of corrosion failure = ", seepDataT[[1, piv[[1]]]], " yr"]
```

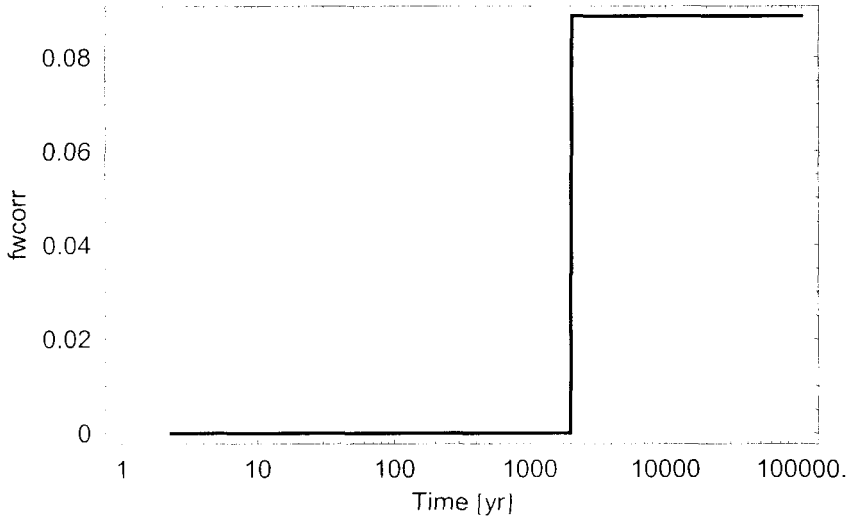
```
Time of mechanical failure = 306.16 yr

Time of corrosion failure = 39250. yr
```

Therefore, the seepage factor correctly responds to the time of mechanical and corrosion failure

■ Localized corrosion WP factor

```
p1 = 8;
LogLinearListPlot[Transpose[{seepDataT[[1]], seepDataT[[p1]]}],
  PlotJoined → True, Frame → True, Axes → None,
  FrameLabel → {"Time [yr]", labels[[p1]], "", ""}, PlotStyle → AbsoluteThickness[2]];
```




```
a1 = Position[parameters, "InitialSeepageReductionFractionWeldLC"][[1, 1]];
Print["Sampled seepage factor = ", sampT[[a1, rea]]];
```

```
Sampled seepage factor = 0.0888021
```

```
(*Heights of the seepage factor*)
heights = Union[seepDataT[[p1]]];
Print["Seepage factor heights = ", heights];

(*Get times of failure from the seepage factor*)
piv = Flatten[Position[seepDataT[[p1]], heights[[2]]]];
Print["Time of failure = ", seepDataT[[1, piv[[1]]]], " yr"]
```

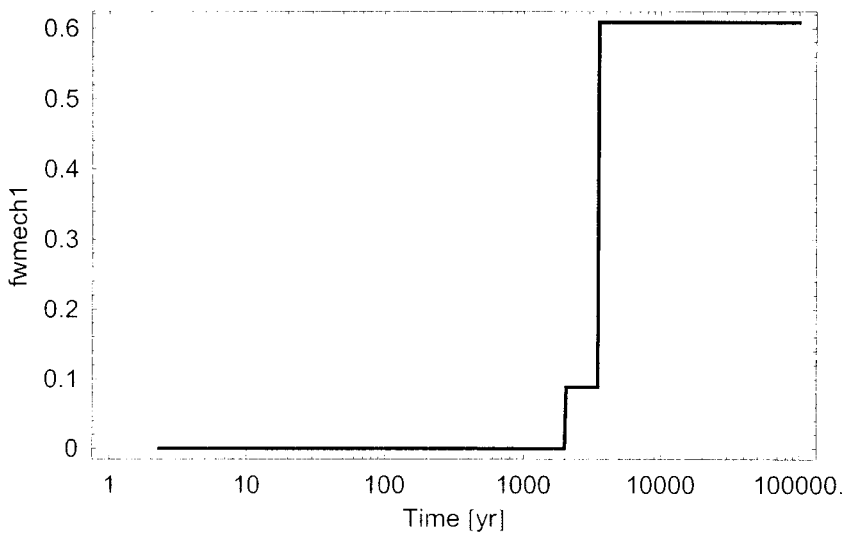
```
Seepage factor heights = {0., 0.038802}

Time of failure = 2043.71 yr
```

According to data in wpsfail.res, localized corrosion breaching occurs at 2.04371E+03 yr (consistent with the above).
Conclusion: the seepage factor for the drip shield is correctly constructed

■ MECH 1 factor

```
p1 = 9;
LogLinearListPlot[Transpose[{seepDataT[[1]], seepDataT[[p1]]}],
  PlotJoined → True, Frame → True, Axes → None,
  FrameLabel → {"Time [yr]", labels[[p1]], "", ""}, PlotStyle → AbsoluteThickness[2]];
```




```
a1 = Position[parameters, "InitialSeepageReductionFractionWeldLC"][[1, 1]];
Print["Sampled seepage factor, weld corrosion = ", sampT[[a1, rea]]];

a2 = Position[parameters, "InitialSeepageReductionFractionByMechFailedWP"][[1, 1]];
Print["Sampled seepage factor, MECH1 = ", sampT[[a2, rea]]];

Print["Addition = ", sampT[[a1, rea]] + sampT[[a2, rea]]];
```

```
Sampled seepage factor, weld corrosion = 0.0888021

Sampled seepage factor, MECH1 = 0.520053

Addition = 0.608855
```

```
(*Heights of the seepage factor*)
heights = Union[seepDataT[[p1]]];
Print["Seepage factor heights = ", heights];
```

```
Seepage factor heights   {0., 0.088802, 0.608855}
```

```
(*Get times of failure from the seepage factor*)
piv = Flatten[Position[seepDataT[[p1]], heights[[2]]]];
Print["Time of corrosion failure = ", seepDataT[[1, piv[[1]]]], " yr"]

piv = Flatten[Position[seepDataT[[p1]], heights[[3]]]];
Print["Time of mechanical failure = ", seepDataT[[1, piv[[1]]]], " yr"]
```

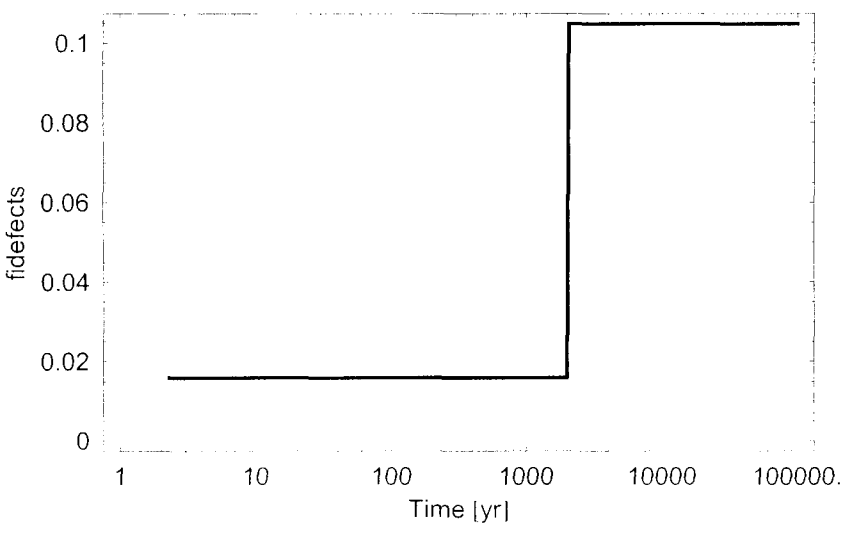
```
Time of corrosion failure = 2043.71 yr

Time of mechanical failure = 3549.31 yr
```

The breaching times are consistent with data in wpsfail.res and wpsfail2.res.
Conclusion: the seepage factor for the MECH WPs is correctly constructed.

■ Initially defective factor

```
p1 = 11;
LogLinearListPlot[Transpose[{seepDataT[[1]], seepDataT[[p1]]}],
  PlotJoined → True, Frame → True, Axes → None,
  FrameLabel → {"Time [yr]", labels[[p1]], "", ""}, PlotStyle → AbsoluteThickness[2]];
```



```
a1 = Position[parameters, "InitialSeepageReductionFractionInitiallyDefWP"][[1, 1]];
Print["Sampled seepage factor, initially defective = ", sampT[[a1, rea]]];

a2 = Position[parameters, "InitialSeepageReductionFractionWeldLC"][[1, 1]];
Print["Sampled seepage factor, weld corrosion = ", sampT[[a2, rea]]];

Print["Addition = ", sampT[[a1, rea]] + sampT[[a2, rea]]];
```

```
Sampled seepage factor, initially defective = 0.0158942

Sampled seepage factor, weld corrosion = 0.0888021

Addition = 0.104696
```

```
(*Heights of the seepage factor*)
heights = Union[seepDataT[[p1]]];
Print["Seepage factor heights = ", heights];
```

```
Seepage factor heights = {0.0158942, 0.104696}
```

```
(*Get times of failure from the seepage factor*)
piv = Flatten[Position[seepDataT[[p1]], heights[[2]]]];
Print["Time of corrosion failure = ", seepDataT[[1, piv[[1]]]], " yr"]
```

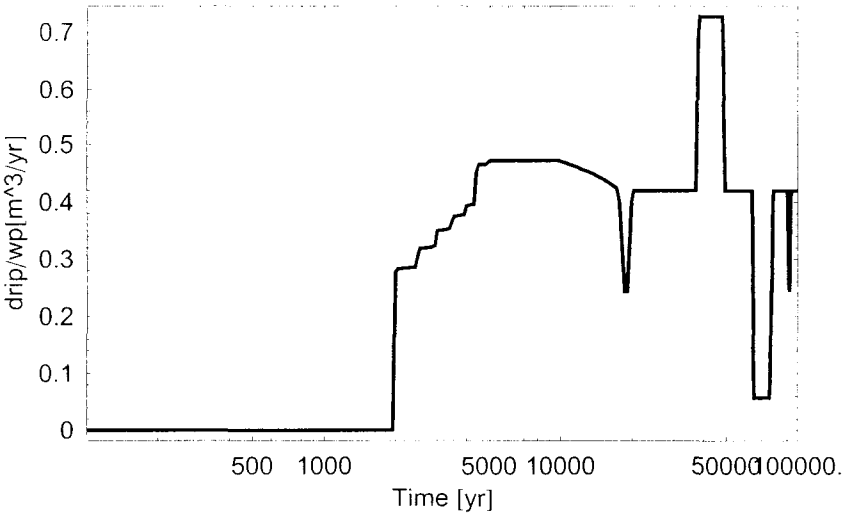
```
Time of corrosion failure = 2043.71 yr
```

The breaching times are consistent with data in wpsfail.res and wpsfail2.res.
Conclusion: the seepage factor for the initially defective WPs is correctly constructed.

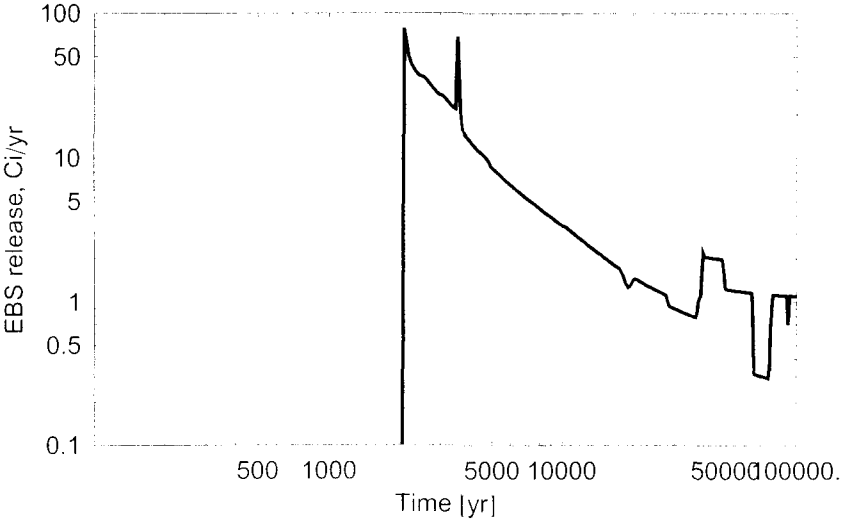
■ Release rates from the EBS

```
rel = LeeDatos["02_01_ebsrel_realizations.txt", 1, 2];
```

```
p1 = 2;
LogLinearListPlot[Transpose[{seepDataT[[1]], seepDataT[[p1]]}], PlotJoined → True,
  Frame → True, Axes → None, FrameLabel → {"Time [yr]", labels[[p1]], "", ""},
  PlotStyle → AbsoluteThickness[2], PlotRange → {{100, 1*^5}, Automatic}];
```




```
LogLogListPlot[rel + 1*^-50, PlotRange → {{100, 1*^5}, {1*^-1, 100}}, PlotJoined → True,
  Frame → True, FrameLabel → {"Time [yr]", "EBS release, Ci/yr", "", ""},
  PlotStyle → AbsoluteThickness[2]];
```



Releases occur immediately after re-wetting (initially defective WPs). A short time after rewetting, localized corrosion occurs (at around 2,000 years). At around 3,500 years, mechanical breaching occurs, resulting in an increase in the seepage rate.

```
!! 02_01_wpsfail.res
```

```
!! 02_01_wpsfail2.res
```

■ Realization 149, subarea 9

```
CopyFile["run/tpa.inp", "02_02_tpa.inp"];
CopyFile["run/ebsflo.dat", "02_02_ebsflo.dat"];
CopyFile["run/dsfailt.dat", "02_02_dsfail.dat"];
CopyFile["run/dsfail.res", "02_02_dsfail.res"];

 (*Script to abstract data from
   ebsrel.rlt and write it in matrix from in output files*)
dir = Directory[]; SetDirectory["run"]; Run["ebsrel.exe"]; SetDirectory[dir];
(*End of script*)
CopyFile["run/ebsrel_nucAverage.txt", "02_02_ebsrel_nucAverage.txt"];
CopyFile["run/ebsrel_realizations.txt", "02_02_ebsrel_realizations.txt"];
CopyFile["run/ebsrel_subAverage.txt", "02_02_ebsrel_subAverage.txt"];
CopyFile["run/wpsfail2.res", "02_02_wpsfail2.res"];
CopyFile["run/wpsfail.res", "02_02_wpsfail.res"];

!! 02_02_dsfail.dat

!! 02_02_dsfail.res
```

```
!! dsfail.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1beta0 Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1beta0
!! Module: EXEC
!! Job started: Mon Mar 05 16:34:37 2007
!!
!! PURPOSE:
!!  Number of Failed Drip Shields by Type of Event
!!  Including Time of Event - Values for Each Vector
!!  SECTION: Dripshield and drift failure times
!!           This section reports the following
!!           The realization number, which is a unitless vector
!!           The time recorded for either a dripshield
!!             mechanical failure or drift failure (yr)
!!           The corrosion status of the Drip Shield at the
!!             time of mechanical failure, either
              uncorroded (0) or corroded (1)
!!           The number of drip shields that were reported
!!             failed at that time (cumulative)
!!           The repository wide drift failure fraction
```

Realization Vector unitless	TIME [yr]	DRIP SHIELD #CORRODE unitless	DRIP SHIELD #MECHANICAL unitless	DRIFT FRACTION unitless
149	3.1564E+02	0	615	0.0000E+00
149	4.8757E+02	0	723	0.0000E+00
149	7.5028E+02	0	723	1.5000E-01
149	9.7134E+02	0	723	1.0000E+00

!! 02_02 wpsfail2.res

```
!! wpsfail2.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1beta0 Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1beta0
!! Module: EXEC
!! Job started: Mon Mar 05 16:34:37 2007
!!
!! PURPOSE:
!!  Number WPs Available for GW Release by Event Type
!!  Including Event Time and Subarea for Each Vector

  vector  subarea      time        #initial      #gencorr      #loccorr   #mechanical
#fault       #ign_act
 unitless unitless      yr         unitless      unitless      unitless      unitless
unitless      unitless
   149        9    3.00375E+03   0.00000E+00   0.00000E+00   0.00000E+00   3.51000E+02
0.00000E+00   0.00000E+00
   149        9    3.54931E+03   0.00000E+00   0.00000E+00   0.00000E+00   6.20000E+01
0.00000E+00   0.00000E+00
```

```
!! 02_02_wpsfail.res

!! wpsfail.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1beta0 Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1beta0
!! Module: EXEC
!! Job started: Mon Mar 05 16:34:37 2007
!!
!! PURPOSE:
!!  Number of WPs Identified by Event Type
!!  Including Event Time and Subarea for Each Vector
!! This file presents a table of five different waste package
!! failure modes in time order for each realization. The
!! subarea of failure is also noted.
!!
!! This file contains only one section.
!!
!! SECTION 1
!!
!! Realization Number = realization number; (ir)
!! Subarea Number = subarea number; (isa)
!! Time  = simulation time in years of failure event;
!!         (tim)
!! Number of Initial = number of initial failures.
!! Number of Corrosion = number of corrosion failures.
!! Number of Mechanical = number of mechanical failures.
!! Number of Faulting = number of failures due to faulting
!!                      event.
!! Number of Igneous Activity = number of indrift failures
!!                              due to volcanic event.

 Realization     Subarea                    Number of      Number of    Number of      Number of
Number of
    Number       Number              Time  Initial        Corrosion    Mechanical     Faulting
Igneous Activity
  (unitless)   (unitless)            (yr)  (unitless)     (unitless)   (unitless)
(unitless)   (unitless)
   149        9    0.00000E+00   1.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
0.00000E+00
   149        9    3.00375E+03   0.00000E+00   0.00000E+00   6.14000E+02   0.00000E+00
0.00000E+00
   149        9    3.54931E+03   0.00000E+00   0.00000E+00   1.08000E+02   0.00000E+00
0.00000E+00
```

According to data in dsfail.dat and dsfail.res

Drip shield corrosion failure time: 40587 yrs

Drip shield mechanical failure times: 3.1564E+02 (85% of the DS), and 4.8757E+02 (remaining 15% of the DS)

```
Round[0.15 NoWPs[[9]]]
```

```
108
```

```
seepData = LeeDatos["02_02_ebsflo.dat", 3, 11];
seepDataT = Transpose[seepData];
labels = {"time[yr]", "drip/wp[m^3/yr]", "fmult", "fow",
   "sawet", "frubble", "fDS", "fwcorr", "fwmech1", "fwmech2", "fidefects"};
```

```
(*Number of WPs per subarea*)
NoWPs = {526, 1062, 2904, 1793, 1452, 343, 696, 931, 723, 1747}
```

```
{526, 1062, 2904, 1793, 1452, 343, 696, 931, 723, 1747}
```

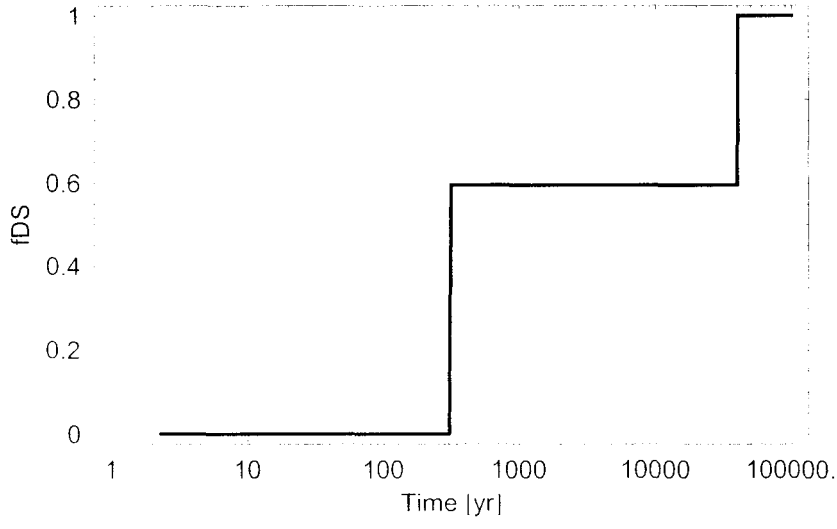
```
(*Read sampled values, all parameters, from file samplpar.res*)
noParameters = 491;
samp = LeeDatos["00_samplpar.txt", 0, noParameters];
sampT = Transpose[dat];

(*Read parameter names*)
fileID = OpenRead["00_samplpar.hdr"];
Do[Read[fileID, Record, RecordSeparators → {"\n"}], {30}];
parameters = {};
Do[
  {piv1, wo1, wo2} = Read[fileID, {Number, Word, Word}];
  AppendTo[parameters, wo2],
  {i, 1, noParameters}];
Close[fileID];

rea = 149 ;  (*Realization number*)
```

■ Drip shield factor

```
p1 = 7;
LogLinearListPlot[Transpose[{seepDataT[[1]], seepDataT[[p1]]}],
  PlotJoined → True, Frame → True, Axes → None,
  FrameLabel → {"Time [yr]", labels[[p1]], "", ""}, PlotStyle → AbsoluteThickness[2]];
```




```
a1 = Position[parameters, "InitialSeepageReductionFractionByMechFailedDS"][[1, 1]];
sampT[[a1, rea]]
```

```
0.594917
```

```
(*Heights of the seepage factor*)
heights = Union[seepDataT[[p1]]]
```

```
{0., 0.594917, 1.}
```

```
(*Get times of failure from the seepage factor*)
piv = Flatten[Position[seepDataT[[p1]], heights[[2]]]];
Print["Time of mechanical failure = ", seepDataT[[1, piv[[1]]]], " yr"]

piv = Flatten[Position[seepDataT[[p1]], heights[[3]]]];
Print["Time of corrosion failure = ", seepDataT[[1, piv[[1]]]], " yr"]
```

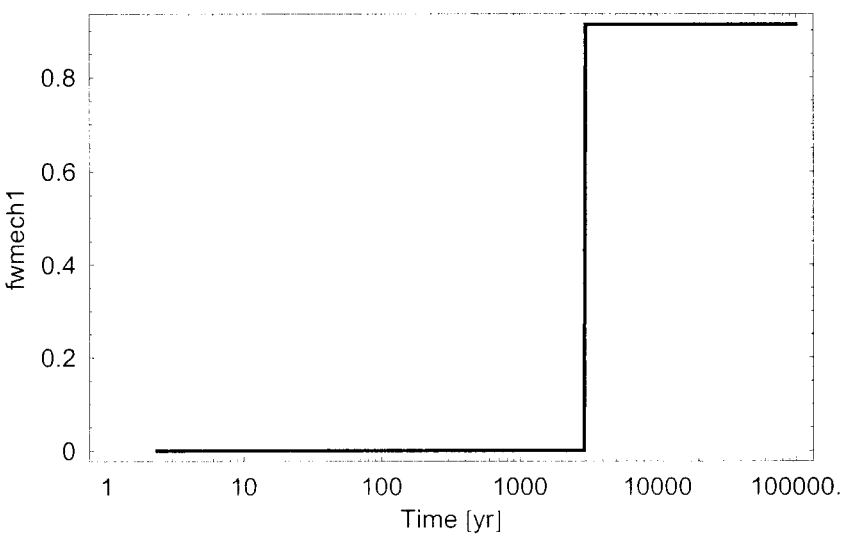
```
Time of mechanical failure = 315.638 yr

Time of corrosion failure = 40150. yr
```

Therefore, the seepage factor correctly responds to the time of mechanical and corrosion failure of the drip shield

■ MECH 1 factor

```
p1 = 9;
LogLinearListPlot[Transpose[{seepDataT[[1]], seepDataT[[p1]]}],
  PlotJoined → True, Frame → True, Axes → None,
  FrameLabel → {"Time [yr]", labels[[p1]], "", ""}, PlotStyle → AbsoluteThickness[2]];
```




```
a2 = Position[parameters, "InitialSeepageReductionFractionByMechFailedWP"][[1, 1]];
Print["Sampled seepage factor, MECH1 = ", sampT[[a2, rea]]];
```

```
Sampled seepage factor, MECH1 = 0.912502
```

```
(*Heights of the seepage factor*)
heights = Union[seepDataT[[p1]]];
Print["Seepage factor heights = ", heights];
```

```
Seepage factor heights = {0., 0.912502}
```

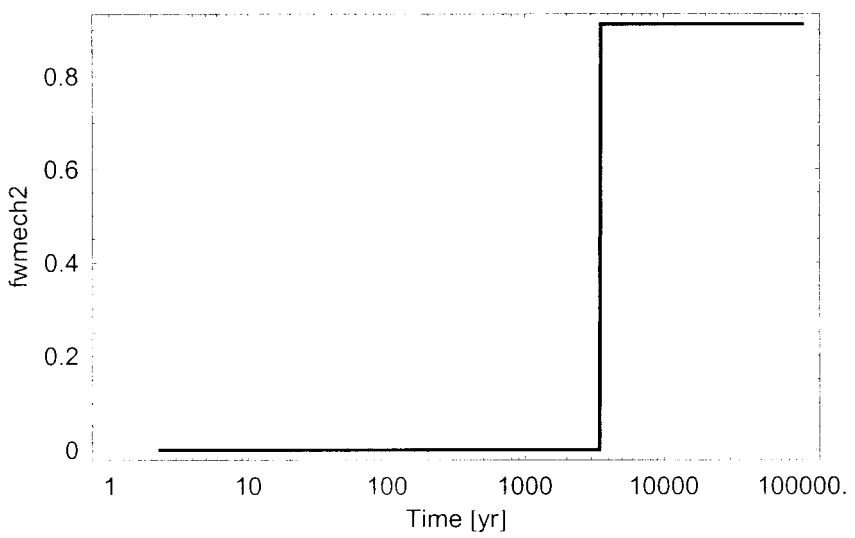
```
(*Get times of failure from the seepage factor*)
piv = Flatten[Position[seepDataT[[p1]], heights[[2]]]];
Print["Time of mechanical breaching = ", seepDataT[[1, piv[[1]]]], " yr"]
```

```
Time of mechanical breaching   3003.75 yr
```

The breaching times are consistent with data in wpsfail.res and wpsfail2.res.
Conclusion: the seepage factor for the MECH WPs is correctly constructed.

■ MECH 2 factor

```
p1 = 10;
LogLinearListPlot[Transpose[{seepDataT[[1]], seepDataT[[p1]]}],
  PlotJoined → True, Frame → True, Axes → None,
  FrameLabel → {"Time [yr]", labels[[p1]], "", ""}, PlotStyle → AbsoluteThickness[2]];
```




```
a2 = Position[parameters, "InitialSeepageReductionFractionByMechFailedWP"][[1, 1]];
Print["Sampled seepage factor, MECH1 = ", sampT[[a2, rea]]];
```

```
Sampled seepage factor, MECH1   0.912502
```

```
(*Heights of the seepage factor*)
heights = Union[seepDataT[[p1]]];
Print["Seepage factor heights = ", heights];
```

```
Seepage factor heights   {0., 0.912502}
```

```
(*Get times of failure from the seepage factor*)
piv = Flatten[Position[seepDataT[[p1]], heights[[2]]]];
Print["Time of mechanical failure = ", seepDataT[[1, piv[[1]]]], " yr"]
```

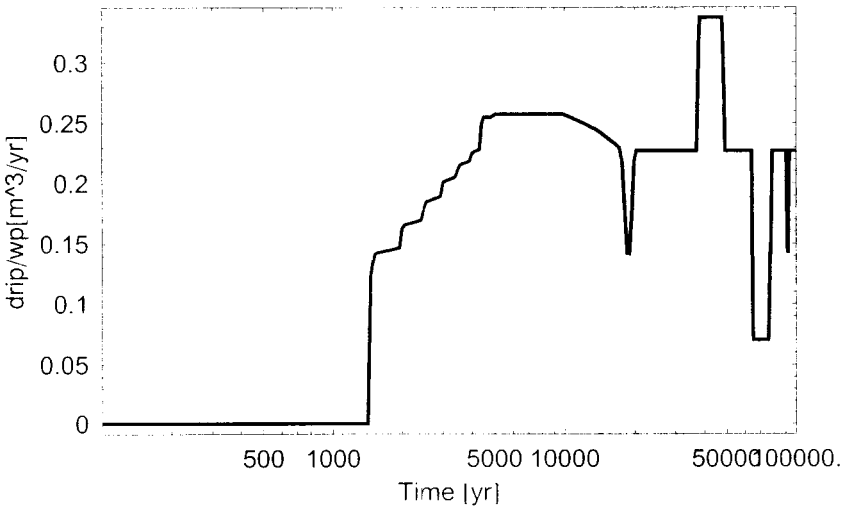
```
Time of mechanical failure   3549.31 yr
```

The breaching times are consistent with data in wpsfail.res and wpsfail2.res.
Conclusion: the seepage factor for the MECH WPs is correctly constructed.

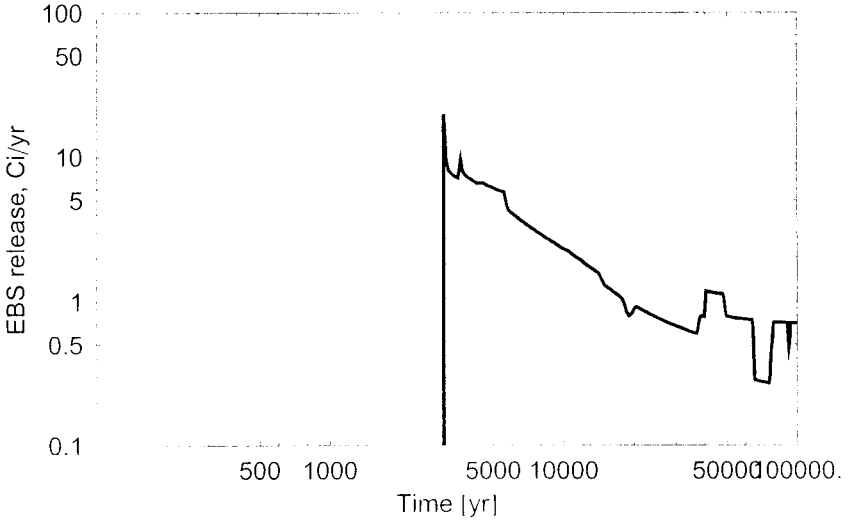
■ Release rates from the EBS

```
rel = LeeDatos["02_02_ebsrel_realizations.txt", 1, 2];

p1 = 2;
LogLinearListPlot[Transpose[{seepDataT[[1]], seepDataT[[p1]]}], PlotJoined → True,
  Frame → True, Axes → None, FrameLabel → {"Time [yr]", labels[[p1]], "", ""},
  PlotStyle → AbsoluteThickness[2], PlotRange → {{100, 1*^5}, Automatic}];
```




```
LogLogListPlot[rel + 1*^-50, PlotRange → {{100, 1*^5}, {1*^-1, 100}}, PlotJoined → True,
  Frame → True, FrameLabel → {"Time [yr]", "EBS release, Ci/yr", "", ""},
  PlotStyle → AbsoluteThickness[2]];
```



Releases occur only after mechanical breaching of the WPs. Releases are consistent with expectations

```
!! 02_02_wpsfail.res

!! wpsfail.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1beta0 Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1beta0
!! Module: EXEC
!! Job started: Mon Mar 05 16:34:37 2007
!!
!! PURPOSE:
!!  Number of WPs Identified by Event Type
!!  Including Event Time and Subarea for Each Vector
!! This file presents a table of five different waste package
!! failure modes in time order for each realization. The
!! subarea of failure is also noted.
!!
!! This file contains only one section.
!!
!! SECTION 1
!!
!! Realization Number = realization number; (ir)
!! Subarea Number = subarea number; (isa)
!! Time  = simulation time in years of failure event;
!!         (tim)
!! Number of Initial = number of initial failures.
!! Number of Corrosion = number of corrosion failures.
!! Number of Mechanical = number of mechanical failures.
!! Number of Faulting = number of failures due to faulting
!!                      event.
!! Number of Igneous Activity = number of indrift failures
!!                              due to volcanic event.

 Realization     Subarea                  Number of      Number of    Number of      Number of
Number of
    Number       Number              Time  Initial        Corrosion    Mechanical     Faulting
Igneous Activity
  (unitless)   (unitless)            (yr)  (unitless)     (unitless)   (unitless)
(unitless)   (unitless)
   149        9    0.00000E+00   1.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
0.00000E+00
   149        9    3.00375E+03   0.00000E+00   0.00000E+00   6.14000E+02   0.00000E+00
0.00000E+00
   149        9    3.54931E+03   0.00000E+00   0.00000E+00   1.08000E+02   0.00000E+00
0.00000E+00
```

```
!! 02_02_wpsfail2.res

!! wpsfail2.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1beta0 Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1beta0
!! Module: EXEC
!! Job started: Mon Mar 05 16:34:37 2007
!!
!! PURPOSE:
!!  Number WPs Available for GW Release by Event Type
!!  Including Event Time and Subarea for Each Vector

  vector  subarea      time        #initial      #gencorr      #loccorr   #mechanical
#fault       #ign_act
 unitless unitless      yr         unitless      unitless      unitless      unitless
unitless      unitless
   149        9    3.00375E+03   0.00000E+00   0.00000E+00   0.00000E+00   3.51000E+02
0.00000E+00   0.00000E+00
   149        9    3.54931E+03   0.00000E+00   0.00000E+00   0.00000E+00   6.20000E+01
0.00000E+00   0.00000E+00
```

Test 02b, Seepage factors, 1-million realization run

Test 05: Seepage factors for a 1-million realization run

(i) Check the seepage factors for one realization and compare seepage factors to known times or failure (drip shield corrosion, drip shield mechanical, waste package corrosion, and waste package mechanical).

(ii) Compare values of the seepage factors to sampled data in the file samplpar.res.

(iii) Explain inflexions in EBS release rates as changes in the seepage factors.

■ Realization 3, subarea 10

```
CopyFile["run/tpa.inp", "1m_01_tpa.inp"];
CopyFile["run/ebsflo.dat", "1m_01_ebsflo.dat"];
CopyFile["run/dsfailt.dat", "1m_01_dsfail.dat"];
CopyFile["run/dsfail.res", "1m_01_dsfail.res"];

(*Run["ebsrel.exe"]; (*Script to abstract data
   from ebsrel.rlt and write it in matrix from in output files*)
 CopyFile["run/ebsrel_nucAverage.txt","02_01_ebsrel_nucAverage.txt"];
 CopyFile["run/ebsrel_realizations.txt","02_01_ebsrel_realizations.txt"];
 CopyFile["run/ebsrel_subAverage.txt","02_01_ebsrel_subAverage.txt"];*)
CopyFile["run/wpsfail2.res", "1m_01_wpsfail2.res"];
CopyFile["run/wpsfail.res", "1m_01_wpsfail.res"];
```

In[453]:=

```
!! 1m_01_dsfailt.dat

GENERATING MODULE: dsfailt
Uniform corrosion of drip shield
Thickness of drip shield vs time
1  Failure Flag (=1 if failed, 0 otherwise)
```

90700 yrs : Drip shield failure time
234 Number of time steps in this file

Time[yr]	Thickness[m]
0.0000E+00	1.5000E-02
2.3102E+00	1.5000E-02
4.6744E+00	1.4999E-02
7.0940E+00	1.4999E-02
9.5702E+00	1.4998E-02
1.2104E+01	1.4998E-02
1.4698E+01	1.4998E-02
1.7352E+01	1.4997E-02
2.0069E+01	1.4997E-02
2.2849E+01	1.4996E-02
2.5694E+01	1.4996E-02
2.8605E+01	1.4995E-02
3.1585E+01	1.4995E-02
3.4635E+01	1.4994E-02
3.7756E+01	1.4994E-02
4.0950E+01	1.4993E-02
4.4219E+01	1.4993E-02
4.7564E+01	1.4992E-02
5.0988E+01	1.4992E-02
5.4492E+01	1.4991E-02
5.8078E+01	1.4990E-02
6.1747E+01	1.4990E-02
6.5503E+01	1.4989E-02
6.9347E+01	1.4989E-02
7.3281E+01	1.4988E-02
7.7306E+01	1.4987E-02
8.1426E+01	1.4987E-02
8.5643E+01	1.4986E-02
8.9958E+01	1.4985E-02
9.4374E+01	1.4984E-02
9.8894E+01	1.4984E-02
1.0352E+02	1.4983E-02
1.0825E+02	1.4982E-02
1.1310E+02	1.4981E-02
1.1806E+02	1.4980E-02
1.2313E+02	1.4980E-02
1.2832E+02	1.4979E-02
1.3364E+02	1.4978E-02
1.3908E+02	1.4977E-02
1.4464E+02	1.4976E-02
1.5034E+02	1.4975E-02
1.5617E+02	1.4974E-02
1.6213E+02	1.4973E-02
1.6824E+02	1.4972E-02
1.7449E+02	1.4971E-02
1.8088E+02	1.4970E-02
1.8743E+02	1.4969E-02
1.9413E+02	1.4968E-02
2.0098E+02	1.4967E-02
2.0800E+02	1.4966E-02
2.1518E+02	1.4964E-02
2.2252E+02	1.4963E-02
2.3004E+02	1.4962E-02
2.3774E+02	1.4961E-02
2.4562E+02	1.4959E-02
2.5368E+02	1.4958E-02
2.6193E+02	1.4957E-02
2.7037E+02	1.4955E-02
2.7901E+02	1.4954E-02
2.8785E+02	1.4952E-02
2.9690E+02	1.4951E-02
3.0616E+02	1.4949E-02
3.1564E+02	1.4948E-02
3.2534E+02	1.4946E-02
3.3526E+02	1.4945E-02

3.4542E+02	1.4943E-02
3.5582E+02	1.4941E-02
3.6646E+02	1.4939E-02
3.7735E+02	1.4938E-02
3.8849E+02	1.4936E-02
3.9990E+02	1.4934E-02
4.1157E+02	1.4932E-02
4.2352E+02	1.4930E-02
4.3574E+02	1.4928E-02
4.4825E+02	1.4926E-02
4.6106E+02	1.4924E-02
4.7416E+02	1.4922E-02
4.8757E+02	1.4919E-02
5.0130E+02	1.4917E-02
5.1535E+02	1.4915E-02
5.2972E+02	1.4912E-02
5.4443E+02	1.4910E-02
5.5949E+02	1.4907E-02
5.7490E+02	1.4905E-02
5.9067E+02	1.4902E-02
6.0680E+02	1.4900E-02
6.2332E+02	1.4897E-02
6.4022E+02	1.4894E-02
6.5752E+02	1.4891E-02
6.7523E+02	1.4888E-02
6.9334E+02	1.4885E-02
7.1189E+02	1.4882E-02
7.3086E+02	1.4879E-02
7.5028E+02	1.4876E-02
7.7016E+02	1.4873E-02
7.9050E+02	1.4869E-02
8.1132E+02	1.4866E-02
8.3262E+02	1.4862E-02
8.5442E+02	1.4859E-02
8.7674E+02	1.4855E-02
8.9957E+02	1.4851E-02
9.2294E+02	1.4847E-02
9.4686E+02	1.4843E-02
9.7134E+02	1.4839E-02
9.9639E+02	1.4835E-02
1.0220E+03	1.4831E-02
1.0483E+03	1.4827E-02
1.0751E+03	1.4822E-02
1.1026E+03	1.4818E-02
1.1307E+03	1.4813E-02
1.1595E+03	1.4808E-02
1.1890E+03	1.4803E-02
1.2191E+03	1.4798E-02
1.2500E+03	1.4793E-02
1.2815E+03	1.4788E-02
1.3138E+03	1.4783E-02
1.3469E+03	1.4777E-02
1.3808E+03	1.4772E-02
1.4154E+03	1.4766E-02
1.4508E+03	1.4760E-02
1.4871E+03	1.4754E-02
1.5242E+03	1.4748E-02
1.5622E+03	1.4742E-02
1.6011E+03	1.4735E-02
1.6409E+03	1.4729E-02
1.6816E+03	1.4722E-02
1.7233E+03	1.4715E-02
1.7660E+03	1.4708E-02
1.8096E+03	1.4701E-02
1.8543E+03	1.4693E-02
1.9000E+03	1.4686E-02
1.9468E+03	1.4678E-02
1.9947E+03	1.4670E-02

2.0437E+03	1.4662E-02
2.0939E+03	1.4654E-02
2.1452E+03	1.4645E-02
2.1977E+03	1.4637E-02
2.2515E+03	1.4628E-02
2.3065E+03	1.4619E-02
2.3628E+03	1.4609E-02
2.4204E+03	1.4600E-02
2.4794E+03	1.4590E-02
2.5398E+03	1.4580E-02
2.6015E+03	1.4570E-02
2.6648E+03	1.4559E-02
2.7295E+03	1.4549E-02
2.7957E+03	1.4538E-02
2.8634E+03	1.4526E-02
2.9328E+03	1.4515E-02
3.0038E+03	1.4503E-02
3.0764E+03	1.4491E-02
3.1507E+03	1.4479E-02
3.2268E+03	1.4466E-02
3.3046E+03	1.4453E-02
3.3843E+03	1.4440E-02
3.4659E+03	1.4427E-02
3.5493E+03	1.4413E-02
3.6347E+03	1.4399E-02
3.7221E+03	1.4384E-02
3.8116E+03	1.4370E-02
3.9031E+03	1.4354E-02
3.9968E+03	1.4339E-02
4.0927E+03	1.4323E-02
4.1908E+03	1.4307E-02
4.2912E+03	1.4290E-02
4.3940E+03	1.4273E-02
4.4992E+03	1.4256E-02
4.6068E+03	1.4238E-02
4.7170E+03	1.4220E-02
4.8297E+03	1.4201E-02
4.9451E+03	1.4182E-02
5.0632E+03	1.4163E-02
5.1840E+03	1.4143E-02
5.3077E+03	1.4122E-02
5.4343E+03	1.4101E-02
5.5638E+03	1.4080E-02
5.6964E+03	1.4058E-02
5.8321E+03	1.4035E-02
5.9709E+03	1.4013E-02
6.1130E+03	1.3989E-02
6.2584E+03	1.3965E-02
6.4073E+03	1.3940E-02
6.5596E+03	1.3915E-02
6.7154E+03	1.3889E-02
6.8750E+03	1.3863E-02
7.0382E+03	1.3836E-02
7.2053E+03	1.3808E-02
7.3763E+03	1.3780E-02
7.5513E+03	1.3751E-02
7.7304E+03	1.3722E-02
7.9137E+03	1.3691E-02
8.1013E+03	1.3660E-02
8.2933E+03	1.3628E-02
8.4897E+03	1.3596E-02
8.6908E+03	1.3563E-02
8.8966E+03	1.3529E-02
9.1072E+03	1.3494E-02
9.3227E+03	1.3458E-02
9.5433E+03	1.3422E-02
9.7690E+03	1.3384E-02
1.0000E+04	1.3346E-02

```
  1.2475E+04    1.2937E-02
  1.4950E+04    1.2528E-02
  1.7425E+04    1.2118E-02
  1.9900E+04    1.1709E-02
  2.2375E+04    1.1300E-02
  2.4850E+04    1.0890E-02
  2.7325E+04    1.0481E-02
  2.9800E+04    1.0072E-02
  3.2275E+04    9.6623E-03
  3.4750E+04    9.2530E-03
  3.7225E+04    8.8437E-03
  3.9700E+04    8.4344E-03
  4.2175E+04    8.0251E-03
  4.4650E+04    7.6157E-03
  4.7125E+04    7.2064E-03
  4.9600E+04    6.7971E-03
  5.2075E+04    6.3878E-03
  5.4550E+04    5.9785E-03
  5.7025E+04    5.5691E-03
  5.9500E+04    5.1598E-03
  6.1975E+04    4.7505E-03
  6.4450E+04    4.3412E-03
  6.6925E+04    3.9319E-03
  6.9400E+04    3.5226E-03
  7.1875E+04    3.1132E-03
  7.4350E+04    2.7039E-03
  7.6825E+04    2.2946E-03
  7.9300E+04    1.8853E-03
  8.1775E+04    1.4760E-03
  8.4250E+04    1.0667E-03
  8.6725E+04    6.5733E-04
  8.9200E+04    2.4801E-04
  9.1675E+04   -1.6130E-04
```

!! 1m_01_dsfail.res

```
!! dsfail.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1beta0 Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1beta0
!! Module: EXEC
!! Job started: Wed Mar 07 18:42:40 2007
!!
!! PURPOSE:
!!  Number of Failed Drip Shields by Type of Event
!!  Including Time of Event - Values for Each Vector
!!  SECTION: Dripshield and drift failure times
!!           This section reports the following
!!           The realization number, which is a unitless vector
!!           The time recorded for either a dripshield
!!             mechanical failure or drift failure (yr)
!!           The corrosion status of the Drip Shield at the
!!             time of mechanical failure, either
                uncorroded (0) or corroded (1)
!!           The number of drip shields that were reported
!!             failed at that time (cumulative)
!!           The repository wide drift failure fraction
```

Realization Vector unitless	TIME [yr]	DRIP SHIELD #CORRODE unitless	DRIP SHIELD #MECHANICAL unitless	DRIFT FRACTION unitless
3	3.3526E+02	0	262	0.0000E+00
3	4.3757E+02	0	1747	0.0000E+00
3	8.1132E+02	0	1747	1.5000E-01
3	1.2500E+03	0	1747	1.0000E+00

In[451]:=

```
!! lm_01_wpsfail2.res

!! wpsfail2.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1betaO Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1betaO
!! Module: EXEC
!! Job started: Wed Mar 07 18:42:40 2007
!!
!! PURPOSE:
!!  Number WPs Available for GW Release by Event Type
!!  Including Event Time and Subarea for Each Vector

  vector  subarea      time        #initial      #gencorr      #loccorr   #mechanical
#fault       #ign_act
 unitless unitless      yr         unitless      unitless      unitless      unitless
unitless      unitless
     3       10    2.19773E+03   0.00000E+00   0.00000E+00   1.70000E+01   0.00000E+00
0.00000E+00   0.00000E+00
     3       10    6.65875E+05   0.00000E+00   1.73000E+03   0.00000E+00   0.00000E+00
0.00000E+00   0.00000E+00
```

In[452]:=

```
!! 1m_01_wpsfail.res
```

```
!! wpsfail.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1beta0 Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1beta0
!! Module: EXEC
!! Job started: Wed Mar 07 18:42:40 2007
!!
!! PURPOSE:
!!  Number of WPs Identified by Event Type
!!  Including Event Time and Subarea for Each Vector
!! This file presents a table of five different waste package
!! failure modes in time order for each realization. The
!! subarea of failure is also noted.
!!
!! This file contains only one section.
!!
!! SECTION 1
!!
!! Realization Number = realization number; (ir)
!! Subarea Number = subarea number; (isa)
!! Time  = simulation time in years of failure event;
!!         (tim)
!! Number of Initial = number of initial failures.
!! Number of Corrosion = number of corrosion failures.
!! Number of Mechanical = number of mechanical failures.
!! Number of Faulting = number of failures due to faulting
!!                      event.
!! Number of Igneous Activity = number of indrift failures
!!                              due to volcanic event.

 Realization     Subarea                  Number of      Number of    Number of      Number of
Number of
    Number       Number              Time  Initial        Corrosion    Mechanical     Faulting
Igneous Activity
  (unitless)   (unitless)            (yr)  (unitless)     (unitless)   (unitless)
(unitless)   (unitless)
     3       10    0.00000E+00   9.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
0.00000E+00
     3       10    2.19773E+03   0.00000E+00   1.74700E+03   0.00000E+00   0.00000E+00
0.00000E+00
```

According to data in dsfail.dat and dsfail.res

Drip shield corrosion failure time: 3.3526E+02 yrs

In[457]:=

```
seepData = LeeDatos["1m_01_ebsflo.dat", 3, 11];
seepDataT = Transpose[seepData];
labels = {"time[yr]", "drip/wp[m^3/yr]", "fmult", "fow",
   "sawet", "frubble", "fDS", "fwcorr", "fwmech1", "fwmech2", "fidefects"};
```

In[460]:=

```
(*Number of WPs per subarea*)
NoWPs = {526, 1062, 2904, 1793, 1452, 343, 696, 931, 723, 1747}
```

Out[460]=

```
{526, 1062, 2904, 1793, 1452, 343, 696, 931, 723, 1747}
```

In[496]:=

```
(*Read sampled values, all parameters, from file samplpar.res*)
noParameters = 491;
samp = LeeDatos["00_samplpar.txt", 0, noParameters];
sampT = Transpose[samp];

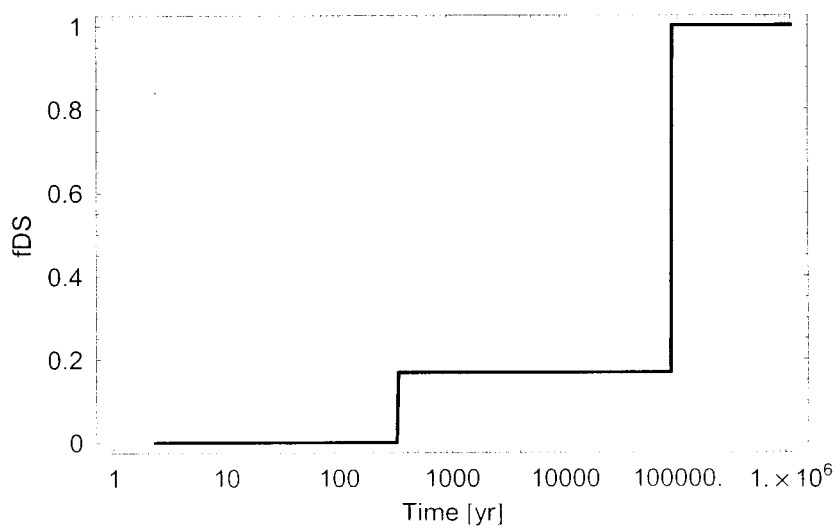
(*Read parameter names*)
fileID = OpenRead["00_samplpar.hdr"];
Do[Read[fileID, Record, RecordSeparators → {"\n"}], {30}];
parameters = {};
Do[
  {piv1, wo1, wo2} = Read[fileID, {Number, Word, Word}];
  AppendTo[parameters, wo2],
  {i, 1, noParameters}];
Close[fileID];

rea = 3;  (*Realization number*)
```

■ Drip shield factor

In[470]:=

```
p1 = 7;
LogLinearListPlot[Transpose[{seepDataT[[1]], seepDataT[[p1]]}],
  PlotJoined → True, Frame → True, Axes → None,
  FrameLabel → {"Time [yr]", labels[[p1]], "", ""}, PlotStyle → AbsoluteThickness[2]];
```



In[506]:=

```
a1 = Position[parameters, "InitialSeepageReductionFractionByMechFailedDS"][[1, 1]];
sampT[[a1, rea]]
```

Out[507]=

```
0.168998
```

In[508]:=

```
(*Heights of the seepage factor*)
heights = Union[seepDataT[[p1]]]
```

Out[508]=

```
{0., 0.168998, 1.}
```

In[509]:=

```
(*Get times of failure from the seepage factor*)
piv = Flatten[Position[seepDataT[[p1]], heights[[2]]]];
Print["Time of mechanical failure = ", seepDataT[[1, piv[[1]]]], " yr"]

piv = Flatten[Position[seepDataT[[p1]], heights[[3]]]];
Print["Time of corrosion failure = ", seepDataT[[1, piv[[1]]]], " yr"]
```

```
Time of mechanical failure = 335.264 yr

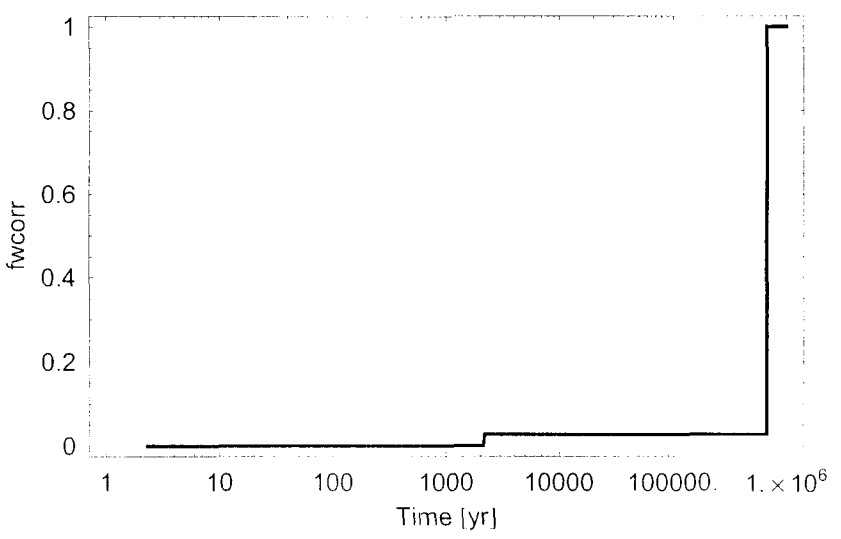
Time of corrosion failure = 89200. yr
```

Therefore, the seepage factor correctly responds to the time of mechanical and corrosion failure

■ Localized corrosion WP factor

In[513]:=

```
p1 = 8;
LogLinearListPlot[Transpose[{seepDataT[[1]], seepDataT[[p1]]}],
  PlotJoined → True, Frame → True, Axes → None,
  FrameLabel → {"Time [yr]", labels[[p1]], "", ""}, PlotStyle → AbsoluteThickness[2]];
```



In[515]:=

```
a1 = Position[parameters, "InitialSeepageReductionFractionWeldLC"][[1, 1]];
Print["Sampled seepage factor = ", sampT[[a1, rea]]];
```

```
Sampled seepage factor = 0.0276689
```

In[517]:=

```
(*Heights of the seepage factor*)
heights = Union[seepDataT[[p1]]];
Print["Seepage factor heights = ", heights];

(*Get times of failure from the seepage factor*)
piv = Flatten[Position[seepDataT[[p1]], heights[[2]]]];
Print["Time of failure = ", seepDataT[[1, piv[[1]]]], " yr"]
```

```
Seepage factor heights = {0., 0.027669, 1.}

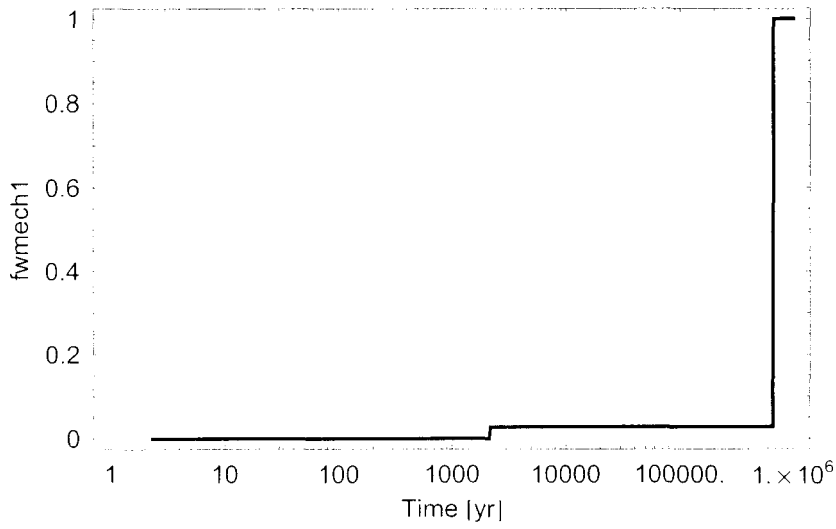
Time of failure = 2197.73 yr
```

According to data in wpsfail.res, localized corrosion breaching occurs at 2.19773E+03 yr (consistent with the above).
Conclusion: the seepage factor for the drip shield is correctly constructed

■ MECH 1 factor

In[521]:=

```
p1 = 9;
LogLinearListPlot[Transpose[{seepDataT[[1]], seepDataT[[p1]]}],
  PlotJoined → True, Frame → True, Axes → None,
  FrameLabel → {"Time [yr]", labels[[p1]], "", ""}, PlotStyle → AbsoluteThickness[2]];
```



In[523]:=

```
a1 = Position[parameters, "InitialSeepageReductionFractionWeldLC"][[1, 1]];
Print["Sampled seepage factor, weld corrosion = ", sampT[[a1, rea]]];

a2 = Position[parameters, "InitialSeepageReductionFractionByMechFailedWP"][[1, 1]];
Print["Sampled seepage factor, MECH1 = ", sampT[[a2, rea]]];

Print["Addition = ", sampT[[a1, rea]] + sampT[[a2, rea]]];
```

```
Sampled seepage factor, weld corrosion = 0.0276689

Sampled seepage factor, MECH1 = 0.185432

Addition = 0.2131
```

In[528]:=

```
(*Heights of the seepage factor*)
heights = Union[seepDataT[[p1]]];
Print["Seepage factor heights = ", heights];
```

```
Seepage factor heights = {0., 0.027669, 1.}
```

In[534]:=

```
(*Get times of failure from the seepage factor*)
piv = Flatten[Position[seepDataT[[p1]], heights[[2]]]];
Print["Time of corrosion failure = ", seepDataT[[1, piv[[1]]]], " yr"]

piv = Flatten[Position[seepDataT[[p1]], heights[[3]]]];
Print["Time of general corrosion failure = ", seepDataT[[1, piv[[1]]]], " yr"]
```

```
Time of corrosion failure = 2197.73 yr

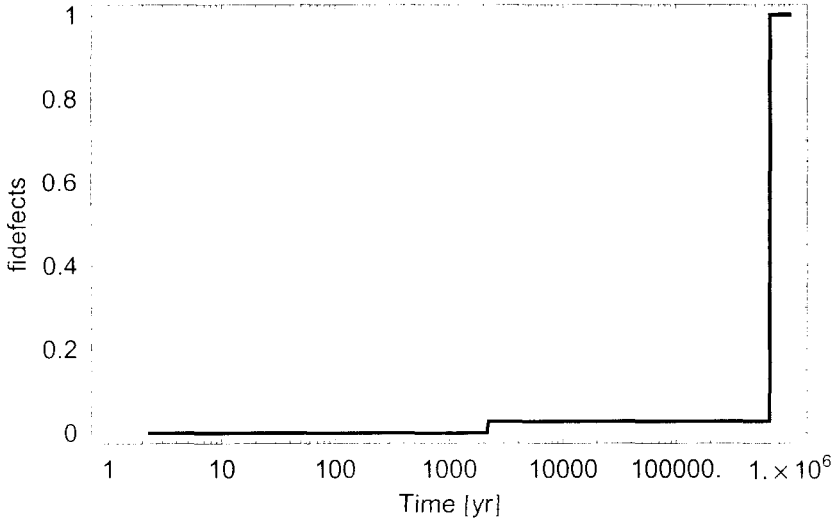
Time of general corrosion failure = 668350. yr
```

The breaching times are consistent with data in wpsfail.res and wpsfail2.res.
Conclusion: the seepage factor for the MECH WPs is correctly constructed.

■ Initially defective factor

In[538]:=

```
p1 = 11;
LogLinearListPlot[Transpose[{seepDataT[[1]], seepDataT[[p1]]}],
  PlotJoined → True, Frame → True, Axes → None,
  FrameLabel → {"Time [yr]", labels[[p1]], "", ""}, PlotStyle → AbsoluteThickness[2]];
```



In[540]:=

```
a1 = Position[parameters, "InitialSeepageReductionFractionInitiallyDefWP"][[1, 1]];
Print["Sampled seepage factor, initially defective = ", sampT[[a1, rea]]];

a2 = Position[parameters, "InitialSeepageReductionFractionWeldLC"][[1, 1]];
Print["Sampled seepage factor, weld corrosion = ", sampT[[a2, rea]]];

Print["Addition = ", sampT[[a1, rea]] + sampT[[a2, rea]]];
```

```
Sampled seepage factor, initially defective = 0.0226912

Sampled seepage factor, weld corrosion = 0.0276689

Addition = 0.0503601
```

In[545]:=

```
(*Heights of the seepage factor*)
heights = Union[seepDataT[[p1]]];
Print["Seepage factor heights = ", heights];
```

```
Seepage factor heights = {0., 0.027669, 1.}
```

In[547]:=

```
(*Get times of failure from the seepage factor*)
piv = Flatten[Position[seepDataT[[p1]], heights[[2]]]];
Print["Time of corrosion failure = ", seepDataT[[1, piv[[1]]]], " yr"]
```

```
Time of corrosion failure = 2197.73 yr
```

The breaching times are consistent with data in wpsfail.res and wpsfail2.res.
Conclusion: the seepage factor for the initially defective WPs is correctly constructed.

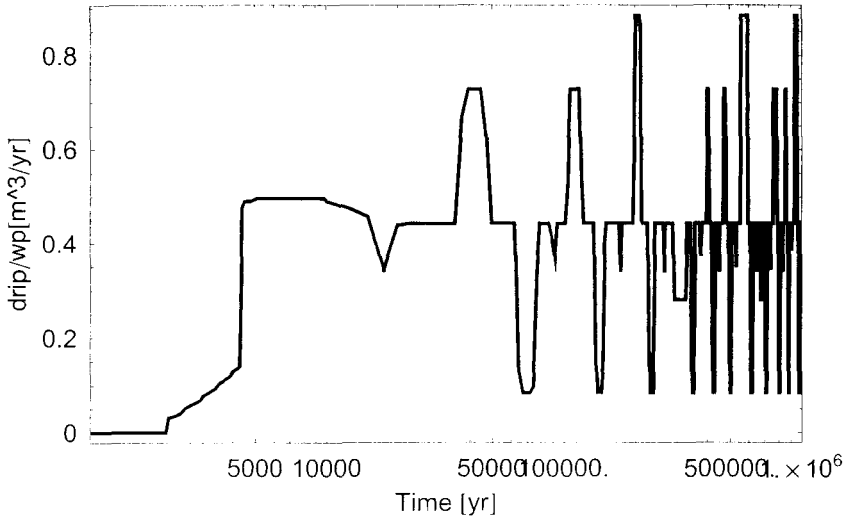
■ Release rates from the EBS

In[557]:=

```
rel = LeeDatos["1m_01_ebsrel_realizations.txt", 1, 2];
```

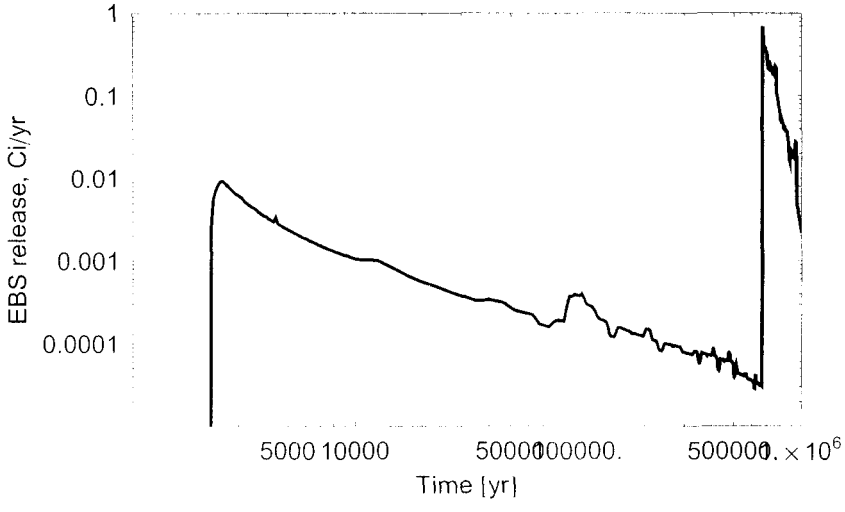
In[555]:=

```
pl = 2;
LogLinearListPlot[Transpose[{seepDataT[[1]], seepDataT[[pl]]}], PlotJoined → True,
  Frame → True, Axes → None, FrameLabel → {"Time [yr]", labels[[pl]], "", ""},
  PlotStyle → AbsoluteThickness[2], PlotRange → {{1000, 1*^6}, Automatic}];
```



In[563]:=

```
LogLogListPlot[rel + 1*^-50, PlotRange → {{1000, 1*^6}, {1*^-5, 1}}, PlotJoined → True,
  Frame → True, FrameLabel → {"Time [yr]", "EBS release, Ci/yr", "", ""},
  PlotStyle → AbsoluteThickness[2]];
```



Releases occur some time after re-wetting (localized corrosion WPs). At around 666,000 years, general corrosion occurs, resulting in an additional WP source.

In[549]:=

```
!! lm_01_wpsfail.res

!! wpsfail.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1beta0 Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1beta0
!! Module: EXEC
!! Job started: Wed Mar 07 18:42:40 2007
!!
!! PURPOSE:
!!  Number of WPs Identified by Event Type
!!  Including Event Time and Subarea for Each Vector
!! This file presents a table of five different waste package
!! failure modes in time order for each realization. The
!! subarea of failure is also noted.
!!
!! This file contains only one section.
!!
!! SECTION 1
!!
!! Realization Number = realization number; (ir)
!! Subarea Number = subarea number; (isa)
!! Time  = simulation time in years of failure event;
!!         (tim)
!! Number of Initial = number of initial failures.
!! Number of Corrosion = number of corrosion failures.
!! Number of Mechanical = number of mechanical failures.
!! Number of Faulting = number of failures due to faulting
!!                      event.
!! Number of Igneous Activity = number of indrift failures
!!                              due to volcanic event.

 Realization     Subarea                  Number of      Number of    Number of      Number of
Number of
    Number       Number              Time  Initial        Corrosion    Mechanical     Faulting
Igneous Activity
  (unitless)   (unitless)            (yr)  (unitless)     (unitless)   (unitless)
(unitless)   (unitless)
     3       10    0.00000E+00   9.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00
0.00000E+00
     3       10    2.19773E+03   0.00000E+00   1.74700E+03   0.00000E+00   0.00000E+00
0.00000E+00
```

In[550]:=

```
!! lm_01_wpsfail2.res

!! wpsfail2.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1beta0 Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1beta0
!! Module: EXEC
!! Job started: Wed Mar 07 18:42:40 2007
!!
!! PURPOSE:
!!  Number WPs Available for GW Release by Event Type
!!  Including Event Time and Subarea for Each Vector

  vector  subarea      time        #initial      #gencorr      #loccorr   #mechanical
#fault       #ign_act
 unitless unitless      yr         unitless      unitless      unitless      unitless
unitless      unitless
     3       10    2.19773E+03   0.00000E+00   0.00000E+00   1.70000E+01   0.00000E+00
0.00000E+00   0.00000E+00
     3       10    6.65875E+05   0.00000E+00   1.73000E+03   0.00000E+00   0.00000E+00
0.00000E+00   0.00000E+00
```

Test 03, WP scaling factor, general corrosion

Test 1 covered scaling factors for initially defective, localized corrosion and mechanically breached WPs. Test 04 is aimed at checking the scaling factor for general corrosion.

Test approach:
10 realizations of a one-million run were executed to test the onset of general corrosion. To force general corrosion to occur in 10^6 years, the following parameter was adjusted

WPFractionThicknessPenetratedForFailureByCorrosion[]=0.2

This caused general corrosion in a shorter time.

For few realizations, we computed a detailed WP balance. The total number of WPs breached in a subarea, once general corrosion occurs, must equal the total number of WPs in the subarea.

A detailed WP balance was performed for realization 5 (data from wpsfail2.res). The WP balance is consistent with expectations. The appropriate number of WPs is passed to RELEASET (verified by inspecting data in ebsrel.ech).

TEST RESULT: PASS

In[383]:=

```
noRea = 10;
doseStats = LeeDatos["1m_ebsrel_statistics.txt", 1, 10];
(*Remove zeros*)
dat = doseStats + 1.0*^-53; datT = Transpose[dat]; co = Length[datT]; coD = noRea + 1;

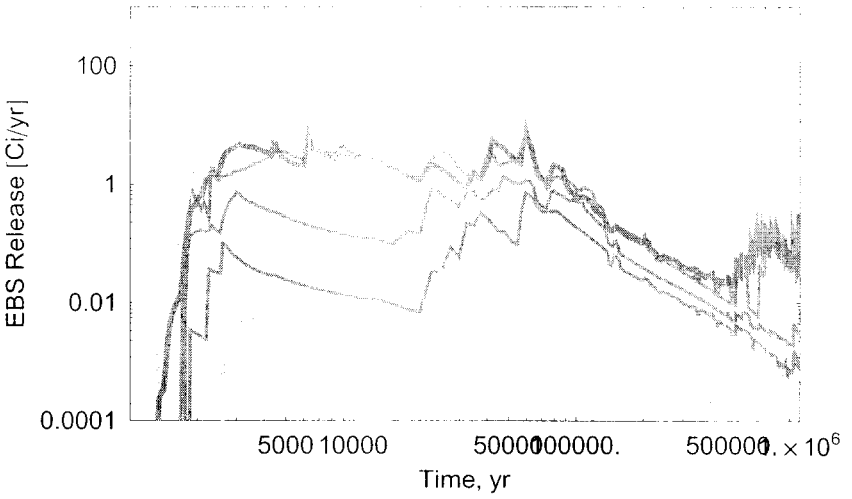
colors = {1/4, 2/4, 3/4, 0.5 (2/4 + 3/4), 3/4, 2/4, 1/4, 1};
thicknesses = {2, 2, 2, 2, 2, 2, 2, 3};
rang = {{1000, 1*^6}, {1*^-4, 1000}};
labe = "EBS Release [Ci/yr]";
plotFunction = LogLogListPlot;
horseTailsQ = False;
ticks = {1*^1, 1*^2, 5*^2, 1*^3, 5*^3, {1*^4, "10^4"}, {5*^4, "5x10^4"}, {1*^5, "10^5"}};
ticks = Automatic;

dr1 = DisplayTogether[
   Table[plotFunction[Transpose[{datT[[1]], datT[[i]]}], PlotJoined → True,
     PlotStyle → {Hue[colors[[i - 1]]], AbsoluteThickness[thicknesses[[i - 1]]]},
     PlotRange → rang, Frame → True, FrameLabel → {"Time, yr", labe, "", ""},
     FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 2, co - 1}]
  ];

If[horseTailsQ,

  dose = LeeDatos["1m_ebsrel_realizations.txt", 1, noRea + 1];
  dat = dose + 1.0*^-53; datTD = Transpose[dat];

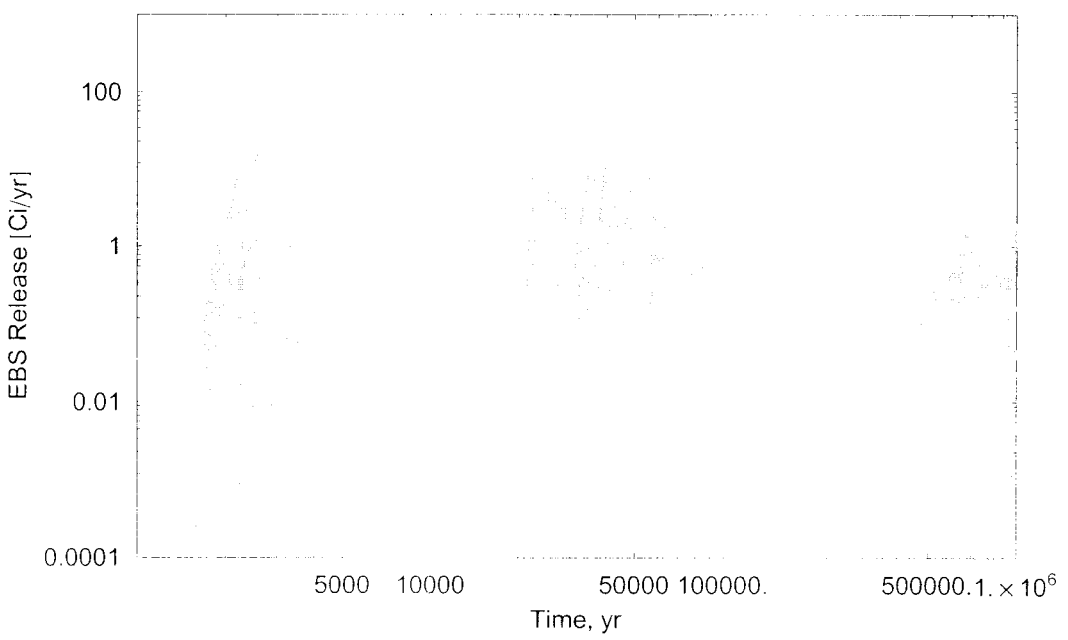
  DisplayTogether[
   Join[
    Table[plotFunction[Transpose[{datTD[[1]], datTD[[i]]}],
      PlotJoined → True, PlotStyle → {AbsoluteThickness[1], GrayLevel[0.7]},
      PlotRange → rang, Frame → True, FrameLabel → {"Time, yr", labe, "", ""},
      FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 2, coD}],
    Table[plotFunction[Transpose[{datT[[1]], datT[[i]]}], PlotJoined → True,
      PlotStyle → {Hue[colors[[i - 1]]], AbsoluteThickness[thicknesses[[i - 1]]]},
      Frame → True], {i, 2, co - 1}]
   ]
  ]];
```



In[417]:=

```
dat = LeeDatos["1m_ebsrel_realizations.txt", 1, noRea + 1];
dat = dat + 1.0*^-53; datTD = Transpose[dat];

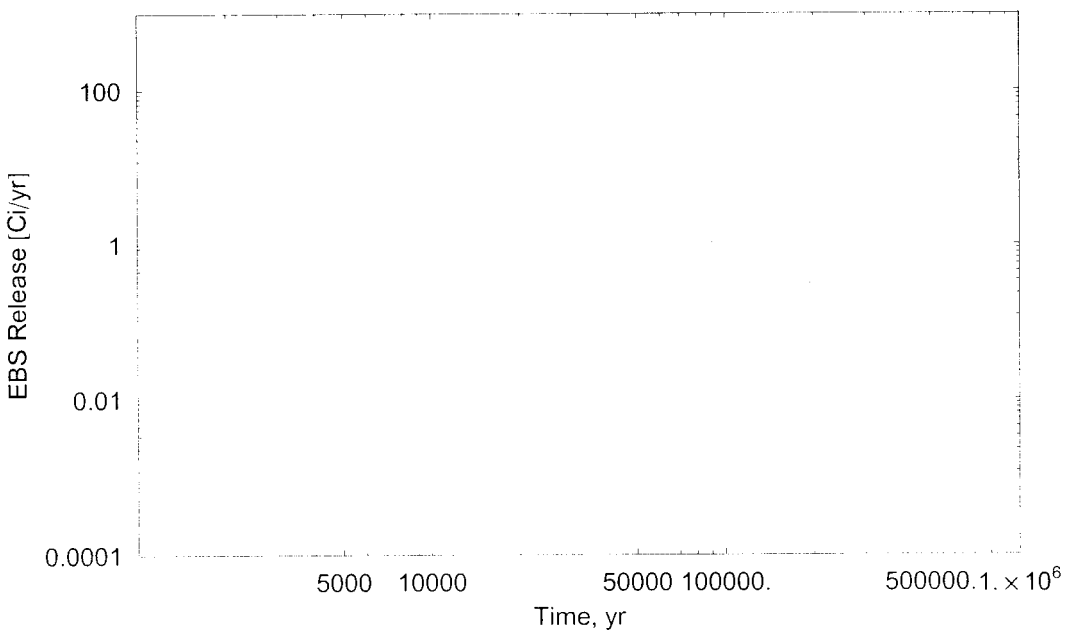
rang = {{1000, 1*^6}, {1*^-4, 1000}};
DisplayTogether[
  Table[plotFunction[Transpose[{datTD[[1]], datTD[[i]]}],
    PlotJoined → True, PlotStyle → {AbsoluteThickness[1], GrayLevel[0.7]},
    PlotRange → rang, Frame → True, FrameLabel → {"Time, yr", labe, "", ""},
    FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 2, coD}]
 ];
```



In[425]:=

```
dat = LeeDatos["1m_ebsrel_realizations.txt", 1, noRea + 1];
dat = dat + 1.0*^-53; datTD = Transpose[dat];

rang = {{1000, 1*^6}, {1*^-4, 1000}};
DisplayTogether[
  Table[plotFunction[Transpose[{datTD[[1]], datTD[[i]]}],
    PlotJoined → True, PlotStyle → {AbsoluteThickness[1], GrayLevel[0.7]},
    PlotRange → rang, Frame → True, FrameLabel → {"Time, yr", labe, "", ""},
    FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 4, 4}]
 ];
```



In[251]:=

```
noRea = 10;
datwp = LeeDatos["1m_wpsfail2.res", 14, 9];
{cumMatix, failMatrix} = CumWPFailed2[datwp];
cumStats = quantilesM[cumMatix, 0.05, 0.25, 0.5, 0.75, 0.95];

cumStats = Drop[cumStats, 1]; (*remove header from matrix*)
cumStats = cumStats + 1.0*^-50;
datT = Transpose[cumStats];

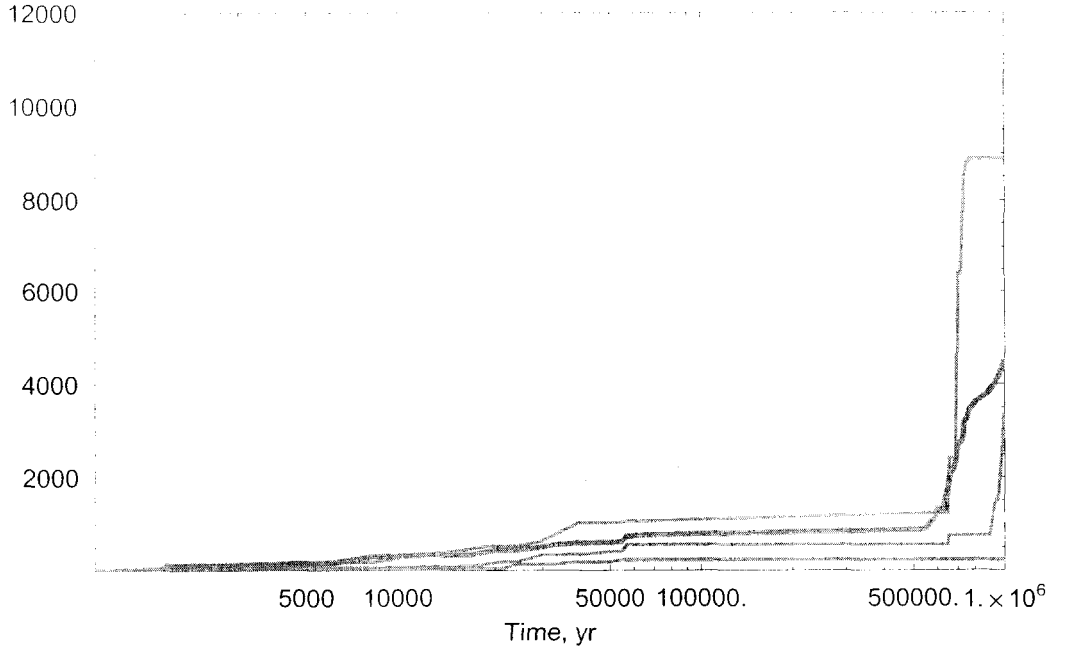
cumMatix = cumMatix + 1.0*^-50;
datTD = Transpose[cumMatix];

co = Length[datT]; coD = noRea + 1;
colors = {1/4, 2/4, 3/4, 0.5 (2/4 + 3/4), 3/4, 2/4, 1/4, 1};
thicknesses = {2, 2, 2, 2, 2, 2, 2, 3};
rang = rang = {{1000, 1*^6}, {1*^-4, 12000}};
labe = "";
plotFunction = LogLinearListPlot;
horseTailsQ = False;
ticks = {1*^1, 1*^2, 5*^2, 1*^3, 5*^3, {1*^4, "10^4"}, {5*^4, "5x10^4"}, {1*^5, "10^5"}};
ticks = Automatic;

dr1 = DisplayTogether[
   Table[plotFunction[Transpose[{datT[[1]], datT[[i]]}], PlotJoined → True,
     PlotStyle → {Hue[colors[[i - 1]]], AbsoluteThickness[thicknesses[[i - 1]]]},
     PlotRange → rang, Frame → True, FrameLabel → {"Time, yr", labe, "", ""},
     FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 2, co - 1}]
  ];

If[horseTailsQ,

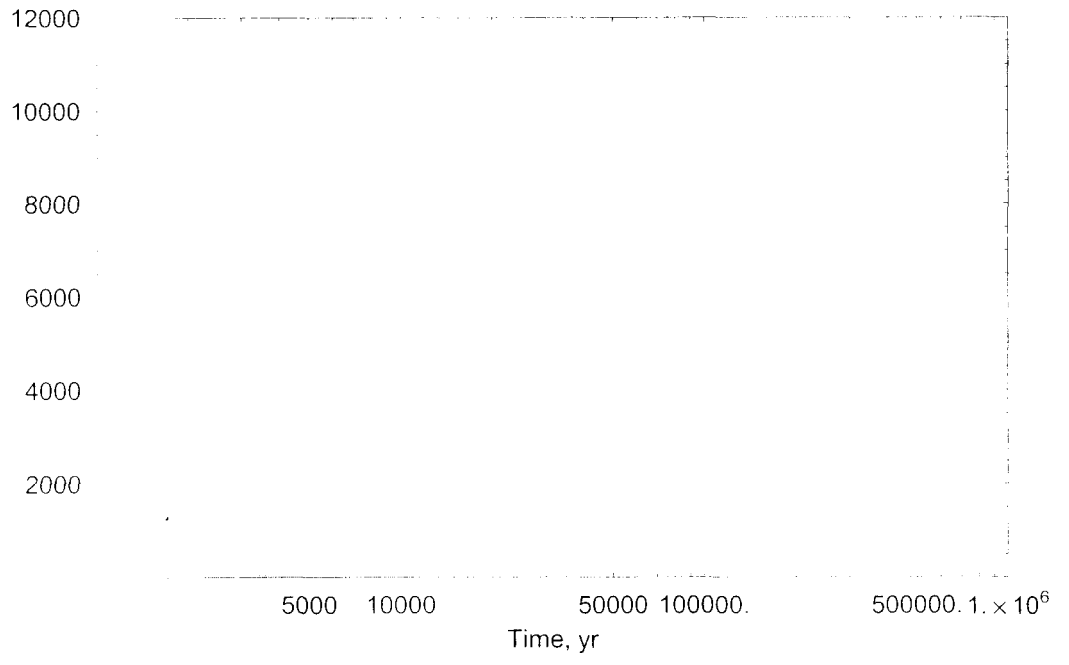
  DisplayTogether[
   Join[
    Table[plotFunction[Transpose[{datTD[[1]], datTD[[i]]}],
      PlotJoined → True, PlotStyle → {AbsoluteThickness[1], GrayLevel[0.7]},
      PlotRange → rang, Frame → True, FrameLabel → {"Time, yr", labe, "", ""},
      FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 2, coD}],
    Table[plotFunction[Transpose[{datT[[1]], datT[[i]]}], PlotJoined → True,
      PlotStyle → {Hue[colors[[i - 1]]], AbsoluteThickness[thicknesses[[i - 1]]]},
      Frame → True], {i, 2, co - 1}]
   ]
  ]];
```



In[243]:=

```
rang = {{1000, 1*^6}, {1*^-4, 12000}};
DisplayTogether[

  Table[plotFunction[Transpose[{datTD[[1]], datTD[[i]]}],
    PlotJoined → True, PlotStyle → {AbsoluteThickness[1], GrayLevel[0.7]},
    PlotRange → rang, Frame → True, FrameLabel → {"Time, yr", labe, "", ""},
    FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 2, coD}]
 ];
```



In[248]:=

```
Table[Union[datTD[[i]]], {i, 2, 11}]
```

Out[248]=

```
{{1.×10^50, 523., 1026.},
 {1.×10^50, 1217., 3010., 3891., 4213., 4909., 5191., 5721., 6444., 6970., 7313.},
 {1.×10^50, 608., 615., 632., 1964., 2199., 2425., 2791.,
  3853., 3941., 5393., 6324., 8054., 8770., 8837., 8880.},
 {1.×10^50, 1., 10., 31., 52., 127., 227.}, {1.×10^-50, 629., 2422., 5326.,
  6388., 7840., 8536., 9467., 11214., 11308., 11376., 11719.}, {1., 29., 739.,
  1061., 2124., 3847., 4908., 5769., 6465., 7017., 8053., 8482., 8794., 9109.},
 {1.×10^-50, 45., 129., 226.}, {1.×10^50, 38., 88., 125., 181.},
 {1.×10^50, 43., 75., 467.}, {1.×10^-50, 55., 189., 326., 1982., 4664., 5645.}}
```

General corrosion occurs for all subareas in realization 5. The following data are available in wpsfail2.res

```
  vector   subarea        time          #initial        #gencorr        #loccorr
#mechanical        #fault        #ign_act
 unitless unitless       yr          unitless       unitless       unitless       unit-
less       unitless       unitless
     5         1     2.98000E+04   0.00000E+00   0.00000E+00   0.00000E+00   4.58000-
E+02   0.00000E+00   0.00000E+00
     5         9     2.98000E+04   0.00000E+00   0.00000E+00   0.00000E+00   6.29000-
E+02   0.00000E+00   0.00000E+00
     5         4     6.53500E+05   0.00000E+00   1.79300E+03   0.00000E+00   0.00000-
E+00   0.00000E+00   0.00000E+00
     5         3     6.98050E+05   0.00000E+00   2.90400E+03   0.00000E+00   0.00000-
E+00   0.00000E+00   0.00000E+00
     5         2     7.03000E+05   0.00000E+00   1.06200E+03   0.00000E+00   0.00000-
E+00   0.00000E+00   0.00000E+00
     5         5     7.30225E+05   0.00000E+00   1.45200E+03   0.00000E+00   0.00000-
E+00   0.00000E+00   0.00000E+00
     5         7     7.32700E+05   0.00000E+00   6.96000E+02   0.00000E+00   0.00000-
E+00   0.00000E+00   0.00000E+00
     5         8     7.37650E+05   0.00000E+00   9.31000E+02   0.00000E+00   0.00000-
E+00   0.00000E+00   0.00000E+00
     5        10     7.62400E+05   0.00000E+00   1.74700E+03   0.00000E+00   0.00000-
E+00   0.00000E+00   0.00000E+00
     5         9     7.72300E+05   0.00000E+00   9.40000E+01   0.00000E+00   0.00000-
E+00   0.00000E+00   0.00000E+00
     5         1     7.97050E+05   0.00000E+00   6.80000E+01   0.00000E+00   0.00000-
E+00   0.00000E+00   0.00000E+00
     5         6     8.09425E+05   0.00000E+00   3.43000E+02   0.00000E+00   0.00000-
E+00   0.00000E+00   0.00000E+00
```

In[249]:=
```
(*Number of WPs per subarea*)
NoWPs = {526, 1062, 2904, 1793, 1452, 343, 696, 931, 723, 1747}
```
Out[249]=
```
{526, 1062, 2904, 1793, 1452, 343, 696, 931, 723, 1747}
```

Under the #gencorr column, the number of WPs add to the total number of WPs in the corresponding subarea, with the exception of subareas 1 and 9. In those cases, the mechanical breaching occurred (column #mechanical). When WPs in that column are added to WPs in the column #gencorr, then the total number of WPs add to the WPs in a subarea:

WPs in subarea 1:

In[270]:=
```
4.58000*^02 + 6.80000*^01
```
Out[270]=
```
526.
```

WPs in subarea 9:

In[271]:=
```
6.2900*^02 + 9.40000*^01
```
Out[271]=
```
723.
```

The following entries are available in the file ebsrel.ech

```
                    5 !! Realization
                    1 !! Subarea
type of event     number wps failed     time of event
   INITIAL           0.0000E+00          0.0000E+00
   FAULTING          0.0000E+00          0.0000E+00
   VOLCANO           0.0000E+00          0.0000E+00
   MECH 1            4.5800E+02          2.9800E+04
   MECH 2            0.0000E+00          0.0000E+00
   NOT USED          0.0000E+00          0.0000E+00
   LOC CORR          0.0000E+00          1.0000E+06
   GEN CORR          6.8000E+01          7.9705E+05
   EXTRUSIVE         0.0000E+00          0.0000E+00


                       5 !! Realization
                    9 !! Subarea
type of event     number wps failed     time of event
   INITIAL           0.0000E+00          0.0000E+00
   FAULTING          0.0000E+00          0.0000E+00
   VOLCANO           0.0000E+00          0.0000E+00
```

```
MECH 1          6.2900E+02        2.9800E+04
MECH 2          0.0000E+00        0.0000E+00
NOT USED        0.0000E+00        0.0000E+00
LOC CORR        0.0000E+00        1.0000E+06
GEN CORR        9.4000E+01        7.7230E+05
EXTRUSIVE       0.0000E+00        0.0000E+00
```

Therefore, the appropriate number of WPs is passed to RELEASET.

TEST RESULT: PASS

Test 04, Invariant UZFT release rate

Approach: Compare 100,000-yr and 10,000-yr runs. Compare EBS releases, if the EBS releases are identical, then UZ and SZ releases must be also identical.

■ Multiple realization releases, nominal case, 10^5 years

```
noRea = 600;
doseStats = LeeDatos["00_ebsrel_statistics.txt", 1, 10];
(*Remove zeros*)
dat = doseStats + 1.0*^-53; datT = Transpose[dat]; co = Length[datT]; coD = noRea + 1;

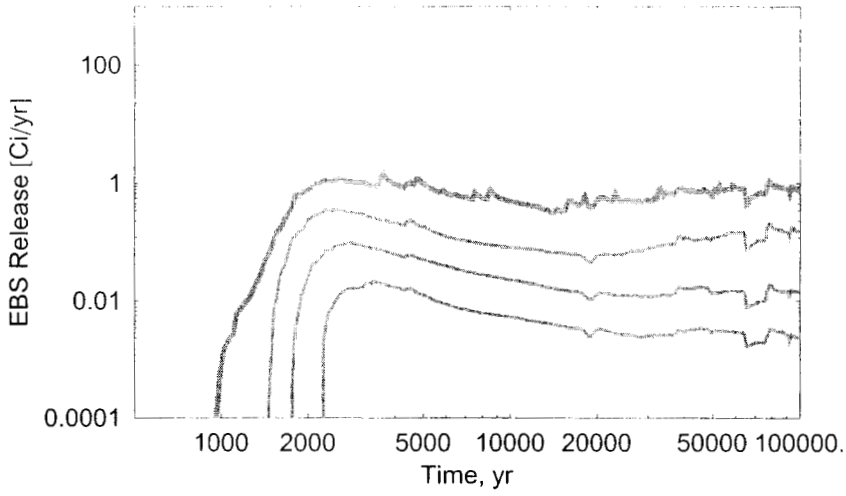
colors = {1 / 4, 2 / 4, 3 / 4, 0.5 (2 / 4 + 3 / 4), 3 / 4, 2 / 4, 1 / 4, 1 };
thicknesses = {2, 2, 2, 2, 2, 2, 2, 3};
rang = {{500, 1*^5}, {1*^-4, 1000}};
labe = "EBS Release [Ci/yr]";
plotFunction = LogLogListPlot;
horseTailsQ = True;
ticks = {1*^1, 1*^2, 5*^2, 1*^3, 5*^3, { 1*^4, "10^4"}, {5*^4, "5x10^4"}, {1*^5, "10^5"}};
ticks = Automatic;

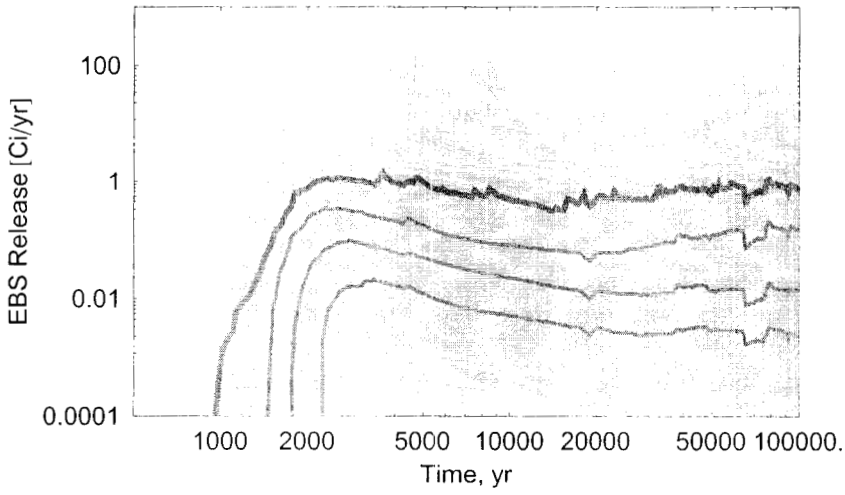
dr1 = DisplayTogether[
   Table[plotFunction[Transpose[{datT[[1]], datT[[i]]}], PlotJoined → True,
     PlotStyle → {Hue[colors[[i - 1]]], AbsoluteThickness[thicknesses[[i - 1]]]},
     PlotRange → rang, Frame → True, FrameLabel → {"Time, yr", labe, "", ""},
     FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 2, co - 1}]
  ];

If[horseTailsQ,

  dose = LeeDatos["00_ebsrel_realizations.txt", 1, noRea + 1];
  dat = dose + 1.0*^-53; datTD = Transpose[dat];

  DisplayTogether[
   Join[
    Table[plotFunction[Transpose[{datTD[[1]], datTD[[i]]}],
      PlotJoined → True, PlotStyle → {AbsoluteThickness[1], GrayLevel[0.7]},
      PlotRange → rang, Frame → True, FrameLabel → {"Time, yr", labe, "", ""},
      FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 2, coD}],
    Table[plotFunction[Transpose[{datT[[1]], datT[[i]]}], PlotJoined → True,
      PlotStyle → {Hue[colors[[i - 1]]], AbsoluteThickness[thicknesses[[i - 1]]]},
      Frame → True], {i, 2, co - 1}]
   ]
  ]];
```


100
1
0.01
0.0001
EBS Release [Ci/yr]
1000
2000
5000
10000
20000
50000
100000.
Time, yr


100
1
0.01
0.0001
EBS Release [Ci/yr]
1000
2000
5000
10000
20000
50000
100000.
Time, yr

```
noRea = 600;
doseStats = LeeDatos["00_uzft_statistics.txt", 1, 10];
(*Remove zeros*)
dat = doseStats + 1.0*^-53; datT = Transpose[dat]; co = Length[datT]; coD = noRea + 1;

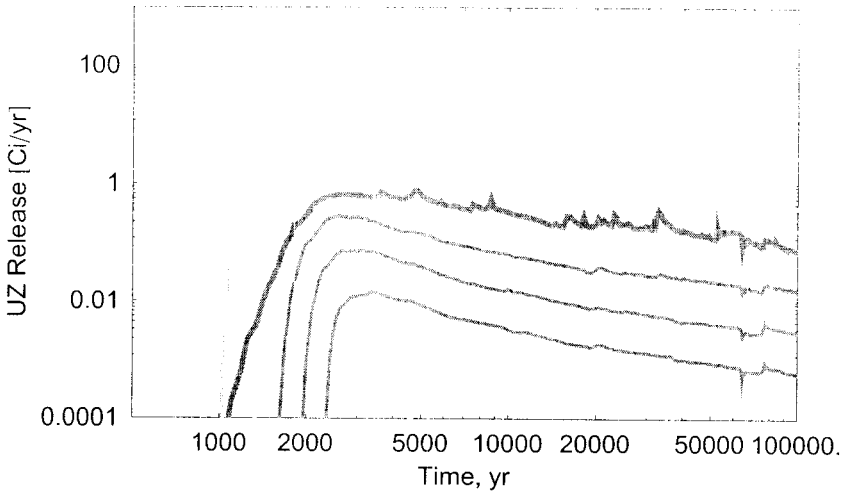
colors = {1 / 4, 2 / 4, 3 / 4, 0.5 (2 / 4 + 3 / 4), 3 / 4, 2 / 4, 1 / 4, 1 };
thicknesses = {2, 2, 2, 2, 2, 2, 2, 3};
rang = {{500, 1*^5}, {1*^-4, 1000}};
labe = "UZ Release [Ci/yr]";
plotFunction = LogLogListPlot;
horseTailsQ = True;
ticks = {1*^1, 1*^2, 5*^2, 1*^3, 5*^3, { 1*^4, "10^4"}, {5*^4, "5x10^4"}, {1*^5, "10^5"}};
ticks = Automatic;

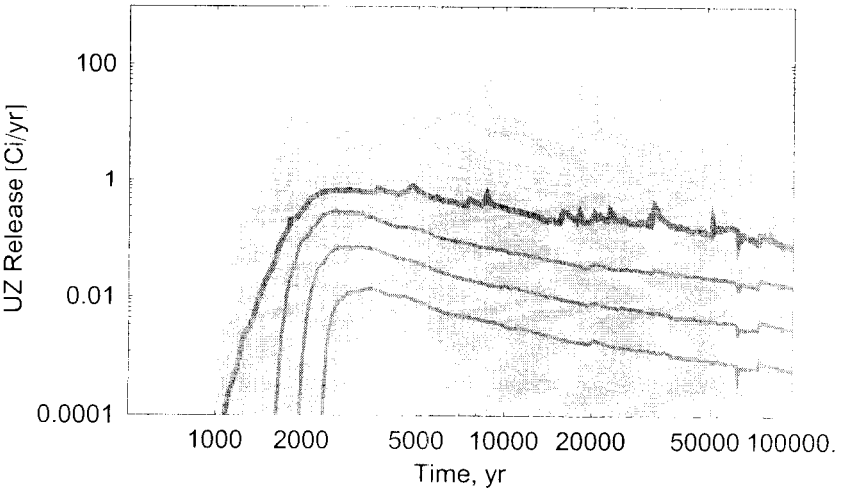
dr1 = DisplayTogether[
   Table[plotFunction[Transpose[{datT[[1]], datT[[i]]}], PlotJoined → True,
     PlotStyle → {Hue[colors[[i - 1]]], AbsoluteThickness[thicknesses[[i - 1]]]},
     PlotRange → rang, Frame → True, FrameLabel → {"Time, yr", labe, "", ""},
     FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 2, co - 1}]
  ];

If[horseTailsQ,

  dose = LeeDatos["00_uzft_realizations.txt", 1, noRea + 1];
  dat = dose + 1.0*^-53; datTD = Transpose[dat];

  DisplayTogether[
   Join[
    Table[plotFunction[Transpose[{datTD[[1]], datTD[[i]]}],
      PlotJoined → True, PlotStyle → {AbsoluteThickness[1], GrayLevel[0.7]},
      PlotRange → rang, Frame → True, FrameLabel → {"Time, yr", labe, "", ""},
      FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 2, coD}],
    Table[plotFunction[Transpose[{datT[[1]], datT[[i]]}], PlotJoined → True,
      PlotStyle → {Hue[colors[[i - 1]]], AbsoluteThickness[thicknesses[[i - 1]]]},
      Frame → True], {i, 2, co - 1}]
   ]
  ]];
```


100
1
0.01
0.0001
UZ Release [Ci/yr]
1000
2000
5000
10000
20000
50000
100000.
Time, yr


100
1
0.01
0.0001
UZ Release [Ci/yr]
1000
2000
5000
10000
20000
50000
100000.
Time, yr

```
noRea = 600;
doseStats = LeeDatos["00_szft_statistics.txt", 1, 10];
(*Remove zeros*)
dat = doseStats + 1.0*^-53; datT = Transpose[dat]; co = Length[datT]; coD = noRea + 1;

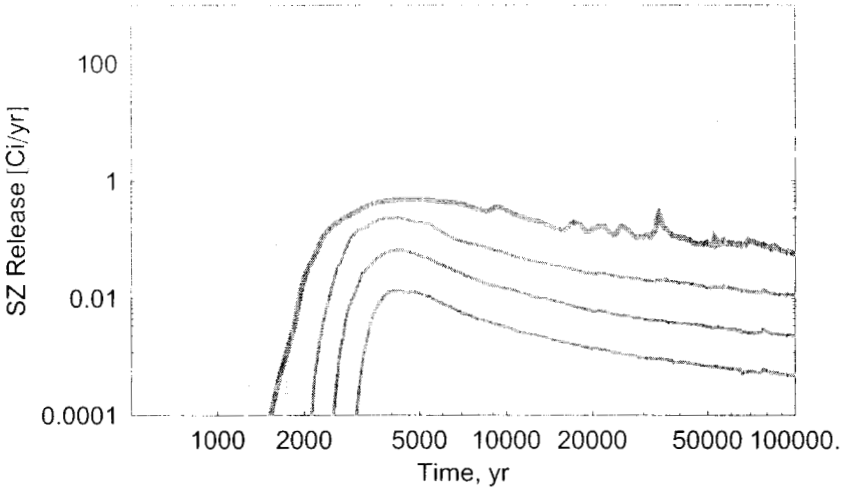
colors = {1 / 4, 2 / 4, 3 / 4, 0.5 (2 / 4 + 3 / 4), 3 / 4, 2 / 4, 1 / 4, 1 };
thicknesses = {2, 2, 2, 2, 2, 2, 2, 3};
rang = {{500, 1*^5}, {1*^-4, 1000}};
labe = "SZ Release [Ci/yr]";
plotFunction = LogLogListPlot;
horseTailsQ = True;
ticks = {1*^1, 1*^2, 5*^2, 1*^3, 5*^3, { 1*^4, "10^4"}, {5*^4, "5x10^4"}, {1*^5, "10^5"}};
ticks = Automatic;

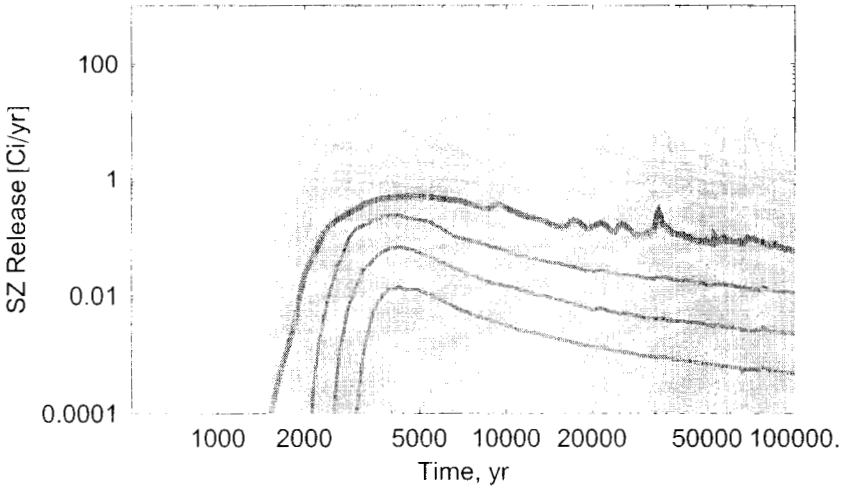
dr1 = DisplayTogether[
   Table[plotFunction[Transpose[{datT[[1]], datT[[i]]}], PlotJoined → True,
     PlotStyle → {Hue[colors[[i - 1]]], AbsoluteThickness[thicknesses[[i - 1]]]},
     PlotRange → rang, Frame → True, FrameLabel → {"Time, yr", labe, "", ""},
     FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 2, co - 1}]
  ];

If[horseTailsQ,

  dose = LeeDatos["00_szft_realizations.txt", 1, noRea + 1];
  dat = dose + 1.0*^-53; datTD = Transpose[dat];

  DisplayTogether[
   Join[
    Table[plotFunction[Transpose[{datTD[[1]], datTD[[i]]}],
      PlotJoined → True, PlotStyle → {AbsoluteThickness[1], GrayLevel[0.7]},
      PlotRange → rang, Frame → True, FrameLabel → {"Time, yr", labe, "", ""},
      FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 2, coD}],
    Table[plotFunction[Transpose[{datT[[1]], datT[[i]]}], PlotJoined → True,
      PlotStyle → {Hue[colors[[i - 1]]], AbsoluteThickness[thicknesses[[i - 1]]]},
      Frame → True], {i, 2, co - 1}]
   ]
  ]];
```





In[339]:=

```
noRea = 600;
(*100 K run*)
dat = LeeDatos["00_ebsrel_realizations.txt", 1, noRea + 1];
ebsDat = dat + 1*^-50; ebsDatT = Transpose[dat] + 1*^-50;
```

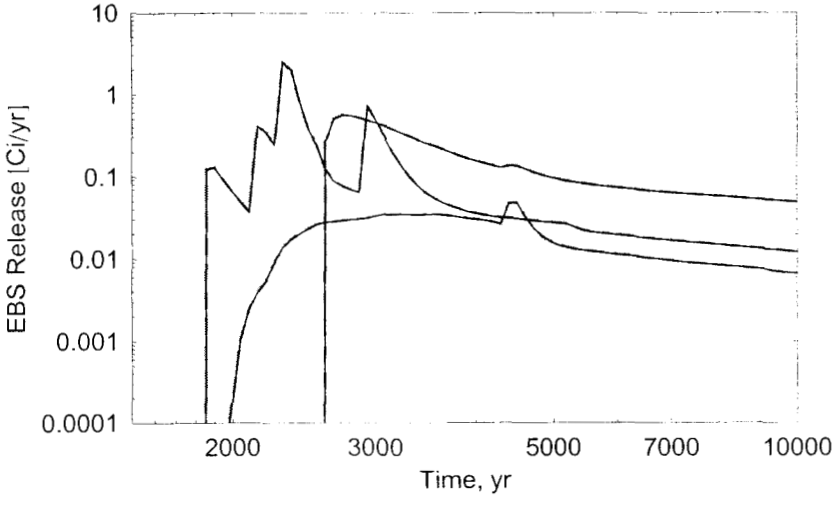
In[334]:=

```
rang = {{1500, 1*^4}, {1*^-4, 10}};

(*10 K run*)
dat = LeeDatos["03_ebsrel_realizations.txt", 1, 4 + 1];
ebsDat10 = dat + 1*^-50; ebsDat10T = Transpose[dat] + 1*^-50;
plotFunction = LogLogListPlot;

DisplayTogether[
  Table[plotFunction[Transpose[{ebsDatT[[1]], ebsDatT[[i]]}], PlotJoined → True,
    PlotStyle → {AbsoluteThickness[2], RGBColor[1, 0, 0], Dashing[{0.02, 0.02}]},
    PlotRange → rang, Frame → True,
    FrameLabel → {"Time, yr", "EBS Release [Ci/yr]", "", ""},
    FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 3, 5}],

  Table[plotFunction[Transpose[{ebsDat10T[[1]], ebsDat10T[[i]]}], PlotJoined → True,
    PlotStyle → {AbsoluteThickness[1], GrayLevel[0.0]}, PlotRange → rang,
    Frame → True, FrameLabel → {"Time, yr", "EBS Release [Ci/yr]", "", ""},
    FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 3, 5}]
 ];
```



Therefore, bot runs, 10K and 100K produce the same releases from the EBS

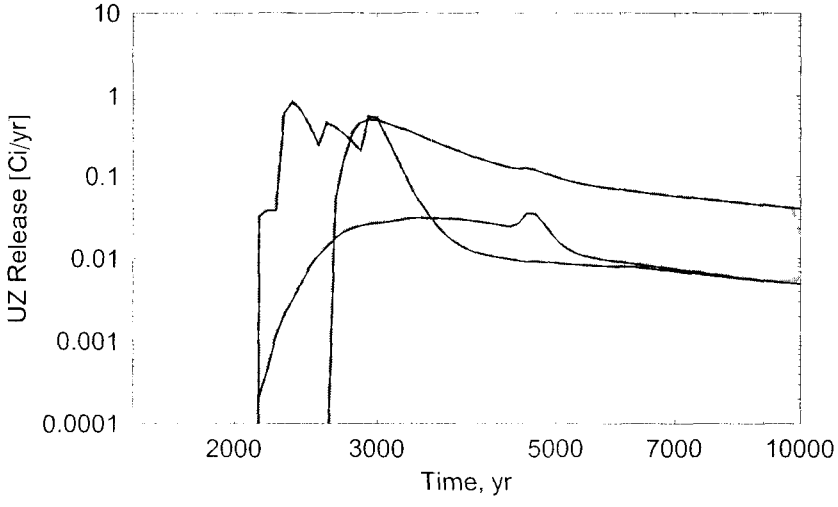
```
(*100 K run*)
dat = LeeDatos["00_uzft_realizations.txt", 1, noRea + 1];
uzDat = dat + 1*^-50 ; uzDatT = Transpose[dat] + 1*^-50 ;
```

```
rang = {{1500, 1*^4}, {1*^-4, 10}};

(*10 K run*)
dat = LeeDatos["03_uzft_realizations.txt", 1, 4 + 1];
uzDat10 = dat + 1*^-50; uzDat10T = Transpose[dat] + 1*^-50;

DisplayTogether[
  Table[plotFunction[Transpose[{uzDatT[[1]], uzDatT[[i]]}], PlotJoined → True,
    PlotStyle → {AbsoluteThickness[2], RGBColor[1, 0, 0], Dashing[{0.02, 0.02}]},
    PlotRange → rang, Frame → True,
    FrameLabel → {"Time, yr", "UZ Release [Ci/yr]", "", ""},
    FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 3, 5}],

  Table[plotFunction[Transpose[{uzDat10T[[1]], uzDat10T[[i]]}], PlotJoined → True,
    PlotStyle → {AbsoluteThickness[1], GrayLevel[0.0]}], {i, 3, 5}]
 ];
```



Therefore, bot runs, 10K and 100K produce the same releases from the UZ

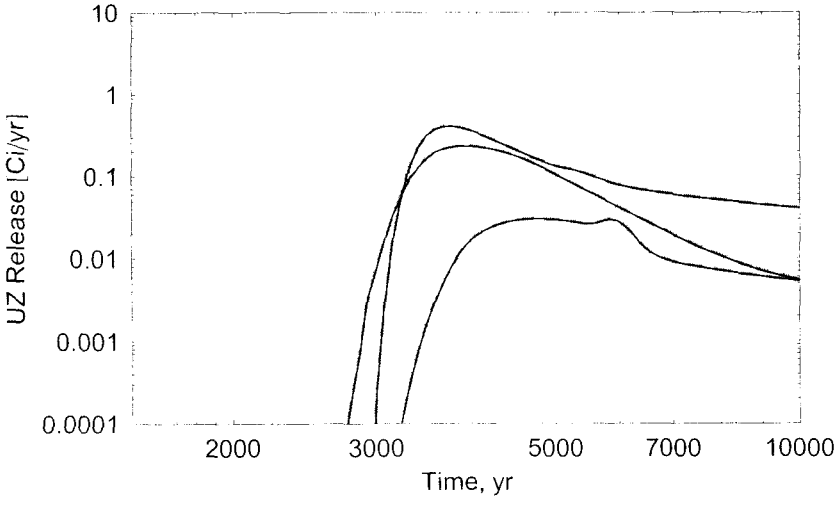
```
(*100 K run*)
noRea = 600;
dat = LeeDatos["00_szft_realizations.txt", 1, noRea + 1];
szDat = dat + 1*^-50 ; szDatT = Transpose[dat] + 1*^-50 ;
```

```
rang = {{1500, 1*^4}, {1*^-4, 10}};

(*10 K run*)
dat = LeeDatos["03_szft_realizations.txt", 1, 4 + 1];
szDat10 = dat + 1*^-50; szDat10T = Transpose[dat] + 1*^-50;

DisplayTogether[
  Table[plotFunction[Transpose[{szDatT[[1]], szDatT[[i]]}], PlotJoined → True,
    PlotStyle → {AbsoluteThickness[2], RGBColor[1, 0, 0], Dashing[{0.02, 0.02}]},
    PlotRange → rang, Frame → True,
    FrameLabel → {"Time, yr", "UZ Release [Ci/yr]", "", ""},
    FrameTicks → {ticks, Automatic, Automatic, Automatic}], {i, 3, 5}],

  Table[plotFunction[Transpose[{szDat10T[[1]], szDat10T[[i]]}], PlotJoined → True,
    PlotStyle → {AbsoluteThickness[1], GrayLevel[0.0]}], {i, 3, 5}]
 ];
```



Therefore, both runs, 10K and 100K produce the same releases from the SZ. Consequently, changes were appropriately implemented and releases from the UZ and SZ are independent of the simulation time.

During this testing, I noted that for a small percentage of realizations with subareas having localized corrosion and mechanical breach of the waste package, differences in EBS releases and doses between 10,000 year and longer simulations (e.g., 100,000 year) are expected. These differences stem from a need to classify dual-breach-type waste packages belonging to unique categories (either localized corrosion or mechanical) to apply appropriate values of the SFWettedFraction parameter and seepage factors. For example, waste packages breached by localized corrosion in the first 10,000 years are classified as "corrosion WPs." On the other hand, if mechanical breaching happens on the same realization and subarea at a time later than 10,000 years in a longer time frame simulation, those same waste packages are classified as "mechanical WPs." This simulation-time-dependent classification causes EBS release rates to slightly depend on the simulation time. This simulation-time-dependence was the result of requiring simplicity in the algorithms for determining the number of waste packages breached and EBS releases, while not underestimating radionuclide releases nor doses. This simulation-time-dependence is not a bug, but a feature of the TPA model.

However, changes in the UZ and SZ modules were properly implemented and the **test is passed**.

SCR - 664

TPA 5.1/ Beta K

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 664	2. Software Title and Version: TPA 5.1BetaK	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f*.

The data written to the files *driftfail.ech* and *driftfail.rlt* include seismic data which is written without consideration of the status of the seismic scenario flag.

5. Change Requested by: J. Mancillas	Date: 2-7-2007
6. Change Authorized by (*Software Developer*): R. Janetzke	Date: 2-7-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

A conditional check has been included in the write statements which are relevant to seismic data for the data files *driftfail.ech* and *driftfail.rlt*. If seismicity is to be evaluated, seismic data (and pertinent header data) will be written to the files, otherwise the seismic data and its introductory header will not be included in the files.

8. Implemented by: J. Mancillas	Date: 2-9-2007

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

None.
Reviewed the "if statements" in exec.f to see what portion of the echo and result files would not be written when the seismic flag is turned off. This was a minor code change and no problems were noted.

Recommend removing the section, "Distribution of Time Steps" and "Number of Time Steps" from driftfail.ech. I don't see the value in this information and it makes the text "All Subareas" out of place with the line below it that reads "(same times for all subareas and vectors)" for the first realization. Also, when the seismicity flag is turned off, I recommend just printing a statement to the driftfail.ech file like, "seismicity flag is off so input data is not displayed in the file." Currently, with the flag turned off, for each realization just the message "All Subareas" is displayed and this is not useful.

Code review accomplished by: G. Adams	Date: 3-7-2007

10. Description of Acceptance Tests:
Performed two test runs using tpa5.1BetaQ on machine GOLDSIM. For the first test, I set tpa.inp to a MaximumTime[yr] of 1.0e5, OutputMode(0=None,1=All,2=UserDefined) to 1 and 10 realizations on 10 subareas. For the second test, in addition, I set the SeismicDisruptiveScenarioFlag(yes=1,no=0) to 0.

In comparing the driftfail.ech and driftfail.rlt files, the seismic portion of the file is removed when the seismic option is turned off. This is the expected result.

TPA version 5.1BetaQ successfully **PASSED** this test because it met the requirements of the code change; however, the previous section included recommendations for improving the driftfail.ech file. (CD attached with Test Results)

10. Tested by: G. Adams	Date: 3-7-2007

Form TOP-5 (10/2006)

SCR - 665

TPA 5.1/ Beta L

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 665	2. Software Title and Version: TPA 5.1BetaL	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *uzflow.f, exec.f, itym.f, estimator.f, climato2.dat*

1. Implement the algorithm for long-term-average climate described in Section 5.3.1.3 of the TPA User's Guide, which uses new input parameters to indicate the time at which a constant climate starts (e.g., *UZFLOW_LongTermAverageOnsetTime[yr]*) and the range of uncertainty for the constant net infiltration rate in this period (e.g., *UZFLOW_LongTermAverageFootprintAverageMeanAnnualInfiltration[mm/yr]*).

2. Revise the output files from ITYM to include *smaiDTBL.dat* if requested.

3. Revise the expected input files from ITYM to include *maiDTBL.dat* and *smaiDTBL.dat*, rather than *mayDTBL.dat* and *smayDTBL.dat*, and revise the procedure for calculating the table of mean annual infiltration for each subarea based on the different input files.

4. Verify that the ITYM code and input files correctly represent the algorithm for the effects of runon to be consistent with Appendix A.2.3 of the TPA User's Guide.

5. Verify that TPA output files (e.g., *infilper.res*) either directly report or contain sufficient information to calculate the repository average net infiltration during pre-10ky and post-10ky time periods.

6. Change, if necessary, the appropriate code and tpa.inp parameters names, values, and distributions, to be consistent with the user guide.

5. Change Requested by: J. Winterle	**Date:** 1-31-2007
6. Change Authorized by (*Software Developer*): R. Janetzke	**Date:** 1-31-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

See attachment A for a description of modifications to TPA modules UZFLOW and NFENV.

8. Implemented by: S. Stothoff	**Date:** 3-6-2007

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

None

Code review accomplished by: R. Nes	**Date:** 4-5-2007

10. Description of Acceptance Tests:

See Test P-4 of TPA5.1 validation report.

11. Tested by: R.Nes	**Date:** 3-30-2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for TPA.INP

SCR 665

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
No Changes to *tpa.inp* parameters							

Attachment A. Changes to TPA modules

1. The algorithm for long-term-average climate described in Section 5.3.1.3 of the TPA User's Guide was implemented through a series of linked modifications.

- The algorithm uses 2 new parameters, uzflow_LongTermAverageOnsetTime[yr] and uzflow_LongTermAverageFootprintAverageMAI[mm/yr], which are obtained in subroutine uzflow..
- Include file uz_flowi.i was modified to include mltamai, a pointer to uzflow_LongTermAverageOnsetTime[yr].
- The previous version of UZFLOW had two flags controlling the infiltration mode. These were combined into uzflow_SampleMode. The flow of execution in subroutine uzflow was significantly revised to accomplish the merge.
- The original algorithm calculated mean annual infiltration (MAI) at fixed intervals, with the time variation of climatic conditions described from input file climato2.dat. The new algorithm also calculates MAI at fixed intervals, but at a user-specified onset time both climate and infiltration switch instantaneously to a long-term-average value. The new algorithm uses the original algorithm until the onset time, whereupon the long-term-average value commences. Several changes were made:

  - Subroutine uzflow was substantially altered to accommodate the revised flow of execution
  - Include file uz_climi.i was modified to add separate variables describing the number of time steps before and after the long-term-average onset, and an unused variable (mGlacial) was removed
  - Subroutine climato_init was modified to calculate the number of time steps before and after the long-term-average onset, and an unused variable (mGlacial) was removed
  - Subroutines calc_ainit, calc_mai, and calc_wp were modified to perform their calculations for a specified subset of the total interval, rather than the entire interval, so that the time-varying and long-term-average periods could be calculated separately
  - Variability in subarea-average MAI was described for all time using the patterns under present-day climate in the original version of UZFLOW. Subroutine uzflow was modified so that variability in subarea-average long-term-average MAI is based on full-glacial-maximum climate. New variables alta, alta_tab, alta_min, and alta_max were defined analogous to the corresponding ainit parameters.

2. Subroutine uzflow_init was revised to read *maiDTBL.dat* and *smaiDTBL.dat* instead of *mayDTBL.dat* and *smayDTBL.dat* as the expected input files from ITYM. These new input files represent pixel-by-pixel values for mean and standard deviation of MAI, rather than the corresponding values of log-transformed MAI. Additional code was added to subroutine uzflow_init to transform the tblMAI and tblsMAI variables into a log-transformed format, so that logic in the remainder of the UZFLOW module is unaffected by the swap in input files.

3. All parameters described in the draft TPA User's Guide Chapter 5 were implemented in tpa.inp, with the exception of uzflow_SampledMAIScalingFactor. This parameter will be removed from the final version of the chapter. Subroutines climato_init, uzflow_init in file uzflow.f were modified accordingly. Also, subroutine nfenvFI in file nfenv.f was modified to read in parameter uzflow_ReferenceMATAtStart[degC] rather than GroundSurfaceTemperature[C] so as to have consistent nomenclature.

SCR - 666

TPA 5.1/ Beta S

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 666	2. Software Title and Version: TPA 5.1BetaS	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *tpa.inp*

In a letter from NRC, dated 7-27-2006, a request was made to identify and review the technical for input parameters, including the range of uncertaintly and variability associates with each parameter.

5. Change Requested by: J. Winterle	Date: 8-1-2006
6. Change Authorized by (*Software Developer*): R. Janetzke	Date: 8-1-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

The *tpa.inp* file was changed based on input provided to O. Osidele by model providers using the modified master spreadsheet information or the parameter tables in their respective user guide chapters.

8. Implemented by: R. Janetzke / O. Osidele	Date: 2-28-07

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☐ **No** ☒

(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).

Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

Code review accomplished by:	Date:

10. Description of Acceptance Tests:

No significant code changes were made, so no testing is required.

11. Tested by:	Date:

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for *TPA.INP*

SCR 666

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM)*	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.)*	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
See Femi's hard copy							

SCR - 667

TPA 5.1/ Beta G

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 667	2. Software Title and Version: TPA 5.1BetaG	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f, corrfail.f, failt.f, ebsrel.f, fileutil.f, burnup.dat,invent.f, nuclides.dat, nfenv.f, drythick.dat, reader.f, repdes.dat, uzflow.f, climato1.dat, climato2.dat, ebsfilt.def, Makefile, echofilt.dat, ebsfilt.dbg, ebsfilt.f, szft.f dcagw.f, strmtube.dat, smaydtbl.dat, maydtbl.dat, tpanames.dbs, tpanames.dat, ebsfilt.fig.*

1) In a letter from NRC, dated 7-27-2006, a request was made to increase the transparency and traceability of the input/output files. Specifically, input parameters should be located/identified in the input files to aid in traceability through the conceptual model calculations. Also, the format and content of the output files should ensure a user can reasonably comprehend the content without excessive recourse to the source code of other documentation.

2) In *corrfail.f* the penetration depth can exceed the thickness in the output files.

3) In *failt.f* the remaining thickness can have negative values.

5. Change Requested by: J. Winterle	**Date:** 8-1-2006
6. Change Authorized by (*Software Developer*): R. Janetzke	**Date:** 8-7-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

Output from **diff** utility is attached as Appendix A.
Reformatted files: *strmtube.dat, ebsfilt.dat, burnup.dat, nuclides.dat, drythick.dat, tpanames.dat (renamed from tpanames.dbs), repdes.dat, climato1.dat, climato2.dat, smaydtbl.dat,* and *maydtbl.dat.*

8. Implemented by: R. Janetzke	**Date:** 11-26-06

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

None

Code review accomplished by: R. Rice	**Date:** 5-18-07

10. Description of Acceptance Tests:

A description of the acceptance testing is included in Appendix B.

11. Tested by: R. Rice	**Date:** 5-18-07

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for *TPA.INP*

SCR 667

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
No Changes to tpa.inp parameters							

Appendix A

dcagw.f

```
3c3
< c File Date:           09/01/06
---
> c File Date:           11/28/06
58a59
> c    11-25-06 rwj SCR667;  Read reformatted strmtube.dat
323,334c324,343
<   100   continue
<         read (ireadtubefile, '(a80)', end=889, err=903) aline
<         iline = iline+1
<         if (aline(1:2) .eq. 'TI' .or.
<      &      aline(1:2) .eq. 'ti' .or.
<      &      aline(1:2) .eq. '**' )   go to 100
<         read (aline,*) numberoftubes
<   150   continue
<         read (ireadtubefile, '(a80)', end=889, err=903) aline
<         iline = iline+1
<         if (aline(1:2) .eq. '**') go to 150
<         read (aline,*) numberflowrates
---
>
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
> c 100   continue
> c       read (ireadtubefile, '(a80)', end=889, err=903) aline
> c       iline = iline+1
> c       if (aline(1:2) .eq. 'TI' .or.
> c    &      aline(1:2) .eq. 'ti' .or.
> c    &      aline(1:2) .eq. '**' )   go to 100
> c       read (aline,*) numberoftubes
> c 150   continue
> c       read (ireadtubefile, '(a80)', end=889, err=903) aline
> c       iline = iline+1
> c       if (aline(1:2) .eq. '**') go to 150
> c       read (aline,*) numberflowrates
>         lDebug = .FALSE.
>         iSkip = 1
>         call FindRecord( ireadtubefile, ' ', 1, iSkip, lDebug)
>         read (ireadtubefile,*) numberoftubes
>         read (ireadtubefile,*) numberflowrates
>
341c350
<          endif
---
>         endif
342a352,357
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
>         iSkip = 1
>         call FindRecord( ireadtubefile, 'SECTION 2', 9, iSkip, lDebug)
>         iSkip = 3
>         call FindRecord( ireadtubefile, ' ', 1, iSkip, lDebug)
>
344,345c359,362
<           read (ireadtubefile, *, end=889, err=903) szflowrate(itube)
<           iline = iline+1
---
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
> c        read (ireadtubefile, *, end=889, err=903) szflowrate(itube)
>          read (ireadtubefile, *, end=889, err=903) idx,szflowrate(itube)
```

```
>          iline = iline+1
348,352c365,372
<   175   continue
<         read (ireadtubefile, '(a80)') aline
<         iline = iline+1
<         if (aline(1:2) .eq. '**') go to 175
<         read (aline,*) anearfielddist, farfielddist
---
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
> c 175   continue
> c       read (ireadtubefile, '(a80)') aline
> c       iline = iline+1
> c       if (aline(1:2) .eq. '**') go to 175
> c       read (aline,*) anearfielddist, farfielddist
>         iSkip = 0
>         call FindRecord( ireadtubefile, 'SECTION 10', 10, iSkip, lDebug)
361,374c381,396
<         do itube = 1, numberoftubes
<
<   177     continue
<           read (ireadtubefile, '(a80)') aline
<           iline = iline+1
<           if (aline(1:2) .eq. '**') go to 177
<
<           read (aline, *, end=889, err=903) itubeid
<           read (ireadtubefile,'(a80)', end=889, err=903) aline
<           iline = iline+1
<
<           read (aline, *, end=889, err=903) nearlegs(itube)
<           read (ireadtubefile,'(a80)', end=889, err=903) aline
<           iline = iline+1
---
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
> c       do itube = 1, numberoftubes
> c
> c 177     continue
> c         read (ireadtubefile, '(a80)') aline
> c         iline = iline+1
> c         if (aline(1:2) .eq. '**') go to 177
> c
> c         read (aline, *, end=889, err=903) itubeid
> c         read (ireadtubefile,'(a80)', end=889, err=903) aline
> c         iline = iline+1
> c
> c         read (aline, *, end=889, err=903) nearlegs(itube)
> c         read (ireadtubefile,'(a80)', end=889, err=903) aline
> c         iline = iline+1
> c
376,380c398,402
<           do ileg = 1,nearlegs(itube)
<             read (ireadtubefile, *, end = 889, err=903) avalue
<             iline = iline+1
<           enddo
<         enddo
---
> c         do ileg = 1,nearlegs(itube)
> c           read (ireadtubefile, *, end = 889, err=903) avalue
> c           iline = iline+1
> c         enddo
> c       enddo
395a418
>
397,400c420,425
<   178     continue
<           read (ireadtubefile, '(a80)') aline
```

```
<           iline = iline+1
<           if (aline(1:2) .eq. '**') go to 178
---
>
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
> c 178     continue
> c         read (ireadtubefile, '(a80)') aline
> c         iline = iline+1
> c         if (aline(1:2) .eq. '**') go to 178
402,404c427,440
<           read (aline, *, end=889, err=903) nearlegs(itube)
<           read (ireadtubefile, '(a80)') aline
<           iline = iline+1
---
> c         read (aline, *, end=889, err=903) nearlegs(itube)
> c         read (ireadtubefile, '(a80)') aline
> c         iline = iline+1
>           iSkip = 1
>           call FindRecord( ireadtubefile, 'SECTION', 7, iSkip, lDebug)
>           iSkip = 1
>           call FindRecord( ireadtubefile, ' ', 1, iSkip, lDebug)
>           read (ireadtubefile, *, end=889, err=903) nearlegs(itube)
>           iSkip = 1
>           call FindRecord( ireadtubefile, 'SECTION', 7, iSkip, lDebug)
>           iSkip = 3
>           call FindRecord( ireadtubefile, ' ', 1, iSkip, lDebug)
>
> cc use only the last width to determine totaltubewidth
```

ebsrel.f

```
3c3
< c File Date:           09/01/06
---
> c File Date:           11/28/06
127a128,129
> cc rwj 11-24-06; SCR667; Read reformatted ebsfilt.def
> cc
543a546,549
> cc rwj 11-24-06; SCR667; Read reformatted ebsfilt.def
>       logical lDebug
>       integer iSkip
>
2661,2662c2667,2670
<         read (iebsfilttmp, 100 ) aline
<         write(iebsfiltinp, 100 ) aline
---
>
> cc rwj 11-24-06; SCR667; Read reformatted ebsfilt.def
> c       read (iebsfilttmp, 100 ) aline
> c       write(iebsfiltinp, 100 ) aline
2664,2666c2672,2684
<         read (iebsfilttmp, 100 ) aline
<         write(aline(1:2), fmt='(i2)') nnucl
<         write(iebsfiltinp, 100 ) aline
---
> c       read (iebsfilttmp, 100 ) aline
> c       write(aline(1:2), fmt='(i2)') nnucl
> c       write(iebsfiltinp, 100 ) aline
>         read (iebsfilttmp, '(a)' ) aline
>         do while (aline(1:1) .eq. '!')
>           write(iebsfiltinp, '(a)' ) aline
>           read (iebsfilttmp, '(a)' ) aline
>         end do
>           write(iebsfiltinp, '(a)' ) aline
>           read (iebsfilttmp, '(a)' ) aline
>           write(aline(1:24), '(i23)') nnucl
>           write(iebsfiltinp, '(a)' ) aline
>
2685,2688c2703,2723
<         write(aline(1:67), fmt='(1pe19.11,4(1pe12.4))')
<      &         avgflux,rp,xinvertksat, x_m,d_m2yr
<         write(iebsfiltinp, 100 ) aline
<         read (iebsfilttmp, 100 ) aline
---
>
> cc rwj 11-24-06; SCR667; Read reformatted ebsfilt.def
> c       write(aline(1:67), fmt='(1pe19.11,4(1pe12.4))')
> c    &         avgflux,rp,xinvertksat, x_m,d_m2yr
>         write(aline(1:24), '(1pe23.6,x)') avgflux
>         write(iebsfiltinp, '(a)' ) aline
>         read (iebsfilttmp, '(a)' ) aline
>         write(aline(1:24), '(1pe23.6,x)') rp
>         write(iebsfiltinp, '(a)' ) aline
>         read (iebsfilttmp, '(a)' ) aline
>         write(aline(1:24), '(1pe23.6,x)') xinvertksat
>         write(iebsfiltinp, '(a)' ) aline
>         read (iebsfilttmp, '(a)' ) aline
>         write(aline(1:24), '(1pe23.6,x)') x_m
>         write(iebsfiltinp, '(a)' ) aline
>         read (iebsfilttmp, '(a)' ) aline
>         write(aline(1:24), '(1pe23.6,x)') d_m2yr
>         write(iebsfiltinp, '(a)' ) aline
```

```
> read (iebsfilttmp, '(a)' ) aline
> write(iebsfiltinp, '(a)' ) aline
>
2692a2728,2741
> cc rwj 11-24-06; SCR667; Read reformatted ebsfilt.def
> read (iebsfilttmp, '(a)' ) aline
> do while (aline(1:1) .eq. '!')
>  write(iebsfiltinp, '(a)' ) aline
>  read (iebsfilttmp, '(a)' ) aline
> end do
> write(iebsfiltinp, '(a)' ) aline
> c Headers
> read (iebsfilttmp, '(a)' ) aline
> write(iebsfiltinp, '(a)' ) aline
> c Units
> read (iebsfilttmp, '(a)' ) aline
> write(iebsfiltinp, '(a)' ) aline
>
2699,2700c2748,2753
< write(aline(1:30), fmt='(a6,2(1pe12.4))') ljustify,halflife,rde
<  write(iebsfiltinp, 100 ) aline
---
>
> cc rwj 11-24-06; SCR667; Read reformatted ebsfilt.def
> c write(aline(1:30), fmt='(a6,2(1pe12.4))') ljustify,halflife,rde
> write(aline(1:38), '(a8,2(1pe15.6))')
>  & ''''//ljustify//'''',halflife,rde
> write(iebsfiltinp, 100 ) aline
2702a2756,2769
> cc rwj 11-24-06; SCR667; Read reformatted ebsfilt.def
> lDebug = .FALSE.
> iSkip = 0
> call FindRecord( iebsfilttmp, ' ', 1, iSkip, lDebug)
> read (iebsfilttmp, '(a)' ) aline
> write(iebsfiltinp, '(a)' ) aline
> read (iebsfilttmp, '(a)' ) aline
> do while (aline(1:1) .eq. '!')
>  write(iebsfiltinp, '(a)' ) aline
>  read (iebsfilttmp, '(a)' ) aline
> end do
> write(iebsfiltinp, '(a)' ) aline
> read (iebsfilttmp, '(a)' ) aline
>
2705,2706d2771
<  write(iebsfiltinp, '(a9)' ) 'Colloids'
<  write(iebsfiltinp, '(i3)' ) numclnuc
2707a2773,2792
> cc rwj 11-24-06; SCR667; Read reformatted ebsfilt.def
> c write(iebsfiltinp, '(a9)' ) 'Colloids'
> c write(iebsfiltinp, '(i3)' ) numclnuc
> write(aline(1:24), '(i23,x)' ) numclnuc
> write(iebsfiltinp, '(a)' ) aline
> read (iebsfilttmp, '(a)' ) aline
> write(iebsfiltinp, '(a)' ) aline
> read (iebsfilttmp, '(a)' ) aline
> do while (aline(1:1) .eq. '!')
>  write(iebsfiltinp, '(a)' ) aline
>  read (iebsfilttmp, '(a)' ) aline
> end do
> write(iebsfiltinp, '(a)' ) aline
> c Headers
> read (iebsfilttmp, '(a)' ) aline
> write(iebsfiltinp, '(a)' ) aline
> c Units
> read (iebsfilttmp, '(a)' ) aline
```

```
>           write(iebsfiltinp, '(a)' ) aline
>
2720c2805,2809
<            write(iebsfiltinp, fmt='(a6,2(1pe12.4))') ljustify,halflife,
---
> cc rwj 11-24-06; SCR667; Read reformatted ebsfilt.def
> c          write(iebsfiltinp, fmt='(a6,2(1pe12.4))') ljustify,halflife,
> c    &                                                 flfc
>            write(iebsfiltinp, '(a8,2(1pe15.6))')
>      &                        ''''//ljustify//'''',halflife,
2724,2725c2813,2818
<           write(iebsfiltinp, '(a9)' ) 'Colloids'
<           write(iebsfiltinp, '(i3)' ) 0
---
>
> cc rwj 11-24-06; SCR667; Read reformatted ebsfilt.def
> c         write(iebsfiltinp, '(a9)' ) 'Colloids'
> c         write(iebsfiltinp, '(i3)' ) 0
>           write(aline(1:24), '(i23,x)' ) 0
>           write(iebsfiltinp, '(a)' ) aline
3293a3387,3392
> cc
> cc rwr 10/5/06; SCR653 (continued); also, make sure rminfailtime
> cc                                  is the minimum of the WP localized
> cc                                  corrosion failure time
> cc        rminfailtime =
> cc      &    MIN(rminfailtime, timeweldfail)
3295c3394
<      &    MIN(rminfailtime, timeweldfail)
---
>      &    MIN(rminfailtime, timeweldfail, timewpfail)
```

exec.f

```
3,4c3,4
< c File Date:            09/27/06
< c Release Version:      5.1betaG
---
> c File Date:            11/28/06
> c Release Version:      5.1betaH
302a303
> c             5.1betaH includes SCR 653 set localized corrosion failure time to minimum
of weld and localized corrosion times.
352c353
< c Executive for TPA Version 5.1betaG
---
> c Executive for TPA Version 5.1betaH
917c918
<       print '(10x,a)','exec: Welcome to TPA Version 5.1betaG'
---
>       print '(10x,a)','exec: Welcome to TPA Version 5.1betaH'
8402c8403
<  341     format( ' TPA 5.1betaG, Job started: ', a24 )
---
>  341     format( ' TPA 5.1betaH, Job started: ', a24 )
8491c8492
<  341     format( ' TPA 5.1betaG, Job started: ', a24 )
---
>  341     format( ' TPA 5.1betaH, Job started: ', a24 )
```

fileutil.f

```
3c3
< c File Date:        07/14/06
---
> c File Date:        11/28/06
63a64
> c                FindRecord
66a68
> c             11-21-06 R. Janetzke ; SCR667 ; Added routine FindRecord
459c461,638
<
---
> cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
>       subroutine FindRecord( iUnit, aString, iLastChar, iRelPos,
>      &                       lDebugFlag)
> cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
> c     NAME:
> c          FindRecord - Find a record, with optional offset, in an ASCII
> c                       text file that contains the given case sensitive
> c                       character string.
> c
> c     PURPOSE:
> c             This routine searches for an ASCII string in the first 80
> c             columns of a text file.  If the string is found the file
> c             is positioned for a 'read' at the record with the
> c             matching string. This record position is optionally offset
> c             by the number of records indicated with the value of
> c             iRelPos.
> c
> c             The search begins at the current position in the file,
> c             which does not have to be the beginning of the file.
> c
> c             If the string is not found, an 'end of file' error occurs
> c             and execution is stopped.
> c
> c     METHOD:
> c             The INDEX() function is used to scan the first 80 characters
> c             of the remaining lines in a file.  The search is
> c             terminated at the line containing the first occurrence of
> c             the string.  If the relative position indicator (iRelPos)
> c             is greater than 0, the file position is advanced by an
> c             appropriate number of records to satisfy the offset
> c             number supplied in iRelPos.
> c
> c             If the debug flag is enabled, files shorter than 3
> c             records will produce a system I/O error.
> c
> c     INPUT:
> c           iUnit      = integer, unit number of file opened for reading
> c           aString    = character*(*), search string
> c           iLastChar  = integer, the last character position of the
> c                        search string to be used in search (i.e. string
> c                        length)
> c           iRelPos    = integer, relative position of the file to the
> c                        record containing the matching string.
> c                        Value should be non-negative.
> c                        0 = ready to read record containing search string
> c                        1 = ready to read record after the one containing
> c                            search string
> c                        2 = etc.
> c           lDebugFlag = logical, flag to enable debug output
> c
> c     OUTPUT:
```

```
> c            (none)
> c
> c     HISTORY:
> c             11-05-06; R. Janetzke; Original text.
> cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
>
>       implicit none
>
>       logical lDebugFlag
>
>       character*(*) aString
>       character*80 aLine
>       character*64 aFileName
>
>       integer iAdvance
>       integer iChar
>       integer iFound
>       integer iUnit
>       integer iLastChar
>       integer iRelPos
>       logical lBlankSearch
> ccccc
> c     Start here.
> ccccc
>       if (iLastChar .le. 0) then
>         inquire (UNIT=iUnit, NAME=aFileName)
>         print *, ' ***>>> Error in FindRecord() <<<*** '
>         print *, ' Search string length must be positive.'
>         print *, ' iLastChar = ', iLastChar
>         print *, ' aFileName = ', aFileName
>         print *, ' iUnit = ', iUnit
>         STOP
>       end if
>
>       if (iRelPos .lt. 0) then
>         inquire (UNIT=iUnit, NAME=aFileName)
>         print *, ' ***>>> Error in FindRecord() <<<*** '
>         print *, ' Relative position must be non-negative.'
>         print *, ' iRelPos = ', iRelPos
>         print *, ' aFileName = ', aFileName
>         print *, ' iUnit = ', iUnit
>         print *, ' aString = ', aString(1:iLastChar)
>         STOP
>       end if
>
> c     Set blank line search flag.
>
>       lBlankSearch = .TRUE.
>
>       do iChar = 1,iLastChar
>         if (aString(iChar:iChar) .ne. ' ') then
>           lBlankSearch = .FALSE.
>         end if
>       end do
>
>       do while (.TRUE.)
>
>          read(iUnit, FMT = '(A80)', ERR=900) aLine
>
>          iFound = 0
>
>          if (lBlankSearch) then
>            if ( aLine .eq. ' ') iFound = 1
>          else
>            iFound = INDEX(aLine, aString(1:iLastChar))
```

```
>          end if
>
>          if (iFound .ge. 1) then
> c
> c Print line containing search string.
> c
>            if (lDebugFlag) then
>              inquire (UNIT=iUnit, NAME=aFileName)
>              backspace (iUnit)
>              print *, 'Context for ''' // aString(1:iLastChar) //
>      &                ''' in file ', aFileName(1:20)
>              read (iUnit, '(A80)') aLine
>              print *, aLine
>              print *
>            end if
> c
> c Advance the number of lines for relative positioning
> c
>            if (iRelPos .eq. 0) then
>               backspace (iUnit)
>            else if (iRelPos .gt. 1) then
>               do iAdvance = 2,iRelPos
>                  read ( iUnit, '(A80)') aLine
>               end do
>            end if
> c
> c Print line at final position
> c
>            if (lDebugFlag .and. iRelPos .gt. 0) then
>              print *, 'Line at relative position ', iRelPos
>              read (iUnit, '(A80)') aLine
>              print *, aLine
>              print *
>              backspace (iUnit)
>            end if
>
>            return
>
>         end if
>       end do
>
>   900 continue
>       inquire (UNIT=iUnit, NAME=aFileName)
>       print *, ' ***>>> Error in FindRecord() <<<*** '
>       print *, ' aFileName = ', aFileName
>       print *, ' iUnit = ', iUnit
>       print *, ' aString = ', aString(1:iLastChar)
>       print *, ' iLastChar = ', iLastChar
>       print *, ' lDebugFlag = ', lDebugFlag
>
>       backspace (iUnit)
>       backspace (iUnit)
>       print *, ' Last context:'
>       read (iUnit, '(A80)', ERR=901) aLine
>       print *, aLine
>       read (iUnit, '(A80)', ERR=901) aLine
>       print *, aLine
>
>   901 continue
>       stop
>
>       end
```

invent.f

```
3c3
< c File Date:           09/01/06
---
> c File Date:           11/28/06
105a106,107
> c
> c    rwj 11-21-06; SCR667 ; Reformat 'burnup.dat' & 'nuclides.dat'.
1569d1570
< c     textLine         =
1600c1601,1602
<       character*80  textLine
---
> cc rwj 11-21-06; SCR667 reformat file nuclides.dat.
> cc    character*80  textLine
1612a1615,1616
> cc rwj 11-21-06; SCR667 reformat file burnup.dat.
>       integer iSkip
1613a1618,1619
>       logical lDebug
>
1673,1674c1679,1695
<   300 continue
< c   Read data file
---
> cc rwj 11-21-06; SCR667 reformat file burnup.dat.
> cc300 continue
> cc  Read data file
> cc
> cc    read (ireadburnupfile, '(a)') textLine
> ccc
> cc    if (textLine(1:2) .eq. 'TI' .or.
> cc   &    textLine(1:2) .eq. 'ti' .or.
> cc   &    textLine(1:2) .eq. '**' )   go to 300
> cc
> cc    backspace(ireadburnupfile)
> cc
> cc    Find first record after first blank line.
> cc
>       lDebug = .FALSE.
>       iSkip  = 1
>       call FindRecord( ireadburnupfile, ' ', 1, iSkip, lDebug)
1676,1684d1696
<       read (ireadburnupfile, '(a)') textLine
<
<       if (textLine(1:2) .eq. 'TI' .or.
<      &    textLine(1:2) .eq. 'ti' .or.
<      &    textLine(1:2) .eq. '**' )   go to 300
<
<       backspace(ireadburnupfile)
<
< cc rwj 7-24-04; SCR 483
1689c1701,1708
<       read(ireadburnupfile, '(a)') textLine
---
>
> cc rwj 11-21-06; SCR667 reformat file burnup.dat.
> cc    read(ireadburnupfile, '(a)') textLine
>       iSkip  = 1
>       call FindRecord( ireadburnupfile, 'SECTION 2', 9, iSkip, lDebug)
>       iSkip  = 3
>       call FindRecord( ireadburnupfile, ' ', 1, iSkip, lDebug)
>
```

```
1732a1752
> cc rwj 11-21-06; SCR667 reformat file nuclides.dat.
1734,1738c1754,1763
<   200 continue
<       read (ireadnuclidefile, '(a)') textLine
<       if (textLine(1:2) .eq. 'TI' .or.
<      &    textLine(1:2) .eq. 'ti' .or.
<      &    textLine(1:2) .eq. '**' )   go to 200
---
> cc  200 continue
> cc      read (ireadnuclidefile, '(a)') textLine
> cc      if (textLine(1:2) .eq. 'TI' .or.
> cc     &    textLine(1:2) .eq. 'ti' .or.
> cc     &    textLine(1:2) .eq. '**' )   go to 200
> cc
> cc      read (textline, *) yearofinventorydata
>       lDebug = .FALSE.
>       iSkip  = 1
>       call FindRecord( ireadnuclidefile, ' ', 1, iSkip, lDebug)
1740,1741c1765
< cc rwj 7-24-04; SCR 483
<       read (textline, *) yearofinventorydata
---
>       read (ireadnuclidefile, *) yearofinventorydata
1743,1745c1767,1773
<   250 continue
<       read (ireadnuclidefile, '(a)') textLine
<       if (textLine(1:2) .eq. '**' )   go to 250
---
> cc rwj 11-21-06; SCR667 reformat file nuclides.dat.
> c 250 continue
> c     read (ireadnuclidefile, '(a)') textLine
> c     if (textLine(1:2) .eq. '**' )   go to 250
> c
> c     read (textLine, 100) iNuclides
>       read (ireadnuclidefile, *) iNuclides
1747d1774
<       read (textLine, 100) iNuclides
1759,1760c1786,1792
<       read (ireadnuclidefile, '(a)') textLine
<       read (ireadnuclidefile, '(a)') textLine
---
> cc rwj 11-21-06; SCR667 reformat file nuclides.dat.
> c     read (ireadnuclidefile, '(a)') textLine
> c     read (ireadnuclidefile, '(a)') textLine
>       iSkip  = 1
>       call FindRecord( ireadnuclidefile, 'SECTION 2', 9, iSkip, lDebug)
>       iSkip  = 3
>       call FindRecord( ireadnuclidefile, ' ', 1, iSkip, lDebug)
```

nfenv.f

```
3c3
< c File Date:           09/07/06
---
> c File Date:           11/28/06
135a136,137
> c       11-21-06  rwj      SCR667 Rewrite thickness_reader() for reformat
> c                                 of file 'drythick.dat'.
2299,2300c2301,2304
< c               See file drythick for current nthick value (is 17 now).
< c               nthick,thickness_tim,thickness are local to this sub only.
---
> c               See file 'drythick.dat' for current nthick value.
> c               nthick, thickness_tim, thickness,
> c               nonDeg_nthick, nonDeg_thickness_tim, and
> c               nonDeg_thickness are local to this sub only.
2307c2311
<        implicit double precision (a-h,o-z)
---
>       implicit double precision (a-h,o-z)
2309,2311c2313,2314
<        CHARACTER * 1 init_char
<        double precision timeDegrade
<        integer flagDegrade
---
> cc rwj 11-21-06 ; SCR667 ; Reformat drythick.dat.
> c     CHARACTER * 1 init_char
2313,2314c2316,2317
<        dimension xinterp_tim(nreflux), xinterp_thick(nreflux)
<        dimension thickness_tim(128), thickness(128)
---
>       double precision timeDegrade
>       integer flagDegrade
2316,2317c2319,2324
<        common / reflux3_1 / ikeyreflux3
<        common / reflux3_2 / ithicklun
---
> cc rwj 11-21-06 ; SCR667 ; Reformat drythick.dat.
>       double precision nonDeg_thickness_tim(128)
>       double precision nonDeg_thickness(128)
>       integer iSkip
>       integer nonDeg_nthick
>       logical lDebug
2319,2320c2326,2327
<        integer  igetunitnumber
<        external igetunitnumber
---
>       dimension xinterp_tim(nreflux), xinterp_thick(nreflux)
>       dimension thickness_tim(128), thickness(128)
2322,2328c2329,2344
<        if (ikeyreflux3 .ne. 306892345) then
<          ithicklun  = igetunitnumber('nfenv   ')
<          ikeyreflux3 = 306892345
<        endif
<
<        open(ithicklun,  file='drythick.dat',status='old')
<
---
>       common / reflux3_1 / ikeyreflux3
>       common / reflux3_2 / ithicklun
>
>       integer  igetunitnumber
>       external igetunitnumber
```

```
>
>       if (ikeyreflux3 .ne. 306892345) then
>         ithicklun  = igetunitnumber('nfenv   ')
>         ikeyreflux3 = 306892345
> cc rwj 11-21-06 ; SCR667 ; Reformat drythick.dat.
> cc    Rewrite entire remainder of routine.
> c
> c     endif
> c
> c     open(ithicklun,  file='drythick.dat',status='old')
> c
2333,2347c2349,2357
<        READ(ithicklun, FMT = '(A1)') init_char
<        DO WHILE(init_char .EQ. ':')
<          READ(ithicklun, FMT = '(A1)') init_char
<        ENDDO
<        BACKSPACE(ithicklun)
<
< c      Read the time for end of the thermal pulse
<        READ(ithicklun, *) timePulseEnd
<
< c      If the drift reached full degradation and the time
< c      to reach full degradation was within the time
< c      for the thermal pulse...
<        IF(timeDegrade .LT. timePulseEnd .AND.
<      &   flagDegrade .EQ. 1)THEN
< c        Use the degraded drift data
---
> c      READ(ithicklun, FMT = '(A1)') init_char
> c      DO WHILE(init_char .EQ. ':')
> c        READ(ithicklun, FMT = '(A1)') init_char
> c      ENDDO
> c      BACKSPACE(ithicklun)
> c
> c     Read the time for end of the thermal pulse
> c     READ(ithicklun, *) timePulseEnd
> c     read(ithicklun, *) nthick
2349,2354c2359,2364
< c        Skip comments
<          READ(ithicklun, FMT = '(A1)') init_char
<          DO WHILE(init_char .EQ. ':')
<            READ(ithicklun, FMT = '(A1)') init_char
<          ENDDO
<          BACKSPACE(ithicklun)
---
> c     If the drift reached full degradation and the time
> c     to reach full degradation was within the time
> c     for the thermal pulse...
> c     IF(timeDegrade .LT. timePulseEnd .AND.
> c    &   flagDegrade .EQ. 1)THEN
> c       Use the degraded drift data
2356,2362c2366,2380
< c        Retrieve data
<          read(ithicklun, fmt = '(i4)') nthick
<          DO i=1, nthick
<            read(ithicklun, *) itimestepdum, thickness_tim(i),
<      &       thickness(i)
<          ENDDO
<        ELSE
---
> c       Skip comments
> c       READ(ithicklun, FMT = '(A1)') init_char
> c       DO WHILE(init_char .EQ. ':')
> c         READ(ithicklun, FMT = '(A1)') init_char
> c       ENDDO
```

```
> c       BACKSPACE(ithicklun)
>
> c       Retrieve data
> c       read(ithicklun, fmt = '(i4)') nthick
>
> c       DO i=1, nthick
> c         read(ithicklun, *) itimestepdum, thickness_tim(i),
> c    &       thickness(i)
> c       ENDDO
> c     ELSE
2367,2372c2385,2390
<          READ(ithicklun, FMT = '(A1)') init_char
<          DO WHILE(init_char .EQ. ':')
<            READ(ithicklun, FMT = '(A1)') init_char
<          ENDDO
<          BACKSPACE(ithicklun)
<
---
> c       READ(ithicklun, FMT = '(A1)') init_char
> c       DO WHILE(init_char .EQ. ':')
> c         READ(ithicklun, FMT = '(A1)') init_char
> c       ENDDO
> c       BACKSPACE(ithicklun)
> c
2374,2378c2392,2396
<          read(ithicklun, fmt = '(i4)') nthick
<          DO i=1, nthick
<            read(ithicklun, *)
<          ENDDO
<
---
> c       read(ithicklun, fmt = '(i4)') nthick
> c       DO i=1, nthick
> c         read(ithicklun, *)
> c       ENDDO
> c
2380,2384c2398,2402
<          READ(ithicklun, FMT = '(A1)') init_char
<          DO WHILE(init_char .EQ. ':')
<            READ(ithicklun, FMT = '(A1)') init_char
<          ENDDO
<          BACKSPACE(ithicklun)
---
> c       READ(ithicklun, FMT = '(A1)') init_char
> c       DO WHILE(init_char .EQ. ':')
> c         READ(ithicklun, FMT = '(A1)') init_char
> c       ENDDO
> c       BACKSPACE(ithicklun)
2387,2392c2405,2416
<          read(ithicklun, fmt = '(i4)') nthick
<          DO i=1, nthick
<            read(ithicklun, *) itimestepdum, thickness_tim(i),
<      &       thickness(i)
<          ENDDO
<        ENDIF
---
> c       read(ithicklun, fmt = '(i4)') nthick
> c       DO i=1, nthick
> c         read(ithicklun, *) itimestepdum, thickness_tim(i),
> c    &       thickness(i)
> c       ENDDO
> c     ENDIF
>
>       open(ithicklun,  file='drythick.dat',status='old')
>
```

```
>       lDebug = .FALSE.
>       iSkip  = 1
>       call FindRecord( ithicklun, ' ', 1, iSkip, lDebug)
2394c2418,2433
<        close (ithicklun)
---
> c     Read the time for end of the thermal pulse
>       READ(ithicklun, *) timePulseEnd
>       read(ithicklun, *) nthick
>       iSkip  = 1
>       call FindRecord( ithicklun, 'SECTION 2', 9, iSkip, lDebug)
>       iSkip  = 3
>       call FindRecord( ithicklun, ' ', 1, iSkip, lDebug)
>       do i=1, nthick
>          read(ithicklun, *) itimestepdum, thickness_tim(i), thickness(i)
>       end do
>
>       iSkip  = 1
>       call FindRecord( ithicklun, 'SECTION 3', 9, iSkip, lDebug)
>       iSkip  = 1
>       call FindRecord( ithicklun, ' ', 1, iSkip, lDebug)
>       read(ithicklun, *) nonDeg_nthick
2396,2397c2435,2457
< c   Interpolate values of thickness for nreflux years.
<        call maplist ( nthick, thickness_tim, thickness,
---
>       iSkip  = 1
>       call FindRecord( ithicklun, 'SECTION 4', 9, iSkip, lDebug)
>       iSkip  = 3
>       call FindRecord( ithicklun, ' ', 1, iSkip, lDebug)
>       do i=1, nonDeg_nthick
>          read(ithicklun, *) itimestepdum, nonDeg_thickness_tim(i),
>      &                                    nonDeg_thickness(i)
>       end do
>
>       close (ithicklun)
>       end if
>
> c     If the drift reached full degradation and the time
> c     to reach full degradation was within the time
> c     for the thermal pulse...
>
>       if(timeDegrade .LT. timePulseEnd .AND.
>      &   flagDegrade .EQ. 1) then
>
> c       Use the degraded drift data
> c       Interpolate values of thickness for nreflux years.
>
>         call maplist ( nthick, thickness_tim, thickness,
2398a2459
>       else
2400,2401c2461,2462
<        return
<        end
---
> c       Use the non-degraded drift data
> c       Interpolate values of thickness for nreflux years.
2402a2464,2470
>         call maplist ( nonDeg_nthick, nonDeg_thickness_tim,
>      &                 nonDeg_thickness, nreflux,
>      &                 xinterp_tim, xinterp_thick)
>       end if
>
>       return
>       end
```

reader.f

```
3c3
< c File Date:           09/01/06
---
> c File Date:           11/28/06
76a77,78
> c rwj - SCR 667 - 11-26-06  Write reformatted and renamed tpanames.dat
> c                           tpanames.dbs changed to tpanames.dat throughout
316c318
< cc     tpanames.dbs file to be updated.  The addition of a new parameter to the
---
> cc     tpanames.dat file to be updated.  The addition of a new parameter to the
323c325
< cc     must manually edit BOTH the tpa.inp file and the tpanames.dbs file.
---
> cc     must manually edit BOTH the tpa.inp file and the tpanames.dat file.
331c333
< cc     the tpa.inp file the tpanames.dbs is checked to see if it has a
---
> cc     the tpa.inp file the tpanames.dat is checked to see if it has a
333c335
< cc     is generated via an add hoc hashing mechanism.  A new tpanames.dbs
---
> cc     is generated via an add hoc hashing mechanism.  A new tpanames.dat
339c341
<         aline = 'cp ' // dpath // 'data/tpanames.dbs .'
---
>         aline = 'cp ' // dpath // 'data/tpanames.dat .'
345c347
<             print *, ' istatus = zportsh( cp tpanames.dbs . ) '
---
>             print *, ' istatus = zportsh( cp tpanames.dat . ) '
1694c1696,1703
<       open (unit=idbsunit,file='tpanames.dbs',status='old')
---
> cc rwj 11-26-06; scr667 ; Write reformatted and renamed tpanames.dat
> c     open (unit=idbsunit,file='tpanames.dbs',status='old')
>       open (unit=idbsunit,file='tpanames.dat',status='old')
>
>       lDebug = .FALSE.
>       iSkip  = 3
>       call FindRecord( idbsunit, ' ', 1, iSkip, lDebug)
>
1697a1707
>
2820c2830
< c              data file tpanames.dbs and places the information into
---
> c              data file tpanames.dat and places the information into
2824c2834
< c     METHOD:  A formatted read of the tpanames.dbs file is performed.
---
> c     METHOD:  A formatted read of the tpanames.dat file is performed.
2840a2851,2853
> cc rwj 11-22-06; scr667 ; Read reformatted tpanames.dat
>       logical lDebug
>       integer iSkip
2844c2857
<       open (unit=idbsunit,file='tpanames.dbs',status='old')
---
>       open (unit=idbsunit,file='tpanames.dat',status='old')
2845a2859,2863
> cc rwj 11-22-06; scr667 ; Read reformatted tpanames.dat
```

```
>       lDebug = .FALSE.
>       iSkip  = 3
>       call FindRecord( idbsunit, ' ', 1, iSkip, lDebug)
>
2851c2869
<         print *, ' Size of tpanames.dbs file exceeds maxpdf.'
---
>         print *, ' Size of tpanames.dat file exceeds maxpdf.'
3027c3045
<       print *, '       in the tpanames.dbs file has been encountered'
---
>       print *, '       in the tpanames.dat file has been encountered'
3033c3051
<       print *, '       However, a new tpanames.dbs'
---
>       print *, '       However, a new tpanames.dat'
3043c3061
<       print *, '       system the tpanames.dbs file must be copied to'
---
>       print *, '       system the tpanames.dat file must be copied to'
3181c3199
<       character*80 aline
---
> c     character*80 aline
3316,3320c3334,3339
<   100 continue
<       read(irepdesunit,'(a80)') aline
<       if (aline(1:5) .eq. 'TITLE' .or.
<      &    aline(1:5) .eq. 'title' .or.
<      &    aline(1:2) .eq. '**' ) go to 100
---
> cc rwj 11-22-06; scr667 ; reformat repdes.dat
> c 100 continue
> c     read(irepdesunit,'(a80)') aline
> c     if (aline(1:5) .eq. 'TITLE' .or.
> c    &    aline(1:5) .eq. 'title' .or.
> c    &    aline(1:2) .eq. '**' ) go to 100
3325c3344,3349
<       read(aline,*) numpanels
---
> c     read(aline,*) numpanels
>       lDebug = .FALSE.
>       iSkip  = 1
>       call FindRecord( irepdesunit, ' ', 1, iSkip, lDebug)
>       read(irepdesunit,*) numpanels
>
3343,3346c3367,3373
<   200 continue
<       read(irepdesunit,'(a80)') aline
<       if (aline(1:2) .eq. '**' ) go to 200
<       read(aline,*) angle
---
> cc rwj 11-22-06; scr667 ; reformat repdes.dat
> c 200 continue
> c     read(irepdesunit,'(a80)') aline
> c     if (aline(1:2) .eq. '**' ) go to 200
> c     read(aline,*) angle
>       read(irepdesunit,*) angle
>
3375,3377c3402,3405
<   300 continue
<       read(irepdesunit,'(a80)') aline
<       if (aline(1:2) .eq. '**') go to 300
---
> cc rwj 11-22-06; scr667 ; reformat repdes.dat
```

```
> c 300 continue
> c     read(irepdesunit,'(a80)') aline
> c     if (aline(1:2) .eq. '**') go to 300
3378a3407
> c
3383c3412,3417
<       read(aline,*) numoutlinepts
---
> c     read(aline,*) numoutlinepts
>       lDebug = .FALSE.
>       iSkip  = 0
>       call FindRecord( irepdesunit, '! numoutlinepts', 15, iSkip,lDebug)
>       read(irepdesunit,*) numoutlinepts
>
3390a3425,3432
>
> cc rwj 11-22-06; scr667 ; reformat repdes.dat
>       lDebug = .FALSE.
>       iSkip  = 1
>       call FindRecord( irepdesunit, 'SECTION', 7, iSkip, lDebug)
>       iSkip  = 3
>       call FindRecord( irepdesunit, ' ', 1, iSkip, lDebug)
>
3400a3443
> cc rwj 11-22-06; scr667 ; reformat repdes.dat
3404,3406c3447,3455
<   400 continue
<       read(irepdesunit,'(a80)') aline
<       if (aline(1:2) .eq. '**') go to 400
---
> c 400 continue
> c     read(irepdesunit,'(a80)') aline
> c     if (aline(1:2) .eq. '**') go to 400
> c     read(aline,*) numempblk
>       lDebug = .FALSE.
>       iSkip  = 1
>       call FindRecord( irepdesunit, 'SECTION', 7, iSkip, lDebug)
>       iSkip  = 1
>       call FindRecord( irepdesunit, ' ', 1, iSkip, lDebug)
3408c3457,3458
<       read(aline,*) numempblk
---
>       read(irepdesunit,*) numempblk
>
3423,3424c3473,3481
<         read(irepdesunit,*,end=459) startx(iempblk), starty(iempblk),
<     &                       stopx(iempblk), stopy(iempblk)
---
>
> cc rwj 11-22-06; scr667 ; reformat repdes.dat
> c       read(irepdesunit,*,end=459) startx(iempblk), starty(iempblk),
> c    &                       stopx(iempblk), stopy(iempblk)
>         read(irepdesunit,*,end=459) startx(iempblk)
>         read(irepdesunit,*,end=459) starty(iempblk)
>         read(irepdesunit,*,end=459) stopx(iempblk)
>         read(irepdesunit,*,end=459) stopy(iempblk)
>
```

szft.f

```
3c3
< c File Date:           09/01/06
---
> c File Date:           11/28/06
66a67
> c    11-25-06 rwj   SCR667;  Read reformatted strmtube.dat
2491a2493,2496
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
>       logical lDebug
>       integer iSkip
>
2515c2520
<       character*80 aline
---
> c     character*80 aline
2558a2564
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
2562,2567c2568,2579
<   100    continue
<          read (itubefile, '(a80)', end=889, err=903) aline
<          iline = iline+1
<          if (aline(1:2) .eq. 'TI' .or.
<      &       aline(1:2) .eq. 'ti' .or.
<      &       aline(1:2) .eq. '**' )   go to 100
---
> c 100    continue
> c        read (itubefile, '(a80)', end=889, err=903) aline
> c        iline = iline+1
> c        if (aline(1:2) .eq. 'TI' .or.
> c    &       aline(1:2) .eq. 'ti' .or.
> c    &       aline(1:2) .eq. '**' )   go to 100
> c
> c        read (aline,*, end=889, err=903) numberoftubes
>          lDebug = .FALSE.
>          iSkip = 1
>          call FindRecord( itubefile, ' ', 1, iSkip, lDebug)
>          read (itubefile,*, end=889, err=903) numberoftubes
2569,2570d2580
<          read (aline,*, end=889, err=903) numberoftubes
<
2584a2595
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
2588,2591c2599,2605
<   150    continue
<          read (itubefile, '(a80)', end=889, err=903) aline
<          iline = iline+1
<          if (aline(1:2) .eq. '**') go to 150
---
> c 150    continue
> c        read (itubefile, '(a80)', end=889, err=903) aline
> c        iline = iline+1
> c        if (aline(1:2) .eq. '**') go to 150
> c
> c        read (aline,*, end=889, err=903) numberflowrates
>          read (itubefile, *, end=889, err=903) numberflowrates
2593,2594d2606
<          read (aline,*, end=889, err=903) numberflowrates
<
2603a2616
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
2606a2620,2624
>          iSkip = 1
```

```
>           call FindRecord( itubefile, 'SECTION 2', 9, iSkip, lDebug)
>          iSkip = 3
>          call FindRecord( itubefile, ' ', 1, iSkip, lDebug)
>
2608c2626,2628
<             read (itubefile, *, end=889, err=903) szflowrate(itube)
---
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
> c           read (itubefile, *, end=889, err=903) szflowrate(itube)
>             read (itubefile, *, end=889, err=903) idx, szflowrate(itube)
2611a2632
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
2613a2635,2645
> c
> c 175     continue
> c         read (itubefile, '(a80)', end=889, err=903) aline
> c         iline = iline+1
> c         if (aline(1:2) .eq. '**') go to 175
> c         read (aline, *, end=889, err=903) anearfielddist,
> c     &                                     farfielddist
>          iSkip = 1
>          call FindRecord( itubefile, 'SECTION 3', 9, iSkip, lDebug)
>          iSkip = 1
>          call FindRecord( itubefile, ' ', 1, iSkip, lDebug)
2615,2621c2647,2648
<   175    continue
<          read (itubefile, '(a80)', end=889, err=903) aline
<          iline = iline+1
<          if (aline(1:2) .eq. '**') go to 175
<
<          read (aline, *, end=889, err=903) anearfielddist,
<      &                                     farfielddist
---
>          read (itubefile, *, end=889, err=903) anearfielddist
>          read (itubefile, *, end=889, err=903) farfielddist
2625,2629c2652,2663
<   200       continue
<             read (itubefile, '(a80)', end=889, err=903) aline
<             iline = iline+1
<             if (aline(1:2) .eq. '**') go to 200
<             read (aline,*) itube
---
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
> c 200       continue
> c           read (itubefile, '(a80)', end=889, err=903) aline
> c           iline = iline+1
> c           if (aline(1:2) .eq. '**') go to 200
> c           read (aline,*) itube
>             iSkip = 1
>             call FindRecord( itubefile, 'SECTION', 7, iSkip, lDebug)
>             iSkip = 1
>             call FindRecord( itubefile, ' ', 1, iSkip, lDebug)
>             read (itubefile,*) itube
>
2654,2655c2688,2694
<             read (itubefile, '(a80)', end=889, err=903) aline
<             iline = iline+1
---
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
> c           read (itubefile, '(a80)', end=889, err=903) aline
> c           iline = iline+1
>             iSkip = 1
>             call FindRecord( itubefile, 'SECTION', 7, iSkip, lDebug)
>             iSkip = 3
>             call FindRecord( itubefile, ' ', 1, iSkip, lDebug)
```

```
2691,2694c2730,2735
<   300     continue
<           read (itubefile, '(a80)', end=889, err=903) aline
<           iline = iline+1
<           if (aline(1:2) .eq. '**' ) go to 300
---
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
> c 300     continue
> c         read (itubefile, '(a80)', end=889, err=903) aline
> c         iline = iline+1
> c         if (aline(1:2) .eq. '**' ) go to 300
>
2700c2741,2751
<             read (aline,*, end=889, err=903) farlegs(itube)
---
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
> c           read (aline,*, end=889, err=903) farlegs(itube)
>             iSkip = 1
>             call FindRecord( itubefile, 'SECTION', 7, iSkip, lDebug)
>             iSkip = 1
>             call FindRecord( itubefile, ' ', 1, iSkip, lDebug)
>             read (itubefile,*, end=889, err=903) farlegs(itube)
>             iSkip = 1
>             call FindRecord( itubefile, 'SECTION', 7, iSkip, lDebug)
>             iSkip = 3
>             call FindRecord( itubefile, ' ', 1, iSkip, lDebug)
2718,2719c2769,2770
<             read (itubefile, '(a80)', end=889, err=903) aline
<             iline = iline+1
---
> c           read (itubefile, '(a80)', end=889, err=903) aline
> c           iline = iline+1
2723a2775
>
2747,2750c2799,2803
<   400       continue
<             read (itubefile, '(a80)', end=889, err=903) aline
<             iline = iline+1
<             if (aline(1:2) .eq. '**' ) go to 400
---
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
> c 400       continue
> c           read (itubefile, '(a80)', end=889, err=903) aline
> c           iline = iline+1
> c           if (aline(1:2) .eq. '**' ) go to 400
2754,2761c2807,2815
<           if (aline(1:9) .ne. 'endoffile') then
<             print *, ' ***>>> Error in getszunits <<<*** '
<             print *, ' Error reading strmtube.dat '
<             print *, ' "endoffile" not reached'
<             print *, ' look on line = ', iline
<             print *, '  '
<             STOP
<           else
---
> cc rwj 11-25-06; SCR667; Read reformatted strmtube.dat
> c         if (aline(1:9) .ne. 'endoffile') then
> c           print *, ' ***>>> Error in getszunits <<<*** '
> c           print *, ' Error reading strmtube.dat '
> c           print *, ' "endoffile" not reached'
> c           print *, ' look on line = ', iline
> c           print *, '  '
> c           STOP
> c         else
2763c2817
```

```
< endif
---
> c endif
```

uzflow.f

```
3c3
< c File Date:        09/13/04
---
> c File Date:        11/28/06
106a107,111
> c             R Janetzke 11-24-06; SCR 667; Read from reformatted climato1.dat
> c             R Janetzke 11-24-06; SCR 667; Read from reformatted climato2.dat
> c             R Janetzke 11-26-06; SCR 667; Read from reformatted smaydtbl.dat
> c             R Janetzke 11-26-06; SCR 667; Read from reformatted  maydtbl.dat
> c
170,173c175
< c            Read each line of the file.  For each successful read,
< c            a counter is incremented.  Then, the number of full noise
< c            sets is calculated based on the value of this counter and
< c            the number of climate time steps.
---
> c            Read the number of entries from the file.
194c196
< cccccc
---
> cccccc
203a206
>       logical*4 lDebug
205a209
>       integer iSkip
217,221d220
<       nNoise  = 0
<       do while (yes)
<         read(iouzflow, *, end=100)
<         nNoise  = nNoise + 1
<       enddo
223c222,229
<  100  continue
---
> cc rwj 11-24-06; SCR667 ;  Read from reformatted climato1.dat
> c     nNoise  = 0
> c     do while (yes)
> c       read(iouzflow, *, end=100)
> c       nNoise  = nNoise + 1
> c     enddo
> c
> c100  continue
224a231,235
> c     close(iouzflow)
>       lDebug = .FALSE.
>       iSkip = 1
>       call FindRecord( iouzflow, ' ', 1, iSkip, lDebug)
>       read(iouzflow, *) nNoise
291a303
>       logical*4 lDebug
295a308
>       integer iSkip
323a337,341
> cc rwj 11-24-06; SCR667 ;  Read from reformatted climato2.dat
>       lDebug = .FALSE.
>       iSkip = 3
>       call FindRecord( iouzflow, ' ', 1, iSkip, lDebug)
>
419a438
>       logical*4 lDebug
423a443
>       integer iSkip
```

```
451a472,478
> cc rwj 11-24-06; SCR667 ;  Read from reformatted climato1.dat
>       lDebug = .FALSE.
>       iSkip = 1
>       call FindRecord( iouzflow, 'SECTION 2', 9, iSkip, lDebug)
>       iSkip = 3
>       call FindRecord( iouzflow, ' ', 1, iSkip, lDebug)
>
1303c1330,1332
<            if (zline(1:1) .eq. '#')  go to 5
---
> cc rwj 11-24-06; SCR 667; Read from reformatted smaydtbl.dat & maydtbl.dat
> c          if (zline(1:1) .eq. '#')  go to 5
>            if (zline(1:1) .eq. '!')  go to 5
```

>diff tpa51betaG/codes/corrfail.f tpa51betaH/codes/corrfail.f

```
3c3
< c File Date:        07/14/06
---
> c File Date:        11/28/06
74a75,76
> c   rwj 10-13-06; SCR667; restrict remmaining thickness to positive
> c                 values on output.
491a494,496
> cc rwj 10-13-06; SCR667; restrict remmaining thickness to positive values on output.
> c      write(FILE_ID, FMT = '(5(1p e12.4,2x))') (rates(i,j),j=1,2),
> c    &   (potentials(i,j), j=1,2), thickness-penetrationDepth(i,2)
493,494c498,501
<     &   (potentials(i,j), j=1,2), thickness-penetrationDepth(i,2)
<      end do
---
>     &   (potentials(i,j), j=1,2),
>     &    MAX(thickness-penetrationDepth(i,2), 0.0d0)
>
>       end do
```

>diff tpa51betaG/codes/failt.f tpa51betaH/codes/failt.f

```
3c3
< c File Date:        07/14/06
---
> c File Date:        11/28/06
67a68
> c 10-13-06 rwj SCR667; Restrict remaining thickness to positive values.
480a482,485
>
> cc rwj 10-13-06; SCR667; Restrict remaining thickness to positive values.
>        pnt = MIN(pnt, thicktot)
>
```

Appendix B

Test Plan for TPA SCR#667

Test Plan Name: Increase Transparency and Traceability of Input/Output Files and Set Maximum Penetration Depth

Tested By: R. Rice **Date:** May 18, 2007

Host Machine: Toshiba Laptop **Host OS:** XP Professional

Baseline Version: 5.1betaG **Test Version:** 5.1betaH

System Level (SL) Tests

SL-1. Name: Input/Output File Transparency and Traceability

Path for run directory: c:\SCR667\tpa51betaG and c:\SCR667\tpa51betaH

Path for archive of results: \SCR667\tpa51betaG\run and \SCR667\tpa51betaH\run (archived on CD)

Environment variables:

TPA_DATA=c:\SCR667\tpa51betaG\
TPA_TEST=c:\SCR667\tpa51betaG\

and

TPA_DATA=c:\SCR667\tpa51betaH\
TPA_TEST=c:\SCR667\tpa51betaH\

Special input files or modifications to input files required: None

Special diagnostic code modifications required : None

Program modes to be used (append flags, scenario/model switches, etc.): Set "StartAtSubarea" and "StoptAtSubarea" at 3 (i.e., run only Subarea 3) in the *tpa.inp* file

Utility scripts needed to perform the test: None

Utility codes needed in the analysis of the test data: None

Test description: Using the basecase TPA code for Versions 5.1betaG and 5.1betaH, verify transparency- and traceability-related modifications were made to input/output files.

- **Objective:** Compare the format of input/output files in the TPA Versions 5.1betaG and 5.1betaH code for the files identified in Attachment A of this SCR.

- **Assumptions:** None, other than the assumptions made in the TPA code

- **Constraints:** None

- **Output files to compare or examine:** *strmtube.dat*, *ebsfilt.dat*, *burnup.dat*, *nuclides.dat*, *drythick.dat*, *tpanames.dat* (renamed from *tpanames.dbs*), *repdes.dat*, *climato1.dat*, *climato2.dat*, *smaydtbl.dat*, and *maydtbl.dat*

- Step by step test procedure to be used:

1. Create "run" subdirectories for TPA Versions 5.1betaG and 5.1betaH code and execute the TPA Versions 5.1betaG and 5.1betaH code for Subarea 3 only.

2. Inspect and compare the format of input/output files in the TPA Versions 5.1betaG and 5.1betaH code for the files identified in Attachment A of this SCR. These files are: *strmtube.dat*, *ebsfilt.dat*, *burnup.dat*, *nuclides.dat*, *drythick.dat*, *tpanames.dat* (renamed from *tpanames.dbs*), *repdes.dat*, *climato1.dat*, *climato2.dat*, *smaydtbl.dat*, and *maydtbl.dat*

- Pass/Fail criteria:

Criteria 1: The format of input/output files (i.e., *strmtube.dat*, *ebsfilt.dat*, *burnup.dat*, *nuclides.dat*, *drythick.dat*, *tpanames.dat* (renamed from *tpanames.dbs*), *repdes.dat*, *climato1.dat*, *climato2.dat*, *smaydtbl.dat*, and *maydtbl.dat*) should reflect modifications related to increasing transparency and traceability

Test Results: Inspection of input/output files (i.e., *strmtube.dat*, *ebsfilt.dat*, *burnup.dat*, *nuclides.dat*, *drythick.dat*, *tpanames.dat* [renamed from *tpanames.dbs]*, *repdes.dat*, *climato1.dat*, *climato2.dat*, *smaydtbl.dat*, and *maydtbl.dat*) showed the formats of all of these files were modified and those modifications were consistent with increasing transparency and traceability.

For example, the format of the file *drythick.dat* in TPA51betaG is:

```
: Title - drythick.dat
: Date - February 2, 2006
: Input data file for the relux3 model (nfenv.f)
: (Manepally, C., A. Sun, r. Fedors, and D. Farrell.
: "Drift-Scale Thermohydrological Process Modeling--
:  In-Drift Heat Transfer and Drift Degradation."
: CNWRA 2004-5. San Antonio, TX: CNWRA. 2004.)
:
: This file is structured to have the first data value
: as the time for the end of the thermal pulse. Then,
: it includes the block of data for the degraded case,
: and finally, the block of data for the non-degraded
: case.  The code requires the data in this order.
:
: Time for the end of the thermal pulse.  This value
: is used to determine if the degraded scenario dryout
: zone thicknesses should be used or if the non-degraded
: zone thicknesses should instead be used.
 4000.0
:
: Data applicable to the case with drift degradation.
: Data derived from METRA runs for the drift degradation case.
: (Manepally, et. al., 2004 - Table 3.1)
: Entry No.  Time(yr)   Dryout Thickness (m)
 17
 1        0.00        0.00
 2        20.00       0.00
 3        50.00       0.00
 4        55.00       2.68
 5        67.00       4.04
 6        74.00       4.92
 7        86.00       4.82
 8        102.00      5.62
 9        123.00      7.25
 10       148.00      6.75
 11       232.00      7.89
 12       456.00      9.31
```

```
 13       690.00      7.00
 14       1000.00     6.00
 15       2290.00     4.00
 16       3790.00     1.00
 17       4300.00     0.00
:
: Data applicable to the case without drift degradation.
: (Manepally, et. al., 2004 - Table 2-2 Boiling Point - 96.3 C)
: Entry No.  Time(yr)   Dryout Thickness (m)
 22
 1        0.00        0.00
 2        20.00       0.00
 3        50.00       0.00
 4        60.00       1.60
 5        70.00       3.16
 6        80.00       3.38
 7        100.00      3.47
 8        200.00      6.97
 9        300.00      8.06
 10       500.00      8.17
 11       700.00      8.13
 12       800.00      8.87
 13       900.00      9.46
 14       1000.00     11.75
 15       1300.00     5.87
 16       1400.00     3.51
 17       1500.00     2.24
 18       1600.00     1.58
 19       1700.00     0.95
 20       1800.00     0.54
 21       1900.00     0.00
 22       2000.00     0.00
```

The format of the reformatted file in TPA51betaH is:

```
! drythick.dat ; Dry out zone thickness
!
! PURPOSE:
! This file contains the drift wall dryout zone tthickkness
! to be used with the 'reflux3' model in the NFENV module.
!
! HISTORY:
! This file format was first used with TPA 5.1betaH.
!
!         02-02-06 ; C. Manepally ; Original text.
!         11-21-06 ; R. Janetzke ; SCR667; Reformatted file.
!
! Manepally, C., A. Sun, r. Fedors, and D. Farrell.
!  "Drift-Scale Thermohydrological Process Modeling--
!   In-Drift Heat Transfer and Drift Degradation."
!  CNWRA 2004-5. San Antonio, TX: CNWRA. 2004.
!
! This file has 4 sections.
!
! SECTION 1 ; END OF THERMAL PULSE
!
! Item 1: timePulseEnd ; Time for the end of the thermal pulse in years.
!                        This value is used to determine if the degraded
!                        scenario dryout zone thicknesses should be used
!                        (for periods before 'timePulseEnd') or if the
!                        non-degraded zone thicknesses should be used
!                        (for periods after 'timePulseEnd').
! Item 2: nThick ; Number of entries in degraded drift section.

                 4000.0 ! timePulseEnd (yr)
                     17 ! nThick
```

```
! SECTION 2 ; DEGRADED DRIFT TABLE
!
! Data applicable to the case with drift degradation.
! Data derived from METRA runs for the drift degradation case.
! (Manepally, et. al., 2004 - Table 3.1)
!
! Entry No. = entry number
! Time      = simulation time in years for dryout thickness
! Dryout Thickness = drift wall dryout zone thickness in meters.
```

Entry No. (-)	Time (yr)	Dryout Thickness (m)
1	0.	0.00
2	20.	0.00
3	50.	0.00
4	55.	2.68
5	67.	4.04
6	74.	4.92
7	86.	4.82
8	102.	5.62
9	123.	7.25
10	148.	6.75
11	232.	7.89
12	456.	9.31
13	690.	7.00
14	1000.	6.00
15	2290.	4.00
16	3790.	1.00
17	4300.	0.00

```
! SECTION 3 ; NON-DEGRADED DRIFT
!
! Item 1: nThick ; Number of entries in non-degraded drift section.

                    22 ! nThick

! SECTION 4 ; NON-DEGRADED DRIFT TABLE
!
! Data applicable to the case without drift degradation.
! Data derived from:
!
! Manepally, et. al., 2004 - Table 2-2 Boiling Point - 96.3 C
!
! Entry No. = entry number
! Time      = simulation time in years for dryout thickness
! Dryout Thickness = drift wall dryout zone thickness in meters.
```

Entry No. (-)	Time (yr)	Dryout Thickness (m)
1	0.	0.00
2	20.	0.00
3	50.	0.00
4	60.	1.60
5	70.	3.16
6	80.	3.38
7	100.	3.47
8	200.	6.97
9	300.	8.06
10	500.	8.17
11	700.	8.13
12	800.	8.87
13	900.	9.46
14	1000.	11.75
15	1300.	5.87
16	1400.	3.51
17	1500.	2.24

18	1600.	1.58
19	1700.	0.95
20	1800.	0.54
21	1900.	0.00
22	2000.	0.00

- Overall test status: <u>PASS</u>

System Level (SL) Tests

SL-2. Name: Set Maximum Penetration Depth

Path for run directory: c:\SCR667\tpa51betaG and c:\SCR667\tpa51betaH

Path for archive of results: \SCR667\tpa51betaG\run\mean\corrosion_failure and \SCR667\tpa51betaH\run\mean\corrosion_failure (archived on CD)

Environment variables:

TPA_DATA=c:\SCR667\tpa51betaG\
TPA_TEST=c:\SCR667\tpa51betaG\

and

TPA_DATA=c:\SCR667\tpa51betaH\
TPA_TEST=c:\SCR667\tpa51betaH\

Special input files or modifications to input files required: None

Special diagnostic code modifications required : None

Program modes to be used (append flags, scenario/model switches, etc.): Employ mean value data set in the *tpa.inp* file; set "StartAtSubarea" and "StoptAtSubarea" at 3 (i.e., run only Subarea 3) in the *tpa.inp* file; and modify the value of the *tpa.inp* file parameter HumidAirCorrosionRate[m/yr] from 2.50E-08 to 2.50E-04

Utility scripts needed to perform the test: None

Utility codes needed in the analysis of the test data: None

Test description: Using the basecase TPA code for Versions 5.1betaG and 5.1betaH, verify the maximum penetration depth is 100% (i.e., waste package thickness is greater than or equal to zero).

- **Objective:** Compare FAILT output (*failt.out*) from TPA Versions 5.1betaG and 5.1betaH code to determine whether the waste package thickness is non-negative and thicknesses. Force corrosion failure of the waste package by increasing the parameter that specifies the humid air corrosion rate in the *tpa.inp* file.

- **Assumptions:** None, other than the assumptions made in the TPA code

- **Constraints:** None

- **Output files to compare or examine:** *failt.out*

- **Step by step test procedure to be used:**

1. Create "run\mean" subdirectories for TPA Versions 5.1betaG and 5.1betaH code and execute the TPA Versions 5.1betaG and 5.1betaH code using the mean value

tpa.inp file (i.e., *tpameans.out* renamed *tpa;inp*).

2. Create "run\mean\corrosion_failure" subdirectories for TPA Versions 5.1betaG and 5.1betaH code and execute the TPA Versions 5.1betaG and 5.1betaH code using the mean value *tpa.inp* file from Step 1 above including the value of the *tpa.inp* file parameter HumidAirCorrosionRate[m/yr] from 2.50E-08 to 2.50E-04.

3. Compare the contents of the FAILT output file *failt.out* to verify there are no negative waste package thicknesses

- Pass/Fail criteria:

Criteria 1: The waste package thicknesses reported in *failt.out* should all be greater than or equal to zero.

Test Results: Inspection of the results in the *failt.out* file showed the negative thicknesses in the TPA Version 5.1betaG code were no longer present in the TPA Version 5.1betaH code. Additionally, in the TPA Version 5.1beta H code provided data for all TPA code times after corrosion failure. Specifically, the contents of the *failt.out* file from TPA Versions 5.1betaG and 5.1betaH code are follows.

failt.out from TPA5.1betaG:

```
ebspac (engineering barrier system performance assessment code)
this is the part of the code that computes wp failure time
version= 1.0
Fri May 18 11:26:13 2007
nhist3= 201
nhist= 201

**Calculation of Weld and General Corrosion Only Failure Time**
Weld failure time =    991.26  yr
General corrosion failure time =    991.26  yr
**End of Weld and General Corrosion Only Failure Calculations**

                calculation of waste package failure time
================================================================================
==
                     end of simulation time [yr]:      10000.
        no. of rows of data to pass to release.f:         201
--------------------------------------------------------------------------------
--
ilayer  tstop      tcan      ecrit      ecorr   chloride   rthick      mode
        [yr]       [C]       [vshe]     [vshe]    flag       [m]
================================================================================
==
1        2.31      59.86     0.0000     0.0000     0    2.0000000E-02  dry oxd
1        4.67      65.64     0.0000     0.0000     0    2.0000000E-02  dry oxd
1        7.09      68.00     0.0000     0.0000     0    2.0000000E-02  dry oxd
1        9.57      69.09     0.0000     0.0000     0    2.0000000E-02  dry oxd
1       12.10      69.67     0.0000     0.0000     0    2.0000000E-02  dry oxd
1       14.70      69.95     0.0000     0.0000     0    2.0000000E-02  dry oxd
1       17.35      70.03     0.0000     0.0000     0    2.0000000E-02  dry oxd
1       20.07      69.98     0.0000     0.0000     0    2.0000000E-02  dry oxd
1       22.85      69.81     0.0000     0.0000     0    2.0000000E-02  dry oxd
1       25.69      69.53     0.0000     0.0000     0    2.0000000E-02  dry oxd
1       28.61      68.92     0.0000     0.0000     0    2.0000000E-02  dry oxd
1       31.59      68.21     0.0000     0.0000     0    2.0000000E-02  dry oxd
1       34.63      67.46     0.0000     0.0000     0    2.0000000E-02  dry oxd
1       37.76      66.70     0.0000     0.0000     0    2.0000000E-02  dry oxd
1       40.95      65.94     0.0000     0.0000     0    2.0000000E-02  dry oxd
```

1	44.22	65.18	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	47.56	64.44	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	50.99	118.07	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	54.49	147.83	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	58.08	156.70	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	61.75	161.46	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	65.50	164.58	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	69.35	166.63	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	73.28	167.87	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	77.31	168.53	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	81.43	168.78	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	85.64	168.68	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	89.96	168.31	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	94.37	167.73	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	98.89	166.98	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	103.52	173.62	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	108.25	175.36	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	113.10	175.49	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	118.06	175.19	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	123.13	174.56	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	128.32	173.67	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	133.64	172.58	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	139.08	171.37	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	144.64	170.06	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	150.34	168.68	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	156.17	167.27	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	162.13	165.83	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	168.24	180.95	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	174.49	205.71	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	180.88	215.64	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	187.43	220.61	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	194.13	223.24	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	200.98	223.89	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	208.00	222.05	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	215.18	220.24	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	222.52	218.44	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	230.04	216.67	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	237.74	214.92	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	245.62	213.20	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	253.68	211.49	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	261.93	209.81	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	270.37	208.16	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	279.01	206.53	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	287.85	204.93	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	296.90	203.36	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	306.16	201.82	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	315.64	200.30	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	325.34	198.80	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	335.26	197.33	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	345.42	195.87	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	355.82	194.45	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	366.46	193.04	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	377.35	191.66	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	388.49	190.29	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	399.90	188.95	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	411.57	187.62	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	423.52	186.33	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	435.74	185.05	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	448.25	183.79	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	461.06	182.54	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	474.16	181.32	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	487.57	179.81	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	501.30	178.26	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	515.35	176.73	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	529.72	175.22	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	544.43	173.73	0.0000	0.0000	0	2.0000000E-02	dry oxd

```
1       559.49      172.26      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       574.90      170.79      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       590.67      169.36      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       606.80      167.93      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       623.32      166.53      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       640.22      165.14      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       657.52      163.77      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       675.23      162.41      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       693.34      161.07      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       711.89      159.76      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       730.86      158.45      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       750.28      157.16      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       770.16      155.89      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       790.50      154.64      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       811.32      153.38      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       832.62      152.14      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       854.42      150.92      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       876.74      149.70      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       899.57      148.50      0.0000      0.0000      0     2.0000000E-02  dry oxd
1       922.94      147.31      0.0000      0.0000      0     1.4157375E-02  hmd oxd
1       946.86      146.12      0.0000      0.0000      0     8.1780000E-03  hmd oxd
1       971.34      144.94      0.0000      0.0000      0     2.0586000E-03  hmd oxd
2       996.39      143.65      0.0000      0.0000      0    -6.2626250E-03  hmd oxd
================================================================================
==
                    wp wetting time [yr]:      99999.
         wp loc. corr. failure time [yr]:        971.
    wp gen. corr. only failure time [yr]:        991.
        penetration by dry oxidation [m]:      1.098+292
                    echoed input data in:      echo_fail.dat
                output data are in files:      ebstrh.dat and corrode.out
================================================================================
==
Finished Subarea #    3
For Realization #    1
```

failt.out from TPA5.1betaH:

```
ebspac (engineering barrier system performance assessment code)
this is the part of the code that computes wp failure time
version= 1.0
Fri May 18 11:30:23 2007
nhist3= 201
nhist= 201

**Calculation of Weld and General Corrosion Only Failure Time**
Weld failure time =    991.26  yr
General corrosion failure time =    991.26  yr
**End of Weld and General Corrosion Only Failure Calculations**

                calculation of waste package failure time
================================================================================
==
                    end of simulation time [yr]:      10000.
        no. of rows of data to pass to release.f:         201
--------------------------------------------------------------------------------
--
ilayer  tstop      tcan      ecrit      ecorr   chloride   rthick      mode
        [yr]       [C]       [vshe]     [vshe]    flag       [m]
================================================================================
==
1        2.31      59.86     0.0000     0.0000     0     2.0000000E-02  dry oxd
1        4.67      65.64     0.0000     0.0000     0     2.0000000E-02  dry oxd
1        7.09      68.00     0.0000     0.0000     0     2.0000000E-02  dry oxd
```

1	9.57	69.09	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	12.10	69.67	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	14.70	69.95	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	17.35	70.03	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	20.07	69.98	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	22.85	69.81	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	25.69	69.53	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	28.61	68.92	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	31.59	68.21	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	34.63	67.46	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	37.76	66.70	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	40.95	65.94	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	44.22	65.18	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	47.56	64.44	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	50.99	118.07	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	54.49	147.83	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	58.08	156.70	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	61.75	161.46	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	65.50	164.58	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	69.35	166.63	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	73.28	167.87	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	77.31	168.53	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	81.43	168.78	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	85.64	168.68	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	89.96	168.31	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	94.37	167.73	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	98.89	166.98	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	103.52	173.62	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	108.25	175.36	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	113.10	175.49	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	118.06	175.19	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	123.13	174.56	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	128.32	173.67	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	133.64	172.58	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	139.08	171.37	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	144.64	170.06	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	150.34	168.68	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	156.17	167.27	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	162.13	165.83	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	168.24	180.95	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	174.49	205.71	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	180.88	215.64	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	187.43	220.61	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	194.13	223.24	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	200.98	223.89	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	208.00	222.05	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	215.18	220.24	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	222.52	218.44	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	230.04	216.67	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	237.74	214.92	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	245.62	213.20	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	253.68	211.49	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	261.93	209.81	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	270.37	208.16	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	279.01	206.53	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	287.85	204.93	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	296.90	203.36	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	306.16	201.82	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	315.64	200.30	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	325.34	198.80	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	335.26	197.33	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	345.42	195.87	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	355.82	194.45	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	366.46	193.04	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	377.35	191.66	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	388.49	190.29	0.0000	0.0000	0	2.0000000E-02	dry oxd

1	399.90	188.95	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	411.57	187.62	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	423.52	186.33	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	435.74	185.05	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	448.25	183.79	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	461.06	182.54	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	474.16	181.32	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	487.57	179.81	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	501.30	178.26	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	515.35	176.73	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	529.72	175.22	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	544.43	173.73	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	559.49	172.26	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	574.90	170.79	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	590.67	169.36	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	606.80	167.93	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	623.32	166.53	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	640.22	165.14	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	657.52	163.77	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	675.23	162.41	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	693.34	161.07	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	711.89	159.76	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	730.86	158.45	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	750.28	157.16	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	770.16	155.89	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	790.50	154.64	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	811.32	153.38	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	832.62	152.14	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	854.42	150.92	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	876.74	149.70	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	899.57	148.50	0.0000	0.0000	0	2.0000000E-02	dry oxd
1	922.94	147.31	0.0000	0.0000	0	1.4157375E-02	hmd oxd
1	946.86	146.12	0.0000	0.0000	0	8.1780000E-03	hmd oxd
1	971.34	144.94	0.0000	0.0000	0	2.0586000E-03	hmd oxd
2	996.39	143.65	0.0000	0.0000	0	0.0000000E+00	hmd oxd
2	1022.03	142.33	0.0000	0.0000	0	0.0000000E+00	hmd oxd
2	1048.26	141.03	0.0000	0.0000	0	0.0000000E+00	hmd oxd
2	1075.12	139.73	0.0000	0.0000	0	0.0000000E+00	hmd oxd
2	1102.60	138.43	0.0000	0.0000	0	0.0000000E+00	hmd oxd
2	1130.72	137.13	0.0000	0.0000	0	0.0000000E+00	hmd oxd
2	1159.50	135.85	0.0000	0.0000	0	0.0000000E+00	hmd oxd
2	1188.96	134.57	0.0000	0.0000	0	0.0000000E+00	hmd oxd

failt: Inner overpack LC initiated at 1219.101700000000 years

2	1219.10	133.29	-10.0009	-0.2813	1	0.0000000E+00	local
2	1249.95	132.03	-10.0000	-0.2803	1	0.0000000E+00	local
2	1281.53	130.77	-10.0000	-0.2790	1	0.0000000E+00	local
2	1313.84	129.52	-10.0000	-0.2777	1	0.0000000E+00	local
2	1346.91	128.26	-10.0000	-0.2763	1	0.0000000E+00	local
2	1380.75	127.01	-10.0000	-0.2749	1	0.0000000E+00	local
2	1415.39	125.76	-10.0000	-0.2734	1	0.0000000E+00	local
2	1450.83	124.51	-10.0000	-0.2719	1	0.0000000E+00	local
2	1487.11	123.28	-10.0000	-0.2704	1	0.0000000E+00	local
2	1524.23	122.05	-10.0000	-0.2689	1	0.0000000E+00	local
2	1562.23	120.82	-10.0000	-0.2673	1	0.0000000E+00	local
2	1601.11	119.60	-10.0000	-0.2656	1	0.0000000E+00	local
2	1640.91	118.38	-10.0000	-0.2639	1	0.0000000E+00	local
2	1681.63	117.15	-10.0000	-0.2622	1	0.0000000E+00	local
2	1723.31	115.93	-10.0000	-0.2604	1	0.0000000E+00	local
2	1765.97	114.71	-10.0000	-0.2586	1	0.0000000E+00	local
2	1809.62	113.49	-10.0000	-0.2567	1	0.0000000E+00	local
2	1854.30	112.29	-10.0000	-0.2548	1	0.0000000E+00	local
2	1900.02	111.09	-10.0000	-0.2529	1	0.0000000E+00	local
2	1946.81	109.89	-10.0000	-0.2509	1	0.0000000E+00	local
2	1994.70	108.79	-9.9263	-0.2772	1	0.0000000E+00	local
2	2043.71	107.84	-9.9160	-0.2848	1	0.0000000E+00	local
2	2093.87	106.91	-9.9167	-0.2831	1	0.0000000E+00	local

2	2145.20	105.99	-9.9175	-0.2814	1	0.0000000E+00	local
2	2197.73	105.09	-9.9182	-0.2797	1	0.0000000E+00	local
2	2251.49	104.19	-9.9189	-0.2779	1	0.0000000E+00	local
2	2306.51	103.31	-9.9195	-0.2762	1	0.0000000E+00	local
2	2362.82	102.44	-9.9202	-0.2744	1	0.0000000E+00	local
2	2420.45	101.56	-9.9209	-0.2727	1	0.0000000E+00	local
2	2479.42	100.70	-9.9216	-0.2709	1	0.0000000E+00	local
2	2539.78	99.84	-9.9222	-0.2691	1	0.0000000E+00	local
2	2601.55	98.99	-9.9229	-0.2673	1	0.0000000E+00	local
2	2664.77	98.15	-9.9236	-0.2655	1	0.0000000E+00	local
2	2729.46	97.32	-9.9242	-0.2636	1	0.0000000E+00	local
2	2795.67	96.48	-9.9249	-0.2618	1	0.0000000E+00	local
2	2863.43	95.66	-9.9255	-0.2600	1	0.0000000E+00	local
2	2932.78	94.85	-9.9261	-0.2581	1	0.0000000E+00	local
2	3003.75	94.04	-9.9268	-0.2562	1	0.0000000E+00	local
2	3076.38	93.23	-9.9274	-0.2544	1	0.0000000E+00	local
2	3150.72	92.41	-9.9280	-0.2524	1	0.0000000E+00	local
2	3226.79	91.61	-9.9287	-0.2505	1	0.0000000E+00	local
2	3304.64	90.82	-9.9293	-0.2486	1	0.0000000E+00	local
2	3384.32	90.04	-9.9299	-0.2467	1	0.0000000E+00	local
2	3465.86	89.25	-9.9305	-0.2447	1	0.0000000E+00	local
2	3549.31	88.47	-9.9311	-0.2428	1	0.0000000E+00	local
2	3634.72	87.70	-9.9317	-0.2408	1	0.0000000E+00	local
2	3722.12	86.95	-9.9323	-0.2389	1	0.0000000E+00	local
2	3811.57	86.19	-9.9329	-0.2369	1	0.0000000E+00	local
2	3903.11	85.44	-9.9335	-0.2349	1	0.0000000E+00	local
2	3996.80	84.69	-9.9340	-0.2329	1	0.0000000E+00	local
2	4092.68	83.94	-9.9346	-0.2309	1	0.0000000E+00	local
2	4190.81	83.21	-9.9352	-0.2289	1	0.0000000E+00	local
2	4291.23	82.49	-9.9358	-0.2269	1	0.0000000E+00	local
2	4394.01	81.78	-9.9363	-0.2250	1	0.0000000E+00	local
2	4499.19	81.08	-9.9369	-0.2230	1	0.0000000E+00	local
2	4606.83	80.38	-9.9374	-0.2210	1	0.0000000E+00	local
2	4716.99	79.68	-9.9379	-0.2190	1	0.0000000E+00	local
2	4829.73	78.98	-9.9385	-0.2170	1	0.0000000E+00	local
2	4945.11	78.29	-9.9390	-0.2150	1	0.0000000E+00	local
2	5063.19	77.62	-9.9395	-0.2130	1	0.0000000E+00	local
2	5184.04	76.96	-9.9401	-0.2110	1	0.0000000E+00	local
2	5307.72	76.31	-9.9406	-0.2090	1	0.0000000E+00	local
2	5434.29	75.67	-9.9411	-0.2071	1	0.0000000E+00	local
2	5563.82	75.03	-9.9416	-0.2051	1	0.0000000E+00	local
2	5696.39	74.39	-9.9421	-0.2032	1	0.0000000E+00	local
2	5832.06	73.77	-9.9426	-0.2012	1	0.0000000E+00	local
2	5970.91	73.15	-9.9430	-0.1993	1	0.0000000E+00	local
2	6113.01	72.54	-9.9435	-0.1973	1	0.0000000E+00	local
2	6258.43	71.94	-9.9440	-0.1954	1	0.0000000E+00	local
2	6407.26	71.36	-9.9444	-0.1935	1	0.0000000E+00	local
2	6559.57	70.77	-9.9449	-0.1916	1	0.0000000E+00	local
2	6715.45	70.20	-9.9453	-0.1897	1	0.0000000E+00	local
2	6874.98	69.63	-9.9458	-0.1878	1	0.0000000E+00	local
2	7038.24	69.06	-9.9462	-0.1860	1	0.0000000E+00	local
2	7205.33	68.50	-9.9467	-0.1841	1	0.0000000E+00	local
2	7376.32	67.95	-9.9471	-0.1822	1	0.0000000E+00	local
2	7551.32	67.40	-9.9475	-0.1803	1	0.0000000E+00	local
2	7730.42	66.85	-9.9479	-0.1785	1	0.0000000E+00	local
2	7913.71	66.33	-9.9484	-0.1766	1	0.0000000E+00	local
2	8101.29	65.80	-9.9488	-0.1748	1	0.0000000E+00	local
2	8293.26	65.29	-9.9492	-0.1730	1	0.0000000E+00	local
2	8489.73	64.78	-9.9496	-0.1712	1	0.0000000E+00	local
2	8690.80	64.27	-9.9500	-0.1694	1	0.0000000E+00	local
2	8896.57	63.77	-9.9503	-0.1676	1	0.0000000E+00	local
2	9107.16	63.27	-9.9507	-0.1658	1	0.0000000E+00	local
2	9322.69	62.78	-9.9511	-0.1640	1	0.0000000E+00	local
2	9543.25	62.30	-9.9515	-0.1623	1	0.0000000E+00	local
2	9768.98	61.82	-9.9519	-0.1605	1	0.0000000E+00	local
2	10000.00	61.34	-9.9522	-0.1587	1	0.0000000E+00	local

```
==================================================================================
==
                    wp wetting time [yr]:       1189.
     no wp loc. corr. failure below [yr]:      10000.
    wp gen. corr. only failure time [yr]:        991.
        penetration by dry oxidation [m]:      2.000E-02
                    echoed input data in:      echo_fail.dat
                output data are in files:      ebstrh.dat and corrode.out
==================================================================================
==
Finished Subarea #    3
For Realization #    1
```

- Overall test status: <u>PASS</u>

SCR - 668

TPA 5.1/ Beta G

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 668	2. Software Title and Version: TPA 5.1BetaG	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *uzft.f, coefkdeq.dat,*

In a letter from NRC, dated 7-27-2006, a request was made to increase the transparency and traceability of the input/output files. Specifically, input parameters should be located/identified in the input files to aid in traceability through the conceptual model calculations. Also, the format and content of the output files should ensure a user can reasonably comprehend the content without excessive recourse to the source code of other documentation.

5. Change Requested by: J. Winterle	**Date:** 8-1-2006
6. Change Authorized by (*Software Developer*): R. Janetzke	**Date:** 8-7-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

File *coefkdeq.dat* was reformatted for transparency. See Attachment A.
File *uzft.f* was modified to read the new format. See Attachment B.

8. Implemented by: R. Janetzke	**Date:** 12-7-06

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☐ **No** ☒
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

Code review accomplished by:	**Date:**

10. Description of Acceptance Tests:

Procedure: Review *coefkdeq.dat* input data file for proper format and transparency of content. Use TPA Version 5.1BetaY with reference case *tpa.inp* input file to run 1 realization for subarea 1. Review *uz_kdrd.out* output file to ensure no problems with *uzft.f* using the input data to generate output. Note that validation task P-12 of TPA Version 5.1 Software Validation Report contains thorough check of Kd and Rd calculations using input coefficient values.

Acceptance Criteria: The header information in *coefkdeq.dat* file should be correct, information should be reasonably transparent, and header information should be free of spelling errors. TPA Version 5.1betaY should run without errors and generate properly formatted *uz_kdrd.out* file.

Status (Pass/Fail): PASS

11. Tested by: James Winterle	**Date:** 05/24/2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for TPA.INP

SCR 668

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
No Changes to tpa.inp parameters							

Attachment A

```
! coefkdeq.dat ; Coefficients for Kd equations.
!
! PURPOSE:
! This file is used to specify the radioelements which will have their Kd values
! calculated rather than sampled from a distribution.  The coefficients used in
! the calculation of the Kds are also specified.
!
! This file contains coefficients for Kd values for six radioelements:
! Am, Cm, Np, Pu, Th, U.
!
! HISTORY:
! The format of this file was first used in TPA V5.1betaI.
!         02/13/03; P. Bertetti ; Values modified.
!         02/14/03; C. Scherer ; Correct coefficient values and increase
!                   precision, at least 8 significant digits are required.
!         03/28/05; P. Bertetti ; MINTEQA2 SCM output generated by D. Turner was
!                   refitted using TableCurve v.4.0.7 and limited pH ranges
!                   appropriate for logCO2 values.
!
!                   The pH range for each coefficient set is limited in tables
!                   below to the range of fitted values.
!
!                   The pH range for the coefficients are further limited to a
!                   pH range reasonable for the tpa.inp file.
!
!                   (e.g., fit of Am(III) at logCO2 = -0.5 good to pH of 5.5,
!                    but limited to 6.0)
!
!         06/03/05; P. Bertetti ; Add Cm with parameters identical to Am.
!                   The actual values for Cm are assumed to be similar to Am.
!                   This enables efficient use of the NEFTRAN code.
!
! Refer to equations provided by D.Turner. Curve fits for model are at discrete
! PCO2 values.  Derived using complete MINTEQA2 generated data set with
! polynomial fitting by TableCurve 2d ver. 4.  Expressed in terms of
!
! log10 (Ka') = a + bx + cx^2 + dx^3 + ex^4 + fx^5 = log10 (Kd/Sa)
!
! with units of [mL/m^2], and where x is pH.
!
! This file has 12 sections.
!
! SECTION 1 ;  Am(III)
!
! Item 1: nradioelements ; number of radioelement coefficient tables
! Item 2: nrows ; number of data rows for each radioelement
! Item 3: radelems ; name of radioelement, two character element name required.

                      6 ! nradioelements
                     10 ! nrows
                   'Am' ! radelems

! SECTION 2
!
! logPCO2 = log10 partial pressure of carbon dioxide.
! pHLow   =
! pHhigh  =
! a       =  first coefficient
! b       =  second coefficient (x)
! c       =  third coefficient  (x^2)
! d       =  fourth coefficient (x^3)
! e       =  fifth coefficient  (x^4)
! f       =  sixth coefficient  (x^5)

logPCO2 pHLow pHhigh    a              b              c              d             e             f
 (atm)  -     -        -              -              -              -             -             -
 -0.5  6.0    8.50  -3488.09627424  2629.51291541  -788.56176251  117.56073070  -8.70093305   0.25541926
 -1.0  6.0    8.50  -2773.90316917  2025.80503602  -588.12441063   84.82299722  -6.06673419   0.17183905
 -1.5  6.0    8.75  -2570.99868836  1798.94821209  -500.31232997   69.11860003  -4.73305712   0.12824036
 -2.0  6.0    9.25   -529.70097000   382.57883000  -109.82740500   15.64244660  -1.09501774   0.02991442
 -2.5  6.0    9.25      9.99115550   -19.12208470     8.43510534   -1.57254303   0.14374613  -0.00530121
 -3.0  6.0    9.50    207.97473500  -163.91087800    50.26749810   -7.53911613   0.56336067  -0.01690361
 -3.5  6.0    9.50    275.22137700  -211.82535300    63.68167270   -9.37809594   0.68606024  -0.02004885
 -4.0  6.0   10.00    277.38065700  -210.45818600    62.29763580   -9.01473543   0.64646365  -0.01846756
 -4.5  6.0   10.00    130.72585800   -98.62225380    28.50975860   -3.95833162   0.27147852  -0.00743480
 -5.0  6.0   10.00     33.74073080   -25.65826470     6.78522964   -0.75797035   0.03813970  -0.00069526

! SECTION 3 ; Np(V)
!
! Item 1: radelems ; name of radioelement.
```

'Np' ! radelems

! SECTION 4
!

logPCO2 (atm)	pHLow	pHhigh	a	b	c	d	e	f
-0.5	6.0	8.00	562.54981909	-500.89579959	176.89291310	-31.07712090	2.71862591	-0.09472022
-1.0	6.0	8.25	2093.54379394	-1650.20606982	518.44037026	-81.22795811	6.34997857	-0.19817761
-1.5	6.0	8.50	3360.84305038	-2509.67817430	746.96930394	-110.83848641	8.20266948	-0.24225613
-2.0	6.25	8.75	5795.34019404	-4067.33587609	1138.92231362	-159.10933648	11.09252611	-0.30878820
-2.5	6.50	9.25	4450.35090337	-3040.94202166	829.04301093	-112.76701087	7.65514069	-0.20751759
-3.0	6.75	9.50	6708.93933767	-4381.17145649	1141.77048723	-148.46955823	9.63518289	-0.24968824
-3.5	6.75	9.50	3211.45694881	-2095.04642211	545.01405769	-70.70323196	4.57549503	-0.11818698
-4.0	6.75	9.50	1346.51069701	-890.32073161	234.26972802	-30.69262895	2.00353111	-0.05214334
-4.5	7.00	9.75	1322.21173052	-859.71080915	222.41887757	-28.64267275	1.83707983	-0.04695287
-5.0	7.00	10.00	1106.08206519	-712.38086622	182.41875534	-23.23471499	1.47291641	-0.03717996

! SECTION 5 ; Pu(V)
!
! Item 1: radelems ; name of radioelement.

'Pu' ! radelems

! SECTION 6
!

logPCO2 (atm)	pHLow	pHhigh	a	b	c	d	e	f
-0.5	6.0	8.00	366.75890755	-290.45801925	91.10737170	-14.22926620	1.11534214	-0.03530710
-1.0	6.0	8.25	869.22207223	-636.87831165	185.29514508	-26.82308684	1.94004147	-0.05630215
-1.5	6.0	8.50	427.10428374	-283.30036981	73.83983268	-9.48024499	0.60537760	-0.01557462
-2.0	6.25	8.50	-1427.39393419	1048.62353965	-306.60395427	44.54748036	-3.21024959	0.09168272
-2.5	6.50	9.00	1154.53608473	-699.56871657	166.97348103	-19.60986323	1.13564166	-0.02602837
-3.0	6.75	9.50	5842.89310451	-3657.34302232	911.90899478	-113.24694750	7.01025797	-0.17318426
-3.5	6.50	9.50	-1127.03127420	757.26130875	-202.36042870	26.85098224	-1.76452805	0.04586762
-4.0	6.50	9.75	-1326.95887035	862.80644367	-223.12180648	28.65734115	-1.82389617	0.04594980
-4.5	6.50	9.75	-1500.18897302	954.15744220	-241.28205853	30.30072357	-1.88600354	0.04648962
-5.0	7.00	10.00	-2361.88329888	1437.86286277	-348.42895826	41.99020928	-2.51303984	0.05969658

! SECTION 7 ; Th(IV)
!
! Item 1: radelems ; name of radioelement.

'Th' ! radelems

! SECTION 8
!

logPCO2 (atm)	pHLow	pHhigh	a	b	c	d	e	f
-0.5	6.0	8.50	-312.14711523	243.99009612	-73.03800105	10.68670601	-0.76572596	0.02148313
-1.0	6.0	9.00	-178.60426661	137.73479859	-39.62233542	5.50279873	-0.36964490	0.00956996
-1.5	6.0	9.00	-22.15437259	17.78354930	-3.27591815	0.06714595	0.03117773	-0.00208040
-2.0	6.0	9.25	22.19042131	-14.82976722	6.12630097	-1.25638885	0.12171609	-0.00447272
-2.5	6.0	9.25	0.00987343	3.44007829	0.13956325	-0.28092710	0.04270240	-0.00192857
-3.0	6.0	9.50	-30.36665828	27.32153765	-7.32247331	0.87766304	-0.04670166	0.00081467
-3.5	6.0	9.50	-50.36155981	42.99824237	-12.20001276	1.63047122	-0.10434437	0.00256662
-4.0	6.0	10.00	-59.35569634	49.98525001	-14.35431507	1.96006372	-0.12936953	0.00332113
-4.5	6.0	10.00	-62.85636897	52.70342414	-15.19121240	2.08779456	-0.13903535	0.00361134
-5.0	6.0	10.00	-63.80070118	53.43751658	-15.41765407	2.12244405	-0.14166587	0.00369062

! SECTION 9 ; U(VI)
!
! Item 1: radelems ; name of radioelement.

'U ' ! radelems

! SECTION 10
!

logPCO2 (atm)	pHLow	pHhigh	a	b	c	d	e	f
-0.5	6.0	8.50	-109.00613767	120.39993399	-49.95905087	9.92659335	-0.94794423	0.03464480
-1.0	6.0	8.50	-195.74323141	176.71524472	-62.86725608	11.03888628	-0.95124562	0.03184985
-1.5	6.0	9.00	-29.18182775	52.10286104	-24.62789427	5.03783001	-0.47158120	0.01637571
-2.0	6.0	9.00	815.18397479	-512.78403463	126.86426513	-15.34454440	0.90594827	-0.02102466
-2.5	6.50	9.50	3059.73497195	-1924.39125807	481.06384571	-59.69824366	3.67990926	-0.09036028
-3.0	6.25	9.50	-75.43057307	96.37998368	-36.95785740	6.31128400	-0.50069832	0.01494114
-3.5	6.25	9.50	-2943.52020106	1944.83311429	-510.19392904	66.47503413	-4.29924708	0.11026458
-4.0	6.50	9.50	-5184.51971388	3302.21750148	-835.85755021	105.14807966	-6.57156173	0.16311656
-4.5	7.00	9.75	-9215.05453242	5594.86360139	-1351.52037089	162.41121670	-9.70671057	0.23071448
-5.0	7.00	9.75	1382.60890665	-955.33506081	261.50876815	-35.38624263	2.36964433	-0.06292418

```
! SECTION 11 ; Cm(III)
!
! Item 1: radelems ; name of radioelement.

                    'Cm' ! radelems

! SECTION 12
!
```

logPCO2 (atm)	pHLow	pHhigh	a	b	c	d	e	f
-	-	-	-	-	-	-	-	-
-0.5	6.0	8.50	-3488.09627424	2629.51291541	-788.56176251	117.56073070	-8.70093305	0.25541926
-1.0	6.0	8.50	-2773.90316917	2025.80503602	-588.12441063	84.82299722	-6.06673419	0.17183905
-1.5	6.0	8.75	-2570.99868836	1798.94821209	-500.31232997	69.11860003	-4.73305712	0.12824036
-2.0	6.0	9.25	-529.70097000	382.57883000	-109.82740500	15.64244660	-1.09501774	0.02991442
-2.5	6.0	9.25	9.99115550	-19.12208470	8.43510534	-1.57254303	0.14374613	-0.00530121
-3.0	6.0	9.50	207.97473500	-163.91087800	50.26749810	-7.53911613	0.56336067	-0.01690361
-3.5	6.0	9.50	275.22137700	-211.82535300	63.68167270	-9.37809594	0.68606024	-0.02004885
-4.0	6.0	10.00	277.38065700	-210.45818600	62.29763580	-9.01473543	0.64646365	-0.01846756
-4.5	6.0	10.00	130.72585800	-98.62225380	28.50975860	-3.95833162	0.27147852	-0.00743480
-5.0	6.0	10.00	33.74073080	-25.65826470	6.78522964	-0.75797035	0.03813970	-0.00069526

Attachment B

```
90a91
> c          12-7-06 R. Janetzke SCR668; Reformat coefkdeq.dat file.
155,156c156
<
<
---
> c
371a372,374
> cc rwj 12-7-06; SCR668
>       integer iSkip
>       logical lDebug
539,557c542,580
< c   Skip header
<         aline=''
<         do while (index(aline,"date").eq.0)
<            read(icoeflun,'(a)',ERR=100) aline
<         enddo
< 100     continue
<         if (index(aline,"date").eq.0) then
<            print *, ' ***>>> Error in uzft <<<*** '
<            print *, ' did not read word "date" indicating last '
<            print *, ' header comment line of coefkdeq.dat file '
<            print *, ' edit file. insert "date" in last header line '
<            STOP
<         endif
<
< c   Read in number of radioelements in table.
< c   Read in number of rows of data for each radioelement.
<         read(icoeflun,*,end=110,err=113) nradioelements,nrows
<
< c   Read in data for each radioelement.
---
> cc rwj 12-07-06; SCR668 ; Reformat coefkdeq.dat.
> cc   Skip header
> c        aline=''
> c        do while (index(aline,"date").eq.0)
> c           read(icoeflun,'(a)',ERR=100) aline
> c        enddo
> c100     continue
> c        if (index(aline,"date").eq.0) then
> c           print *, ' ***>>> Error in uzft <<<*** '
> c           print *, ' did not read word "date" indicating last '
> c           print *, ' header comment line of coefkdeq.dat file '
> c           print *, ' edit file. insert "date" in last header line '
> c           STOP
> c        endif
> c
> cc   Read in number of radioelements in table.
> cc   Read in number of rows of data for each radioelement.
> c        read(icoeflun,*,end=110,err=113) nradioelements,nrows
> c
> cc   Read in data for each radioelement.
> c        do i=1,nradioelements
> c           read (icoeflun,'(a)',end=110,err=115) radelems(i)
> c           read (icoeflun,*,end=110,err=110)           !column labels
> c           do j=1,nrows
> c              read (icoeflun,*, end=110, err=115)
> c     &             (params(k,j,i), k=1,nparams)
> c              params(1,j,i) = 10.D0**params(1,j,i)     !was log value.
> c           enddo
> c        enddo
```

```
> c
> c         close(icoeflun)
>          lDebug = .FALSE.
>          iSkip  = 1
>          call FindRecord( icoeflun, ' ', 1, iSkip, lDebug)
>          read( icoeflun,*,end=110) nradioelements
>          read( icoeflun,*,end=110) nrows
> c
> c        Read coefficient array.
> c
559,560c582,589
<             read (icoeflun,'(a)',end=110,err=115) radelems(i)
<             read (icoeflun,*,end=110,err=110)           !column labels
---
>             read( icoeflun,*,end=110) radelems(i)
>             iSkip  = 1
>             call FindRecord( icoeflun, 'SECTION', 7, iSkip, lDebug)
>             iSkip  = 3
>             call FindRecord( icoeflun, ' ', 1, iSkip, lDebug)
> c
> c           Read and convert values from LOG space.
> c
562,563c591,592
<                read (icoeflun,*, end=110, err=115)
<      &              (params(k,j,i), k=1,nparams)
---
>                read (icoeflun,*, end=110, err=115)
>      &                        (params(k,j,i), k=1,nparams)
565a595,603
> c
> c           Skip file advance if last parameter set is complete.
> c
>             if (i .lt. nradioelements) then
>                iSkip  = 1
>                call FindRecord( icoeflun, 'SECTION', 7, iSkip, lDebug)
>                iSkip  = 1
>                call FindRecord( icoeflun, ' ', 1, iSkip, lDebug)
>             end if
568d605
<          close(icoeflun)
```

SCR - 669

TPA 5.1/ Beta G

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 669	2. Software Title and Version: TPA 5.1BetaG	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *fileutil.f, findrecord.f* (new), *mechdrive.f, mechfail.f, mechfail_ds.def, mechfail_wp.def*

In a letter from NRC, dated 7-27-2006, a request was made to increase the transparency and traceability of the input/output files. Specifically, input parameters should be located/identified in the input files to aid in traceability through the conceptual model calculations. Also, the format and content of the output files should ensure a user can reasonably comprehend the content without excessive recourse to the source code of other documentation.

5. Change Requested by: J. Winterle	**Date:** 8-1-2006
6. Change Authorized by (*Software Developer*): R. Janetzke	**Date:** 8-7-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

Reformatted the mechanical failure module (MECHFAIL) default input files *mechfail_wp.def* and *mechfail_ds.def*. Added subroutines to *fileutil.f* to retrieve the input in the updated format. Modified *mechdrive.f* and *mechfail.f* to use the new subroutines in *fileutil.f*.
Due to a compiler error in LF95, all instances of the concatenation operator (//) in a FORMAT string used in a WRITE statement were removed.

8. Implemented by: G. Adams / R. Janetzke	**Date:** 12/1/2006; 3-30-07

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

None

Code review accomplished by:	**Date:** 6/18/07

10. Description of Acceptance Tests:

See Attachment A

11. Tested by: J. Menchaca	**Date:** 04/19/07

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for TPA.INP

SCR 669

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
No Changes to tpa.inp parameters							

Attachment A

Description of Acceptance Tests

Test Plan Name: File Format Test

Tested By: Jose M. Menchaca Date: 04/19/2007

Host Machine: "TPA" 64 bit Microsoft Windows Server Host OS: Microsoft Windows Ver 5.2

Baseline Version: TPA51betaH Test Version: TPA51betaV

Process Level (PL) Tests

PL-1 Name:

Path for run directory: D:\Public\jmenchaca\tpa51betaV\basecaseRuns\singleVector

Path for archive directory:

Environment variable: TPA_TEST = Y:\tpa51betaV (Y: is "Alby")
TPA_DATA = Y:\tpa51betaV (Y: is "Alby")

Special input files or modifications to input files required: Non required.

Special diagnostic code modifications required: NONE

Program modes to be used: STANDARD

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: None required.

Test Description: The objective of the test is to assure that the mechfail_ds.def file and mechfail_wp.def files conform to the new file format standard. A simple visual inspection of the files in the run directory will verify compliance with the new data format.
Addtionally, a comparison of the mechfail_ds.inp and mechfail_wp.inp files from tpa51betaU and tpa51betaV will verify that the Lahey concatenation operator error has been resolved.

There are no special assumptions necessary for running this test.

There are no constraints applied to the execution of this test.

The mechfail_wp.def and mechfail_ds.def data files are to be inspected to assure that they comply with the new file format specification.

The test passes if the files comply with the new file formats.

The test passes if the files names are correctly given as described above.

Test Results:

mechfail_wp.def meets new file format standard. **PASS**

mechfail_ds.def meets new file format standard. **PASS**

tpa51betaV version of mechfail_ds.inp is the same as tpa51betaU version of mechfail_ds.inp. **PASS**

tpa51betaV version of mechfail_wp.inp is the same as tpa51betaU version of mechfail_wp.inp. **PASS**

SCR - 671

TPA 5.1/ Beta I

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 671	2. Software Title and Version: TPA 5.1Beta1	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f, dsfail.f, dsfailt.f, driftdrive.f , driftfail.f* and *dsfailt.def*

In a letter from NRC, dated 7-27-2006, a request was made to increase the transparency and traceability of the input/output files. Specifically, input parameters should be located/identified in the input files to aid in traceability through the conceptual model calculations. Also, the format and content of the output files should ensure a user can reasonably comprehend the content without excessive recourse to the source code of other documentation.

5. Change Requested by: J. Winterle	Date: 8-1-2006
6. Change Authorized by (*Software Developer*): R. Janetzke	Date: 8-7-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

The files *dsfail.f*, *dsfailt.f*, *driftdrive.f* , *driftfail.f* and *dsfailt.def* have been modified to generate and read input files which contain enhanced transparency of parameters and data being transferred to the modules DRIFTFAIL and DSFAILT. File names *dsfailt.out* and *driftfail.out* were changed to *dsfailt.dbg* and *driftfail.dbg* respectively.

8. Implemented by: J. Mancillas	Date: 12-11-2006

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

None

Code review accomplished by: J. Menchaca	Date: 6-18-2007

10. Description of Acceptance Tests: See Attachment A

The files dsfailt.def and dsfailt.inp did not pass the new file format compliance test. The files will be reformatted in SCR684.

11. Tested by: J. Menchaca	Date: 03-12-2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for TPA.INP

SCR 671

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM)*	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.)*	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
No Changes to tpa.inp parameters							

Attachment A

Description of Acceptance Tests

Test Plan Name: File Format Test

Tested By: Jose M. Menchaca

Date: 03/12/2007

Host Machine: "TPA" 64 bit Microsoft Windows Server

Host OS: Microsoft Windows Ver 5.2

Baseline Version: TPA51betaI

Test Version: TPA51betaK

Process Level (PL) Tests

PL-1 Name:

Path for run directory:

Path for archive directory:

Environment variable: TPA_TEST = L:\tpabetaK (L: is "Ladybug")
TPA_DATA = L:\tpabetaK (L: is "Ladybug")

Special input files or modifications to input files required: Non required.

Special diagnostic code modifications required: NONE

Program modes to be used: STANDARD

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: None required.

Test Description: The objective of the test is to assure that the *dsfailt.def* file an *dsfailt.inp* files conform to the new file format standard. Additionally the *dsfailt.out* and *driftfail.out* files should no longer appear in the run directory but instead should be replaced by the *dsfailt.dbg* and *driftfail.dbg* files.

There are no special assumptions necessary for running this test.

There are no constraints applied to the execution of this test.

The *dsfailt.def* data file and *dsfailt.inp* output file are to be inspected to assure that they comply with the new file format specification.

The test passes if the files comply with the new file formats.

A directory listing of the run directory should be inspected to assure that *dsfailt.out* is replaced with *dsfailt.dbg* and that *driftfail.out* is replaced by *driftfail.dbg*.

The test passes if the files names are correctly given as described above.

Test Results:

dsfailt.def meets new file format standard. **FAIL** This will be addressed in SCR684.

dsfailt.inp meets new file format standard. **FAIL** This will be addressed in SCR684.

dsfailt.out file replaced by dsfailt.dbg file: **PASS**

driftfail.out file replaced by driftfail.dbg file: **PASS**

SCR - 672

TPA 5.1/ Beta G

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 672	2. Software Title and Version: TPA 5.1BetaG	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f,*
In a letter from NRC, dated 7-27-2006, a request was made to increase the transparency and traceability of the input/output files. Specifically, input parameters should be located/identified in the input files to aid in traceability through the conceptual model calculations. Also, the format and content of the output files should ensure a user can reasonably comprehend the content without excessive recourse to the source code of other documentation.

5. Change Requested by: J. Winterle	**Date:** 8-1-2006
6. Change Authorized by (*Software Developer*): R. Janetzke	**Date:** 8-7-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

New file formats were applied to the input data files, *ebsfail.def* and *ebsrel.def*. The reader files *ebsfail.f* and *ebsrel.f* were modified to read the newly formatted **.def* files and to write the intermediate corresponding files *ebsfail.inp* and *ebsrel.inp*. The standalone files *failt.f* and *releaset.f* were modified to read the corresponding **.inp* files.

Attachment A is the newly formatted *ebsfail.def* file.
Attachment B is the newly formatted *ebsrel.def* file.
Attachment C is a diff of the changes needed in the *ebsfail.f* module to read/write the *ebsfail.def/ebsfail.inp* file.
Attachment D is a diff of the changes needed in the *ebsrel.f* module to read and write the *ebsrel.def/ebsrel.inp* file.
Attachment E is a diff of the changes needed in the *failt.f* standalone module to read the *ebsfail.inp* file.
Attachment F is a diff of the changes needed in the *releaset.f* standalone module to read the *ebsrel.inp* file.

8. Implemented by: J. Menchaca	**Date:** 2-16-2007

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☐ **No** ☒
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

Code review accomplished by:	**Date:**

10. Description of Acceptance Tests:

Procedure: Inspected input files *ebsfail.def,* and *ebsrel.def* for correct format, accuracy of information, correct spelling, and transparency of information. Used TPA Version 5.1BetaY with reference case *tpa.inp* input file Output Option set to append all files. Ran 2 realizations for all 10 subareas. Inspected *ebsfail.inp* and *ebsrel.inp* files to ensure revised input files are properly utilized in the creation of these two intermediate files.

Acceptance Criteria: User should be able to understand what is in the files by reading the header and column heading information; header and column heading information should be correct, and headers should be free of spelling errors. The *ebsfail.inp* and *ebsrel.inp* files generated by TPA using the *ebsfail.def,* and *ebsrel.def* inputs should correctly reflect the input data and not cause *ebsfail.f* or *eberel.f* to crash during a run.

Status (Pass/Fail): PASS

11. Tested by: James Winterle	**Date:** 05/22/2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for TPA.INP

SCR 672

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	**Module**	**Parameter Name**	**Description** (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	**Distribution**	**Range**	**Justification** *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	**Source**
No Changes to tpa.inp parameters							

ATTACHMENT A

New ebsfail.def file:

```
! ebsfail.def: Default input file for ebsfail
!
! Purpose:
! This is the template file read by the ebsfail.f module to produce the
! ebsfail.inp file, the input file for the failt.f standalone module.
!
! History: ebsfail.def is a legacy file with versions found in tpa32
!          03/18/06 previous version adding drip shield failure parameters
!          11/22/06 reformatted version
!
! This file has 10 sections.  Each section has a description of its
! respective contents.
!
! SECTION 1 ; SIMULATION TIME
!
! Item 1 Simulation time

                 10000. ! tend: simulation time length [yr]

! SECTION 2 ; WASTE PACKAGE GEOMETRY
!
! Item 1 Waste Package Length [m]
! Item 2 Waste Package Diameter [m]
! Item 3 Waste Package Layer 1 Thickness [m]
! Item 4 Waste Package Layer 2 Thickness [m]
! Item 5 Weld Alloy Thickness [m]

                  5.2750 ! wplen: wp length [m]
                  1.5790 ! wpdia: wp diameter [m]
                    0.02 ! cthick1: wp layers 1 thickness [m]
                    0.05 ! cthick2: wp layers 2 thickness [m]
                   0.035 ! thickness: weld alloy thickness [m]

! SECTION 3 ; DRY OXIDATION OF WP OUTER OVERPACK
!
! Item 1 Metal Grain Radius [micrometer]
! Item 2 Terms In Infinite Series For WP Oxidation
! Item 3 Boundary thickness [micrometer]
! Item 4 Constant Relating Matrix And Grain Boundary Diff

               1.375E+01 ! grainr: metal grain radius [micrometer]
                      25 ! nseries: terms in infinite series for wp oxidation
                  0.7e-3 ! gbthick: bundary thickness [micrometer]
                   1.e-5 ! constant1: constant relating matrix and grain boundary diff

! SECTION 4 ; EVAPORATION-CONDENSATION
!
! Item 1 Critical Relative Humidity 1
! Item 2 Critical Relative Humidity 2
! Item 3 Thickness Of Water Film [m]

                     0.2 ! humdc1: crit. rel. hums.
                     0.3 ! humdc2: crit. rel. hums.
                     0.0 ! filmthk: thickness of water film [m]

! SECTION 5 ; WELD AREA PARAMETERS
!
! Item 1 Erp Intercept [mVSHE]
! Item 2 Temperature Coefficient Erp Intercept [mVSHE/C]
! Item 3 Erp Slope [mVSHE], Slope of Efp vs log10(Cl)
! Item 4 Temperature Coefficient of Erp Slope [mVSHE/C]
! Item 5 Minimum Chloride Concentration For LC For Weld[mol/L]
! Item 6 Critical Inhibitor To Chloride Ratio
! Item 7 Increase In Critical Potential At [inh]/[Cl]=inhToClw  [mV]
! Item 8 Weld Surface Fraction For Advective Transport

              1.0412E+03 ! ErpInt: Erp Intercept [mVSHE]
             -1.0000E+01 ! TErpInt: Temp Coef Erp Intercept [mVSHE/C]
             -5.8420E+02 ! ErpSlope: Erp Slope [mVSHE], Slope of Efp vs log10(Cl)
              3.7000E+00 ! TErpSlope: Temp Coeff of Erp Slope [mVSHE/C]
                  7.8e-3 ! clcritw: minimum chloride conc. for LC for weld[mol/L]
                     0.2 ! inhToClw: critical inhibitor to chloride ratio
                   800.0 ! deltaEcInhWeld: Increase in crit. pot. at [inh]/[Cl]=inhToClw  [mV]
              4.0000E-03 ! frac_weld_surf, weld surface fraction for advective transport

! SECTION 6 ; CRITICAL POTENTIAL PARAMETERS
!             Ep: pitting potential [mVshe]
```

```
!             Erp: repassivation potential [mVshe]
!
! Item  1 : Outer Overpack Ep Intercept[mV]
! Item  2 : Temperature Coefficient Of Outer Overpack Ep Intercept[mV/degC]
! Item  3 : Outer Overpack Ep Slope[mV]
! Item  4 : Temperature Coefficient Of Outer Overpack Ep Slope[mV/degC]
! Item  5 : Outer Overpack Erp Intercept[mV]
! Item  6 : Temperature Coefficient Of Outer Overpack Erp Intercept[mV/degC]
! Item  7 : Outer Overpack Erp Slope[mV]
! Item  8 : Temperature Coefficient Of Outer Overpack Erp Slope[mV/degC]
! Item  9 : Inner Overpack Ep Intercept[mV]
! Item 10 : Temperature Coefficient Of Inner Overpack Ep Intercept[mV/degC]
! Item 11 : Inner Overpack Ep Slope[mV]
! Item 12 : Temperature Coefficient Of Inner Overpack Ep Slope[mV/degC]
! Item 13 : Inner Overpack Erp Intercept[mV]
! Item 14 : Temperature Coefficient Of Inner Overpack Erp Intercept[mV/degC]
! Item 15 : Inner Overpack Erp Slope[mV]
! Item 16 : Temperature Coefficient Of Inner Overpack Erp Slope[mV/degC]

                  -584.8 ! xipto: outer overpack Ep intercept[mV]
                    3.92 ! pttemo: temp. coef. of outer overpack Ep intercept[mV/degC]
                   -24.5 ! slpto: outer overpack Ep slope[mV]
                    -1.1 ! slpttemo: temp. coef. of outer overpack Ep slope[mV/degC]
             0.1541E+04 ! xirpo: outer overpack Erp intercept[mV]
            -0.1310E+02 ! rptemo: temp. coef. of outer overpack Erp intercept[mV/degC]
            -0.3627E+03 ! slrpo: outer overpack Erp slope[mV]
             0.2300E+01 ! slrptemo: temp. coef. of outer overpack Erp slope[mV/degC]
                   200. ! xipti: inner overpack Ep intercept[mV]
                     0. ! pttemi: temp. coef. of inner overpack Ep intercept[mV/degC]
                  -240. ! slpti: inner overpack Ep slope[mV]
                     0. ! slpttemi: temp. coef. of inner overpack Ep slope[mV/degC]
            -0.1000E+05 ! xirpi: inner overpack Erp intercept[mV]
             0.0000E+00 ! rptemi: temp. coef. of inner overpack Erp intercept[mV/degC]
             0.0000E+00 ! slrpi: inner overpack Erp slope[mV]
             0.0000E+00 ! slrptemi: temp. coef. of inner overpack Erp slope[mV/degC]

! Section 7 ; CORROSION POTENTIAL PARAMETERS
!             hi: high pH parameter
!             lo: low pH parameter
!
! Item  1 pHtran: transition pH between low pH and high pH behaviour
! Item  2 irelhi, C/(m^2 yr), reference curr main red. react., outer overpack
! Item  3 irello, C/(m^2 yr), reference curr main red. react., outer overpack
! Item  4 beta1hi, effective transf. coeff., high pH, outer overpack
! Item  5 beta1lo, effective transf. coeff., low pH, outer overpack
! Item  6 betahy1: transfer coefficient for water reduction, outer overpack
!
! Item  7 ire2hi, C/(m^2 yr), reference curr main red. react., inner overpack
! Item  8 ire2lo, C/(m^2 yr), reference curr main red. react., inner overpack
! Item  9 beta2hi, effective transf. coeff., high pH, inner overpack
! Item 10 beta2lo, effective transf. coeff., low pH, inner overpack
! Item 11 betahy2: transfer coefficient for water reduction, inner overpack
!
! Item 12 rkhy1 [Coul/(m^2 yr)], rate constant for water reduction outer overpack
! Item 13 g1hi, [J/mol], activation energies for main red. react., outer overpack
! Item 14 g1lo [J/mol], activation energies for main red. react., outer overpack
! Item 15 ghy1 [J/mol], activation energy water reduction, outer overpack
! Item 16 npH1hi, pH reaction order, outer overpack
! Item 17 npH1lo, pH reaction order, outer overpack
! Item 18 nO1hi, oxygen reaction order, outer overpack
! Item 19 nO1lo, oxygen reaction order, outer overpack
!
! Item 20 rkhy2 [Coul/(m^2 yr)], rate constant for water reduction, inner overpack
! Item 21 g2hi, [J/mol], activation energies for main red. react., outer overpack
! Item 22 g1lo [J/mol], activation energies for main red. react., outer overpack
! Item 23 ghy2 [J/mol], activation energy water reduction, outer overpack
! Item 24 npH2hi, pH reaction order, outer overpack
! Item 25 npH2lo, pH reaction order, outer overpack
! Item 26 nO2hi, oxygen reaction orders, outer overpack
! Item 27 nO2lo, oxygen reaction orders, outer overpack
!
! Item 28 aa(1,1) [C/m2/yr] Passive current density for WP outer overpack
! Item 29 aa(1,2)
! Item 30 aa(1,3)
! Item 31 aa(2,1) [C/m2/yr] Passive current density for WP inner overpack
! Item 32 aa(2,2)
! Item 33 aa(2,3)
! Item 34 g1anod [J/mol], act. energy general corrosion rate, outer overpack
! Item 35 g2anod [J/mol], act. energy general corrosion rate, inner overpack
! Item 36 refTanod [K], temperature at which passive curr. is specified
!
```

```
! Item 37 eexpt: measured galvanic couple potentia [VSHE]
! Item 38 rcoef: coef. for loc. corr. of outer overpack
! Item 39 rexpont: exponent for loc. corr. of outer overpack
! Item 40 rcoef2: coef. for loc. corr. of inner overpack
! Item 41 rexpont2: exponent for loc. corr. of outer overpack
! Item 42 cratehac: humd.air corr.rt.
! Item 43 xcouple, efficiency of galvanic coupling
! Item 44 xread: factor for defining choice of crit. potential
! Item 45 clcrit1: min. chloride conc. for LC, outer overpack [mol/L]
! Item 46 clcrit2: min. chloride conc. for LC, inner overpack [mol/L]
! Item 47 inhToCl1: critical inhibitor to Cl ratio, outer overpack
! Item 48 inhToCl2: critical inhibitor to Cl ratio, inner overpack
! Item 49 deltaEcInh1: Incr in crit pot at [inh]/[Cl]=inhToCl1, [mV], outer
! Item 50 deltaEcInh2: Incr in crit pot at [inh]/[Cl]=inhToCl2, [mV], inner
! Item 51 xgas: oxygen partial pressure [atm]
! Item 52 scalthk: scale thickness
! Item 53 taus: tortuosity
! Item 54 spor:porosity

                6.0 ! pHtran: transition pH between low pH and high pH behaviour
          5.513E+09 ! ire1hi, C/(m^2 yr), reference curr main red. react., outer overpack
          7.572E+09 ! ire1lo, C/(m^2 yr), reference curr main red. react., outer overpack
             0.0248 ! beta1hi, effective transf. coeff., high pH, outer overpack
            0.01287 ! beta1lo, effective transf. coeff., low pH, outer overpack
                0.0 ! betahy1: transfer coefficient for water reduction, outer overpack
          5.513E+09 ! ire2hi, C/(m^2 yr), reference curr main red. react., inner overpack
          7.572E+09 ! ire2lo, C/(m^2 yr), reference curr main red. react., inner overpack
             0.0248 ! beta2hi, effective transf. coeff., high pH, inner overpack
            0.01287 ! beta2lo, effective transf. coeff., low pH, inner overpack
                0.0 ! betahy2: transfer coefficient for water reduction, inner overpack
                0.0 ! rkhy1 [Coul/(m^2 yr)], rate constant for water reduction outer ovrpack
            40000.0 ! g1hi [J/mol], activation energies for main red. react., outer overpack
            40000.0 ! g1lo [J/mol], activation energies for main red. react., outer overpack
            25000.0 ! ghy1 [J/mol], activation energy water reduction, outer overpack
            0.01897 ! npH1hi, pH reaction order, outer overpack
             0.0256 ! npH1lo, pH reaction order, outer overpack
             0.0248 ! nO1hi, oxygen reaction order, outer overpack
            0.01287 ! nO1lo, oxygen reaction order, outer overpack
                0.0 ! rkhy2 [Coul/(m^2 yr)], rate constant for water reduction, inner ovrpck
            40000.0 ! g2hi, [J/mol], activation energies for main red. react., outer ovrpack
            40000.0 ! g2lo, [J/mol], activation energies for main red. react., outer ovrpack
            25000.0 ! ghy2 [J/mol], activation energy water reduction, outer overpack
            0.01897 ! npH2hi, pH reaction order, outer overpack
             0.0256 ! npH2lo, pH reaction order, outer overpack
             0.0248 ! nO2hi, oxygen reaction orders, outer overpack
            0.01287 ! nO2lo, oxygen reaction orders, outer overpack
            3.301E3 ! aa(1,1) [C/m2/yr]
                0.0 ! aa(1,2)
                0.0 ! aa(1,3)
              1.0E4 ! aa(2,1) [C/m2/yr]
                0.0 ! aa(2,2)
                0.0 ! aa(2,3)
            44700.0 ! g1anod [J/mol], act. energy general corrosion rate, outer overpack
                0.0 ! g2anod [J/mol], act. energy general corrosion rate, inner overpack
             368.15 ! refTanod [K], temperature at which passive curr. is specified
        0.0000E+00 ! eexpt: measured galvanic couple potentia [VSHE]
        0.2500E-03 ! rcoef: coef. for loc. corr. of outer overpack
                1.0 ! rexpont: exponent for loc. corr. of outer overpack
                1.0 ! rcoef2: coef. for loc. corr. of inner overpack
                1.0 ! rexpont2: exponent for loc. corr. of outer overpack
            1.0E-15 ! cratehac: humd.air corr.rt.
                0.0 ! xcouple, efficiency of galvanic coupling
                0.0 ! xread: factor for defining choice of crit. potential
                0.5 ! clcrit1: min. chloride conc. for LC, outer overpack [mol/L]
                0.0 ! clcrit2: min. chloride conc. for LC, inner overpack [mol/L]
                0.1 ! inhToCl1: critical inhibitor to Cl ratio, outer overpack
             1.0e10 ! inhToCl2: critical inhibitor to Cl ratio, inner overpack
              800.0 ! deltaEcInh1: Incr in crit pot at [inh]/[Cl]=inhToCl1, [mV], outer
                0.0 ! deltaEcInh2: Incr in crit pot at [inh]/[Cl]=inhToCl2, [mV], inner
               0.21 ! xgas: oxygen partial pressure [atm]
                0.0 ! scalthk: scale thick
                1.0 ! taus: tortuosity
                1.0 ! spor:porosity

! Section 8 ; Radiolysis parameters
!
! Item 55 deltaEo : Delta Potential Due To Radiolysis. [V]
! Item 56 lamb : Radiolysis decaying constant.  [1/yr]
! Item 57 dense1 : Density of Outer Overpack. [kg/m3]
! Item 58 dense2 : Density of Inner Overpack.  [kg/m3]
! Item 59 wtmol1 : Equivalent Weight of Outer Overpack. [kg/mol]
```

```
! Item 60 wtmol2 : Equivalent Weight of Inner Overpack. [kg/mol]

                    0.0 ! deltaEo: Delta Potential Due To Radiolysis. [V]
                  7.e-5 ! lamb: Radiolysis decaying constant. [1/yr]
               8.69E+03 ! dense1 [kg/m3]
                7.7E+03 ! dense2 [kg/m3]
             2.597E-02 ! wtmol1 [kg/mol]
             2.494E-02 ! wtmol2 [kg/mol]

! Section 9 ; Mechanical failure data
!
! Item 61 yieldstr: yield strength [MPa]
! Item 62 sfactor: safety factor
! Item 63 dkic: fracture toughness [MPa-m**0.5]

            0.3700E+03 ! yieldstr: yield strength [MPa]
            0.3700E+03 ! sfactor: safety factor
            0.1000E+08 ! dkic: fracture toughness [MPa-m**0.5]

! Section 10 ; Runge-kutta control parameters
!
! Item 64 dtini
! Item 65 dtmax
! Item 66 errrel (same as eps)
! Item 67 errabs (same as tiny)

                  1.e-3 ! dtini
                   1.e0 ! dtmax
                  1.e-2 ! errrel (same as eps)
                 1.e-30 ! errabs (same as tiny)

!end
```

ATTACHMENT B

New ebsrel.def file:

```
! ebsrel.def: Default input file for ebsrel
!
! Purpose:
! This is the template file read by the ebsrel.f module to produce the
! ebsrel.inp file, the input file for the releaset.f standalone module.
! Input data file for release for glass, diffusion and clad: releaset5d.f 7/26/02 rbc
!
! History: ebsrel.def is a legacy file with versions found in tpa32
!          03/18/06 previous version adding drip shield failure parameters
!          11/22/06 reformatted version
!
! This file has 10 sections.  Each section has a description of its
! respective contents.
!
! Section 1 Cell Information
!
! Item 01 xcon: # of WP
! Item 02 sawetfrac: wetted subarea
! Item 03 defect: initially defective time [yr] ebsrel: releasewpfailedtime(2,1)
! Item 04 idefect: WPs affected   ebsrel: releasewpfailedtime(1,1)
! Item 05 sftimef: faulting fail time [yr] ebsrel: releasewpfailedtime(2,2)
! Item 06 isconf: WPs affected   ebsrel: releasewpfailedtime(1,2)
! Item 07 sftimev: volcano fail time [yr] ebsrel: releasewpfailedtime(2,3)
! Item 08 isconv:  WPs affected   ebsrel: releasewpfailedtime(1,3)
! Item 09 seismt1: first  seismic failure time [yr] ebsrel: releasewpfailedtime(2,4)
! Item 10 seismp1: WP affected   ebsrel: releasewpfailedtime(1,4)
! Item 11 seismt2: second seismic failure time [yr] ebsrel: releasewpfailedtime(2,5)
! Item 12 seismp2: WP affected   ebsrel: releasewpfailedtime(1,5)
! Item 13 seismt3: third  seismic failure time [yr] ebsrel: releasewpfailedtime(2,6)
! Item 14 seismp3: WP affected   ebsrel: releasewpfailedtime(1,6)
! Item 15 seismt4: fourth seismic failure time [yr] ebsrel: releasewpfailedtime(2,7)
! Item 16 seismp4: WP affected   ebsrel: releasewpfailedtime(1,7)

            8.96000E+02 ! xcon: # of WP
            1.66549E-01 ! sawetfrac: wetted subarea
            0.00000E+00 ! defect: initially defective time [yr] ebsrel: releasewpfailedtime(2,1)
            1.00000E+00 ! idefect: WPs affected   ebsrel: releasewpfailedtime(1,1)
            0.00000E+00 ! sftimef: faulting fail time [yr] ebsrel: releasewpfailedtime(2,2)
            0.00000E+00 ! isconf: WPs affected   ebsrel: releasewpfailedtime(1,2)
            0.00000E+00 ! sftimev: volcano fail time [yr] ebsrel: releasewpfailedtime(2,3)
            0.00000E+00 ! isconv:  WPs affected   ebsrel: releasewpfailedtime(1,3)
            9.96390E+02 ! seismt1:first seismic failure time[yr] ebsrel: releasewpfailedtime(2,4)
            0.00000E+00 ! seismp1: WP affected   ebsrel: releasewpfailedtime(1,4)
            3.46586E+03 ! seismt2: second seismic failure time [yr] ebsrel: releasewpfailedtime(2,5)
            0.00000E+00 ! seismp2: WP affected   ebsrel: releasewpfailedtime(1,5)
            7.37632E+03 ! seismt3: third  seismic failure time [yr] ebsrel: releasewpfailedtime(2,6)
            0.00000E+00 ! seismp3: WP affected   ebsrel: releasewpfailedtime(1,6)
            5.50000E+04 ! seismt4: fourth seismic failure time [yr] ebsrel: releasewpfailedtime(2,7)
            0.00000E+00 ! seismp4: WP affected   ebsrel: releasewpfailedtime(1,7)

! Section 2 WP information
!
! Item 01 dintl: wp internal diameter [m]
! Item 02 xintl: wp internal length [m]
! Item 03 xvol: wp internal vol[m3]

            1.57900E+00 ! dintl: wp ID [m]
            5.27500E+00 ! xintl: internal length [m]
            4.83000E+00 ! xvol: wp internal vol[m3]

! Section 3 Thermal data
!
! Item 01 temfil: temp. file (output from ebspac_fail.f)
! Item 02 ctemp: critical temperature for the onset of liquid flow around wp [C]

           'ebstrh.dat' ! temfil: temp. file (output from ebspac_fail.f)
            9.99000E+02 ! ctemp: BP of water at atm. condition [C]

! Section 4 Flow parameters
!
! Item 01 hydfil: flow parameters file

           'ebsflo.dat' ! hydfil: flow parameters file

! Section 5 Spent Fuel (SF) materials
!
! Item 01 amassc: mass of SF per WP [kg]
```

```
! Item 02 fueden: SF density [kg/m3]

            0.83500E+04 ! amassc: SF mass per WP [kg]
            1.06000E+04 ! fueden: SF density [kg/m3]

! Section 6 Fuel leaching model paramters and water contact mode (bathtub=0, flowthru=1)
!
! Item 01 wetfrac(1): height of fraction of wet SF for init defective WPs
! Item 02 iwatcont(1): water contact mode ebsrel: iwatcont(1)
! Item 03 wetfrac(2): height of fraction of wet SF for fault failed WPs
! Item 04 iwatcont(2): water contact mode ebsrel: iwatcont(2)
! Item 05 wetfrac(3): height of fraction of wet SF for volcanic failed WPs
! Item 06 iwatcont(3): water contact mode ebsrel: iwatcont(3)
! Item 07 wetfrac(4): height of fraction of wet SF for seism 1 failure
! Item 08 iwatcont(4): water contact mode ebsrel: iwatcont(4)
! Item 09 wetfrac(5): height of fraction of wet SF for seism 2 failure
! Item 10 iwatcont(5): water contact mode ebsrel: iwatcont(5)
! Item 11 wetfrac(6): height of fraction of wet SF for seism 3 failure
! Item 12 iwatcont(6): water contact mode ebsrel: iwatcont(6)
! Item 13 wetfrac(7): height of fraction of wet SF for seism 4 failure
! Item 14 iwatcont(7): water contact mode ebsrel: iwatcont(7)
! Item 15 wetfrac(8): height of fraction of wet SF for corrosion failure
! Item 16 iwatcont(8): water contact mode ebsrel: iwatcont(8)
! Item 17 imodel: leaching model [unitless]
! Item 18 pH value [unitless]
! Item 19 oxygen partial pressure (0.002-0.2 atm overpressure), oxgnovpr [atm]
! Item 20 Negative Log10 Carbonate Concentration, cco3 [mol/L]: used if imodel=1
! Item 21 User Leach Rate, usrlrate:[kg/yr/m2]: used if imodel=3
! Item 22 Preexponential SF Dissolution Model 2, preexpo: preexponential term for imodel=2
! Item 23 Waste Form Dissolution Enhancement Factor, ratefactor

            7.59571E-01 ! wetfrac(1): init def ht fract of wet SF  ebsrel: wetfraci(sa)
                      1 ! iwatcont(1): water contact mode ebsrel: iwatcont(1)
            1.63517E-01 ! wetfrac(2): fau fail ht fract of wet SF  ebsrel: wetfracf
                      1 ! iwatcont(2): water contact mode ebsrel: iwatcont(2)
            6.98734E-01 ! wetfrac(3): vol fail ht fract of wet SF  ebsrel: wetfracv
                      1 ! iwatcont(3): water contact mode ebsrel: iwatcont(3)
            2.17325E-01 ! wetfracs(4): seim1 fail ht fract of wet SF  ebsrel: wetfrac(1,sa)
                      1 ! iwatcont(4): water contact mode ebsrel: iwatcont(4)
            1.64902E-01 ! wetfrac(5): seim2 fail ht fract of wet SF  ebsrel: wetfracs(2,sa)
                      1 ! iwatcont(5): water contact mode ebsrel: iwatcont(5)
            4.93428E-01 ! wetfrac(6): seim3 fail ht fract of wet SF  ebsrel: wetfracs(3,sa)
                      1 ! iwatcont(6): water contact mode ebsrel: iwatcont(6)
            8.97272E-01 ! wetfrac(7): seim4 fail ht fract of wet SF  ebsrel: wetfracs(4,sa)
                      1 ! iwatcont(7): water contact mode ebsrel: iwatcont(7)
            3.50432E-01 ! wetfrac(8): cor fail ht fract of wet SF  ebsrel: wetfracc(sa)
                      1 ! iwatcont(8): water contact mode ebsrel: iwatcont(8)
                      2 ! imodel: leaching model [unitless]
              9.000E+00 ! phvalue [unitless]
              2.100E-01 ! oxgnovpr [atm]
              3.710E+00 ! cco3 [mol/L]: used if imodel=1
              2.500E-06 ! usrlrate:[kg/yr/m2]: used if imodel=3
              7.106E+04 ! preexpo: preexponential term for imodel=2
                    1.0 ! ratefactor: waste dissolution enhancemant factor [unitless]

! Section 7 Radionuclide inventory
!
! Item 01 ebsrel output file, 'ebspac.nuc', nuclide names, t1/2,invent ,correction for Diff

           'ebspac.nuc' ! elefil: nuclide names, t1/2,invent ,correction for Diff

! Section 8 C-14 generation
!
! Item 01 r0z: initial radius of SF particle [m]
! Item 02 claddingcorfact: cladding correction factor
! Item 03 cladve, velocity enhancement factor (1 to 240)
! Item 04 ltube0, half length of fuel rod, [m]  ebsrel: eltube0
! Item 05 rrod, radius of fuel in rod, [m]

            2.17412E-03 ! r0z: initial radius of SF particle [m]
                    1.0 ! claddingcorfact: cladding correction factor
                  100.0 ! cladve, velocity enhancement factor (1 to 240)
                    2.0 ! ltube0, half length of fuel rod, meters  ebsrel: eltube0
                  0.005 ! rrod, radius of fuel in rod, meters

! Section 9 glass model
!
! Item 01 SurfaceAreaOfGlass, simglass [m^2/kg]
! Item 02 pH for glass model, phglass
! Item 03 Log Of Glass Dissolution Constant High Range, logkeffhi
! Item 04 pH Parameter High Range, etahi
```

```
! Item 05 Glass Activation Energy High Range, eahi [kj/mol deg K]
! Item 06 Log Of Glass Dissolution Constant Low Range, logkefflow
! Item 07 pH Parameter Low Range, etalow
! Item 08  Glass Activation Energy Low Range, ealow [kj/mol deg K]

                5.63e-2 ! simglass m^2/kg
                    9.5 ! phglass
                    7.1 ! logkeffhi
                    0.4 ! etahi
                   77.0 ! eahi kj/mol deg K
                    9.0 ! logkefflow
                   -0.6 ! etalow
                   53.0 ! ealow kj/mol deg K

! Section 10 diffusion model
!
! Item 01 Length of Weld Crack, cr_length, [m]
! Item 02 Total Area Of Cracks Per WP At Emplacement, cr-area_a, [m^2]
! Item 03 Slope Of Crack Area Curve, cr_area_b, [m^2/yr]
! Item 04 Length Of Film Path Inside WP, l_internal, [m]  ebsrel: el_internal
! Item 05 Internal Film Cross Sectional Area, a_internal,  [m^2]
! Item 06 Self Diffusion Coefficient Of Water At 20C, d_water,  [m^2/sec]
! Item 07 Fraction Of WPs With Diffusion Tilt, ftilt, fraction of WPs in diffusion orientation

                    0.1 ! cr_length, length of crack, [m]
                20.0e-6 ! cr-area_a, area of crack at t=0, m^2
                 1.0e-8 ! cr_area_b, slope of crack growth, m^2/yr
                    0.2 ! l_internal,length of interior film pathway, [m]  ebsrel: el_internal
                20.0e-6 ! a_internal, cross section of interior film, m^2
                 2.3e-9 ! d_water, diffusivity of water at 20C, m^2/sec
                    0.1 ! ftilt, fraction of WPs in diffusion orientation

! NUMERICAL Sections
!
! Section 11 Grids
!
! imax, # of grid nodes in the i direction
! jmax, # of grid nodes in the j direction

imax jmax
 -    -
10,  10                  ! imax,jmax: # of grid nodes in i,j directions

! X and Y coordinates of grid nodes

X-COOR, Y-COOR
 -       -
0.1     0.1
0.5     0.5
1.0     1.0
2.0     2.0
4.0     4.0
5.0     5.0
6.0     6.0
7.0     7.0
8.0     8.0
9.0     9.0

! Section 12 Zones
!
! Note: zones apply to the above grid, zones are the same for all cell
!
! Item 1, Number of zondes for material types

4                        ! nzones: no. of zones for material types

! iz, zone identifier
! ib, beginning x-node for a zone
! jb, beginning y-node for a zone
! ie, ending x-node for a zone
! je, ending y-coordinate for a zone

iz, ib, jb, ie, je
1   1   1   1   1        ! iz,ib,jb,ie,je: for zone 1
2   2   1   2   1        ! iz,ib,jb,ie,je: for zone 2
3   3   1   3   1        ! iz,ib,jb,ie,je: for zone 3
4   4   1   10  1        ! iz,ib,jb,ie,je: for zone 4

! Section 13 Rock parameters
!
! Item 1, rpor(1): rock porosity for zone 1 (unitless)
```

```
! Item 2, rpor(2): rock porosity for zone 2 (unitless)
! Item 3, rpor(3): rock porosity for zone 3 (unitless)
! Item 4, rpor(4): rock porosity for zone 4 (unitless)

                    0.14 ! rpor(1): rock porosity for zone 1 (unitless)
                    0.14 ! rpor(2): rock porosity for zone 2 (unitless)
                    0.14 ! rpor(3): rock porosity for zone 3 (unitless)
                    0.14 ! rpor(4): rock porosity for zone 4 (unitless)

! Section 14 Radionuclide transport
!
! Item 1, rdiff(1): diffusion coefficient for zone 1 [m2/yr]
! Item 2, rdiff(2): diffusion coefficient for zone 2 [m2/yr]
! Item 3, rdiff(3): diffusion coefficient for zone 3 [m2/yr]
! Item 4, rdiff(4): diffusion coefficient for zone 4 [m2/yr]
! Item 5, driftdia: Drift Diameter [m]

                  5.6e-5 ! rdiff(1):diffusion coef. [m2/yr]
                  5.6e-5 ! rdiff(2):diffusion coef. [m2/yr]
                  5.6e-5 ! rdiff(3):diffusion coef. [m2/yr]
                  5.6e-5 ! rdiff(4):diffusion coef. [m2/yr]
             5.50000E+00 ! driftdia [m]

! Section 10 Solution algorithm control parameters (Runge-Kutta)
!
! Item 1 dtinit [yr]
! Item 2 dtmin [yr]
! Item 3 dtmax [yr]
! Item 4 eps
! Item 5 tiny

                     25. ! dtinit [yr]
                     0.0 ! dtmin [yr]
                     10. ! dtmax [yr]
                  1.0e-2 ! eps
                 1.0e-10 ! tiny

! Section 11 Output parameters
!
! Item 1 nbt: number of time intervals for output [unitless]

                     200 ! nbt: number of time intervals for output

! END
```

ATTACHMENT C

ebsfail.f diffs:

```
82d81
< c        12-08-06   jmm; scr672; File Format change
448c447
<       character*120 aline
---
>       character*60 aline
1723,1727c1722
< cjmm 20061208 SCR672 File Reformatting
< cjmm  do i = 1,3
< cjmm  read and write 17 initial comment lines
< 100   format(a120)
<       do i = 1,17
---
>       do i = 1,3
1730a1726,1729
>
> 100   format(a60)
> c read comments from .tmp and write them with value tend
> c  (coming from .inp)  for input subroutine:
1732,1733c1731,1732
< cjmm  " ! tend: simulation time length [yr]"
<       write(iebsfailinp,'(f24.2,a)') tend, aline(25:)
---
>       write(aline(1:10),fmt='(f10.2)') tend
>       write(iebsfailinp,100) aline
1735,1736c1734
< cjmm  Read Section 2
<       do i = 1,9
---
>       do i = 1,2
1742,1756c1740,1741
< cjmm  " ! wplen: wp length [m]"
<       write(iebsfailinp,'(f24.4,a)') wplen, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! wpdia: wp diameter [m]"
<       write(iebsfailinp,'(f24.4,a)') wpdia, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! cthick1: wp layers 1 thickness [m]"
<       write(iebsfailinp,'(e24.4,a)') cthick1*wppenetration, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! cthick2: wp layers 2 thickness [m]"
<       write(iebsfailinp,'(e24.4,a)') cthick2, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! thickness: weld alloy thickness [m]"
<       write(iebsfailinp,'(1pe24.4,a)') thickness*weldpenetration,
<      &                                 aline(25:)
---
>       write(aline(1:15),fmt='(f7.4,1x,f7.4)') wplen, wpdia
>       write(iebsfailinp,100) aline
1758,1759c1743,1761
< cjmm  Read Section 3
<       do i = 1,8
---
>       read(iebsfailtmp,100)aline
> cc jwm 11-18-05; SCR607 pass fraction thickness penetration for corrosion failure
> c      write(aline(1:23),fmt='(e11.4,1x,e11.4)') cthick1,cthick2
>       write(aline(1:23),fmt='(e11.4,1x,e11.4)') cthick1*wppenetration,ct
>      &hick2
> cc end changes; SCR607
>       write(iebsfailinp,100) aline
>
> c     Alloy thickness of the weld
>
>
>       READ(iebsfailtmp, 100) aline
> cc SCR607 add fraction thickness penetration for corrosion failure
> c      WRITE(aline(1:11), FMT = '(1pe11.4)') thickness
>       WRITE(aline(1:11), FMT = '(1pe11.4)') thickness*weldpenetration
> cc  end changes;SCR607
>       WRITE(iebsfailinp, 100) aline
>
>       do i = 1,2
1764,1766c1766,1768
<       read(iebsfailtmp,100) aline
< cjmm  " ! grainr: metal grain radius [micrometer]"
<       write(iebsfailinp,'(e24.4,a)') grainr, aline(25:)
---
```

```
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') grainr
>       write(iebsfailinp,100) aline
1773d1774
< cjmm                  25 ! nseries: terms in infinite series for wp oxidation
1775,1780c1776,1778
<       read(iebsfailtmp,100) aline
< cjmm  " ! gbthick: bundary thickness [micrometer]"
<       write(iebsfailinp,'(e24.4,a)') gbthick, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! constant1: constant relating matrix and grain boundary diff"
<       write(iebsfailinp,'(e24.4,a)') constant1, aline(25:)
---
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') gbthick
>       write(iebsfailinp,100) aline
1782,1783c1780,1784
< cjmm  Read Section 4
<       do i = 1,7
---
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') constant1
>       write(iebsfailinp,100) aline
>
>       do i = 1,2
1788,1796c1789,1791
<       read(iebsfailtmp,100) aline
< cjmm  " ! humdc1: crit. rel. hums."
<       write(iebsfailinp,'(e24.4,a)') humdc1, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! humdc2: crit. rel. hums."
<       write(iebsfailinp,'(e24.4,a)') humdc2, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! filmthk: thickness of water film [m]"
<       write(iebsfailinp,'(e24.4,a)') filmthk, aline(25:)
---
>       read(iebsfailtmp,100)aline
>       write(aline(1:24),fmt='(e11.4,2x,e11.4)') humdc1,humdc2
>       write(iebsfailinp,100) aline
1798,1802c1793,1795
< cjmm  Read Section 5
<       do i = 1,12
<         read(iebsfailtmp,100) aline
<         write(iebsfailinp,100) aline
<       enddo
---
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') filmthk
>       write(iebsfailinp,100) aline
1804,1827c1797,1805
<       read(iebsfailtmp,100) aline
< cjmm  " ! ErpInt: Erp Intercept [mVSHE]"
<       write(iebsfailinp,'(1pe24.4,a)') ErpInt, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! TErpInt: Temp Coef Erp Intercept [mVSHE/C]"
<       write(iebsfailinp,'(1pe24.4,a)') TErpInt, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! ErpSlope: Erp Slope [mVSHE], Slope of Efp vs log10(Cl)"
<       write(iebsfailinp,'(1pe24.4,a)') ErpSlope, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! TErpSlope: Temp Coeff of Erp Slope [mVSHE/C]"
<       write(iebsfailinp,'(1pe24.4,a)') TErpSlope, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! clcritw: minimum chloride conc. for LC for weld[mol/L]"
<       write(iebsfailinp,'(e24.4,a)') clcritw, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! inhToClw: critical inhibitor to chloride ratio"
<       write(iebsfailinp,'(e24.4,a)') inhToClw, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! deltaEcInhW: Increase in crit. pot. at [inh]/[Cl]=inhToClw  [mV]"
<       write(iebsfailinp,'(e24.4,a)') deltaEcInhW, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! frac_weld_surf, weld surface fraction for advective transport"
<       write(iebsfailinp,'(1pe24.4,a)') frac_weld_surf, aline(25:)
---
> c ZW SCR478 05-07-04
> c      read(iebsfailtmp,100)aline
> c      write(aline(1:11),fmt='(e11.4)') ctemp
> c      write(iebsfailinp,100) aline
>
>       READ(iebsfailtmp, 100) aline
```

```
>       WRITE(iebsfailinp, 100) aline
>       READ(iebsfailtmp, 100) aline
>       WRITE(iebsfailinp, 100) aline
1829,1830c1807,1843
< cjmm  Read Section 6
<       do i = 1,22
---
>       READ(iebsfailtmp, 100) aline
>       WRITE(aline(1:11), FMT = '(1pe11.4)') ErpInt
>       WRITE(iebsfailinp, 100) aline
>
>       READ(iebsfailtmp, 100) aline
>       WRITE(aline(1:11), FMT = '(1pe11.4)') TErpInt
>       WRITE(iebsfailinp, 100) aline
>
>       READ(iebsfailtmp, 100) aline
>       WRITE(aline(1:11), FMT = '(1pe11.4)') ErpSlope
>       WRITE(iebsfailinp, 100) aline
>
>       READ(iebsfailtmp, 100) aline
>       WRITE(aline(1:11), FMT = '(1pe11.4)') TErpSlope
>       WRITE(iebsfailinp, 100) aline
>
> c  ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') clcritw
>       write(iebsfailinp,100) aline
>
> c  ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') inhToClw
>       write(iebsfailinp,100) aline
>
> c  ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') deltaEcInhW
>       write(iebsfailinp,100) aline
>
> c     Process the drip shield weld surface fraction
>       READ(iebsfailtmp, 100) aline
>       WRITE(aline(1:11), FMT = '(1pe11.4)') frac_weld_surf
>       WRITE(iebsfailinp, 100) aline
>
>       do i = 1,2
1834a1848,1921
> c ZW SCR478 05-07-04.  Saving xipto:
>       read(iebsfailtmp,100)aline
>       WRITE(aline(1:11), FMT = '(e11.4)') -584.8
>       WRITE(iebsfailinp, 100) aline
>
> c ZW SCR478 05-07-04.  Saving pttemo:
>       read(iebsfailtmp,100)aline
>       WRITE(aline(1:11), FMT = '(e11.4)') 3.92
>       WRITE(iebsfailinp, 100) aline
>
> c ZW SCR478 05-07-04.  Saving slpto:
>       read(iebsfailtmp,100)aline
>       WRITE(aline(1:11), FMT = '(e11.4)') -24.5
>       WRITE(iebsfailinp, 100) aline
>
> c ZW SCR478 05-07-04.  Saving slpttemo:
>       read(iebsfailtmp,100)aline
>       WRITE(aline(1:11), FMT = '(e11.4)') -1.1
>       WRITE(iebsfailinp, 100) aline
>
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') xirpo
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') rptemo
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') slrpo
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') slrptemo
>       write(iebsfailinp,100) aline
```

```
>
> c ZW SCR478 05-07-04.  Saving xipti:
>       read(iebsfailtmp,100)aline
>       WRITE(aline(1:11), FMT = '(e11.4)') -200.0
>       WRITE(iebsfailinp, 100) aline
>
> c ZW SCR478 05-07-04.  Saving pttemi:
>       read(iebsfailtmp,100)aline
>       WRITE(aline(1:11), FMT = '(e11.4)') 0.0
>       WRITE(iebsfailinp, 100) aline
>
> c ZW SCR478 05-07-04.  Saving slpti:
>       read(iebsfailtmp,100)aline
>       WRITE(aline(1:11), FMT = '(e11.4)') -240.0
>       WRITE(iebsfailinp, 100) aline
>
> c ZW SCR478 05-07-04.  Saving slpttemi:
>       read(iebsfailtmp,100)aline
>       WRITE(aline(1:11), FMT = '(e11.4)') 0.0
>       WRITE(iebsfailinp, 100) aline
>
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') xirpi
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') rptemi
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') slrpi
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') slrptemi
>       write(iebsfailinp,100) aline
>
1836,1837c1923
< cjmm  " ! xipto: outer overpack Ep intercept[mV] "
<       WRITE(iebsfailinp,'(e24.4,a)') -584.8, aline(25:)
---
>       write(iebsfailinp,100) aline
1839,1882c1925
< cjmm  " ! pttemo: temp. coef. of outer overpack Ep intercept[mV/degC] "
<       WRITE(iebsfailinp,'(e24.4,a)') 3.92, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! slpto: outer overpack Ep slope[mV]"
<       WRITE(iebsfailinp,'(e24.4,a)') -24.5, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! slpttemo: temp. coef. of outer overpack Ep slope[mV/degC]"
<       WRITE(iebsfailinp,'(e24.4,a)') -1.1, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! xirpo: outer overpack Erp intercept[mV]"
<       write(iebsfailinp,'(e24.4,a)') xirpo, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! rptemo: temp. coef. of outer overpack Erp intercept[mV/degC]"
<       write(iebsfailinp,'(e24.4,a)') rptemo, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! slrpo: outer overpack Erp slope[mV]"
<       write(iebsfailinp,'(e24.4,a)') slrpo, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! slrptemo: temp. coef. of outer overpack Erp slope[mV/degC]"
<       write(iebsfailinp,'(e24.4,a)') slrptemo, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! xipti: inner overpack Ep intercept[mV]"
<       WRITE(iebsfailinp,'(e24.4,a)') -200., aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! pttemi: temp. coef. of inner overpack Ep intercept[mV/degC]"
<       WRITE(iebsfailinp,'(e24.4,a)') 0., aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! slpti: inner overpack Ep slope[mV]"
<       WRITE(iebsfailinp,'(e24.4,a)') -240., aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! slpttemi: temp. coef. of inner overpack Ep slope[mV/degC]"
<       WRITE(iebsfailinp,'(e24.4,a)') 0., aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! xirpi: inner overpack Erp intercept[mV]"
<       write(iebsfailinp,'(e24.4,a)') xirpi, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! rptemi: temp. coef. of inner overpack Erp intercept[mV/degC]"
```

```
<       write(iebsfailinp,'(e24.4,a)') rptemi, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! slrpi: inner overpack Erp slope[mV]"
<       write(iebsfailinp,'(e24.4,a)') slrpi, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! slrptemi: temp. coef. of inner overpack Erp slope[mV/degC]"
<       write(iebsfailinp,'(e24.4,a)') slrptemi, aline(25:)
---
>       write(iebsfailinp,100) aline
1884,1885c1927,1956
< cjmm  Read Section 7
<       do i = 1,65
---
> c ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') pHtran
>       write(iebsfailinp,100) aline
>
> c ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:24),fmt='(e11.4,2x,e11.4)') ire1hi, ire1lo
>       write(iebsfailinp,100) aline
>
> c ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:23),fmt='(e11.4,1x,e11.4)') beta1hi, beta1lo
>       write(iebsfailinp,100) aline
>
> c ZW SCR478 05-07-04
> c      READ(iebsfailtmp, 100) aline
> c      WRITE(aline(1:12), FMT = '(1pe12.5)') std_iO2o
> c      WRITE(iebsfailinp, 100) aline
> c      READ(iebsfailtmp, 100) aline
> c      WRITE(aline(1:11), FMT = '(1pe11.4)') EO2o
> c      WRITE(iebsfailinp, 100) aline
>
> c ZW SCR478 05-07-04 betaox1 deleted
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') betahy1
> c      write(aline(1:23),fmt='(e11.4,1x,e11.4)') betaox1,betahy1
>       write(iebsfailinp,100) aline
>
>       do i = 1,1
1890,1907c1961,1964
<       read(iebsfailtmp,100) aline
< cjmm  " ! pHtran: transition pH between low pH and high pH behaviour"
<       write(iebsfailinp,'(e24.4,a)') pHtran, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! ire1hi, C/(m^2 yr), reference curr main red. react., outer overpack"
<       write(iebsfailinp,'(e24.4,a)') ire1hi, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! ire1lo, C/(m^2 yr), reference curr main red. react., outer overpack"
<       write(iebsfailinp,'(e24.4,a)') ire1lo, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! beta1hi, effective transf. coeff., high pH, outer overpack"
<       write(iebsfailinp,'(e24.4,a)') beta1hi, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! beta1lo, effective transf. coeff., low pH, outer overpack"
<       write(iebsfailinp,'(e24.4,a)') beta1lo, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! betahy1: transfer coefficient for water reduction, outer overpack"
<       write(iebsfailinp,'(e24.4,a)') betahy1, aline(25:)
---
> c ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:23),fmt='(e11.4,1x,e11.4)') ire2hi, ire2lo
>       write(iebsfailinp,100) aline
1909,1923c1966,1969
<       read(iebsfailtmp,100) aline
< cjmm  " ! ire2hi, C/(m^2 yr), reference curr main red. react., inner overpack"
<       write(iebsfailinp,'(e24.4,a)') ire2hi, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! ire2lo, C/(m^2 yr), reference curr main red. react., inner overpack"
<       write(iebsfailinp,'(e24.4,a)') ire2lo, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! beta2hi, effective transf. coeff., high pH, inner overpack "
<       write(iebsfailinp,'(e24.4,a)') beta2hi, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! beta2lo, effective transf. coeff., low pH, inner overpack "
<       write(iebsfailinp,'(e24.4,a)') beta2lc, aline(25:)
<       read(iebsfailtmp,100) aline
```

```
< cjmm  " ! betahy2: transfer coefficient for water reduction, inner overpack"
<       write(iebsfailinp,'(e24.4,a)') betahy2, aline(25:)
---
> c ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:23),fmt='(e11.4,1x,e11.4)') beta2hi,beta2lo
>       write(iebsfailinp,100) aline
1924a1971,1976
> c ZW SCR478 05-07-04 betaox2 deleted:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') betahy2
> c      write(aline(1:23),fmt='(e11.4,1x,e11.4)') betaox2,betahy2
>       write(iebsfailinp,100) aline
>
1926,1944d1977
< cjmm  " ! rkhy1 [Coul/(m^2 yr)], rate constant for water reduction outer overpack"
<       write(iebsfailinp,'(e24.4,a)') rkhy1, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! g1hi [J/mol], activation energies for main red. react., outer overpack"
<       write(iebsfailinp,'(e24.4,a)') g1hi, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! g1lo [J/mol], activation energies for main red. react., outer overpack"
<       write(iebsfailinp,'(e24.4,a)') g1lo, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! ghy1 [J/mol], activation energy water reduction, outer overpack"
<       write(iebsfailinp,'(e24.4,a)') ghy1, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! npH1hi, pH reaction order, outer overpack "
<       write(iebsfailinp,'(e24.4,a)') npH1hi, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! npH1lo, pH reaction order, outer overpack "
<       write(iebsfailinp,'(e24.4,a)') npH1lo, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! nO1hi, oxygen reaction order, outer overpack"
1945a1979,2003
>
> c ZW SCR478 05-07-04 rkox1 deleted:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') rkhy1
> c      write(aline(1:23),fmt='(e11.4,1x,e11.4)') rkox1,rkhy1
>       write(iebsfailinp,100) aline
>
> c ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:23),fmt='(e11.4,1x,e11.4)') g1hi,g1lo
>       write(iebsfailinp,100) aline
>
> c ZW SCR478 05-07-04 gox1 deleted:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') ghy1
> c      write(aline(1:23),fmt='(e11.4,1x,e11.4)') gox1,ghy1
>       write(iebsfailinp,100) aline
>
> c ZW SCR478 05-07-04 new: npH1hi,npH1lo
>       read(iebsfailtmp,100)aline
>       write(aline(1:23),fmt='(e11.4,1x,e11.4)') npH1hi,npH1lo
>       write(iebsfailinp,100) aline
>
>
> c ZW SCR478 05-07-04 new. read defaults nO1hi, nO1lo in 1 line:
1947d2004
< cjmm  " ! nO1lo, oxygen reaction order, outer overpack"
1949a2007
> c Read \  (comment):
1951,1969d2008
< cjmm  " ! rkhy2 [Coul/(m^2 yr)], rate constant for water reduction, inner overpack"
<       write(iebsfailinp,'(e24.4,a)') rkhy2, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! g2hi, [J/mol], activation energies for main red. react., outer overpack"
<       write(iebsfailinp,'(e24.4,a)') g2hi, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! g2lo, [J/mol], activation energies for main red. react., outer overpack"
<       write(iebsfailinp,'(e24.4,a)') g2lo, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! ghy2 [J/mol], activation energy water reduction, outer overpack"
<       write(iebsfailinp,'(e24.4,a)') ghy2, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! npH2hi, pH reaction order, outer overpack "
<       write(iebsfailinp,'(e24.4,a)') npH2hi, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! npH2lo, pH reaction order, outer overpack "
```

```
<       write(iebsfailinp,'(e24.4,a)') npH2lo, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! nO2hi, oxygen reaction orders, outer overpack"
1970a2010,2033
>
> c ZW SCR478 05-07-04 rkox2 deleted:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') rkhy2
> c      write(aline(1:23),fmt='(e11.4,1x,e11.4)') rkox2,rkhy2
>       write(iebsfailinp,100) aline
>
> c ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:23),fmt='(e11.4,1x,e11.4)') g2hi,g2lo
>       write(iebsfailinp,100) aline
>
> c ZW SCR478 05-07-04 gox2 deleted:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') ghy2
> c      write(aline(1:23),fmt='(e11.4,1x,e11.4)') gox2,ghy2
>       write(iebsfailinp,100) aline
>
> c ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:23),fmt='(e11.4,1x,e11.4)') npH2hi,npH2lo
>       write(iebsfailinp,100) aline
>
> c ZW SCR478 05-07-04 new.   Read defaults nO2hi, nO2lo
1972d2034
< cjmm  " ! nO2lo, oxygen reaction orders, outer overpack"
1976,2001c2038
< cjmm  " ! aa(1,1) [C/m2/yr]"
<       write(iebsfailinp,'(e24.4,a)') aa_1_1, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! aa(1,2)"
<       write(iebsfailinp,'(e24.1,a)') 0.0, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! aa(1,3)"
<       write(iebsfailinp,'(e24.1,a)') 0.0, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! aa(2,1) [C/m2/yr]"
<       write(iebsfailinp,'(e24.4,a)') aa_2_1, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! aa(2,2) "
<       write(iebsfailinp,'(e24.1,a)') 0.0, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! aa(2,3)"
<       write(iebsfailinp,'(e24.1,a)') 0.0, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! g1anod [J/mol], act. energy general corrosion rate, outer overpack"
<       write(iebsfailinp,'(e24.4,a)') g1anod, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! g2anod [J/mol], act. energy general corrosion rate, inner overpack"
<       write(iebsfailinp,'(e24.4,a)') g2anod, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! refTanod [K], temperature at which passive curr. is specified"
<       write(iebsfailinp,'(e24.4,a)') refTanod, aline(25:)
---
>       write(iebsfailinp,100) aline
2002a2040,2061
> c   ZW SCR478 05-07-04:
>       read(iebsfailtmp,100)aline
>       write(aline(1:21),fmt='(e11.4,1x,f4.1,1x,f4.1)')aa_1_1, 0.0, 0.0
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:21),fmt='(e11.4,1x,f4.1,1x,f4.1)')aa_2_1, 0.0, 0.0
>       write(iebsfailinp,100) aline
>
> c  ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') g1anod
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') g2anod
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') refTanod
>       write(iebsfailinp,100) aline
```

```
>
2004,2056c2063
< cjmm  " ! eexpt: measured galvanic couple potentia [VSHE]"
<       write(iebsfailinp,'(e24.4,a)') eexpt, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! rcoef: coef. for loc. corr. of outer overpack "
<       write(iebsfailinp,'(e24.4,a)') rcoef, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! rexpont: exponent for loc. corr. of outer overpack"
<       write(iebsfailinp,'(e24.4,a)') rexpont, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! rcoef2: coef. for loc. corr. of inner overpack"
<       write(iebsfailinp,'(e24.4,a)') rcoef2, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! rexpont2: exponent for loc. corr. of outer overpack"
<       write(iebsfailinp,'(e24.4,a)') rexpont2, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! cratehac: humd.air corr.rt."
<       write(iebsfailinp,'(e24.4,a)') cratehac, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! xcouple, efficiency of galvanic coupling"
<       write(iebsfailinp,'(e24.4,a)') xcouple, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! xread: factor for defining choice of crit. potential"
<       write(iebsfailinp,'(e24.4,a)') xread, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! clcrit1: min. chloride conc. for LC, outer overpack [mol/L]"
<       write(iebsfailinp,'(e24.4,a)') clcrit1, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! clcrit2: min. chloride conc. for LC, inner overpack [mol/L]"
<       write(iebsfailinp,'(e24.4,a)') clcrit2, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! inhToCl1: critical inhibitor to Cl ratio, outer overpack"
<       write(iebsfailinp,'(e24.4,a)') inhToCl1, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! inhToCl2: critical inhibitor to Cl ratio, inner overpack"
<       write(iebsfailinp,'(e24.4,a)') inhToCl2, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! deltaEcInh1: Incr in crit pot at [inh]/[Cl]=inhToCl1, [mV], outer"
<       write(iebsfailinp,'(e24.4,a)') deltaEcInh1, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! deltaEcInh2: Incr in crit pot at [inh]/[Cl]=inhToCl2, [mV], inner"
<       write(iebsfailinp,'(e24.4,a)') deltaEcInh2, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! xgas: oxygen partial pressure [atm]"
<       write(iebsfailinp,'(e24.4,a)') xgas, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! scalthk: scale thick"
<       write(iebsfailinp,'(e24.1,a)') scalthk, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! taus: tortuosity"
<       write(iebsfailinp,'(e24.1,a)') taus, aline(25:)
<       read(iebsfailtmp,100) aline
< cjmm  " ! spor:porosity"
<       write(iebsfailinp,'(e24.1,a)') spor, aline(25:)
---
>       write(iebsfailinp,100) aline
2058,2059c2065,2147
< cjmm  Read Section 8
<       do i = 1,10
---
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') eexpt
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') rcoef
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') rexpont
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') rcoef2
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') rexpont2
>       write(iebsfailinp,100) aline
>
```

```
>       read(iebsfailtmp,100)aline
>       write(aline(1:24),fmt='(e11.4,2x,e11.4)') cratehac
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') xcouple
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') xread
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') clcrit1
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') clcrit2
>       write(iebsfailinp,100) aline
>
> c  ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') inhToCl1
>       write(iebsfailinp,100) aline
>
> c  ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') inhToCl2
>       write(iebsfailinp,100) aline
>
> c  ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') deltaEcInh1
>       write(iebsfailinp,100) aline
>
> c  ZW SCR478 05-07-04 new:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') deltaEcInh2
>       write(iebsfailinp,100) aline
>
> c     GADAMS SCR609 3-6-2006: Removed chloride factors
> c      read(iebsfailtmp,100)aline
> c      write(aline(1:11),fmt='(e11.4)') cfactor
> c      write(iebsfailinp,100) aline
> c     GADAMS SCR609 3-6-2006: End of change
>
> c  ZW SCR478 05-07-04.  Delete refph:
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') xgas
> c      write(aline(1:23),fmt='(e11.4,1x,e11.4)') xgas, refph
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:36),fmt='(3(e11.4,1x))') scalthk,taus,spor
>       write(iebsfailinp,100) aline
>
> c     GADAMS SCR609 3-6-2006: Removed chloride factors
> c      read(iebsfailtmp,100)aline
> c      write(aline(1:11),fmt='(e11.4)') cfactor2
> c      write(iebsfailinp,100) aline
> c     GADAMS SCR609 3-6-2006: End of change
>
>       do i = 1,2
2064,2075c2152,2184
<       read(iebsfailtmp,100) aline
<       write(iebsfailinp,'(e24.4,a)') deltaEo, aline(25:)
<       read(iebsfailtmp,100) aline
<       write(iebsfailinp,'(e24.4,a)') lamb, aline(25:)
<       read(iebsfailtmp,100) aline
<       write(iebsfailinp,'(e24.6,a)') dense1, aline(25:)
<       read(iebsfailtmp,100) aline
<       write(iebsfailinp,'(e24.6,a)') dense2, aline(25:)
<       read(iebsfailtmp,100) aline
<       write(iebsfailinp,'(e24.6,a)') wtmol1, aline(25:)
<       read(iebsfailtmp,100) aline
<       write(iebsfailinp,'(e24.6,a)') wtmol2, aline(25:)
---
> c     GADAMS SCR609 3-6-2006: Removed drip shield failure
> c     information from ebstrh.dat
> c      CALL getDSFailure(ds_time_mark, seismicFailDS, tim,
> c     &  ntim, fraction_failed_first, failure_time_first,
```

```
> c      &  fraction_failed_mark, fraction_failed_end_sim)
>
> c      Process the drip shield time mark
> c       READ(iebsfailtmp, 100) aline
> c       WRITE(aline(1:17), FMT = '(1pe17.10)') ds_time_mark
> c       WRITE(iebsfailinp, 100) aline
> c
> c      Process the first fraction of drip shields failed and
> c      the failure time for the first fraction.
> c       READ(iebsfailtmp, 100) aline
> c       WRITE(aline(1:29), FMT = '(1pe11.4, 1x, 1pe17.10)')
> c      &  fraction_failed_first, failure_time_first
> c       WRITE(iebsfailinp, 100) aline
> c
> c      Process the fraction failed at the time mark
> c       READ(iebsfailtmp, 100) aline
> c       WRITE(aline(1:11), FMT = '(1pe11.4)') fraction_failed_mark
> c       WRITE(iebsfailinp, 100) aline
> c
> c      Process the fraction failed at the end of simulation
> c       READ(iebsfailtmp, 100) aline
> c       WRITE(aline(1:11), FMT = '(1pe11.4)') fraction_failed_end_sim
> c       WRITE(iebsfailinp, 100) aline
> c
> c       do i = 1,2
> c         read(iebsfailtmp,100) aline
> c         write(iebsfailinp,100) aline
> c       enddo
> c      GADAMS SCR609 3-6-2006: End of change
2077,2078c2186,2195
< cjmm  Read Section 9
<       do i = 1,7
---
>       read(iebsfailtmp,100)aline
>       write(aline(1:24),fmt='(e11.4,2x,e11.4)') deltaEo, lamb
>       write(iebsfailinp,100) aline
>
>       read(iebsfailtmp,100)aline
>       write(aline(1:52),fmt='(4(e12.6,1x))') dense1,dense2,wtmol1,
>      & wtmol2
>       write(iebsfailinp,100) aline
>
>       do i = 1,2
2083,2088c2200,2202
<       read(iebsfailtmp,100) aline
<       write(iebsfailinp,'(e24.4,a)') yieldstr, aline(25:)
<       read(iebsfailtmp,100) aline
<       write(iebsfailinp,'(e24.4,a)') sfactor, aline(25:)
<       read(iebsfailtmp,100) aline
<       write(iebsfailinp,'(e24.4,a)') dkic, aline(25:)
---
>       read(iebsfailtmp,100)aline
>       write(aline(1:23),fmt='(e11.4,1x,e11.4)') yieldstr, sfactor
>       write(iebsfailinp,100) aline
2090,2091c2204,2208
< cjmm  Read Section 10
<       do i = 1,8
---
>       read(iebsfailtmp,100)aline
>       write(aline(1:11),fmt='(e11.4)') dkic
>       write(iebsfailinp,100) aline
>
>       do i = 1,2
2095a2213
> c ZW SCR478 05-07-04. Save dtini, dtmax:
2097c2215,2218
<       write(iebsfailinp,'(e24.4,a)') 1.e-3, aline(25:)
---
>       write(aline(1:23),fmt='(e11.4,1x,e11.4)') 1e-3, 1.e0
>       write(iebsfailinp,100) aline
>
> c ZW SCR478 05-07-04.  Saving  errel, errabs:
2099c2220,2222
<       write(iebsfailinp,'(e24.4,a)') 1.e0, aline(25:)
---
>       write(aline(1:23),fmt='(e11.4,1x,e11.4)') 1e-2, 1.e-30
>       write(iebsfailinp,100) aline
>
2101,2663c2224,2226
<       write(iebsfailinp,'(e24.4,a)') 1.e-2, aline(25:)
<       read(iebsfailtmp,100) aline
```

```
<       write(iebsfailinp,'(e24.4,a)') 1.e-30, aline(25:)
< cjmm 20061208 SCR672 File Reformatting.
< cjmm100   format(a60)
< cjmmc read comments from .tmp and write them with value tend
< cjmmc  (coming from .inp)  for input subroutine:
< cjmm      read(iebsfailtmp,100) aline
< cjmm      write(aline(1:10),fmt='(f10.2)') tend
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      do i = 1,2
< cjmm        read(iebsfailtmp,100) aline
< cjmm        write(iebsfailinp,100) aline
< cjmm      enddo
< cjmm
< cjmm      read(iebsfailtmp,100) aline
< cjmm      write(aline(1:15),fmt='(f7.4,1x,f7.4)') wplen, wpdia
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmmcc jwm 11-18-05; SCR607 pass fraction thickness penetration for corrosion failure
< cjmmc      write(aline(1:23),fmt='(e11.4,1x,e11.4)') cthick1,cthick2
< cjmm      write(aline(1:23),fmt='(e11.4,1x,e11.4)') cthick1*wppenetration,ct
< cjmm     &hick2
< cjmmcc end changes; SCR607
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc     Alloy thickness of the weld
< cjmm
< cjmm
< cjmm      READ(iebsfailtmp, 100) aline
< cjmmcc SCR607 add fraction thickness penetration for corrosion failure
< cjmmc      WRITE(aline(1:11), FMT = '(1pe11.4)') thickness
< cjmm      WRITE(aline(1:11), FMT = '(1pe11.4)') thickness*weldpenetration
< cjmmcc  end changes;SCR607
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmm      do i = 1,2
< cjmm        read(iebsfailtmp,100) aline
< cjmm        write(iebsfailinp,100) aline
< cjmm      enddo
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') grainr
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmC read nseries:
< cjmm      do i = 1,1
< cjmm        read(iebsfailtmp,100) aline
< cjmm        write(iebsfailinp,100) aline
< cjmm      enddo
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') gbthick
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') constant1
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      do i = 1,2
< cjmm        read(iebsfailtmp,100) aline
< cjmm        write(iebsfailinp,100) aline
< cjmm      enddo
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:24),fmt='(e11.4,2x,e11.4)') humdc1,humdc2
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') filmthk
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04
< cjmmc      read(iebsfailtmp,100)aline
< cjmmc      write(aline(1:11),fmt='(e11.4)') ctemp
< cjmmc      write(iebsfailinp,100) aline
< cjmm
< cjmm      READ(iebsfailtmp, 100) aline
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm      READ(iebsfailtmp, 100) aline
< cjmm      WRITE(iebsfailinp, 100) aline
```

```
< cjmm
< cjmm      READ(iebsfailtmp, 100) aline
< cjmm      WRITE(aline(1:11), FMT = '(1pe11.4)') ErpInt
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmm      READ(iebsfailtmp, 100) aline
< cjmm      WRITE(aline(1:11), FMT = '(1pe11.4)') TErpInt
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmm      READ(iebsfailtmp, 100) aline
< cjmm      WRITE(aline(1:11), FMT = '(1pe11.4)') ErpSlope
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmm      READ(iebsfailtmp, 100) aline
< cjmm      WRITE(aline(1:11), FMT = '(1pe11.4)') TErpSlope
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmmc  ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') clcritw
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc  ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') inhToClw
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc  ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') deltaEcInhW
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc     Process the drip shield weld surface fraction
< cjmm      READ(iebsfailtmp, 100) aline
< cjmm      WRITE(aline(1:11), FMT = '(1pe11.4)') frac_weld_surf
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmm      do i = 1,2
< cjmm        read(iebsfailtmp,100) aline
< cjmm        write(iebsfailinp,100) aline
< cjmm      enddo
< cjmm
< cjmmc ZW SCR478 05-07-04.  Saving xipto:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      WRITE(aline(1:11), FMT = '(e11.4)') -584.8
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04.  Saving pttemo:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      WRITE(aline(1:11), FMT = '(e11.4)') 3.92
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04.  Saving slpto:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      WRITE(aline(1:11), FMT = '(e11.4)') -24.5
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04.  Saving slpttemo:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      WRITE(aline(1:11), FMT = '(e11.4)') -1.1
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') xirpo
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') rptemo
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') slrpo
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') slrptemo
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04.  Saving xipti:
< cjmm      read(iebsfailtmp,100)aline
```

```
< cjmm      WRITE(aline(1:11), FMT = '(e11.4)') -200.0
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04.  Saving pttemi:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      WRITE(aline(1:11), FMT = '(e11.4)') 0.0
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04.  Saving slpti:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      WRITE(aline(1:11), FMT = '(e11.4)') -240.0
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04.  Saving slpttemi:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      WRITE(aline(1:11), FMT = '(e11.4)') 0.0
< cjmm      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') xirpi
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') rptemi
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') slrpi
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') slrptemi
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100) aline
< cjmm      write(iebsfailinp,100) aline
< cjmm      read(iebsfailtmp,100) aline
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') pHtran
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:24),fmt='(e11.4,2x,e11.4)') ire1hi, ire1lo
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:23),fmt='(e11.4,1x,e11.4)') beta1hi, beta1lo
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04
< cjmmc      READ(iebsfailtmp, 100) aline
< cjmmc      WRITE(aline(1:12), FMT = '(1pe12.5)') std_iO2o
< cjmmc      WRITE(iebsfailinp, 100) aline
< cjmmc      READ(iebsfailtmp, 100) aline
< cjmmc      WRITE(aline(1:11), FMT = '(1pe11.4)') EO2o
< cjmmc      WRITE(iebsfailinp, 100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 betaox1 deleted
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') betahy1
< cjmmc      write(aline(1:23),fmt='(e11.4,1x,e11.4)') betaox1,betahy1
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      do i = 1,1
< cjmm        read(iebsfailtmp,100) aline
< cjmm        write(iebsfailinp,100) aline
< cjmm      enddo
< cjmm
< cjmmc ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:23),fmt='(e11.4,1x,e11.4)') ire2hi, ire2lo
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
```

```
< cjmm      write(aline(1:23),fmt='(e11.4,1x,e11.4)') beta2hi,beta2lo
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 betaox2 deleted:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') betahy2
< cjmmc      write(aline(1:23),fmt='(e11.4,1x,e11.4)') betaox2,betahy2
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100) aline
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 rkox1 deleted:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') rkhy1
< cjmmc      write(aline(1:23),fmt='(e11.4,1x,e11.4)') rkox1,rkhy1
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:23),fmt='(e11.4,1x,e11.4)') g1hi,g1lo
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 gox1 deleted:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') ghy1
< cjmmc      write(aline(1:23),fmt='(e11.4,1x,e11.4)') gox1,ghy1
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 new: npH1hi,npH1lo
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:23),fmt='(e11.4,1x,e11.4)') npH1hi,npH1lo
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm
< cjmmc ZW SCR478 05-07-04 new. read defaults nO1hi, nO1lo in 1 line:
< cjmm      read(iebsfailtmp,100) aline
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc Read \  (comment):
< cjmm      read(iebsfailtmp,100) aline
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 rkox2 deleted:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') rkhy2
< cjmmc      write(aline(1:23),fmt='(e11.4,1x,e11.4)') rkox2,rkhy2
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:23),fmt='(e11.4,1x,e11.4)') g2hi,g2lo
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 gox2 deleted:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') ghy2
< cjmmc      write(aline(1:23),fmt='(e11.4,1x,e11.4)') gox2,ghy2
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:23),fmt='(e11.4,1x,e11.4)') npH2hi,npH2lo
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04 new.   Read defaults nO2hi, nO2lo
< cjmm      read(iebsfailtmp,100) aline
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100) aline
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc   ZW SCR478 05-07-04:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:21),fmt='(e11.4,1x,f4.1,1x,f4.1)')aa_1_1, 0.0, 0.0
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:21),fmt='(e11.4,1x,f4.1,1x,f4.1)')aa_2_1, 0.0, 0.0
< cjmm      write(iebsfailinp,100) aline
< cjmm
```

```
< cjmmc  ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') g1anod
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') g2anod
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') refTanod
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100) aline
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') eexpt
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') rcoef
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') rexpont
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') rcoef2
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') rexpont2
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:24),fmt='(e11.4,2x,e11.4)') cratehac
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') xcouple
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') xread
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') clcrit1
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') clcrit2
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc  ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') inhToCl1
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc  ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') inhToCl2
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc  ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') deltaEcInh1
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc  ZW SCR478 05-07-04 new:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') deltaEcInh2
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc     GADAMS SCR609 3-6-2006: Removed chloride factors
< cjmmc      read(iebsfailtmp,100)aline
< cjmmc      write(aline(1:11),fmt='(e11.4)') cfactor
< cjmmc      write(iebsfailinp,100) aline
< cjmmc     GADAMS SCR609 3-6-2006: End of change
```

```
< cjmm
< cjmmc  ZW SCR478 05-07-04.  Delete refph:
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') xgas
< cjmmc      write(aline(1:23),fmt='(e11.4,1x,e11.4)') xgas, refph
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:36),fmt='(3(e11.4,1x))') scalthk,taus,spor
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc     GADAMS SCR609 3-6-2006: Removed chloride factors
< cjmmc      read(iebsfailtmp,100)aline
< cjmmc      write(aline(1:11),fmt='(e11.4)') cfactor2
< cjmmc      write(iebsfailinp,100) aline
< cjmmc     GADAMS SCR609 3-6-2006: End of change
< cjmm
< cjmm      do i = 1,2
< cjmm        read(iebsfailtmp,100) aline
< cjmm        write(iebsfailinp,100) aline
< cjmm      enddo
< cjmm
< cjmmc     GADAMS SCR609 3-6-2006: Removed drip shield failure
< cjmmc     information from ebstrh.dat
< cjmmc      CALL getDSFailure(ds_time_mark, seismicFailDS, tim,
< cjmmc     &  ntim, fraction_failed_first, failure_time_first,
< cjmmc     &  fraction_failed_mark, fraction_failed_end_sim)
< cjmm
< cjmmc     Process the drip shield time mark
< cjmmc      READ(iebsfailtmp, 100) aline
< cjmmc      WRITE(aline(1:17), FMT = '(1pe17.10)') ds_time_mark
< cjmmc      WRITE(iebsfailinp, 100) aline
< cjmmc
< cjmmc     Process the first fraction of drip shields failed and
< cjmmc     the failure time for the first fraction.
< cjmmc      READ(iebsfailtmp, 100) aline
< cjmmc      WRITE(aline(1:29), FMT = '(1pe11.4, 1x, 1pe17.10)')
< cjmmc     &  fraction_failed_first, failure_time_first
< cjmmc      WRITE(iebsfailinp, 100) aline
< cjmmc
< cjmmc     Process the fraction failed at the time mark
< cjmmc      READ(iebsfailtmp, 100) aline
< cjmmc      WRITE(aline(1:11), FMT = '(1pe11.4)') fraction_failed_mark
< cjmmc      WRITE(iebsfailinp, 100) aline
< cjmmc
< cjmmc     Process the fraction failed at the end of simulation
< cjmmc      READ(iebsfailtmp, 100) aline
< cjmmc      WRITE(aline(1:11), FMT = '(1pe11.4)') fraction_failed_end_sim
< cjmmc      WRITE(iebsfailinp, 100) aline
< cjmmc
< cjmmc      do i = 1,2
< cjmmc        read(iebsfailtmp,100) aline
< cjmmc        write(iebsfailinp,100) aline
< cjmmc      enddo
< cjmmc     GADAMS SCR609 3-6-2006: End of change
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:24),fmt='(e11.4,2x,e11.4)') deltaEo, lamb
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:52),fmt='(4(e12.6,1x))') dense1,dense2,wtmol1,
< cjmm     & wtmol2
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      do i = 1,2
< cjmm        read(iebsfailtmp,100) aline
< cjmm        write(iebsfailinp,100) aline
< cjmm      enddo
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:23),fmt='(e11.4,1x,e11.4)') yieldstr, sfactor
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100)aline
< cjmm      write(aline(1:11),fmt='(e11.4)') dkic
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      do i = 1,2
< cjmm        read(iebsfailtmp,100) aline
< cjmm        write(iebsfailinp,100) aline
```

```
< cjmm      enddo
< cjmm
< cjmmc ZW SCR478 05-07-04. Save dtini, dtmax:
< cjmm      read(iebsfailtmp,100) aline
< cjmm      write(aline(1:23),fmt='(e11.4,1x,e11.4)') 1e-3, 1.e0
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmc ZW SCR478 05-07-04.  Saving  errel, errabs:
< cjmm      read(iebsfailtmp,100) aline
< cjmm      write(aline(1:23),fmt='(e11.4,1x,e11.4)') 1e-2, 1.e-30
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmm      read(iebsfailtmp,100) aline
< cjmm      write(iebsfailinp,100) aline
< cjmm
< cjmmcccccccccccccccccccccccccccccccccccccc
< cjmm
< cjmmc  ZW SCR478 05-07-04 future:
< cjmmc      read(iebsfailtmp,100)aline
< cjmmc      write(aline(1:11),fmt='(e11.4)') inhcToCl1
< cjmmc      write(iebsfailinp,100) aline
< cjmm
< cjmmc  ZW SCR478 05-07-04 future:
< cjmmc      read(iebsfailtmp,100)aline
< cjmmc      write(aline(1:11),fmt='(e11.4)') inhsToCl1
< cjmmc      write(iebsfailinp,100) aline
< cjmm
< cjmmc  ZW SCR478 05-07-04 future:
< cjmmc      read(iebsfailtmp,100)aline
< cjmmc      write(aline(1:11),fmt='(e11.4)') inhcToCl2
< cjmmC      write(iebsfailinp,100) aline
< cjmm
< cjmmc  ZW SCR478 05-07-04 future:
< cjmmc      read(iebsfailtmp,100)aline
< cjmmc      write(aline(1:11),fmt='(e11.4)') inhsToCl2
< cjmmc      write(iebsfailinp,100) aline
< cjmm
< cjmmc  ZW SCR478 05-07-04 future:
< cjmmc      read(iebsfailtmp,100)aline
< cjmmc      write(aline(1:11),fmt='(e11.4)') inhcToClw
< cjmmc      write(iebsfailinp,100) aline
< cjmm
< cjmmc  ZW SCR478 05-07-04 future:
< cjmmc      read(iebsfailtmp,100)aline
< cjmmc      write(aline(1:11),fmt='(e11.4)') inhsToClw
< cjmmc      write(iebsfailinp,100) aline
< cjmm
< cjmm
< cjmmc     Read weld failure headers
< cjmmc      READ(iebsfailtmp, 100) aline
< cjmmc     WRITE(iebsfailinp, 100) aline
< cjmmc      READ(iebsfailtmp, 100) aline
< cjmmc      WRITE(iebsfailinp, 100) aline
< cjmmc
< cjmmc      read(iebsfailtmp,100) aline
< cjmmc      write(iebsfailinp,100) aline
< cjmm
< cjmmc     getDSFailure.  This module evaluates the information from
< cjmmc     module seismo and returns failure times required for
< cjmmc     output to the ebstrh.dat file.
< cjmmc
< cjmmc     Read drip shield failure headers
< cjmmc      READ(iebsfailtmp, 100) aline
< cjmmc      WRITE(iebsfailinp, 100) aline
< cjmmc      READ(iebsfailtmp, 100) aline
< cjmmc      WRITE(iebsfailinp, 100) aline
< cjmmc
< cjmmc      read(iebsfailtmp,100) aline
< cjmmc      write(iebsfailinp,100) aline
< cjmm
< cjmmc     Read radiolysis headers
< cjmmc      READ(iebsfailtmp, 100) aline
< cjmmc      WRITE(iebsfailinp, 100) aline
< cjmmc      READ(iebsfailtmp, 100) aline
< cjmmc      WRITE(iebsfailinp, 100) aline
---
>       write(iebsfailinp,100) aline
>
> cccccccccccccccccccccccccccccccccccccccc
2664a2228,2286
> c  ZW SCR478 05-07-04 future:
```

```
> c      read(iebsfailtmp,100)aline
> c      write(aline(1:11),fmt='(e11.4)') inhcToCl1
> c      write(iebsfailinp,100) aline
>
> c  ZW SCR478 05-07-04 future:
> c      read(iebsfailtmp,100)aline
> c      write(aline(1:11),fmt='(e11.4)') inhsToCl1
> c      write(iebsfailinp,100) aline
>
> c  ZW SCR478 05-07-04 future:
> c      read(iebsfailtmp,100)aline
> c      write(aline(1:11),fmt='(e11.4)') inhcToCl2
> C      write(iebsfailinp,100) aline
>
> c  ZW SCR478 05-07-04 future:
> c      read(iebsfailtmp,100)aline
> c      write(aline(1:11),fmt='(e11.4)') inhsToCl2
> c      write(iebsfailinp,100) aline
>
> c  ZW SCR478 05-07-04 future:
> c      read(iebsfailtmp,100)aline
> c      write(aline(1:11),fmt='(e11.4)') inhcToClw
> c      write(iebsfailinp,100) aline
>
> c  ZW SCR478 05-07-04 future:
> c      read(iebsfailtmp,100)aline
> c      write(aline(1:11),fmt='(e11.4)') inhsToClw
> c      write(iebsfailinp,100) aline
>
>
> c     Read weld failure headers
> c      READ(iebsfailtmp, 100) aline
> c     WRITE(iebsfailinp, 100) aline
> c      READ(iebsfailtmp, 100) aline
> c      WRITE(iebsfailinp, 100) aline
> c
> c      read(iebsfailtmp,100) aline
> c      write(iebsfailinp,100) aline
>
> c     getDSFailure.  This module evaluates the information from
> c     module seismo and returns failure times required for
> c     output to the ebstrh.dat file.
> c
> c     Read drip shield failure headers
> c      READ(iebsfailtmp, 100) aline
> c      WRITE(iebsfailinp, 100) aline
> c      READ(iebsfailtmp, 100) aline
> c      WRITE(iebsfailinp, 100) aline
> c
> c      read(iebsfailtmp,100) aline
> c      write(iebsfailinp,100) aline
>
> c     Read radiolysis headers
> c      READ(iebsfailtmp, 100) aline
> c      WRITE(iebsfailinp, 100) aline
> c      READ(iebsfailtmp, 100) aline
> c      WRITE(iebsfailinp, 100) aline
>
2672,2674d2293
< cjmm end SCR672 modifications
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
<
3161,3163d2779
< cjmm 20061208 SCR672 File Reformatting.
< cjmm end SCR672 modifications
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
```

ATTACHMENT D

ebsrel differences:

```
128,129d127
< cc jmm 01/26/06; SCR672; ebsrel.def reformat
< cc
2127,2132c2125,2126
< cjmm 20061208 SCR672 File Reformatting.
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
< cjmmC   COPY LINES 1 - 3                    ! OLD FORMAT
< cjmm      do i = 1, 3                       ! OLD FORMAT
< cjmm  COPY 33 HEADER LINES (including blanks)
<       do i = 1, 33
---
> C   COPY LINES 1 - 3
>       do i = 1, 3
2151c2145
< cjmm  read(iebsreltmp, 100 ) aline
---
>       read(iebsreltmp, 100 ) aline
2160,2169c2154,2157
< cjmm  write( aline(1:32), fmt='(1pe14.5,1x,1pe14.5)' )
< cjmm &       XCON, SAWETFRAC
< cjmmLINE 4                                  ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm LINE 34
<       read(iebsreltmp, 100 ) aline
<       write(iebsrelinp,'(1pe24.5,a)') XCON, aline(25:)
< cjmm LINE 35
<       read(iebsreltmp, 100 ) aline
<       write(iebsrelinp,'(1pe24.5,a)') SAWETFRAC, aline(25:)
---
>       write( aline(1:32), fmt='(1pe14.5,1x,1pe14.5)' )
>      &       XCON, SAWETFRAC
> C   LINE 4
>       write(iebsrelinp, 100 ) aline
2173,2174c2161
< cjmmC   LINE 5 - LINE 11 OLD FORMAT
< cjmm  LINE 36 - LINE 49
---
> C   LINE 5 - LINE 11
2180,2184d2166
< cjmm     read(iebsreltmp, 100 ) aline
< cjmm     write( aline(1:24),fmt='(1pe12.5, I12)' )
< cjmm &        releasewpfailedtime(2,1),
< cjmm &        nint(releasewpfailedtime(1,1) * wp_frac)  !init
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
2186,2191c2168,2171
<          write(iebsrelinp,'(1pe24.5,a)') releasewpfailedtime(2,1),
<      &                                   aline(25:)
< cjmm     write( aline(1:24),fmt='(1pe12.5, I12)' )
< cjmm &        releasewpfailedtime(2,1),
< cjmm &        nint(releasewpfailedtime(1,1) * wp_frac)  !init
< cjmm     write(iebsrelinp, 100 ) aline
---
>          write( aline(1:24),fmt='(1pe12.5, I12)' )
>      &        releasewpfailedtime(2,1),
>      &        nint(releasewpfailedtime(1,1) * wp_frac)  !init
>          write(iebsrelinp, 100 ) aline
2193,2195c2173,2176
<          write(iebsrelinp,'(I24,a)') nint(releasewpfailedtime(1,1)
<      &                                * wp_frac), aline(25:)
<
---
>          write( aline(1:24),fmt='(1pe12.5, I12)' )
>      &        releasewpfailedtime(2,2),
>      &        nint(releasewpfailedtime(1,2) * wp_frac)  !fault
>          write(iebsrelinp, 100 ) aline
2197,2202c2178,2181
<          write(iebsrelinp,'(1pe24.5,a)') releasewpfailedtime(2,2),
<      &                                   aline(25:)
< cjmm     write( aline(1:24),fmt='(1pe12.5, I12)' )
< cjmm &        releasewpfailedtime(2,2),
< cjmm &        nint(releasewpfailedtime(1,2) * wp_frac)  !fault
< cjmm     write(iebsrelinp, 100 ) aline
---
>          write( aline(1:24),fmt='(1pe12.5, I12)' )
>      &        releasewpfailedtime(2,3),
>      &        nint(releasewpfailedtime(1,3) * wp_frac)  !volcano
>          write(iebsrelinp, 100 ) aline
```

```
2204,2207c2183,2186
<          write(iebsrelinp,'(I24,a)') nint(releasewpfailedtime(1,2)
<      &                                * wp_frac), aline(25:)
<
<
---
>          write( aline(1:24),fmt='(1pe12.5,I12)' )
>      &        releasewpfailedtime(2,4),
>      &        nint(releasewpfailedtime(1,4) * wp_frac)  !seismo1
>          write(iebsrelinp, 100 ) aline
2209,2214c2188,2191
<          write(iebsrelinp,'(1pe24.5,a)') releasewpfailedtime(2,3),
<      &                                   aline(25:)
< cjmm     write( aline(1:24),fmt='(1pe12.5, I12)' )
< cjmm &       releasewpfailedtime(2,3),
< cjmm &       nint(releasewpfailedtime(1,3) * wp_frac)  !volcano
< cjmm     write(iebsrelinp, 100 ) aline
---
>          write( aline(1:24),fmt='(1pe12.5, I12)' )
>      &        releasewpfailedtime(2,5),
>      &        nint(releasewpfailedtime(1,5) * wp_frac)  !seismo2
>          write(iebsrelinp, 100 ) aline
2216,2219c2193,2196
<          write(iebsrelinp,'(I24,a)') nint(releasewpfailedtime(1,3)
<      &                                * wp_frac), aline(25:)
<
<
---
>          write( aline(1:24),fmt='(1pe12.5, I12)' )
>      &        releasewpfailedtime(2,6),
>      &        nint(releasewpfailedtime(1,6) * wp_frac)  !seismo3
>          write(iebsrelinp, 100 ) aline
2221,2266c2198,2201
<          write(iebsrelinp,'(1pe24.5,a)') releasewpfailedtime(2,4),
<      &                                   aline(25:)
< cjmm     write( aline(1:24),fmt='(1pe12.5,I12)' )
< cjmm &       releasewpfailedtime(2,4),
< cjmm &       nint(releasewpfailedtime(1,4) * wp_frac)  !seismo1
< cjmm     write(iebsrelinp, 100 ) aline
<          read(iebsreltmp, 100 ) aline
<          write(iebsrelinp,'(I24,a)') nint(releasewpfailedtime(1,4)
<      &                                * wp_frac), aline(25:)
<
<
<          read(iebsreltmp, 100 ) aline
<          write(iebsrelinp,'(1pe24.5,a)') releasewpfailedtime(2,5),
<      &                                   aline(25:)
< cjmm     write( aline(1:24),fmt='(1pe12.5, I12)' )
< cjmm &       releasewpfailedtime(2,5),
< cjmm &       nint(releasewpfailedtime(1,5) * wp_frac)  !seismo2
< cjmm     write(iebsrelinp, 100 ) aline
<          read(iebsreltmp, 100 ) aline
<          write(iebsrelinp,'(I24,a)') nint(releasewpfailedtime(1,5)
<      &                                * wp_frac), aline(25:)
<
<
<          read(iebsreltmp, 100 ) aline
<          write(iebsrelinp,'(1pe24.5,a)') releasewpfailedtime(2,6),
<      &                                   aline(25:)
< cjmm     write( aline(1:24),fmt='(1pe12.5, I12)' )
< cjmm &       releasewpfailedtime(2,6),
< cjmm &       nint(releasewpfailedtime(1,6) * wp_frac)  !seismo3
< cjmm     write(iebsrelinp, 100 ) aline
<          read(iebsreltmp, 100 ) aline
<          write(iebsrelinp,'(I24,a)') nint(releasewpfailedtime(1,6)
<      &                                * wp_frac), aline(25:)
<
<
<          read(iebsreltmp, 100 ) aline
<          write(iebsrelinp,'(1pe24.5,a)') releasewpfailedtime(2,7),
<      &                                   aline(25:)
< cjmm     write( aline(1:24),fmt='(1pe12.5, I12)' )
< cjmm &       releasewpfailedtime(2,7),
< cjmm &       nint(releasewpfailedtime(1,7) * wp_frac)  !seismo4
< cjmm     write(iebsrelinp, 100 ) aline
<          read(iebsreltmp, 100 ) aline
<          write(iebsrelinp,'(I24,a)') nint(releasewpfailedtime(1,7)
<      &                                * wp_frac), aline(25:)
<
---
>          write( aline(1:24),fmt='(1pe12.5, I12)' )
```

```
>      &        releasewpfailedtime(2,7),
>      &        nint(releasewpfailedtime(1,7) * wp_frac)  !seismo4
>          write(iebsrelinp, 100 ) aline
2294,2296c2229,2230
< cjmmC   Copy two lines  LINE 12 - LINE 13       ! OLD FORMAT
< cjmm  Copy seven lines  LINE 50 - LINE 56
<       do i = 1, 7
---
> C   Copy two lines  LINE 12 - LINE 13
>       do i = 1, 2
2306d2239
< cjmm      LINES 57-59
2308,2312c2241,2244
< cjmm      write( aline(1:30), fmt='(1pe14.5,2h, 1pe14.5)' ) DINTL, XINTL
< cjmm      write(iebsrelinp, 100 ) aline
<       write(iebsrelinp,'(1pe24.5,a)') DINTL, aline(25:)
<       read(iebsreltmp, 100 ) aline
<       write(iebsrelinp,'(1pe24.5,a)') XINTL, aline(25:)
---
>       write( aline(1:30), fmt='(1pe14.5,2h, 1pe14.5)' ) DINTL, XINTL
> C   LINE 14
>       write(iebsrelinp, 100 ) aline
>
2315,2318c2247,2249
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) XVOL
<       write(iebsrelinp,'(1pe24.5,a)') XVOL, aline(25:)
< cjmmC   LINE 15                          ! OLD FORMAT
< cjmm      write(iebsrelinp, 100 ) aline
---
>       write( aline(1:14), fmt='(1pe14.5)' ) XVOL
> C   LINE 15
>       write(iebsrelinp, 100 ) aline
2320,2322c2251,2252
< cjmmC   Copy LINE 16 - LINE 18          ! OLD FORMAT
< C   Copy six lines, LINE 60 - LINE 65
<       do i = 1,6
---
> C   Copy LINE 16 - LINE 18
>       do i = 1,3
2327c2257
< cjmm  Read temp filename, LINE 66
---
>       CTEMP = valuesp(i_ctemp)
2328a2259,2260
>       write( aline(1:14), fmt='(1pe14.5)' ) CTEMP
> C   LINE 19
2331,2339c2263,2264
<       CTEMP = valuesp(i_ctemp)
<       read(iebsreltmp, 100 ) aline
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) CTEMP
< cjmm  write(iebsrelinp, 100 ) aline
<       write(iebsrelinp,'(1pe24.5,a)') CTEMP, aline(25:)
<
< cjmmC   Copy 3 lines  LINE 20 - LINE 22 ! OLD FORMAT
< cjmm  Copy 5 lines  LINE 68 - LINE 72
<       do i = 1, 5
---
> C   Copy 3 lines  LINE 20 - LINE 22
>       do i = 1, 3
2344,2350c2269,2270
< cjmm  copy hydfil filename, flow parameters file, ebsflo.dat, LINE 73
<       read(iebsreltmp, 100 ) aline
<       write(iebsrelinp, 100 ) aline
<
< cjmmC   Copy 3 lines  LINE 23 - LINE 25 ! OLD FORMAT
< C   Copy 6 lines  LINE 74 - LINE 79
<       do i = 1, 6
---
> C   Copy 3 lines  LINE 23 - LINE 25
>       do i = 1, 3
2362,2366c2282,2284
< cjmm  write( aline(1:14), fmt='(e14.5)' ) AMASSC
< cjmm C   LINE 26                         ! OLD FORMAT
< cjmm  LINE 80
< cjmm  write(iebsrelinp, 100 ) aline
<       write(iebsrelinp,'(1pe24.5,a)') AMASSC, aline(25:)
---
>       write( aline(1:14), fmt='(e14.5)' ) AMASSC
> C   LINE 26
>       write(iebsrelinp, 100 ) aline
2370,2375c2288,2291
```

```
< cjmm  write( aline(1:23), fmt='(1pe14.5)' )
< cjmm &   FUEDEN
< cjmmC   LINE 27                          ! OLD FORMAT
< C   LINE 81
< cjmm  write(iebsrelinp, 100 ) aline
<       write(iebsrelinp,'(1pe24.5,a)') FUEDEN, aline(25:)
---
>       write( aline(1:23), fmt='(1pe14.5)' )
>      &   FUEDEN
> C   LINE 27
>       write(iebsrelinp, 100 ) aline
2377,2379c2293,2294
< cjmmC   Copy 2 lines  LINE 28 - LINE 29 ! OLD FORMAT
< C   Copy 27 lines  LINE 82 - LINE 108
<       do i = 1, 27
---
> C   Copy 2 lines  LINE 28 - LINE 29
>       do i = 1, 2
2426,2427c2341
< cjmmC   LINE 30 - LINE 37                ! OLD FORMAT
< C   LINE 109 - LINE 124
---
> C   LINE 30 - LINE 37
2430,2435c2344,2345
< cjmm  write( aline(1:16),fmt='(1pe12.5,2x,i2)' ) wetfraci,iwatcont(1)  !init
< cjmm  write(iebsrelinp, 100 ) aline
<       write(iebsrelinp,'(1pe24.5,a)') wetfraci, aline(25:)
<       read(iebsreltmp, 100 ) aline
<       write(iebsrelinp,'(i24,a)') iwatcont(1), aline(25:)
<
---
>       write( aline(1:16),fmt='(1pe12.5,2x,i2)' ) wetfraci,iwatcont(1)  !init
>       write(iebsrelinp, 100 ) aline
2438,2443c2348,2349
< cjmm  write( aline(1:16),fmt='(1pe12.5,2x,i2)' ) wetfracf,iwatcont(2)  !fault
< cjmm  write(iebsrelinp, 100 ) aline
<       write(iebsrelinp,'(1pe24.5,a)') wetfracf, aline(25:)
<       read(iebsreltmp, 100 ) aline
<       write(iebsrelinp,'(i24,a)') iwatcont(2), aline(25:)
<
---
>       write( aline(1:16),fmt='(1pe12.5,2x,i2)' ) wetfracf,iwatcont(2)  !fault
>       write(iebsrelinp, 100 ) aline
2446,2451c2352,2353
< cjmm  write( aline(1:16),fmt='(1pe12.5,2x,i2)' ) wetfracv,iwatcont(3)  !volcano
< cjmm  write(iebsrelinp, 100 ) aline
<       write(iebsrelinp,'(1pe24.5,a)') wetfracv, aline(25:)
<       read(iebsreltmp, 100 ) aline
<       write(iebsrelinp,'(i24,a)') iwatcont(3), aline(25:)
<
---
>       write( aline(1:16),fmt='(1pe12.5,2x,i2)' ) wetfracv,iwatcont(3)  !volcano
>       write(iebsrelinp, 100 ) aline
2455,2459c2357,2358
< cjmm    write(aline(1:16),fmt='(1pe12.5,2x,i2)')wetfracs,iwatcont(i+3)  !seismo1,2,3,4
< cjmm    write(iebsrelinp, 100 ) aline
<         write(iebsrelinp,'(1pe24.5,a)') wetfracs, aline(25:)
<         read(iebsreltmp, 100 ) aline
<         write(iebsrelinp,'(i24,a)') iwatcont(i+3), aline(25:)
---
>         write(aline(1:16),fmt='(1pe12.5,2x,i2)')wetfracs,iwatcont(i+3)  !seismo1,2,3,4
>         write(iebsrelinp, 100 ) aline
2461d2359
<
2464,2468c2362,2363
< cjmm  write( aline(1:16),fmt='(1pe12.5,2x,i2)' ) wetfracc,iwatcont(8)  !corrosion
< cjmm  write(iebsrelinp, 100 ) aline
<       write(iebsrelinp,'(1pe24.5,a)') wetfracc, aline(25:)
<       read(iebsreltmp, 100 ) aline
<       write(iebsrelinp,'(i24,a)') iwatcont(8), aline(25:)
---
>       write( aline(1:16),fmt='(1pe12.5,2x,i2)' ) wetfracc,iwatcont(8)  !corrosion
>       write(iebsrelinp, 100 ) aline
2481,2486c2376,2380
< cjmm  write( aline(1:16),
< cjmm & fmt='(i2,2x,1pe12.3)') IMODEL
< cjmmC   LINE 38                          ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  LINE 125
<       write(iebsrelinp,'(i24,a)') IMODEL, aline(25:)
---
```

```
>       write( aline(1:16),
>      & fmt='(i2,2x,1pe12.3)') IMODEL
> C   LINE 38
>       write(iebsrelinp, 100 ) aline
>
2488,2498c2382,2386
< cjmm  write( aline(1:32),
< cjmm & fmt='(1pe10.3,1x,1pe10.3,1x,1pe10.3)')
< cjmm & PHVALUE, OXGNOVPR, CC03
< cjmmC   LINE 39                          ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  LINE 126-128
<       write(iebsrelinp,'(1pe24.3,a)') PHVALUE, aline(25:)
<       read(iebsreltmp, 100 ) aline
<       write(iebsrelinp,'(1pe24.3,a)') OXGNOVPR, aline(25:)
<       read(iebsreltmp, 100 ) aline
<       write(iebsrelinp,'(1pe24.3,a)') CC03, aline(25:)
---
>       write( aline(1:32),
>      & fmt='(1pe10.3,1x,1pe10.3,1x,1pe10.3)')
>      & PHVALUE, OXGNOVPR, CC03
> C   LINE 39
>       write(iebsrelinp, 100 ) aline
2501,2506c2389,2392
< cjmm  write( aline(1:12),
< cjmm & fmt='(1pe12.3)') usrlrate
< cjmmC   LINE 40                          ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  LINE 129
<       write(iebsrelinp,'(1pe24.3,a)') usrlrate, aline(25:)
---
>       write( aline(1:12),
>      & fmt='(1pe12.3)') usrlrate
> C   LINE 40
>       write(iebsrelinp, 100 ) aline
2509,2514c2395,2398
< cjmm  write( aline(1:12),
< cjmm & fmt='(1pe12.3)') preexpo
< cjmmC   LINE 41                          ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  LINE 130
<       write(iebsrelinp,'(1pe24.3,a)') preexpo, aline(25:)
---
>       write( aline(1:12),
>      & fmt='(1pe12.3)') preexpo
> C   LINE 41
>       write(iebsrelinp, 100 ) aline
2516d2399
<
2519,2524c2402,2405
< cjmm  write( aline(1:12),
< cjmm & fmt='(1pe12.3)') ratefactor
< cjmmC   LINE 42                          ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  LINE 131
<       write(iebsrelinp,'(1pe24.3,a)') ratefactor, aline(25:)
---
>       write( aline(1:12),
>      & fmt='(1pe12.3)') ratefactor
> C   LINE 42
>       write(iebsrelinp, 100 ) aline
2526,2527c2407
< cjmmC   Copy LINE 43 - LINE 47           ! OLD FORMAT
< cjmm  Copy 5 lines, LINES 132 - 136
---
> C   Copy LINE 43 - LINE 47
2533c2413
< cjmm  Copy elefil filename, "ebspac.nuc" LINE 137
---
>       R0Z = valuesp(i_r0z)
2534a2415,2416
>       write( aline(1:14), fmt='(1pe14.5)' ) R0Z
> C   LINE 48
2537,2550d2418
< cjmm  Copy 9 lines, LINES 138 - 146
<       do i = 1, 9
<         read(iebsreltmp, 100 ) aline
<         write(iebsrelinp, 100 ) aline
<       enddo
<
<       R0Z = valuesp(i_r0z)
```

```
<       read(iebsreltmp, 100 ) aline
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) R0Z
< cjmmC   LINE 48                          ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  LINE 147
<       write(iebsrelinp,'(1pe24.5,a)') R0Z, aline(25:)
<
2567,2572c2435,2437
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) claddingcorfact
< cjmmC   LINE 49                          ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  LINE 148
<       write(iebsrelinp,'(1pe24.5,a)') claddingcorfact, aline(25:)
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
---
>       write( aline(1:14), fmt='(1pe14.5)' ) claddingcorfact
> C   LINE 49
>       write(iebsrelinp, 100 ) aline
2574d2438
<
2578,2582c2442,2444
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) CLADVE
< cjmmC   glass & cladding LINE 50         ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  LINE 149
<       write(iebsrelinp,'(1pe24.5,a)') CLADVE, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) CLADVE
> C   glass & cladding LINE 50
>       write(iebsrelinp, 100 ) aline
2587,2591c2449,2451
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) ELTUBE
< cjmmC   glass & cladding LINE 51         ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  LINE 150
<       write(iebsrelinp,'(1pe24.5,a)') ELTUBE, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) ELTUBE
> C   glass & cladding LINE 51
>       write(iebsrelinp, 100 ) aline
2596,2600c2456,2458
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) RROD
< cjmmC   glass & cladding LINE 52         ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  LINE 151
<       write(iebsrelinp,'(1pe24.5,a)') RROD, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) RROD
> C   glass & cladding LINE 52
>       write(iebsrelinp, 100 ) aline
2606c2464
< cjmmcjmmC   glass & cladding LINE 55
---
> cjmmC   glass & cladding LINE 55
2633,2636c2491,2492
< cjmmC   Copy LINE 53 - LINE 54   ! OLD FORMAT
< cjmm  do i = 1, 2
< cjmm  Copy 12 lines, Copy LINE 152 - LINE 163
<       do i = 1, 12
---
> C   Copy LINE 53 - LINE 54
>       do i = 1, 2
2645,2649c2501,2503
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) SIMGLASS
< cjmmC   glass & cladding LINE 55         ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 164
<       write(iebsrelinp,'(1pe24.5,a)') SIMGLASS, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) SIMGLASS
> C   glass & cladding LINE 55
>       write(iebsrelinp, 100 ) aline
2653,2657c2507,2509
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) PHGLASS
< cjmmC   glass & cladding LINE 56         ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 165
<       write(iebsrelinp,'(1pe24.5,a)') PHGLASS, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) PHGLASS
> C   glass & cladding LINE 56
```

```
>       write(iebsrelinp, 100 ) aline
2661,2665c2513,2515
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) RLOGKEFFHI
< cjmmC   glass & cladding LINE 57        ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 166
<       write(iebsrelinp,'(1pe24.5,a)') RLOGKEFFHI, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) RLOGKEFFHI
> C   glass & cladding LINE 57
>       write(iebsrelinp, 100 ) aline
2669,2673c2519,2521
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) ETAHI
< cjmmC   glass & cladding LINE 58        ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 167
<       write(iebsrelinp,'(1pe24.5,a)') ETAHI, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) ETAHI
> C   glass & cladding LINE 58
>       write(iebsrelinp, 100 ) aline
2677,2681c2525,2527
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) EAHI
< cjmmC   glass & cladding LINE 59        ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 168
<       write(iebsrelinp,'(1pe24.5,a)') EAHI, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) EAHI
> C   glass & cladding LINE 59
>       write(iebsrelinp, 100 ) aline
2685,2689c2531,2533
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) RLOGKEFFLOW
< cjmmC   glass & cladding LINE 60        ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 169
<       write(iebsrelinp,'(1pe24.5,a)') RLOGKEFFLOW, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) RLOGKEFFLOW
> C   glass & cladding LINE 60
>       write(iebsrelinp, 100 ) aline
2693,2697c2537,2539
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) ETALOW
< cjmmC   glass & cladding LINE 61        ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 170
<       write(iebsrelinp,'(1pe24.5,a)') ETALOW, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) ETALOW
> C   glass & cladding LINE 61
>       write(iebsrelinp, 100 ) aline
2701,2705c2543,2545
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) EALOW
< cjmmC   glass & cladding LINE 62        ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 171
<       write(iebsrelinp,'(1pe24.5,a)') EALOW, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) EALOW
> C   glass & cladding LINE 62
>       write(iebsrelinp, 100 ) aline
2707,2710c2547,2548
< cjmmC   Copy LINE 63 - LINE 64  ! OLD FORMAT
< cjmm  do i = 1, 2
< cjmm  Copy 11 lines, Copy LINE 172 - LINE 182
<       do i = 1, 11
---
> C   Copy LINE 63 - LINE 64
>       do i = 1, 2
2720,2724c2558,2560
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) CR_LENGTH
< cjmmC   glass & cladding LINE 65        ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 183
<       write(iebsrelinp,'(1pe24.5,a)') CR_LENGTH, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) CR_LENGTH
> C   glass & cladding LINE 65
>       write(iebsrelinp, 100 ) aline
2728,2732c2564,2566
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) CR_AREA_A
```

```
< cjmmC   glass & cladding LINE 66        ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 184
<       write(iebsrelinp,'(1pe24.5,a)') CR_AREA_A, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) CR_AREA_A
> C   glass & cladding LINE 66
>       write(iebsrelinp, 100 ) aline
2736,2740c2570,2572
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) CR_AREA_B
< cjmmC   glass & cladding LINE 67        ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 185
<       write(iebsrelinp,'(1pe24.5,a)') CR_AREA_B, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) CR_AREA_B
> C   glass & cladding LINE 67
>       write(iebsrelinp, 100 ) aline
2744,2748c2576,2578
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) EL_INTERNAL
< cjmmC   glass & cladding LINE 68        ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 186
<       write(iebsrelinp,'(1pe24.5,a)') EL_INTERNAL, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) EL_INTERNAL
> C   glass & cladding LINE 68
>       write(iebsrelinp, 100 ) aline
2752,2756c2582,2584
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) A_INTERNAL
< cjmmC   glass & cladding LINE 69        ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 187
<       write(iebsrelinp,'(1pe24.5,a)') A_INTERNAL, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) A_INTERNAL
> C   glass & cladding LINE 69
>       write(iebsrelinp, 100 ) aline
2760,2764c2588,2590
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) D_WATER
< cjmmC   glass & cladding LINE 70        ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 188
<       write(iebsrelinp,'(1pe24.5,a)') D_WATER, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) D_WATER
> C   glass & cladding LINE 70
>       write(iebsrelinp, 100 ) aline
2768,2772c2594,2596
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) FTILT
< cjmmC   glass & cladding LINE 71        ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 189
<       write(iebsrelinp,'(1pe24.5,a)') FTILT, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) FTILT
> C   glass & cladding LINE 71
>       write(iebsrelinp, 100 ) aline
2774,2777c2598,2599
< cjmmC   Copy 22 lines  LINE 72 to LINE 93       ! OLD FORMAT
< cjmm  do i = 1, 22
< cjmmC   Copy 71 lines, LINE 190 to LINE 260
<       do i = 1, 71
---
> C   Copy 22 lines  LINE 72 to LINE 93
>       do i = 1, 22
2784,2788c2606,2608
< cjmm  write( aline(1:14), fmt='(1pe14.5)' ) DRIFTDIA
< cjmmc   LINE 94 ! OLD FORMAT
< cjmm  write(iebsrelinp, 100 ) aline
< cjmm  Line 261
<       write(iebsrelinp,'(1pe24.5,a)') DRIFTDIA, aline(25:)
---
>       write( aline(1:14), fmt='(1pe14.5)' ) DRIFTDIA
> c   LINE 94
>       write(iebsrelinp, 100 ) aline
2790,2792c2610
< cjmmc   LINE 95 - 103  (until "\END" is read)   ! OLD FORMAT
< cjmm  Read/Write Remainder of file, LINE 262 - 284  (until "\END" is read)   ! OLD FORMAT
< cjmm end SCR672 modifications
---
```

```
> c   LINE 95 - 103  (until "\END" is read)
4613,4616d4430
< cjmm 20061208 SCR672 File Reformatting.
< cjmm end SCR672 modifications
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
<
```

ATTACHMENT E

failt.f differences:

```
69,70d68
< c 12-08-06 jmm     SCR672
< c
2597a2596
>        integer i
2599c2598,2599
<        INTEGER i
---
> c     read basic control parameters
> c            first card is a comment line
2601,2614c2601,2606
< cjmmc        read basic control parameters
< cjmmc        first card is a comment line
< cjmm
< cjmm        read (9, *)
< cjmm
< cjmmc        end time of simulation in years.
<
< cjmm 20061208 SCR672 File Reformatting.
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
< cjmm    read 17 initial comment lines.
<         do i = 1, 17
<            read (9, *)
<         enddo
< cjmm end SCR672 modifications
---
>         read (9, *)
>
> c     end time of simulation in years.
>
>         read (9, *)
>         read (9, *)
2620,2627c2612,2614
<         do i = 1, 9
<            read (9, *)
<         enddo
< cjmm    read (9, *)
< cjmm    read (9, *)
< cjmm    read (9, *) wplen, wpdia
<         read (9, *) wplen
<         read (9, *) wpdia
---
>         read (9, *)
>         read (9, *)
>         read (9, *) wplen, wpdia
2629,2631c2616
< cjmm    read (9, *) cthick1, cthick2
<         read (9, *) cthick1
<         read (9, *) cthick2
---
>         read (9, *) cthick1, cthick2
2640,2644c2625,2626
<         do i = 1, 8
<            read (9, *)
<         enddo
< cjmm    read (9, *)
< cjmm    read (9, *)
---
>         read (9, *)
>         read (9, *)
2657,2664c2639,2641
<         do i = 1, 7
<            read (9, *)
<         enddo
< cjmm    read (9, *)
< cjmm    read (9, *)
< cjmm    read (9, *) humdc1,humdc2
<         read (9, *) humdc1
<         read (9, *) humdc2
---
>         read (9, *)
>         read (9, *)
>         read (9, *) humdc1,humdc2
2670,2674c2647,2648
<         do i = 1, 12
<            read (9, *)
<         enddo
```

```
< cjmm     read (9, *)
< cjmm     read (9, *)
---
>          read (9, *)
>          read (9, *)
2694,2698c2668,2669
<          do i = 1, 22
<             read (9, *)
<          enddo
< cjmm     read (9, *)
< cjmm     read (9, *)
---
>          read (9, *)
>          read (9, *)
2736,2740c2707,2708
<          do i = 1, 65
<             read (9, *)
<          enddo
< cjmm     read (9, *)
< cjmm     read (9, *)
---
>          read (9,*)
>          read (9,*)
2742,2747c2710,2711
< cjmm     read (9,*) ire1hi,ire1lo
<          read (9,*) ire1hi
<          read (9,*) ire1lo
< cjmm     read (9,*) beta1hi, beta1lo
<          read (9,*) beta1hi
<          read (9,*) beta1lo
---
>          read (9,*) ire1hi,ire1lo
>          read (9,*) beta1hi, beta1lo
2749c2713
< cjmm     read (9, *)
---
>          read (9, *)
2754,2759c2718,2719
< cjmm     read (9,*) ire2hi,ire2lo
<          read (9,*) ire2hi
<          read (9,*) ire2lo
< cjmm     read (9,*) beta2hi, beta2lo
<          read (9,*) beta2hi
<          read (9,*) beta2lo
---
>          read (9,*) ire2hi,ire2lo
>          read (9,*) beta2hi, beta2lo
2761c2721
< cjmm     read (9, *)
---
>          read (9, *)
2767,2769c2727
< cjmm     read (9,*) g1hi, g1lo
<          read (9,*) g1hi
<          read (9,*) g1lo
---
>          read (9,*) g1hi, g1lo
2771,2777c2729,2731
< cjmm     read (9,*) npH1hi, npH1lo
<          read (9,*) npH1hi
<          read (9,*) npH1lo
< cjmm     read (9,*) nO1hi, nO1lo
<          read (9,*) nO1hi
<          read (9,*) nO1lo
< cjmm     read (9,*)
---
>          read (9,*) npH1hi, npH1lo
>          read (9,*) nO1hi, nO1lo
>          read (9,*)
2784,2786c2738
< cjmm     read (9,*) g2hi, g2lo
<          read (9,*) g2hi
<          read (9,*) g2lo
---
>          read (9,*) g2hi, g2lo
2788,2794c2740,2742
< cjmm     read (9,*) npH2hi, npH2lo
<          read (9,*) npH2hi
<          read (9,*) npH2lo
< cjmm     read (9,*) nO2hi, nO2lo
<          read (9,*) nO2hi
```

```
<         read (9,*) nO2lo
< cjmm    read (9,*)
---
>         read (9,*) npH2hi, npH2lo
>         read (9,*) nO2hi, nO2lo
>         read (9,*)
2800,2807c2748,2749
< cjmm    read (9, *) aa(1, 1), aa(1, 2), aa(1, 3)
<         read (9, *) aa(1, 1)
<         read (9, *) aa(1, 2)
<         read (9, *) aa(1, 3)
< cjmm    read (9, *) aa(2, 1), aa(2, 2), aa(2, 3)
<         read (9, *) aa(2, 1)
<         read (9, *) aa(2, 2)
<         read (9, *) aa(2, 3)
---
>         read (9, *) aa(1, 1), aa(1, 2), aa(1, 3)
>         read (9, *) aa(2, 1), aa(2, 2), aa(2, 3)
2811c2753
< cjmm    read (9,*)
---
>         read (9,*)
2849,2852c2791
< cjmm    read (9, *) scalthk, taus, spor
<         read (9, *) scalthk
<         read (9, *) taus
<         read (9, *) spor
---
>         read (9, *) scalthk, taus, spor
2878,2882c2817,2818
<         do i = 1, 10
<            read (9, *)
<         enddo
< cjmm    READ(9, *)
< cjmm    READ(9, *)
---
>         READ(9, *)
>         READ(9, *)
2884,2886c2820
< cjmm    read (9,*) deltaEo, lamb
<         read (9,*) deltaEo
<         read (9,*) lamb
---
>      read (9,*) deltaEo, lamb
2888,2892c2822
< cjmm    read (9,*) dense1, dense2, wtmol1, wtmol2
<         read (9,*) dense1
<         read (9,*) dense2
<         read (9,*) wtmol1
<         read (9,*) wtmol2
---
>      read (9,*) dense1, dense2, wtmol1, wtmol2
2895,2902c2825,2827
<         do i = 1, 7
<            read (9, *)
<         enddo
< cjmm    read(9, *)
< cjmm    read(9, *)
< cjmm    read (9, *) yieldstr, sfactor
<         read (9, *) yieldstr
<         read (9, *) sfactor
---
>         read (9, *)
>         read (9, *)
>      read (9, *) yieldstr, sfactor
2908,2915c2833,2835
<         do i = 1, 8
<            read (9, *)
<         enddo
< cjmm    read(9, *)
< cjmm    read(9, *)
< cjmm    read (9, *) dtini, dtmax
<         read (9, *) dtini
<         read (9, *) dtmax
---
>         read (9, *)
>         read (9, *)
>         read (9, *) dtini, dtmax
2917,2919c2837
< cjmm    read (9, *) errrel, errabs
<         read (9, *) errrel
```

```
<         read (9, *) errabs
---
>         read (9, *) errrel, errabs
```

ATTACHMENT F

releaset.f differences:

```
199d198
< c        2-08-07 jmm    SCR672 Reformatting
4058,4062c4057
< cjmm 20070207 SCR672 File Reformatting.
< cjmm    Read first 33 comment lines, Lines 1-33
<         do i = 1,33
<            read (4, *)
<         end do
---
>
4065,4093c4060,4070
< cjmm    read (4, *)
< cjmm    read (4, *)
< cjmm    read (4, *)
< cjmm    read (4, *) xcon, sawetfrac
< cjmm    read (4, *) defectt, idefect
< cjmm    read (4, *) sftimef, isconf
< cjmm    read (4, *) sftimev, isconv
< cjmm    read (4, *) seismt1, iseismp1
< cjmm    read (4, *) seismt2, iseismp2
< cjmm    read (4, *) seismt3, iseismp3
< cjmm    read (4, *) seismt4, iseismp4
< cjmm    Read lines 34-49
<         read (4, *) xcon
< cjmm    write(*,*) 'xcon = ', xcon
<         read (4, *) sawetfrac
<         read (4, *) defectt
<         read (4, *) idefect
<         read (4, *) sftimef
<         read (4, *) isconf
<         read (4, *) sftimev
<         read (4, *) isconv
<         read (4, *) seismt1
<         read (4, *) iseismp1
<         read (4, *) seismt2
<         read (4, *) iseismp2
<         read (4, *) seismt3
<         read (4, *) iseismp3
<         read (4, *) seismt4
<         read (4, *) iseismp4
---
>         read (4, *)
>         read (4, *)
>         read (4, *)
>         read (4, *) xcon, sawetfrac
>         read (4, *) defectt, idefect
>         read (4, *) sftimef, isconf
>         read (4, *) sftimev, isconv
>         read (4, *) seismt1, iseismp1
>         read (4, *) seismt2, iseismp2
>         read (4, *) seismt3, iseismp3
>         read (4, *) seismt4, iseismp4
4101,4111c4078,4081
< cjmm    read (4, *)
< cjmm    read (4, *)
< cjmm    read (4, *) dintl, xlintl
< cjmm    Read 7 comment lines, lines 50 - 56
<         do i = 1,7
<            read (4, *)
<         end do
< cjmm    Read lines 57 - 59
<         read (4, *) dintl
< cjmm    write(*,*) 'dintl = ', dintl
<         read (4, *) xlintl
---
>
>         read (4, *)
>         read (4, *)
>         read (4, *) dintl, xlintl
4122,4128c4092,4093
< cjmm    read (4, *)
< cjmm    read (4, *)
< cjmm    Read 6 comment lines, lines 60 - 65
<         do i = 1,6
<            read (4, *)
<         end do
< cjmm    Read line 66
```

```
---
>         read (4, *)
>         read (4, *)
4130d4094
< cjmm    write(*,*) 'temfil = ', temfil
4137c4101
< cjmm    Read line 67
---
>
4142,4148c4106,4107
< cjmm    read (4, *)
< cjmm    read (4, *)
< cjmm    Read 5 comment lines, lines 68 - 72
<         do i = 1,5
<            read (4, *)
<         end do
< cjmm    Read line 73
---
>         read (4, *)
>         read (4, *)
4150d4108
< cjmm    write(*,*) 'hydfil = ', hydfil
4215,4222c4173,4175
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   Read 6 comment lines, lines 74 - 79
<        do i = 1,6
<            read (4, *)
<        end do
< cjmm   Read lines 80 - 81
---
>        read (4, *)
>        read (4, *)
>        read (4, *)
4224d4176
< cjmm    write(*,*) 'amassc = ', amassc
4229,4235c4181,4182
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   Read 27 comment lines, lines 82 - 108
<        do i = 1,27
<            read (4, *)
<        end do
< cjmm   Read lines 109 - 131
---
>        read (4, *)
>        read (4, *)
4238,4254c4185,4192
<        read (4, *) wetfrac(1)
< cjmm    write(*,*) 'wetfrac(1) = ', wetfrac(1)
<        read (4, *) bathflowt(1)
<        read (4, *) wetfrac(2)
<        read (4, *) bathflowt(2)
<        read (4, *) wetfrac(3)
<        read (4, *) bathflowt(3)
<        read (4, *) wetfrac(4)
<        read (4, *) bathflowt(4)
<        read (4, *) wetfrac(5)
<        read (4, *) bathflowt(5)
<        read (4, *) wetfrac(6)
<        read (4, *) bathflowt(6)
<        read (4, *) wetfrac(7)
<        read (4, *) bathflowt(7)
<        read (4, *) wetfrac(8)
<        read (4, *) bathflowt(8)
---
>        read (4, *) wetfrac(1), bathflowt(1)
>        read (4, *) wetfrac(2), bathflowt(2)
>        read (4, *) wetfrac(3), bathflowt(3)
>        read (4, *) wetfrac(4), bathflowt(4)
>        read (4, *) wetfrac(5), bathflowt(5)
>        read (4, *) wetfrac(6), bathflowt(6)
>        read (4, *) wetfrac(7), bathflowt(7)
>        read (4, *) wetfrac(8), bathflowt(8)
4257,4260c4195
< cjmm    write(*,*) 'imodel = ', imodel
<        read (4, *) phvalue
<        read (4, *) oxgnovpr
<        read (4, *) pco3
---
```

```
>        read (4, *) phvalue, oxgnovpr, pco3
4305,4311c4240,4241
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   Read 5 comment lines, lines 132 - 136
<        do i = 1,5
<           read (4, *)
<        end do
< cjmm   Read line 137
---
>        read (4, *)
>        read (4, *)
4323,4329c4253,4254
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   Read 9 comment lines, lines 138 - 146
<        do i = 1,9
<           read (4, *)
<        end do
< cjmm   Read line 147
---
>        read (4, *)
>        read (4, *)
4331d4255
< cjmm    write(*,*) 'r0z = ', r0z
4335d4258
< cjmm   Read lines 148 - 151
4346,4352c4269,4270
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   Read 12 comment lines, lines 152 - 163
<        do i = 1,12
<           read (4, *)
<        end do
< cjmm   Read lines 164 - 171
---
>        read(4,*)
>        read(4,*)
4354d4271
< cjmm    write(*,*) 'simglass = ', simglass
4364,4370c4281,4282
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   Read 11 comment lines, lines 172 - 182
<        do i = 1,11
<           read (4, *)
<        end do
< cjmm   Read lines 183 - 189
---
>        read(4,*)
>        read(4,*)
4372d4283
< cjmm    write(*,*) 'cr_length = ', cr_length
4384,4392c4295,4298
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   Read 10 comment lines, lines 190 - 199
<        do i = 1,10
<           read (4, *)
<        end do
< cjmm   Read line 200
---
>        read (4, *)
>        read (4, *)
>        read (4, *)
>        read (4, *)
4394d4299
< cjmm   write(*,*) 'imax = ', imax
4398,4406c4303,4304
< cjmm   read (4, *)
< cjmm   read (4, *) (xco(i), i=1, imax)
< cjmm   Read 5 comment lines, lines 201 - 205
<        do i = 1,5
<           read (4, *)
<        end do
< cjmm   Read lines 206 - 215 (assuming imax = 10)
<        read (4, *) (xco(i), yco, i=1, imax)
< cjmm   write(*,*) 'yco = ', yco
---
```

```
>        read (4, *)
>        read (4, *) (xco(i), i=1, imax)
4409d4306
< cjmm   Is an (i) needed for yco?
4411,4412c4308,4309
< cjmm   read (4, *)
< cjmm   read (4, *) (yco, i=1, jmax)
---
>        read (4, *)
>        read (4, *) (yco, i=1, jmax)
4417,4423c4314,4315
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   Read 7 comment lines, lines 216 - 222
<        do i = 1,7
<           read (4, *)
<        end do
< cjmm   Read line 223
---
>        read (4, *)
>        read (4, *)
4425d4316
< cjmm   write(*,*) 'nzones = ', nzones
4427,4431d4317
< cjmm   Read 8 comment lines, lines 224 - 231
<        do i = 1,8
<           read (4, *)
<        end do
< cjmm   Read lines 232 - 235 (assuming 4 nzones)
4440d4325
< cjmm   write(*,*) 'ie = ', ie
4449,4461c4334,4337
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   Read 8 comment lines, lines 236 - 243
<        do i = 1,8
<           read (4, *)
<        end do
< cjmm   read (4, *) (rpor(i), i=1, nzones)
< cjmm   Read lines 244 - 247 (assuming 4 nzones)
<        do i = 1, nzones
<           read (4, *) rpor(i)
<        end do
< cjmm   write(*,*) 'rpor(4) = ', rpor(4)
<
---
>        read (4, *)
>        read (4, *)
>        read (4, *) (rpor(i), i=1, nzones)
>
4466,4477c4342,4344
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   Read 9 comment lines, lines 248 - 256
<        do i = 1,9
<           read (4, *)
<        end do
< cjmm   read (4, *) (diff(i), i=1, 4)
< cjmm   Read lines 257 - 260 (assuming 4 nzones)
<        do i = 1, nzones
<           read (4, *) diff(i)
<        end do
< cjmm   write(*,*) 'diff(4) = ', diff(4)
---
>        read (4, *)
>        read (4, *)
>        read (4, *) (diff(i), i=1, 4)
4480c4347
< cjmm   Read line 261
---
>
4482d4348
< cjmm    write(*,*) 'driftdia = ', driftdia
4486,4498c4352,4355
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   Read 9 comment lines, lines 262 - 270
<        do i = 1,9
<           read (4, *)
<        end do
< cjmm   Read lines 271 - 275
```

```
<         read (4, *) dtinit
< cjmm     write(*,*) 'dtinit = ', dtinit
<         read (4, *) dtmin
<         read (4, *) dtmax
<         read (4, *) eps
<         read (4, *) tiny
---
>         read (4, *)
>         read (4, *)
>         read (4, *) dtinit, dtmin, dtmax
>         read (4, *) eps, tiny
4502,4508c4359,4360
< cjmm   read (4, *)
< cjmm   read (4, *)
< cjmm   Read 5 comment lines, lines 276 - 280
<        do i = 1,5
<           read (4, *)
<        end do
< cjmm   Read line 281
---
>        read (4, *)
>        read (4, *)
4510d4361
< cjmm    write(*,*) 'nbt = ', nbt
4512c4363
< cjmm end SCR672 modifications
---
>
5269,5271d5119
< cjmm 20061208 SCR672 File Reformatting.
< cjmm end SCR672 modifications
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
```

SCR - 673

TPA 5.1/ Beta N

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR673	**2. Software Title and Version:** TPA51betaN	**3. Project No:** 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *ashplumo.f*, *ebsfail.f*, *ebsrel.f*, exec.f, *releaset.f*, *tpa.inp*, *tpanames.dat*, *uzft.f*, *ebsrel.def* and *wpflow.def*.

The flow rates into and out of a WP reported in *infilper.res* were in units of mm/yr, instead of m3/yr and these values needed to be weighted by the number of WPs available for release; also, the size of the *infilper.res* was large and needed to be reduced. Additionally, the *tpa.inp* file specified values used in EBSREL for "SFWettedFraction" by failure type and by subarea for WPs that were initially defective, mechanically failed, and failed by localized and general corrosion. The subarea dependence necessitated use of a large number of correlations. Other *tpa.inp* parameters and correlations needed to be modified. Lastly, the screenprint stated the same time for drip shield failures by corrosion and mechanical load; the *ebsrel.def* file comments for SEISMO needed to be updated; Fow values in *wpflow.def* were not equal to 1.0; and flow into the WP occurred when the WP temperature was above boiling.

5. Change Requested by: J. Winterle Date: 2-26-07	**6. Change Authorized by** (*Software Developer*): R. Janetzke Date: 2-26-07

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

The *infilper.res* file now provides results at every 10th time step and the user has the option to generate (using append flag) all the results in a new file called *infilper.cum*. The flow rates into and out of a WP in these two files are WP-weighted and have units of m3/yr.

The subarea dependence of the "SFWettedFraction" for initial defective, MECH1, MECH2, LC, and general corrosion was removed. Also, correlations and parameter values were implemented in the *tpa.inp* file. See the following table.

The screenprint was modified to provide the drip shield failure time by mechanical load; the comments in *ebsrel.inp* were updated from SEISMO to indicate the mechanical and localized corrosion scenarios; Fow in *wpflow.def* was set equal to 1.0; and *releaset.f* was modified to only allow flow into the WP when the WP temperature was below boiling..

8. Implemented by: R. Rice	**Date:** 3-5-07

R9. **Description of Acceptance Tests:**

500 realizations of TPA 5.1 beta U were executed for Tests 1 – 3
5 realizations of TPA 5.1 beta W were executed for Test 6

Requirement 1. The flow rates into and out of a WP reported in *infilper.res* were in units of mm/yr, instead of m3/yr and these values needed to be weighted by the number of WPs available for release; also, the size of the *infilper.res* was large and needed to be reduced.

Test 1. Using data from TPA 5.1 beta U, 500 realizations, it was verified that a detailed file names infilper.cum is created with an appropriate append flag is activated. The input file tpa.inp includes option 23 to create infilper.cum.

Units in the files infilper.res and infilper.cum for flow rates in and out per waste package are in m^3/yr as requested. The quantities are well computed. This was verified by comparing release rates (kg/yr units) of solubility-limited radionuclides (^{238}U, ^{239}Pu, ^{237}Np), reported in the ebsrel.rlt file, divided by the average solubility per element (kg/m^3) to data in infilper.cum (see Figure 1 in the attachment). The ratio (in units of m^3/yr) can be interpreted as an "average" flow rate leaving the breached waste packages. This ratio compares well in trend to data from infilper.cum (10th column). The "average" flow rate computed from data in ebsrel.rlt and average solubilities is higher than the average derived from data in infilper.cum, which tracks flow rates per breached waste package. This test verified that data reported in infilper.cum (10th column) shows a consistent trend and consistent order of magnitude to data in ebsrel.rlt.

Requirement 2. Additionally, the *tpa.inp* file specified values used in EBSREL for "SFWettedFraction" by failure type and by subarea for WPs that were initially defective, mechanically failed, and failed by localized and general corrosion. The subarea dependence necessitated use of a large number of correlations. Other *tpa.inp* parameters and correlations needed to be modified.

Test 2. I verified that all of the parameters indicated in the were properly input in the file tpa.inp. I verified that the parameter SFWettedFraction is not subarea-dependent. I verified that correlations were well defined in tpa.inp. Furthermore, I plotted data sampled few input parameters and computed rank correlation coefficients from the sample data to verify that correlations were well preserved by the sampling (See Figures 2 and 3 in the attachment).

Requirement 3: The screenprint stated the same time for drip shield failures by corrosion and mechanical load.

I verified that screen prints are consistent with failure times by mechanical breaching and corrosion. This was a visual test.

Requirement 4: The *ebsrel.def* file comments for SEISMO needed to be updated.

I visually inspected the file ebsrel.def. The following comments were introduced:
! Item 11 wetfrac(6): NOT USED FOR TPA CALCULATIONS
! Item 12 iwatcont(6): NOT USED FOR TPA CALCULATIONS

Therefore, the requirement is fulfilled.

Requirement 5: Fow values in *wpflow.def* were not equal to 1.0.

Test 5: I inspected the file wpflow.def and verified that values under Fow and Fwet columns equal 1.0

Requirement 6: flow into the WP occurred when the WP temperature was above boiling.

Test 6: I executed 10 realizations of the TPA Code Beta W, subarea 3 only, assuming 100% initially defective waste packages (DefectiveFractionOfWPs/cell=1.0) and no drip shield protection (DSFractionThicknessPenetratedForFailureByCorrosion[]=1.0E-10). I recorded the waste package temperature of the first time step at which release from the EBS initiated. I derived the following values for the first 10 realizations: 95.819, 88.896, 95.85, 95.266, 94.439, 95.29, 95.149, 77.152, 95.439, 93.986 °C. All of these temperatures are below FlowOnsetTemperature[C]=96 °C. Figure 4 in the attachment shows total releases from the EBS, the waste package temperature, and the flow rate per waste package after reflux for the first 10 realizations. It is concluded that the requirement was well implemented.

10. Tested by: O. Pensado	**Date: 4/20/2007**

CNWRA Form TOP-5 (05/2000)

UPDATE REQUIREMENTS for TPA.INP

SCR 673

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM)*	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.)*	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source

MODIFY FROM	EBSREL	InitialRadiusOfSFParticle[m]	Initial radius of spent fuel particle	logbeta	4.42e-4, 4.72e-3, 3.549, 9.664	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, based on spent fuel grain dimensions. By multiplying the specific area by the spent fuel dissolution rate [specified in units of mg/(m^2 day) in the TPA code], the fractional release rate is determined (in units of 1/Time) and used to compute spent fuel dissolution rates by radionuclide. In the nominal case, by considering the specific area as a constant, uncertainty in the fractional release derives from uncertainty in the spent fuel dissolution rate (through the parameter *Preexponential_SFDissolutionModel2*). The radius, *r*, as function of the specific area is defined as *r*=3/(*sa* r), where r is the spent fuel density (*SFDensity[kg/m3]* = 10,600 kg/m^3).	File named "parameters.wpd" by O. Pensado dated 2/26/07
MODIFY TO	EBSREL	InitialRadiusOfSFParticle[m]	see above	constant	1.286e-3	see above	see above

MODIFY FROM	EBSREL	SFWettedFraction_Initial_X X=1, 2, ..., 10	For initially defective WPs, the fraction of the spent fuel contacted by water	loguniform	1.0d-3, 1.0d-1	Distribution selected consistent with InitialSeepageReductionFractionInitiallyDefWP (**correlated with rank correlation coefficient equal to 0.9**). The ranges of the distribution were selected to cause the fraction of the waste form surface exposed to water range from 0.001 to 0.1. 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.	see above

						In the TPA code, the set of initially defective WPs is treated as a disjoint set of the mech WPs. However, initially defective WPs are assumed to also experience localized corrosion, as a conservative approach. Localized corrosion damage could increase the amount of water contacting the waste form. In reality, it is unlikely that initially defective WPs also experience localized corrosion. For that reason, it is recommended to disregard additional damage due to localized corrosion. The fraction of the waste form surface exposed to water is a function of the parameter SFWettedFraction. $fwet(SFWettedFraction) := \begin{cases} \text{if } SFWettedFraction \le 0.5 \ \frac{\beta - \sin(\cos\beta)}{\pi} \text{ with } \beta := \cos^{-1}(1 - 2 \cdot SFWettedFraction) \\ \text{if } SFWettedFraction > 0.5 \ \frac{\pi - \beta - \sin(\cos\beta)}{\pi} \text{ with } \beta := \cos^{-1}(2 \cdot SFWettedFraction - 1) \end{cases}$	
						The parameter InitialSeepageReductionFractionInitiallyDefWP is assumed to range from 0.001 to 0.1. Using the above formula fwet(0.007) = 0.001 fwet(0.156) = 0.1	

MODIFY TO AND RENAME	EBSREL	SFWettedFraction_Initial	see above and remove the subarea dependence	loguniform	0.007, 0.156	see above	see above
MODIFY FROM	EBSREL	SFWettedFraction_Initial_X X=1, 2, ..., 10 and InitialSeepageReductionFractionInitiallyDefWP	correlate the spent fuel wet fraction with the seepage reduction for initially deffective WPs	correlateinputs	0.7	see above	see above
MODIFY TO	EBSREL	SFWettedFraction_Initial and InitialSeepageReductionFractionInitiallyDefWP	see above and remove the subarea dependence	correlateinputs	0.9	see above	see above

MODIFY FROM	EBSREL	SFWettedFraction_LC_X X=1, 2, ..., 10	For WPs identified with localized corrosion (LC) for release calculations, the fraction of the spent fuel contacted by water	loguniform	1.0d-3, 1.0d-1	Distribution selected consistent with InitialSeepageReductionFractionLC (**correlated with rank correlation coefficient equal to 0.9**). The ranges of the distribution were selected to cause the fraction of the waste form surface exposed to water range from 0.001 to 0.1. 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.	see above

						The fraction of the waste form surface exposed to water is a function of the parameter SFWettedFraction. The parameter InitialSeepageReductionFractionLC is assumed to range from 0.001 to 0.1. Using the above formula fwet(0.007) = 0.001 fwet(0.156) = 0.1	
MODIFY TO AND RENAME	EBSREL	SFWettedFraction_LC	see above and remove the subarea dependence	loguniform	0.007, 0.156	see above	see above
MODIFY FROM	EBSREL	SFWettedFraction_LC_X X=1, 2, ..., 10 and InitialSeepageReductionFractionLC	correlate the spent fuel wet fraction with the seepage reduction for LC WPs	correlateinputs	0.7	see above	see above
MODIFY TO	EBSREL	SFWettedFraction_LC and InitialSeepageReductionFractionLC	see above and remove the subarea dependence	correlateinputs	0.9	see above	see above

MODIFY FROM	EBSREL	SFWettedFraction_MECH1_X X=1, 2, ..., 10	For mechanically failed WPs (MECH1), the fraction of the spent fuel contacted by water	uniform	1.0d-2, 1.0d0	Distribution selected consistent with InitialSeepageReductionFractionByMechFailedWP (**correlated with rank correlation coefficient equal to 0.9**). The ranges of the distribution were selected to cause the fraction of the waste form surface exposed to water range from 0.01 to 1.0. 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.	see above

						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. ENG2 feedback: change distribution to reflect change in InitialSeepageReductionFractionByMechFailedWP. Resolution: distribution changed for consistency. The fraction of the waste form surface exposed to water is a function of the parameter SFWettedFraction. $$\mathrm{fwet}(\mathrm{SFWettedFraction}) = \begin{cases} \mathrm{SFWettedFraction} & \text{if } \mathrm{SFWettedFraction} \le 0.33 \\ \frac{0.33 - \mathrm{SFWettedFraction}}{0.67} & \text{if } \mathrm{SFWettedFraction} > 0.33 \end{cases}$$	
						The parameter InitialSeepageReductionFractionByMechFailedWP is assumed to range from 0.01 to 1.0. Using the above formula fwet(0.033) = 0.01 fwet(1.0) = 1.0	

MODIFY TO AND RENAME	EBSREL	SFWettedFraction_MECH 1	see above and remove the subarea dependence	uniform	0.033, 1.0	see above	see above
MODIFY FROM	EBSREL	SFWettedFraction_MECH 1_X X=1, 2, ..., 10 and InitialSeepageReductionFr actionByMechFailedWP	correlate the spent fuel wet fraction with the seepage reduction for MECH1 failed WPs	correlateinputs	0.7	see above	see above
MODIFY TO	EBSREL	SFWettedFraction_MECH 1 and InitialSeepageReductionFr actionByMechFailedWP	see above and remove the subarea dependence	correlateinputs	0.9	see above	see above

MODIFY FROM	EBSREL	SFWettedFraction_MECH2_X X=1, 2, ..., 10	For mechanically failed WPs (MECH2), the fraction of the spent fuel contacted by water	uniform	1.0d-2, 1.0d0	Distribution selected consistent with InitialSeepageReductionFractionByMechFailedWP (**correlated with rank correlation coefficient equal to 0.9**). The ranges of the distribution were selected to cause the fraction of the waste form surface exposed to water range from 0.01 to 1.0. 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.	see above

						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. ENG2 feedback: change distribution to reflect change in InitialSeepageReductionFractionByMechFailedWP. Resolution: distribution changed for consistency. The fraction of the waste form surface exposed to water is a function of the parameter SFWettedFraction. $$\begin{cases} \text{SFWettedFraction} \le 1: & \frac{\ln(\text{SFWettedFraction}) - \ln(0.033)}{\ln(1.0) - \ln(0.033)} \\ \text{SFWettedFraction} > 1: & \frac{\ln(\text{SFWettedFraction}) - \ln(1.0)}{\ln(1.0) - \ln(0.033)} \end{cases}$$	
						The parameter InitialSeepageReductionFractionByMechFailedWP is assumed to range from 0.01 to 1.0. Using the above formula fwet(0.033) = 0.01 fwet(1.0) = 1.0	

MODIFY TO AND RENAME	EBSREL	SFWettedFraction_MECH 2	see above and remove the subarea dependence	uniform	0.033, 1.0	see above	see above
MODIFY FROM	EBSREL	SFWettedFraction_MECH 2_X X=1, 2, ..., 10 and InitialSeepageReductionFr actionByMechFailedWP	correlate the spent fuel wet fraction with the seepage reduction for MECH failed WPs	correlateinputs	0.7	see above	see above
MODIFY TO	EBSREL	SFWettedFraction_MECH 2 and InitialSeepageReductionFr actionByMechFailedWP	see above and remove the subarea dependence	correlateinputs	0.9	see above	see above
MODIFY FROM	EBSREL	SFWettedFraction_Corrosi on_X X=1, 2, ..., 10	For general corrosion failed WPs, the fraction of the spent fuel contacted by water	uniform	0.0, 1.0	Remove the subarea dependence. No change with respect to previous TPA code versions. This parameter will be applied to waste packages failed by general corrosion.	see above
MODIFY TO AND RENAME	EBSREL	SFWettedFraction_Corrisi on	see above and remove the subarea dependence	uniform	0.0, 1.0 (no change in the distribution)	see above	see above
ADD	NFENV	EnvironmentII_Cl_Subare a_X[mol/L] and EnvironmentII_CO3_Suba rea_X[mol/L] X=1, 2, ..., 10	By subarea, the Environment II Cl and CO3 concentrations by subarea	correlateinputs	-0.8	Need to specify all three correlations between Cl, CO3, and pH	D.S. Dunn et al., Passive Localized Corrosion of Alloy 22 ---Modeling and Experiment s.CNWRA 2005-02. Table 5-4, p. 5-14 (2005)

ADD	EXEC	SelectAppendFiles	Option for the user to generate a specific append file	iconstant	23 (new option)	This option allows the user to generate the file *infilper.cum* which contains results at every TPA code time step (compared to every 10th time step in *infilper.res*).	Recommendation in file named "infil.wpd" received from O. Pensado
MODIFY FROM	EBSREL	WastePackageFlowMultiplicationFactor	Factor applied to the flow of water entering the WP	constant	1.0	Contained in emails that were sent from O. Pensado to R. Rice on 3/6/07 with subject line "Missing correlations in tpa.inp" and on 3/7/07 with subject line "RE: Missing correlations in tpa.inp"	see left
MODIFY TO	EBSREL	WastePackageFlowMultiplicationFactor	see above	loguniform	1.0, 4.0	see above	see above
MODIFY FROM	EBSREL	SubareaWetFraction	Fraction of the subarea (or WPs) receiving water, thus having the capability to release; there is one value used for all subareas in a realization	uniform	0.0, 1.0	see above	see above
MODIFY TO	EBSREL	SubareaWetFraction	see above	loguniform	0.25, 1.0	see above	see above
DELETE	EBSRE/ UZFTL	SubAreaWetFraction MatrixPermeability_TSw_[m2]	correlation between these *tpa.inp* parameters	correlateinputs	-0.623	see above	see above
MODIFY FROM	EBSRE/ UZFLOW	SubAreaWetFraction ArealAverageMeanAnnualInfiltrationAtStart[mm/yr]	see above	correlateinputs	0.631	see above	see above
MODIFY TO	EBSRE/ UZFLOW	SubAreaWetFraction ArealAverageMeanAnnualInfiltrationAtStart[mm/yr]	see above	correlateinputs	0.7	see above	see above

ADD	EBSREL	SubAreaWetFraction WastePackageFlowMultiplicationFactor	see above	correlateinputs	-0.9999	see above	see above
ADD	EBSREL	SubAreaWetFraction X0FmultCoefficient	see above	correlateinputs	-0.5	see above	see above
ADD	EBSREL	ArealAverageMeanAnnualInfiltrationAtStart[mm/yr] WastePackageFlowMultiplicationFactor	see above	correlateinputs	-0.7	see above	see above
ADD	EBSREL	ArealAverageMeanAnnualInfiltrationAtStart[mm/yr] X0FmultCoefficient	see above	correlateinputs	-0.9	see above	see above
ADD	EBSREL	WastePackageFlowMultiplicationFactor X0FmultCoefficient	see above	correlateinputs	0.5	see above	see above
MODIFY FROM	EBSREL	SFWettedFraction_Initial	For initially defective WPs, the fraction of the spent fuel contacted by water	loguniform	0.007, 0.156	From email (see right): Tae Ahn has consulted the literature are arrived at the conclusion that there is no sufficient technical basis to assume low values of the parameter SFWettedFraction. Hydration could play a role; the spent fuel can dissolve at considerable rates under hydrated conditions. It appears that hydration alone can change the exposed surface area (causing an increase in the effective dissolution rate). Accordingly, it is wiser to set the SFWettedFraction with the same range as the proposed range for the MECH waste packages: uniform(0.033, 1.0)	Contained in an email that were sent from O. Pensado to R. Rice on 3/7/07 with subject line "SFWetted Fraction?"

						Originally, I recommended not to change the SFWettedFraction for general corrosion, faulting, and igneous WPs (before was uniform(0.0, 1.0)). Now, I do not see any reason why a lower bound is allowable for those WPs. Therefore, I recommend the same distribution for all WP types. The low bound of 0.033 corresponds to a exposed surface fraction of 0.01 (order of magnitude guess on the low bound). In practice uniform(0.0, 1.0) or uniform(0.033, 1.0) make no difference, but I prefer a better defined low bound to avoid cases where the SFWettedFraction could be so small that the waste form lasts forever (e.g. billions of years). I recommend to still consider correlations of SFWettedFraction to seepage factors. These correlations allow for consideration of cases of WP with small openings and small values of the SFWettedFraction.	
MODIFY TO	EBSREL	SFWettedFraction_Initial	see above	uniform	0.033, 1.0	see above	see above
MODIFY FROM	EBSREL	SFWettedFraction_LC	For WPs failed by localized corrosion, the fraction of the spent fuel contacted by water	loguniform	0.007, 0.156	see above	see above
MODIFY TO	EBSREL	SFWettedFraction_LC	see above	uniform	0.033, 1.0	see above	see above

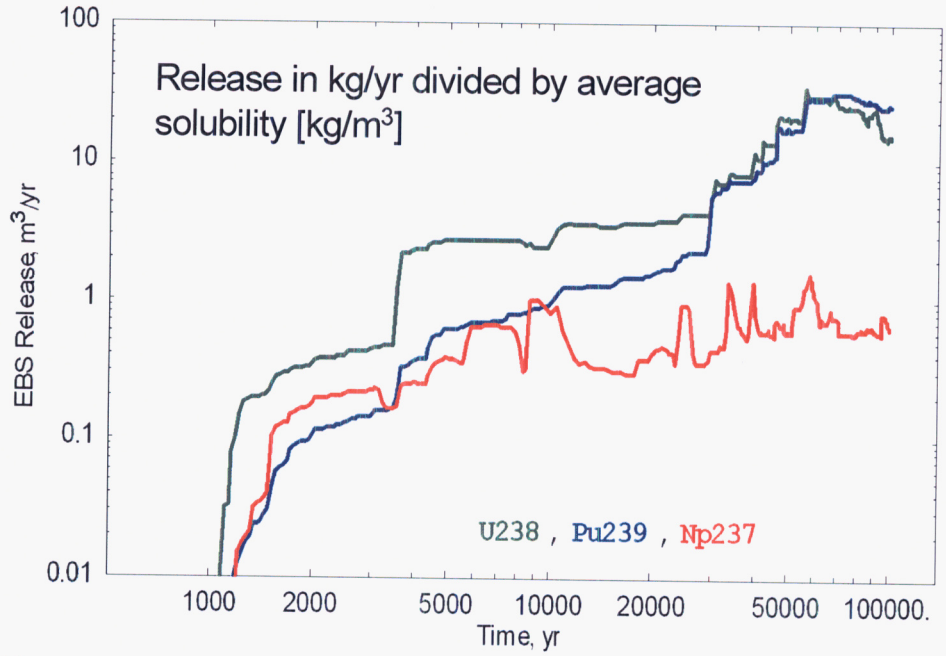
MODIFY FROM	EBSREL	SFWettedFraction_FAULTO	For WPs failed by faulting, the fraction of the spent fuel contacted by water	uniform	0.0, 1.0	see above	see above
MODIFY TO	EBSREL	SFWettedFraction_FAULTO	see above	uniform	0.033, 1.0	see above	see above
MODIFY FROM	EBSREL	SFWettedFraction_VOLCANO	For W\Ps failed by intrusive volcanism, the fraction of the spent fuel contacted by water	uniform	0.0, 1.0	see above	see above
MODIFY TO	EBSREL	SFWettedFraction_VOLCANO	see above	uniform	0.033, 1.0	see above	see above
MODIFY FROM	EBSREL	SFWettedFraction_Corrosion	For general corrosion failed WPs, the fraction of the spent fuel contacted by water	uniform	0.0, 1.0	see above	see above
MODIFY TO	EBSREL	SFWettedFraction_Corrosion	see above	uniform	0.033, 1.0	see above	see above
MODIFY FROM	DSFAIL	DripShieldCorrosionRate[m/yr]	Corrosion rate of the drip shield	triangular	2.0e-8, 2.98e-7, 6.4e-7	Change from a triangular distribution to a logtriangular distribution	In an email from O. Pensado to R. Rice on 3/7/07 titled "DripShield CorrosionRate and wpflow.def" ; also see "parameters.wpd"
MODIFY TO	DSFAIL	DripShieldCorrosionRate[m/yr]	see above	logtriangular	2.0e-8, 2.98e-7, 6.4e-7	see above	see above

ADD	EBSREL	SFWettedFraction_MECH 1 SFWettedFraction_MECH 2	correlation between these *tpa.inp* parameters	correlateinputs	0.9999	define the correlation matrix	Emails from S. Stothoff to R. Rice titled "correlation s" and from O. Pensado to R. Rice titled "RE: Need Correlation s?" on 3/9/07
ADD	UZFLO W	uzflow_LongTermAverage FootprintAverageMAI[mm/ yr] uzflow_HydraulicProperty UncertaintyDeviation[N(0,1)]	see above	correlateinputs	0.9999	see above	see above
ADD	UZFLO W	uzflow_LongTermAverage FootprintAverageMAI[mm/ yr] uzflow_FootprintAverageM eanAnnualInfiltrationAtStar t[mm/yr]	see above	correlateinputs	0.9999	see above	see above
ADD	EBSREL /UZFLO W	uzflow_LongTermAverage FootprintAverageMAI[mm/ yr] SubAreaWetFraction	see above	correlateinputs	0.7	see above	see above
ADD	EBSREL /UZFLO W	uzflow_LongTermAverage FootprintAverageMAI[mm/ yr] WastePackageFlowMultipl icationFactor	see above	correlateinputs	-0.7	see above	see above
ADD	EBSREL /UZFLO W	uzflow_LongTermAverage FootprintAverageMAI[mm/ yr] X0FmultCoefficient	see above	correlateinputs	0.6	see above	see above

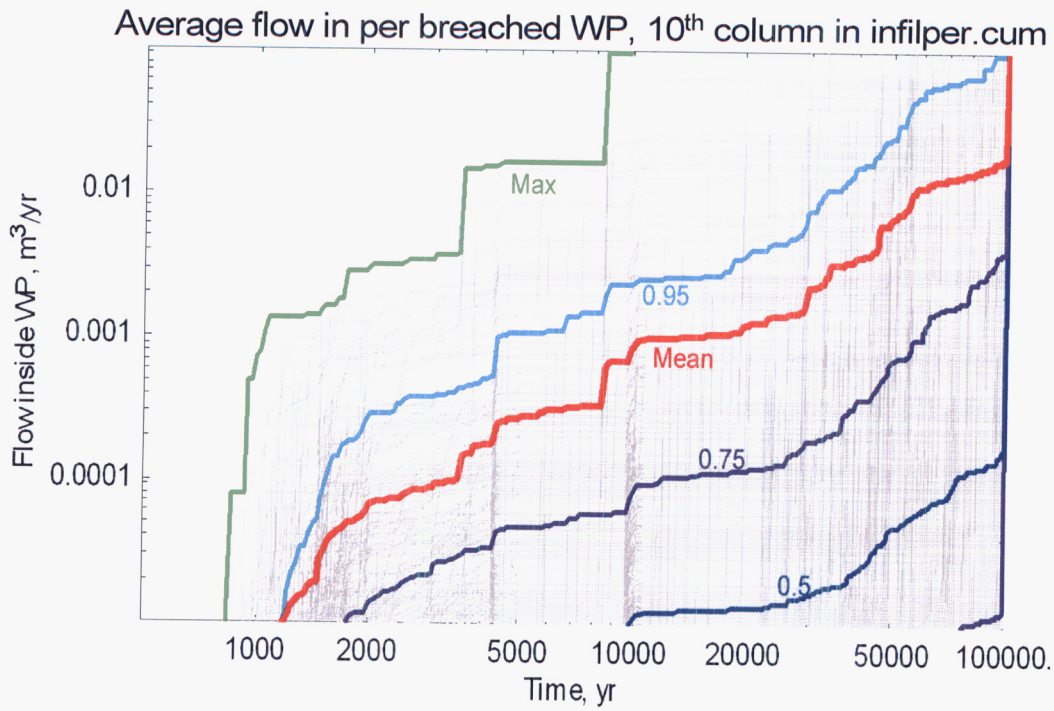
ADD	EBSREL	uzflow_HydraulicProperty UncertaintyDeviation[N(0,1)] uzflow_FootprintAverageMeanAnnualInfiltrationAtStart[mm/yr]	see above	correlateinputs	0.9999	see above	see above
ADD	EBSREL	uzflow_HydraulicProperty UncertaintyDeviation[N(0,1)] SubAreaWetFraction	see above	correlateinputs	0.7	see above	see above
ADD	EBSREL	uzflow_HydraulicProperty UncertaintyDeviation[N(0,1)] WastePackageFlowMultiplicationFactor	see above	correlateinputs	-0.7	see above	see above
ADD	EBSREL	uzflow_HydraulicProperty UncertaintyDeviation[N(0,1)] X0FmultCoefficient	see above	correlateinputs	0.6	see above	see above
ADD	EBSREL	uzflow_FootprintAverageMeanAnnualInfiltrationAtStart[mm/yr] SubAreaWetFraction	see above	correlateinputs	0.7	see above	see above
ADD	EBSREL	uzflow_FootprintAverageMeanAnnualInfiltrationAtStart[mm/yr] WastePackageFlowMultiplicationFactor	see above	correlateinputs	-0.7	see above	see above
ADD	EBSREL /UZFLOW	uzflow_FootprintAverageMeanAnnualInfiltrationAtStart[mm/yr] X0FmultCoefficient	see above	correlateinputs	0.6	see above	see above
ADD	EBSREL	SubAreaWetFraction WastePackageFlowMultiplicationFactor	see above	correlateinputs	-0.9999	see above	see above
ADD	EBSREL	SubAreaWetFraction X0FmultCoefficient	see above	correlateinputs	0.9	see above	see above

ADD	EBSREL	WastePackageFlowMultiplicationFactor X0FmultCoefficient	see above	correlateinputs	-0.9	see above	see above

ATTACHMENT: Figures documenting acceptance testing

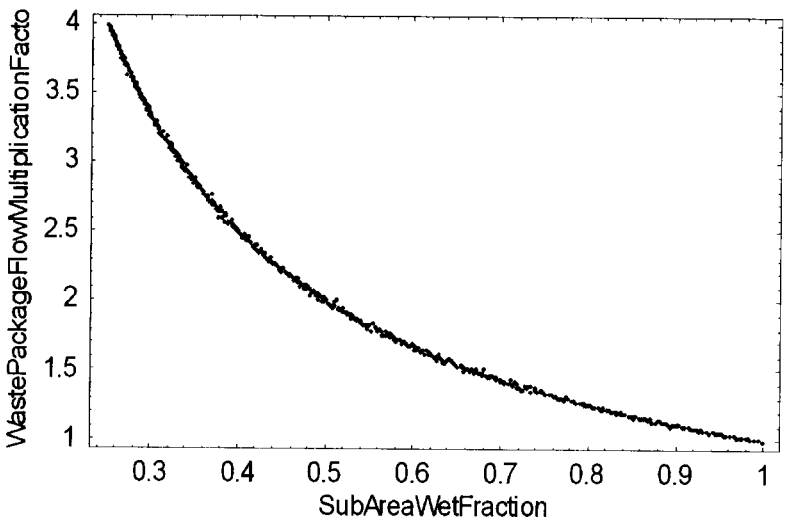


(A)

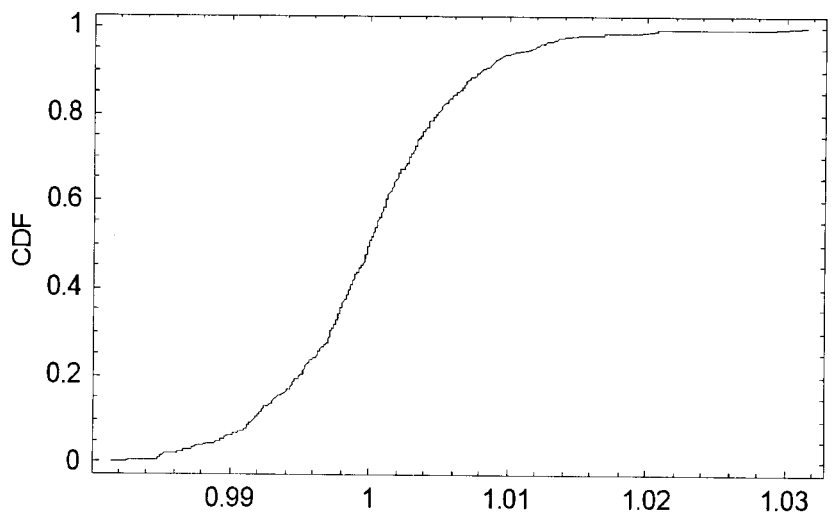


(B)

Figure 1: (A) Average release (from 500 realizations), from data in file ebsrel.rlt. (B) Multiple realization data from data in infilper.cum. TPA 5.1 beta U.



(A)



(B)

Figure 2: (A) Plot of sampled values by the Latin Hypercube Sampling method in the TPA Code Version 5.1 beta U, 500 realizations. (B) Cumulative distribution of the product SubareaWetFraction × WastePackageFlowMultiplicationFactor. TPA 5.1 beta U.

```
name1 = "LogCO2PartialPressure_AllUZ_SZLayers[atm]";
name2 = "pH_AllUZ_SZLayers[StandardUnits]";
a1 = Flatten[Position[parameters, name1]][[1]]; a2 = Flatten[Position[parameters, name2]][[1]];
N[SpearmanRankCorrelation[sampT[[a1]], sampT[[a2]]]]
```

```
-0.945357
```

```
Correlation[normalMT[[a1]], normalMT[[a2]]]
```

```
-0.949138
```

```
name1 = "uzflow_LongTermAverageFootprintAverageMAI[mm/yr]";
name2 = "uzflow_HydraulicPropertyUncertaintyDeviation[N(0,1)]";
a1 = Flatten[Position[parameters, name1]][[1]]; a2 = Flatten[Position[parameters, name2]][[1]];
N[SpearmanRankCorrelation[sampT[[a1]], sampT[[a2]]]]
```

```
0.978362
```

```
name1 = "SubAreaWetFraction";
name2 = "WastePackageFlowMultiplicationFactor";
a1 = Flatten[Position[parameters, name1]][[1]]; a2 = Flatten[Position[parameters, name2]][[1]];
N[SpearmanRankCorrelation[sampT[[a1]], sampT[[a2]]]]
```

```
-0.99986
```

```
Correlation[normalMT[[a1]], normalMT[[a2]]]
```

```
-0.999857
```

```
name1 = "uzflow_LongTermAverageFootprintAverageMAI[mm/yr]";
name2 = "uzflow_FootprintAverageMeanAnnualInfiltrationAtStart[mm/yr]";
a1 = Flatten[Position[parameters, name1]][[1]]; a2 = Flatten[Position[parameters, name2]][[1]];
N[SpearmanRankCorrelation[sampT[[a1]], sampT[[a2]]]]
```

```
0.978439
```

Figure 3: Detailed checking of few rank correlations from data in samplpar.res. TPA 5.1 beta U.

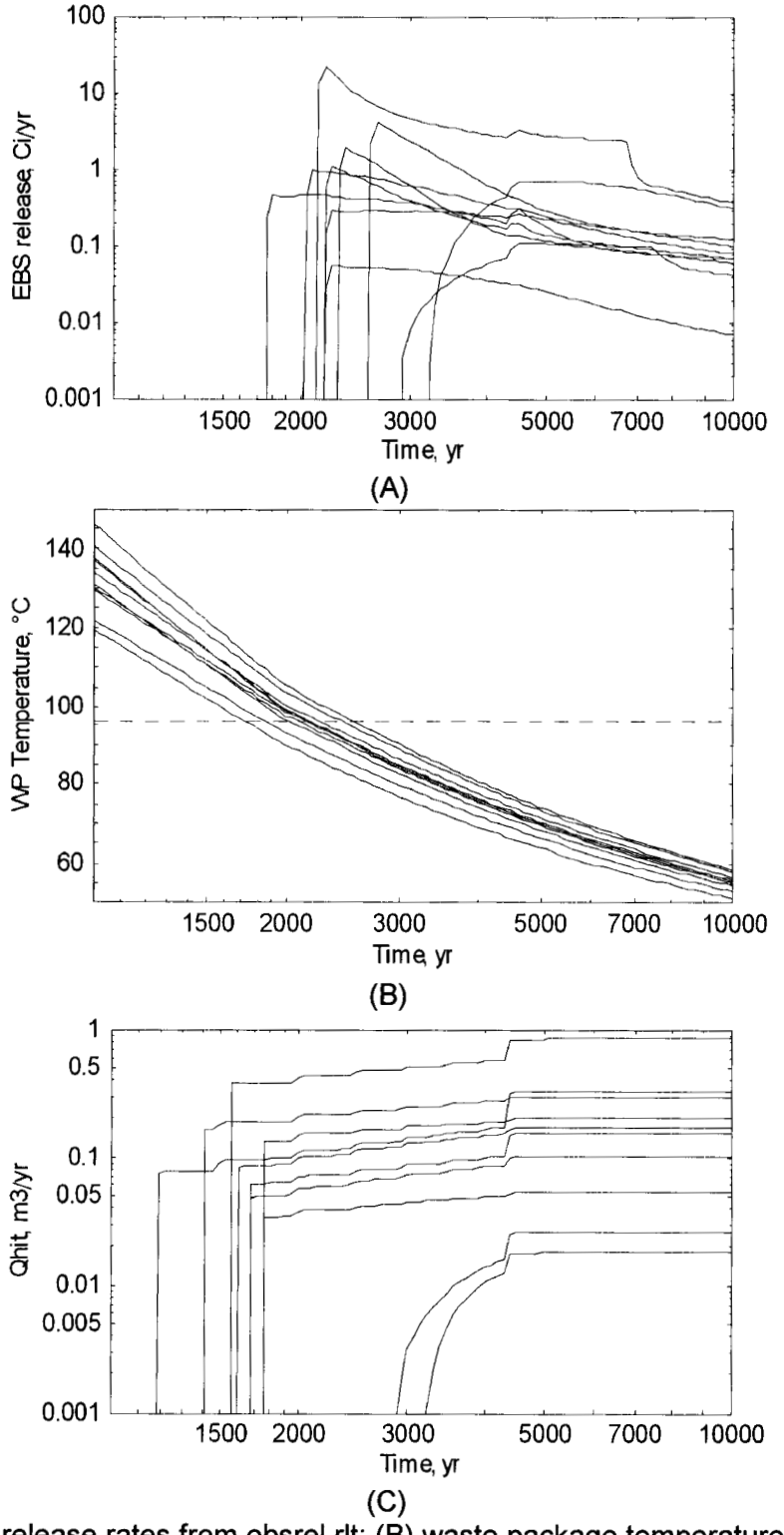


Figure 4: (A) total release rates from ebsrel.rlt; (B) waste package temperature from nfenv.rlt; (C) flow rate per waste package after reflux from nfenv.rlt. TPA 5.1 beta W.

SCR - 675

TPA 5.1/ Beta I

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 675	2. Software Title and Version: TPA 5.1Beta1	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f, nuclides.dat, reader.f, exece.i, mv.f, releaset.f, sampler.f.*

In a letter from NRC, dated 7-27-2006, a request was made to increase the transparency and traceability of the input/output files. Specifically, input parameters should be located/identified in the input files to aid in traceability through the conceptual model calculations. Also, the format and content of the output files should ensure a user can reasonably comprehend the content without excessive recourse to the source code of other documentation.

In *nuclides.dat* the EPA limit values need updating.

5. Change Requested by: J. Winterle	Date: 8-1-2006
6. Change Authorized by (*Software Developer*): R. Janetzke	Date: 8-7-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

The new file headers were placed in a new file called *exece.i*. *Releaset.f* was changed to reformat *inv1000.out*. See Appendix A for this and other changes.

8. Implemented by: R. Janetzke	Date: 12-20-06

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☐ **No** ☒

(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).

Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

Code review accomplished by:	Date:

10. Description of Acceptance Tests:

Procedure: Visual code inspection of *exece.i* file provided with TPA Version 5.1BetaY. Then, used TPA Version 5.1BetaY with reference case *tpa.inp* input file. Set Output Option to append all files. Ran 2 realizations for all 10 subareas. Compared headers in *exece.i* file to TPA output files *cp.tpa, sp.tpa, mv.tpa, gwp_ave.res, gwp_pktim.out, samplpar.abb, samplpar.hdr, samplpar.res, totdose.res, totdose_c.res, wpsfail.dbg, wpsfail.res, uzflow.ech, uzflow.rlt, uzft.ech, uzft.rlt, rgsna.tpa, rgsnr.tpa, rgssa.tpa, rgwna.tpa, rgwnr.tpa, rgwsa.tpa, rgwsap.tpa, rgwsr.tpa, and pkmndose.res.*

Acceptance Criteria: User should be able to understand what is in the files by reading the header and column heading information; header and column heading information should be correct, and headers should be free of spelling errors. The file *epapktim.out* should no longer be an output.

Status (Pass/Fail): PASS

11. Tested by: James Winterle	Date: 05/22/2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for TPA.INP

SCR 675

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
No Changes to tpa.inp parameters							

Appendix A

File differences for *exec.f*:

```
3,4c3,4
< c File Date:           12/11/06
< c Release Version:     5.1betaI
---
> c File Date:           01/21/07
> c Release Version:     5.1betaK
304a305,306
> c             5.1betaJ includes SCR 675; Reformat output files and new EPA limits for nuclides.dat.
> c             5.1betaK includes SCRs 671,677&679 reformat files for dsfail,driftfail, and mechfail.
354c356
< c Executive for TPA Version 5.1betaI
---
> c Executive for TPA Version 5.1betaK
371a374
>       include 'exece.i'
876a880,998
> c    SCR679 J. Mancillas File format change
> c   A character array has been added which contains text and comments
> c   for the format file changes associated with SCR679
>       CHARACTER*65 text679(112)
>       Data (text679(i),i=1,112)
>      &/'!! SECTION:  Number of time steps                          ' ! 1
>      &,'                                                           ' ! 2
>      &,' !! Number of time steps                                   ' ! 3
>      &,'                                                           ' ! 4
>      &,'!! SECTION:  Distribution of Time steps                    ' ! 5
>      &,'                                                           ' ! 6
>      &,'                                                           ' ! 7
>      &,'!! SECTION: Number of Seismic Events                       ' ! 8
>      &,'                                                           ' ! 9
>      &,' !! Number of seismic events                               ' ! 10
>      &,'                                                           ' ! 11
>      &,'!! SECTION: Seismic events descriptive data                ' ! 12
>      &,'!!         This section contains data describing seismic events' ! 13
>      &,'!!         Descriptive data includes the following items   ' ! 14
>      &,'!!         The time of the seismic event (yr)              ' ! 15
>      &,'!!         The Mean Annual Probability of Exceedance (MAPE)  ' ! 16
>      &,'!!         The Peak Ground Velocity (PGV) of the event (m/sec) ' ! 17
>      &,'!!         The Peak Ground Acceleration (PGA) of the event (g) ' ! 18
>      &,'                                                           ' ! 19
>      &,'                                                           ' ! 20
>      &,'!! SECTION: SUBAREA and REALIZATION                        ' ! 21
>      &,'                                                           ' ! 22
>      &,' !! Realization                                            ' ! 23
>      &,' !! Subarea                                                ' ! 24
>      &,'                                                           ' ! 25
>      &,'!! SECTION: Number of seismic events                       ' ! 26
>      &,'                                                           ' ! 27
>      &,' !! Number of seismic events                               ' ! 28
>      &,'                                                           ' ! 29
>      &,'!!  SECTION: Vertical static pressures at the time of the  ' ! 30
>      &,'!!           seismic events for both rock types: rock type 1  ' ! 31
>      &,'!!           is lithophysal rock and rock type 2 is        ' ! 32
>      &,'!!           nonlithophysal rock. These pressures are given in ' ! 33
>      &,'!!           kiloPascals (kPa).                            ' ! 34
>      &,'                                                           ' ! 35
>      &,'                                                           ' ! 36
>      &,'!!  SECTION: Drift failure status and times                ' ! 37
>      &,'!!           This section contains data relevant to the failure' ! 38
>      &,'!!           status and times of failure for the drifts for ' ! 39
>      &,'!!           two rock types: rock type 1 (lithophysal) and ' ! 40
>      &,'!!           rock type 2 (nonlithophysal)                  ' ! 41
>      &,'                                                           ' ! 42
>      &,' !! Drift failure Rock type 1 (yes/no:1/0)                 ' ! 43
>      &,' !! Drift rock type 1 failure time (yr)                    ' ! 44
>      &,' !! Drift failure Rock type 2 (yes/no:1/0)                 ' ! 45
>      &,' !! Drift rock type 2 failure time (yr)                    ' ! 46
>      &,'                                                           ' ! 47
>      &,'!!  SECTION: Equivalent Diameters and Vertical Pressures   ' ! 48
>      &,'!!           This section includes the following           ' ! 49
>      &,'!!      The equivalent vertical drift diameter (m)         ' ! 50
>      &,'!!      The equivalent horizontal drift diameter (m)       ' ! 51
>      &,'!!      The equivalent vertical backfill diameter thickness(m) ' ! 52
>      &,'!!      The equivalent horizontal backfil diameter thickness(m)' ! 53
>      &,'!!      The average height of the drift ceiling above the  ' ! 54
```

```
>      &,'!!       invert for the two differing rock types                ' ! 55
>      &,'!!      The vertical pressure in the drift for rock type 1      ' ! 56
>      &,'!!       where rock type 1 is lithophysal rock                  ' ! 57
>      &,'!!      The vertical pressure in the drift for rock type 2      ' ! 58
>      &,'!!       where rock type 2 is nonlithophysal rock               ' ! 59
>      &,'!!                                                              ' ! 60
>      &,' !!  Subarea for Analysis                                        ' ! 61
>      &,'                                                                ' ! 62
>      &,'                                                                ' ! 63
>      &,'!! SECTION: Subarea Averaging Data                              ' ! 64
>      &,'                                                                ' ! 65
>      &,' !! Realization Number                                          ' ! 66
>      &,' !! Total number of subareas averaged                           ' ! 67
>      &,'                                                                ' ! 68
>      &,'!! SECTION: Subarea averaged values for drift equivalent        ' ! 69
>      &,'!!          diameters and vertical pressures.                   ' ! 70
>      &,'!!          This section contains data which is an average of   ' ! 71
>      &,'!!          individual subarea results for the following        ' ! 72
>      &,'!!          The equivalent vertical drift diameter (m)          ' ! 73
>      &,'!!          The equivalent horizontal drift diameter(m)         ' ! 74
>      &,'!!          The average height of the drift ceiling above the   ' ! 75
>      &,'!!               invert                                         ' ! 76
>      &,'!!          The vertical pressure in the drift for rock type 1  ' ! 77
>      &,'!!               where rock type 1 is lithophysal rock          ' ! 78
>      &,'!!          The vertical pressure in the drift for rock type 2  ' ! 79
>      &,'!!            where rock type 2 is nonlithophysal rock          ' ! 80
>      &,'                                                                ' ! 81
>      &,'                                                                ' ! 82
>      &,'!! SECTION: Number of time steps for all subareas and vectors   ' ! 83
>      &,'                                                                ' ! 84
>      &,' !! Number of time steps                                        ' ! 85
>      &,'                                                                ' ! 86
>      &,'!! SECTION: Time dependent Fluoride concnetrations              ' ! 87
>      &,'                                                                ' ! 88
>      &,'                                                                ' ! 89
>      &,'!! SECTION: Drip shield failure status                          ' ! 90
>      &,'                                                                ' ! 91
>      &,' !! Drip shield failure time                                    ' ! 92
>      &,'                                                                ' ! 93
>      &,' !! No failure of the drip shield during the simulation time    ' ! 94
>      &,' !! Drip shield corrosion rate (m/yr)                           ' ! 95
>      &,'                                                                ' ! 96
>      &,'!! SECTION: Drip shield thickness and fraction failed versus    ' ! 97
>      &,'!!            time                                              ' ! 98
>      &,'                                                                ' ! 99
>      &,'                                                                ' ! 100
>      &,'!!  SECTION: Dripshield and drift failure times                 ' ! 101
>      &,'!!           This section reports the following                 ' ! 102
>      &,'!!           The realization number, which is a unitless vector' ! 103
>      &,'!!           The time recorded for either a dripshield          ' ! 104
>      &,'!!             mechanical failure or drift failure (yr)         ' ! 105
>      &,'!!           The corrosion status of the Drip Shield at the     ' ! 106
>      &,'!!             time of mechanical failure, either               ' ! 107
>      &,'               uncorroded (0) or corroded (1)                   ' ! 108
>      &,'!!           The number of drip shields that were reported      ' ! 109
>      &,'!!             failed at that time (cumulative)                 ' ! 110
>      &,'!!           The repository wide drift failure fraction         ' ! 111
>      &,'                                                                ' ! 112
>      &/
>
919c1041
<       print '(10x,a)','exec: Welcome to TPA Version 5.1betaI'
---
>       print '(10x,a)','exec: Welcome to TPA Version 5.1betaK'
940c1062,1065
<      &  iunitsp, iunitcp, mylastcheck)
---
>      &  iunitsp, iunitcp, mylastcheck, abbtext, 16, hdrtext, 19,
>      &  sptext, 36)
> c    &  iunitsp, iunitcp, mylastcheck)
> cc rwj 102-20-06; SCR675
1002,1004c1127,1207
<         ilength = 25*16+5
<         call clearchar(ilength,columnheader1)
<         call clearchar(ilength,columnheader2)
---
> cc rwj 12-20-06; SCR675
> c       ilength = 25*16+5
> c       call clearchar(ilength,columnheader1)
> c       call clearchar(ilength,columnheader2)
> c
```

```
> c       do i = 1,12
> c
> c         if ( i .eq. 1 ) then
> c           columnheader1(3:13) = 'realization'
> c           columnheader2(3:13) = '  unitless '
> c         elseif ( i .eq. 2 ) then
> c           columnheader1(25:35) = 'gross alpha'
> c           columnheader2(20:43) = 'conc(pCi/L)         time'
> c         elseif ( i .eq. 3 ) then
> c           columnheader1(59:67) = 'radium226'
> c           columnheader2(52:72) = 'conc(pCi/L)      time'
> c         elseif ( i .eq. 4 ) then
> c           columnheader1(91:98)='  Gonad '
> c           columnheader2(84:105)='dose(mrem/yr)     time'
> c         elseif ( i .eq. 5 ) then
> c           columnheader1(123:130)=' Breast '
> c           columnheader2(116:137)='dose(mrem/yr)     time'
> c         elseif ( i .eq. 6 ) then
> c           columnheader1(155:162)='   Lung '
> c           columnheader2(148:169)='dose(mrem/yr)     time'
> c         elseif ( i .eq. 7 ) then
> c           columnheader1(187:194)='R Marrow'
> c           columnheader2(180:201)='dose(mrem/yr)     time'
> c         elseif ( i .eq. 8 ) then
> c           columnheader1(219:227)='B Surface'
> c           columnheader2(212:233)='dose(mrem/yr)     time'
> c         elseif ( i .eq. 9 ) then
> c           columnheader1(251:258)=' Thyroid'
> c           columnheader2(244:266)='dose(mrem/yr)     time'
> c         elseif ( i .eq. 10) then
> c           columnheader1(283:291)='Ramainder'
> c           columnheader2(276:297)='dose(mrem/yr)     time'
> c         elseif ( i .eq. 11) then
> c           columnheader1(315:324)='Whole Body'
> c           columnheader2(308:330)='dose(mrem/yr)     time'
> c         elseif ( i .eq. 12) then
> c           columnheader1(346:355)='Total Dose'
> c           columnheader2(339:362)='dose(mrem/yr)     time'
> c         elseif ( i .eq. 3 ) then
> c           columnheader1(59:67) = 'radium226'
> c           columnheader2(54:71) = ' conc        time '
> c         elseif ( i .eq. 4 ) then
> c           columnheader1(91:98)='  Gonad '
> c           columnheader2(86:103)=' dose        time '
> c         elseif ( i .eq. 5 ) then
> c           columnheader1(123:130)=' Breast '
> c           columnheader2(118:135)=' dose        time '
> c         elseif ( i .eq. 6 ) then
> c           columnheader1(155:162)='   Lung '
> c           columnheader2(150:167)=' dose        time '
> c         elseif ( i .eq. 7 ) then
> c           columnheader1(187:194)='R Marrow'
> c           columnheader2(182:199)=' dose        time '
> c         elseif ( i .eq. 8 ) then
> c           columnheader1(219:227)='B Surface'
> c           columnheader2(214:231)=' dose        time '
> c         elseif ( i .eq. 9 ) then
> c           columnheader1(251:258)=' Thyroid'
> c           columnheader2(246:264)=' dose         time '
> c         elseif ( i .eq. 10) then
> c           columnheader1(283:291)='Remainder'
> c           columnheader2(278:295)=' dose        time '
> c         elseif ( i .eq. 11) then
> c           columnheader1(315:324)='Whole Body'
> c           columnheader2(310:328)=' dose         time '
> c         elseif ( i .eq. 12) then
> c           columnheader1(346:355)='Total Dose'
> c           columnheader2(341:360)=' dose          time '
> c         endif
> c       enddo
> c       write(iwriteepapktim,'(a)')
> c    &    (columnheader1(1:400))
> c       write(iwriteepapktim,'(a)')
> c    &    (columnheader2(1:402))
>         write( iwriteepapktim, '(a)') (epapktext(i),i=1,36)
>         write( iwriteepapktim, '(a)') (epapkhdr(i),i=1,3)
1006,1080d1208
<         do i = 1,12
<
<           if ( i .eq. 1 ) then
<             columnheader1(3:13) = 'realization'
```

```
<             columnheader2(3:13) = '  unitless '
<           elseif ( i .eq. 2 ) then
<             columnheader1(25:35) = 'gross alpha'
<             columnheader2(20:43) = 'conc(pCi/L)         time'
<           elseif ( i .eq. 3 ) then
<             columnheader1(59:67) = 'radium226'
<             columnheader2(52:72) = 'conc(pCi/L)      time'
<           elseif ( i .eq. 4 ) then
<             columnheader1(91:98)='  Gonad '
<             columnheader2(84:105)='dose(mrem/yr)     time'
<           elseif ( i .eq. 5 ) then
<             columnheader1(123:130)=' Breast '
<             columnheader2(116:137)='dose(mrem/yr)     time'
<           elseif ( i .eq. 6 ) then
<             columnheader1(155:162)='   Lung '
<             columnheader2(148:169)='dose(mrem/yr)     time'
<           elseif ( i .eq. 7 ) then
<             columnheader1(187:194)='R Marrow'
<             columnheader2(180:201)='dose(mrem/yr)     time'
<           elseif ( i .eq. 8 ) then
<             columnheader1(219:227)='B Surface'
<             columnheader2(212:233)='dose(mrem/yr)     time'
<           elseif ( i .eq. 9 ) then
<             columnheader1(251:258)=' Thyroid'
<             columnheader2(244:266)='dose(mrem/yr)     time'
<           elseif ( i .eq. 10) then
<             columnheader1(283:291)='Ramainder'
<             columnheader2(276:297)='dose(mrem/yr)     time'
<           elseif ( i .eq. 11) then
<             columnheader1(315:324)='Whole Body'
<             columnheader2(308:330)='dose(mrem/yr)     time'
<           elseif ( i .eq. 12) then
<             columnheader1(346:355)='Total Dose'
<             columnheader2(339:362)='dose(mrem/yr)     time'
<           elseif ( i .eq. 3 ) then
<             columnheader1(59:67) = 'radium226'
<             columnheader2(54:71) = ' conc        time '
<           elseif ( i .eq. 4 ) then
<             columnheader1(91:98)='  Gonad '
<             columnheader2(86:103)=' dose        time '
<           elseif ( i .eq. 5 ) then
<             columnheader1(123:130)=' Breast '
<             columnheader2(118:135)=' dose        time '
<           elseif ( i .eq. 6 ) then
<             columnheader1(155:162)='   Lung '
<             columnheader2(150:167)=' dose        time '
<           elseif ( i .eq. 7 ) then
<             columnheader1(187:194)='R Marrow'
<             columnheader2(182:199)=' dose        time '
<           elseif ( i .eq. 8 ) then
<             columnheader1(219:227)='B Surface'
<             columnheader2(214:231)=' dose        time '
<           elseif ( i .eq. 9 ) then
<             columnheader1(251:258)=' Thyroid'
<             columnheader2(246:264)=' dose         time '
<           elseif ( i .eq. 10) then
<             columnheader1(283:291)='Remainder'
<             columnheader2(278:295)=' dose        time '
<           elseif ( i .eq. 11) then
<             columnheader1(315:324)='Whole Body'
<             columnheader2(310:328)=' dose         time '
<           elseif ( i .eq. 12) then
<             columnheader1(346:355)='Total Dose'
<             columnheader2(341:360)=' dose          time '
<           endif
<         enddo
<         write(iwriteepapktim,'(a)')
<      &    (columnheader1(1:400))
<         write(iwriteepapktim,'(a)')
<      &    (columnheader2(1:402))
<
1160c1288
<      &       ' for Compliance Period'
---
>      &       ' for the Compliance Period specified in tpa.inp'
1174a1303,1305
> cc rwj 12-20-06; SCR675
>       write( iunittotdose, '(a)') (totdtext(i),i=1,17)
>
1181c1312
<      &       ' for Compliance Period'
```

```
---
>      &       ' for the Compliance Period specified in tpa.inp'
1185a1317,1319
> cc rwj 12-20-06; SCR675
>       write( iunittotdose_c, '(a)') (totdctext(i),i=1,19)
>
1202c1336
<      &     'for Compliance Period'
---
>      &       ' for the Compliance Period specified in tpa.inp'
1223c1357
<      &     'for Compliance Period'
---
>      &       ' for the Compliance Period specified in tpa.inp'
1233,1235c1367,1375
<       mes1=' Near Field WP Temp, RH, and Cl Averaged for All Subareas'
<       mes2=' Printed for Each 10th Time and Each Vector'
<
---
>
> c     GADAMS SCR677 1/2/2007: Reformatted output files
> c      mes1=' Near Field WP Temp, RH, and Cl Averaged for All Subareas'
> c      mes2=' Printed for Each 10th Time and Each Vector'
>       mes1='Generates Near Field WP Temp, RH, and Cl Averaged for' //
>      &  ' All Subareas'
>       mes2='Information tabulated for each 10th time and each vector'
> c     GADAMS SCR677 1/2/2007: End of change
>
1237a1378,1416
>
> c     GADAMS SCR677 1/2/2007: Modified format of output files
>       WRITE(iunitnearfld, FMT = '(6(a/),a)')
>      & '!!',
>      & '!! This file displays the values generated from the Near Field',
>      & '!! Environment module, NFENV.  It displays subarea averaged',
>      & '!! values for waste package temperature, relative humidity and',
>      & '!! chloride concentration at the waste package surface for',
>      & '!! each realization.',
>      & '!!'
>
>         WRITE(iunitnearfld, FMT = '(17(a/))')
>      & '!! This file contains only one section',
>      & '!!',
>      & '!! SECTION 1 ; NEAR FIELD DATA (each 10th time step)',
>      & '!!',
>      & '!! This section contains Near Field data for each vector',
>      & '!! at each 10th time step',
>      & '!!',
>      & '!! Vector              ; realization being processed',
>      & '!! Time                ; time corresponding to this tpa time',
>      & '!!                       step',
>      & '!! Avg WP Temperature  ; subarea averaged temperature at the',
>      & '!!                       waste package surface',
>      & '!! Avg WP Rel Humidity ; subarea averaged relative humidity at',
>      & '!!                       the waste package surface',
>      & '!! Avg WP Chloride     ; subarea averaged chloride',
>      & '!!                       concentration of water contacting the',
>      & '!!                       waste package'
>
>         WRITE(iunitnearfld, FMT = '(5(2x, A12))')
>      &    'Vector', 'Time', 'Avg WP', 'Avg WP', 'Avg WP'
>         WRITE(iunitnearfld, FMT = '(28x, 3(2x, A12))')
>      &    'Temperature', 'Rel Humidity', 'Chloride'
>         WRITE(iunitnearfld, FMT = '(14x, 4(2x, A12))')
>      &    '(year)', '(deg C)', '(unitless)',
>      &    '(mol/liter)'
> c     GAAMS SCR677 1/2/2007: End of change
>
1265c1444
<      &     ' for Compliance Period'
---
>      &       ' for the Compliance Period specified in tpa.inp'
1288c1467
<      &     ' for Compliance Period'
---
>      &       ' for the Compliance Period specified in tpa.inp'
1307c1486,1488
<
---
> cc rwj 12-20-06; SCR675
>       write( iunitwpsfail, '(a)') (wpftext(i),i=1,20)
```

```
>       write( iunitwpsfail, '(a)') (wpf2text(i),i=1,3)
1315,1316c1496,1503
<       mes1=' Mechanical Waste Package Failure Data'
<       mes2=' Note: Failure Mechanism (0 = Trapezoid, 1 = Chimney)'
---
>
> c     GADAMS SCR677 1/19/2007: Modified format of output files
> c      mes1=' Mechanical Waste Package Failure Data'
> c      mes2=' Note: Failure Mechanism (0 = Trapezoid, 1 = Chimney)'
>       mes1='Displays Data for Mechanical Waste Package Failure'
>       mes2='for all vectors and subareas'
> c     GADAMS SCR677 1/19/2007: End of change
>
1319a1507,1516
> c     GADAMS SCR677 12/22/2006: Modified format of output files
>       WRITE(iunitmechfail_wp, FMT = '(a/a/a/a/a/a)')
>      & '!!',
>      & '!! This file displays the values generated from mechanical',
>      & '!! failure module, MECHFAIL.  It contains result summary data',
>      & '!! for mechanical waste package failure for each realization',
>      & '!! and each subarea.',
>      & '!!'
> c     GAAMS SCR677 12/22/2006: End of change
>
1325,1326c1522,1529
<       mes1=' Mechanical Drip Shield Failure Data'
<       mes2=' Note: Failure Mechanism (0 = Trapezoid, 1 = Chimney)'
---
>
> c     GADAMS SCR677 1/2/2007: Modified format of output files
> c      mes1=' Mechanical Drip Shield Failure Data'
> c      mes2=' Note: Failure Mechanism (0 = Trapezoid, 1 = Chimney)'
>       mes1='Displays Data for Mechanical Drip Shield Failure'
>       mes2='for all vectors and subareas'
> c     GADAMS SCR677 1/2/2007: End of change
>
1329a1533,1542
> c     GADAMS SCR677 12/22/2006: Modified format of output files
>       WRITE(iunitmechfail_ds, FMT = '(a/a/a/a/a/a)')
>      & '!!',
>      & '!! This file displays the values generated from mechanical',
>      & '!! failure module, MECHFAIL.  It contains result summary data',
>      & '!! for mechanical drip shield failure for each realization',
>      & '!! and each subarea.',
>      & '!!'
> c     GADAMS SCR677 12/22/2006: End of change
>
1368a1582,1583
> cc rwj 12-20-06; SCR675
>       write( iunitsamplpar, '(a)') (sprestext(i),i=1,10)
1396c1611
<      &     ' for Compliance Period'
---
>      &       ' for the Compliance Period specified in tpa.inp'
1682,1689c1897,1905
<         write(iunittotdose,'(/,4(4x,a,4x))')
<      & ' vector ','  time  ','  tede  ','dilutvol'
<         write(iunittotdose,'(4(4x,a,4x))')
<      & 'unitless','   yr   ',' rem/yr ',' m^3/yr '
<         write(iunittotdose_c,'(/,4(4x,a,4x))')
<      & ' vector ','  time  ','  tede  ','dilutvol'
<         write(iunittotdose_c,'(4(4x,a,4x))')
<      & 'unitless','   yr   ',' rem/yr ',' m^3/yr '
---
> cc rwj 12-20-06; SCR675
> c       write(iunittotdose,'(/,4(4x,a,4x))')
> c    & ' vector ','  time  ','  tede  ','dilutvol'
> c       write(iunittotdose,'(4(4x,a,4x))')
> c    & 'unitless','   yr   ',' rem/yr ',' m^3/yr '
> c       write(iunittotdose_c,'(/,4(4x,a,4x))')
> c    & ' vector ','  time  ','  tede  ','dilutvol'
> c       write(iunittotdose_c,'(4(4x,a,4x))')
> c    & 'unitless','   yr   ',' rem/yr ',' m^3/yr '
1777,1782c1993,2000
<         write(iunitnearfld,'(/,5(4x,a,4x))')
<      & ' vector ','  time  ','avwptemp','  avrh  ',
<      & '  avcl  '
<         write(iunitnearfld,'(5(4x,a,4x))')
<      & 'unitless','   yr   ',' deg C  ','unitless',
<      & ' mol/lit'
---
```

```
> c       GADAMS SCR677 1/3/2007: Modifed format of output file
> c        write(iunitnearfld,'(/,5(4x,a,4x))')
> c     & ' vector ','  time  ','avwptemp','  avrh  ',
> c     & '  avcl  '
> c        write(iunitnearfld,'(5(4x,a,4x))')
> c     & 'unitless','   yr   ',' deg C  ','unitless',
> c     & ' mol/lit'
> c       GADAMS SCR677 1/3/2007: End of change
2080,2084c2298,2306
<         write(iunitwpsfail,'(/,2(x,a),3(3x,a,3x), (a, 3x),
<      &    2(3x,a,3x) )')
<      &    ' vector ','subarea ','  time  ','#initial','#corrode',
<      &    '#mechanical',' #fault ','#ign_act'
< c       GADAMS SCR609 3-6-2006: End of change
---
> cc rwj 12-20-06; SCR675
> c       write(iunitwpsfail,'(/,2(x,a),3(3x,a,3x), (a, 3x),
> c    &    2(3x,a,3x) )')
> c    &    ' vector ','subarea ','  time  ','#initial','#corrode',
> c    &    '#mechanical',' #fault ','#ign_act'
> c
> c       write(iunitwpsfail,'(2(x,a),6(3x,a,3x))')
> c    & 'unitless','unitless','   yr   ','unitless','unitless',
> c    & 'unitless','unitless','unitless'
2086,2088d2307
<         write(iunitwpsfail,'(2(x,a),6(3x,a,3x))')
<      & 'unitless','unitless','   yr   ','unitless','unitless',
<      & 'unitless','unitless','unitless'
2090d2308
<
2091a2310
> c       GADAMS SCR677 1/19/2007: Modified output file format
2093,2100c2312,2353
<         WRITE(iunitmechfail_wp, FMT = '(/,3(2X, A7), 9(2x, A12))')
<      &    'Vector', 'Subarea', 'Grid', 'Time', 'VPress', 'Shell Thick',
<      &    'Con. Angle', 'Con. Length', 'PGA', 'Stat Fail', 'Dyn Fail',
<      &    'Failure'
<         WRITE(iunitmechfail_wp, FMT = '(27x, 9(2x, A12))')
<      &    '[yr]', '[kPa]', '[m]',
<      &    '[degrees]', '[m]', '[g]', '(0=no,1=yes)', '(0=no,1=yes)',
<      &    'Mechanism'
---
> c        WRITE(iunitmechfail_wp, FMT = '(/,3(2X, A7), 9(2x, A12))')
> c     &    'Vector', 'Subarea', 'Grid', 'Time', 'VPress', 'Shell Thick',
> c     &    'Con. Angle', 'Con. Length', 'PGA', 'Stat Fail', 'Dyn Fail',
> c     &    'Failure'
> c        WRITE(iunitmechfail_wp, FMT = '(27x, 9(2x, A12))')
> c     &    '[yr]', '[kPa]', '[m]',
> c     &    '[degrees]', '[m]', '[g]', '(0=no,1=yes)', '(0=no,1=yes)',
> c     &    'Mechanism'
>
>        WRITE(iunitmechfail_wp, FMT = '(18(a/))')
>     & '!! SECTION 1 ; SUMMARY FAILURE DATA',
>     & '!!',
>     & '!! This section contains summary failure data for each',
>     & '!! waste package failure',
>     & '!!',
>     & '!! Vector            ; realization where failure occurred',
>     & '!! Subarea           ; subarea where failure occurred',
>     & '!! Type              ; type of rock',
>     & '!!                     1 = lithophysal',
>     & '!!                     2 = nonlithophysal',
>     & '!! Time              ; time for this mechanical failure',
>     & '!! VPress            ; vertical pressure at failure',
>     & '!! WP Thick          ; waste package outer layer thickness',
>     & '!! Contact Angle     ; contact angle when failure occurred',
>     & '!! Contact Length    ; contact length when failure occurred',
>     & '!! PGA               ; peak ground acceleration at failure',
>     & '!! Static Failure    ; static failure flag (0=no, 1=yes)',
>     & '!! Dynamic Failure   ; dynamic failure flag (0=no, 1=yes)',
>     & '!! Caving Mechanism  ; caving failure mechanism for the drift',
>     & '!!                     (0=trapezoid, 1=chimney)'
>
>        WRITE(iunitmechfail_wp, FMT = '(3(2X, A7), 9(2x, A12))')
>     &    'Vector', 'Subarea', 'Type', 'Time', 'VPress', 'WP Thick',
>     &    'Contact', 'Contact', 'PGA', 'Static', 'Dynamic',
>     &    'Caving'
>        WRITE(iunitmechfail_wp,
>     &    FMT = '(69x, 2(2x, A12), 14x, 3(2x, A12))')
>     &    'Angle', 'Length', 'Failure', 'Failure',
>     &    'Mechanism'
```

```
>         WRITE(iunitmechfail_wp, FMT = '(27x, 6(2x, A12))')
>      &    '(year)', '(kPa)', '(m)',
>      &    '(degrees)', '(m)', '(g)'
2103,2106c2356,2395
<         WRITE(iunitmechfail_ds, FMT = '(/, 3(2x, A7), 11(2x, A12))')
<      &    'Vector', 'Subarea', 'Grid', 'Time', 'VPress', 'PGA', 'MAFE',
<      &    'DS Temp', 'Horz-Vert LR', 'Creep Thres', 'DS Thick',
<      &    'Stat Fail', 'Dyn Fail', 'Failure'
---
> c        WRITE(iunitmechfail_ds, FMT = '(/, 3(2x, A7), 11(2x, A12))')
> c     &    'Vector', 'Subarea', 'Grid', 'Time', 'VPress', 'PGA', 'MAFE',
> c     &    'DS Temp', 'Horz-Vert LR', 'Creep Thres', 'DS Thick',
> c     &    'Stat Fail', 'Dyn Fail', 'Failure'
> c        WRITE(iunitmechfail_ds,
> c     &    FMT = '(27x, 3(2x, A12), 14x, (2x, A12), 28x, 4(2x, A12))')
> c     &    '[yr]', '[kPa]', '[g]','[C]', '[m]',
> c     &    '(0=no,1=yes)', '(0=no,1=yes)', 'Mechanism'
>
>         WRITE(iunitmechfail_ds, FMT = '(25(a/))')
>      & '!! SECTION 1 ; SUMMARY FAILURE DATA',
>      & '!!',
>      & '!! This section contains summary failure data for each',
>      & '!! drip shield failure',
>      & '!!',
>      & '!! Reference: Ibarra et al., "Drip Shield - Waste Package',
>      & '!!            Mechanical Interaction," 2006',
>      & '!!',
>      & '!! Vector                ; realization where failure occurred',
>      & '!! Subarea               ; subarea where failure occurred',
>      & '!! Type                  ; type of rock',
>      & '!!                         1 = lithophysal',
>      & '!!                         2 = nonlithophysal',
>      & '!! Time                  ; time for this mechanical failure',
>      & '!! VPress                ; vertical pressure at failure',
>      & '!! PGA                   ; peak ground acceleration',
>      & '!! MAFE                  ; mean annual frequency of exceedance',
>      & '!! DS Temp               ; drip shield surface temperature',
>      & '!! Horiz-Vert Load Ratio ; horizontal to vertical load ratio',
>      & '!! Creep Threshold       ; creep threshold',
>      & '!! DS Thick              ; drip shield shell thickness',
>      & '!! Static Failure        ; static failure flag (0=no, 1=yes)',
>      & '!! Dynamic Failure       ; dynamic failure flag (0=no, 1=yes)',
>      & '!! Failure Mechanism     ; drift degradation mechanism',
>      & '!!                         (0=trapezoid, 1=chimney)'
>
>         WRITE(iunitmechfail_ds, FMT = '(3(2X, A7), 11(2x, A12))')
>      &    'Vector', 'Subarea', 'Type', 'Time', 'VPress', 'PGA',
>      &    'MAFE', 'DS Temp', 'Horiz-Vert', 'Creep', 'DS Thick',
>      &    'Static', 'Dynamic', 'Failure'
2108,2110c2397,2404
<      &    FMT = '(27x, 3(2x, A12), 14x, (2x, A12), 28x, 4(2x, A12))')
<      &    '[yr]', '[kPa]', '[g]','[C]', '[m]',
<      &    '(0=no,1=yes)', '(0=no,1=yes)', 'Mechanism'
---
>      &    FMT = '(97x, 2(2x, A12), 14x, 3(2x, A12))')
>      &    'Load Ratio', 'Threshold', 'Failure', 'Failure',
>      &    'Mechanism'
>         WRITE(iunitmechfail_ds,
>      &    FMT = '(27x, 5(2x, A12), 28x, 2x, A12)')
>      &    '(year)', '(kPa)', '(g)', '(1/year)', '(degrees C)', '(m)'
> c       GADAMS SCR677 1/19/2007: End of change
>
2114,2115c2408,2426
<         WRITE(iunitdsfailres, '(/, 32x, 3(4x, A12))')
<      &    'DRIP SHIELD', 'DRIP SHIELD', 'DRIFT'
---
> c    SCR679 J. Mancillas File format change
> c        WRITE(iunitdsfailres, '(/, 32x, 3(4x, A12))')
> c     &    'DRIP SHIELD', 'DRIP SHIELD', 'DRIFT'
> c        WRITE(iunitdsfailres, '(5(4x, A12))')
> c     &    'Vector', 'TIME', '#CORRODE', '#MECHANICAL', 'FRACTION'
> c        WRITE(iunitdsfailres, '(5(4x, A12))')
> c     &    'unitless', 'yr', 'unitless', 'unitless', 'unitless'
>         WRITE(iunitdsfailres, '(A)') text679(101)
>         WRITE(iunitdsfailres, '(A)') text679(102)
>         WRITE(iunitdsfailres, '(A)') text679(103)
>         WRITE(iunitdsfailres, '(A)') text679(104)
>         WRITE(iunitdsfailres, '(A)') text679(105)
>         WRITE(iunitdsfailres, '(A)') text679(106)
>         WRITE(iunitdsfailres, '(A)') text679(107)
>         WRITE(iunitdsfailres, '(A)') text679(108)
```

```
>         WRITE(iunitdsfailres, '(A)') text679(109)
>         WRITE(iunitdsfailres, '(A)') text679(110)
>         WRITE(iunitdsfailres, '(A)') text679(111)
>         WRITE(iunitdsfailres, '(A)') text679(112)
2116a2428,2429
>      &    'Realization ',' ','DRIP SHIELD', 'DRIP SHIELD', 'DRIFT'
>         WRITE(iunitdsfailres, '(5(4x, A12))')
2119c2432
<      &    'unitless', 'yr', 'unitless', 'unitless', 'unitless'
---
>      &    'unitless', '[yr]', 'unitless', 'unitless', 'unitless'
2239c2552,2554
<       write(iunitsamplpar,'(/,a)')
---
> cc rwj 12-20-06; SCR675
> c     write(iunitsamplpar,'(/,a)')
>       write(iunitsamplpar,'(a,/,a,/)') '!!', '!! '//
2396a2712,2713
> cc rwj 11-19-06; SCR675
>       write(iunitsp,'(a)') (sptext(isptext),isptext=1,11)
2406a2724,2725
> cc rwj 11-19-06; SCR675
>       write(iunitcp,'(a)') (cptext(icptext),icptext=1,16)
2416a2736,2737
> cc rwj 11-19-06; SCR675
>       write(iunitmv,'(a)') (mvtext(imvtext),imvtext=1,13)
3147c3468,3471
<           call newrealization(iunitsp, iunitcp, mylastcheck )
---
> cc rwj 12-20-06; SCR675
> c         call newrealization(iunitsp, iunitcp, mylastcheck)
>           call newrealization(iunitsp, iunitcp, mylastcheck,
>      &                        sptext, 36)
3311,3315c3635,3642
<             write( iunitechouzflow,'(a,/)')
<      &     '(same values and time steps for all subareas and vectors)'
<             write( iunitechouzflow, fmt='("   ntim")')
<             write( iunitechouzflow, fmt='(i6,/)') ntim
<             write( iunitechouzflow, fmt='("       time")')
---
> cc rwj 12-20-06; SCR675
> c           write( iunitechouzflow,'(a,/)')
> c    &     '(same values and time steps for all subareas and vectors)'
> c           write( iunitechouzflow, fmt='("   ntim")')
> c           write( iunitechouzflow, fmt='(i6,/)') ntim
> c           write( iunitechouzflow, fmt='("       time")')
>             write( iunitechouzflow,'(a)') (uzf1text(i),i=17,24)
>
3318a3646,3648
> cc rwj 12-20-06; SCR675
>             write(iunitechouzflow,'(a)') uzf1text(25)
>
3320,3321c3650,3651
<             write( iunitechouzflow,'(/,/,a)')
<      &      '(there are no new values for each subarea and vector)'
---
> c           write( iunitechouzflow,'(/,/,a)')
> c    &      '(there are no new values for each subarea and vector)'
3378,3379c3708,3712
<           write( iunitresultsuzflow, '(a)') '       time '//
<      &     '       qm3/yr/sa'
---
> cc rwj 12-20-06; SCR675
> c         write( iunitresultsuzflow, '(a)') '       time '//
> c    &     '       qm3/yr/sa'
>           write( iunitresultsuzflow, '(a)') (uzf2text(i),i=14,23)
>
3383a3717,3720
>
> cc rwj 12-20-06; SCR675
>             write(iunitresultsuzflow,'(a)') uzf2text(24)
>
3560,3562c3897,3908
<               write( iunitechodriftfail, fmt='("   ntim")')
<               write( iunitechodriftfail, fmt='(i7,/)') ntim
<               write( iunitechodriftfail, fmt='("       time")')
---
> c    SCR679 J. Mancillas File format change
> c              write( iunitechodriftfail, fmt='("   ntim")')
> c              write( iunitechodriftfail, fmt='(i7,/)') ntim
> c              write( iunitechodriftfail, fmt='("       time")')
```

```
>                write(iunitechodriftfail,'(A)') text679(1)
>                write(iunitechodriftfail,'(A)') text679(2)
>                write(iunitechodriftfail,'(I26,1x,A)') ntim, text679(3)
>                write(iunitechodriftfail,'(A)') text679(4)
>                write(iunitechodriftfail,'(A)') text679(5)
>                write(iunitechodriftfail,'(A)') text679(6)
>                write(iunitechodriftfail,'(A)')
>      &          "  Step        Time (yr)  "
3564c3910
<                write(iunitechodriftfail,fmt='(i4,1pe12.4)')i,tim(i)
---
>                write(iunitechodriftfail,fmt='(i4,7x,1pe12.6)')i,tim(i)
3565a3912
>                write(iunitechodriftfail,'(A)') text679(7)
3581,3583c3928,3947
<               write( iunitechodriftfail,
<      &          fmt='(/,"numberofevents =",i7)') numberofseismicevents
<               write( iunitechodriftfail, FMT='(/, 5x, 5(3x, A12))')
---
> c    SCR679 J. Mancillas File formate change
> c               write( iunitechodriftfail,
> c     &          fmt='(/,"numberofevents =",i7)') numberofseismicevents
> c               write( iunitechodriftfail, FMT='(/, 5x, 5(3x, A12))')
> c     &          'Time[yr]', 'MAPE', 'PGV[m/s]', 'PGA[g]',
> c     &          'CF'
>                write(iunitechodriftfail,'(A)') text679(8)
>                write(iunitechodriftfail,'(A)') text679(9)
>                write(iunitechodriftfail,'(I26,1x,A)')
>      &          numberofseismicevents, text679(10)
>                write(iunitechodriftfail,'(A)') text679(11)
>                write(iunitechodriftfail,'(A)') text679(12)
>                write(iunitechodriftfail,'(A)') text679(13)
>                write(iunitechodriftfail,'(A)') text679(14)
>                write(iunitechodriftfail,'(A)') text679(15)
>                write(iunitechodriftfail,'(A)') text679(16)
>                write(iunitechodriftfail,'(A)') text679(17)
>                write(iunitechodriftfail,'(A)') text679(18)
>                write(iunitechodriftfail,'(A)') text679(19)
>               write( iunitechodriftfail, FMT='(5x, 5(3x, A12))')
3586c3950,3951
<
---
>
>
3592c3957
<
---
>
3593a3959,3960
> c    SCR679 J. Mancillas File formate change
>                write(iunitechodriftfail,'(A)') text679(20)
3702,3707c4069,4086
<              write(iunitresultsdriftfail, FMT = '(//A,I3/A)')
<      &        'Subarea: ', isa,
<      &        'Vertical pressures at the seismic times'
<               write( iunitresultsdriftfail,
<      &          fmt='(/,"numberofevents =",i7)') numberofseismicevents
<
---
> c    SCR679 J. Mancillas File formate change
> c             write(iunitresultsdriftfail, FMT = '(//A,I3/A)')
> c     &        'Subarea: ', isa,
> c     &        'Vertical pressures at the seismic times'
> c               write( iunitresultsdriftfail,
> c     &          fmt='(/,"numberofevents =",i7)') numberofseismicevents
>
>              write(iunitresultsdriftfail,'(A)') text679(21)
>              write(iunitresultsdriftfail,'(A)') text679(22)
>              write(iunitresultsdriftfail,'(I26,1x,A)') ir, text679(23)
>              write(iunitresultsdriftfail,'(I26,1x,A)') isa,text679(24)
>              write(iunitresultsdriftfail,'(A)') text679(25)
>              write(iunitresultsdriftfail,'(A)') text679(26)
>              write(iunitresultsdriftfail,'(A)') text679(27)
>              write(iunitresultsdriftfail, FMT='(I26,1x,A)')
>      &       numberofseismicevents, text679(28)
>              write(iunitresultsdriftfail,'(A)') text679(29)
>
3709,3719c4088,4119
<                 write(iunitresultsdriftfail, FMT='(2x, A5, 3(2x, A12))')
<      &            'Event', 'Time', 'Press Seis 1', 'Press Seis 2'
<                 write(iunitresultsdriftfail, FMT='(7x, 3(2x, A12))')
```

```
<       &                   '(yr)', '(kPa)',        '(kPa)'
<                 do i = 1,numberofseismicevents
<                   write(iunitresultsdriftfail,
<       &             FMT='(2x, I5, 3(2X, 1pe12.5))')
<       &             i, timeofseismicevents(i),
<       &             vert_pressure1_seismic(i, isa),
<       &             vert_pressure2_seismic(i, isa)
<                 enddo
---
> c     SCR679 J. Mancillas File formate change
> c                 write(iunitresultsdriftfail, FMT='(2x, A5, 3(2x, A12))')
> c      &            'Event', 'Time', 'Press Seis 1', 'Press Seis 2'
> c                 write(iunitresultsdriftfail, FMT='(7x, 3(2x, A12))')
> c      &                   '(yr)', '(kPa)',        '(kPa)'
> c                 do i = 1,numberofseismicevents
> c                   write(iunitresultsdriftfail,
> c      &             FMT='(2x, I5, 3(2X, 1pe12.5))')
> c      &             i, timeofseismicevents(i),
> c      &             vert_pressure1_seismic(i, isa),
>
> c      &             vert_pressure2_seismic(i, isa)
> c                 enddo
>               write(iunitresultsdriftfail,'(A)') text679(30)
>               write(iunitresultsdriftfail,'(A)') text679(31)
>               write(iunitresultsdriftfail,'(A)') text679(32)
>               write(iunitresultsdriftfail,'(A)') text679(33)
>               write(iunitresultsdriftfail,'(A)') text679(34)
>               write(iunitresultsdriftfail,'(A)') text679(35)
>               write(iunitresultsdriftfail,'(A)')
>       &       " Seismic      Event      Vertical Press    Vertical Press "
>               write(iunitresultsdriftfail,'(A)')
>       &       "   Event       Time         Rock type 1       Rock type 2 "
>               write(iunitresultsdriftfail,'(A)')
>       &       "                (yr)                (kPa)             (kPa) "
>               do i=1,numberofseismicevents
>               write(iunitresultsdriftfail, FMT='(I9, 3(4x,1pe12.5))')
>       &       i,timeofseismicevents(i),vert_pressure1_seismic(i,isa),
>       &                                vert_pressure2_seismic(i,isa)
>               end do
>               write(iunitresultsdriftfail,'(A)') text679(36)
>
3724,3725c4124,4126
<               write( iunitresultsdriftfail,'(/,a)')
<       &         'Drift failure results'
---
> c     SCR679 J. Mancillas File formate change
> c              write( iunitresultsdriftfail,'(/,a)')
> c      &         'Drift failure results'
3742,3751c4143,4152
<               WRITE(iunitresultsdriftfail, FMT = '(/, A, I2,/,
<       &             A, 1pe12.5,/A, I2,/A, 1pe12.5)')
<       &         'Rock Type One Drift Failure (yes=1, no=0): ',
<       &         drift_flag_one,
<       &         'Rock Type One Failure Time:                ',
<       &         drift_time_one,
<       &         'Rock Type Two Drift Failure (yes=1, no=0): ',
<       &         drift_flag_two,
<       &         'Rock Type Two Failure Time:                ',
<       &         drift_time_two
---
> c              WRITE(iunitresultsdriftfail, FMT = '(/, A, I2,/,
> c      &             A, 1pe12.5,/A, I2,/A, 1pe12.5)')
> c      &         'Rock Type One Drift Failure (yes=1, no=0): ',
> c      &         drift_flag_one,
> c      &         'Rock Type One Failure Time:                ',
> c      &         drift_time_one,
> c      &         'Rock Type Two Drift Failure (yes=1, no=0): ',
> c      &         drift_flag_two,
> c      &         'Rock Type Two Failure Time:                ',
> c      &         drift_time_two
3752a4154,4168
>               write(iunitresultsdriftfail,'(A)') text679(37)
>               write(iunitresultsdriftfail,'(A)') text679(38)
>               write(iunitresultsdriftfail,'(A)') text679(39)
>               write(iunitresultsdriftfail,'(A)') text679(40)
>               write(iunitresultsdriftfail,'(A)') text679(41)
>               write(iunitresultsdriftfail,'(A)') text679(42)
>               write(iunitresultsdriftfail,'(I26,1x,A)') drift_flag_one,
>       &        text679(43)
>               write(iunitresultsdriftfail,'(14x,1pe12.5,1x,A)')
>       &        drift_time_one, text679(44)
```

```
>             write(iunitresultsdriftfail,'(I26,1x,A)') drift_flag_two,
>      &       text679(45)
>             write(iunitresultsdriftfail,'(14x,1pe12.5,1x,A)')
>      &        drift_time_two, text679(46)
>             write(iunitresultsdriftfail,'(A)') text679(47)
3754,3757c4170,4174
<             WRITE(iunitresultsdriftfail, FMT = '(/, A, I3)')
<      &        'Equivalent Diameters and Vertical Pressures,' //
<      &        ' Subarea Analysis: Subarea ', isa
<
---
>
> c    SCR679 J. Mancillas File formate change
> c             WRITE(iunitresultsdriftfail, FMT = '(/, A, I3)')
> c     &        'Equivalent Diameters and Vertical Pressures,' //
> c     &        ' Subarea Analysis: Subarea ', isa
3761,3766d4177
<             WRITE(iunitresultsdriftfail, FMT = '(/, 8(2x, A12))')
<      &        'Time', 'Drift Dia A', 'Drift Dia B', 'BF Dia A',
<      &        'BF Dia B', 'Drift Ht', 'Vert Press 1', 'Vert Press 2'
<             WRITE(iunitresultsdriftfail, FMT = '(8(2x, A12))')
<      &        '(yr)', '(m)',          '(m)',          '(m)',
<      &        '(m)',       '(m)',       '(kPa)',         '(kPa)'
3767a4179,4217
> c             WRITE(iunitresultsdriftfail, FMT = '(/, 8(2x, A12))')
> c     &        'Time', 'Drift Dia A', 'Drift Dia B', 'BF Dia A',
> c     &        'BF Dia B', 'Drift Ht', 'Vert Press 1', 'Vert Press 2'
> c             WRITE(iunitresultsdriftfail, FMT = '(8(2x, A12))')
> c     &        '(yr)', '(m)',          '(m)',          '(m)',
> c     &        '(m)',       '(m)',       '(kPa)',         '(kPa)'
>             WRITE(iunitresultsdriftfail,'(A)') text679(48)
>             WRITE(iunitresultsdriftfail,'(A)') text679(49)
>             WRITE(iunitresultsdriftfail,'(A)') text679(50)
>             WRITE(iunitresultsdriftfail,'(A)') text679(51)
>             WRITE(iunitresultsdriftfail,'(A)') text679(52)
>             WRITE(iunitresultsdriftfail,'(A)') text679(53)
>             WRITE(iunitresultsdriftfail,'(A)') text679(54)
>             WRITE(iunitresultsdriftfail,'(A)') text679(55)
>             WRITE(iunitresultsdriftfail,'(A)') text679(56)
>             WRITE(iunitresultsdriftfail,'(A)') text679(57)
>             WRITE(iunitresultsdriftfail,'(A)') text679(58)
>             WRITE(iunitresultsdriftfail,'(A)') text679(59)
>             WRITE(iunitresultsdriftfail,'(A)') text679(60)
> c             WRITE(iunitresultsdriftfail,'(I26,A)') isa , text679(61)
>             WRITE(iunitresultsdriftfail,'(A)') text679(62)
>            WRITE(iunitresultsdriftfail,FMT= '(2x,8(A12,2x))')"     TIME"
>      &       ,"Equivalent", "Equivalent", "Equivalent", "Equivalent",
>      &        " Avg Drift", "  Vertical" , " Vertical"
>
>            WRITE(iunitresultsdriftfail,FMT= '(2x,8(A12,2x))')"         "
>      &       ,"    Vertical", "  Horizontal", "    Vertical",
>      &        "  Horizontal",
>      &        "Height Above", "    Pressure" , "   Pressure"
>
>            WRITE(iunitresultsdriftfail,FMT= '(2x,8(A12,2x))')"         "
>      &       ," Drift Dia", " Drift Dia", "Backfill Dia","Backfill Dia",
>      &        "    Invert", " Rocktype1" ," Rocktype2"
>
>            WRITE(iunitresultsdriftfail,FMT= '(2x,8(A12,2x))')"     (yr)"
>      &       ,"          (m)", "          (m)", "          (m)",
>      &        "          (m)",
>      &        "          (m)", "        (kPa)" , "       (kPa)"
>
3769a4220
> c    SCR679 J. Mancillas File formate change
3786a4238
>             WRITE(iunitresultsdriftfail,'(A)') text679(63)
3789c4241,4245
< c              WRITE(iunitresultseqvdia, FMT = '(/, A)')
---
> c    SCR679 J. Mancillas File formate change
> cc              WRITE(iunitresultseqvdia, FMT = '(/, A)')
> cc     &          'Equivalent Diameters,' //
> cc     &          ' Repository Analysis'
> c              WRITE(iunitresultsdriftfail, FMT = '(/, A)')
3792,3796c4248,4252
<              WRITE(iunitresultsdriftfail, FMT = '(/, A)')
<      &          'Equivalent Diameters,' //
<      &          ' Repository Analysis'
<
< c              WRITE(iunitresultseqvdia, FMT = '(A, I4)')
```

```
---
> c
> cc              WRITE(iunitresultseqvdia, FMT = '(A, I4)')
> cc     &          'Total number of subareas in analysis: ',
> cc     &          istopsuba - istartsuba + 1
> c              WRITE(iunitresultsdriftfail, FMT = '(A, I4)')
3798,3803c4254,4259
< c     &          istopsuba - istartsuba - 1
<               WRITE(iunitresultsdriftfail, FMT = '(A, I4)')
<      &          'Total number of subareas in analysis: ',
<      &          istopsuba - istartsuba + 1
<
< c              WRITE(iunitresultseqvdia, FMT = '(/, 6(2x, A12))')
---
> c     &          istopsuba - istartsuba - 1
> c
> cc              WRITE(iunitresultseqvdia, FMT = '(/, 6(2x, A12))')
> cc     &          'Time', 'Drift Dia A', 'Drift Dia B',
> cc     &          'BF Dia A', 'BF Dia B', 'Drift Ht'
> c              WRITE(iunitresultsdriftfail, FMT = '(/, 6(2x, A12))')
3806,3812c4262,4299
<               WRITE(iunitresultsdriftfail, FMT = '(/, 6(2x, A12))')
<      &          'Time', 'Drift Dia A', 'Drift Dia B',
<      &          'BF Dia A', 'BF Dia B', 'Drift Ht'
<               WRITE(iunitresultsdriftfail, FMT = '(6(2x, A12))')
<      &          '(yr)', '(m)',          '(m)',
<      &          '(m)',      '(m)',      '(m)'
<
---
> c              WRITE(iunitresultsdriftfail, FMT = '(6(2x, A12))')
> c     &          '(yr)', '(m)',          '(m)',
> c     &          '(m)',      '(m)',      '(m)'
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(64)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(65)
>               WRITE(iunitresultsdriftfail, FMT = '(I26,1x,A)')
>      &        ir, text679(66)
>               WRITE(iunitresultsdriftfail, FMT = '(I26,1x,A)')
>      &          istopsuba - istartsuba + 1, text679(67)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(68)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(69)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(70)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(71)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(72)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(73)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(74)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(75)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(76)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(77)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(78)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(79)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(80)
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(81)
>               WRITE(iunitresultsdriftfail, FMT = '( 6(2x, A13))')
>      &          'Time', 'Average', 'Average',
>      &          'Average', 'Average', 'Avg Drift'
>               WRITE(iunitresultsdriftfail, FMT = '( 6(2x, A13))')
>      &          ' ', 'Vertical', 'Horizontal',
>      &          'Vertical', 'Horizontal', 'Height Above'
>               WRITE(iunitresultsdriftfail, FMT = '( 6(2x, A13))')
>      &          ' ', 'Drift Dia', 'Drift Dia',
>      &          'Backfill Dia', 'Backfill Dia', 'Invert'
>
>               WRITE(iunitresultsdriftfail, FMT = '(6(2x, A13))')
>      &          '(yr)', '(m)',  '(m)',
>      &          '(m)',  '(m)',  '(m)'
>
>
3819c4306,4308
<      &            FMT = '(6(2x, 1pe12.5))') tim(i),
---
> c     SCR679 J. Mancillas File formate change
> c     &            FMT = '(6(2x, 1pe12.5))') tim(i),
>      &            FMT = '(6(3x, 1pe12.5))') tim(i),
3822a4312
>               WRITE(iunitresultsdriftfail, FMT = '(A)') text679(82)
3833a4324
>
3916,3920c4407,4414
<          do itime = 1,ntim
<             cumtempwp(itime) = cumtempwp(itime) + tempwp(itime)
<             cumrelhumwp(itime) = cumrelhumwp(itime) + relhumwp(itime)
```

```
<             cumclwp(itime) = cumclwp(itime) + clwp(itime)
<          enddo
---
> c        GADAMS SCR677 1/2/2007: Moved to later because clwp is not
> c        set in the call to nfenfFL
> c         do itime = 1,ntim
> c            cumtempwp(itime) = cumtempwp(itime) + tempwp(itime)
> c            cumrelhumwp(itime) = cumrelhumwp(itime) + relhumwp(itime)
> c            cumclwp(itime) = cumclwp(itime) + clwp(itime)
> c         enddo
> c        GADAMS SCR677 1/2/2007: End of change
3939,3945c4433,4443
<             WRITE( iunitechodsfail,'(a,/)')
<      &        '(same value for all subareas and vectors)'
<             WRITE( iunitechodsfail, fmt='("   ntim")')
<             WRITE( iunitechodsfail, fmt='(i7,/)') ntim
<             WRITE( iunitechodsfail,'(/,a,/)')
<      &        '(the following values are for each subarea and vector)'
<
---
> c SCR679 J. Mancillas File Format changes
> c            WRITE( iunitechodsfail,'(a,/)')
> c     &        '(same value for all subareas and vectors)'
> c            WRITE( iunitechodsfail, fmt='("   ntim")')
> c            WRITE( iunitechodsfail, fmt='(i7,/)') ntim
> c            WRITE( iunitechodsfail,'(/,a,/)')
> c     &        '(the following values are for each subarea and vector)'
>             WRITE( iunitechodsfail,'(a)') text679(83)
>             WRITE( iunitechodsfail,'(a)') text679(84)
>             WRITE( iunitechodsfail, '(I26,1x, A)') ntim, text679(85)
>             WRITE( iunitechodsfail,'(a)') text679(86)
3947a4446,4447
>             WRITE( iunitechodsfail,'(a)') text679(87)
>             WRITE( iunitechodsfail,'(a)') text679(88)
3954c4454,4456
<         ENDIF
---
> c SCR679 J. Mancillas File Format changes
>           WRITE( iunitechodsfail,'(a)') text679(89)
>        ENDIF
3987,3990c4489,4500
<
<           IF(ids_failure_flag(isa) .EQ. 1) THEN
<             WRITE(iunitresultsdsfail, '(/,a, 4x, 1pe12.4)')
<      &        'Drip shield failure time: ', ds_failure_time(isa)
---
> c SCR679 J. Mancillas 01-02-07 File format change
>             WRITE(iunitresultsdsfail, '(A)') text679(90)
>
>          IF(ids_failure_flag(isa) .EQ. 1) THEN
> c SCR679 J. Mancillas 01-02-07 File format change
> c            WRITE(iunitresultsdsfail, '(/,a, 4x, 1pe12.4)')
> c     &        'Drip shield failure time: ', ds_failure_time(isa)
>             WRITE(iunitresultsdsfail, '(A)') text679(91)
>             WRITE(iunitresultsdsfail, '(12x,1pe12.6,1x,A)')
>      &       ds_failure_time(isa), text679(92)
>
>
3993,3994c4503,4508
< c           GADAMS SCR562 4-18-2005: Corrected spelling error:
< c           shiled to shield
---
> c SCR679 J. Mancillas 01-02-07 File format change
> cc           GADAMS SCR562 4-18-2005: Corrected spelling error:
> cc           shiled to shield
> cc            WRITE(iunitresultsdsfail, '(/,a, 4x, 1pe12.4, a)')
> cc     &        'No failure of the drip shiled in: ', tim(ntim),
> cc     &        ' years'
3996c4510
< c     &        'No failure of the drip shiled in: ', tim(ntim),
---
> c     &        'No failure of the drip shield in: ', tim(ntim),
3998,4001c4512,4515
<             WRITE(iunitresultsdsfail, '(/,a, 4x, 1pe12.4, a)')
<      &        'No failure of the drip shield in: ', tim(ntim),
<      &        ' years'
< c           GADAMS SCR562 4-18-2005: End of change
---
> cc           GADAMS SCR562 4-18-2005: End of change
>             WRITE(iunitresultsdsfail, '(A)') text679(93)
>             WRITE(iunitresultsdsfail, '(12x,1pe12.6,1x,A)')tim(ntim),
```

```
>      &      text679(94)
4004,4008c4518,4531
<           WRITE(iunitresultsdsfail,'(/,a, 3x, 1pe12.4)')
<      &      'Drip shield corrosion rate:', ds_corrosion_rate
<
<           WRITE(iunitresultsdsfail,'(/,a)')
<      &      'Drip shield thickness and fraction failed versus time'
---
> c SCR679 J. Mancillas 01-02-07 File format change
> c          WRITE(iunitresultsdsfail,'(/,a, 3x, 1pe12.4)')
> c     &      'Drip shield corrosion rate:', ds_corrosion_rate
>            WRITE(iunitresultsdsfail,'(12x,1pe12.6,1x,A)')
>      &      ds_corrosion_rate, text679(95)
>             WRITE(iunitresultsdsfail, '(A)') text679(96)
>
> c
> c SCR679 J. Mancillas 01-02-07 File format change
> c          WRITE(iunitresultsdsfail,'(/,a)')
> c     &      'Drip shield thickness and fraction failed versus time'
>           WRITE(iunitresultsdsfail,'(A)') text679(97)
>           WRITE(iunitresultsdsfail,'(A)') text679(98)
>           WRITE(iunitresultsdsfail,'(A)') text679(99)
4010,4011c4533,4537
<           WRITE( iunitresultsdsfail, fmt='(/,5x, 3(4x, a12))')
<      &      'Time[yr] ', 'Thickness[m]', 'Fraction'
---
> c SCR679 J. Mancillas 01-02-07 File format change
> c          WRITE( iunitresultsdsfail, fmt='(/,5x, 3(4x, a12))')
> c     &      'Time[yr] ', 'Thickness[m]', 'Fraction'
>           WRITE( iunitresultsdsfail, fmt='(A6,3(4x, a12))')
>      &    'Index', 'Time[yr] ', 'Thickness[m]', 'Fraction'
4013d4538
<
4018c4543
<      &        i,tim(i), ds_thickness(i), dmechfaildssubarea(i, isa)
---
>      &        i,tim(i), ds_thickness(i), dmechfaildssubarea(i, isa)
4020d4544
<
4021a4546
>            WRITE(iunitresultsdsfail, '(A)') text679(100)
4083a4609,4616
> c     GADAMS SCR677 1/2/2007: Summary data for nearfld.res
>       do itime = 1,ntim
>         cumtempwp(itime) = cumtempwp(itime) + tempwp(itime)
>         cumrelhumwp(itime) = cumrelhumwp(itime) + relhumwp(itime)
>         cumclwp(itime) = cumclwp(itime) + clwp(itime)
>       enddo
> c     GADAMS SCR677 1/2/2007: End of change
>
4197,4205c4730,4742
<               write( iunitechomechfail,'(a,/)')
<      &        '(same times for all subareas and vectors)'
<
<               write( iunitechomechfail, fmt='("   ntim")')
<               write( iunitechomechfail, fmt='(i7,/)') ntim
<               write( iunitechomechfail, fmt='("       time")')
<               do i = 1,ntim
<                 write(iunitechomechfail,fmt='(i4,1pe12.4)')i,tim(i)
<               enddo
---
>
> c             GADAMS SCR677 12-20-2006: Reformatted output file
> c              write( iunitechomechfail,'(a,/)')
> c     &        '(same times for all subareas and vectors)'
> c
> c              write( iunitechomechfail, fmt='("   ntim")')
> c              write( iunitechomechfail, fmt='(i7,/)') ntim
> c              write( iunitechomechfail, fmt='("       time")')
> c              do i = 1,ntim
> c                write(iunitechomechfail,fmt='(i4,1pe12.4)')i,tim(i)
> c              enddo
> c             GADAMS SCR677 12-20-2006: End of change
>
4210c4747,4749
<            if(isfirstsubarea) then
---
> c           GADAMS SCR677 12/21/2006: Display realization and subarea
> c           for all realizations as well as seismic data
> c            if(isfirstsubarea) then
4222,4234c4761,4773
```

```
<                write( iunitechomechfail, fmt='(/,"numberofevents =",i7)')
<       &          numberofseismicevents
<                write( iunitechomechfail, FMT='(/, 5x, 6(3x, A12))')
<       &          'Time[yr]', 'MAPE', 'PGV[m/s]', 'PGA[g]',
<       &          'VPress1[kPa]', 'VPress2[kPa]'
<
<                do i = 1,numberofseismicevents
<                  write(iunitechomechfail,
<       &             fmt='(1x, I4, 6(3x, 1pe12.5))')i,
<       &             timeofseismicevents(i), dmape(i), pgv(i), pga(i),
<       &             vert_pressure1_seismic(i, isa),
<       &             vert_pressure2_seismic(i, isa)
<                enddo
---
> c               write( iunitechomechfail, fmt='(/,"numberofevents =",i7)')
> c     &          numberofseismicevents
> c               write( iunitechomechfail, FMT='(/, 5x, 6(3x, A12))')
> c     &          'Time[yr]', 'MAPE', 'PGV[m/s]', 'PGA[g]',
> c     &          'VPress1[kPa]', 'VPress2[kPa]'
> c
> c               do i = 1,numberofseismicevents
> c                 write(iunitechomechfail,
> c     &             fmt='(1x, I4, 6(3x, 1pe12.5))')i,
> c     &             timeofseismicevents(i), dmape(i), pgv(i), pga(i),
> c     &             vert_pressure1_seismic(i, isa),
> c     &             vert_pressure2_seismic(i, isa)
> c               enddo
4236c4775,4786
<              end if
---
> c              end if
>
>              WRITE(iunitechomechfail, FMT = '(a/a/a/a/a/)')
>       & '!! SECTION 1 ; CURRENT STATE',
>       & '!!',
>       & '!! Current realization and subarea being evaluated',
>       & '!! Item 1: realization - realization being evaluated',
>       & '!! Item 2: subarea identifier - subarea being evaluated'
>
>              WRITE(iunitechomechfail, FMT = '(I24,a,/,I24,a,/)')
>       &        ir, '    ! Realization being evaluated',
>       &        isa, '    ! Subarea being evaluated'
4240,4241c4790,4791
<              WRITE(iunitechomechfail, FMT = '(//, A, I3)')
<       &        'SUBAREA ', isa
---
> c              WRITE(iunitechomechfail, FMT = '(//, A, I3)')
> c     &        'SUBAREA ', isa
4246,4248c4796,4854
<              WRITE(iunitechomechfail, FMT = '(/, 5x, 7(3x, A12))')
<       &        'Time[yr]', 'DS Thick[m]', 'DS Temp[C]', 'OL Thick[m]',
<       &        'WP Temp[C]', 'VPress1[kPa]', 'VPress2[kPa]'
---
> c              WRITE(iunitechomechfail, FMT = '(/, 5x, 7(3x, A12))')
> c     &        'Time[yr]', 'DS Thick[m]', 'DS Temp[C]', 'OL Thick[m]',
> c     &        'WP Temp[C]', 'VPress1[kPa]', 'VPress2[kPa]'
>
>              WRITE(iunitechomechfail, FMT = '(13(a/))')
>       & '!! SECTION 2 ; SEISMIC DATA',
>       & '!!',
>       & '!! This section contains data for each seismic event',
>       & '!!',
>       & '!! Event          ; seismic event number',
>       & '!! Seis Time      ; time of this seismic event',
>       & '!! MAFE           ; mean annual frequency of exceedance',
>       & '!! PGV            ; peak ground velocity',
>       & '!! PGA            ; peak ground acceleration',
>       & '!! VPress Lith    ; vertical pressure in the lithophysal',
>       & '!!                  region of the drift',
>       & '!! VPress Nonlith ; vertical pressure in the nonlithophysal',
>       & '!!                  region of the drift'
>
>              WRITE(iunitechomechfail, FMT = '(A6, 6A14)')
>       & ' Event', '     Seis Time', '          MAFE', '            PGV',
>       & '            PGA', '        VPress', '        VPress'
>              WRITE(iunitechomechfail, FMT = '(62x, 2A14)')
>       & '          Lith', '       Nonlith'
>              WRITE(iunitechomechfail, FMT = '(6x, 6A14)')
>       & '        (year)', '      (1/year)', '          (m/s)',
>       & '           (g)', '         (kPa)', '          (kPa)'
>
```

```
>             DO i = 1,numberofseismicevents
>               WRITE(iunitechomechfail,
>      &          FMT='(1x, I5, 6(2x, 1pe12.5))')i,
>      &          timeofseismicevents(i), dmape(i), pgv(i), pga(i),
>      &          vert_pressure1_seismic(i, isa),
>      &          vert_pressure2_seismic(i, isa)
>             ENDDO
>
>             WRITE(iunitechomechfail, FMT = '(/,13(a/))')
>      & '!! SECTION 3 ; TIME VARYING DATA',
>      & '!!',
>      & '!! This section contains data for each tpa time step',
>      & '!!',
>      & '!! Step           ; tpa time step',
>      & '!! TPA Time       ; time corresponding to this time step',
>      & '!! DS Thick       ; drip shield shell thickness',
>      & '!! DS Temp        ; drip shield temperature',
>      & '!! WP Thick       ; waste package outer layer thickness',
>      & '!! VPress Lith    ; vertical pressure in the lithophysal',
>      & '!!                  region of the drift',
>      & '!! VPress Nonlith ; vertical pressure in the nonlithophysal',
>      & '!!                  region of the drift'
>
>             WRITE(iunitechomechfail, FMT = '(A6, 6A14)')
>      & '  Step', '      TPA Time', '      DS Thick', '       DS Temp',
>      & '      WP Thick', '         VPress', '         VPress'
>             WRITE(iunitechomechfail, FMT = '(62x, 2A14)')
>      & '          Lith', '       Nonlith'
>             WRITE(iunitechomechfail, FMT = '(6x, 6A14)')
>      & '        (year)', '            (m)', '        (deg C)',
>      & '           (m)', '         (kPa)', '          (kPa)'
4254a4861,4865
> c              WRITE(iunitechomechfail,
> c     &          FMT = '(1x, I4, 7(3x, 1pe12.5))') i, tim(i),
> c     &          ds_thickness(i), tempdsiB(i), dthick_ol(i), tempwp(i),
> c     &          vert_pressure1_subarea(i, isa),
> c     &          vert_pressure2_subarea(i, isa)
4256,4257c4867,4868
<      &          FMT = '(1x, I4, 7(3x, 1pe12.5))') i, tim(i),
<      &          ds_thickness(i), tempdsiB(i), dthick_ol(i), tempwp(i),
---
>      &          FMT = '(1x, I5, 6(2x, 1pe12.5))') i, tim(i),
>      &          ds_thickness(i), tempdsiB(i), dthick_ol(i),
4259c4870
<      &          vert_pressure2_subarea(i, isa)
---
>      &          vert_pressure2_subarea(i, isa)
4261c4872,4874
<             ENDDO
---
>             ENDDO
>             WRITE(iunitechomechfail, *)
> c           GADAMS SCR677 12/21/2006: End of change
4329a4943,4945
>
> c           GADAMS SCR677 12/22/2006: Modified output file format
>
4332,4333c4948,4949
<             write( iunitresultsmechfail,'(/,a)')
<      &        'Fraction of Waste Packages Failed Mechanically'
---
> c            write( iunitresultsmechfail,'(/,a)')
> c     &        'Fraction of Waste Packages Failed Mechanically'
4338,4340c4954,4956
<             WRITE(iunitresultsmechfail, FMT = '(/, A, I3)')
<      &        'Mechanical Failure: [fraction failed versus time],' //
<      &        ' Subarea Analysis: Subarea ', isa
---
> c            WRITE(iunitresultsmechfail, FMT = '(/, A, I3)')
> c     &        'Mechanical Failure: [fraction failed versus time],' //
> c     &        ' Subarea Analysis: Subarea ', isa
4358,4362c4974,4978
<               WRITE(iunitresultsmechfail,
<      &          FMT = '(4x, A, 1pe12.4, A, /, 4x, A)')
<      &          '<<WARNING>> DRIP SHIELD CORROSIVE FAILURE:',
<      &          ds_failure_time(isa), ' [yr] ',
<      &          ' (OCCURRED PRIOR TO MECHANICAL FAILURE)'
---
> c              WRITE(iunitresultsmechfail,
> c     &          FMT = '(4x, A, 1pe12.4, A, /, 4x, A)')
> c     &          '<<WARNING>> DRIP SHIELD CORROSIVE FAILURE:',
```

```
> c     &          ds_failure_time(isa), ' [yr] ',
> c     &          ' (OCCURRED PRIOR TO MECHANICAL FAILURE)'
4363a4980,5006
>
>               WRITE(iunitresultsmechfail, FMT = '(7(a/))')
>      & '!! SECTION 1 ; CURRENT STATE',
>      & '!!',
>      & '!! Current realization and subarea being evaluated',
>      & '!! Item 1: realization - realization being evaluated',
>      & '!! Item 2: subarea identifier - subarea being evaluated',
>      & '!! Item 3: ds corrosive failure time - time for drip shield',
>      & '!!         corrosive failure (if prior to mechanical failure)'
>
>               WRITE(iunitresultsmechfail,
>      &          FMT = '(I24,a,/,I24,a,/,12x,1pe12.5,a,/)')
>      &          ir, '   ! Realization being evaluated',
>      &          isa, '   ! Subarea being evaluated',
>      &          ds_failure_time(isa),
>      &          '   ! drip shield corrosive failure time'
>             ELSE
>               WRITE(iunitresultsmechfail, FMT = '(5(a/))')
>      & '!! SECTION 1 ; CURRENT STATE',
>      & '!!',
>      & '!! Current realization and subarea being evaluated',
>      & '!! Item 1: realization - realization being evaluated',
>      & '!! Item 2: subarea identifier - subarea being evaluated'
>
>               WRITE(iunitresultsmechfail, FMT = '(I24,a,/,I24,a,/)')
>      &          ir, '   ! Realization being evaluated',
>      &          isa, '   ! Subarea being evaluated'
4364a5008
> c           GADAMS SCR677 12/22/2006: End of change
4376,4378c5020,5044
<             WRITE(iunitresultsmechfail, FMT = '(/, 8(2x, A12))')
<      &        'Time', 'DS Total', 'DS Corrosion', 'DS Static',
<      &        'DS Dynamic', 'WP Total', 'WP Static', 'WP Dynamic'
---
> c           GADAMS SCR677 1/19/2007: Modified output file format
> c            WRITE(iunitresultsmechfail, FMT = '(/, 8(2x, A12))')
> c     &        'Time', 'DS Total', 'DS Corrosion', 'DS Static',
> c     &        'DS Dynamic', 'WP Total', 'WP Static', 'WP Dynamic'
>
>             WRITE(iunitresultsmechfail, FMT = '(19(a/))')
>      & '!! SECTION 2 ; TIME VARYING DATA FOR SUBAREA',
>      & '!!',
>      & '!! This section displays failure fractions',
>      & '!! for each tpa time step for the subarea',
>      & '!! identified in SECTION 1',
>      & '!!',
>      & '!! Step           ; tpa time step',
>      & '!! TPA Time       ; time corresponding to this time step',
>      & '!! DS Total       ; total drip shield failure fraction',
>      & '!!                  sum of corrosion, static, and dynamic',
>      & '!!                  drip shield failure fractions',
>      & '!! DS Corrosion   ; corrosion drip shield failure fraction',
>      & '!! DS Static      ; static drip shield failure fraction',
>      & '!! DS Dynamic     ; dynamic drip shield failure fraction',
>      & '!! WP Total       ; total waste package failure fraction',
>      & '!!                  sum of static and dynamic waste',
>      & '!!                  package failure fractions',
>      & '!! WP Static      ; static waste package failure fraction',
>      & '!! WP Dynamic     ; dynamic waste package failure fraction'
4379a5046,5057
>             WRITE(iunitresultsmechfail, FMT = '(A6, 8A14)')
>      & 'Step', 'TPA Time', 'DS Total', 'DS Corrosion',
>      & 'DS Static', 'DS Dynamic', 'WP Total', 'WP Static',
>      & 'WP Dynamic'
>             WRITE(iunitresultsmechfail, FMT = '(20x, 7A14)')
>      & 'Fraction', 'Fraction', 'Fraction', 'Fraction',
>      & 'Fraction', 'Fraction', 'Fraction'
>             WRITE(iunitresultsmechfail, FMT = '(6x, 8A14)') '(year)',
>      & '(unitless)', '(unitless)', '(unitless)', '(unitless)',
>      & '(unitless)', '(unitless)', '(unitless)'
> c           GADAMS SCR677 1/19/2007: End of Change
>
4396c5074,5085
< c     &          seismicdriftheightsubarea(i, isa)
---
> c     &          seismicdriftheightsubarea(i, isa)
>
> c              GADAMS SCR677 12/22/2006: Modified output file format
```

```
> c              WRITE(iunitresultsmechfail,
> c     &          FMT = '(8(2x, 1pe12.5))') tim(i),
> c     &          dmechfaildssubarea(i, isa),
> c     &          dmechfaildssubareacorrosion(i, isa),
> c     &          dmechfaildssubareastatic(i, isa),
> c     &          dmechfaildssubareadynamic(i, isa),
> c     &          dmechfailwpsubarea(i, isa),
> c     &          dmechfailwpsubareastatic(i, isa),
> c     &          dmechfailwpsubareadynamic(i, isa)
4398c5087
<      &          FMT = '(8(2x, 1pe12.5))') tim(i),
---
>      &          FMT = '(1x, I5, 8(2x, 1pe12.5))') i, tim(i),
4405c5094,5095
<      &          dmechfailwpsubareadynamic(i, isa)
---
>      &          dmechfailwpsubareadynamic(i, isa)
> c             GADAMS SCR677 12/22/2006: End of change
4492a5183,5185
>
> c           GADAMS SCR677 12/22/2006: Modified output file format
>             WRITE(iunitresultsmechfail, *)
4494a5188,5189
>
> c             GADAMS SCR677 1/19/2007: Modified output file format
4498,4500c5193,5195
<               WRITE(iunitresultsmechfail, FMT = '(/, A)')
<      &          'Mechanical Failure: [fraction failed versus time],' //
<      &          ' Repository Analysis'
---
> c              WRITE(iunitresultsmechfail, FMT = '(/, A)')
> c     &          'Mechanical Failure: [fraction failed versus time],' //
> c     &          ' Repository Analysis'
4505,4507c5200,5202
<               WRITE(iunitresultsmechfail, FMT = '(A, I4)')
<      &          'Total number of subareas in analysis: ',
<      &          istopsuba - istartsuba + 1
---
> c              WRITE(iunitresultsmechfail, FMT = '(A, I4)')
> c     &          'Total number of subareas in analysis: ',
> c     &          istopsuba - istartsuba + 1
4513,4515c5208,5232
<               WRITE(iunitresultsmechfail, FMT = '(/, 8(2x, A12))')
<      &          'Time', 'DS Total', 'DS Corrosion', 'DS Static',
<      &          'DS Dynamic', 'WP Total', 'WP Static', 'WP Dynamic'
---
> c              WRITE(iunitresultsmechfail, FMT = '(/, 8(2x, A12))')
> c     &          'Time', 'DS Total', 'DS Corrosion', 'DS Static',
> c     &          'DS Dynamic', 'WP Total', 'WP Static', 'WP Dynamic'
>
>              WRITE(iunitresultsmechfail, FMT = '(20(a/))')
>      & '!! SECTION 3 ; REPOSITORY ANALYSIS',
>      & '!!',
>      & '!! This section displays subarea weighted failure fractions',
>      & '!! for each tpa time step',
>      & '!!',
>      & '!! Number Subareas ; number of subareas in the repository',
>      & '!!                   analysis',
>      & '!! Step            ; tpa time step',
>      & '!! TPA Time        ; time corresponding to this time step',
>      & '!! DS Total        ; total drip shield failure fraction',
>      & '!!                   including corrosion, static, and dynamic',
>      & '!!                   drip shield failure',
>      & '!! DS Corrosion    ; corrosion drip shield failure fraction',
>      & '!! DS Static       ; static drip shield failure fraction',
>      & '!! DS Dynamic      ; dynamic drip shield failure fraction',
>      & '!! WP Total        ; total waste package failure fraction',
>      & '!!                   including static and dynamic waste',
>      & '!!                   package failure',
>      & '!! WP Static       ; static waste package failure fraction',
>      & '!! WP Dynamic      ; dynamic waste package failure fraction'
4516a5234,5248
>              WRITE(iunitresultsmechfail, FMT = '(I24,a/)')
>      &          istopsuba - istartsuba + 1,
>      &          '    ! Number of subareas in the repository analysis'
>
>              WRITE(iunitresultsmechfail, FMT = '(A6, 8A14)')
>      & 'Step', 'TPA Time', 'DS Total', 'DS Corrosion',
>      & 'DS Static', 'DS Dynamic', 'WP Total', 'WP Static',
>      & 'WP Dynamic'
>             WRITE(iunitresultsmechfail, FMT = '(20x, 7A14)')
```

```
>      & 'Fraction', 'Fraction', 'Fraction', 'Fraction',
>      & 'Fraction', 'Fraction', 'Fraction'
>            WRITE(iunitresultsmechfail, FMT = '(6x, 8A14)') '(year)',
>      & '(unitless)', '(unitless)', '(unitless)', '(unitless)',
>      & '(unitless)', '(unitless)', '(unitless)'
>
4531a5264,5269
> c                WRITE(iunitresultsmechfail,
> c     &            FMT = '(8(2x, 1pe12.5))') tim(i),
> c     &            dmechfailds(i), dmechfaildscorrosion(i),
> c     &            dmechfaildsstatic(i), dmechfaildsdynamic(i),
> c     &            dmechfailwp(i), dmechfailwpstatic(i),
> c     &            dmechfailwpdynamic(i)
4533c5271
<      &            FMT = '(8(2x, 1pe12.5))') tim(i),
---
>      &            FMT = '(1x, I5, 8(2x, 1pe12.5))') i, tim(i),
4537c5275
<      &            dmechfailwpdynamic(i)
---
>      &            dmechfailwpdynamic(i)
4538a5277,5279
>
>               WRITE(iunitresultsmechfail, *)
> c             GADAMS SCR677 12/22/2006: End of change
5913,5921c6654,6667
<             write( iunitechouzft,'(/,a,/)')
<      &      '(same names and values for all subareas and vectors)'
<             write( iunitechouzft, '(a)')'  maxntime  '//
<      &     '    maxaqnuc   ntim   nnucl + numclnuc'
<
<             write( iunitechouzft, fmt='(i9,i13,i10,i7,/)')
<      &        maxntime, maxaqnuc, ntim, nnucl + numclnuc
<
<             write( iunitechouzft, fmt='("index   nuclide name")')
---
> cc rwj 12-20-06; SCR675
> c           write( iunitechouzft,'(/,a,/)')
> c    &      '(same names and values for all subareas and vectors)'
> c           write( iunitechouzft, '(a)')'  maxntime  '//
> c    &     '    maxaqnuc   ntim   nnucl + numclnuc'
> c
> c           write( iunitechouzft, fmt='(i9,i13,i10,i7,/)')
> c    &        maxntime, maxaqnuc, ntim, nnucl + numclnuc
> c
> c           write( iunitechouzft, fmt='("index   nuclide name")')
>            write( iunitechouzft,'(i24,a)') ntim, uzft1text(18)
>            write( iunitechouzft,'(i24,a)') nnucl+numclnuc,uzft1text(19)
>            write( iunitechouzft,'(a)') (uzft1text(i),i=20,27)
>
5926,5927c6672,6675
<             write( iunitechouzft,'(/,/,a)')
<      &        '(the following values are for each subarea and vector)'
---
> cc rwj 12-20-06; SCR675
> c           write( iunitechouzft,'(/,/,a)')
> c    &        '(the following values are for each subarea and vector)'
>
5929,5930c6677,6682
<           write( iunitechouzft, '(/,a)') '       time  '//
<      &     '      qm3/yr/sa '
---
>
> cc rwj 12-20-06; SCR675
> c         write( iunitechouzft, '(/,a)') '       time  '//
> c    &     '      qm3/yr/sa '
>           write( iunitechouzft,'(a)') (uzft1text(i),i=36,45)
>
5935,5963c6687,6737
<           write( iunitechouzft,
<      &      fmt='(/,"All Aqueousnuclides - ciperyrinsaintoloweruz")')
<           write( iunitechouzft,
<      &      fmt='("(Ci/yr for this subarea from the ebs)")')
<           do i = 1, nnucl + numclnuc, 5
<             iend = i + 4
<             if ( iend .le. nnucl + numclnuc) then
<               write(iunitechouzft,fmt='(/,"        time",
<      &           3x,5(3x,a6,4x),/)') (names(j),j=i,iend)
<               do j = 1,ntim
<                 write(iunitechouzft,fmt='(i4,6(1pe12.4))')j,tim(j),
<      &                (ciperyrinsaintoloweruz(j,k),k=i,iend)
```

```
<                 enddo
<               else
<                 idiff = nnucl + numclnuc - i + 1
<                 call clearchar( 60, formatstr )
<                 write( formatstr,'(a,i2,a)')
<      &               '(/,"        time",3x,',idiff,'(3x,a6,4x),/)'
<                 write(iunitechouzft,formatstr)
<      &                (names(j),j=i,nnucl + numclnuc)
<                 call clearchar( 60, formatstr )
<                 do j = 1,ntim
<                   write( formatstr,'(a,i2,a)')
<      &                  '(i4,',(idiff+1),'(1pe12.4))'
<                   write(iunitechouzft,formatstr)
<      &                  j,tim(j),(ciperyrinsaintoloweruz(j,k),k=i,
<      &                  nnucl + numclnuc)
<                 enddo
<               endif
---
>
> cc rwj 12-20-06; SCR675
> c          write( iunitechouzft,
> c     &      fmt='(/,"All Aqueousnuclides - ciperyrinsaintoloweruz")')
> c          write( iunitechouzft,
> c     &      fmt='("(Ci/yr for this subarea from the ebs)")')
> c          do i = 1, nnucl + numclnuc, 5
> c            iend = i + 4
> c            if ( iend .le. nnucl + numclnuc) then
> c              write(iunitechouzft,fmt='(/,"        time",
> c     &          3x,5(3x,a6,4x),/)') (names(j),j=i,iend)
> c              do j = 1,ntim
> c                write(iunitechouzft,fmt='(i4,6(1pe12.4))')j,tim(j),
> c     &                (ciperyrinsaintoloweruz(j,k),k=i,iend)
> c              enddo
> c            else
> c              idiff = nnucl + numclnuc - i + 1
> c              call clearchar( 60, formatstr )
> c              write( formatstr,'(a,i2,a)')
> c     &               '(/,"        time",3x,',idiff,'(3x,a6,4x),/)'
> c              write(iunitechouzft,formatstr)
> c     &                (names(j),j=i,nnucl + numclnuc)
> c              call clearchar( 60, formatstr )
> c              do j = 1,ntim
> c                write( formatstr,'(a,i2,a)')
> c     &                  '(i4,',(idiff+1),'(1pe12.4))'
> c                write(iunitechouzft,formatstr)
> c     &                  j,tim(j),(ciperyrinsaintoloweruz(j,k),k=i,
> c     &                  nnucl + numclnuc)
> c              enddo
> c            endif
> c          enddo
>
> cc rwj 12-20-06; SCR675
>          write( iunitechouzft,'(a)') (uzft1text(i),i=46,53)
>          write( iunitechouzft,'(a)') (uzft1text(i),i=46,53)
>          write( iunitechouzft,'(a)') (uzft1text(i),i=46,53)
>          write( formatstr,'(a,i3,a)') '(22x,',nnucl+numclnuc, 'a)'
>          write( iunitechouzft,formatstr) (names(i)//' EBS  ',
>     &                                    i=1,nnucl+numclnuc)
>          write( formatstr,'(a,i3,a)')
>     &          '(a,', nnucl+numclnuc, 'a)'
>          write( iunitechouzft,formatstr) ' Index       Time        ',
>     &          ('Release          ',i=1,nnucl+numclnuc)
>          write( iunitechouzft,formatstr) ' -----       (yr)        ',
>     &          ('(Ci/yr)',i=1,nnucl+numclnuc)
>          write( formatstr,'(a,i3,a)')
>     &          '(i4,',(nnucl+numclnuc+1),'(1pe12.4))'
>          do j = 1,ntim
>             write(iunitechouzft,formatstr)j,tim(j),
>     &           (ciperyrinsaintoloweruz(j,k),k=i,nnucl+numclnuc)
5964a6739
>
6039,6043c6814,6868
<          write( iunitresultsuzft, '(a)') '       time '//
<     &     '       qm3/yr/sa'
<          do i = 1,ntim
<            write(iunitresultsuzft,fmt='(i4,2(1pe12.4))')i,tim(i),
<     &          qm3peryrinsafromuz(i)
---
> cc rwj 12-20-06; SCR675
>          write(iunitresultsuzft,'(i24,a)') ntim, ' !! Nsteps'
>          write(iunitresultsuzft,'(a)') (uzft2text(i),i=17,24)
```

```
> c          write( iunitresultsuzft, '(a)') '       time '//
> c     &      '       qm3/yr/sa'
> c          do i = 1,ntim
> c            write(iunitresultsuzft,fmt='(i4,2(1pe12.4))')i,tim(i),
> c     &           qm3peryrinsafromuz(i)
> c          enddo
> c          write( iunitresultsuzft,
> c     &      fmt='(/,"All Aqueousnuclides - ciperyrinsafromuz")')
> c          write( iunitresultsuzft,
> c     &     fmt='("(Ci/yr for this subarea from the unsaturated zone)")')
> c
> c          do i = 1, nnucl + numclnuc, 5
> c            iend = i + 4
> c            if ( iend .le. nnucl + numclnuc) then
> c              write(iunitresultsuzft,fmt='(/,"        time",
> c     &           3x,5(3x,a6,4x),/)')
> c     &              (names(j),j=i,iend)
> c              do j = 1,ntim
> c                write(iunitresultsuzft,fmt='(i4,6(1pe12.4))')j,tim(j),
> c     &                (ciperyrinsafromuz(j,k),k=i,iend)
> c              enddo
> c            else
> c              idiff = nnucl + numclnuc - i + 1
> c              call clearchar( 60, formatstr )
> c              write( formatstr,'(a,i2,a)')
> c     &            '(/,"        time",3x,',idiff,'(3x,a6,4x),/)'
> c              write(iunitresultsuzft,formatstr)
> c     &              (names(j),j=i,nnucl + numclnuc)
> c              call clearchar( 60, formatstr )
> c              do j = 1,ntim
> c                write( formatstr,'(a,i2,a)')
> c     &                '(i4,',(idiff+1),'(1pe12.4))'
> c                write(iunitresultsuzft,formatstr)
> c     &                j,tim(j),(ciperyrinsafromuz(j,k),k=i,
> c     &                nnucl + numclnuc)
> c              enddo
> c            endif
> c          enddo
>          write( formatstr,'(a,i3,a)') '(19x,',nnucl+numclnuc, 'a)'
>          write( iunitresultsuzft,formatstr) (names(i)//' UZ    ',
>     &                                   i=1,nnucl+numclnuc)
>          write( formatstr,'(a,i3,a)')
>     &          '(a,', nnucl+numclnuc, 'a)'
>          write( iunitresultsuzft,formatstr) ' Index     Time      ',
>     &          ('Release      ',i=1,nnucl+numclnuc)
>          write( iunitresultsuzft,formatstr) ' -----     (yr)      ',
>     &          ('(Ci/yr)      ',i=1,nnucl+numclnuc)
>          write( formatstr,'(a,i3,a)')
>     &          '(i4, 1p',(nnucl+numclnuc+1),'e12.4)'
>          do j = 1,ntim
>             write(iunitresultsuzft,formatstr) j,tim(j),
>     &           (ciperyrinsafromuz(j,k),k=1,nnucl+numclnuc)
6045,6048c6870
<          write( iunitresultsuzft,
<     &      fmt='(/,"All Aqueousnuclides - ciperyrinsafromuz")')
<          write( iunitresultsuzft,
<     &     fmt='("(Ci/yr for this subarea from the unsaturated zone)")')
---
>          write(iunitresultsuzft,'(a)') ''
6050,6076d6871
<          do i = 1, nnucl + numclnuc, 5
<            iend = i + 4
<            if ( iend .le. nnucl + numclnuc) then
<              write(iunitresultsuzft,fmt='(/,"        time",
<     &           3x,5(3x,a6,4x),/)')
<     &              (names(j),j=i,iend)
<              do j = 1,ntim
<                write(iunitresultsuzft,fmt='(i4,6(1pe12.4))')j,tim(j),
<     &                (ciperyrinsafromuz(j,k),k=i,iend)
<              enddo
<            else
<              idiff = nnucl + numclnuc - i + 1
<              call clearchar( 60, formatstr )
<              write( formatstr,'(a,i2,a)')
<     &            '(/,"        time",3x,',idiff,'(3x,a6,4x),/)'
<              write(iunitresultsuzft,formatstr)
<     &              (names(j),j=i,nnucl + numclnuc)
<              call clearchar( 60, formatstr )
<              do j = 1,ntim
<                write( formatstr,'(a,i2,a)')
<     &                '(i4,',(idiff+1),'(1pe12.4))'
```

```
<                 write(iunitresultsuzft,formatstr)
<      &                j,tim(j),(ciperyrinsafromuz(j,k),k=i,
<      &                nnucl + numclnuc)
<               enddo
<             endif
<           enddo
6800c7595,7601
<           write(iunitnearfld,'(5x,i5,6x,5(1pe13.4,3x))') ir,
---
> c         GADAMS SCR677 1/3/2007: Modified format of output file
> c          write(iunitnearfld,'(5x,i5,6x,5(1pe13.4,3x))') ir,
> c     &          tim(itime),
> c     &          cumtempwp(itime),
> c     &          cumrelhumwp(itime),
> c     &          cumclwp(itime)
>           write(iunitnearfld,'((2x, I12), 4(2x, 1pe12.5))') ir,
6804c7605,7606
<      &          cumclwp(itime)
---
>      &          cumclwp(itime)
> c         GADAMS SCR677 1/3/2007: End of change
7586,7588c8388,8392
<         call printvaluessp( iunitsp, ir )
<         if( ir .eq. 1 ) call printtitlesmv( iunitmv )
<         call printvaluesmv( iunitmv, ir )
---
> cc rwj 11-19-06; sSCR675
> c       call printvaluessp( iunitsp, ir )
> c
> c       if( ir .eq. 1 ) call printtitlesmv( iunitmv )
> c       call printvaluesmv( iunitmv, ir )
7589a8394,8399
>         call printvaluessp( iunitsp, ir, sptext, 36 )
>
>         if( ir .eq. 1 ) call printtitlesmv( iunitmv, mvtext, 41)
>         call printvaluesmv( iunitmv, ir, mvtext, 41)
> c End SCR675
>
8383c9193,9194
< c                                   if size > 0, open file as old with append; do not write header
---
> c                                   if size > 0, open file as old with append;
> c                                                do not write header
8401,8407c9212,9229
<          write( iunit,fmt='(a80)') title1
<          write( iunit,fmt='(a80)') title2
<          write( iunit, 341 ) datetim
<  341     format( ' TPA 5.1betaI, Job started: ', a24 )
<          write( iunit, 342 ) m1
<  342     format( a160 )
<          write( iunit, 342 ) m2
---
> cc rwj 12-12-06; SCR675; Reformat headers for *.res & *.tpa files.
> c        write( iunit, 341 ) datetim
> c341     format( ' TPA 5.1betaI, Job started: ', a24 )
> c        write( iunit, 342 ) m1
> c342     format( a160 )
> c        write( iunit, 342 ) m2
>          write( iunit,fmt='(a)') '!! '//filename
>          write( iunit,fmt='(a)') '!! '
>          write( iunit,fmt='(a)') '!! '//title1
>          write( iunit,fmt='(a)') '!! '//title2
>          write( iunit,fmt='(a)') '!! Created by: TPA 5.1betaK'
>          write( iunit,fmt='(a)') '!! Module: EXEC'
>          write( iunit,fmt='(a)') '!! Job started: '//datetim
>          write( iunit,fmt='(a)') '!! '
>          write( iunit,fmt='(a)') '!! PURPOSE:'
>          write( iunit,fmt='(a)') '!! '//m1
>          write( iunit,fmt='(a)') '!! '//m2
>
8490,8497c9312,9333
<          write( iunit,fmt='(a80)') title1
<          write( iunit,fmt='(a80)') title2
<          write( iunit, 341 ) datetim
<  341     format( ' TPA 5.1betaI, Job started: ', a24 )
<          write( iunit, 342 ) m1
<  342     format( a160 )
<          write( iunit, 343 ) m2
<  343     format( a320 )
---
>
```

```
> cc rwj 12-12-06; SCR675; Reformat headers for *.res & *.tpa files.
> c        write( iunit,fmt='(a80)') title1
> c        write( iunit,fmt='(a80)') title2
> c        write( iunit, 341 ) datetim
> c341     format( ' TPA 5.1betaI, Job started: ', a24 )
> c        write( iunit, 342 ) m1
> c342     format( a160 )
> c        write( iunit, 343 ) m2
> c343     format( a320 )
>          write( iunit,fmt='(a)') '!! '//filename
>          write( iunit,fmt='(a)') '!! '
>          write( iunit,fmt='(a)') '!! '//title1
>          write( iunit,fmt='(a)') '!! '//title2
>          write( iunit,fmt='(a)') '!! Created by: TPA 5.1betaK'
>          write( iunit,fmt='(a)') '!! Module: EXEC'
>          write( iunit,fmt='(a)') '!! Job started: '//datetim
>          write( iunit,fmt='(a)') '!! '
>          write( iunit,fmt='(a)') '!! PURPOSE:'
>          write( iunit,fmt='(a)') '!! '//m1
>          write( iunit,fmt='(a)') '!! '//m2
>
10074a10911,10913
> cc rwj 12-20-06; SCR675
>       include 'exece.i'
>       integer i
10227,10228c11066,11067
<         INQUIRE(FILE = 'dsfailt.out', EXIST = lexist)
<         IF(lexist) istatus = zportsh('rm dsfailt.out')
---
>         INQUIRE(FILE = 'dsfailt.dbg', EXIST = lexist)
>         IF(lexist) istatus = zportsh('rm dsfailt.dbg')
10236,10237c11075,11077
<         INQUIRE(FILE = 'mechfail_ds.out', EXIST = lexist)
<         IF(lexist) istatus = zportsh('rm mechfail_ds.out')
---
> c       GADAMS SCR677 12/22/2006: Modified extension to debug file
> c        INQUIRE(FILE = 'mechfail_ds.out', EXIST = lexist)
> c        IF(lexist) istatus = zportsh('rm mechfail_ds.out')
10239,10240c11079,11088
<         INQUIRE(FILE = 'mechfail_wp.out', EXIST = lexist)
<         IF(lexist) istatus = zportsh('rm mechfail_wp.out')
---
> c        INQUIRE(FILE = 'mechfail_wp.out', EXIST = lexist)
> c        IF(lexist) istatus = zportsh('rm mechfail_wp.out')
>
>         INQUIRE(FILE = 'mechfail_ds.dbg', EXIST = lexist)
>         IF(lexist) istatus = zportsh('rm mechfail_ds.dbg')
>
>         INQUIRE(FILE = 'mechfail_wp.dbg', EXIST = lexist)
>         IF(lexist) istatus = zportsh('rm mechfail_wp.dbg')
> c       GADAMS SCR677 12/22/2006: End of change
>
10390c11238,11240
<
---
> cc rwj 12-20-06; SCR675
>           write( iunitechouzflow, '(a)') (uzf1text(i),i=1,9)
>
10391a11242
>
10402a11254,11256
> cc rwj 12-20-06; SCR675
>           write(iunitresultsuzflow, '(a)') (uzf2text(i),i=1,6)
>
10456a11311,11312
>           write(iunitechodsfail,'(a)') ''
>
10489a11346
>             write(iunitechodriftfail,'(a)') ''
10524c11381,11388
<             mes1 = ' Echo of MECHFAIL Input Values'
---
> c           GADAMS SCR677 1/2/2007: Modified format of output files
> c            mes1 = ' Echo of MECHFAIL Input Values'
> c
> c            mes2 = ' with the output mode specified in "tpa.inp" '
>
>            mes1 = 'Echos input values for Mechanical Failure Module'
>            mes2 = 'for all realizations and subareas'
> c           GADAMS SCR677 1/2/2007: End of change
10526,10527d11389
```

```
<             mes2 = ' with the output mode specified in "tpa.inp" '
<
10531c11393
<      &                     datetim,mes1,mes2,filename,mylastcheck)
---
>      &                     datetim,mes1,mes2,filename,mylastcheck)
10532a11395,11403
> c           GADAMS SCR677 12/20/2006: Modified format of output files
>             WRITE(iunitechomechfail, FMT = '(a/a/a/a/a)')
>      & '!!',
>      & '!! This file displays the input values to the mechanical',
>      & '!! failure module, MECHFAIL.  It contains information for each',
>      & '!! realization and each subarea.',
>      & '!!'
> c           GAAMS SCR677 12/20/2006: End of change
>
10542c11413,11414
<             mes1 = ' MECHFAIL Results'
---
> c           GADAMS SCR677 1/2/2007: Modified format of output files
> c            mes1 = ' MECHFAIL Results'
10544c11416,11420
<             mes2 = ' with the output mode specified in "tpa.inp" '
---
> c            mes2 = ' with the output mode specified in "tpa.inp" '
>
>             mes1 = 'Displays mechanical failure data'
>             mes2 = 'for all realizations and subareas'
> c           GADAMS SCR677 1/2/2007: End of change
10549c11425,11435
<      &                     mes1,mes2,filename,mylastcheck)
---
>      &                     mes1,mes2,filename,mylastcheck)
>
> c           GADAMS SCR677 12/22/2006: Modified format of output files
>             WRITE(iunitresultsmechfail, FMT = '(a/a/a/a/a)')
>      & '!!',
>      & '!! This file displays the values generated from mechanical',
>      & '!! failure module, MECHFAIL.  It contains information for each',
>      & '!! realization and each subarea.',
>      & '!!'
> c           GAAMS SCR677 12/22/2006: End of change
>
10606a11493,11495
> cc rwj 12-20-06; SCR675
>           write( iunitechouzft, '(a)') (uzft1text(i),i=1,17)
>
10618a11508,11509
> cc rwj 12-20-06; SCR675
>           write( iunitresultsuzft, '(a)') (uzft2text(i),i=1,7)
10699,10723c11590,11615
<           if (iselectappend .eq. 0 .or. iselectappend .eq. 1) then
<             write(iunitechouzflow,fmt='(/,"REALIZATION ",i4,/)') ir
<           ENDIF
<           IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 1 .OR.
<      &      iselectappend .EQ. 22) THEN
<             write(iunitresultsuzflow,fmt='(/,"REALIZATION ",i4,/)') ir
<           endif
<           if (iselectappend .eq. 0 .or. iselectappend .eq. 2) then
<             write(iunitechonfenv,fmt='(/,"REALIZATION ",i4,/)') ir
<           ENDIF
<           IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 2 .OR.
<      &      iselectappend .EQ. 22) THEN
<             write(iunitresultsnfenv,fmt='(/,"REALIZATION ",i4,/)') ir
<           endif
<           if (iselectappend .eq. 0 .or. iselectappend .eq. 3) then
<             write(iunitechoebsfail,fmt='(/,"REALIZATION ",i4,/)') ir
<           ENDIF
<           IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 3 .OR.
<      &      iselectappend .EQ. 22) THEN
<             write(iunitresultsebsfail,fmt='(/,"REALIZATION ",i4,/)') ir
<           endif
<           if (iselectappend .eq. 0 .or. iselectappend .eq. 21) then
<             write(iunitechodsfail,fmt='(/,"REALIZATION ",i4,/)') ir
<             write(iunitresultsdsfail,fmt='(/,"REALIZATION ",i4,/)') ir
<           endif
---
> cc rwj 12-20-06; SCR675
> c         if (iselectappend .eq. 0 .or. iselectappend .eq. 1) then
> c           write(iunitechouzflow,fmt='(/,"REALIZATION ",i4,/)') ir
> c         ENDIF
```

```
> c          IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 1 .OR.
> c     &      iselectappend .EQ. 22) THEN
> c            write(iunitresultsuzflow,fmt='(/,"REALIZATION ",i4,/)') ir
> c          endif
> c          if (iselectappend .eq. 0 .or. iselectappend .eq. 2) then
> c            write(iunitechonfenv,fmt='(/,"REALIZATION ",i4,/)') ir
> c          ENDIF
> c          IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 2 .OR.
> c     &      iselectappend .EQ. 22) THEN
> c            write(iunitresultsnfenv,fmt='(/,"REALIZATION ",i4,/)') ir
> c          endif
> c          if (iselectappend .eq. 0 .or. iselectappend .eq. 3) then
> c            write(iunitechoebsfail,fmt='(/,"REALIZATION ",i4,/)') ir
> c          ENDIF
> c          IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 3 .OR.
> c     &      iselectappend .EQ. 22) THEN
> c            write(iunitresultsebsfail,fmt='(/,"REALIZATION ",i4,/)') ir
> c          endif
> c          if (iselectappend .eq. 0 .or. iselectappend .eq. 21) then
> c            write(iunitechodsfail,fmt='(/,"REALIZATION ",i4,/)') ir
> c            write(iunitresultsdsfail,fmt='(/,"REALIZATION ",i4,/)') ir
> c          endif
10734,10736c11626,11633
<                write(iunitechodriftfail,fmt='(/,"REALIZATION ",i4,/)') ir
<                write(iunitechodriftfail,fmt='(/,"ALL SUBAREAS ",/)')
<                write(iunitresultsdriftfail,fmt='(/,"REALIZATION ",i4,/)')
---
> c  SCR679 J. Mancillas 01-02-07 Format file change
> c                write(iunitechodriftfail,fmt='(/,"REALIZATION ",i4,/)') ir
> c                write(iunitechodriftfail,fmt='(/,"ALL SUBAREAS ",/)')
> c                write(iunitresultsdriftfail,fmt='(/,"REALIZATION ",i4,/)')
> c     &            ir
>                write(iunitechodriftfail,'(i24,a)') ir, ' !! Realization'
>                write(iunitechodriftfail,fmt='(/,"!! ALL SUBAREAS ",/)')
>                write(iunitresultsdriftfail,fmt='("!! REALIZATION",i4,/)')
10737a11635
>
10743c11641,11642
<              if (iselectappend .eq. 0 .or. iselectappend .eq. 4) then
---
> c            GADAMS SCR677 12/20/2006: Modified format of output files
> c             if (iselectappend .eq. 0 .or. iselectappend .eq. 4) then
10749,10752c11648,11651
<                write(iunitechomechfail,fmt='(/,"REALIZATION ",i4,/)') ir
<                write(iunitechomechfail,fmt='(/,"ALL SUBAREAS ",/)')
<                write(iunitresultsmechfail,
<      &           fmt='(/,"REALIZATION ",i4,/)') ir
---
> c               write(iunitechomechfail,fmt='(/,"REALIZATION ",i4,/)') ir
> c               write(iunitechomechfail,fmt='(/,"ALL SUBAREAS ",/)')
> c               write(iunitresultsmechfail,
> c     &           fmt='(/,"REALIZATION ",i4,/)') ir
10754c11653,11654
<              endif
---
> c             endif
> c            GADAMS SCR677 12/20/2006: End of change
10765,10785c11665,11688
<            if (iselectappend .eq. 0 .or. iselectappend .eq. 7) then
<              write(iunitechoebsrel,fmt='(/,"REALIZATION ",i4,/)') ir
<            ENDIF
<            IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 7 .OR.
<      &      iselectappend .EQ. 22) THEN
<              write(iunitresultsebsrel,fmt='(/,"REALIZATION ",i4,/)') ir
<            endif
<            if (iselectappend .eq. 0 .or. iselectappend .eq. 8) then
<              write(iunitechouzft,fmt='(/,"REALIZATION ",i4,/)') ir
<            ENDIF
<            IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 8 .OR.
<      &      iselectappend .EQ. 22) THEN
<              write(iunitresultsuzft,fmt='(/,"REALIZATION ",i4,/)') ir
<            endif
<            if (iselectappend .eq. 0 .or. iselectappend .eq. 9) then
<              write(iunitechoszft,fmt='(/,"REALIZATION ",i4,/)') ir
<            ENDIF
<            IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 9 .OR.
<      &      iselectappend .EQ. 22) THEN
<              write(iunitresultsszft,fmt='(/,"REALIZATION ",i4,/)') ir
<            endif
---
>
```

```
> cc rwj 12-20-06; SCR675
> c          if (iselectappend .eq. 0 .or. iselectappend .eq. 7) then
> c            write(iunitechoebsrel,fmt='(/,"REALIZATION ",i4,/)') ir
> c          ENDIF
> c          IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 7 .OR.
> c     &      iselectappend .EQ. 22) THEN
> c            write(iunitresultsebsrel,fmt='(/,"REALIZATION ",i4,/)') ir
> c          endif
> c          if (iselectappend .eq. 0 .or. iselectappend .eq. 8) then
> c            write(iunitechouzft,fmt='(/,"REALIZATION ",i4,/)') ir
> c          ENDIF
> c          IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 8 .OR.
> c     &      iselectappend .EQ. 22) THEN
> c            write(iunitresultsuzft,fmt='(/,"REALIZATION ",i4,/)') ir
> c          endif
> c          if (iselectappend .eq. 0 .or. iselectappend .eq. 9) then
> c            write(iunitechoszft,fmt='(/,"REALIZATION ",i4,/)') ir
> c          ENDIF
> c          IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 9 .OR.
> c     &      iselectappend .EQ. 22) THEN
> c            write(iunitresultsszft,fmt='(/,"REALIZATION ",i4,/)') ir
> c          endif
>
10794a11698
>
10800a11705,11755
>
> cc rwj 12-20-06; SCR675
> c          if (iselectappend .eq. 0 .or. iselectappend .eq. 1) then
> c            write(iunitechouzflow,fmt='(/,"SUBAREA ",i4,/)') isa
> c
> c          ENDIF
> c          IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 1 .OR.
> c     &      iselectappend .EQ. 22) THEN
> c            write(iunitresultsuzflow,fmt='(/,"SUBAREA ",i4,/)') isa
> c          endif
> c          if (iselectappend .eq. 0 .or. iselectappend .eq. 2) then
> c            write(iunitechonfenv,fmt='(/,"SUBAREA ",i4,/)') isa
> c          ENDIF
> c          IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 2 .OR.
> c     &      iselectappend .EQ. 22) THEN
> c            write(iunitresultsnfenv,fmt='(/,"SUBAREA ",i4,/)') isa
> c          endif
> c          if (iselectappend .eq. 0 .or. iselectappend .eq. 3) then
> c            write(iunitechoebsfail,fmt='(/,"SUBAREA ",i4,/)') isa
> c          ENDIF
> c          IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 3 .OR.
> c     &      iselectappend .EQ. 22) THEN
> c            write(iunitresultsebsfail,fmt='(/,"SUBAREA ",i4,/)') isa
> c          endif
> c
> c          IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 21) THEN
> c            WRITE(iunitechodsfail, FMT = '(/,"SUBAREA ",i4,/)') isa
> c            WRITE(iunitresultsdsfail, FMT = '(/,"SUBAREA ",i4,/)') isa
> c          ENDIF
> c
> c          if (iselectappend .eq. 0 .or. iselectappend .eq. 7) then
> c            write(iunitechoebsrel,fmt='(/,"SUBAREA ",i4,/)') isa
> c          ENDIF
> c          IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 7 .OR.
> c     &      iselectappend .EQ. 22) THEN
> c            write(iunitresultsebsrel,fmt='(/,"SUBAREA ",i4,/)') isa
> c          endif
> c          if (iselectappend .eq. 0 .or. iselectappend .eq. 8) then
> c            write(iunitechouzft,fmt='(/,"SUBAREA ",i4,/)') isa
> c          ENDIF
> c          IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 8 .OR.
> c     &      iselectappend .EQ. 22) THEN
> c            write(iunitresultsuzft,fmt='(/,"SUBAREA ",i4,/)') isa
> c          endif
> c          if (iselectappend .eq. 0 .or. iselectappend .eq. 9) then
> c            write(iunitechoszft,fmt='(/,"SUBAREA ",i4,/)') isa
> c          ENDIF
> c          IF(iselectappend .EQ. 0 .OR. iselectappend .EQ. 9 .OR.
> c     &      iselectappend .EQ. 22) THEN
> c            write(iunitresultsszft,fmt='(/,"SUBAREA ",i4,/)') isa
> c          endif
10802c11757,11759
<            write(iunitechouzflow,fmt='(/,"SUBAREA ",i4,/)') isa
---
>            write(iunitechouzflow,'(a)') (uzf1text(i),i=10,14)
```

```
>             write(iunitechouzflow,'(i24,a)') ir, ' !! Realization'
>             write(iunitechouzflow,'(i24,a)') isa, ' !! Subarea'
10806c11763,11765
<             write(iunitresultsuzflow,fmt='(/,"SUBAREA ",i4,/)') isa
---
>             write(iunitresultsuzflow,'(a)') (uzf2text(i),i=7,11)
>             write(iunitresultsuzflow,'(i24,a)') ir, ' !! Realization'
>             write(iunitresultsuzflow,'(i24,a)') isa, ' !! Subarea'
10809c11768,11769
<             write(iunitechonfenv,fmt='(/,"SUBAREA ",i4,/)') isa
---
>             write(iunitechonfenv,'(i24,a)') ir, ' !! Realization'
>             write(iunitechonfenv,'(i24,a)') isa, ' !! Subarea'
10813c11773,11774
<             write(iunitresultsnfenv,fmt='(/,"SUBAREA ",i4,/)') isa
---
>             write(iunitresultsnfenv,'(i24,a)') ir, ' !! Realization'
>             write(iunitresultsnfenv,'(i24,a)') isa, ' !! Subarea'
10816c11777,11778
<             write(iunitechoebsfail,fmt='(/,"SUBAREA ",i4,/)') isa
---
>             write(iunitechoebsfail,'(i24,a)') ir, ' !! Realization'
>             write(iunitechoebsfail,'(i24,a)') isa, ' !! Subarea'
10820c11782,11783
<             write(iunitresultsebsfail,fmt='(/,"SUBAREA ",i4,/)') isa
---
>             write(iunitresultsebsfail,'(i24,a)') ir, ' !! Realization'
>             write(iunitresultsebsfail,'(i24,a)') isa, ' !! Subarea'
10824,10825c11787,11795
<             WRITE(iunitechodsfail, FMT = '(/,"SUBAREA ",i4,/)') isa
<             WRITE(iunitresultsdsfail, FMT = '(/,"SUBAREA ",i4,/)') isa
---
> c   SCR679 J. Mancillas File Format change
> c            WRITE(iunitechodsfail, FMT = '(/,"SUBAREA ",i4,/)') isa
> c            WRITE(iunitresultsdsfail, FMT = '(/,"SUBAREA ",i4,/)') isa
>             write(iunitechodsfail,'(i24,a)') ir, ' !! Realization'
>             write(iunitechodsfail,'(i24,a)') isa, ' !! Subarea'
>             write(iunitechodsfail,'(a)') ''
>             write(iunitresultsdsfail,'(i24,a)') ir, ' !! Realization'
>             write(iunitresultsdsfail,'(i24,a)') isa, ' !! Subarea'
>             write(iunitresultsdsfail,'(a)') ''
10829c11799,11800
<             write(iunitechoebsrel,fmt='(/,"SUBAREA ",i4,/)') isa
---
>             write(iunitechoebsrel,'(i24,a)') ir, ' !! Realization'
>             write(iunitechoebsrel,'(i24,a)') isa, ' !! Subarea'
10833c11804,11805
<             write(iunitresultsebsrel,fmt='(/,"SUBAREA ",i4,/)') isa
---
>             write(iunitresultsebsrel,'(i24,a)') ir, ' !! Realization'
>             write(iunitresultsebsrel,'(i24,a)') isa, ' !! Subarea'
10836c11808,11809
<             write(iunitechouzft,fmt='(/,"SUBAREA ",i4,/)') isa
---
>             write(iunitechouzft,'(i24,a)') ir, ' !! Realization'
>             write(iunitechouzft,'(i24,a)') isa, ' !! Subarea'
10840c11813,11816
<             write(iunitresultsuzft,fmt='(/,"SUBAREA ",i4,/)') isa
---
>             write(iunitresultsuzft,'(a)') '!! SECTION A'
>             write(iunitresultsuzft,'(a)') ''
>             write(iunitresultsuzft,'(i24,a)') ir, ' !! Realization'
>             write(iunitresultsuzft,'(i24,a)') isa, ' !! Subarea'
10843c11819,11820
<             write(iunitechoszft,fmt='(/,"SUBAREA ",i4,/)') isa
---
>             write(iunitechoszft,'(i24,a)') ir, ' !! Realization'
>             write(iunitechoszft,'(i24,a)') isa, ' !! Subarea'
10847c11824,11825
<             write(iunitresultsszft,fmt='(/,"SUBAREA ",i4,/)') isa
---
>             write(iunitresultsszft,'(i24,a)') ir, ' !! Realization'
>             write(iunitresultsszft,'(i24,a)') isa, ' !! Subarea'
10848a11827
>
10911d11889
<       character*80 aline
10942a11921,11925
> cc rwj 12-20-06; SCR675
> c       open(iunit,FILE='relgwgs.res',STATUS='UNKNOWN')
> c       do i=1,NHEADER_LINES
```

```
> c                read(iunit,'(a80)') aline
> c        end do
10944,10946c11927,11928
<         do i=1,NHEADER_LINES
<                  read(iunit,'(a80)') aline
<         end do
---
>         call FindRecord( iunit, ' ', 1, 3, .FALSE.)
>
11109d12090
<       character*80 aline
11141c12122,12128
<         open(iunit,FILE='rlgwgs_c.res',STATUS='UNKNOWN')
---
> cc rwj 12-20-06; SCR675
> c       open(iunit,FILE='rlgwgs_c.res',STATUS='OLD')
> c       do i=1,NHEADER_LINES
> c          read(iunit,'(a80)') aline
> c       end do
>         open(iunit,FILE='rlgwgs_c.res',STATUS='OLD')
>         call FindRecord( iunit, ' ', 1, 3, .FALSE.)
11143,11146d12129
<         do i=1,NHEADER_LINES
<            read(iunit,'(a80)') aline
<         end do
<
11175c12158,12159
<         mes1 = '  Ground water release CCDF for Compliance Period ' //
---
>         mes1 = '  Ground water release CCDF ' //
>      &         'for the Compliance Period specified in tpa.inp '//
11212c12196,12197
<         mes1 = '  Ground surface release CCDF for Compliance Period ' //
---
>         mes1 = '  Ground surface release CCDF ' //
>      &         'for the Compliance Period specified in tpa.inp '//
11248,11249c12233,12235
<         mes1 = '  Total release CCDF for Compliance Period' //
<      &         ' for one scenario.'
---
>         mes1 = '  Total release CCDF ' //
>      &         'for the Compliance Period specified in tpa.inp '//
>      &         'for one scenario.'
11781d12766
<       character*80 heading
11847,11848c12832,12836
<       read (inunit, '(a80)') heading
<       read (inunit, '(a80)') heading
---
> cc rwj 12-21-06; SCR675
> c     read (inunit, '(a80)') heading
> c     read (inunit, '(a80)') heading
>       call FindRecord(inunit, ' ', 1, 3, .FALSE.)
>
```

File differences for *nuclides.dat*:

```
19a20
> ! 11-20-06  R. Janetzke ; SCR675 ; Removed EPA limits by setting value to 1.
77,84c78,85
<    01     U238    U238     U238      U   238.0d0   4.468d9      0.10   3.32d-01   3.34d-01      4
<    02    Cm246   Cm246    CM246     Cm   246.0d0   4.731d3      0.10   2.05d-01   0.00d+00      2
<    03    Pu242   Pu242    PU242     Pu   242.0d0   3.869d5      0.10   3.77d+00   6.41d-02      2
<    04   Am242m  Am242m   AM242M     Am   242.0d0   1.520d2      0.10   1.51d+01   0.00d+00      1
<    05    Pu238   Pu238    PU238     Pu   238.0d0   8.774d1      0.10   3.22d+03   2.80d+03      2
<    06     U234    U234     U234      U   234.0d0   2.445d5      0.10   1.42d+00   6.10d-01      4
<    07    Th230   Th230    TH230     Th   230.0d0   7.700d4      0.01   4.74d-04   7.02d-05      2
<    08    Ra226   Ra226    RA226     Ra   226.0d0   1.600d3      0.10   0.00d+00   1.01d-04      3
---
>    01     U238    U238     U238      U   238.0d0   4.468d9      1.00   3.32d-01   3.34d-01      4
>    02    Cm246   Cm246    CM246     Cm   246.0d0   4.731d3      1.00   2.05d-01   0.00d+00      2
>    03    Pu242   Pu242    PU242     Pu   242.0d0   3.869d5      1.00   3.77d+00   6.41d-02      2
>    04   Am242m  Am242m   AM242M     Am   242.0d0   1.520d2      1.00   1.51d+01   0.00d+00      1
>    05    Pu238   Pu238    PU238     Pu   238.0d0   8.774d1      1.00   3.22d+03   2.80d+03      2
>    06     U234    U234     U234      U   234.0d0   2.445d5      1.00   1.42d+00   6.10d-01      4
>    07    Th230   Th230    TH230     Th   230.0d0   7.700d4      1.00   4.74d-04   7.02d-05      2
>    08    Ra226   Ra226    RA226     Ra   226.0d0   1.600d3      1.00   0.00d+00   1.01d-04      3
86,101c87,102
<    10    Cm243   Cm243    CM243     Cm   243.0d0   2.850d1      0.10   2.23d+01   0.00d+00      2
<    11    Am243   Am243    AM243     Am   243.0d0   7.380d3      0.10   3.21d+01   4.83d-01      2
<    12    Pu239   Pu239    PU239     Pu   239.0d0   2.406d4      0.10   3.39d+02   1.46d+02      2
<    13     U235    U235     U235      U   235.0d0   7.038d8      0.10   1.70d-02   1.28d-02      4
<    14    Pa231   Pa231    PA231     Pa   231.0d0   3.277d4      0.10   5.81d-05   3.03d+01      2
<    15    Ac227   Ac227    AC227     Ac   227.0d0   2.177d1      0.10   2.79d-05   5.79d-02      1
<    16    Cm245   Cm245    CM245     Cm   245.0d0   8.499d3      0.10   6.00d-01   0.00d+00      2
<    17    Pu241   Pu241    PU241     Pu   241.0d0   1.440d1   1000.00   1.72d+04   5.27d+02      1
<    18    Am241   Am241    AM241     Am   241.0d0   4.322d2      0.10   3.76d+03   5.41d+02      2
<    19    Np237   Np237    NP237     Np   237.0d0   2.140d6      0.10   4.17d-01   2.94d-01      2
<    20     U233    U233     U233      U   233.0d0   1.585d5      0.10   8.43d-05   7.86d-01      4
<    21    Th229   Th229    TH229     Th   229.0d0   7.339d3      0.10   0.00d+00   2.96d-03      2
<    22    Cm244   Cm244    CM244     Cm   244.0d0   1.811d1   1000.00   2.81d+03   0.00d+00      2
<    23    Pu240   Pu240    PU240     Pu   240.0d0   6.537d3      0.10   5.91d+02   4.40d+01      2
<    24     U236    U236     U236      U   236.0d0   2.341d7      0.10   3.16d-01   1.63d-02      4
<    25     U232    U232     U232      U   232.0d0   7.200d1      0.10   2.77d-02   3.77d-02      4
---
>    10    Cm243   Cm243    CM243     Cm   243.0d0   2.850d1      1.00   2.23d+01   0.00d+00      2
>    11    Am243   Am243    AM243     Am   243.0d0   7.380d3      1.00   3.21d+01   4.83d-01      2
>    12    Pu239   Pu239    PU239     Pu   239.0d0   2.406d4      1.00   3.39d+02   1.46d+02      2
>    13     U235    U235     U235      U   235.0d0   7.038d8      1.00   1.70d-02   1.28d-02      4
>    14    Pa231   Pa231    PA231     Pa   231.0d0   3.277d4      1.00   5.81d-05   3.03d+01      2
>    15    Ac227   Ac227    AC227     Ac   227.0d0   2.177d1      1.00   2.79d-05   5.79d-02      1
>    16    Cm245   Cm245    CM245     Cm   245.0d0   8.499d3      1.00   6.00d-01   0.00d+00      2
>    17    Pu241   Pu241    PU241     Pu   241.0d0   1.440d1      1.00   1.72d+04   5.27d+02      1
>    18    Am241   Am241    AM241     Am   241.0d0   4.322d2      1.00   3.76d+03   5.41d+02      2
>    19    Np237   Np237    NP237     Np   237.0d0   2.140d6      1.00   4.17d-01   2.94d-01      2
>    20     U233    U233     U233      U   233.0d0   1.585d5      1.00   8.43d-05   7.86d-01      4
>    21    Th229   Th229    TH229     Th   229.0d0   7.339d3      1.00   0.00d+00   2.96d-03      2
>    22    Cm244   Cm244    CM244     Cm   244.0d0   1.811d1      1.00   2.81d+03   0.00d+00      2
>    23    Pu240   Pu240    PU240     Pu   240.0d0   6.537d3      1.00   5.91d+02   4.40d+01      2
>    24     U236    U236     U236      U   236.0d0   2.341d7      1.00   3.16d-01   1.63d-02      4
>    25     U232    U232     U232      U   232.0d0   7.200d1      1.00   2.77d-02   3.77d-02      4
105c106
<    29     I129    I129     I129      I   129.0d0   1.570d7      0.10   3.88d-02   5.28d-02      1
---
>    29     I129    I129     I129      I   129.0d0   1.570d7      1.00   3.88d-02   5.28d-02      1
110c111
<    34     Tc99    Tc99     TC99     Tc    99.0d0   2.130d5     10.00   1.62d+01   7.23d+01      1
---
>    34     Tc99    Tc99     TC99     Tc    99.0d0   2.130d5      1.00   1.62d+01   7.23d+01      1
119c120
<    43      C14     C14      C14      C    14.0d0   5.729d3      0.10   7.60d-01   0.00d+00      1
---
>    43      C14     C14      C14      C    14.0d0   5.729d3      1.00   7.60d-01   0.00d+00      1
```

File differences for *reader.f*:

```
3c3
< c File Date:          11/28/06
---
> c File Date:          12/22/06
78a79
> c rwj - SCR 675 - 12-20-06  Write reformatted samplpar.hdr, samplpar.abb.
85c86,89
<      &  iunitsp, iunitcp, restart_flag)
---
>      &  iunitsp, iunitcp, restart_flag, abbtext, iabbtext,
>      &  hdrtext, ihdrtext, sptext, isptext)
> c    &  iunitsp, iunitcp, restart_flag)
> cc rwj 12-20-06; SCR675
167a172,176
> cc rwj 12-20-06; SCR675
>       integer ihdrtext
>       character*(*) hdrtext(ihdrtext)
>       integer iabbtext
>       character*(*) abbtext(iabbtext)
377a387,388
> cc rwj 12-20-06; SCR675
>       write(ihdrunit, '(a)') (hdrtext(i),i=1,19)
386a398,399
> cc rwj 12-20-06; SCF675
>       write(iabbunit, '(a)') (abbtext(i),i=1,16)
1739c1752,1756
<          call newrealization(iunitsp, iunitcp, restart_flag)
---
> cc rwj 12-20-06; SCR675
> c        call newrealization(iunitsp, iunitcp, restart_flag)
>          call newrealization(iunitsp, iunitcp, restart_flag,
>      &                       sptext, isptext)
>
```

File differences for *mv.f*:

```
3c3
< c File Date:          02/11/04
---
> c File Date:          12/22/06
66a67
> c     12-20-06 R. Janetzke; SCR675; Reformat file mv.tpa
472c473,475
<       subroutine printtitlesmv( iunit )
---
> cc rwj 12-20-06; SCR675
> c     subroutine printtitlesmv( iunit )
>       subroutine printtitlesmv( iunit, mvtext, imvtext )
511,512c514,518
<       write( iunit, 99 ) (iopenmv-1)
<   99  format( i10 )
---
> cc rwj 12-20-06; SCR675
> c     write( iunit, 99 ) (iopenmv-1)
> c 99  format( i10 )
>       integer imvtext
>       character*(*) mvtext(imvtext)
513a520,523
>       write( iunit, '(i24,a)') (iopenmv-1), mvtext(14)
>       write( iunit, '(a)') (mvtext(i),i=15,23)
> cc end SCR675
>
524c534,536
<       subroutine printvaluesmv( iunit, ir )
---
> cc rwj 12-20-06; SCR675
> c     subroutine printvaluesmv( iunit, ir )
>       subroutine printvaluesmv( iunit, ir, mvtext, imvtext )
564,565c576,586
<       write( iunit, 99 ) ir, (iopenmv-1)
<   99  format( 2i10 )
---
> cc rwj 12-20-06; SCR675
> c     write( iunit, 99 ) ir, (iopenmv-1)
> c 99  format( 2i10 )
>       integer imvtext
>       character*(*) mvtext(imvtext)
>
>       write( iunit, '(a)') (mvtext(i),i=24,29)
>       write( iunit, '(i24,a)') ir, mvtext(30)
>       write( iunit, '(i24,a)') (iopenmv-1), mvtext(31)
>       write( iunit, '(a)') (mvtext(i),i=32,40)
> cc End SCR675
569c590
<  201   format( i5, '  ', e20.5 )
---
>  201   format( i5, '  ', 1pe20.5 )
571d591
<
```

File differences for *releaset.f*:

```
3c3
< C File Date:          09/07/06
---
> C File Date:          01/21/07
198a199
> c        12-21-06 rwj   SCR675 Reformat inv1000.out file.
1735c1736,1763
<         write (23, *) 'k,i,1000 yr inventory, ini. inv./subarea'
---
> cc rwj 12-20-06; SCR675
> c       write (23, *) 'k,i,1000 yr inventory, ini. inv./subarea'
>         write (23, '(a)') '!! inv1000.out'
>         write (23, '(a)') '!! '
>         write (23, '(a)') '!! PUPOSE:'
>         write (23, '(a)') '!! This file presents the waste package '//
>      &                    'inventory at 1,000 years, assuming no loss'
>         write (23, '(a)') '!! mechanism is active.  '
>         write (23, '(a)') '!! '
>         write (23, '(a)') '!! SECTION 1'
>         write (23, '(a)') '!! '
>         write (23, '(a)') '!! Chain Number = Chain number as ordered '//
>      &                                    'in the input file; (k)'
>         write (23, '(a)') '!! Member Number = Member position as '//
>      &                                 'ordered in the input file; (i)'
>         write (23, '(a)') '!! Nuclide Name = Nuclide name as '//
>      &                                 'presented in the input file;'//
>      &                                  ' (namall)'
>         write (23, '(a)') '!! 1000 Year Inventory = inventory at '//
>      &                                       '1000 years; (ci1000)'
>         write (23, '(a)') '!! Inital WP Inventory = initital '//
>      &                    'inventory per waste package in curies per '//
>      &                    'waste package; (curall)'
>         write (23, '(a)') ''
>         write(23,'(a)')' Chain  Member  Nuclide  1000 Year  Initial WP'
>         write(23,'(a)')'Number  Number   Name    Inventory  Inventory'
>         write(23,'(a)')'------  ------  -------    (Ci)      (Ci/WP) '
>
1740c1768,1772
<             write (23, *) k, i, namall(k, i), ci1000(k, i), curall(k, i)
---
> cc rwj 12-20-06; SCR675
> c           write (23, *) k, i, namall(k, i), ci1000(k, i), curall(k, i)
>             write (23, '(i6, i8, 3x, a6, 1p2e13.5)')
>      &            k, i, namall(k, i), ci1000(k, i), curall(k, i)
>
```

File differences for *sampler.f*:

```
3c3
< c File Date:          09/01/06
---
> c File Date:          12/22/06
64a65
> c    R. Janetzke 12-20-06 SCR675; Reformat output file samplpar.*
666c667,670
<       subroutine newrealization(iunitsp, iunitcp, restart_flag)
---
> cc rwj 12-20-06; SCR675
> c     subroutine newrealization(iunitsp, iunitcp, restart_flag)
>       subroutine newrealization(iunitsp, iunitcp, restart_flag,
>      &                          sptext, isptext)
678a683,685
> cc rwj 12-20-06; SCR675
>       integer isptext
>       character*(*)sptext
842c849,852
<                 call printtitlessp(iunitcp,iunitsp, restart_flag)
---
> cc rwj 12-20-06; SCR675
> c               call printtitlessp(iunitcp,iunitsp, restart_flag)
>                 call printtitlessp(iunitcp,iunitsp, restart_flag,
>      &                             sptext, isptext)
877c887,891
<           call printtitlessp(iunitcp,iunitsp, restart_flag)
---
> cc rwj 12-20-06; SCR675
> c         call printtitlessp(iunitcp,iunitsp, restart_flag)
>           call printtitlessp(iunitcp,iunitsp, restart_flag,
>      &                             sptext, isptext)
>
897c911,915
<           call printtitlessp(iunitcp,iunitsp, restart_flag)
---
> cc rwj 12-20-06; SCR675
> c         call printtitlessp(iunitcp,iunitsp, restart_flag)
>           call printtitlessp(iunitcp,iunitsp, restart_flag,
>      &                             sptext, isptext)
>
1650c1668,1671
<       subroutine printtitlessp( iunitcp, iunitsp, restart_flag )
---
> cc rwj 12-20-06; SCR675
> c     subroutine printtitlessp( iunitcp, iunitsp, restart_flag )
>       subroutine printtitlessp( iunitcp, iunitsp, restart_flag,
>      &                          sptext, isptext )
1661a1683,1684
> c sptext = input, character*(*), array of text for file header.
> c isptext = input, integer, dimension of sptext.
1666a1690,1692
> cc rwj 12-20-06; SCR675
>       integer isptext
>       character*(*) sptext(isptext)
1702,1703c1728,1733
<          write( iunitsp, 99 ) 0, ipdfimp
<   99     format( 2i10 )
---
> cc rwj 12-19-06; SCR675 Reformat files.
> c        write( iunitsp, 99 ) 0, ipdfimp
> c 99     format( 2i10 )
>          write( iunitsp, '(i24,a)') ipdfimp, sptext(12)
>          write( iunitsp, '(a)') (sptext(i),i=13,19)
>
1732c1762,1764
<       subroutine printvaluessp( iunit, ir )
---
> cc rwj 11-19-06; SCR675
> c     subroutine printvaluessp( iunit, ir )
>       subroutine printvaluessp( iunit, ir, sptext, isp )
1745a1778,1779
> cc rwj 11-19-06; SCR675
>       character*(*) sptext(isp)
1747,1748c1781,1787
<       write( iunit, 99 ) ir, ipdfimp
<   99  format( 2i10 )
---
> cc rwj 11-19-06; SCR675
```

```
> c      write( iunit, 99 ) ir, ipdfimp
> c 99   format( 2i10 )
>        write( iunit, '(a)' ) (sptext(i),i=20,25)
>        write( iunit, '(i24,a)' ) ir, sptext(26)
>        write( iunit, '(i24,a)' ) ipdfimp, sptext(27)
>        write( iunit, '(a)' ) (sptext(i),i=28,35)
```

SCR - 677

TPA 5.1/ Beta J

SOFTWARE CHANGE REPORT (SCR)

1. **SCR No.** (*Software Developer Assigns*): SCR 677	2. **Software Title and Version:** TPA 5.1BetaJ	3. **Project No:** 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *mechdrive.f, exec.f, ebsfail.f, codes/failt.f, data/ebsfail.def, codes/corrfail.f, codes/corrosn.f*

In a letter from NRC, dated 7-27-2006, a request was made to increase the transparency and traceability of the input/output files. Specifically, input parameters should be located/identified in the input files to aid in traceability through the conceptual model calculations. Also, the format and content of the output files should ensure a user can reasonably comprehend the content without excessive recourse to the source code of other documentation.

5. Change Requested by: J. Winterle	**Date:** 8-1-2006
6. Change Authorized by (*Software Developer*): R. Janetzke	**Date:** 8-7-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

This change affected 10 output files described below:

1. Reformatted the following output files: *failt.cum, nearfld.res, mechfail.ech, mechfail.rlt, mechfail_ds.res, mechfail_wp.res*
2. Changed the extension on the following files to "*.dbg:*" *echofail.dat* to *echofail.dbg, mechfail_ds.out* to *mechfail_ds.dbg*, *mechfail_wp.out* to *mechfail_wp.dbg*
3. Removed the file, "*corrode.out*."

8. Implemented by: G. Adams	**Date:** 1/5/2007

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☐ **No** ☒

(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).

Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

Code review accomplished by:	**Date:**

10. Description of Acceptance Tests:

Procedure: Used TPA Version 5.1BetaY with reference case *tpa.inp* input file. Set Output Option to append all files. Ran 2 realizations for all 10 subareas. Inspected output files *failt.cum, nearfld.res, mechfail.ech, mechfail.rlt, mechfail_ds.res, mechfail_wp.res* for correct format, accuracy of information, correct spelling, and transparency of information. Ensure *echofail.dbg, mechfail_ds.dbg*, and *mechfail_wp.dbg* files are printed instead of their old *.dat* and *.out* filenames. Ensure that *corrode.out* is not generated.

Acceptance Criteria: User should be able to understand what is in the files by reading the header and column heading information; header and column heading information should be correct, and headers should be free of spelling errors; *echofail.dbg, mechfail_ds.dbg*, and *mechfail_wp.dbg* files are printed instead of their old *.dat* and *.out* filenames; *corrode.out* is not generated.

Status (Pass/Fail): PASS (note that *failt.cum* does not echo the version and run information from the top 2 lines of *tpa.inp*, however all acceptance criteria are met.)

11. Tested by: James Winterle	**Date:** 05/22/2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for TPA.INP

SCR 677

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
No Changes to tpa.inp parameters							

SCR - 678

TPA 5.1/ Beta K

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 678	2. Software Title and Version: TPA 5.1BetaK	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f,*

In a letter from NRC, dated 7-27-2006, a request was made to increase the transparency and traceability of the input/output files. Specifically, input parameters should be located/identified in the input files to aid in traceability through the conceptual model calculations. Also, the format and content of the output files should ensure a user can reasonably comprehend the content without excessive recourse to the source code of other documentation.

5. Change Requested by: J. Winterle	**Date:** 8-1-2006
6. Change Authorized by (*Software Developer*): R. Janetzke	**Date:** 8-7-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

The file *exec.f* has been modified to provide detailed descriptions and file format changes for the following files; *relgwgs.res, rgwsa.tpa* and *rgwsr.tpa*

8. Implemented by: J. Mancillas	**Date:** 1-23-2007

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☐ **No** ☒

(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).

Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

Code review accomplished by:	**Date:**

10. Description of Acceptance Tests:

Procedure: Used TPA Version 5.1BetaY with reference case *tpa.inp* input file. Set Output Option to append all files. Ran 2 realizations for all 10 subareas. Inspected output files *relgwgs.res, rgwsa.tpa* and *rgwsr.tpa* for correct format, accuracy of information, correct spelling, and transparency of information.

Acceptance Criteria: User should be able to understand what is in the files by reading the header and column heading information; header and column heading information should be correct, and headers should be free of spelling errors.

Status (Pass/Fail): PASS

11. Tested by: James Winterle	**Date:** 05/22/2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for TPA.INP

SCR 678

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
No Changes to tpa.inp parameters							

SCR - 679

TPA 5.1/ Beta H

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 679	2. Software Title and Version: TPA 5.1BetaH	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f,*

In a letter from NRC, dated 7-27-2006, a request was made to increase the transparency and traceability of the input/output files. Specifically, input parameters should be located/identified in the input files to aid in traceability through the conceptual model calculations. Also, the format and content of the output files should ensure a user can reasonably comprehend the content without excessive recourse to the source code of other documentation.

5. Change Requested by: J. Winterle	**Date:** 8-1-2006
6. Change Authorized by (*Software Developer*): R. Janetzke	**Date:** 8-7-2006

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

The file *exec.f* has been modified to provide detailed descriptions and file format changes for the following files; *driftfail.ech, driftfail.rlt, dsfail.ech, dsfail.res* and *dsfail.rlt*.

8. Implemented by: J. Mancillas	**Date:** 12-11-2006

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☐ **No** ☒

(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).

Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

Code review accomplished by:	**Date:**

10. Description of Acceptance Tests:

Procedure: Used TPA Version 5.1BetaY with reference case *tpa.inp* input file. Set Output Option to append all files. Ran 2 realizations for all 10 subareas. Inspected output files *driftfail.ech, driftfail.rlt, dsfail.ech, dsfail.res* and *dsfail.rlt* for correct format, accuracy of information, correct spelling, and transparency of information.

Acceptance Criteria: User should be able to understand what is in the files by reading the header and column heading information; header and column heading information should be correct, and headers should be free of spelling errors.

Status (Pass/Fail): PASS

11. Tested by: James Winterle	**Date:** 05/22/2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for TPA.INP

SCR 679

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM)*	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.)*	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
No Changes to tpa.inp parameters							

SCR - 680

TPA 5.1/ Beta K

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 680	2. Software Title and Version: TPA 5.1BetaK	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f, ebsfail.f, codes/failt.f, nfenv.f*

In a letter from NRC, dated 7-27-2006, a request was made to increase the transparency and traceability of the input/output files. Specifically, input parameters should be located/identified in the input files to aid in traceability through the conceptual model calculations. Also, the format and content of the output files should ensure a user can reasonably comprehend the content without excessive recourse to the source code of other documentation.

5. Change Requested by: J. Winterle	**Date:** 8-1-2006
6. Change Authorized by (*Software Developer*): R. Janetzke	**Date:** 1-22-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

Reformatted output files nfenv.ech, nfenv.rlt, and chlrdmf.dat.

Changed the file extension on file thermal.dat to thermal.dbg.

8. Implemented by: G. Adams	**Date:** 2/4/2007

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

NONE

Code review accomplished by:	**Date:** 6/18/2007

10. Description of Acceptance Tests:

See Attachment A

10. Tested by: J. Mancillas	**Date:** 2/27/07

Form TOP-5 (10/2006)

Attachment A
Test Plan for TPA SCR680

Test Plan Name: SCR680 Test Plan

Tested By: J. Mancillas Date: 2/27/07

Host Machine: Manta Host OS: Windows XP (SP2)

Baseline Version: TPA51betaK Test Version: TPA51betaL

Process Level (PL) Tests

PL-1. Name: File Format Changes for *nfenv.ech, nfenv.rlt*, and *chlrdmf.dat*

Path for run directory:

Basecase: [Manta]D:\SCR680\runK1
Testcase: [Manta]D:\SCR680\runL1

Path for archive of results:

Basecase: CD[Titled: SCR680 Testing]:\SCR680\runK1
Testcase: CD[Titled: SCR680 Testing]:\SCR680\runL1

Environment variables:

Basecase: TPA_DATA=..\tpa51betaK
TPA_TEST=..\tpa51betaK

Testcase: TPA_DATA=..\tpa51betaL
TPA_TEST=..\tpa51betaL

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): Append All

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description: The formats of the files *nfenv.ech, nfenv.rlt*, and *chlrdmf.dat* have been modified to provide more detailed descriptions of the data in these files. And the file *thermal.dat* has been renamed *thermal.dbg*. This test will examine these changes and verify that they have been correctly implemented

- objective Verify that the files contain adequate descriptions of the data in the files.

- assumptions None, other than those made within the TPA code.

- constraints None

- output files to compare or examine *nfenv.ech, nfenv.rlt*, and *chlrdmf.dat*

- step by step test procedure to be used
  1) Examine the changes to the files *exec.f ebsfail.f, failt.f* and *nfenv.f.*
  2) Perform a reference case realization for the basecase and testcase versions of the TPA code.
  3) Examine the descriptions and contents of the modified files.

- pass fail criteria
  1) The changes made to the files *exec.f ebsfail.f, failt.f* and *nfenv.f* are logical and consistent with the stated intent of SCR680.
  2) The file *nfenv.ech* includes enhanced data descriptions and data formats .
  3) The file *nfenv.rlt* includes enhanced data descriptions and data formats.
  4) The file *thermal.dat* has been properly renamed *thermal.dbg.*

Test Results:

- criterion 1

An examination of the files *exec.f, ebsfail.f, failt.f* and *nfenv.f* shows the changes made to these files are logical and consistent with the intent of modifying the comments and format of the files *nfenv.rlt* and *nfenv.ech.* In addition, it was verified that no changes outside the stated scope of SCR680 were made to the modified codes. A comparison between the basecase and testcase versions of these files was made using the DOS file compare command. An examination of these comparisons; *exec.f_fc, ebsfail.f_fc, failt.f_fc* and *nfenv.f* saved in the following directory \SCR680\files_fc further verified the content of the changes made to these codes. These files are presented as evidence that this SCR has been properly implemented.

- criterion 2

A reference case realization for the basecase and the testcase versions of the code were performed with the output mode set to append all files. This resulted in the generation of the file *nfenv.ech*.for both versions of the TPA code.

The following text is an excerpt from the basecase version of the file *nfenv.ech*
\SCR680\runK1*nfevn.ech*

```
*******************************************************************************
!! nfenv.ech
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1betaK Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1betaK
!! Module: EXEC
!! Job started: Tue Feb 27 14:56:52 2007
!!
!! PURPOSE:
!!  Echo of NFENV Input Values

!!  with the output mode specified in "tpa.inp"

                        1 !! Realization
                        1 !! Subarea
```

```
(same value for all subareas and vectors)

  ntim
  201

(the following values are for each subarea and vector)

        time       qm3/yr/wp/sa
   1  0.0000E+00  2.2864E+00
   2  2.3102E+00  2.2864E+00
   3  4.6744E+00  2.2864E+00
   4  7.0940E+00  2.2864E+00
   5  9.5702E+00  2.2864E+00
   6  1.2104E+01  2.2864E+00
   7  1.4698E+01  2.2864E+00

...


 195  8.6908E+03  1.5308E+01
 196  8.8966E+03  1.5308E+01
 197  9.1072E+03  1.5308E+01
 198  9.3227E+03  1.5308E+01
 199  9.5433E+03  1.5308E+01
 200  9.7690E+03  1.5308E+01
 201  1.0000E+04  1.5308E+01
                       1 !! Realization
                       2 !! Subarea
        time       qm3/yr/wp/sa
   1  0.0000E+00  4.1164E+00
   2  2.3102E+00  4.1164E+00
   3  4.6744E+00  4.1164E+00
   4  7.0940E+00  4.1164E+00
   5  9.5702E+00  4.1164E+00
   6  1.2104E+01  4.1164E+00
...
...
*******************************************************************************
```

The following text is an excerpt from the testcase version of the file *nfenv.ech*
\SCR680\runL1*nfevn.ech*

```
*******************************************************************************
!! nfenv.ech
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1betaL Code.
!!  Preliminary testing case.
!! Created by: TPA 5.1betaL
!! Module: EXEC
!! Job started: Tue Feb 27 14:59:30 2007
!!
!! PURPOSE:
!!  Echos input values for Near Field Environment Module

!!  for all realizations and subareas

!!
!! SECTION 1 ; CURRENT STATE
!!
!! Current realization and subarea being evaluated
!! Item 1: realization - realization being evaluated
!! Item 2: subarea identifier - subarea being evaluated

                       1 !! Realization
                       1 !! Subarea

!! SECTION 2 ; SUBAREA DATA
!!
!! This section contains data for each subarea
!!
!! Step      ; tpa time step
```

```
!! TPA Time  ; time corresponding to this step
!! Flow Rate ; time dependent flow rate per waste package
!!             in subarea

  Step      TPA Time       Flow Rate
              (year)    (m3/yr/wp/sa)
     1   0.00000E+00     2.28637E+00
     2   2.31016E+00     2.28637E+00
     3   4.67440E+00     2.28637E+00
     4   7.09399E+00     2.28637E+00
     5   9.57023E+00     2.28637E+00
     6   1.21044E+01     2.28637E+00
     7   1.46980E+01     2.28637E+00

...

   195   8.69080E+03     1.53078E+01
   196   8.89657E+03     1.53078E+01
   197   9.10716E+03     1.53078E+01
   198   9.32269E+03     1.53078E+01
   199   9.54325E+03     1.53078E+01
   200   9.76898E+03     1.53078E+01
   201   1.00000E+04     1.53078E+01

!!
!! SECTION 1 ; CURRENT STATE
!!
!! Current realization and subarea being evaluated
!! Item 1: realization - realization being evaluated
!! Item 2: subarea identifier - subarea being evaluated

                      1 !! Realization
                      2 !! Subarea

!! SECTION 2 ; SUBAREA DATA
!!
!! This section contains data for each subarea
!!
!! Step      ; tpa time step
!! TPA Time  ; time corresponding to this step
!! Flow Rate ; time dependent flow rate per waste package
!!             in subarea

  Step      TPA Time       Flow Rate
              (year)    (m3/yr/wp/sa)
     1   0.00000E+00     4.11643E+00
     2   2.31016E+00     4.11643E+00
     3   4.67440E+00     4.11643E+00
     4   7.09399E+00     4.11643E+00
     5   9.57023E+00     4.11643E+00
     6   1.21044E+01     4.11643E+00
...
*******************************************************************************
```

These two text excerpts show that the file *nfenv.ech* has been altered in format. The new format includes clear descriptive headers for each data section, includes units and descriptions for the columnar data ,time and flow rates and flow rate data has been written to a higher precision. These results are presented as evidence that SCR680 has been properly implemented.

- criterion3

A reference case realization for the basecase and the testcase versions of the code were performed with the output mode set to append all files. This resulted in the generation of the file *nfenv.rlt* for both versions of the TPA code.

The following text is an excerpt from the basecase version of the file *nfenv.rlt*
\SCR680\runK1*nfevn.rlt*
****

```
!! nfenv.rlt
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1betaK Code.

!!  Preliminary testing case.

!! Created by: TPA 5.1betaK
!! Module: EXEC
!! Job started: Tue Feb 27 14:56:52 2007
!!
!! PURPOSE:
!!  NFENV Results


!!  with the output mode specified in "tpa.inp"


                        1 !! Realization
                        1 !! Subarea

            time      temprep     tempbfoA     tempbfoB     tempdsoA     tempdsoB
tempdsiA    tempdsiB       tempwp     relhumwp         phwp         clwp
qm3miss/yr/wp/sa             qm3hit            flds       del_ecrit
CritRH          ThrSee          RewHum             CO3             NO3
SO4
   1  0.0000E+00  2.3500E+01  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
0.0000E+00  0.0000E+00  3.4053E+01  1.1144E-01  7.0000E+00  0.0000E+00
2.2864E+00         0.0000E+00      0.0000E+00      0.0000E+00      3.0000E-01
1.1253E+02      9.6724E-01      0.0000E+00      0.0000E+00      0.0000E+00
   2  2.3102E+00  5.2181E+01  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
0.0000E+00  0.0000E+00  6.0167E+01  2.9585E-02  7.0000E+00  0.0000E+00
2.2622E+00         2.4192E-02      0.0000E+00      0.0000E+00      3.0000E-01
1.1253E+02      9.6724E-01      0.0000E+00      0.0000E+00      0.0000E+00
   3  4.6744E+00  5.8790E+01  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
0.0000E+00  0.0000E+00  6.6071E+01  2.2636E-02  7.0000E+00  0.0000E+00
2.2457E+00         4.0634E-02      0.0000E+00      0.0000E+00      3.0000E-01
1.1253E+02      9.6724E-01      0.0000E+00      0.0000E+00      0.0000E+00
...
******************************************************************************
```

The following text is an excerpt from the testcase version of the file *nfenv.rlt*
\SCR680\runL1*nfevn.rlt*

```
******************************************************************************
!! nfenv.rlt
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1betaL Code.

!!  Preliminary testing case.

!! Created by: TPA 5.1betaL
!! Module: EXEC
!! Job started: Tue Feb 27 14:59:30 2007
!!
!! PURPOSE:
!!  Displays near field environment data


!!  for all realizations and subareas


!!
!! SECTION 1 ; CURRENT STATE
!!
!! Current realization and subarea being evaluated
```

```
!! Item 1: realization - realization being evaluated
!! Item 2: subarea identifier - subarea being evaluated

                        1 !! Realization
                        1 !! Subarea

!! SECTION 2 ; SUBAREA DATA
!!
!! This section contains data for each subarea
!!
!! Step               ; tpa time step
!! TPA Time           ; time corresponding to this step
!! Temp Rock Wall     ; temperature at the rock wall
!! Temp Backfill      ; temperature at the outer surface
!!   Upwards          ; of the backfill radially upwards
!! Temp Backfill      ; temperature at the outer surface
!!   Sides            ; of the backfill radially to the
!!                    ; sides
!! Temp Drip Shield   ; temperature at the outer surface
!!   Outer Upwards    ; of the drip shield radially
!!                    ; upwards
!! Temp Drip Shield   ; temperature at the outer surface
!!   Outer Sides      ; of the drip shield radially
!!                    ; to the sides
!! Temp Drip Shield   ; temperature at the inner surface
!!   Inner Upwards    ; of the drip shield radially
!!                    ; upwards
!! Temp Drip Shield   ; temperature at the inner surface
!!   Inner Sides      ; of the drip shield radially
!!                    ; to the sides
!! Temp Waste         ; temperature at the surface of the
!!   Package          ; waste package
!! Relative Humidity  ; relative humidity at the surface of the
!!   Waste Package    ; waste package
!! pH Waste Package   ; pH at the waste package surface
!! Chloride Waste     ; chloride concentration at the waste
!!   Package          ; package surface
!! Flow Rate Miss     ; flow rate that passes through the area
!!                    ; not occupied by a waste package
!! Flow Rate Hit      ; flow rate that passes through the area
!!                    ; of a single waste package
!! Fluoride Drip      ; fluoride concentration at the surface
!!   Shield           ; of the drip shield
!! Delta E Crit       ; correction term to critical potential
!!                    ; to account for the effect of inhibitors
!!                    ; in volts (standard hydrogen electrode)
!! Critical RH        ; critical relative humidity for
!!   Aqueous          ; aqueous corrosion
!! Threshold Seepage  ; threshold temperature for seepage into
!!   Temperature      ; the drift
!! Rewetting          ; rewetting humidity used to determine
!!   Humidity         ; corrosive environment transition
!! Carbonate          ; carbonate concentration at the
!!   Concentration    ; waste package surface
!! Nitrate            ; nitrate concentration at the
!!   Concentration    ; waste package surface
!! Sulfate            ; sulfate concentration at the
!!   Concentration    ; waste package surface

  Step            TPA Time      Temp Rock Wall       Temp Backfill       Temp
Backfill    Temp Drip Shield    Temp Drip Shield    Temp Drip Shield    Temp
Drip Shield          Temp Waste   Relative Humidity    pH Waste Package
Chloride Waste      Flow Rate Miss       Flow Rate Hit       Fluoride Drip
  Delta E Crit         Critical RH   Threshold Seepage           Rewetting
     Carbonate             Nitrate             Sulfate
```

```
                                                                    Upwards
 Sides        Outer Upwards          Outer Sides        Inner Upwards
Inner Sides              Package        Waste Package
    Package                                                           Shield
                         Aqueous          Temperature             Humidity
Concentration        Concentration        Concentration
                      (year)          (degrees C)          (degrees C)
(degrees C)          (degrees C)          (degrees C)          (degrees C)
(degrees C)          (degrees C)           (unitless)           (unitless)
(mol/liter)        (m3/yr/wp/sa)        (m3/yr/wp/sa)          (mol/liter)
(volts SHE)           (unitless)          (degrees C)           (unitless)
(mol/liter)          (mol/liter)          (mol/liter)
     1          0.00000E+00          2.35000E+01          0.00000E+00
0.00000E+00          0.00000E+00          0.00000E+00          0.00000E+00
0.00000E+00          3.40531E+01          1.11439E-01          7.00000E+00
0.00000E+00          2.28637E+00          0.00000E+00          0.00000E+00
0.00000E+00          3.00000E-01          1.12529E+02          9.67242E-01
0.00000E+00          0.00000E+00          0.00000E+00
     2          2.31016E+00          5.21810E+01          0.00000E+00
0.00000E+00          0.00000E+00          0.00000E+00          0.00000E+00
0.00000E+00          6.01665E+01          2.95847E-02          7.00000E+00
0.00000E+00          2.26218E+00          2.41921E-02          0.00000E+00
0.00000E+00          3.00000E-01          1.12529E+02          9.67242E-01
0.00000E+00          0.00000E+00          0.00000E+00
     3          4.67440E+00          5.87900E+01          0.00000E+00
0.00000E+00          0.00000E+00          0.00000E+00          0.00000E+00
0.00000E+00          6.60715E+01          2.26358E-02          7.00000E+00
0.00000E+00          2.24574E+00          4.06340E-02          0.00000E+00
0.00000E+00          3.00000E-01          1.12529E+02          9.67242E-01
0.00000E+00          0.00000E+00          0.00000E+00
...
*******************************************************************************
```

These two text excerpts show that the file *nfenv.rlt* has been altered in format. The new format includes clear descriptive headers for the data contained in each section. The columnar titles include units and descriptions and the columnar data is written to a higher precision. These results are presented as evidence that SCR680 has been properly implemented.

- criterion 4

The file thermal.dat has been renamed thermal.dbg. The following excerpt from nfenv.f depicts this name change.

\SCR680\tpa51betaL\ *nfenv.f*

```
*******************************************************************************
**
c       Generate the thermal factors to a file for analysis
c       GADAMS SCR680 2-1-2007: Changed file extension to dbg for debug
c        open (ithermal, file='thermal.dat',status='UNKNOWN')
        open (ithermal, file='thermal.dbg',status='UNKNOWN')
c       GADAMS SCR680 2-1-2007: End of change
*******************************************************************************
```

No changes in format or content were made to this file. A file comparison made between the basecase *thermal.dat* file and the testcase *thermal.dbg* file show that there are no differences between the files.

The following is the comparison of the two files and is saved in the following directory \SCR680\files_fc*thermal_fc*.

```
*******************************************************************************
The following is the result of the file comparison
```

```
Comparing files RUNK1\thermal.dat and RUNL1\THERMAL.DBG
FC: no differences encountered
*****************************************************************************
```

These file excerpts from *nfenv.f* and *thermal_fc* are presented as evidence that SCR680 has been properly implemented.

- overall test status : PASS

Notes:

SCR - 681

TPA 5.1/ Beta K

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 681	2. Software Title and Version: TPA 5.1BetaK	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f, reader.f, sampler.f , samplers.i, tpa.inp, tpanames.dat,* and *addhazardcurve.h.*

In the current version of the TPA code, the contents of the seismic hazard curve have been hardwired into the function "*PeakSeismicVandA*", in the *sampler.f* module and the *tpa.inp* parameter **SeismicHazardCurveforSEISMO** contains data which is inaccurately presented.

5. Change Requested by: L. Ibarra	Date: 2-13-2007
6. Change Authorized by (*Software Developer*): R. Janetzke	Date: 2-13-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):
The *tpa.inp* parameter **SeismicHazardCurveforSEISMO** has been replaced by the parameter **Seismic_MAPE_PGV_PGAm_PGAsd_CFmin_CFmax[1/yr,m/s,m/s2,_,_,_]** which lists in a columnar fashion the MAPE, PGV, PGA mean , PGA std dev, the CF min and CF max for each MAPE category.
SeedForRandomNumberForSEISMO has been renamed **SeedForRandomNumberForSeismicity.** The name changes are intended to more accurately reflect that there is no SEISMO module.
The functions *samplehazardcurve* and *PeakSeismicVandA* were consolidated into the single function *samplehazardcurve*.

8. Implemented by: J. Mancillas	Date: 2-15-07

9. Code Review Needed (see TOP-018, 5.4.7) Yes ☒ No ☐
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution (*If no errors are found, indicate with "**None**".*):

Error: Within tpa.inp for an MAFE of 1e-5, the PGV should be 1.05 as indicated on page 5-17 of Ibarra et. al., 2006 (Drip Shield-Waste Package Mechanical Interaction) The value in tpa.inp is 1.07 which corresponds to the previously hardcoded value taken from page B-4 of this same report.

Recommend for consistency, to update the text from "MAPE" to "MAFE." Ibarra et. al., 2006 uses mean annual frequency of exceedance on page 5-19. This would also be consistent with mechfail.ech.

Code review accomplished by: George Adams	Date: 3-9-2007

10. Description of Acceptance Tests:
Using tpa51BetaK and tpa51BetaQ, ran the code on machine GOLDSIM for one subarea and compared the values printed to the screen and stored in an output file. In version BetaQ, a print statement was uncommented so that the values could be obtained. In BetaK, a print statement was added.

See the attached plots which show the MAPE, PGV, PGA, and CF results were comparable between the test runs. However, the probability density areas differed when compared to the values on page 5-20 of Ibarra et. al., 2006 for MAPE values as shown on the Summary tab of scr681.xls and in the attachment. The comparison of MAPE values to Ibarra et. al., 2006 needs to be done during validation testing to determine if the MAPE values are acceptable.

TPA version 5.1BetaQ **PASSED** this test because the MAPE, PGV, PGA, and CF results were comparable between the two test runs. Primarily, this change involved removing the hardcoded tables from the code. Because order was changed within the code, values for any particular time step were different between the two versions of the code, so the results were compiled and are shown on the attached plots and in spreadsheet scr681.xls on the attached CD.

10. Tested by: George Adams	Date: 3-9-2007

UPDATE REQUIREMENTS for TPA.INP

SCR 681

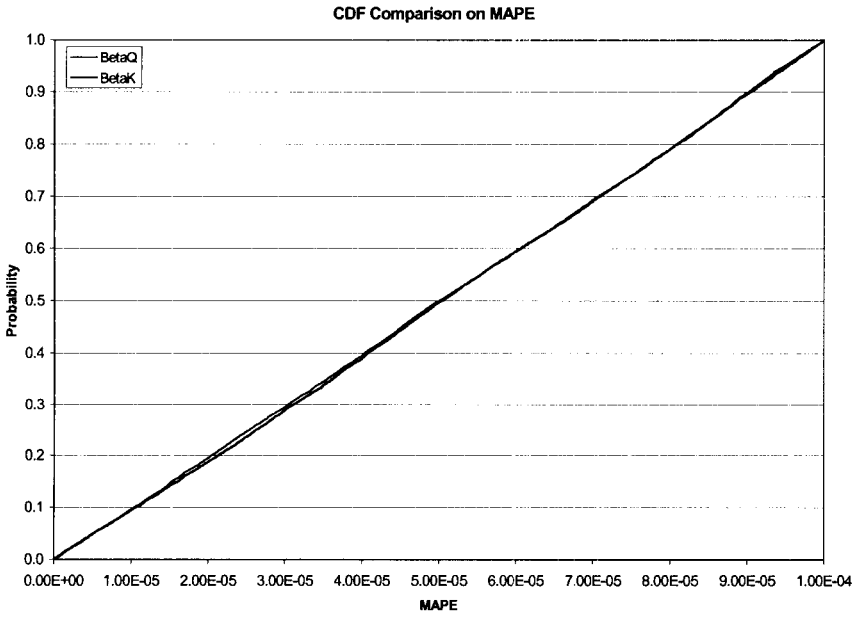
Status (***ADD, DELETE, MODIFY TO, MODIFY FROM***)	**Module**	**Parameter Name**	**Description** (***Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.***)	**Distribution**	**Range**	**Justification** ***1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.***	**Source**
Modify From	sampler	**SeismicHazard CurveforSEISMO**	number of seismic point on the hazard curve and the annual probability distribution of these points	hazardcurve	5 4.0 10000 5.0 100000 6.0 1000000 7.0 10000000 8.0 100000000	Center report titled "DRIP SHIELD–WASTE PACKAGE MECHANICAL INTERACTION" by Luis Iberra 2006	L. Ibarra
Modify to	sampler	**Seismic_MAPE_PGV_PGAm_PGAsd_CFmin_CFmax[1/yr,m/s,m/s2,_,_,_]**	number of seismic points used to construct the seismic hazard curve. The mean annual probability of exceedence, the peak ground, the mean peak ground acceleration, the peak ground acceleration standard deviation, the minimum and maximum compaction factor, for each seismic point.	hazardcurve	5 1.0e-4 0.47 0.47 0.64 0.10 0.20 1.0e-5 1.07 2.27 0.64 0.20 0.40 1.0e-6 2.44 4.75 0.53 0.30 0.60 1.0e-7 5.35 12.7 0.53 0.40 0.60 1.0e-8 5.35 12.7 0.53 0.40 0.60	Center report titled "DRIP SHIELD–WASTE PACKAGE MECHANICAL INTERACTION" by Luis Iberra 2006	L. Ibarra

ATTACHMENT - SUPPORTING PLOTS

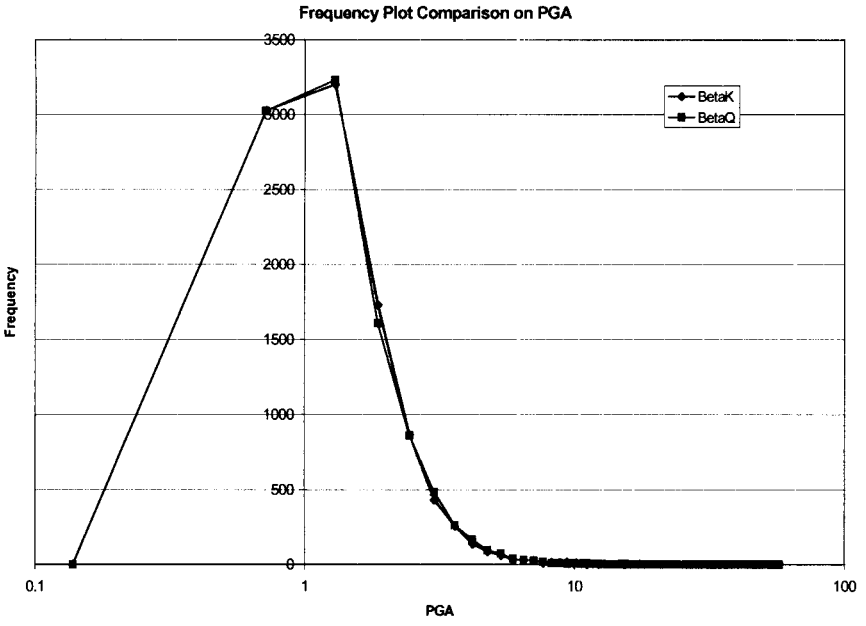
Comparison of MAPE probability density areas to those on page 5-20 of Ibarra et. al., 2006

	MAFE <= 1e-4	1e-5 < MAFE <= 1e-4	1e-6 < MAFE <= 1e-5	1e-7 < MAFE <= 1e-6	MAFE <=1e-7
BetaQ	100.000%	90.370%	8.700%	0.860%	0.070%
BetaK	100.000%	90.560%	8.430%	0.910%	0.100%
Report (Ibarra, et. al, 2006)	100.000%	90.100%	9.200%	0.700%	0.080%

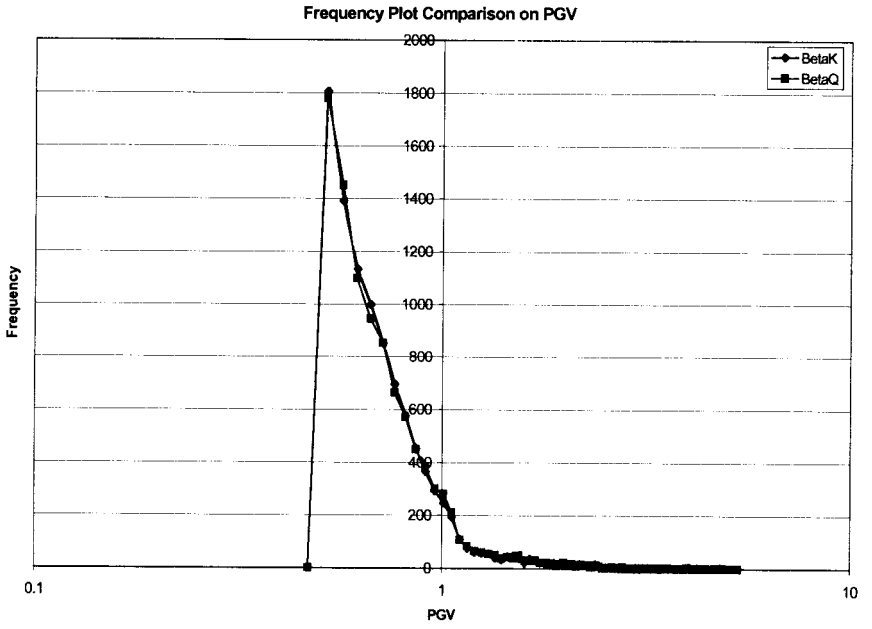
CDF Comparison of MAPE



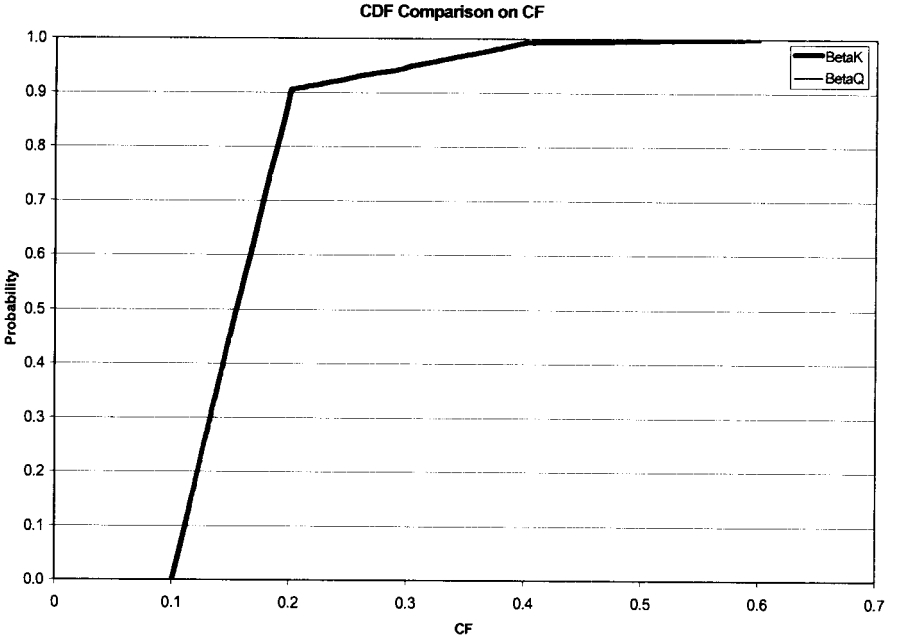
Frequency Plot Comparison of PGA



Frequency Plot Comparison on PGV



CDF Comparison on CF



SCR - 682

TPA 5.1/ Beta K

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 682	2. Software Title and Version: TPA 5.1BetaK	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *ashremob.f, remob_lut.dat*

a) In a letter from NRC, dated 7-27-2006, a request was made to increase the transparency and traceability of the input/output files. Specifically, input parameters should be located/identified in the input files to aid in traceability through the conceptual model calculations.

b) Massloading is increasing with time due to the fact that the airborne mass load is creating a negative contribution at the initial receptor location.

c) *ashremob.out* file displays exponents incorrectly when they are less than `e-100`. Format needs to be changed.

5. Change Requested by: A. Simpkins and R. Benke	**Date:** 2-13-2007
6. Change Authorized by (*Software Developer*): R. Janetzke	**Date:** 2-13-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

See Attachment A

8. Implemented by: Jose M. Menchaca	**Date:** 2-21-2007

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐

(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).

Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

None

Code review accomplished by: Ali A. Simpkins	**Date:** 2-28-07

10. Description of Acceptance Tests:

See Attachment B

10. Tested by: Ali A. Simpkins	**Date:** 2-28-07

Form TOP-5 (10/2006)

Description of Change(s) or Problem Resolution

1. Modify the outdoor airborne mass load modeling in ASHREMOB so that the presence of ash cannot result in a negative contribution to the airborne mass load.

Considering the FORTRAN statements below that are currently within *ashremob.f.* Change the following statements

Change
```
abnmassldinth(it) = (massloadashheavy - massloadoutheavy) *
     &          reductionfactor(it) + massloadoutheavy
```
to
```
if (massloadoutheavy .gt. massloadashheavy) then
abnmassldinth(it) =massloadoutheavy
else
abnmassldinth(it) = (massloadashheavy - massloadoutheavy) *
     &          reductionfactor(it) + massloadoutheavy
endif
```

and change
```
abnmassldintl(it) = (massloadashlight - massloadoutlight) *
     &          reductionfactor(it) + massloadoutlight
```
to

```
if (massloadoutlight .gt. massloadashlight) then
abnmassldintl(it) = massloadoutlight
else
abnmassldintl(it) = (massloadashlight - massloadoutlight) *
     &          reductionfactor(it) + massloadoutlight
endif
```

Modify ALL print warning statements shown below by changing

```
       print *, 'which will cause a negative contribrution to'//
     &             ' the airborne mass load.'
```

to
```
       print *, 'Mass load for soil is used to avoid a negative
     &             'contribution to the airborne mass load '
     &            'Due to the presence of ash.'
```

Section of FORTRAN that needs to be modified

```
if (massashinit(iashplumerealindex) .eq. 0.d0) then
            abnmassldinth(it) = massloadoutheavy
            abnmassldintl(it) = massloadoutlight
         else
            if (massloadoutheavy .gt. massloadashheavy) then
               print *, 'WARNING: '//
     &                 'AirborneMassLoadOutsideHeavyDisturbance exceeds '
               print *,
     &                'AirborneMassLoadAboveFreshAshBlanketHeavyDisturbance'
               print *, 'which will cause a negative contribrution to'//
```

```
     &              ' the airborne mass load.'
            end if
            abnmassldinth(it) = (massloadashheavy - massloadoutheavy) *
     &         reductionfactor(it) + massloadoutheavy
cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
cc jmm; 12-05-06; SCR654
c           if (massloadoutheavy .gt. massloadashheavy) then
            if (massloadoutlight .gt. massloadashlight) then

               print *, 'WARNING: '//
     &              'AirborneMassLoadOutsideLightDisturbance exceeds '
               print *,
     &            'AirborneMassLoadAboveFreshAshBlanketLightDisturbance'
               print *, 'which will cause a negative contribrution to'//
     &            ' the airborne mass load.'
            end if
            abnmassldintl(it) = (massloadashlight - massloadoutlight) *
     &         reductionfactor(it) + massloadoutlight
        endif
```

2. Make similar corrections for eolian source region. Change

```
        partmassloadeoli(it) = (massloadashlight - massloadoutlight) *
     &                         reductionfactor(it) + massloadoutlight
```

---

to

```
if (massloadoutlight .gt. massloadashlight) then
     partmassloadeoli(it) =massloadoutlight
     else
     partmassloadeoli(it) = (massloadashlight - massloadoutlight) *
     &                         reductionfactor(it) + massloadoutlight
endif
```

---

3. Fix *ashremob.out* printout from printing incorrectly when numbers less than E-100.

Change the format statement for printing *ashremob.out* at the very end of *ashremob.f* from (1pe14.8, 3x) to (1pe14.4,3x)

---

4. Add descriptive header information to *remob_lut.dat* auxiliary input file.

a. Delete "`g/m2,g/m2,g,g,m2,g,g,m2 (HLW masses are based on 1MTU of HLW erupted)`" from the header

b. At the top of the file, add the new header information below.

Column header symbols are separated by semicolons and described below. The underscore (_) indicates subscript text, and the carrot (^) indicates superscript text.

`c_HLW,i` = Mass of high-level waste for the initial deposit at the receptor location per unit area [g/m^2]
`c_ash,i` = Mass of ash for the initial deposit at the receptor location per unit area [g/m^2]
`m_HLW,f` = Mass of high-level waste deposited in the Fortymile Wash catchment basin from the eruption [g]

m_ash,f = Mass of ash deposited in the Fortymile Wash catchment basin from the eruption [g]
a_ash,f = Area of the Fortymile Wash catchment basin with an ash deposit from the eruption [m^2]
m_HLW,e = Mass of high-level waste deposited in the eolian source region from the eruption [g]
m_ash,e = Mass of ash deposited in the eolian source region from the eruption [g]
a_ash,e = Area of the eolian source region with an initial ash deposit from the eruption [m^2]

Note: HLW masses are based on 1 MTU of HLW erupted

c. Modify column headers from

c_HLW,I,c_ash_I,m_HLW_f,m_ash_f,area_f,m_HLW_e,m_ash_e,area_e

to

c_HLW,i ; c_ash,i ; m_HLW,f ; m_ash,f ; a_ash,f ; m_HLW,e ; m_ash,e ; a_ash,e

d. Update how data are read from the file due to these line changes above.

Attachment B

Description of Acceptance Test

All validation tests were performed with the following settings (unless otherwise noted):

- VolcanismDisruptiveScenarioFlag(yes=1,no=0) set to 1,
- DirectReleaseOnlyFlag(yes=1,no=0) set to 1,
- TimeOfNextVolcanicEventinRegionOfInterest[yr] set to a constant at 500.0,
- OutputMode(0=None,1=All,2=UserDefined) set to 1, and
- SelectAppendFiles set to 12.

Test 1a. (No initial deposit at receptor location, zero ash mass load)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ashremob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	1
AirborneMassLoadAboveFreshAshBlanketHeavyDisturbance[g/m3]	constant	0.0
AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3]	constant	0.0

Test Criteria: Check for error warning and look at output in *ashremob.out.* Test is passed if:
(1) If results are presented in *ashremob.out*, verify that **partmassloadeoli** does not increase with time and is positive (nonnegative and nonzero) at all time steps after the volcanic event. **PASSED**

Test 1b. (No initial deposit at receptor location, zero ash mass load, no erosion)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ashremob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	1
AirborneMassLoadAboveFreshAshBlanketHeavyDisturbance[g/m3]	constant	0.0
AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3]	constant	0.0
RelativeRateOfBlanketRemoval[1/yr]	–	0.0

Test Criteria: Test is passed if: (1) If results are presented in *ashremob.out*, verify that **partmassloadeoli** does not increase with time and is positive (nonnegative and nonzero) for all time steps after the volcanic event. **PASSED**

Test 1c. (Initial deposit at receptor location, zero ash mass load)

Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ashremob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	2
AirborneMassLoadAboveFreshAshBlanketHeavyDisturbance[g/m3]	constant	0.0
AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3]	constant	0.0

Test Criteria: Check for error warning and look at output in *ashremob.out.* Test is passed if error/warning regarding negative mass load contribution is presented for both heavy- and light-disturbance mass loads. If results are presented in *ashremob.out*, verify that **abnmassldinth**, **abnmassldintl**, and **partmassloadeoli** do not increase with time and are positive (nonnegative and nonzero) in all time steps. **PASSED**

Test 1d. (Initial deposit at receptor location, no soil mass load, no mass load reduction)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ashremob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	2
AirborneMassLoadOutsideHeavyDisturbance[g/m3]	–	0.0
AirborneMassLoadOutsideLightDisturbance[g/m3]	–	0.0
RateOfReductionOfMassLoadingFactor[1/yr]	–	0.0

Test Criteria: Look at output in *ashremob.out.* Test is passed if:
(1) **abnmassldinth** is zero for times before the volcanic event, and constant and equal to AirborneMassLoadAboveFreshAshBlanketHeavyDisturbance[g/m3] in all following time steps; **PASSED**
(2) **abnmassldintl** is constant in time and equals AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3] in all following time steps; **PASSED**

(3) **partmassloadeoli** is zero for times before the volcanic event, and constant and equal to AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3] in all following time steps. **PASSED**

Test 1e. (No initial deposit at receptor location, zero ash mass load)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ashremob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	2
AirborneMassLoadAboveFreshAshBlanketHeavyDisturbance[g/m3]	constant	0.0
AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3]	constant	0.0

Test Criteria: Check for error warning and look at output in *ashremob.out.* Test is passed if:
(1) **hlwgpm3inth** is decreasing with time after the volcanic event and **PASSED**
(2) **hlwgpm3intl** is decreasing with time after the volcanic event. **PASSED**

Test 1f. (No initial deposit at receptor location, zero ash mass load, no erosion)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ashremob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	2
AirborneMassLoadAboveFreshAshBlanketHeavyDisturbance[g/m3]	constant	0.0
AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3]	constant	0.0
RelativeRateOfBlanketRemoval[1/yr]	–	0.0

Test Criteria: Check for error warning and look at output in *ashremob.out.* Test is passed if:
(1) **hlwgpm3inth** is nonzero and constant with time after the volcanic event and **PASSED**
(2) **hlwgpm3intl** is nonzero and constant with time after the volcanic event. **PASSED**

Test 1g. (Initial deposit at receptor location, zero ash mass load)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ashremob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	2
AirborneMassLoadAboveFreshAshBlanketHeavyDisturbance[g/m3]	constant	0.0

Test Criteria: Check for error warning and look at output in *ashremob.out*. Test is passed if error/warning regarding negative mass load contribution is presented for heavy disturbance with no error/warning for light disturbance. If results are presented in *ashremob.out*, verify that **abnmassldinth**, **abnmassldintl**, and **partmassloadeoli** do not increase with time and are positive (nonnegative and nonzero) in all time steps.
PASSED

Test 1h. (Initial deposit at receptor location, zero ash mass load)
Input: See additional test inputs in the table below.

Parameter	Distribution for Test (if changed)	Value for Test
NumberOfRealizations	–	3
AshEvolutionMode[0=no_ashremob,1=ashremob]	–	1
AshPlumeRealizationIndex[]	iconstant	2
AirborneMassLoadAboveFreshAshBlanketLightDisturbance[g/m3]	constant	0.0

Test Criteria: Check for error warning and look at output in *ashremob.out.* Test is passed if error/warning regarding negative mass load contribution is presented for light disturbance with no error/warning for heavy disturbance. If results are presented in *ashremob.out*, verify that **abnmassldinth**, **abnmassldintl**, and **partmassloadeoli** do not increase with time and are positive (nonnegative and nonzero) in all time steps.
PASSED

SCR - 683

TPA 5.1/ Beta W

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 683	2. Software Title and Version: TPA 5.1betaW	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *ebsfail.f, dcagw.f,* and *dcags.f*

Use 'append' flag to control the generation of the header section of *failt.cum* in *ebsfail.f.*

5. Change Requested by: R. Janetzke	Date: 3-15-2007
6. Change Authorized by (*Software Developer*): R. Janetzke	Date: 3-15-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

In the *ebsfail.f* module: surrounded the writing of the *failt.cum* header with the same "if ... then" cluster that surrounds the writing of the *failt.cum* file. Additionally, the *dcags.f* and *dcagw.f* modules did not properly test for the numerical value of the "SelectAppendFiles" option in cases when the "OutputMode" flag was set to 1. This resulted in the *dcfgw.cum* file appearing whenever the "OutputMode" flag was set to 1 irrespective of what the value of the "SelectAppendFiles" option was set to.

See Appendix A for a diff comparisons of the *ebsfail.f, dcags.f,* and *dcagw.f* files before and after modification.

8. Implemented by: Jose M. Menchaca	Date: 3-21-2007

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*: In the file dcagw.f, a comment (at approximately line # 2601) says "*dcfgs.cum*" when it should say "*dcfgw.cum*". Otherwise, the visual inspection of the code changes passed.

Code review accomplished by: C. Scherer	Date: 6-1-2007

10. Description of Acceptance Tests:

Tests were carried out in accordance with the test plan tp_scr683.wpd (see attachment B), which also includes the test report. All tests passed. Test directories are archived on the CD entitled "TPA SCR #683 - Test Directories".

11. Tested by: C. Scherer	Date: 6-1-2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for *TPA.INP*

SCR 683

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
No Changes to tpa.inp parameters							

Attachment A

diff of the *ebsfail.f* file before and after modification:

```
/home/jmench/tpa51betaU{77}>diff -w ebsfail.f origs
101d100
< c         3-21-07   jmm SCR683 : suppress failt.cum header until proper append flags enabled.
1525,1530d1523
< cjmm SCR683 suppress failt.cum header until proper append flags enabled
< cjmm SCR683 relocated iappend_flag assignment to implement header writing test
<         iappend_flag = ivaluesp(iiappend_flag)
<         if ( iappend_flag .gt. 0) then
<           if ( iappend_flag .eq. 1 .or. iappend_flag .eq. 2) then
<             if (iselectappend .eq. 0 .or. iselectappend .eq. 15) then
1540,1543d1532
<             endif
<           endif
<         endif
< cjmm SCR683 end
1701,1703c1690
< cjmm SCR683 relocate assignment to before header writing section
< cjmm  iappend_flag = ivaluesp(iiappend_flag)
< cjmm SCR683 end
---
>       iappend_flag = ivaluesp(iiappend_flag)
```

diff of the *dcags.f* file before and after modification:

```
/home/jmench/tpa51betaU{78}>diff -w dcags.f origs
75d74
< c                 3-28-07 jmm; SCR683 append flag conformance
2564,2566d2562
< cjmm SCR683 Needed to bring dcfgs.cum into append flag conformance.
<            if (iselectappend .eq. 0 .or. iselectappend .eq. 20) then
< cjmm SCR683 end
2589d2584
< cjmm SCR683 Needed to bring dcfgs.cum into append flag conformance.
2591,2592d2585
< cjmm SCR683 end
<          endif
```

diff of the *dcagf.f* file before and after modification:

```
/home/jmench/tpa51betaU{79}>diff -w dcagf.f origs
diff: dcagf.f: No such file or directory
/home/jmench/tpa51betaU{80}>diff -w dcagw.f origs
60d59
< c    03-28-07 jmm SCR683; append flag conformance
2576,2578d2574
< cjmm SCR683 Needed to bring dcfgs.cum into append flag conformance.
<            if (iselectappend .eq. 0 .or. iselectappend .eq. 20) then
< cjmm SCR683 end
2601d2596
< cjmm SCR683 Needed to bring dcfgs.cum into append flag conformance.
2603,2604d2597
< cjmm SCR683 end
<          endif
/home/jmench/tpa51betaU{81}>
```

Attachment B

Test Plan/Report for TPA SCR #683

Test Plan Name: Test Changes to *dcags.f*, *dcagw.f*, and *ebsfail.f*, to Correct Errors Related to the Use of SelectAppendFile and OutputMode Parameters in *tpa.inp*.

Tested By: Carol S. Scherer

Date: June1, 2007

Host Machine: "**TPA**" 64-bit MS Windows

Host OS: Windows Server 2003, Standard x64 Edition, Service Pack1

Baseline Version: TPA 5.1betaW

Test Version: TPA 5.1betaX

Testing Setup:

Directories/paths used for testing:

$HOME = ***"TPA":d\cscherer\run2***

Path for run directory: **$HOME*tpa51betaW*** and **$HOME*tpa51betaX***

Environment variables:

For basecase:

TPA_TEST = **$HOME/*tpa51betaW***

TPA_DATA = **$HOME/*tpa51betaW***

For testcase:

TPA_TEST = **$HOME/*tpa51betaX***

TPA_DATA = **$HOME/*tpa51betaX***

Disposition of documentation of results: All modified/new source code files, all executables used in testing, and all input/output files are stored in the archive directories until the contents of the archive directories are onto a CD titled "*TPA SCR # 683 - Test Directories*" (attached).

Test preparation instructions:

1. In the directory **$HOME**, create the subdirectories ***tpa51betaW*** and ***tpa51betaX***.

2. Copy **TPA** version 5.1betaW to **$HOME/*tpa51betaW***.

3. Copy **TPA** version 5.1betaX to **$HOME/*tpa51betaX***..

Function Level Tests:

These tests are designed to demonstrate the functionality of the specified module.

1. Name: Test OutputMode = 1 and SelectAppendFiles = 15.

   Paths for archives of results: **Guardian:*d:\css\SCRs\SCR683-testruns\base-OM1AF15*** and **Guardian:*d:\css\SCRs\SCR683-testruns/test-OM1AF15*.**

   Special input files or modifications to input files required: none.

   Special diagnostic code modifications required: none.

   Program modes to be used: basecase *tpa.inp* for each version; set the following parameters:

   For both basecase and testcase:

OutputMode	1
SelectAppendFiles	15
VolcanismDisruptiveScenarioFlag	1
AshEvolutionMode	0

   Utility scripts needed to perform the test: none.

   Utility codes needed in the analysis of the test data: none.

   Test description:

   - objective: to verify that the code modifications disallow the generation of *dcfgw.cum* and *dcfgs.cum* when SelectAppendFiles is set to 15, which should only allow the generation of *failt.cum*

   - assumptions: all setup instructions have been carried out.

   - constraints: none.

   - output files to compare or examine:

   - step by step test procedure to be used:
     1. Execute the following command in the **$HOME*tpa51betaX*** directory: <%TPA_TEST%\tpa.exe > tpa_baseOM1AF15.out>. Copy output files to **Guardian:*d:\css\SCRs\SCR683-testruns\base-OM1AF15*.** Create a directory listing.

     2. Execute the following command in the tpa51betaX directory: <%TPA_TEST%\tpa.exe > tpa_testOM1AF15.out>. Copy output files to **Guardian:*d:\css\SCRs\SCR683-testruns\test-OM1AF15*..** Create a directory listing.

   - pass/fail criteria: the test passes if:

1. The code runs to completion.

2. *Failt.cum* appears in the directory listing for ***base-OM1AF15***, as well as *dcfgs.cum* and *dcfgw.cum*.

3. *Failt.cum* appears in the directory listing for ***test-OM1AF15***, but *dcfgs.cum* and *dcfgw.cum* do not.

Results of running test:

PASSED.

2. Name: Test OutputMode = 1 and SelectAppendFiles = 20.

   Paths for archives of results: **Guardian:*d:\css\SCRs\SCR683-testruns\base-OM1AF20*** and **Guardian:*d:\css\SCRs\SCR683-testruns/test-OM1AF20*.**

   Special input files or modifications to input files required: none.

   Special diagnostic code modifications required: none.

   Program modes to be used: basecase *tpa.inp* for each version; set the following parameters:

   For both basecase and testcase:

OutputMode	1
SelectAppendFiles	20
VolcanismDisruptiveScenarioFlag	1
AshEvolutionMode	0

   Utility scripts needed to perform the test: none.

   Utility codes needed in the analysis of the test data: none.

   Test description:

   - objective: to verify that the code modifications disallow the generation of *failt.cum* (containing only header information) when SelectAppendFiles is set to 20, which should only allow the generation of *dcfgs.cum* and *dcfgw.cum*

   - assumptions: all setup instructions have been carried out.

   - constraints: none.

   - output files to compare or examine:

   - step by step test procedure to be used:
     1. Execute the following command in the **$HOME*tpa51betaX*** directory: <%TPA_TEST%\tpa.exe > tpa_baseOM1AF20.out>. Copy output files to **Guardian:*d:\css\SCRs\SCR683-testruns\base-OM1AF20*.** Create a directory listing.

     2. Execute the following command in the tpa51betaX directory: <%TPA_TEST%\tpa.exe > tpa_testOM1AF20.out>. Copy output files to **Guardian:*d:\css\SCRs\SCR683-testruns\test-OM1AF20*..** Create a directory listing.

   - pass/fail criteria: the test passes if:

     1. The code runs to completion.

2. *Failt.cum* (containing only header information) appears in the directory listing for ***base-OM1AF20***, as well as *dcfgs.cum* and *dcfgw.cum*.

3. *Dcfgs.cum* and *dcfgw.cum* appear in the directory listing for ***test-OM1AF20***, but *failt.cum* does not.

Results of running test:

PASSED.

NOTES:

SCR - 684

TPA 5.1/ Beta T

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 684	2. Software Title and Version: TPA 5.1BetaT	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *dsfail.f. dsfailt.def*

In a letter from NRC, dated 7-27-2006, a request was made to increase the transparency and traceability of the input/output files. Specifically, input parameters should be located/identified in the input files to aid in traceability through the conceptual model calculations. Also, the format and content of the output files should ensure a user can reasonably comprehend the content without excessive recourse to the source code of other documentation.

Address failed test from SCR671.

5. Change Requested by: R. Janetzke	**Date:** 3-12-2007
6. Change Authorized by (*Software Developer*): R. Janetzke	**Date:** 3-12-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

The file *dsfail.f* has been modified to read the *dsfailt.def* input file and write the *dsfailt.inp* file with enhanced transparency of parameters and data.

See Appendix A for a diff comparisons of the *dsfail.f*, and the *dsfailt.def* files before and after modification.

8. Implemented by: J. Menchaca	**Date:** 3-13-2007

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

Code review accomplished by: J. Mancillas	**Date:** 5-11-2007

10. Description of Acceptance Tests:

See Attachment B

11. Tested by: J. Mancillas	**Date:** 5-11-2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for *TPA.INP*

SCR 684

Status (***ADD, DELETE, MODIFY TO, MODIFY FROM***)	**Module**	**Parameter Name**	**Description** (***Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.***)	**Distributio n**	**Range**	**Justification** ***1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.***	**Source**
No Changes to *tpa.inp* parameters							

Appendix A

diff of the dsfail.f file before and after modification:

```
diff dsfail.f origs
73d72
< c              03-12-07 jmm; scr684; reformat dsfailt.def
541,552d539
< cjmm SCR684 file format change
<       CHARACTER*100 line14
<       CHARACTER*100 line15
<       CHARACTER*100 line16
<       CHARACTER*100 line17
<       CHARACTER*100 line18
<       CHARACTER*100 line19
<       CHARACTER*100 line20
<       CHARACTER*100 line21
<       CHARACTER*100 line22
<       CHARACTER*100 line23
< cjmm SCR684 end
589d575
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
593,597c579
< cjmm SCR684
< cjmm &  line8, line9, line10, line11,line12,line13
<      &  line8, line9, line10, line11,line12,line13,line14,line15,line16,
<      & line17,line18, line19, line20,line21,line22,line23
< cjmm SCR684 end
---
>      &  line8, line9, line10, line11,line12,line13
653c635
< c   Build the 15 input file
---
> c   Build the dsfailt input file
660d641
< cjmm SCR684 file format changes
671,680c652
<       WRITE(iUnitFile, FMT='(A100)') line6
<       WRITE(iUnitFile, FMT='(A100)') line7
<       WRITE(iUnitFile, FMT='(A100)') line8
<       WRITE(iUnitFile, FMT='(A100)') line9
<       WRITE(iUnitFile, FMT='(A100)') line10
<       WRITE(iUnitFile, FMT='(A100)') line11
<       WRITE(iUnitFile, FMT='(A100)') line12
<       WRITE(iUnitFile, FMT='(A100)') line13
<       WRITE(iUnitFile, FMT='(A100)') line14
<       WRITE(iUnitFile, FMT='(A100)') line15
```

```
---
>
687,690c659,660
< cjmm  WRITE(iUnitFile, FMT='(A100)') line6
< cjmm  WRITE(iUnitFile, FMT='(A100)') line7
<       WRITE(iUnitFile, FMT='(A100)') line16
<       WRITE(iUnitFile, FMT='(A100)') line17
---
>       WRITE(iUnitFile, FMT='(A100)') line6
>       WRITE(iUnitFile, FMT='(A100)') line7
696,697c666
< cjmm  WRITE(line8(1:18), FMT = '(1PE15.5, 3x)') dripShieldCorrosionRate
<       WRITE(line18(1:24), FMT = '(1PE24.5)') dripShieldCorrosionRate
---
>       WRITE(line8(1:18), FMT = '(1PE15.5, 3x)') dripShieldCorrosionRate
700,701c669
<       WRITE(iUnitFile, FMT='(A100)') line18
< cjmm SCR684 end
---
>       WRITE(iUnitFile, FMT='(A100)') line8
712,715c680
< cjmm  WRITE(line9(1:18), FMT = '(1PE15.5, 3x)') drip_shield_thickness*ds
< cjmm &penetration
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
<       WRITE(line19(1:24), FMT = '(1PE24.5)') drip_shield_thickness*ds
---
>       WRITE(line9(1:18), FMT = '(1PE15.5, 3x)') drip_shield_thickness*ds
720c685
<       WRITE(iUnitFile, FMT='(A100)') line19
---
>       WRITE(iUnitFile, FMT='(A100)') line9
727,728c692
< cjmm  WRITE(iUnitFile, FMT='(A100)') line10
<       WRITE(iUnitFile, FMT='(A100)') line20
---
>       WRITE(iUnitFile, FMT='(A100)') line10
735,736c699
< cjmm  WRITE(iUnitFile, FMT='(A100)') line11
<       WRITE(iUnitFile, FMT='(A100)') line21
---
>       WRITE(iUnitFile, FMT='(A100)') line11
744,745c707
< cjmm  WRITE(iUnitFile, FMT='(A100)') line12
<       WRITE(iUnitFile, FMT='(A100)') line22
---
>       WRITE(iUnitFile, FMT='(A100)') line12
753,755c715
< cjmm  WRITE(iUnitFile, FMT='(A100)') line13
```

```
<       WRITE(iUnitFile, FMT='(A100)') line23
< cjmm SCR684 end
---
>       WRITE(iUnitFile, FMT='(A100)') line13
875,886d834
< cjmm SCR684 file format change
<       CHARACTER*100 line14
<       CHARACTER*100 line15
<       CHARACTER*100 line16
<       CHARACTER*100 line17
<       CHARACTER*100 line18
<       CHARACTER*100 line19
<       CHARACTER*100 line20
<       CHARACTER*100 line21
<       CHARACTER*100 line22
<       CHARACTER*100 line23
< cjmm SCR684 end
910,914c858
< cjmm SCR684
< cjmm &  line8, line9, line10, line11,line12,line13
<      &  line8, line9, line10, line11,line12,line13,line14,line15,line16,
<      & line17,line18, line19, line20,line21,line22,line23
< cjmm SCR684 end
---
>      &  line8, line9, line10, line11,line12,line13
949,950c893
< cjmm SCR684 Read 15 lines of header, description and blank lines
< cjmmc SCR671 J. Mancillas 12-11-06 file format changes
---
> c SCR671 J. Mancillas 12-11-06 file format changes
957,965d899
<       READ(iUnitInput, FMT = '(A100)') line7
<       READ(iUnitInput, FMT = '(A100)') line8
<       READ(iUnitInput, FMT = '(A100)') line9
<       READ(iUnitInput, FMT = '(A100)') line10
<       READ(iUnitInput, FMT = '(A100)') line11
<       READ(iUnitInput, FMT = '(A100)') line12
<       READ(iUnitInput, FMT = '(A100)') line13
<       READ(iUnitInput, FMT = '(A100)') line14
<       READ(iUnitInput, FMT = '(A100)') line15
969,971d902
< cjmm  SCR684
<       READ(iUnitInput, FMT = '(A100)') line16
< cjmm  SCR684 end
979,982c910
< cjmm  SCR684
< cjmm  READ(iUnitInput, FMT = '(A100)') line7
<       READ(iUnitInput, FMT = '(A100)') line17
```

```
< cjmm  SCR684 end
---
>       READ(iUnitInput, FMT = '(A100)') line7
996,1009c924,929
< cjmm  SCR684
< cjmm  READ(iUnitInput, FMT = '(A100)') line8
< cjmm  READ(iUnitInput, FMT = '(A100)') line9
< cjmm  READ(iUnitInput, FMT = '(A100)') line10
< cjmm  READ(iUnitInput, FMT = '(A100)') line11
< cjmm  READ(iUnitInput, FMT = '(A100)') line12
< cjmm  READ(iUnitInput, FMT = '(A100)') line13
<       READ(iUnitInput, FMT = '(A100)') line18
<       READ(iUnitInput, FMT = '(A100)') line19
<       READ(iUnitInput, FMT = '(A100)') line20
<       READ(iUnitInput, FMT = '(A100)') line21
<       READ(iUnitInput, FMT = '(A100)') line22
<       READ(iUnitInput, FMT = '(A100)') line23
< cjmm  SCR684 end
---
>       READ(iUnitInput, FMT = '(A100)') line8
>       READ(iUnitInput, FMT = '(A100)') line9
>       READ(iUnitInput, FMT = '(A100)') line10
>       READ(iUnitInput, FMT = '(A100)') line11
>       READ(iUnitInput, FMT = '(A100)') line12
>       READ(iUnitInput, FMT = '(A100)') line13
```

diff of the dsfailt.def file before and after modification:

```
diff dsfailt.def origs
4d3
< !
6,14d4
< !
< ! Item 1 fileIn, Input data file, fluoride concentration versus time
< ! Item 2 fileOut, Output data file 1, tracking thickness of the drip shield vs time
< ! Item 3 CorrRate, m/yr, drip shield corrosion rate : DSCorrRate[m/yr]
< ! Item 4 DSThick, m, drip shield thickness : DripShieldThickness[m]
< ! Item 5 slope, dimensionless, slope of drip shield enhancing factor
< ! Item 6 minF, M, minimum fluoride concentration affecting the DS corrosion rate, [mol/L]
< ! Item 7 maxF, M, maximum fluoride concentration affecting the DS corrosion rate, [mol/L]
< ! Item 8 FluorideEnh, (0 or 1). 0 : no fluoride enhancing, 1: fluoride enhancing.
16,23c6,14
<           'fluoride.dat' ! fileIn
<            'dsfailt.dat' ! fileOut
<                  8.6e-08 ! CorrRate [m/yr]
<                    0.015 ! DSThick [m]
<                     2.84 ! slope
<                  1.0e-04 ! minF [mol/L]
<                  2.0e-03 ! maxF [mol/L]
<                        0 ! FluorideEnh
---
>  'fluoride.dat'   ! fileIn, Input data file, fluoride concentration versus time
>   'dsfailt.dat'   ! fileOut, Output data file 1, tracking thickness of the drip shield vs time
>         8.6e-08   ! CorrRate, m/yr, drip shield corrosion rate : DSCorrRate[m/yr]
>           0.015   ! DSThick, m, drip shield thickness : DripShieldThickness[m]
>            2.84   ! slope, dimensionless, slope of drip shield enhancing factor
>         1.0e-04   ! minF, M, minimum fluoride concentration affecting the DS corrosion rate
>         2.0e-03   ! maxF, M, maximum fluoride concentration affecting the DS corrosion rate
>               0   ! FluorideEnh, (0 or 1). 0 : no fluoride enhancing, 1: fluoride enhancing.
>
```

Attachment B
Test Plan for TPA SCR684

Test Plan Name: File Format Test for SCR684

Tested By: James Mancillas Date: 11 May 2007

Host Machine: Manta Host OS: Windows XP SP2

Baseline Version: TPA51betaT Test Version: TPA51betaX

Process Level (PL) Tests

PL-1. Name: Verify *dsfail.inp* and *dsfail.def* file formats.

Path for run directory:

Baseline Version : [Manta] D:\SCR684\runT
Test Version : [Manta] D:\SCR684\runX

Path for archive of results:

Baseline Version : [CD Titled: SCR684 Testing]:\SCR684\runT
Test Version : [CD Titled: SCR684 Testing]:\SCR684\runX

Environment variables:

Baseline Version TPA_DATA=..\tpa51betaT
TPA_TEST=..\tpa51betaT

Test Version TPA_DATA=..\tpa51betaX
TPA_TEST=..\tpa51betaX

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): NONE

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: NONE

Test description:

- **objective** Verify that the format for the files *dsfail.def* and *dsfail.inp* conform to the format described in the NRC letter dated 7-27-2006, requesting an increase in transparency and traceability of the input/output files.

- **assumptions** None, other than those made within the TPA code.

- **constraints** None

- **output files to compare or examine** Compare the format of the *dsfail.def* data file, the *dsfail.inp* input data file and the output file *dsfail.dat*.

- **step by step test procedure to be used**
  1) Perform a single mean value case realization of the baseline version of the TPA code for subarea one.
  2) Perform a single mean value case realization of the test version of the TPA code for subarea one.
  3) Examine the dsfail.def and dsfail.inp file formats to ensure they comply with the format specified by the NRC.
  4) Examine the output of DSFAIL

- **pass fail criteria**
  1) The format of dsfail.def and dsfail.inp comply with the request of the NRC.
  2) The operation of DSFAIL should be unaffected by the file format change.

Test Results:

- criterion 1

The following text is an excerpt of the test version of the TPA code *dsfail.def* and *dsfail.inp* data files.

\testx*dsfail.def*

```
*******************************************************************************
! dsfailt.def
!
! PURPOSE:
! This file is the input file for module DSFAILT and is rewritten by
! DSFAIL for each subarea and realization.  It contains the file names
! for the fluoride concentration data and DS thickness vs. time data
! and other parameters relevant to DS corrosion.
!
! HISTORY:
! This file format was first used with TPA 5.1betaV'
!
! 3-03-07; J. M. Menchaca; Reformatted
! 4-12-07; R. Janetzke; Add repository closure time
!
! SECTION 1
!
! Item 1: fileIn; Name of data file containing fluoride concentration versus time
! Item 2: fileOut; Name of output file containing thickness of the drip shield vs time
! Item 3: CorrRate; Drip shield corrosion rate in meters per year
! Item 4: DSThick; Drip shield thickness in meters
! Item 5: slope; Slope of drip shield enhancing factor (unitless)
! Item 6: minF; Minimum fluoride concentration affecting the DS corrosion rate in moles per liter
! Item 7: maxF; Maximum fluoride concentration affecting the DS corrosion rate in moles per liter
! Item 8: FluorideEnh; Fluoride enhancing control flag, 0=>no fluoride enhancing, 1=>fluoride enhancing.
! Item 9: closure; Repository closure time in years of simulation

          'fluoride.dat' ! fileIn
           'dsfailt.dat' ! fileOut
                 8.6e-08 ! CorrRate [m/yr]
                   0.015 ! DSThick [m]
                    2.84 ! slope
                 1.0e-04 ! minF [mol/L]
```

```
                2.0e-03 ! maxF [mol/L]
                      0 ! FluorideEnh
                   100. ! closure [yr]
*******************************************************************************
```

The following text is an excerpt of the test version of the TPA code *dsfail.inp*.
\testx*dsfail.inp*

```
*******************************************************************************
!! dsfailt.inp
!!
!! PURPOSE:
!! This file is the input file for module DSFAILT and is rewritten by
!! DSFAIL for each subarea and realization.  It contains the file names
!! for the fluoride concentration data and DS thickness vs. time data
!! and other parameters relevant to DS corrosion.
!!
!! HISTORY:
!! This file format was first used with TPA 5.1betaV'
!!
!! 3-03-07; J. M. Menchaca; Reformatted
!! 4-12-07; R. Janetzke; Add repository closure time
!!
!! SECTION 1
!!
!! Item 1: fileIn; Name of data file containing fluoride concentration versus time
!! Item 2: fileOut; Name of output file containing thickness of the drip shield vs time
!! Item 3: CorrRate; Drip shield corrosion rate in meters per year
!! Item 4: DSThick; Drip shield thickness in meters
!! Item 5: slope; Slope of drip shield enhancing factor (unitless)
!! Item 6: minF; Minimum fluoride concentration affecting the DS corrosion rate in moles per liter
!! Item 7: maxF; Maximum fluoride concentration affecting the DS corrosion rate in moles per liter
!! Item 8: FluorideEnh; Fluoride enhancing control flag, 0=>no fluoride enhancing, 1=>fluoride enhan
!! Item 9: closure; Repository closure time in years of simulation

       'fluoride.dat   ' ! fileIn
       'dsfailt.dat    ' ! fileOut
             1.56246E-07 ! CorrRate [m/yr]
             1.50000E-02 ! DSThick [m]
                    2.84 ! slope
                 1.0e-04 ! minF [mol/L]
                 2.0e-03 ! maxF [mol/L]
```

```
                    0 ! FluorideEnh
          1.00000E+02 ! closure [yr]
*******************************************************************************
```

The format of these files is consistent with the format requested to improve transparency of the TPA code. These results are submitted as evidence that SCR684 has been successfully implemented.

- criterion 2

The operation of the DSFAIL module should be unaffected by the change in the input file format. To confirm this the TPA code was run with the mean value case for subarea one and for one realization using both versions of the TPA code. A comparison was made of the input and output data to and from (*dsfail.inp, dsfail.dat*) the DSFAIL module for the baseline and test versions of the TPA code. The comparison showed that the DSFAIL module in the test version of the TPA code generated the same results as the basline version, given the same input values in *dsfail.inp*. The results of this test have been saved in the directories SCR684\testT and SCR684\testX. These results are presented as evidence that SCR684 has been properly implemented.

- overall test status : **PASS**

Subject: spquery & flags, etc.
From: Carol Scherer <cscherer@cnwra.swri.edu>
Date: Thu, 10 May 2007 18:09:28 -0500
To: 'Ron Janetzke' <rjanetzke@cnwra.swri.edu>

1) With version X, setting OneTemperatureCellPerWP does NOT bomb. However, it took about 3.5 hours to run 1 realization at 10,000 years.

2) The code bombs if IrreversibleColloidModel is set to 0, InvertBypass is set to 0, and InvertMatrixPermeability is set to 7.0, which is what Rob and I do when we want to ensure that Invert is not bypassed. The usual number is 7.0e-18. I don't know how how big I could make that number and still have the code run. Let me know if you want me to pursue it.

3) I'll rerun FT1 tomorrow without the flags mentioned in 2). That ought to give me all the files and let me figure out if all parameters are used. I'll let you know as soon as I have those results.

Carol S. Scherer
Bldg. 189, Rm. 242, ext. 6840
cell: 355-2900

SCR - 685

TPA 5.1/ Beta V

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 685	2. Software Title and Version: TPA 5.1betaV	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f, tpa.inp, uzft.f, ebsrel.f, releaset.f, dsfail.f, dsfailt.f, exece.i, faulto.f, climato1.dat, climato2.dat, wpflow.def,* and *tpanames.dat.*

1-6) See contents of e-mail from J. Winterle dated 4-5-07 in attachment A.
7) Fix RELEASET read of glass waste package temperature. (***Part 1***)
8) Drip shield thickness decreases before DS emplacement. (***Part 1***)
9) Change *pkmndose.res* file header to reflect correct file name. (***Part 1***)
10) Scrub *tpa.inp* for unused parameters. (***Part 2***)
11) Update invert thickness. See Attachment N for email request from D. Pickett.(***Part 2***)
12) Seepage correction for localized corrosion in *ebsrel.f.*(***Part 2***)
13) Insert glossary into *faulto.f*, and update *climato*.dat* file headers and climate initial value parameters.(***Part 2***)
14) Rename groundwater protection files and fix multiple realization averages.(***Part 2***)

5. Change Requested by: J. Winterle	Date: 3-19-2007
6. Change Authorized by (*Software Developer*): R. Janetzke	Date: 3-20-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):
1) Changes implemented as described in Attachment A.
2) No changes made, since request was rescinded after the contents of the file were clarified.
3) Changes implemented as described in Attachment A.
4) See Attachment F
5) See Attachment G
6) File *wpsfail.res* was renamed a debug file, *wpsfail.dbg*, and *wpsfail2.res* was renamed a result file, *wpsfail.res*, since it contained more information than the original file of the same name. In addition the resulting file *wpsfail.res* was reformatted for transparency. See Attachment H for a display of the new format.
7) See Attachment I
8) See Attachments J, K, and L
9) See Attachment M for *pkmndose.res* file header.
10) Removed **GapFractionForPU242** parameter from *tpa.inp*.
11) **InvertThickness[m]** changed to 0.86.
12) See Attachment O
13) See Attachment E
14) See Attachment P

8. Implemented by: R. Rice, R. Janetzke, C. Scherer	Date: 4-17-07 (Part 1) 5-09-07 (Part 2)

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐

(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).

Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

Visual inspection of **TPA** 5.1betaX files was used to verify code modifications for 3, 11, & 13. The file *tpanames.dat* (in the data subdirectory) was examined to verify that the 4 parameter abbreviations were modified as specified in Attachment A. The parameter **InvertThickness[m]** in *tpa.inp* was examined to verify that the value was changed as described. The glossary in *faulto.f,* and changes to *tpa.inp, climato1.dat,* and *climato2.dat* were updated as shown in Attachment E. Code modifications for item 10 were verified in **TPA** 5.1betaY. **GapFractionForPU242** was commented out in *tpa.inp*. The visual inspection tests for 3, 10, 11, & 13 all **PASSED**.

Code review accomplished by:	**Date:**
C. Scherer Carol S. Scherer	5-25-07

10. Description of Acceptance Tests:

Attachment B = 4 & 9 Winterle
Attachment C = 1 & 8 Adams
Attachment D = 5 Mancillas
Attachment Q = 7 Pensado
Attachment R = 6 & 14 Menchaca
Attachment S = 12 Pensado

11. Tested by:	**Date:**
O. Pensado J. Winterle G. Adams J. Mancillas C. Scherer J. M. Menchaca	5-22-07

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for *TPA.INP*

SCR 685

Status (***ADD, DELETE, MODIFY TO, MODIFY FROM***)	**Module**	**Parameter Name**	**Description** (***Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.***)	**Distribution**	**Range**	**Justification** ***1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.***	**Source**
MODIFY FROM	EBSFILT	InvertThickness[m]	Invert thickness	Constant	0.606		
MODIFY TO	EBSFILT	InvertThickness[m]	Invert thickness	Constant	0.86	Maximum thickness of the invert, according to Bechtel SAIC Company, LLC. "EBS Radionuclide Transport Abstraction." ANL-WIS-PA-000001 Rev 02. Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2005. p 6-175.	
DELETE	EBSREL	GapFractionForPU242	Gap Fraction for Plutonium 242	Constant	0.0		

Attachment A

1. Request from Goodluck. Please change values of the following parameters:
RockMassDensityForRockTypeOne = 2,068
RockMassDensityForRockTypeTwo = 2,245 (***Part 1***)

2. Request from Winterle. In the ebsflo.dat output file, the last line of the header information does not print until the end of the first line of data. This could cause problems with data processing scripts. Also, after the third column, I'm not sure the values for the remaining columns have correct values (e.g., columns for fow and sawet report values of 1.0 for every time step, but I know that the sampled value for SubareaWetFraction was not 1.0). If columns 4 thru 11 are not used, perhaps we should delete them. (***Rescinded after clarification of file contents***)

3. Request from Chris Grossman and Richard Codell. There are some erroneous parameter abbreviations in the *data/tpanames.dat* file. Specifically, element abbreviation for Tin is Sn, not Tn; and the abbreviation for strontium is Sr, not Sn. The following lines in *tpanames.dat* should be updated accordingly:

KdOfTinInVolcanicAsh[cm3/g] VA-Kd-Tn ---------> should be VA-Kd-Sn
KdOfStrontiumInVolcanicAsh[cm3/g] VA-Kd-Sn ---------> should be VA-Kd-Sr
SolubilityOfTinInVolcanicAsh[moles/liter] VA-Sl-Tn ---------> should be VA-Sl-Sn
SolubilityOfStrontiumInVolcanicAsh[moles/liter] VA-Sl-Sn ---------> should be VA-Sl-Sr (***Part 2***)

4. Request from Jim Winterle and Chris Grossman. The UZFT module does not apply colloid filtration for the matrix bypass fraction (see variable "fracturefraction" in uzft.f) that does not go through a UZ matrix layer. Need to apply PermanentLossColloidFilterFactor_CHnv[] as the default for the fraction of flow that does not go through a UZ matrix layer. Technical justification is that all flow in the SZ at some point must pass through the Calico Hills unit. Need to exercise care that the permanent loss colloid filtration factor is only applied to J-Species. (***Part 1***)

5. Request from Scott Painter and David Pickett. There is an error in the EBSREL model for competition of aqueous species for irreversible sorption to colloids. Apparently a calculation that should have the element concentration is instead using concentration of individual nuclide species. (***Part 1***)

6. Request identified by Jack Gwo and Osvaldo Pensado. It is confusing as to what the differences are in content between *wpsfail.res* and *wpsfail2.res* files. The header information should be improved for transparency. Additionally, only one of these files should be named with a ".res" extension; the other file should be either eliminated, or changed to a ".out" file. Additionally, the files *wpsfail.res* and *wpsfail2.res* do not have complete information for the last realization; they include only one line of information and no more. (***Part 2***)

ATTACHMENT B

Test 4: Colloid Filtration for "UZ Bypass Fraction"

Tested by: James Winterle

Test 4: Procedure

The purpose of this test is to make sure that the colloid filtration factor for the CHv layer is applied the "bypass fraction" for subarea realizations in which no matrix layer can handle all of the flow. The following steps were applied for this test.

1. Changed to run only subarea 1 by setting the following values

```
iconstant
StartAtSubarea
1
**
iconstant
StopAtSubarea
1
```

2. Set initial defective fraction to 1.0 to ensure there would be some releases.

```
constant
DefectiveFractionOfWPs/cell
1.0
```

3. Set thickness of Calico Hills vitric unit for subarea 1 to constant of 10 m to make sure a zero thickness did not get sampled. Also set BFw and UFZ thicknesses from zero to 10 m so that all layers have no-zero thickness.

```
constant
CHnvThickness_1SubArea[m]
10
**
constant
CH_Total_Thickness_1SubArea[m]
108.0
**
**
constant
PPw_Thickness_1SubArea[m]
43.1
**
constant
UCF_Thickness_1SubArea[m]
44.8
**
constant
BFw_Thickness_1SubArea[m]
10.0
**
constant
UFZ_Thickness_1SubArea[m]
10.0
```

4. Set filtration factors for each layer to values that are significantly different from each other to facilitate being able to tell which value was used by looking at results for colloids released from the EBS versus colloids that leave the UZ.

```
constant
```

```
PermanentLossColloidFilterFactor_TSw_[]
0.1
**
constant
PermanentLossColloidFilterFactor_CHnv[]
0.2
**
constant
PermanentLossColloidFilterFactor_CHnz[]
0.3
**
constant
PermanentLossColloidFilterFactor_PPw_[]
0.4
**
constant
PermanentLossColloidFilterFactor_UCF_[]
0.5
**
constant
PermanentLossColloidFilterFactor_BFw_[]
0.6
**
constant
PermanentLossColloidFilterFactor_UFZ_[]
0.7
```

5. Set Output Mode to Append all files.

```
iconstant
OutputMode(0=None,1=All,2=UserDefined)
1
```

6. Set the matrix permeability values for all layers to very low values such that effectively all (i.e., at least 99 percent) releases will be sent to the bypass fraction.

```
constant
MatrixPermeability_TSw_[m2]
1e-19
**
constant
MatrixPermeability_CHnv[m2]
1e-19
**
constant
MatrixPermeability_CHnz[m2]
1e-19
**
constant
MatrixPermeability_PPw_[m2]
1e-19
**
constant
MatrixPermeability_UCF_[m2]
1e-19
**
constant
MatrixPermeability_BFw_[m2]
1e-19
**
constant
MatrixPermeability_UFZ_[m2]
1e-19
**
```

7. Run TPA code and capture screen print in *tpa.out*. The screen print can be used to ensure nearly all source release is bypassing the UZ by comparing "Highest Release Rate from Sub Area 1" and "Highest Release Rate from UZ" and to make sure release rates [Ci/yr] for the non-colloids species released from the UZ are at least 99 percent of the Subarea release, and also making sure the times of peak releases are identical to four significant figures. The following excerpt from *tpa.out* output was obtained, demonstrating that this was achieved.

```
                Highest release rates from Sub Area 1
            Am241   2.0528E-01 [Ci/yr/SA] at  1.723E+03 yr
            Tc99    1.3680E-01 [Ci/yr/SA] at  2.094E+03 yr
            Am243   4.8989E-02 [Ci/yr/SA] at  5.564E+03 yr
            Ni59    1.0607E-02 [Ci/yr/SA] at  3.635E+03 yr
            Cs135   3.1049E-03 [Ci/yr/SA] at  3.076E+03 yr
            Ja241   1.8928E-03 [Ci/yr/SA] at  1.723E+03 yr
exec: calling uzft
                    Highest release rates from UZ
            Am241   2.0323E-01 [Ci/yr/SA] at  1.723E+03 yr
            Tc99    1.3556E-01 [Ci/yr/SA] at  2.602E+03 yr
            Am243   4.8615E-02 [Ci/yr/SA] at  5.564E+03 yr
            Ni59    1.0522E-02 [Ci/yr/SA] at  3.635E+03 yr
            Cs135   3.0790E-03 [Ci/yr/SA] at  3.076E+03 yr
            Ja241   1.4991E-03 [Ci/yr/SA] at  1.723E+03 yr
```

From the above numbers, the ratio of UZ to Subarea releases for non-colloids such as Tc99 and Cs135 is 0.991, which is greater than 99 percent bypassing the UZ. It can also be seen that the peak release times are identical.

8. Compare the colloid release rates reported in the *nefiisz.src* (output from the UZ is the source for the SZ) and *ebscld.out* files to make calculate the colloid filtration that was applied. The change implemented in SCR 685 was that the colloid filtration factor for the CHv layer should be applied to the bypass fraction. Based on the values used in *tpa.inp* for this test, 20 percent of the colloids that were bypassed should be removed from filtration. For simplification purposes, it is assumed, based on the information developed from step 7, that the bypass fraction is 0.991. The filtration factor for the bypass fraction was calculated in a spreadsheet named *SCR685_Test4.xls*. The filtration factor was calculated as 1-(UZ Release)/(EBS Release*0.991).

Test 4: Pass/Fail Criteria

Based on the input data provided, the colloid filtration factor applied to the UZ bypass fraction should be very close to 0.2. This number may not be exact as the fraction of bypass changes slightly during the simulation as the infiltration rate increases and the UZ release at later times may include a small fraction of mass that was transported in the UZ. Values between 0.195 and 0.205 would generally indicated that the appropriate filtration is being applied to the bypass fraction.

Test 4: Results

Briefly, the results obtained were as described in the above PASS/FAIL Criteria. The results contained in the spreadsheet *SCR685_Test4.xls* indicate that all of the calculated filtration fractions were between 0.199 and 0.201. Indicating that the desired 20 percent of colloids were being removed from the bypass fraction.

Test 4: Status (PASS/FAIL): PASS.

Test 9: Correction to *pkmndose.res* file header

Tested by: James Winterle

Test 9: Procedure

The procedure for this test is simply to run TPA Version 5.1BetaW for a single subarea and single realization and visually inspect the *pkmndose.res* output file to ensure the information is correct. The error in the previous code version was that this file had the wrong title at the top: it erroneously was `totdos.res`.

Test 9: Pass/Fail Criteria
Corrected output file should say `pkmndose.res` at the top line of the file

Test 9: Results
Following is the header content of the *pkmndose.res* file.

```
!! pkmndose.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1betaW Code.

!!  Validation nominal scenario reference case.

!! Created by: TPA 5.1betaW
!! Module: EXEC
!! Job started: Fri Apr 20 15:24:29 2007
!!
!! PURPOSE:
!!
!!
!! Dose value for each realization at the time of peak mean
!! dose
!!
!! SECTION 1
!!
!! Realization = realization number
!! Time = Time of peak dose over all realizations in years
!! TEDE = peak total effective dose equivalent for the given
!!        realization in rem per year
```

Test 9: Status (PASS/FAIL): PASS

Attachment C

Code Review for item #1
The following rock mass density is used in the thermal calculations:

For *tpa.inp*,

```
constant
MassDensityofYMRock[kg/m^3]
2540.0
```

Validation team should consider consistency between the mass density value used for the thermal calculations and the mass density values for the MECHFAIL module.

Acceptance Tests for #1 and #8

For test #1, TPA version 5.1BetaW was run on Machine GOLDSIM. A base case version was run for subarea 3 only. Files *tpa.inp* and *driftfail.inp* were reviewed for the rock mass density values.

For *tpa.inp*,

```
**
** rwj 4-17-07 scr685
constant
RockMassDensityForRockTypeOne[kg/m^3]
2068.0
**2250.0
**
constant
RockMassDensityForRockTypeTwo[kg/m^3]
2245.0
**2250.0
** end scr685
**
```

For *driftfail.inp*, items 16 and 17 show the required values were obtained.

```
2.06800E+03  ! Item 16: RockMassDensityForRockTypeOne[kg/m^3]

2.24500E+03  ! Item 17: RockMassDensityForRockTypeTwo[kg/m^3]
```

For test #8, TPA version 5.1BetaW was run on Machine GOLDSIM. Three cases were considered. All three cases were for subarea 3 only. A base case was run, a case with 0.0 m drip shield thickness, and a case with 0.013 m drip shield thickness.

Files *dsfail.rlt, mechfail_ds.inp*, and *mechfail_wp.inp* were examined for drip shield thickness versus time. The drip shield thickness remained at the initial thickness value for the period prior to repository closure in all three cases.

Attachment D

Test Plan for TPA SCR685 Test 5

Test Plan Name: Test EBSREL competitive colloid model

Tested By: James Mancillas Date: 24 April 2007

Host Machine: Manta Host OS: Windows XP (SP2)

Baseline Version: TPA51BetaV Test Version: TPA51BetaW

Process Level (PL) Tests

PL-1. Name: Verify ratio of colloids to aqueous release of elemental isotopes.

Path for run directory:

Baseline Version: [Manta] D:\SCR685\test5\testv
Test Version: [Manta] D:\SCR685\test5\testw

Path for archive of results:

Baseline Version CD [titled : SCR685 Testing]\test5\testv
Test Version CD [titled : SCR685 Testing]\test5\testw

Environment variables:

Baseline Version: TPA_DATA=..\..\tpa51betaV
TPA_TEST=..\..tpa51betaV

Test Version: TPA_DATA=..\..\tpa51betaW
TPA_TEST=..\..\tpa51betaW

Special input files or modifications to input files required : NONE

Special diagnostic code modifications required : NONE

Program modes to be used (append flags, scenario/model switches, etc.): Append All

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: MS Excel

Test description: EBSREL has been modified to correct an error in the colloid competitive model. The model was corrected to account for the total elemental availability for colloid formation when evaluating the contribution from individual isotopes.

- objective Verify that the isotopic fraction of colloids for each element (which generates colloids) is the same for each isotope of an element.

- assumptions None, other than those made within the TPA code.

- constraints NONE

- output files to compare or examine *ebsrel.rlt*

- step by step test procedure to be used

1) Perform a reference case realization for subarea 1, with the baseline and test versions of the TPA code, appending all files and setting an initial failure to ensure RN releases.

2) Examine the file *ebsrel.rlt* from the baseline and test versions of the TPA code.

- pass fail criteria

1) The TPA code should properly execute under the test conditions.
2) The ratio of J species to aqueous species should be the same for each isotope of an element.

Test Results:

- criterion 1 evidence

The TPA versions tpa51betaV and tpa51betaW both successfully executed under the test conditions. The input files for the baseline and test versions are archived to CD, \SCR685\test5\testv*tpa.inp* and SCR685\test5\testw*tpa.inp* and the outputs are archived to CD, SCR685\test5\testv*out* and SCR685\test5\testw*out*, respectively.
These files are presented as evidence that SCR685 test 5 was successfully tested.

- criterion 2 evidence

The ratio of J species to aqueous species: Jc245/Cm245, Jc246/Cm246, Ja241/Am241, Ja243/Am243 and Jp239/Pu239, Jp240/Pu240 were verified in the test version of the code to be correct. Jc245/Cm245 equals Jc246/Cm246, Ja241/Am241 equals Ja243/Am243, and Jp239/Pu239 equals Jp240/Pu240. In the baseline version of the TPA code this isotopic ratio is not maintained, most obviously in the examination of the Ja241/Am241 and Ja243/Am243 ratios. A summary of these examinations is in the MS excel worksheet SCR685\test5*colloid_fractions.xls* on the archived results CD. These results and files are presented as evidence that SCR685 test 5 was successfully tested.

- overall test status (**PASS/FAIL**): **PASS**

Note: The precision of results in *ebsrel.rlt* is set to 4 decimal places, thus the results of these evaluations are limited to a relative precision of about 0.1%. Further, it is noted that these results have verified these ratios on a case by case basis, and that care should be taken when evaluating the ensemble averages of these ratio calculations.

Attachment E

Glossary text for *faulto.f* from P. Dubreuilh:

```
c    adisp =           Generic fault displacement
c    alength =         Fault length
c    alengthinsa =     Length of the intersection of a fault in a subarea
c    anedisp =         Northeast-striking fault displacement
c    anel =            Northeast-striking fault length
c    aneorient =       Northeast-striking fault orientation
c    anerate =         Northeast-striking fault displacement rate
c    anew =            Northeast-striking fault width
c    angle =           Angle of a fault orientation or strike measured from North clockwise
c    anwdisp =         Northwest-striking fault displacement
c    anwl =            Northwest-striking fault length
c    anworient =       Northwest-striking fault orientation
c    anwrate =         Northwest-striking fault displacement rate
c    anww =            Northwest-striking fault width
c    arate =           Generic fault displacement rate
c    area =            Surface of a subarea
c    fracfail =                Areal fraction of subarea intersected by a fault
c    fracfailinitial =         Initial areal fraction of subarea intersected by a fault, set at 0
c    i =               Integer loop index
c    idoloop =         Integer loop index
c    iflaglhit =       Flag index used in calculation of time of failure while comparing
displacement to threshold
c    iforient =                Randomly-generated value to determine fault orientation compared to
the NW fault occurrence probability
c    ikey =            Fixed arbitrary value for a test condition
c    inedisp =         Displacement of a Northeast-striking fault
c    inel =            Length of a Northeast-striking fault
c    ineorient =       Orientation of a Northeast-striking fault
c    inew =            Width of a Northeast-striking fault
c    inw =             Key, part of a test to determine orientation of a fault
c    inwdisp =         Displacement of a Northwest-striking fault
c    inwl =            Length of a Northwest-striking fault
c    inworient =       Orientation of a Northwest-striking fault
c    inerate =         Displacement rate of a Northeast-striking fault (Note: was missing in the c
- listed glossary list in fault.f file)
c    inwrate =         Displacement rate of a Northwest-striking fault
c    inww =            Width of a Northwest-striking fault
c    ithreshold =      Threshold minimal displacement of a fault to cause damage
c    itime =           Time of a faulting event
c    ixloc =           X coordinate of the center of a fault in the region of interest
c    ixnwprob =                Probability of occurrence of a Northwest-striking fault
c    iyloc =           Y coordinate of the center of a fault in the region of interest
c    name =
c    porient =         Randomly-generated value to determine fault orientation compared to the NW
fault occurrence probability
c    tfail =           Time of failure of waste package
c    threshold =       Threshold minimal displacement of a fault to cause damage
c    timefail =                Time of failure of waste package
c    timeofevent =     Time of a faulting event
c    width =           Generic width of a fault zone (i.e., of NE or NW orientation)
c    xlocm =           X coordinate of the center of a fault in the region of interest
c    xnwprob =         Probability of occurrence of a Northwest-striking fault
c    xyp1 =            X Coordinate of the mid-point location of a fault in the region of interest
c    xyp2 =            Y Coordinate of the mid-point location of a fault in the region of interest
c    ylocm =           Y coordinate of the center of a fault in the region of interest
```

Differences for *climato1.dat*

```
22c22
< ! Random Number = random number in range from -1 to 1 generated by the
MATLAB
---
> ! Random Number = random number in range from -Inf to Inf generated by the
MATLAB
```

Differences for *climato2.dat*

```
14c14,19
< ! MAPF  = Mean annual precipitation factor normalized to a range of 0 to 1.
---
> ! MAPF  = Mean annual precipitation factor.
> !         MAPF = (MAP - MAP_pd) / (MAP_fgm - MAP_pd),
> !         where
> !         MAP is mean annual precipitation,
> !         MAP_pd is present-day mean annual precipitation, and
> !         MAP_fgm is full glacial maximum mean annual precipitation.
19c24,29
< ! MATF  = Mean annual temperature factor normalized to a range of -1 to 1.
---
> ! MATF  = Mean annual temperature factor.
> !         MATF = (MAT - MAT_pd) / (MAT_fgm - MAT_pd),
> !         where
> !         MAT is mean annual temperature,
> !         MAT_pd is present-day mean annual temperature, and
> !         MAT_fgm is full glacial maximum mean annual temperature.
```

```
*** tpa51betaW/tpa.inp        Tue Apr 17 20:10:26 2007
--- tpa51betaX/tpa.inp        Wed May  9 18:59:20 2007
***************
*** 1,5 ****
  title
!  Input file tpa.inp as supplied with TPA Version 5.1betaW Code.
   Validation nominal scenario reference case.
  **
  **           ***>>>  GLOBAL PARAMETERS   <<<***
--- 1,5 ----
  title
!  Input file tpa.inp as supplied with TPA Version 5.1betaX Code.
   Validation nominal scenario reference case.
  **
  **           ***>>>  GLOBAL PARAMETERS   <<<***
***************
*** 415,429 ****
  **
  constant
  uzflow_ReferenceMAPAtStart[mm/yr]
! 162.8
  **
  constant
  uzflow_ReferenceMATAtStart[degC]
! 17.38
  **
  lognormal
  uzflow_FootprintAverageMeanAnnualInfiltrationAtStart[mm/yr]
! 0.27, 126
  **
  uniform
  uzflow_MeanAnnualPrecipitationMultiplierAtGlacialMaximum
--- 415,432 ----
  **
  constant
  uzflow_ReferenceMAPAtStart[mm/yr]
! 185.0
! **162.8    Replacement update for SCR685
  **
  constant
  uzflow_ReferenceMATAtStart[degC]
! 15.7
! **17.38    Replacement update for SCR685
  **
  lognormal
  uzflow_FootprintAverageMeanAnnualInfiltrationAtStart[mm/yr]
! 0.465, 156.0
! **0.27, 126    Replacement update for SCR685
  **
  uniform
  uzflow_MeanAnnualPrecipitationMultiplierAtGlacialMaximum
***************
*** 443,449 ****
  **
  lognormal
  uzflow_LongTermAverageFootprintAverageMAI[mm/yr]
! 4.2,288.0
  **
  constant
  uzflow_TimeStep[yr]
--- 446,453 ----
  **
  lognormal
  uzflow_LongTermAverageFootprintAverageMAI[mm/yr]
! 3.577,  285.3
! **4.2,288.0     Replacement update for SCR685
  **
  constant
  uzflow_TimeStep[yr]
***************
*** 2712,2720 ****
  *GroundSurfaceTemperature[C]
  *17.38
  **
  constant
  MassDensityofYMRock[kg/m^3]
```

```
! 2540.0
  **
  constant
  SpecificHeatofYMRock[J/(kg-K)]
--- 2716,2726 ----
  *GroundSurfaceTemperature[C]
  *17.38
  **
+ ** jmm 5-09-07 scr687
  constant
  MassDensityofYMRock[kg/m^3]
! 2166.0
! **2540.0
  **
  constant
  SpecificHeatofYMRock[J/(kg-K)]
***************
*** 3460,3473 ****
  0.721
  **
  ** rwj 4-17-07 scr685
  constant
  RockMassDensityForRockTypeOne[kg/m^3]
! 2068.0
  **2250.0
  **
  constant
  RockMassDensityForRockTypeTwo[kg/m^3]
! 2245.0
  **2250.0
  ** end scr685
  **
--- 3466,3483 ----
  0.721
  **
  ** rwj 4-17-07 scr685
+ ** jmm 5-09-07 scr687
  constant
  RockMassDensityForRockTypeOne[kg/m^3]
! 2139.0
! **2068.0
  **2250.0
  **
+ ** jmm 5-09-07 scr687
  constant
  RockMassDensityForRockTypeTwo[kg/m^3]
! 2322.0
! **2245.0
  **2250.0
  ** end scr685
  **
***************
*** 3511,3595 ****
  FractionRockTypeOneInSubarea_10[]
  0.85
  **
  beta
  BulkingFactorRockTypeOneSubarea_1[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_2[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_3[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_4[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_5[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_6[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
```

```
  BulkingFactorRockTypeOneSubarea_7[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_8[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_9[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_10[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_1[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_2[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_3[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_4[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_5[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_6[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_7[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_8[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_9[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_10[]
! 1.0, 2.0, 23.1747, 92.6989
  **
  lognormal
  DegradationTimeRockTypeOneSubarea_1[yr]
--- 3521,3612 ----
  FractionRockTypeOneInSubarea_10[]
  0.85
  **
+ ** rwj 5-9-07; SCR687
+ ** It is normally thought that the bulking factor distributions are in the range from
+ ** 1 to 2, and that the boundary points are not selected under normal sampling techniques.
+ ** However, a value of 1 for the lower limit causes a numerical instability in the code
+ ** when the tpamin.out file is used as an input file.  To avoid this condition a lower
+ ** limit of 1.01 is used since this small change does not significantly change the
+ ** distribution of parameter values and avoids the numerical instability.
  beta
  BulkingFactorRockTypeOneSubarea_1[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_2[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_3[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
```

```
  BulkingFactorRockTypeOneSubarea_4[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_5[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_6[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_7[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_8[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_9[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeOneSubarea_10[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_1[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_2[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_3[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_4[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_5[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_6[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_7[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_8[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_9[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  beta
  BulkingFactorRockTypeTwoSubarea_10[]
! 1.01, 2.0, 23.1747, 92.6989
  **
  lognormal
  DegradationTimeRockTypeOneSubarea_1[yr]
***************
*** 5043,5049 ****
  **
  constant
  InvertThickness[m]
! 0.606
  ** 0.75 removed for SCR552.
  **
  constant
--- 5060,5067 ----
  **
  constant
```

```
  InvertThickness[m]
! 0.86
! ** 0.606 removed for SCR685
  ** 0.75 removed for SCR552.
  **
  constant
```

Attachment F

>diff *tpa51betaU/uzft.f tpa51betaW/uzft.f*

```
160a161
> c        04-17-07  R. Janetzke  SCR685; Add colloid filter to fracture flow
1746a1748,1750
> cc rwj 4-17-07; SCR685 add colloid filter for fracture flow
>       double precision fracturefilter
>
2038a2043,2047
> cc rwj 4-17-07; SCR685 Add CHnv colloid filter to fracture flow.
>          if (salayernam(i) .eq. 'CHnv') then
>              fracturefilter = valuesp(ispquery( spname ))
>          end if
>
2414c2423,2427
<              ciperyrinsaintouzfracture(itime, inuc) = fracturefraction
---
> cc rwj 4-17-07; SCR685 Add CHnv unit colloid filter to fracture flow.
> c            ciperyrinsaintouzfracture(itime, inuc) = fracturefraction
> c    &           * ciperyrinsaintoloweruz(itime, inuc)
>              if (name(inuc)(1:1) .eq. 'J') then
>                ciperyrinsaintouzfracture(itime, inuc) = fracturefraction
2415a2429,2434
>      &           * (1.0 - fracturefilter)
>              else
>                ciperyrinsaintouzfracture(itime, inuc) = fracturefraction
>      &           * ciperyrinsaintoloweruz(itime, inuc)
>              end if
>
```

Attachment G

>diff *tpa51betaU/ebsrel.f tpa51betaW/ebsrel.f*

```
5528a5529,5537
> c css 4/13/07 - SCR685: modify colloid equations; add arrays to store
> c                  total colloid concentration (over all colloidal
> c                  nuclides) and total colloidal element concentration
> c                  (e.g., all Pu nuclides)
> c               calculate total concentration for all colloids per
> c                  timestep
> c               calculate total concentration for each colloid nuclide
> c                  per timestep
> c end change:  SCR685
5555,5559c5564,5568
< c     ajconc     = array containing concentrations per isotope that
< c                  may both aqueous and colloid values
< c     am         = 1, americium
< c     cm         = 4, curium
< c     colloidAffinity = array containing affinity factors per element
---
> c     ajconc            = array containing concentrations per isotope that
> c                         may both aqueous and colloid values
> c     am                = 1, americium
> c     cm                = 4, curium
> c     colloidAffinity   = array containing affinity factors per element
5561,5570c5570,5585
< c                  that may attach irreversibly to colloids
< c     i          = loop counter
< c     j          = array index
< c     numcollel  = number of elements that can attach to
< c                  colloids that are part of calculations
< c     pu         = 2, plutonium
< c     qout       = water leaving waste package (flow)
< c     sorpcap    = sorption capacity
< c     th         = 5, thorium
< c     u          = 3, uranium
---
> c                         that may attach irreversibly to colloids
> c     i                 = loop counter
> c     j                 = array index
> c     k                 = array index
> c     numcollel         = number of elements that can attach to
> c                         colloids that are part of calculations
> c     pu                = 2, plutonium
> c     qout              = water leaving waste package (flow)
> c     sorpcap           = sorption capacity
> c     th                = 5, thorium
> c css 4/13/07 - SCR685: modify colloid equations; add arrays to store
> c     totalelementconc  = array containing total concentration for each
> c                         element that will be separated into aqeuous
> c                         and colloidal forms by time step and element
> c end change:  SCR685
> c     u                 = 3, uranium
5607a5623,5625
>        character*6 nameiso
>        character*6 ucljs
>
5611a5630,5631
>        external nameiso
>        external ucljs
5619a5640,5644
>        do i=1,numcollel
```

```
>           do j=1,ntimstep
>              totalelementconc(i,j) = 0.0
>           end do
>        end do
5629d5653
< cc css SCR611;
5661a5686,5701
> c css 4/13/07 - SCR685: modify colloid equations; add arrays to store
> c
> c keep running totals of concentrations by element
>              if (k .ne. 0) then
>                 totalelementconc(k,j) = totalelementconc(k,j) +
>      &                                  ajconc(i,j)
>              end if
> c end change:  SCR685
> c
>           end do
>        end do
> c
> c css 4/13/07 - SCR685: modify colloid equations
> c move calcuation of total affinity times concentration to after ebsnef read
> c replace ajconc(i,j) in calculation with totalelementconc(k,j)
> c
5668,5671c5708,5713
<              if (k .ne. 0) then
<                 totalAffCon(j) = totalAffCon(j) + (colloidAffinity(k) *
<      &            min(ajconc(i,j), colloidSolubility(k)))
<              end if
---
>        do k=1,numcollel
>           do j=1,ntimstep
>              totalAffCon(j) = totalAffCon(j) + (colloidAffinity(k) *
>      &          min(totalelementconc(k,j), colloidSolubility(k)))
> cc
> cc      &          min(ajconc(k,j), colloidSolubility(k)))
5673a5716
> c end change:  SCR685
5717c5760
< c
---
> c                4-13-07 C. Scherer - modify equations
5729,5731c5772,5774
< c     am         = 1, americium
< c     cm         = 4, curium
< c     colloidAffinity = array containing affinity factors per element
---
> c     am                = 1, americium
> c     cm                = 4, curium
> c     colloidAffinity   = array containing affinity factors per element
5733,5741c5776,5788
< c                  that may attach irreversibly to colloids
< c     conc      = concentration of radionuclide
< c     numcollel  = number of elements that can attach to
< c                  colloids that are part of calculations
< c     numeffsol  = 2
< c     pu         = 2, plutonium
< c     sorpcap    = sorption capacity
< c     th         = 5, thorium
< c     u          = 3, uranium
---
> c                         that may attach irreversibly to colloids
> c     conc              = concentration of radionuclide
> c     numcollel         = number of elements that can attach to
> c                         colloids that are part of calculations
> c     numeffsol         = 2
```

```
> c     pu                  = 2, plutonium
> c     sorpcap             = sorption capacity
> c     th                  = 5, thorium
> c css 4/13/07 - SCR685: modify colloid equations; add arrays to store
> c     totalelementconc  = array containing total concentration for each
> c                         colloidal element by time step and element
> c end change:  SCR685
> c     u                   = 3, uranium
5772c5819
< c     Start here.     set_Colloid
---
> c      Start here.     set_Colloid
5773a5821
>
5794a5843
> c css 4/13/07 - SCR685: modify colloid equations
5795a5845,5847
> cc             conc = sorpcap * (colloidAffinity(i) *
> cc     &             (min(ajConc(cldidx,itimestep),
> cc     &             colloidSolubility(i))) / totalAffCon(itimestep))
5797c5849
<      &             (min(ajConc(cldidx,itimestep),
---
>      &             (min(totalelementconc(i,itimestep),
5798a5851,5855
> c prorate colloid concentration according to ratio of nuclide concentration
> c    to element concentration (e.g., Pu239 concentration / Pu concentration)
>              conc = conc * (ajconc(cldidx,itimestep) /
>      &                      (totalelementconc(i,itimestep)))
> c end change: SCR685
```

Attachment H

```
!! wpsfail.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1betaX Code.
!!  Validation nominal scenario reference case.
!! Created by: TPA 5.1betaX
!! Module: EXEC
!! Job started: Wed May  9 19:16:46 2007
!!
!! PURPOSE:
!!  Number of WPs Identified by Event Type
!!  Including Event Time and Subarea for Each Vector
!! This file presents a table of six different waste package
!! failure modes in time order for each realization. The
!! subarea of failure is also noted.
!!
!! SECTION 1
!!
!! Realization Number = realization number; (ir)
!! Subarea Number = subarea number; (isa)
!! Time  = simulation time in years of failure event;
!!         (tim)
!! Number of Initial = number of initial failures.
!! Number of General Corr = number of general corrosion
!!                          failures.
!! Number of Local Corr = number of localized corrosion
!!                          failures.
!! Number of Mechanical = number of mechanical failures.
!! Number of Faulting = number of failures due to faulting
!!                      event.
!! Number of Igneous Activity = number of indrift failures
!!                              due to volcanic event.
```

Realiz. Number (unitless)	Subarea Number	Time (yr)	Number of Initial (unitless)	Number of General Corr (unitless)	Number of Local Corr (unitless)	Number of Mechanical (unitless)	Number of Faulting (unitless)	Number of Igneous Activity (unitless)
1	1	1.21910E+03	0.00000E+00	0.00000E+00	2.70000E+01	0.00000E+00	0.00000E+00	0.00000E+00
1	5	1.52423E+03	0.00000E+00	0.00000E+00	7.40000E+01	0.00000E+00	0.00000E+00	0.00000E+00
1	3	1.72331E+03	0.00000E+00	0.00000E+00	1.49000E+02	0.00000E+00	0.00000E+00	0.00000E+00

Attachment I

To compute glass dissolution rate, the drift wall temperature was used. It was assumed that the temperature of the glass waste form is less than the spent fuel temperature. The drift wall temperature was used to approximate the glass temperature. However, such an approach was incorrect, because the "waste package" temperature is an average temperature, accounting for the lower heat output from the glass waste form. Therefore, it is recommended to use to use the average waste package temperature to compute both spent fuel and glass waste form dissolution rates. This recommendation was implemented by modifying the code *releaset.f*, section reading temperatures from the input file *ebstrh.dat*.

> diff *tpa51betaU/code/releaset.f tpa51betaW/codes/releaset.f*

```
202a203,204
> c        4-05-07 rwr    SCR673 Control 'qinpart()' by comparing 'tcan()' with
> c                               the critical temperature
1257,1258c1259,1267
< cc rwr 4/4/06; SCR608; change Fw to Fwc; add Fwm1 & Fwm2
< cc (calcuate qin(i) except for the Fw part - i.e., Fwc, Fwm1, and Fwm2)
---
> cc rwr 3/15/07; SCR673; Reformat Input/Output/Intermediate Files
> cc                      (do not allow flow into WP if the WP temperature)
> cc                      (is greater than Tboil)
> cc cc rwr 4/4/06; SCR608; change Fw to Fwc; add Fwm1 & Fwm2
> cc cc (calcuate qin(i) except for the Fw part - i.e., Fwc, Fwm1, and Fwm2)
> cc           do i = 1, ntflo
> cc             qinpart(i) = (floref(i)*flowfactr) * ctfmult(i) * ctfow(i) *
> cc      &                                                ctfr(i) * ctfd(i)
> cc           enddo
1260,1261c1269,1274
<             qinpart(i) = (floref(i)*flowfactr) * ctfmult(i) * ctfow(i) *
<      &                                                ctfr(i) * ctfd(i)
---
>             if (tcan(i) .ge. ctemp) then
>                qinpart(i) = 0.0d0
>             else
>                qinpart(i) = (floref(i)*flowfactr) * ctfmult(i) *
>      &                                   ctfow(i) * ctfr(i) * ctfd(i)
>             endif
4541c4554,4556
<          if(imodel.ne.5) then
---
> cc rwr 4-5-07; SCR673; Remove following IF test for glass, since
> cc       tcan() is a composite temperature for both SF & glass.
> c        if(imodel.ne.5) then
4543,4544c4558,4559
<           read (nunit(3), *) inputit, ttemp(it), tcan(it), tave(it)
<          else
---
> c         read (nunit(3), *) inputit, ttemp(it), tcan(it), tave(it)
> c        else
4547,4548c4562,4564
<           read (nunit(3), *) inputit, ttemp(it), tave(it), tcan(it)
<          end if
---
> c         read (nunit(3), *) inputit, ttemp(it), tave(it), tcan(it)
> c        end if
>           read (nunit(3), *) inputit, ttemp(it), tcan(it), tave(it)
```

Attachment J

>diff *tpa51betaU/codes/dsfailt.f tpa51betaW/codes/dsfailt.f*

```
98a99,100
> c        R. Janetzke  04-13-07 SCR685; Inhibit fluoride corrosion rate
> c                                      for rep pre-closure period.
172a175
>       REAL  ClosureTime
175c178,180
<       COMMON /DS3/ FluorideEnh
---
> cc rwj 4-13-07; SCR685
> c     COMMON /DS3/ FluorideEnh
>       COMMON /DS3/ FluorideEnh, ClosureTime
257a263
>       REAL  ClosureTime
267c273,275
<       COMMON /DS3/ FluorideEnh
---
> cc rwj 4-13-07; SCR685
> c     COMMON /DS3/ FluorideEnh
>       COMMON /DS3/ FluorideEnh, ClosureTime
289a298
>       READ(FILE_ID, *) ClosureTime
514a524
>       REAL  ClosureTime
522c532,534
<       COMMON /DS3/ FluorideEnh
---
> cc rwj 4-13-07; SCR685
> c     COMMON /DS3/ FluorideEnh
>       COMMON /DS3/ FluorideEnh, ClosureTime
543c555,562
<           fluoride_corrosion_rate(index_time, 2) = corrosionRate
---
> cc rwj 4-13-07;scr685 Emplace DS at rep closure time
> c         fluoride_corrosion_rate(index_time, 2) = corrosionRate
>           if (time(index_time) .ge. ClosureTime) then
>              fluoride_corrosion_rate(index_time, 2) = corrosionRate
>           else
>              fluoride_corrosion_rate(index_time, 2) = 0.0
>           end if
>
547,550c566,578
<         fluoride_corrosion_rate(index_time, 1) = time(index_time)
<         fluoride_corrosion_rate(index_time, 2) =
<      &    dripShieldEnhance(fluoride(index_time), slopeEnhance,
<      &    fluorideMinimum, fluorideMaximum) * corrosionRate
---
>           fluoride_corrosion_rate(index_time, 1) = time(index_time)
> cc rwj 4-13-07;scr685 Emplace DS at rep closure time
> c         fluoride_corrosion_rate(index_time, 2) =
> c    &    dripShieldEnhance(fluoride(index_time), slopeEnhance,
> c    &    fluorideMinimum, fluorideMaximum) * corrosionRate
>           if (time(index_time) .ge. ClosureTime) then
>              fluoride_corrosion_rate(index_time, 2) =
>      &          dripShieldEnhance(fluoride(index_time), slopeEnhance,
>      &          fluorideMinimum, fluorideMaximum) * corrosionRate
>           else
>              fluoride_corrosion_rate(index_time, 2) = 0.0
>           end if
>
```

Attachment K

>diff *tpa51betaU/dsfail.f tpa51betaW/dsfail.f*

```
72a73,74
> c              03-12-07 jmm; scr684; reformat dsfailt.def
> c              04-13-07 rwj; scr685; Emplace DS at rep closure
248c250,251
<       CALL buildInputFiles(iunitdsfailtinp, iunitfluoridedat,
---
>       CALL buildInputFiles(iunitdsfailtinp, iunitfluoridedat,
>      & iunitdsfailtdef,
250c253,255
<      &  dripShieldCorrosionRate, fluoride_file)
---
> cc rwj 4-13-07;scr685
> c    &  dripShieldCorrosionRate, fluoride_file)
>      &  dripShieldCorrosionRate, fluoride_file, data_file)
451c456,460
<       SUBROUTINE buildInputFiles(iUnitFile, iUnitFluoride,
---
> c     SUBROUTINE buildInputFiles(iUnitFile, iUnitFluoride,
> c    &  numberOfTimeSteps, timeValue, fluorideConcentration,
> c    &  dripShieldCorrosionRate, fluorideFile)
> cc rwj 4-13-07; SCR685
>       SUBROUTINE buildInputFiles(iUnitFile, iUnitFluoride, iUnitInput,
453c462
<      &  dripShieldCorrosionRate, fluorideFile)
---
>      &  dripShieldCorrosionRate, fluorideFile, data_file)
525a535,536
>       CHARACTER*100 line
>
527,539c538,562
<       CHARACTER*100 line1
<       CHARACTER*100 line2
<       CHARACTER*100 line3
<       CHARACTER*100 line4
<       CHARACTER*100 line5
<       CHARACTER*100 line6
<       CHARACTER*100 line7
<       CHARACTER*100 line8
<       CHARACTER*100 line9
<       CHARACTER*100 line10
<       CHARACTER*100 line11
<       CHARACTER*100 line12
<       CHARACTER*100 line13
---
> c     CHARACTER*100 line1
> c     CHARACTER*100 line2
> c     CHARACTER*100 line3
> c     CHARACTER*100 line4
> c     CHARACTER*100 line5
> c     CHARACTER*100 line6
> c     CHARACTER*100 line7
> c     CHARACTER*100 line8
> c     CHARACTER*100 line9
> c     CHARACTER*100 line10
> c     CHARACTER*100 line11
> c     CHARACTER*100 line12
> c     CHARACTER*100 line13
> cjmm SCR684 file format change
> c     CHARACTER*100 line14
```

```
> c      CHARACTER*100 line15
> c      CHARACTER*100 line16
> c      CHARACTER*100 line17
> c      CHARACTER*100 line18
> c      CHARACTER*100 line19
> c      CHARACTER*100 line20
> c      CHARACTER*100 line21
> c      CHARACTER*100 line22
> c      CHARACTER*100 line23
> cjmm SCR684 end
540a564
>       INTEGER i
546a571,572
>       integer i_closuretime
>       real closuretime
576c602
<       COMMON /dsfail1/ line1, line2, line3, line4, line5, line6, line7,
---
> c     COMMON /dsfail1/ line1, line2, line3, line4, line5, line6, line7,
579c605,609
<      &  line8, line9, line10, line11,line12,line13
---
> cjmm SCR684
> cjmm &  line8, line9, line10, line11,line12,line13
> c    &  line8, line9, line10, line11,line12,line13,line14,line15,line16,
> c    & line17,line18, line19, line20,line21,line22,line23
> cjmm SCR684 end
588a619,620
> cc rwj 4-13-07; SCR685
>      &                ,i_closuretime
592c624
<       CHARACTER zportfdatefun*60
---
> c     CHARACTER zportfdatefun*60
625a658,659
> cc rwj 4-13-07; scr685
>       ClosureTime = valuesp(i_closuretime)
636c670
<       OPEN(UNIT = iUnitFile, FILE = 'dsfailt.inp', status='unknown')
---
> c     OPEN(UNIT = iUnitFile, FILE = 'dsfailt.inp', status='unknown')
639,640c673,674
<       write(iUnitFile,FMT='(A)')'! TITLE - dsfailt.inp '
<       write(iUnitFile,FMT='(A,A)')'! DATE/TIME ', zportfdatefun()
---
> c     write(iUnitFile,FMT='(A)')'! TITLE - dsfailt.inp '
> c     write(iUnitFile,FMT='(A,A)')'! DATE/TIME ', zportfdatefun()
641a676
> cjmm SCR684 file format changes
647,653c682,697
<       WRITE(iUnitFile, FMT='(A100)') line1
<       WRITE(iUnitFile, FMT='(A100)') line2
<       WRITE(iUnitFile, FMT='(A100)') line3
<       WRITE(iUnitFile, FMT='(A100)') line4
<       WRITE(iUnitFile, FMT='(A100)') line5
<
<
---
> c     WRITE(iUnitFile, FMT='(A100)') line1
> c     WRITE(iUnitFile, FMT='(A100)') line2
> c     WRITE(iUnitFile, FMT='(A100)') line3
> c     WRITE(iUnitFile, FMT='(A100)') line4
> c     WRITE(iUnitFile, FMT='(A100)') line5
> c     WRITE(iUnitFile, FMT='(A100)') line6
> c     WRITE(iUnitFile, FMT='(A100)') line7
```

```
> c      WRITE(iUnitFile, FMT='(A100)') line8
> c      WRITE(iUnitFile, FMT='(A100)') line9
> c      WRITE(iUnitFile, FMT='(A100)') line10
> c      WRITE(iUnitFile, FMT='(A100)') line11
> c      WRITE(iUnitFile, FMT='(A100)') line12
> c      WRITE(iUnitFile, FMT='(A100)') line13
> c      WRITE(iUnitFile, FMT='(A100)') line14
> c      WRITE(iUnitFile, FMT='(A100)') line15
> c
659,661c703,707
<        WRITE(iUnitFile, FMT='(A100)') line6
<        WRITE(iUnitFile, FMT='(A100)') line7
<
---
> cjmm  WRITE(iUnitFile, FMT='(A100)') line6
> cjmm  WRITE(iUnitFile, FMT='(A100)') line7
> c      WRITE(iUnitFile, FMT='(A100)') line16
> c      WRITE(iUnitFile, FMT='(A100)') line17
> c
666c712,713
<        WRITE(line8(1:18), FMT = '(1PE15.5, 3x)') dripShieldCorrosionRate
---
> cjmm  WRITE(line8(1:18), FMT = '(1PE15.5, 3x)') dripShieldCorrosionRate
> c      WRITE(line18(1:24), FMT = '(1PE24.5)') dripShieldCorrosionRate
669,670c716,718
<        WRITE(iUnitFile, FMT='(A100)') line8
<
---
> c      WRITE(iUnitFile, FMT='(A100)') line18
> cjmm SCR684 end
> c
680,681c728,732
<        WRITE(line9(1:18), FMT = '(1PE15.5, 3x)') drip_shield_thickness*ds
<       &penetration
---
> cjmm  WRITE(line9(1:18), FMT = '(1PE15.5, 3x)') drip_shield_thickness*ds
> cjmm &penetration
> cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
> c      WRITE(line19(1:24), FMT = '(1PE24.5)') drip_shield_thickness*ds
> c     &penetration
685,686c736,737
<        WRITE(iUnitFile, FMT='(A100)') line9
<
---
> c      WRITE(iUnitFile, FMT='(A100)') line19
> c
692,693c743,745
<        WRITE(iUnitFile, FMT='(A100)') line10
<
---
> cjmm  WRITE(iUnitFile, FMT='(A100)') line10
> c      WRITE(iUnitFile, FMT='(A100)') line20
> c
699,700c751,753
<        WRITE(iUnitFile, FMT='(A100)') line11
<
---
> cjmm  WRITE(iUnitFile, FMT='(A100)') line11
> c      WRITE(iUnitFile, FMT='(A100)') line21
> c
707c760,761
<        WRITE(iUnitFile, FMT='(A100)') line12
---
> cjmm  WRITE(iUnitFile, FMT='(A100)') line12
> c      WRITE(iUnitFile, FMT='(A100)') line22
```

```
715c769,790
<       WRITE(iUnitFile, FMT='(A100)') line13
---
> cjmm  WRITE(iUnitFile, FMT='(A100)') line13
> c     WRITE(iUnitFile, FMT='(A100)') line23
> cjmm SCR684 end
> ccrwj 4-13-07 SCR685; Redo subroutine
>       OPEN(UNIT = iUnitInput, FILE = 'dsfailt.def', STATUS = 'old')
>       OPEN(UNIT = iUnitFile, FILE = 'dsfailt.inp', status='unknown')
>
>       read (iUnitInput, '(a100)') line
>       write(iUnitFile,FMT='(A)')'!! dsfailt.inp '
>
>       do i = 2,25
>          read (iUnitInput, '(a100)') line
>          write (iUnitFile, '(a100)') '!'//line
>       end do
>
>       read (iUnitInput, '(a100)') line
>       write (iUnitFile, '(a1)') ' '
>
>       read (iUnitInput, '(a100)') line
>       read (line, *) fluorideFile
>       write (line(1:24), '(a24)') "'"//fluorideFile//"'"
>       write (iUnitFile, '(a100)') line
716a792,817
>       read (iUnitInput, '(a100)') line
>       read (line, *) data_File
>       write (line(1:24), '(a24)') "'"//data_File//"'"
>       write (iUnitFile, '(a100)') line
>
>       read (iUnitInput, '(a100)') line
>       WRITE(line(1:24), FMT = '(1PE24.5)') dripShieldCorrosionRate
>       write (iUnitFile, '(a100)') line
>
>       read (iUnitInput, '(a100)') line
>       WRITE(line(1:24), FMT = '(1PE24.5)') drip_shield_thickness *
>      &                                     dspenetration
>       write (iUnitFile, '(a100)') line
>
>       do i = 31,34
>          read (iUnitInput, '(a100)') line
>          write (iUnitFile, '(a100)') line
>       end do
>
>       read (iUnitInput, '(a100)') line
>       WRITE(line(1:24), FMT = '(1PE24.5)') ClosureTime
>       write (iUnitFile, '(a100)') line
>
>       CLOSE(iUnitInput)
> cc rwj ; end of scr685
>
745c846
<       SUBROUTINE setupCommons(iUnitInput, dataFile, fluorideFile)
---
>       SUBROUTINE setupCommons(iUnitInput, data_File, fluorideFile)
760c861
< c            dataFile = name for DSFAILT's data file.
---
> c            data_File = name for DSFAILT's data file.
778c879
< c     dataFile = name for DSFAILT's data file.
---
> c     data_File = name for DSFAILT's data file.
822,834c923,947
```

```
<       CHARACTER*100 line1
<       CHARACTER*100 line2
<       CHARACTER*100 line3
<       CHARACTER*100 line4
<       CHARACTER*100 line5
<       CHARACTER*100 line6
<       CHARACTER*100 line7
<       CHARACTER*100 line8
<       CHARACTER*100 line9
<       CHARACTER*100 line10
<       CHARACTER*100 line11
<       CHARACTER*100 line12
<       CHARACTER*100 line13
---
> c     CHARACTER*100 line1
> c     CHARACTER*100 line2
> c     CHARACTER*100 line3
> c     CHARACTER*100 line4
> c     CHARACTER*100 line5
> c     CHARACTER*100 line6
> c     CHARACTER*100 line7
> c     CHARACTER*100 line8
> c     CHARACTER*100 line9
> c     CHARACTER*100 line10
> c     CHARACTER*100 line11
> c     CHARACTER*100 line12
> c     CHARACTER*100 line13
> cjmm SCR684 file format change
> c     CHARACTER*100 line14
> c     CHARACTER*100 line15
> c     CHARACTER*100 line16
> c     CHARACTER*100 line17
> c     CHARACTER*100 line18
> c     CHARACTER*100 line19
> c     CHARACTER*100 line20
> c     CHARACTER*100 line21
> c     CHARACTER*100 line22
> c     CHARACTER*100 line23
> cjmm SCR684 end
841a955
>       integer i_closuretime
855c969
<       COMMON /dsfail1/ line1, line2, line3, line4, line5, line6, line7,
---
> c     COMMON /dsfail1/ line1, line2, line3, line4, line5, line6, line7,
858c972,976
<      &  line8, line9, line10, line11,line12,line13
---
> cjmm SCR684
> cjmm &  line8, line9, line10, line11,line12,line13
> c    &  line8, line9, line10, line11,line12,line13,line14,line15,line16,
> c    & line17,line18, line19, line20,line21,line22,line23
> cjmm SCR684 end
868a987,988
> cc rwj 4-13-07; SCR685
>      &                ,i_closuretime
887c1007
<       OPEN(UNIT = iUnitInput, FILE = 'dsfailt.def', STATUS = 'old')
---
> c     OPEN(UNIT = iUnitInput, FILE = 'dsfailt.def', STATUS = 'old')
893,900c1013,1030
< c SCR671 J. Mancillas 12-11-06 file format changes
<       READ(iUnitInput, FMT = '(A100)') line1
<       READ(iUnitInput, FMT = '(A100)') line2
<       READ(iUnitInput, FMT = '(A100)') line3
```

```
<       READ(iUnitInput, FMT = '(A100)') line4
<       READ(iUnitInput, FMT = '(A100)') line5
<       READ(iUnitInput, FMT = '(A100)') line6
<
---
> cjmm SCR684 Read 15 lines of header, description and blank lines
> cjmmc SCR671 J. Mancillas 12-11-06 file format changes
> c     READ(iUnitInput, FMT = '(A100)') line1
> c     READ(iUnitInput, FMT = '(A100)') line2
> c     READ(iUnitInput, FMT = '(A100)') line3
> c     READ(iUnitInput, FMT = '(A100)') line4
> c     READ(iUnitInput, FMT = '(A100)') line5
> c     READ(iUnitInput, FMT = '(A100)') line6
> c     READ(iUnitInput, FMT = '(A100)') line7
> c     READ(iUnitInput, FMT = '(A100)') line8
> c     READ(iUnitInput, FMT = '(A100)') line9
> c     READ(iUnitInput, FMT = '(A100)') line10
> c     READ(iUnitInput, FMT = '(A100)') line11
> c     READ(iUnitInput, FMT = '(A100)') line12
> c     READ(iUnitInput, FMT = '(A100)') line13
> c     READ(iUnitInput, FMT = '(A100)') line14
> c     READ(iUnitInput, FMT = '(A100)') line15
> c
903,904c1033,1037
<       BACKSPACE(iUnitInput)
<       READ(iUnitInput, *) fluorideFile
---
> cjmm  SCR684
> c     READ(iUnitInput, FMT = '(A100)') line16
> cjmm  SCR684 end
> c     BACKSPACE(iUnitInput)
> c     READ(iUnitInput, *) fluorideFile
907c1040
<
---
> c
910,915c1043,1051
<       READ(iUnitInput, FMT = '(A100)') line7
<
<       BACKSPACE(iUnitInput)
<       READ(iUnitInput, *) dataFile
<       print*,"dataFile= ",dataFile
<
---
> cjmm  SCR684
> cjmm  READ(iUnitInput, FMT = '(A100)') line7
> c     READ(iUnitInput, FMT = '(A100)') line17
> cjmm  SCR684 end
> c
> c     BACKSPACE(iUnitInput)
> c     READ(iUnitInput, *) dataFile
> c     print*,"dataFile= ",dataFile
> c
924,929c1060,1085
<       READ(iUnitInput, FMT = '(A100)') line8
<       READ(iUnitInput, FMT = '(A100)') line9
<       READ(iUnitInput, FMT = '(A100)') line10
<       READ(iUnitInput, FMT = '(A100)') line11
<       READ(iUnitInput, FMT = '(A100)') line12
<       READ(iUnitInput, FMT = '(A100)') line13
---
> cjmm  SCR684
> cjmm  READ(iUnitInput, FMT = '(A100)') line8
> cjmm  READ(iUnitInput, FMT = '(A100)') line9
> cjmm  READ(iUnitInput, FMT = '(A100)') line10
```

```
> cjmm  READ(iUnitInput, FMT = '(A100)') line11
> cjmm  READ(iUnitInput, FMT = '(A100)') line12
> cjmm  READ(iUnitInput, FMT = '(A100)') line13
> c     READ(iUnitInput, FMT = '(A100)') line18
> c     READ(iUnitInput, FMT = '(A100)') line19
> c     READ(iUnitInput, FMT = '(A100)') line20
> c     READ(iUnitInput, FMT = '(A100)') line21
> c     READ(iUnitInput, FMT = '(A100)') line22
> c     READ(iUnitInput, FMT = '(A100)') line23
> cjmm  SCR684 end
> c     READ(iUnitInput, FMT = '(A100)') line24
> c     READ(iUnitInput, FMT = '(A100)') line25
> c     READ(iUnitInput, FMT = '(A100)') line26
> c     READ(iUnitInput, FMT = '(A100)') line27
> c     READ(iUnitInput, FMT = '(A100)') line28
> c     READ(iUnitInput, FMT = '(A100)') line29
> c     READ(iUnitInput, FMT = '(A100)') line30
> c     READ(iUnitInput, FMT = '(A100)') line31
> c     READ(iUnitInput, FMT = '(A100)') line32
> c     READ(iUnitInput, FMT = '(A100)') line33
> c     READ(iUnitInput, FMT = '(A100)') line34
> c     READ(iUnitInput, FMT = '(A100)') line35
931,932c1087,1088
<       CLOSE(iUnitInput)
<
---
> c     CLOSE(iUnitInput)
> c
950a1107,1110
> cc rwj 4-13-07;scr685 Emplace DS at rep closure time.
>       CALL clearchar(60, sample_name)
>       sample_name = 'TimeOfRepositoryClosure[yr]'
>       i_closuretime = ispquery(sample_name)
973d1132
<
```

Attachment L

>diff *tpa51betaU/data/dsfailt.def tpa51betaW/data/dsfailt.def*

```
1,3c1,14
< ! Input file for module DSfailt and is rewritten for each realization
< ! This file contains the file names for the fluoride concentration data and DS
thickness vs. time
< ! data and parameters relevant to DS corrosion
---
> ! dsfailt.def
> !
> ! PURPOSE:
> ! This file is the input file for module DSFAILT and is rewritten by
> ! DSFAIL for each subarea and realization.  It contains the file names
> ! for the fluoride concentration data and DS thickness vs. time data
> ! and other parameters relevant to DS corrosion.
> !
> ! HISTORY:
> ! This file format was first used with TPA 5.1betaV'
> !
> ! 3-03-07; J. M. Menchaca; Reformatted
> ! 4-12-07; R. Janetzke; Add repository closure time
> !
4a16,25
> !
> ! Item 1: fileIn; Name of data file containing fluoride concentration versus time
> ! Item 2: fileOut; Name of output file containing thickness of the drip shield vs time
> ! Item 3: CorrRate; Drip shield corrosion rate in meters per year
> ! Item 4: DSThick; Drip shield thickness in meters
> ! Item 5: slope; Slope of drip shield enhancing factor (unitless)
> ! Item 6: minF; Minimum fluoride concentration affecting the DS corrosion rate in moles
per liter
> ! Item 7: maxF; Maximum fluoride concentration affecting the DS corrosion rate in moles
per liter
> ! Item 8: FluorideEnh; Fluoride enhancing control flag, 0=>no fluoride enhancing,
1=>fluoride enhancing.
> ! Item 9: closure; Repository closure time in years of simulation
6,14c27,35
<  'fluoride.dat'   ! fileIn, Input data file, fluoride concentration versus time
<   'dsfailt.dat'   ! fileOut, Output data file 1, tracking thickness of the drip shield
vs time
<         8.6e-08   ! CorrRate, m/yr, drip shield corrosion rate : DSCorrRate[m/yr]
<           0.015   ! DSThick, m, drip shield thickness : DripShieldThickness[m]
<            2.84   ! slope, dimensionless, slope of drip shield enhancing factor
<         1.0e-04   ! minF, M, minimum fluoride concentration affecting the DS corrosion
rate
<         2.0e-03   ! maxF, M, maximum fluoride concentration affecting the DS corrosion
rate
<               0   ! FluorideEnh, (0 or 1). 0 : no fluoride enhancing, 1: fluoride
enhancing.
<
---
>           'fluoride.dat' ! fileIn
>            'dsfailt.dat' ! fileOut
>                  8.6e-08 ! CorrRate [m/yr]
>                    0.015 ! DSThick [m]
>                     2.84 ! slope
>                  1.0e-04 ! minF [mol/L]
>                  2.0e-03 ! maxF [mol/L]
>                        0 ! FluorideEnh
>                     100. ! closure [yr]
```

Attachment M

```
!! pkmndose.res
!!
!!  Input file tpa.inp as supplied with TPA Version 5.1betaX Code.
!!  Validation nominal scenario reference case.
!! Created by: TPA 5.1betaX
!! Module: EXEC
!! Job started: Wed May  9 19:16:46 2007
!!
!! PURPOSE:
!!
!!
!! Dose value for each realization at the time of peak mean
!! dose
!!
!! SECTION 1
!!
!! Realization = realization number
!! Time = Time of peak dose over all realizations in years
!! TEDE = peak total effective dose equivalent for the given
!!        realization in rem per year

    Realization       Time          TEDE
    (unitless)        (yr)        (rem/yr)
         1         1.0000E+04     3.5487E-06
```

Attachment N

Two part email request from D. Pickett:

```
I'd like to make a (relatively unimportant) parameter change for the
EBSREL block.  Is this email enough?

constant
InvertThickness[m]
0.86

thanks,

David

-----

Maximum thickness of the invert, according to Bechtel SAIC Company, LLC.
"EBS Radionuclide Transport Abstraction."  ANL-WIS-PA-000001 Rev 02.
Las Vegas, Nevada: Bechtel SAIC Company, LLC.  2005.  p 6-175.
```

Attachment O

Changes to *ebsrel.f*:

```
144a145
> cc rwj 5/8/07;  SCR685; Enable 'initialreductionlc' as a switch to use values in
wpflow.def
1756c1757,1761
<         if (initialreductionwp .lt. 0.0d0 .or.
---
>
> cc rwj 5-8-07 SCR685;
> c       if (initialreductionwp .lt. 0.0d0 .or.
>         if (initialreductionlc .lt. 0.0d0 .or.
>
```

Attachment P

>diff *tpa51betaW/exec.f tpa51betaX/exec.f*

```
3476a3496,3499
> cc rwj 4-26-07 685
>
>       call zero( maxntime*maxnnucl*maxnpathgw, remperyrgwnap(1,1,1) )
>       call zero( maxntime*maxnpathgw, remperyrgwsap(1,1) )
3731,3732c3754,3757
<         call zero( maxntime*maxnnucl*maxnpathgw, remperyrgwnap(1,1,1) )
<         call zero( maxntime*maxnpathgw, remperyrgwsap(1,1) )
---
>
> cc rwj 4-26-07 685
> c       call zero( maxntime*maxnnucl*maxnpathgw, remperyrgwnap(1,1,1) )
> c       call zero( maxntime*maxnpathgw, remperyrgwsap(1,1) )
13620a13646,13653
> cc rwj 4-18-07; SCR685
>         inquire( file='gwp_ave.res', EXIST=lexist)
>         if ( lexist) istatus = zportsh( 'rm gwp_ave.res')
>
> cc rwj 4-18-07; SCR685
>         inquire( file='gwppktim.res', EXIST=lexist)
>         if ( lexist) istatus = zportsh( 'rm gwppktim.res')
>
```

Attachment Q

7) Test by inspection results.

The source code was checked to verify that the same waste package temperature is used for spent fuel and glass waste dissolution computations. On line 4564 of the file *releaset.f* the change was implemented. Data are now read from the file *ebstrh.dat* via the instruction

```
read (nunit(3), *) inputit, ttemp(it), tcan(it), tave(it)
```

The temperature for waste form dissolution computations is tracked by the FORTRAN variable tcan(it). It was verified that "if" statements selecting different temperatures depending on the waste form were removed (lines 4556 to 4563 were commented out).

Attachment R

6) **Description of Acceptance Tests**:

Test Plan Name: wpsfail output files test (item 6)

Tested By: Jose M. Menchaca | Date: 05/11/2007

Host Machine: "TPA" 64 bit Microsoft Windows Server | Host OS: Microsoft Windows Ver 5.2

Baseline Version: TPA51betaW | Test Version: TPA51betaX

Process Level (PL) Tests

PL-1 Name:

Path for run directory: D:\public\jmenchaca\tpa51betaW (tpa.cnwra.swri.edu)
D:\public\jmenchaca\tpa51betaX (tpa.cnwra.swri.edu)

Path for archive directory: On attached CD:
\tpa51betaW
\tpa51betaX

Environment variable: TPA_TEST = Y:\tpabetaX (Y: is "Alby")
TPA_DATA = Y:\tpabetaX (Y: is "Alby")

Special input files or modifications to input files required: Non required.

Special diagnostic code modifications required: NONE

Program modes to be used: STANDARD

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: None required.

Test Description: The objective of the test is to verify the data file transparency and the file naming corrections.

There are no special assumptions necessary for running this test.

There are no constraints applied to the execution of this test.

1, Transparency Requirement:
The *wpsfail.res* data file and *wpsfail.dbg* output files are to be inspected to assure that they comply with the transparency requirement of the new file format specification.

The test passes if the files comply with the new transparency requirements.

2. File Naming Requirement:

A directory listing of the run directory should be inspected to assure that *wpsfail.res* file is now the *wpsfail.dbg* file and that *wpsfail2.out* is now the *wpsfail.res* file.

The test passes if the files names are correctly given as described above.

Test Results:

wpsfail.res meets new file format standard. **PASS**

wpsfail.dbg meets new file format standard. **PASS**

wpsfail.res file replaced by *wpsfail.dbg* file: **PASS**

wpsfail2.res file replaced by *wpsfail.res* file: **PASS**

14) **Description of Acceptance Tests**

Test Plan Name: gwp_ave.res calculation test (item 14)

Tested By: Jose M. Menchaca | Date: 05/21/2007

Host Machine: "TPA" 64 bit Microsoft Windows Server | Host OS: Microsoft Windows Ver 5.2

Baseline Version: TPA51betaW | Test Version: TPA51betaX

Process Level (PL) Tests

PL-1 Name:

Path for run directory: D:\public\jmenchaca\tpa51betaW (tpa.cnwra.swri.edu)
D:\public\jmenchaca\tpa51betaX (tpa.cnwra.swri.edu)

Path for archive directory: On attached CD:
\tpa51betaW
\tpa51betaX

Environment variable: TPA_TEST = Y:\tpabetaX (Y: is "Alby")
TPA_DATA = Y:\tpabetaX (Y: is "Alby")

Special input files or modifications to input files required: modified lhs.out files were created.

Special diagnostic code modifications required: NONE

Program modes to be used: STANDARD

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: Microsoft Excel®

Test Description: There are two parts to the testing. First a direct inspection of the output filenames to verify the change in output filenames, second external calculations to verify that the average is being calculated correctly.
There are no special assumptions necessary for running this test.

There are no constraints applied to the execution of this test.

1. File Naming Requirement:

The files *epapktim.out* and *epa_ave.out* are to be renamed *gwppktim.res* and *gwp_ave.res* respectively.

A directory listing of the run directory should be inspected to assure that the *epapktim.out* file is now named *gwppktim.res* and that the *epa_ave.out* file is now named *gwp_ave.res*.

The test passes if the files names are correctly given as described above.

2. Dose Average Calculation Requirement:

The *gwp_ave.res* file contains time varying average dose (in mrem/yr) for several organs. The "zeroing" out of the dose array was moved to correct a miscalculation. The method for verifying the calculations is given

below.

The *gwp_ave.res* file is only printed if GroundwaterProtectionCalc flag is set and the program detects that the last realization has been reached (irrespective of how many realizations may have preceded it.) Time varying dose amounts for each realization used in the average calculation are unavailable for inspection so a method had to be devised that allowed for viewing this data.

A built in testing option (option 3) for the iconstant "LatinHypercubeSampling" allows the developer to use an existing *lhs.out* file as parameter input thus bypassing the *snllhs.e* LHS generation module. A pre-existing *lhs.out* file was modified to represent one realization, two realization, and three realization *lhs.out* files for use with three different *tpa.inp* files. Each subsequent *lhs.out* file includes the realization from the previous iteration so the average may be easily calculated. Corresponding *tpa.inp* files were modified to start and stop at the final realization so as to generate the *gwp_ave.res* file. A fourth *tpa.inp* file was set to run all three realizations with the same *lhs.out* file used in the three realization case 3. After each run was executed with its corresponding *lhs.out* file, the *gwp_ave.res* files were read into an Excel® spreadsheet. Because the runs were in actuality single vector runs but were divided by the number of realizations specified in the *tpa.inp* file, in calculating the Excel® average the single realization, averages were weighted according to the following formula

$$ave = \frac{a + 2 \times b + 3 \times c}{3}$$

where a, b, and c, represent the average dose from the single realization runs of the cases with sample sizes of one, two, and three respectively.

The test passes if the averages in the *gwp_ave.res* file are equivalent to the calculated average obtained from the Excel® calculations.

Test Results:

1. File name substitutions

epapktim.out is replaced with gwppktim.res: **PASS**

epa_ave.out is replaced with gwp_ave.res: **PASS**

2. Average Dose Calculations: **PASS**

Attachment S

12) Test by inspection of source code.

The source code was checked to verify that the change was properly implemented. Line 1760 of the file *ebsrel.f* was modified to

```
if (initialreductionlc .lt. 0.0d0 .or. weldadvfract .lt. 0.0d0) then
```

Therefore if either of the parameters **InitialSeepageReductionFractionLC** or **InitialSeepageReductionFractionWeldLC** is negative, then values under the column **fwc** in the file *wpflow.def* are adopted for the waste package flow factor. Such modification is consistent with the requested change.

Test Result: **PASS**

SCR - 686

TPA 5.1/ Beta W

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 686	2. Software Title and Version: TPA 5.1BetaW	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *ashremob.f*

Process-level validation testing discovered a formatting error in some of the intermediate output presented in *ashremob.out* for long simulation times after a volcanic eruption. At very long times after an eruption, any initial deposit at the receptor location is eroded to extremely thin thicknesses, which correspond to extremely small values of the resuspendible fraction {`resuspendiblefraction(it)` in *ashremob.f*}. For example, these extremely small values for resuspendible fraction create extremely small values for H_i-H (RMEI deposit outdoor, heavy disturbance contribution to airborne HLW concentration at RMEI) and H_i-L (RMEI deposit outdoor, light disturbance contribution to airborne HLW concentration at RMEI) in *ashremob.out*. When the values of these intermediate outputs drop below 1.E-99, the negative three digit exponential overwrites the E in *ashremob.out* (e.g., 1.74E-99 followed by 8.22-100 instead of 8.22E-100).

The *ashremob.f* calculations currently include the scaling by the MTU ejected at the stage where radionuclide doses are calculated. In order for the values in *ashremob.out* to match their indicated units, which are not normalized (i.e., not on a per MTU basis like *remob_lut.dat*), the scaling should occur earlier in the ASHREMOB module calculations.

5. Change Requested by: R. Benke	**Date:** 4-20-2007
6. Change Authorized by (*Software Developer*): R. Janetzke	**Date:** 4-20-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

See Attachment A..

8. Implemented by: R. Janetzke	**Date:** 5-8-07

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐

(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).

Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

Verified implementation as specified in Attachment A.

No errors found.

Code review accomplished by: Jose M. Menchaca	**Date:** 6-14-07

10. Description of Acceptance Tests:

See Attachment B

11. Tested by: Jose M. Menchaca	**Date:** 6-6-07

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for *TPA.INP*

SCR 686

Status *(ADD, DELETE, MODIFY TO, MODIFY FROM)*	**Module**	**Parameter Name**	**Description** *(Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.)*	**Distribution**	**Range**	**Justification** *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	**Source**
No Changes to *tpa.inp* parameters							

Attachment A

To solve the format problem, values of the resuspendible fraction less than 1.E-50 will be set to zero in *ashremob.f*.

After the existing block of code in *ashremob.f*

```
if (resuspendiblefraction(it) .gt. 1.0d0) then
   resuspendiblefraction(it) = 1.0d0
endif
```

<u>Add the following new block of code</u>

```
if (resuspendiblefraction(it) .lt. 1.0d-50) then
   resuspendiblefraction(it) = 0.0d0
endif
```

Scaling by the MTU ejected {`amtuejected` in *ashremob.f*} will be changed to occur at the three stages where the HLW concentrations are calculated and removed from the dose calculation stage.

Change

```
concentfactorinit = masshlwinit(iashplumerealindex) /
     &                              massashinit(iashplumerealindex)
```

to

```
concentfactorinit = amtuejected * masshlwinit(iashplumerealindex) /
     &                              massashinit(iashplumerealindex)
```

Change

```
          concentfactorfluv = masshlwfluv(iashplumerealindex) /
     &                              massashfluv(iashplumerealindex)
```

to

```
          concentfactorfluv = amtuejected * masshlwfluv(iashplumerealindex) /
     &                              massashfluv(iashplumerealindex)
```

Change

```
          concentfactoreoli = masshlweol(iashplumerealindex)/
     &                               massasheol(iashplumerealindex)
```

to

```
          concentfactoreoli = amtuejected * masshlweol(iashplumerealindex)/
     &                               massasheol(iashplumerealindex)
```

Change

```
          remperyrpernuclgs(j,k) = doseinh(j,ik) * amtuejected
```

to

```
          remperyrpernuclgs(j,k) = doseinh(j,ik)
```

Test Description: The objective of the test is to verify that formatting errors in the *ashremob.out* output file for long time periods and for large realization runs are corrected.

There are no special assumptions necessary for running this test.

There are no constraints applied to the execution of this test.

Test A: *ashremob.out* formatting

Execute a tpa run with the *tpa.inp* input file as described above for the tpa51betaW version and verify that the formatting error occurs. This can be done using the gvim editing utility to view the *ashremob.out* file and searching for the error as shown.

/[0-9]-[0-9][0-9][0-9]

This will find the erroneous output format.

Execute a tpa run with the *tpa.inp* input file as described above for the tpa51betaX version and verify that the formatting errors have been corrected. A search as described above while in gvim mode should not detect any occurrences of the search string.

The test passes if the there are no occurrences of the format error.

Test Results:

Removal of formatting errors: **PASS**

Test B: Division by zero test.

Verify that no divide by zero errors have been introduced by implementing the format corrections.

tpa.inp input file as described above for both the tpa51betaW version and verify that the formatting error occurs.

Divide by zero errors are indicated with an "Inf" in the output. A search of the string "Inf" in all of the output files of the 1024 run executed in Test A above will verify that no divide by zeros have been introduced.

This can be done using the DOS "Find" utility. The following line

find "Inf" *.* > ..\DivByZeroSearch.txt

will display occurrences of "Inf" in the output files.

The test passes if there are no occurrences of "Inf" in the search of the output files (unless intentionally expressed in the text.)

Test Results:

No Division By Zero introduced: **PASS**

Test C: Output Comparisons

(a) Dose Comparisons: Verify that the modified code does not change the dose histories for a 1024 realization run.

Because of changes to other sections of the tpa51betaX code, the best way to test this is to run the tpa51betaW code with the tpa51betaX version of the *ashremob.f* module. A comparison of the two *totdose.res* files will show that the dose history is the same.

The test passes if the *totdose.res* files of both versions are identical.

Test Results:

Identical dose history: **PASS**

Test C(b) Intermediate outputs for tpa51betaX version of H_i-H, H_i-L, H_f, H_e, H_RMEIoutdoor, H_RMEIindoor H_RMEIoffsite, H_RMEI in the *ashremob.out* file should increase by a factor equal to the value of MTU ejected over their tpa51betaW counterpart for a 3 realization simulation.

In order to test this, the OutputMode flag must be set to 1 and the SelectAppendFiles must be set to 6 in the *tpa.inp* input file. This allows the MTU ejected amount to be displayed in the *volcano.rlt* file. The Excel program may be used to read in the *ashremob.out* file from each version and calculate the ratios of the specified outputs. The ratios should correspond to the MTU ejected that is written in the *volcano.rlt* file.

The test passes if the specified outputs of the tpa51betaX values are larger than the tpa51betaW values by a factor equivalent to the MTU ejected.

Test Results:

Outputs increased by MTU ejected factor: **PASS**

Test C(c) identical values for intermediate outputs (not specified in item (b) above)

A comparison using the same Excel file as described above will indicate that the intermediate values are identical.

The test passes if the intermediate values are identical.

Increase by MTU ejected factor: **PASS**

SCR - 687

TPA 5.1/ Beta W

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 687	2. Software Title and Version: TPA 5.1betaW	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *uzft.f, exec.f, tpa.inp*

The *uzft.f* module is using rock grain density instead of rock bulk density to calculate effective surface area ("ssarea") which in turn is used to calculate the actinide Kds. The is no indication that Kd and Rd values for Curium (Cm) are being calculated. No Kd or Rd data is being reported to the *uz_kdrd.out* file. Update comment lines to reflect that calculations are executed for six actinides.

5. Change Requested by: J. Winterle	**Date:** 4-24-2007
6. Change Authorized by (*Software Developer*): R. Janetzke	**Date:** 4-26-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

See Appendix A for `diff` comparisons of the *uzft.f, exec.f*, and *tpa.inp* files before and after modification.

Kd/Rd data is shown in *uz_revers.out* and is not supposed to be in *uz_kdrd.out*.

8. Implemented by: Jose M. Menchaca	**Date:** 4-26-2007

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐

(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).

Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

Visual inspection of files was done using TPA5.1betaX source code. Visual inspection of *tpa.inp* verified that the specified changes were made. Visual inspection of *exec.f* and *uzft.f* verified that the indicated changes were made to comments to include Curium in the list of calculated actinides. Note: there is one place in the header block of the subroutine calc_rd where Cm needs to be listed along with the other actinides.

Code review accomplished by: C. Scherer	**Date:** 5-25-2007

10. Description of Acceptance Tests:

Changes to uzft.f replacing rock grain density with rock bulk density were verified and validated in validation tests P-12.1 and P-12.3. Please see Software Validation Report P-12.

11. Tested by: C. Scherer	**Date:** 5-25-2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for *TPA.INP*

SCR 687

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM*)	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.*)	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
Modify from	driftfail	RockMassDensityForRockTypeOne	used for calculating seismic static presures	Constant	2068.0	Bechtel SAIC Company, LLC. "Subsurface Geotechnical Parameters Report" 800-K0C-WIS0-00400-000-00A. Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2003.	G. I. Ofoegbu see Attachment B
Modify to					2139.0		
Modify from	driftfail	RockMassDensityForRockTypeTwo	used for calculating seismic static presures	Constant	2245.0	Same as above	same as above
Modify to					2322.0		
Modify from	nfenv	MassDensityofYMRock	used for calculating "bump" in temperature	Constant	2540.0	Same as above	same as above
Modify to					2166.0		

Appendix A

diff of the uzft.f file before and after modification:

```
diff uzft.f origs
162,165d161
< c
< c        05-09-07  J. Menchaca SCR687; Calculation of effective surface area
< c                                      Am to Am/Cm comments (Am kds/rds = Cm kds/rds)
< c                                      R. Rices avgwtttemp changes
794c790
< c   Calculate Kd's for radioelements Am/Cm,Np,Pu,Th,U.
---
> c   Calculate Kd's for radioelements Am,Np,Pu,Th,U.
797,799d792
< cjmm SCR687 EffectiveSurfaceArea calculation correction
< cjmm   EffectiveSurfaceArea = SpecificSurfaceArea =
< cjmm      3*rock_porosity / (rock_grain_density[g/m^3]*pore_radius[m])
801c794
< c      3*rock_porosity / (rock_bulk_density[kg/m^3]*pore_radius[m])
---
> c      3*rock_porosity / (rock_grain_density[g/m^3]*pore_radius[m])
831,834c824
< cjmm            ssarea     = 3.0d0*porosity / (density*poreradius)
<             ssarea  = 3.0d0*porosity / (density*(1-porosity)*poreradius)
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
< cjmm end of SCR687
---
>             ssarea     = 3.0d0*porosity / (density*poreradius)
856a847
>
875,879d865
< cjmm SCR687 Adding notation indicating Am and Cm are equivalent.
<          labels(9:11) = '/Cm'
<          labels(90:92) = '/Cm'
< cjmm end SCR687
<
881,884d866
< cjmm SCR687 Clarification of above comment:  rds are not calculated at this point.
< cjmm        Matrix rds are not calculated until a leg is known to be passed to NEFTRAN
< cjmm        where values are written to nefii.inp.
< cjmm        The rd values can be inspected in uz_reverse.out.
1660,1662d1641
< cjmm SCR687 (Rob's additions)
<       double precision avgwtttemp
< cjmm end SCR687
2655,2663d2633
< cjmm SCR687 (Rob's additions)
< cjmmcc reset the avgwtt of the layer so it is kept
< cjmm          avgwtt(ilayercondmaxmatrix) = gwttmin * 1.001d0
< cjmmcc reset the length of this layer
< cjmm          leglen(NP, ilayercondmaxmatrix) =
< cjmm     &                              leglen(NP, ilayercondmaxmatrix) *
< cjmm     &                       ( gwttmin / avgwtt(ilayercondmaxmatrix) )
< cc save the value of the gw travel time for the kept leg
<           avgwtttemp = avgwtt(ilayercondmaxmatrix)
2666c2636
< cc reset the length of this kept layer
---
> cc reset the length of this layer
2669,2670c2639
<      &                     ( avgwtt(ilayercondmaxmatrix) / avgwtttemp )
< cjmm end SCR687 (Rob's additions)
---
>      &                       ( gwttmin / avgwtt(ilayercondmaxmatrix) )
4792c4761
< c             calculates Kd's for Am/Cm,Np,Pu,Th,U using Response
---
> c             calculates Kd's for Am,Np,Pu,Th,U using Response
4819c4788
```

```
< c              kds      = double precision, calculated Kds of Am/Cm, Np, Pu,
---
> c              kds      = double precision, calculated Kds of Am, Np, Pu,
4872c4841
<       do i=1,nradioelements  !Am/Cm,Np,Pu,Th,U
---
>       do i=1,nradioelements  !Am,Np,Pu,Th,U
4908c4877
< c      do i=1,nradioelements  !Am/Cm,Np,Pu,Th,U
---
> c      do i=1,nradioelements  !Am,Np,Pu,Th,U
4942c4911
< c               Calculates RD's for Am/Cm,Np,Pu,Th,U using Response
---
> c               Calculates RD's for Am,Np,Pu,Th,U using Response
5005c4974
<          do i=1,nradioelements  !Am/Cm,Np,Pu,Th,U
---
>          do i=1,nradioelements  !Am,Np,Pu,Th,U
5009c4978
<          do i=1,nradioelements  !Am/Cm,Np,Pu,Th,U
---
>          do i=1,nradioelements  !Am,Np,Pu,Th,U
```

diff of the exec.f file before and after modification:

```
diff exec.f origs
14051,14056d14050
< cjmm SCR687 Noting identical coefficients for Americium and Curium
<       write(iuzkdrd, '(a)')
<      &      '     Note: The coefficient file named coefkdeq.dat has '//
<      &      'identical information for Americium and Curium.'
< cjmm+-^--1----+----2----+----3----+----4----+----5----+----6----+----7--!-+----8
< cjmm end SCR687
```

diff of the tpa.inp file before and after modification:

```
diff -C 2 tpa.inp origs
*** tpa.inp     Wed May  9 12:20:52 2007
--- origs/tpa.inp       Tue Apr 17 20:10:26 2007
***************
*** 2713,2721 ****
  *17.38
  **
- ** jmm 5-09-07 scr687
  constant
  MassDensityofYMRock[kg/m^3]
! 2166.0
! **2540.0
  **
  constant
--- 2713,2719 ----
  *17.38
  **
  constant
  MassDensityofYMRock[kg/m^3]
! 2540.0
  **
  constant
***************
*** 3463,3478 ****
  **
  ** rwj 4-17-07 scr685
- ** jmm 5-09-07 scr687
  constant
  RockMassDensityForRockTypeOne[kg/m^3]
! 2139.0
! **2068.0
  **2250.0
  **
```

```
- ** jmm 5-09-07 scr687
  constant
  RockMassDensityForRockTypeTwo[kg/m^3]
! 2322.0
! **2245.0
  **2250.0
  ** end scr685
--- 3461,3472 ----
  **
  ** rwj 4-17-07 scr685
  constant
  RockMassDensityForRockTypeOne[kg/m^3]
! 2068.0
  **2250.0
  **
  constant
  RockMassDensityForRockTypeTwo[kg/m^3]
! 2245.0
  **2250.0
  ** end scr685
```

Appendix B

Justification for Values of TPA Parameters

Parameters: RockMassDensityForRockTypeOne (bulk density of lower lithophysal unit)
RockMassDensityForRockTypeTwo (bulk density of middle nonlithophysal unit)
MassDensityofYMRock (average site-scale bulk density)

Author: G.I. Ofoegbu
Date: April 3, 2007
Revised: April 25, 2007

Bechtel SAIC Company, LLC. (2003, table 8-7, p. 8-20) provides values of dry bulk density ($\rho_{b\text{-}dry}$) for Topopah Spring Tuff units, including

$\rho_{b\text{-}dry}$ = 1979 kg/m^3 for Tptpll (lower lithophysal unit)
$\rho_{b\text{-}dry}$ = 2148 kg/m^3 for Tptpmn (middle nonlithophysal unit)
$\rho_{b\text{-}dry}$ = 2211 kg/m^3 for Tptpln (lower nonlithophysal unit)

Values of moist bulk density are not provided but an average saturated bulk density ($\rho_{b\text{-}sat}$) of 2411 kg/m^3 is given for the Tptpln unit (Bechtel SAIC Company, LLC., 2003, table 8-8, p. 8-21).

To estimate the moist bulk density for Tptpll and Tptpmn units using this data, it is assumed the bulk density (ρ_b) at a given saturation (s)[range: 0.0, 1.0] can be represented using the equation

$\rho_b = \rho_{b\text{-}dry} + s(\rho_{b\text{-}sat} - \rho_{b\text{-}dry})$ and $\rho_{b\text{-}sat} - \rho_{b\text{-}dry} = \alpha\rho_{b\text{-}dry}$

The data for Tptpln gives α=0.09 and s is set to 0.9 to obtain an estimate for average moist conditions. Therefore, the above equations give

$\rho_b = 1.081(\rho_{b\text{-}dry})$

which gives

ρ_b = 2,139 for Tptpll and ρ_b = 2,322 for Tptpmn. The average site-scale bulk density $\rho_{b\text{-}sitescale}$ is estimated as a weighted average assuming Tptpll and Tptpmn occupy 85% and 15%, respectively, of the site.

$\rho_{b\text{-}sitescale} = 0.85(2139) + 0.15(2322) = 2166$

Therefore,

RockMassDensityForRockTypeOne	=	2,139 kg/m^3
RockMassDensityForRockTypeTwo	=	2,322 kg/m^3
MassDensityofYMRock	=	2,166 kg/m^3

References

Bechtel SAIC Company, LLC. "Subsurface Geotechnical Parameters Report" 800-K0C-WIS0-00400-000-00A. Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2003.

SCR - 688

TPA 5.1/ Beta W

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 688	2. Software Title and Version: TPA 5.1betaW	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *releaset.f*

The drip shield is not breached by faulting or igneous events. Instead, the drip shield remains intact until it is breached by either mechanical load (rockfall) or general corrosion. The drip shield should allow seepage following faulting or igneous events.

5. Change Requested by: O. Pensado	Date: 4-23-2007
6. Change Authorized by (*Software Developer*): J. Winterle	Date: 4-25-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

The problem resolution was modification of *releaset.f* by using a value of 1.0 for the drip shield seepage factor (F_d) following the occurrence of a faulting or igneous event. As part of this change, Attachment A provides the lines of code added to *releaset.f* and the descriptive comment lines and shows a comparison between the original TPA 5.1betaW version of *releaset.f* and the modified *releaset.f*. Also, the conditions for printing a message on the screen regarding the consistency of WP failure times was modified.

8. Implemented by: R. Rice	Date: 4-26-2007

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☒ **No** ☐

(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).

Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*: **None**

Code review accomplished by: O. Pensado	Date: 05/25/07

10. Description of Acceptance Tests:

The EBS ground water releases (recorded in the file ebsrel.rlt) of FAULTO and VOLCANO were reproduced in independent runs considering only initially defective waste packages and selecting appropriate values of parameters DefectiveFractionOfWPs/cell, InitialFailureTime[yr], SFWettedFraction constants, FlagPartialProtectionFromSeepageByInitialDefWP[1=yes,0=no]=0, and FlagPartialProtectionFromSeepageByMechFailedDS[1=yes,0=no] = 0. Because VOLCANO and FAULTO EBS releases could only be simulated in independent runs by adopting FlagPartialProtectionFromSeepageByMechFailedDS[1=yes,0=no] = 0, it is concluded that in the faulting and igneous scenarios drip shields do not offer any partial protection against seepage. Therefore, the requested change was properly implemented. Details on the test are provided in Attachment B.

11. Tested by: O. Pensado	Date: 05/25/07

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for *TPA.INP*

SCR 688

Status (*ADD, DELETE, MODIFY TO, MODIFY FROM)*	Module	Parameter Name	Description (*Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.)*	Distribution	Range	Justification *1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.*	Source
None							

ATTACHMENT A

Comparing files releaset.f and RELEASET_ORIGINAL.F

```
***** releaset.f
c                                the critical temperature
c        4-23-07 rwr     SCR688 Account for drip shield failure/seepage following
c                        faulting and igneous events by setting ctfd(i) = 1.0
c
***** RELEASET_ORIGINAL.F
c                                the critical temperature
c
*****

***** releaset.f
cc      &      cftime .lt. sftimef .or. cftime .lt. sftimev) then
cc rwr 4/23/07; SCR688; account for drip shield failure/seepage following
cc                       faulting and igneous events by setting ctfd(i) = 1.0
cc                       (also, add a check to be sure imechp2 .gt. 0)
cc         if (mecht2 .lt. mecht1 .or.
        if ( (mecht2 .lt. mecht1 .and. imechp2 .gt. 0) .or.
     &                                 cftime .lt. mecht1  .or.
***** RELEASET_ORIGINAL.F
cc      &      cftime .lt. sftimef .or. cftime .lt. sftimev) then
        if (mecht2 .lt. mecht1 .or.
     &                                 cftime .lt. mecht1  .or.
*****

***** releaset.f

cc rwr 4/23/07; SCR688; account for drip shield failure/seepage following
cc                       faulting and igneous events by setting ctfd(i) = 1.0
cc                       (note that qinpart(i) is reset above)
cc             tfail = max(tfirstflow,tfail)
            do i=1,ntflo
              if(floref(i)*ctfr(i).gt.0.0d0) then
                tfail = max(tflo(i),tfail)
                go to 501
              end if
            end do
            tfail = max(tflo(ntflo),tfail)
  501       continue

***** RELEASET_ORIGINAL.F

            tfail = max(tfirstflow,tfail)

*****

***** releaset.f

cc rwr 4/23/07; SCR688; account for drip shield failure/seepage following
cc                       faulting and igneous events by setting ctfd(i) = 1.0
cc                       (note that qinpart(i) is reset above)
cc             tfail = max(tfirstflow,tfail)
            do i=1,ntflo
              if(floref(i)*ctfr(i).gt.0.0d0) then
                tfail = max(tflo(i),tfail)
                go to 502
              end if
            end do
            tfail = max(tflo(ntflo),tfail)
  502       continue
```

```
***** RELEASET_ORIGINAL.F

            tfail = max(tfirstflow,tfail)

*****

***** releaset.f
            elseif (itype .eq. 2) then

cc rwr 4/23/07; SCR688; account for drip shield failure/seepage following
cc                      faulting and igneous events by setting ctfd(i) = 1.0
cc                      (note that qinpart(i) is reset above)
            if (tflo(i) .lt. sftimef .and.
     &                         dabs((sftimef - tflo(i))/tflo(max(2,i)))
     &               .gt. 1.0d-3) then
                qinpart(i) = (floref(i)*flowfactr) * ctfmult(i) *
     &                                   ctfow(i) * ctfr(i) * ctfd(i)
            else
                qinpart(i) = (floref(i)*flowfactr) * ctfmult(i) *
     &                                   ctfow(i) * ctfr(i) * 1.0d0
            endif

c             if (tflo(i) .lt. sftimef .and.
***** RELEASET_ORIGINAL.F
            elseif (itype .eq. 2) then
c             if (tflo(i) .lt. sftimef .and.
*****

***** releaset.f
            elseif (itype .eq. 3) then

cc rwr 4/23/07; SCR688; account for drip shield failure/seepage following
cc                      faulting and igneous events by setting ctfd(i) = 1.0
cc                      (note that qinpart(i) is reset above)
            if (tflo(i) .lt. sftimev .and.
     &                         dabs((sftimev - tflo(i))/tflo(max(2,i)))
     &               .gt. 1.0d-3) then
                qinpart(i) = (floref(i)*flowfactr) * ctfmult(i) *
     &                                   ctfow(i) * ctfr(i) * ctfd(i)
            else
                qinpart(i) = (floref(i)*flowfactr) * ctfmult(i) *
     &                                   ctfow(i) * ctfr(i) * 1.0d0
            endif

c             if (tflo(i) .lt. sftimev .and.
***** RELEASET_ORIGINAL.F
            elseif (itype .eq. 3) then
c             if (tflo(i) .lt. sftimev .and.
*****
```

In[2028]:=

```
SetDirectory["D:/Version5.1beta/betaY/"];
<< LeeDatos.m;
<< CommonPackages.m;
```

■ SCR 688, ATTACHMENT B

TPA 5.1 beta Y
***Mathematica* 5.1**

Approach:
1. Run d00
Execute FAULTO scenario with the following changes to tpa.inp
Subarea 3 only, 10,000 yr, 10 realizations
FAULTO scenario: FaultingDisruptiveScenarioFlag(yes=1,no=0)=1
No initials: DefectiveFractionOfWPs/cell = loguniform(1.0e-10, 1.0e-9)
No LC: WeldCritChlorideConc[mol/L]=100.0; CritChlorideConcForFirstLayer[mol/L]=100.0
No Mech: DripShieldBulkheadTributaryArea[m^2] = 0.0
Same SFWettedFraction: SFWettedFraction_Initial=0.5; SFWettedFraction_FAULTO=0.5; SFWettedFraction_-VOLCANO=0.5

2. Run d01
Find a realization with a reasonable number of breached WPs by FAULTO (realization 5)
Same as Run d00, only realization 5 executed

3. Run d02
Same as d01 with the following changes (to reproduce releases and doses with initially defective WPs):
FaultingDisruptiveScenarioFlag(yes=1,no=0)=0
Probability_WPWaterAllowance_InitialDefects=uniform(0.9999, 1.0)
InitialFailureTime[yr]=5.833E+03
Force 7 failed WP (out of 2904 in SA 3): DefectiveFractionOfWPs/cell=loguniform(0.0024, 0.00241)
FlagPartialProtectionFromSeepageByInitialDefWP[1=yes,0=no]=0

4. Run d03
Same as d02 with the following changes:
FlagPartialProtectionFromSeepageByMechFailedDS[1=yes,0=no]=0 (No seepage protection by DS)

Run d03 must be identical to Run d01. Run d02 must yield lower EBS release because the DS does divert some water away.

If Run d03 is identical than Run d01, then it is concluded that in the FAULTO scenario the drip shield is not assumed to divert water away.

In[2111]:=

```
(*Fraction of initially defective WPs *)
7.0 / 2904
```

Out[2111]=

```
0.00241047
```

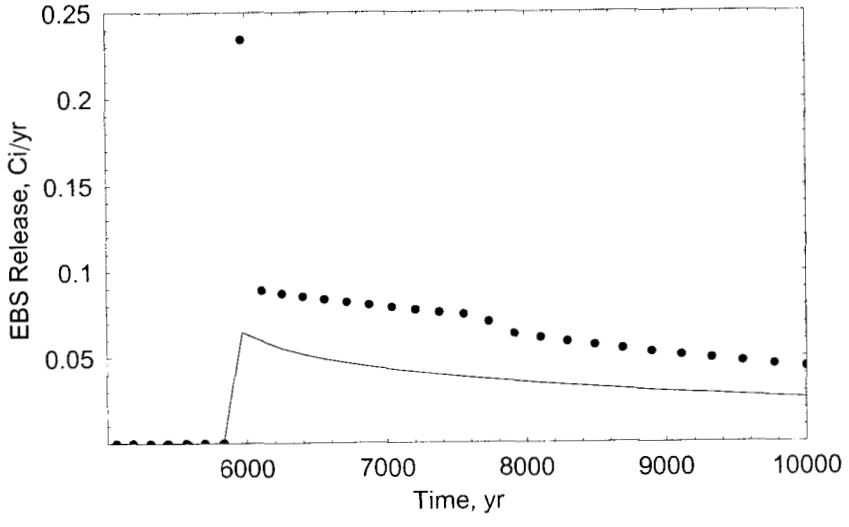
In[2133]:=

```
(*Read data from ebsrel.rlt*)
dat01 = LeeDatos["d01\ebsrel_realizations.txt", 1, 2];
dat02 = LeeDatos["d02\ebsrel_realizations.txt", 1, 2];
dat03 = LeeDatos["d03\ebsrel_realizations.txt", 1, 2];
```

In[2142]:=

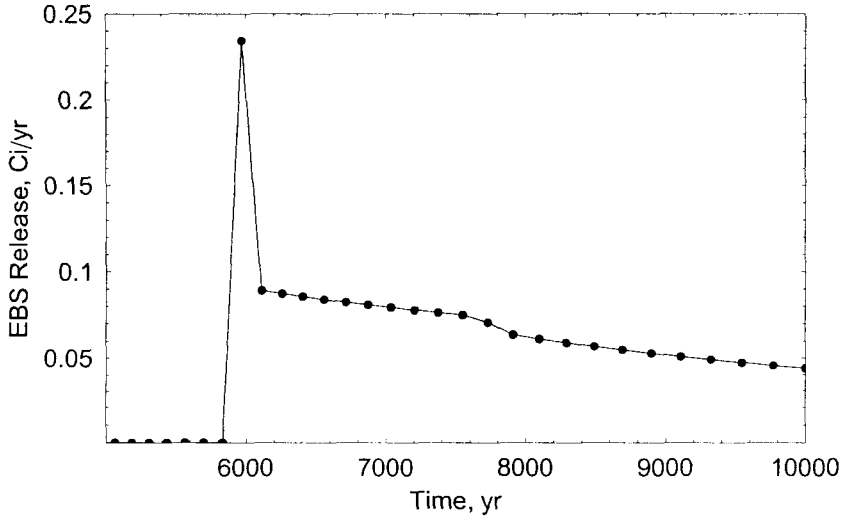
```
plotFunction = ListPlot;
Print["Dots: d01   Line: d02"];
DisplayTogether[
  plotFunction[dat01 + 1*^-50, Frame → True,
   PlotRange → {{5000, 1*^4}, {0, 0.25}}, Axes → None, PlotStyle → AbsolutePointSize[4],
   FrameLabel → {"Time, yr", "EBS Release, Ci/yr", "", ""}],
  plotFunction[dat02 + 1*^-50, PlotJoined → True]];
```

Dots: d01 Line: d02



```
In[2145]:=
plotFunction = ListPlot;
Print["Dots: d01   Line: d03"];
DisplayTogether[
  plotFunction[dat01 + 1*^-50, Frame → True,
   PlotRange → {{5000, 1*^4}, {0, 0.25}}, Axes → None, PlotStyle → AbsolutePointSize[4],
   FrameLabel → {"Time, yr", "EBS Release, Ci/yr", "", ""}],
  plotFunction[dat03 + 1*^-50, PlotJoined → True]];
```

```
Dots: d01   Line: d03
```



Since Run d01 and d03 produce identical releases from the EBS, it is concluded that the software change request was properly implemented for the FAULTO scenario.

TPA 5.1 beta Y
***Mathematica* 5.1**

VOLCANO Approach:
1. Run v00
Execute VOLCANO scenario with the following changes to tpa.inp
Subarea 3 only, 10,000 yr, 10 realizations
VolcanismDisruptiveScenarioFlag(yes=1,no=0)=1
No initials: DefectiveFractionOfWPs/cell = loguniform(1.0e-10, 1.0e-9)
No LC: WeldCritChlorideConc[mol/L]=100.0; CritChlorideConcForFirstLayer[mol/L]=100.0
No Mech: DripShieldBulkheadTributaryArea[m^2] = 0.0
Same SFWettedFraction: SFWettedFraction_Initial=0.5; SFWettedFraction_FAULTO=0.5; SFWettedFraction_-VOLCANO=0.5

2. Run v01
Find a realization with a reasonable number of breached WPs by FAULTO (realization 1).
Same as v00, only realization 1 executed

3. Run v02

Realization 1

Same as v01 with the following changes (to reproduce releases and doses with initially defective WPs):

FaultingDisruptiveScenarioFlag(yes=1,no=0)=0

Probability_WPWaterAllowance_InitialDefects=uniform(0.9999, 1.0)

InitialFailureTime[yr]=3.0764E+03

Force 7 failed WP (out of 2904 in SA 3): DefectiveFractionOfWPs/cell=loguniform(0.220386, 0.2204)

FlagPartialProtectionFromSeepageByInitialDefWP[1=yes,0=no]=0

4. Run v03

Same as v02 with the following changes

FlagPartialProtectionFromSeepageByMechFailedDS[1=yes,0=no]=0 (No seepage protection by DS)

Run v03 must be identical to Run v01. Run v02 must yield lower EBS release because the DS does divert some water away.

If Run v03 is identical than Run v01, then it is concluded that in the VOLCANO scenario the drip shield is not assumed to divert water away.

In[2110]:=

```
(*Fraction of initially defective WPs *)
640.0 / 2904
```

Out[2110]=

```
0.220386
```

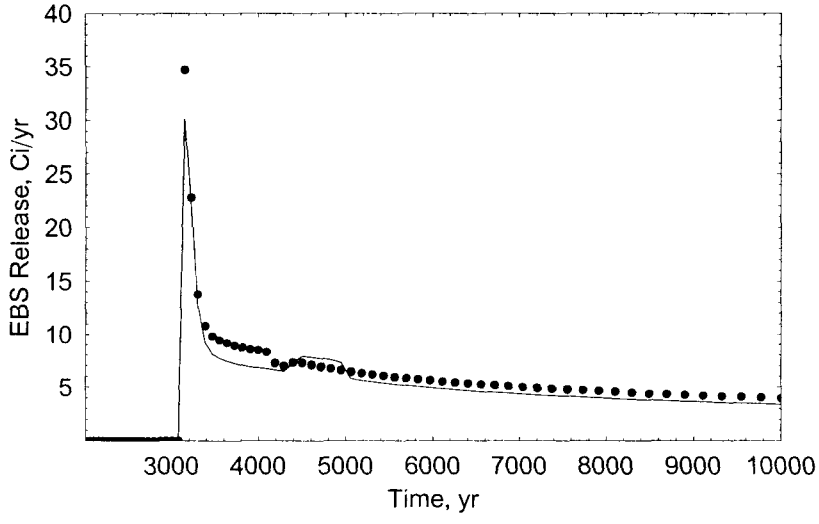
In[2148]:=

```
(*Read data from ebsrel.rlt*)
dat01 = LeeDatos["v01\ebsrel_realizations.txt", 1, 2];
dat02 = LeeDatos["v02\ebsrel_realizations.txt", 1, 2];
dat03 = LeeDatos["v03\ebsrel_realizations.txt", 1, 2];
```

In[2151]:=

```
plotFunction = ListPlot;
Print["Dots: v01   Line: v02"];
DisplayTogether[
  plotFunction[dat01 + 1*^-50, Frame → True,
   PlotRange → {{2000, 1*^4}, {0, 40}}, Axes → None, PlotStyle → AbsolutePointSize[4],
   FrameLabel → {"Time, yr", "EBS Release, Ci/yr", "", ""}],
  plotFunction[dat02 + 1*^-50, PlotJoined → True]];
```

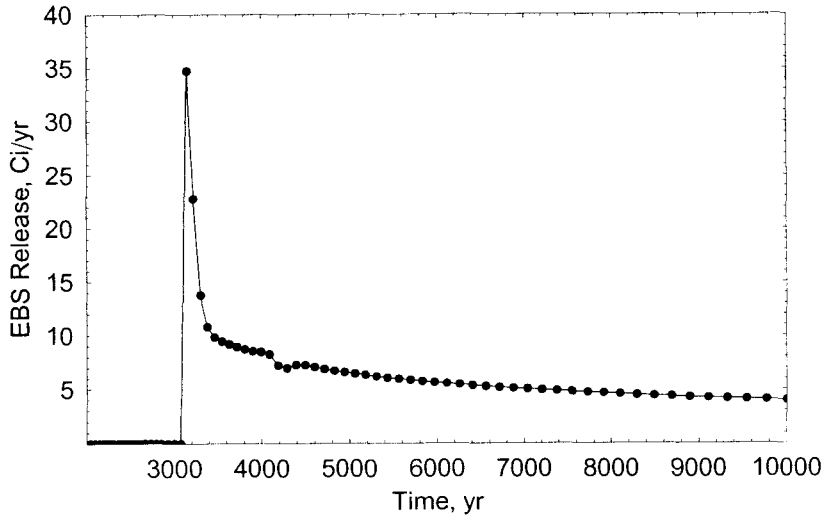
Dots: v01 Line: v02



In[2154]:=

```
plotFunction = ListPlot;
Print["Dots: v01   Line: v03"];
DisplayTogether[
  plotFunction[dat01 + 1*^-50, Frame → True,
   PlotRange → {{2000, 1*^4}, {0, 40}}, Axes → None, PlotStyle → AbsolutePointSize[4],
   FrameLabel → {"Time, yr", "EBS Release, Ci/yr", "", ""}],
  plotFunction[dat03 + 1*^-50, PlotJoined → True]];
```

```
Dots: v01   Line: v03
```



Since Runs v01 and v03 produce identical releases from the EBS, it is concluded that the software change request was properly implemented for the VOLCANO scenario.

TEST CONCLUSION: PASS

xxx

SCR - 689

TPA 5.1/ Beta X

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 689	2. Software Title and Version: TPA 5.1betaX	3. Project No: 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *ebsfilt.f, tpa.inp, execc.i, fu2.i, exec.f, ashplume.f, burnup.dat, coefkdeq.dat, drythick.dat, ebsfail.def, ebsrel.def, mechfail_ds.def, mechfail_wp.def, nuclides.dat, repdes.dat,* and *strmtube.dat.*

1) The EBSFILT module does not process the *ebsfilt.inp* file correctly when the number of colloids is zero.
2) Set SeismicDisruptiveScenarioFlag(yes=1,no=0) to 0 for reference case.
3) Reconcile the InvertThickness and InvertHeight values in the *tpa.inp* file.
4) Use the term "effective dose equivalent" in *gwppktim.res* rather than "dose equivalent".
5) Remove the phrase "This has *n* sections" in the reformatted files.
6) Increase the number of file unit numbers to 255. 200 is insufficient for some elaborate tests.
7) The EBS release values are missing from the *uzft.ech* file.

5. Change Requested by: C. Scherer	Date: 5-10-2007
6. Change Authorized by (*Software Developer*): R. Janetzke Ron Janetzke	Date: 5-11-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):

See Attachment A.

8. Implemented by: R. Janetzke Ron Janetzke	Date: 5-11-2007

9. Code Review Needed (see TOP-018, 5.4.7) Yes ☐ No ☒
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution (*If no errors are found, indicate with "None".*):

Code review accomplished by:	Date:

10. Description of Acceptance Tests:

See Attachments B & C.

11. Tested by: J. Menchaca JMen P. LaPlante	Date: 05-23-2007 05-31-2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for *TPA.INP*

SCR 689

Status (***ADD, DELETE, MODIFY TO, MODIFY FROM***)	**Module**	**Parameter Name**	**Description** (***Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.***)	**Distribution**	**Range**	**Justification** ***1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.***	**Source**
modify from	DRIFT FAIL	SeismicDisruptiveScenarioFlag(yes=1,no=0)	Seismicity flag.	iflag	1		
modify to	DRIFT FAIL	SeismicDisruptiveScenarioFlag(yes=1,no=0)	Seismicity flag.	iflag	0	NRC direction	Winterle
modify from	MECH FAIL	InvertHeight[m]	Maximum thickness of invert	constant	0.721		
modify to	MECH FAIL	InvertHeight[m]	Maximum thickness of invert	constant	0.806	CRWMSM&O 2000, SDD-EDS-SE-00000 1 REV 1,	Mancilla s
modify from	EBSFILT	InvertThickness[m]	Maximum thickness of invert	constant	0.86		
modify to	EBSFILT	InvertThickness[m	Maximum thickness of invert	constant	0.806	CRWMSM&O 2000, SDD-EDS-SE-00000 1 REV 1,	Mancilla s

Attachment A

7. Description of Changes or Problem Resolution

1) The EBSFILT module read SECTION 4 of the *ebsfilt.inp* file irregardless of whether is was in the file or not. This section is not written when the irreversible colloids are turned off. So in this case it tried to read a non-existent section. A test was moved in the EBSFILT module to include this read statement in the part that is skipped when the colloids are absent.

2) The **SeismicDisruptiveScenarioFlag(yes=1,no=0)** flag in *tpa.inp* is set to 0.

3) The **InvertHeight[m]** parameter and the **InvertThickness[m]** are both set to 0.806.

4) The phrase "dose equivalent" was changed to "effective dose equivalent" in file *gwppktim.res*. Description clarification edits were also applied to the "Whole Body" term.

5) The phrase "This file has *n* sections" was removed from all reformatted files.

6) The maximum number of file units (**maxunit**) was changed from 200 to 255 in *fu2.i.*

7) A correction was made to an "implied DO loop" that writes the *uzft.ech* file in *exec.f.* The original loop was not set to start at the first position in the array, thus it skipped the portion of the array desired fro output.

Attachment B

Description of Acceptance Tests:

Test Plan Name: Cleanup Test

Tested By: Jose M. Menchaca | Date: 05/23/2007

Host Machine: "TPA" 64 bit Microsoft Windows Server | Host OS: Microsoft Windows Ver 5.2

Baseline Version: TPA51betaX | Test Version: TPA51betaY

Process Level (PL) Tests

PL-1 Name:

Path for run directory: D:\public\jmenchaca\tpa51betaX (tpa.cnwra.swri.edu)
D:\public\jmenchaca\tpa51betaY (tpa.cnwra.swri.edu)

Path for archive directory: On attached CD:
\tpa51betaX
\tpa51betaY

Environment variable: TPA_TEST = Y:\tpabetaX (Y: is "Alby")
TPA_DATA = Y:\tpabetaY (Y: is "Alby")
TPA_TEST = L:\tpabetaX (L: is "Ladybug" for item 06 test)
TPA_DATA = L:\tpabetaY (L: is "Ladybug" for item 06 test)

Special input files or modifications to input files required: Modify the *tpa.inp* when necessary as described in test plan sections.

Special diagnostic code modifications required: NONE

Program modes to be used: STANDARD (except for special exec module for testing item 06)

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: fc, find

Test Description: The objective of the test is to verify that the multiple changes described in SCR 689 have been correctly implemented.

There are no special assumptions necessary for running this test.

There are no constraints applied to the execution of this test.

1. EBSFILT processing with zero colloids:

The tpa51betaX code would malfunction when the following parameters in the *tpa.inp* file were set as described below:

InvertBypass = 0 instead of 1 forcing a pass through the invert

InvertMatrixPermeability = 7.0 m^2 instead of 7.0×10^{-18} m^2 thus making the invert pervious to flow.

IrreversibleColloidModel = 0 instead of 1 setting all irreversible colloids to 0.

The test passes if the code runs with the above settings with no malfunctions.

Test Results:

EBSFILT processing with zero colloids: **PASS**

2. SeismicDisruptiveScenarioFlag set to 0 for reference case:

A visual inspection of the *tpa.inp* file will verify whether this parameter has been changed.

The test passes if the SeismicDisruptiveScenarioFlag is set to 0 in the *tpa.inp* file.

Test Results:

```
***** Y:\TPA51BETAX\tpa.inp
SeismicDisruptiveScenarioFlag(yes=1,no=0)
1
**
***** Y:\TPA51BETAY\TPA.INP
SeismicDisruptiveScenarioFlag(yes=1,no=0)
0
**
*****
```

SeismicDisruptiveScenarioFlag set to 0 for reference case: **PASS**

3. InvertThickness and InvertHeight values:

A visual inspection of the *tpa.inp* file will verify implementation of the values as shown in the table on page 2.

The test passes if the InvertThickness and InvertHeight values are as shown in the table on page 2.

Test Results:

```
***** Y:\TPA51BETAX\tpa.inp
InvertHeight[m]
0.721
**
***** Y:\TPA51BETAY\TPA.INP
InvertHeight[m]
0.806
**0.721   SCR689
**
*****

***** Y:\TPA51BETAX\tpa.inp
InvertThickness[m]
0.86
** 0.606 removed for SCR685
***** Y:\TPA51BETAY\TPA.INP
InvertThickness[m]
0.806
** 0.86    SCR689
** 0.606 removed for SCR685
*****
```

InvertThickness and InvertHeight values: **PASS**

5. Remove the phrase "This has n sections" in the reformatted files:

The dos "find" utility will be used to find occurrences of "This file has " in tpa51betaX and tpa51betaY input and output files.

The test passes if no occurrences of "This file has *n* sections" appears in any of the input, intermediate or output files.

Test Results:

Phrase "This has n sections" removed in the reformatted files:**PASS**

6. Increase the number of file unit numbers to 255:

A visual inspection of the *fu2.i* file will verify if this task has been completed.

The test passes if the maxunit parameter is set for 255 in the *fu2.i* file. Additionally a modification to the *exec.f* module as shown below will verify that 255 files are allowed to open.

```
L:\tpa51betaY>fc exec.f origs\exec.f
Comparing files exec.f and ORIGS\EXEC.F
***** exec.f
cc (read failure information from ebstrh.dat)
cjmm  Inserted to test SCR689 Item 6.
      integer idummyUnit
      integer idummyLoop

      do idummyLoop = 1,500
         idummyUnit =  igetunitnumber('exec    ')
         print *,' idummyUnit is now ', idummyUnit
      enddo

      iunitebstrh   =  igetunitnumber('exec    ')
***** ORIGS\EXEC.F
cc (read failure information from ebstrh.dat)
      iunitebstrh   =  igetunitnumber('exec    ')
*****
```

Test Results:

Visual Inspection

```
P:\>fc Y:\tpa51betaX\fu2.i Y:\tpa51betaY\fu2.i
Comparing files Y:\TPA51BETAX\fu2.i and Y:\TPA51BETAY\FU2.I
***** Y:\TPA51BETAX\fu2.i
c rlr parameter (maxunit = 150 )
      parameter (maxunit = 200 )
      common / iunit2 / iunit(maxunit)
***** Y:\TPA51BETAY\FU2.I
c rlr parameter (maxunit = 150 )
cc rwj 5-15-07; SCR689
c     parameter (maxunit = 200 )
      parameter (maxunit = 255 )

      common / iunit2 / iunit(maxunit)
*****
```

Special Run

```
 idummyUnit is now  11
 idummyUnit is now  12
 idummyUnit is now  13
      .
      .
      .
 idummyUnit is now  263
 idummyUnit is now  264
 idummyUnit is now  265
 ***>>> Error in igetunitnumber <<<***
    iopen .gt. maxunit
    iopen =  256
    maxunit =  255
    need to increase size of maxunit

 File Unit Numbers Currently Being Used
```

```
Number,  Name of Subroutine
  11   exec
  12   exec
  13   exec
     .
     .
     .
 263   exec
 264   exec
 265   exec
```

Increase the number of file unit numbers to 255: **PASS**

7. EBS release values are missing from the *uzft.ech* file:

A visual inspection of the *uzft.ech* file will verify the presence of the EBS release values in the *uzft.ech* file.

The test passes if the EBS release values are present for each nuclide in the *uzft.ech* file.

Test resuts:

EBS release values are missing from the *uzft.ech* file: **PASS**

Attachment C

Acceptance Test Plan and Results for TPA SCR#689, Item 4, Changes

Test Plan Name: Acceptance Test for Text Changes to *gwp_ave.res* File

Tested By: P. LaPlante

Date: 5/31/07

Host Machine: Froggy (PC)

Host OS: Windows XP Professional, V2002, Service Pack 2

Baseline Version: TPA5.1BetaY

Test Version: TPA5.1BetaY

Process Level (PL) Tests

PL-4. Name: Verification of Text Changes to Groundwater Protection Output File gwp_ave.res

Path for run directory: c:\TPA51BetaY\
Path for archive of results: CD
Environment variables:

Basecase TPA_DATA=c:\tpa51BetaY\
TPA_DATA=c:\tpa51BetaY\

Testcase TPA_DATA=c:\tpa51BetaY\
TPA_DATA=c:\tpa51BetaY\

Special input files or modifications to input files required:

Run an unmodified base case *tpa.inp* and rename the file *tpameans.out* to *tpa.inp*, change

NumberOfRealizations to 1
StopAtRealization to 0
DSFractionThicknessPenetratedForFailureByCorrosion[] to 0
WPFractionThicknessPenetratedForFailureByCorrosion[] to 0

(Note: an initial test run verified no releases to groundwater for a mean value reference case run so DS and WP inputs above were modified to force early waste package failure so groundwater computations provide results)

Special diagnostic code modifications required : None
Program modes to be used (append flags, scenario/model switches, etc.): No further changes
Utility scripts needed to perform the test: None
Utility codes needed in the analysis of the test data: None

Test description:

Objective:

1) Verify *gwp_ave.res* file header includes in the Whole Body Dose definition the word "effective" before "dose equivalent" to read "....average whole body committed effective dose equivalent ....".

Assumptions: None
Constraints: None
Output files to compare or examine
gwp_ave.res

Step by step test procedure to be used

1. Run an unmodified base case *tpa.inp* and rename the file *tpameans.out* to *tpa.inp*, change inputs as described above.

2. Run the "mean value" *tpa.inp* file created in Step 1 and copy output files from the run directory to a uniquely named file archive directory (\SCR689\p4).

3. Verify by inspection that the groundwater protection calculation output file header for file *gwp_ave.out* includes in the Whole Body Dose definition the word "effective" before "dose equivalent" to read "....average whole body committed effective dose equivalent ....".

Pass/fail criteria

Criterion 1: output file header for file *gwp_ave.out* includes in the Whole Body Dose definition the word "effective" before "dose equivalent" to read "....average whole body committed effective dose equivalent ....".

Test Results:

Files referenced herein including code run and post processing are included in attached CD \SCR689\P4

Criterion 1: **PASS**

Overall test status (**PASS**):

SCR - 694

TPA 5.1/ Beta Y

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (*Software Developer Assigns*): SCR 694	**2. Software Title and Version:** TPA 5.1betaY	**3. Project No:** 20.06002.01.354

4. Affected Software Module(s), Description of Problem(s): *exec.f,* .
1) Bug fix for averaging multiple realizations in the *rgwsap.tpa* file.
2) Change the parameter units to unitless for:
FractionOfCondensateRemoved[1/yr]
FractionOfCondensateTowardRepository[1/yr]
FractionOfCondensateTowardRepositoryRemoved[1/yr]
3) Headers in file *uzft.ech* are not aligned.
4) Add Numerical Recipe disclaimer to subroutines **tred2()** and **tqli()** in the ITYM file *uncertain.f.*
5) Update selected data in *tpa.inp, ggenii.def* and *ggeniis.def* data files. (See Attachments A, B, C, and D for details.)
6) Update solubility values for Mo and Ag to be the same as Pb in ASHRMOVO section of *tpa.inp.*
7) Correct spelling error "genereator" in *climato1.dat.*

5. Change Requested by: R. Janetzke (1&3) H. Basagaoglu (2) J. Winterle (4) P. LaPlante (5) D. Hooper (6) C. Scherer (7)	**Date:** 6-1-2007
6. Change Authorized by (*Software Developer*): R. Janetzke	Date: 6-1-2007

7. Description of Change(s) or Problem Resolution (*If changes not implemented, please justify*):
1) Variable **ntim** was changed to **maxntime** at line 9950 of *exec.f.*
2) Spelling change made to *tpa.inp* and *nfenv.f.*
3) Modified header for *uzft.ech* in *exece.i*, and the file format in *exec.f.*
4) Added disclaimers to *uncertain.f.*
5) *tpa.inp, ggenii.def*, and *ggeniis.def* modified as described in Attachments A, B, C, and D.
6) Set solubilities for Mo and Ag to the Pb values in *tpa.inp.*
7) Spelling change in *climato1.dat.*

8. Implemented by: R. Janetzke	**Date:** 6-7-07

9. Code Review Needed (see TOP-018, 5.4.7) **Yes** ☐ **No** ☒
(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with ☒).
Describe any errors detected and their resolution *(If no errors are found, indicate with "**None**".)*:

Code review accomplished by:	**Date:**

10. Description of Acceptance Tests:
See Attachment E.

11. Tested by: J. M. Menchaca J. M. M	**Date:** 6-18-2007

Form TOP-5 (10/2006)

UPDATE REQUIREMENTS for *TPA.INP*

SCR 694

Status (***ADD, DELETE, MODIFY TO, MODIFY FROM***)	**Module**	**Parameter Name**	**Description** (***Definition of parameter in terms of its function in TPA code; calculated from . . ., used for calculating . . ., used to relate . . ., etc.***)	**Distributio n**	**Range**	**Justification** ***1. Site references (journals, scientific notebooks, publications). 2. Indicate level of uncertainty covered by the distribution / range. 3. Explain why you chose this range / distribution vs. other possible values / methods / distributions.***	**Source**
MODIFY FROM							
MODIFY TO							

Attachment A

Email for Item 5 from P. LaPlante

Femi/Ron,

The attached word perfect files include parameter changes and associated input data file changes for DCAGW and DCAGS. These are included in redline/strikeout format (new values are in red). These files are submitted to comply with the request to have all input parameter changes provided by Feb 28. Existing and updated values and bases for all DCAGW/DCAGS tpa.inp input parameters are included in the large WP table file (DCAGW.DCAGS*.wpd) which matches the format and content guidelines for the user guide (this is for Chapter 17). The two excel files merely support the values included in the WP files and are provided for information purposes only (you may or may not have any use for them but I will probably include them in a scientific notebook that will go with the Chapter 17 user guide file archive).

Changes to TPA data files (ggenii.def; ggeniis.def) are redlined into copies of the files imported into WP (ggenii.def.update.wpd; ggeniis.def.update.wpd). These are intended to show changes (very few) and not for direct incorporation into the code (actual ascii files must be edited with a text editor…I can do that if you want…just let me know if that is what you need). I currently do not have permission to access to Spock or ALBY drives where the current code files exist (not sure why….working on that). Changes to the data files were needed for consistency with the changes to tpa.inp inputs, to remove outdated labeling information (title, dates etc).

The general bases for the recommended changes are described briefly in the e-mail below. Let me know if you need additional information or if additional work needs to be done on any of this to meet your needs.

Thanks

Pat

Attachment B

Parameter changes and associated input data file changes for DCAGW and DCAGS.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
DCAGW	ReceptorGroup (1=Farming, 2=Residential)	Receptor Group (1=Member of Farming Community, 2=Residential)	iconstant 1	Farming community consistent with 10 CFR 63.312(b) requirements.
DCAGW	DistanceTo ReceptorGroup[km]	Distance to receptor group [km]	constant 18	18 km consistent with 10 CFR 63.312(a) requirements.
DCAGW	PluvialSwitchTime [yr]	Time to switch from nonpluvial (current) biosphere climate conditions to pluvial (cooler and wetter) [yr]	constant 2000	Available information and analyses on climate change is summarized in Forester (2000). This analysis suggests a transition to the Glacial Transition Climate after 2,000 years. This value is consistent with updated information that the TPA code uses to calculate mean annual precipitation and temperature values for each timestep.
GENTPA	Age&Dosimetry (1=inf,2=todl, 3=pteen,4=teen, 5=Adlt,6=AdltFG 11)	Flag to select dosimetry standard	iconstant 5	Allows selection of either the existing Federal Guidance Report No. 11 dosimetry approach (value = 6) or the newer ICRP 72 approach (value = 5) for all TPA dose calculations in DCAGW and DCAGS.
GENTPA	InterceptionFraction /Irrigate	Irrigation interception fraction [unitless]	triangular 0.06, 0.4, 0.8	Based on review of the literature summary by Anspaugh (1987). The lower bound is 0.06 and the upper bound was reduced from 1.0 in the reference to 0.8 to limit excessive conservatism. The mode of the distribution is the recommended value of 0.4.
GENTPA	DepthOfSurfaceSoil [cm]	Depth of surface soil [cm]	constant 15	Default value from Napier, et al. (1988). Parameter represents plow depth that is used in the model to differentiate between two soil layers (surface and deep). The surface layer is contaminated and the deep layer is clean. TPA implementation assumes all roots are in surface soil layer.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	YearsOfIrrigation PriorToIntakePeriod [yr]	Years of irrigation water deposition prior to the intake period [yr]	iconstant 15	Assumption based on transient nature of farming in Amargosa Valley (insights gained from visiting with local residents). DOE has concluded that the irrigation time significantly affects soil buildup for elements such as Am, Cs, Ni, Pa, Pu, Ra, Sr, Th, and U (CRWMS M&O, 2000b), but not the key contributors to dose for the groundwater irrigation-based exposure scenario (i.e., Tc-99, I-129, Np-237). Thus uncertainty in the parameter is not expected to be significant for the basecase results. For the igneous scenario, there is no irrigation buildup of radionuclides, and the radionuclides that dominate that scenario dose are not prone to leaching so any "washout" effect from irrigation would be small.
GENTPA	LeafyVegetable IrrigationRatePB [in/yr]	Leafy vegetable irrigation rate for pluvial biosphere [in/yr]	triangular ~~14.3, 19.5, 25.7~~ 15, 21, 25	Average annual irrigation rates ~~data~~ for an upper bound glacial transition climate are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (20~~03~~4) ~~showing irrigation rates~~ for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods~~. The climate adjustment done by the Center for Nuclear Waste Regulatory Analyses (CNWRA), documented by LaPlante and Poor (1997) for pluvial biosphere dose conversion factors, is applied to the irrigation rate data from Bechtel SAIC Company, LLC (2003). The CNWRA climate adjustment to the irrigation rate estimates is based on differences in irrigation rates for the Yucca Mountain region and a location in Idaho exhibits temperature and rainfall characteristics similar to~~ that are expected to be representative of estimated future Yucca Mountain region climate change conditions (semiarid). The input parameter distribution represents the variation in the average annual irrigation rates for those crops included in the specified category.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	OtherVegetable IrrigationRatePB [in/yr]	Other vegetable irrigation rate for pluvial biosphere [in/yr]	triangular ~~11.1, 24.1, 42.0~~ 7, 17, 28	Same as for LeafyVegetableIrrigationRatePB ~~Irrigation rate data are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (2003) showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods. The climate adjustment done by the Center for Nuclear Waste Regulatory Analyses (CNWRA), documented by LaPlante and Poor (1997) for pluvial biosphere dose conversion factors, is applied to the irrigation rate data from Bechtel SAIC Company, LLC (2003). The CNWRA climate adjustment to the irrigation rate estimates is based on differences in irrigation rates for the Yucca Mountain region and a location in Idaho that exhibits temperature and rainfall characteristics similar to estimated future Yucca Mountain region climate change conditions (semiarid).~~
GENTPA	FruitIrrigationRate PB[in/yr]	Fruit irrigation rate for pluvial biosphere [in/yr]	triangular ~~27.4, 39.4, 50.9~~ 6, 17, 29	Same as for LeafyVegetableIrrigationRatePB ~~Irrigation rate data are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (2003) showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods. The climate adjustment done by the Center for Nuclear Waste Regulatory Analyses (CNWRA), documented by LaPlante and Poor (1997) for pluvial biosphere dose conversion factors, is applied to the irrigation rate data from Bechtel SAIC Company, LLC (2003). The CNWRA climate adjustment to the irrigation rate estimates is based on differences in irrigation rates for the Yucca Mountain region and a location in Idaho that exhibits temperature and rainfall characteristics similar to estimated future Yucca Mountain region climate change conditions (semiarid).~~

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	GrainIrrigationRate PB[in/yr]	Grain irrigation rate for pluvial biosphere [in/yr]	triangular ~~15.9, 21.1, 26.3~~ 12, 22, 29	Same as for LeafyVegetableIrrigationRatePB ~~Irrigation rate data are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (2003) showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods. The climate adjustment done by the Center for Nuclear Waste Regulatory Analyses (CNWRA), documented by LaPlante and Poor (1997) for pluvial biosphere dose conversion factors, is applied to the irrigation rate data from Bechtel SAIC Company, LLC (2003). The CNWRA climate adjustment to the irrigation rate estimates is based on differences in irrigation rates for the Yucca Mountain region and a location in Idaho that exhibits temperature and rainfall characteristics similar to estimated future Yucca Mountain region climate change conditions (semiarid).~~
GENTPA	HomeIrrigationRate PB[in/yr]	Residential irrigation rate for pluvial biosphere [in/yr]	constant ~~45~~ 33	Same as for LeafyVegetableIrrigationRatePB ~~Irrigation rate data are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (2003) showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods. The climate adjustment done by the Center for Nuclear Waste Regulatory Analyses (CNWRA), documented by LaPlante and Poor (1997) for pluvial biosphere dose conversion factors, is applied to the irrigation rate data from Bechtel SAIC Company, LLC (2003). The CNWRA climate adjustment to the irrigation rate estimates is based on differences in irrigation rates for the Yucca Mountain region and a location in Idaho that exhibits temperature and rainfall characteristics similar to estimated future Yucca Mountain region climate change conditions (semiarid).~~

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	PoultryFeed IrrigationRatePB [in/yr]	Poultry feed irrigation rate for pluvial biosphere [in/yr]	triangular ~~15.9, 21.1, 26.3~~ 12, 22, 29	Same as for LeafyVegetableIrrigationRatePB ~~Irrigation rate data are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (2003) showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods. The climate adjustment done by the Center for Nuclear Waste Regulatory Analyses (CNWRA), documented by LaPlante and Poor (1997) for pluvial biosphere dose conversion factors, is applied to the irrigation rate data from Bechtel SAIC Company, LLC (2003). The CNWRA climate adjustment to the irrigation rate estimates is based on differences in irrigation rates for the Yucca Mountain region and a location in Idaho that exhibits temperature and rainfall characteristics similar to estimated future Yucca Mountain region climate change conditions (semiarid).~~
GENTPA	HenFeedIrrigation RatePB[in/yr]	Egg-laying hen feed irrigation rate for pluvial biosphere [in/yr]	triangular ~~15.9, 21.1, 26.3~~ 12, 22, 29	Same as for LeafyVegetableIrrigationRatePB ~~Irrigation rate data are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (2003) showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods. The climate adjustment done by the Center for Nuclear Waste Regulatory Analyses (CNWRA), documented by LaPlante and Poor (1997) for pluvial biosphere dose conversion factors, is applied to the irrigation rate data from Bechtel SAIC Company, LLC (2003). The CNWRA climate adjustment to the irrigation rate estimates is based on differences in irrigation rates for the Yucca Mountain region and a location in Idaho that exhibits temperature and rainfall characteristics similar to estimated future Yucca Mountain region climate change conditions (semiarid).~~

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	LeafyVegetable IrrigationTimePB [mo/yr]	Leafy vegetable irrigation time for pluvial biosphere [mo/yr]	~~uniform~~ ~~3.0, 7.0~~ constant 5	Crop-specific growing season lengths for eastern Washington State were documented as an analogue for future upper bound glacial maximum climate agricultural conditions in the Yucca Mountain region (Bechtel SAIC Company, LLC 2004), table 6.4-1). The selected value is within the range of potential future climate and agricultural conditions discussed in LaPlante and Poor (1997), however, the specific point estimate is preferred to maintain consistency with the annual average irrigation rates (e.g., LeafyVegetableIrrigationRatePB was derived using the same growing season information). ~~Crops that are grown in Amargosa Valley were selected from a list produced by the local agricultural extension office (Mills, 1993). The list also contained information on the duration of the growing season for various crops. Selected crop growing times were then obtained from a gardening book (Chambers and Mays, 1994), and the irrigation duration was calculated based on the number of plantings per year that was possible given the estimated pluvial temperature profile in LaPlante and Poor (1997).~~
GENTPA	OtherVegetable IrrigationTimePB [mo/yr]	Other vegetable irrigation time for pluvial biosphere [mo/yr]	~~uniform~~ ~~2.0, 7.0~~ constant 7	Same as for LeafyVegetableIrrigationTimePB ~~Crops that are grown in Amargosa Valley were selected from a list produced by the local agricultural extension office (Mills, 1993). The list also contained information on the duration of the growing season for various crops. Selected crop growing times were then obtained from a gardening book (Chambers and Mays, 1994), and the irrigation duration was calculated based on the number of plantings per year that was possible given the estimated pluvial temperature profile in LaPlante and Poor (1997).~~
GENTPA	FruitIrrigationTime PB[mo/yr]	Fruit irrigation time for pluvial biosphere [in/yr]	~~uniform~~ ~~2.0, 6.0~~ constant 4	Same as for LeafyVegetableIrrigationTimePB ~~Crops that are grown in Amargosa Valley were selected from a list produced by the local agricultural extension office (Mills, 1993). The list also contained information on the duration of the growing season for various crops. Selected crop growing times were then obtained from a gardening book (Chambers and Mays, 1994), and the irrigation duration was calculated based on the number of plantings per year that was possible given the estimated pluvial temperature profile in LaPlante and Poor (1997).~~

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	GrainIrrigationTime PB[mo/yr]	Grain irrigation time for pluvial biosphere [mo/yr]	~~uniform~~ ~~3.0, 7.0~~ constant 6	Same as for LeafyVegetableIrrigationTimePB ~~Crops that are grown in Amargosa Valley were selected from a list produced by the local agricultural extension office (Mills, 1993). The list also contained information on the duration of the growing season for various crops. Selected grain crop growing times were obtained from English and Nakamura (1989), and the irrigation duration was calculated based on the number of plantings per year that was possible given the estimated pluvial temperature profile in LaPlante and Poor (1997) and a 1-month drying period prior to harvest.~~
GENTPA	HomeIrrigationTime PB[mo/yr]	Residential irrigation time for pluvial biosphere [mo/yr]	~~uniform~~ ~~6.0,12.0~~ constant 12	Based on the assumption that the receptor cares for a lawn ~~a minimum of 6 months (i.e., during the cooler months of the year) and a maximum~~ for the entire year. This assumption was informed by a pamphlet provided by a local agricultural extension office (Mills, 1993) as discussed by LaPlante and Poor (1997). Selected value is consistent with growing period used for irrigation rate (HomeIrrigationRatePB) derived from Bechtel SAIC Company, LLC, (2004).
GENTPA	PoultryFeed IrrigationTime PB[mo/yr]	Poultry feed irrigation time for pluvial biosphere [mo/yr]	~~uniform~~ ~~3.0, 7.0~~ constant 6	Same as for GrainIrrigationTimePB.
GENTPA	HenFeedIrrigation TimePB[mo/yr]	Egg-laying hen feed irrigation time for pluvial biosphere [mo/yr]	~~uniform~~ ~~3.0, 7.0~~ constant 6	Same as for GrainIrrigationTimePB.
GENTPA	LeafyVegetable IrrigationRateCB [in/yr]	Leafy vegetable irrigation rate for current biosphere [in/yr]	triangular ~~20.1, 27.4, 36.2~~ 20, 34, 59	Average annual Irrigation rates for current climate conditions ~~data~~ are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (2003~~4~~) ~~showing irrigation rates~~ for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods that are expected to be representative of current Yucca Mountain region climate and agricultural conditions (arid). The input parameter distribution represents the variation in the average annual irrigation rates for those crops included in the specified category

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	OtherVegetable IrrigationRateCB [in/yr]	Other vegetable irrigation rate for current biosphere [in/yr]	triangular ~~15.7, 34.0, 59.1~~ 16, 31, 52	Same as for LeafyVegetableIrrigationRateCB ~~Irrigation rate data are tabulated in table 6.5-2 of Bechtel SAIC Company, LLC (2003) showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods.~~
GENTPA	FruitIrrigationRate CB[in/yr]	Fruit irrigation rate for current biosphere [in/yr]	triangular ~~38.6, 55.5, 71.7~~ 27, 45, 60	Same as for LeafyVegetableIrrigationRateCB except upper limit was truncated to maintain consistency with local permitted maximum water use as reported in LaPlante and Poor (1997). ~~Irrigation rate data are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (2003) showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods.~~
GENTPA	GrainIrrigationRate CB[in/yr]	Grain irrigation rate for current biosphere [in/yr]	triangular ~~22.4, 29.7, 37.0~~ 22, 35, 47	Same as for LeafyVegetableIrrigationRateCB ~~Irrigation rate data are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (2003) showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods.~~
GENTPA	HomeIrrigationRate CB[in/yr]	Residential irrigation rate for current biosphere [in/yr]	constant 63.~~4~~	Same as for LeafyVegetableIrrigationRateCB ~~Irrigation rate data are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (2003) showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods.~~
GENTPA	PoultryFeed IrrigationRateCB [in/yr]	Poultry feed irrigation rate for current biosphere [in/yr]	triangular ~~22.4, 29.7, 37.0~~ 22, 35, 47	Same as for GrainIrrigationRateCB[in/yr].
GENTPA	HenFeedIrrigation RateCB[in/yr]	Egg-laying hen feed irrigation rate for current biosphere [in/yr]	triangular ~~22.4, 29.7, 37.0~~ 22, 35, 47	Same as for GrainIrrigationRateCB[in/yr].

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	LeafyVegetable IrrigationTimeCB [mo/yr]	Leafy vegetable irrigation time for current biosphere [mo/yr]	~~uniform~~ ~~3.0, 8.0~~ constant 5	Crop-specific growing season lengths applicable to the current climate and agricultural conditions in the Yucca Mountain region are provided in Bechtel SAIC Company, LLC 2004, table 6.4-1. The selected value is within the range of climate and agricultural conditions discussed in LaPlante and Poor (1997), however, the specific point estimate is preferred to maintain consistency with the annual average irrigation rates (e.g., LeafyVegetableIrrigationRateCB was derived using the same growing season information). ~~Crops that are grown in Amargosa Valley were selected from a list produced by the local agricultural extension office (Mills, 1993). The list also contained information on the duration of the growing season for various crops. Selected crop growing times were then obtained from a gardening book (Chambers and Mays, 1994), and the irrigation duration was calculated based on the number of plantings per year that was possible per season.~~
GENTPA	OtherVegetable IrrigationTimeCB [mo/yr]	Other vegetable irrigation time for current biosphere [mo/yr]	~~uniform~~ ~~2.0, 8.0~~ constant 5	Same as for LeafyVegetableIrrigationTimeCB ~~Crops that are grown in Amargosa Valley were selected from a list produced by the local agricultural extension office (Mills, 1993). The list also contained information on the duration of the growing season for various crops. Selected crop growing times were then obtained from a gardening book (Chambers and Mays, 1994), and the irrigation duration was calculated based on the number of plantings per year that was possible per season.~~
GENTPA	FruitIrrigationTime CB[mo/yr]	Fruit irrigation time for current biosphere [mo/yr]	~~uniform~~ ~~2.0, 3.0~~ constant 5	Same as for LeafyVegetableIrrigationTimeCB except to note that a value outside the previously derived range in LaPlante and Poor (1997) is due to the inclusion of additional crops in the fruit crop category used to compute the current value. ~~Crops that are grown in Amargosa Valley were selected from a list produced by the local agricultural extension office (Mills, 1993). The list also contained information on the duration of the growing season for various crops. Selected crop growing times were then obtained from a gardening book (Chambers and Mays, 1994), and the irrigation duration was calculated based on the number of plantings per year that was possible per season.~~

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	GrainIrrigationTime CB[mo/yr]	Grain irrigation time for current biosphere [mo/yr]	~~uniform~~ ~~6.0, 8.0~~ constant 7	Same as for LeafyVegetableIrrigationTimeCB ~~Crops that are grown in Amargosa Valley were selected from a list produced by the local agricultural extension office (Mills, 1993). The list also contained information on the duration of the growing season for various crops. Selected grain crop growing times were obtained from English and Nakamura (1989), and the irrigation duration was calculated based on the number of plantings per year that was possible given the estimated pluvial temperature profile in LaPlante and Poor (1997) and a 1-month drying period prior to harvest.~~
GENTPA	HomeIrrigationTime CB[mo/yr]	Residential irrigation time for current biosphere [mo/yr]	~~uniform~~ ~~6.0, 12.0~~ constant 12	Based on the assumption that the receptor cares for a lawn ~~a minimum of 6 months (i.e., during the cooler months of the year) and a maximum~~ for the entire year. This assumption was informed by a pamphlet provided by a local agricultural extension office (Mills, 1993) as discussed by LaPlante and Poor (1997). Selected value is consistent with growing period used for irrigation rate (HomeIrrigationRateCB) derived from Bechtel SAIC Company, LLC, (2004).
GENTPA	PoultryFeed IrrigationTimeCB [mo/yr]	Poultry feed irrigation time for current biosphere [mo/yr]	~~uniform~~ ~~6.0, 8.0~~ constant 7.0	Same as for GrainIrrigationTimeCB[mo/yr].
GENTPA	HenFeedIrrigation TimeCB[mo/yr]	Egg-laying hen feed irrigation time for current biosphere [mo/yr]	~~uniform~~ ~~6.0, 8.0~~ constant 7.0	Same as for GrainIrrigationTimeCB[mo/yr].
GENTPA	PoultryFeedGrow Time[day]	Poultry feed growing time [day]	~~uniform~~ ~~60.0, 90.0~~ constant 200	Same as for GrainIrrigationTimeCB[mo/yr]. ~~Value for wheat from English and Nakamura (1989).~~
GENTPA	HenFeedGrowTime [day]	Egg-laying hen feed growing time [day]	~~uniform~~ ~~60.0, 90.0~~ constant 200	Same as for GrainIrrigationTimeCB[mo/yr]. ~~Value for wheat from English and Nakamura (1989).~~
GENTPA	BeefFreshForage DietFraction	Beef cattle fresh forage diet fraction [unitless]	normal 0.12, 0.98	Values are from a Nevada test site pathways study by Breshears, et al. (1992) and are relevant to southern Nevada livestock husbandry.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	MilkFreshForage DietFraction	Dairy cattle fresh forage diet fraction [unitless]	normal 0.12, 0.98	Values are from a Nevada test site pathways study by Breshears, et al. (1992) and are relevant to southern Nevada livestock husbandry.
GENTPA	BeefFreshForage GrowTime[day]	Beef cattle fresh forage growing time [day]	uniform 30.0, 62.0	The values are derived from available information on alfalfa discussed by Stichler (1991) and Kennedy and Strenge (1992) as discussed by LaPlante and Poor (1997). Range encompasses value used to derive BeefFreshForageIrrigationTimeCB and BeefFreshForageIrrigationRatePB.
GENTPA	MilkFreshForage GrowTime[day]	Dairy cattle fresh forage growing time [day]	uniform ~~60.0~~30.0, 62.0	Same as for BeefFreshForageGrowTime[day]. ~~The values for this parameter distribution were derived from available information on alfalfa discussed by Stichler (1991) and Kennedy and Strenge (1992) as discussed by LaPlante and Poor (1997).~~
GENTPA	BeefFreshForage IrrigationRatePB [in/yr]	Beef cattle fresh forage irrigation rate for pluvial biosphere [in/yr]	~~triangular~~ ~~23.2, 36.8, 54.2~~ constant 33	Same as for LeafyVegetableIrrigationRatePB except a constant value is used because Alfalfa is assumed to be the primary feed crop as described in LaPlante and Poor, 1997. ~~Forage is assumed to be alfalfa based on local conditions discussed by LaPlante and Poor (1997). Irrigation rate data are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (2003), showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulae that incorporate data on local climate, soil, crops, and irrigation methods. The climate adjustment done by CNWRA and documented by LaPlante and Poor (1997) for pluvial biosphere dose conversion factors is applied to the irrigation rate data from Bechtel SAIC Company, LLC (2003). The CNWRA climate adjustment to the irrigation rate estimates is based on differences in irrigation rates for the Yucca Mountain region and a location in Idaho that exhibits temperature and rainfall characteristics similar to estimated future Yucca Mountain region climate change conditions (semiarid).~~

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	MilkFreshForage IrrigationRatePB [in/yr]	Milk fresh forage irrigation rate for pluvial biosphere [in/yr]	~~triangular~~ ~~23.2, 36.8, 54.2~~ constant 33	Same as for LeafyVegetableIrrigationRatePB except a constant value is used because Alfalfa is assumed to be the primary feed crop as described in LaPlante and Poor, 1997. ~~Forage is assumed to be alfalfa based on local conditions discussed by LaPlante and Poor (1997). Irrigation rate data is tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (2003), showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods. The climate adjustment done by CNWRA and documented by LaPlante and Poor (1997) for pluvial biosphere dose conversion factors is applied to the irrigation rate data from Bechtel SAIC Company, LLC (2003). The CNWRA climate adjustment to the irrigation rate estimates is based on differences in irrigation rates for the Yucca Mountain region and a location in Idaho that exhibits temperature and rainfall characteristics similar to estimated future Yucca Mountain region climate change conditions (semiarid).~~
GENTPA	BeefFreshForage IrrigationTimePB [mo/yr]	Beef cattle fresh forage irrigation time for pluvial biosphere [mo/yr]	~~uniform~~ ~~3.0, 7.0~~ constant 7	Same as for LeafyVegetableIrrigationTimePB ~~Based on expected climate change temperature conditions for pluvial period and forage information discussed by LaPlante and Poor (1997); 5 months of the year are expected to have temperatures intolerable for forage crops resulting in maximum growing season for forage of 7 months. Using the reported alfalfa growing times (see BeefFreshForageGrowTime) of 30 to 62 days (between cuttings) and 3 to 5 cuttings per season noted by LaPlante and Poor (1997), it is possible to irrigate for a minimum of 3 months for three cuttings and a maximum of 7 months for the entire growing season.~~
GENTPA	MilkFreshForage IrrigationTimePB [mo/yr]	Dairy cattle fresh forage irrigation time for pluvial biosphere [mo/yr]	~~uniform~~ ~~3.0, 7.0~~ constant 7	Same as for LeafyVegetableIrrigationTimePB ~~Based on expected climate change temperature conditions for pluvial period and forage information discussed by LaPlante and Poor (1997); 5 months of the year are expected to have temperatures intolerable for forage crops resulting in maximum growing season for forage of 7 months. Using the reported alfalfa growing times (see BeefFreshForageGrowTime) of 30 to 62 days (between cuttings) and 3 to 5 cuttings per season noted in LaPlante and Poor (1997), it is possible to irrigate for a minimum of 3 months for three cuttings and a maximum of 7 months for the entire growing season.~~

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	BeefFreshForage IrrigationRateCB [in/yr]	Beef cattle fresh forage irrigation rate for current biosphere [in/yr]	~~triangular~~ ~~32.7, 51.8, 76.4~~ constant 60	Same as for LeafyVegetableIrrigationRateCB except a constant value is used because Alfalfa is assumed to be the primary feed crop (as described in LaPlante and Poor, 1997) and the current value was truncated to maintain consistency with local permitted maximum water use as reported in LaPlante and Poor (1997). ~~Forage is assumed to be alfalfa based on local conditions discussed by LaPlante and Poor (1997). Irrigation rate data are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (2003), showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods.~~
GENTPA	MilkFreshForage IrrigationRateCB [in/yr]	Dairy cattle fresh forage irrigation rate for current biosphere [in/yr]	~~triangular~~ ~~32.7, 51.8, 76.4~~ constant 60	Same as for LeafyVegetableIrrigationRateCB except a constant value is used because Alfalfa is assumed to be the primary feed crop (as described in LaPlante and Poor, 1997) and the current value was truncated to maintain consistency with local permitted maximum water use as reported in LaPlante and Poor (1997). ~~Forage is assumed to be alfalfa based on local conditions discussed by LaPlante and Poor (1997). Irrigation rate data are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (2003) showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods.~~

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	BeefFreshForage IrrigationTimeCB [mo/yr]	Beef cattle fresh forage irrigation time for current biosphere [mo/yr]	~~uniform~~ ~~3.0, 8.0~~ constant 9	Same as for LeafyVegetableIrrigationTimeCB except a slightly higher value is used than was considered in LaPlante and Poor (1997) and the value was also truncated from the reported value in the current reference (11 mo) to maintain consistency with the corresponding irrigation rate (BeefFreshForageIrrigationRateCB[in/yr]) which was truncated to avoid exceeding the local permitted maximum water use. ~~Based on current temperature conditions and forage information discussed by LaPlante and Poor (1997), 4 months of the year are expected to have temperatures intolerable for forage crops, resulting in a maximum growing season for forage of 8 months. Using the reported alfalfa growing times (see BeefFreshForageGrowTime) of 30 to 62 days (between cuttings) and 3 to 5 cuttings per season noted by LaPlante and Poor (1997), it is possible to irrigate for a minimum of 3 months for three cuttings and maximum of 8 months for the entire growing season.~~
GENTPA	MilkFreshForageI rrigationTimeCB [mo/yr]	Dairy cattle fresh forage irrigation time for current biosphere [mo/yr]	~~uniform~~ ~~3.0, 8.0~~ constant 9	Same as for LeafyVegetableIrrigationTimeCB except a slightly higher value is used than was considered in LaPlante and Poor (1997) and the value was also truncated from the reported value in the current reference (11 mo) to maintain consistency with the corresponding irrigation rate (BeefFreshForageIrrigationRateCB[in/yr]) which was truncated to avoid exceeding the local permitted maximum water use. ~~Based on current temperature conditions and forage information discussed by LaPlante and Poor (1997), 4 months of the year are expected to have temperatures intolerable for forage crops, resulting in maximum growing season for forage of 8 months. Using the reported alfalfa growing times (see BeefFreshForageGrowTime) of 30 to 62 days (between cuttings) and 3 to 5 cuttings per season noted by LaPlante and Poor (1997), it is possible to irrigate for a minimum of 3 months for three cuttings and maximum of 8 months for the entire growing season.~~
GENTPA	DrinkingWater ConsumptionRate5 [L/yr]	Drinking water consumption rate for adult:ICRP72 [l/yr]	constant 730	Specified in the Nuclear Regulatory Commission regulation 10 CFR 63.312(d) that the reasonably maximally exposed individual drinks 2 liters of water per day. That value equals 730 liters per year.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	LeafyVegetable ConsumptionRate5 [kg/yr]	Leafy vegetable consumption rate for adult:ICRP72 [kg/yr]	constant 15	Mean annual consumption for residents of Amargosa Valley that consume local produce. This is the mean consumption rate of the adult population in Amargosa Valley that consumes locally produced food, based on a DOE survey of local residents (CRWMS M&O, 2000a).
GENTPA	OtherVegetable ConsumptionRate5 [kg/yr]	Other vegetable consumption rate for adult:ICRP72 [kg/yr]	constant 7.8	Mean annual consumption for residents of Amargosa Valley that consume local produce. This is the mean consumption rate of the adult population in Amargosa Valley that consumes locally produced food, based on a DOE survey of local residents (CRWMS M&O, 2000a).
GENTPA	FruitConsumption Rate5[kg/yr]	Fruit consumption rate for adult:ICRP72 [kg/yr]	constant 16	Mean annual consumption for residents of Amargosa Valley that consume local produce. This is the mean consumption rate of the adult population in Amargosa Valley that consumes locally produced food, based on a DOE survey of local residents (CRWMS M&O, 2000a).
GENTPA	GrainConsumption Rate5[kg/yr]	Grain consumption rate for adult:ICRP72 [kg/yr]	constant 0.48	Mean annual consumption for residents of Amargosa Valley that consume local produce. This is the mean consumption rate of the adult population in Amargosa Valley that consumes locally produced food, based on a DOE survey of local residents (CRWMS M&O, 2000a).
GENTPA	BeefConsumption Rate5[kg/yr]	Beef consumption rate for adult:ICRP72 [kg/yr]	constant 2.9	Mean annual consumption for residents of Amargosa Valley that consume local produce. This is the mean consumption rate of the adult population in Amargosa Valley that consumes locally produced food, based on a DOE survey of local residents (CRWMS M&O, 2000a).
GENTPA	Poultry ConsumptionRate5 [kg/yr]	Poultry consumption rate for adult:ICRP72 [kg/yr]	constant 0.8	Mean annual consumption for residents of Amargosa Valley that consume local produce. This is the mean consumption rate of the adult population in Amargosa Valley that consumes locally produced food, based on a DOE survey of local residents (CRWMS M&O, 2000a).
GENTPA	MilkConsumption Rate5[kg/yr]	Milk consumption rate for adult:ICRP72 [kg/yr]	constant 4.1	Mean annual consumption for residents of Amargosa Valley that consume local produce. This is the mean consumption rate of the adult population in Amargosa Valley that consumes locally produced food. Based on a DOE survey of local residents (CRWMS M&O, 2000a).

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	EggConsumption Rate5[kg/yr]	Egg consumption rate for adult:ICRP72 [kg/yr]	constant 6.7	Mean annual consumption for residents of Amargosa Valley that consume local produce. This is the mean consumption rate of the adult population in Amargosa Valley that consumes locally produced food, based on a DOE survey of local residents (CRWMS M&O, 2000a).
GENTPA	InhalationExposure Time5[hr]	Inhalation exposure time for adult:ICRP72 [hr/yr]	constant ~~4200~~ 4843	Based on information in Mohanty et al. (2005, Chapter 5) and Kennedy and Strenge (1992)~~ as described by LaPlante and Poor (1997)~~, including a 0.5 indoor exposure factor; ~~4800~~6,022 hr/yr indoors; ~~1,700~~1,832 hr/yr outdoors~~; and 100 hr/yr gardening~~ (i.e., ~~4,800~~6022 × 0.5 + ~~1,700 + 100~~ 1832= ~~4,200~~4843). ~~Forty~~ About seventeen hours per week are assumed to be spent outside of the area for employment.
GENTPA	InhalationRate5 [cm3/s]	Inhalation rate for adult:ICRP72 [cm^3/s]	constant 270	Default chronic inhalation rate for GENII 1.485 code (Napier, et al., 1988). ~~Information and recommendations in the EPA exposure factors handbook (EPA, 1997) suggest this value is above average for U.S. adults.~~ Magnitude of breathing rate is influenced by the level of human activity. Value used is between light and moderate work activities discussed in Kennedy and Strenge (1992).
GENTPA	SoilContamination ExposureTime5[hr]	Soil contamination exposure time adult:ICRP72 [hr/yr]	constant ~~1800~~ 1832	Based on same assumptions for outdoor activity as for InhalationRate5[cm3/s] ~~Based on outdoor exposure duration provided in Kennedy and Strenge (1992) as described by LaPlante and Poor (1997). Includes 1,700 hr/yr outdoors and 100 hr/yr gardening.~~
GENTPA	PlantUptakeScale Factor	Plant uptake scaling factor used to scale plant transfer factors in *gftrans.dat*	lognormal 0.10, 9.8	The range for this parameter is the 0.1 to 99.9 percent interval using distribution statistics from International Union of Radioecologists (1989). For Yucca Mountain relevant crop types and elements, an uncertainty factor of four generally bounded the data (LaPlante and Poor, 1997). Assuming the data are lognormally distributed and the uncertainty factor used in the reference was for a 95 percent confidence interval, the applicable geometric standard deviation is 2. Applying this geometric standard deviation to a 0.1- and 99.9-percentile interval using lognormal distribution statistics results in the range of 0.1 to 9.8. This scale factor is multiplied by the tabulated plant uptake factors to induce variation in the fixed (tabulated) values.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	AnimalUptakeScale Factor	Animal uptake scaling factor used to scale animal transfer factors in *gftrans.dat*	lognormal 0.10, 9.8	Information quantifying uncertainty in animal uptake factors equivalent to that available for plants was not provided in the source documentation, but the scale factor distribution applied to plant uptake (based on a geometric standard deviation of 2) generally encompassed the variation reported for the animal uptake factors in International Atomic Energy Agency (1994). (See basis for PlantUptakeScaleFactor.)
GENTPA	KD_Soil_Cm [cm3/g]	Soil K_d for Curium [cm^3/g]	usersuppliedpwisecdf 7666.0, 0.0 7785.4, 0.115 9604.6, 0.184 11849.0, 0.274 14617.9, 0.382 18033.7, 0.500 22247.8, 0.618 27446.7, 0.726 33860.4, 0.816 41772.8, 0.885 44260.0, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.
GENTPA	KD_Soil_Pu[cm3/g]	Soil K_d for Plutonium [cm^3/g]	usersuppliedpwisecdf 316.0, 0.0 395.4, 0.115 742.5, 0.184 1394.1, 0.274 2617.6, 0.382 4914.8, 0.500 9228.0, 0.618 17326.6, 0.726 32532.7, 0.816 61083.7, 0.885 114691.4, 0.933 190000.0, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	KD_Soil_U[cm3/g]	Soil K_d for Uranium [cm^3/g]	usersuppliedpwisecdf 0.17, 0.0 0.27, 0.067 0.71, 0.115 1.86, 0.184 4.85, 0.274 12.7, 0.382 33.1, 0.500 86.5, 0.618 225.9, 0.726 589.9, 0.816 1540.7, 0.885 4023.9, 0.933 6000.0, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.
GENTPA	KD_Soil_Am[cm3/g]	Soil K_d for Americium [cm^3/g]	usersuppliedpwisecdf 100.0, 0.0 192.5, 0.184 419.9, 0.274 916.0, 0.382 1998.2, 0.500 4359.0, 0.618 9509.1, 0.726 20743.7, 0.816 45251.9, 0.885 98715.8, 0.933 215345.7, 0.964 300000.0, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	KD_Soil_Np[cm3/g]	Soil K_d for Neptunium [cm^3/g]	usersuppliedpwisecdf 1.30, 0.0 1.92, 0.067 3.19, 0.115 5.31, 0.184 8.85, 0.274 14.7, 0.382 24.5, 0.500 40.9, 0.618 68.0, 0.726 113.3, 0.816 188.7, 0.885 314.2, 0.933 400.0, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.
GENTPA	KD_Soil_Ra[cm3/g]	Soil K_d for Radium [cm^3/g]	usersuppliedpwisecdf 1262.0, 0.0 2230.5, 0.184 5653.3, 0.274 14328.4, 0.382 36315.5, 0.500 92042.0, 0.618 233281.2, 0.726 530000.0, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.
GENTPA	KD_Soil_Pb[cm3/g]	Soil K_d for Lead [cm^3/g]	usersuppliedpwisecdf 800.0, 0.0 955.0, 0.274 2187.8, 0.382 5011.9, 0.500 11481.5, 0.618 26302.7, 0.726 60256.0, 0.816 100000.0, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	KD_Soil_Cs[cm3/g]	Soil K_d for Cesium [cm^3/g]	usersuppliedpwisecdf 1000.0, 0.0 1380.2, 0.184 2038.6, 0.274 3010.9, 0.382 4447.1, 0.500 6568.2, 0.618 9701.2, 0.726 14328.4, 0.816 21162.8, 0.885 31257.0, 0.933 46166.1, 0.964 61287.0, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.
GENTPA	KD_Soil_Th[cm3/g]	Soil K_d for Thorium [cm^3/g]	usersuppliedpwisecdf 1700.0, 0.0 2981.0, 0.500 5597.1, 0.618 10509.1, 0.726 19732.1, 0.816 37049.1, 0.885 69563.8, 0.933 130613.8, 0.964 170000.0, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.
GENTPA	KD_Soil_I[cm3/g]	Soil K_d for Iodine [cm^3/g]	usersuppliedpwisecdf 0.1, 0.0 0.12, 0.036 0.22, 0.067 0.41, 0.115 0.74, 0.184 1.35, 0.274 2.46, 0.382 4.48, 0.500 8.17, 0.618 14.88, 0.726 27.11, 0.816 43.0, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	KD_Soil_Tc[cm3/g]	Soil K_d for Technetium [cm^3/g]	usersuppliedpwisecdf 0.01, 0.0 0.016, 0.115 0.027, 0.184 0.046, 0.274 0.079, 0.382 0.135, 0.500 0.232, 0.618 0.399, 0.726 0.684, 0.816 1.174, 0.885 2.014, 0.933 3.456, 0.964 5.930, 0.982 10.176, 0.992 16.0, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.
GENTPA	KD_Soil_Ni[cm3/g]	Soil K_d for Nickel [cm^3/g]	usersuppliedpwisecdf 60.0, 0.0 100.0, 0.036 141.3, 0.067 199.5, 0.115 281.8, 0.184 398.1, 0.274 562.3, 0.382 794.3, 0.500 1122.0, 0.618 1584.9, 0.726 2238.7, 0.816 3162.3, 0.885 4466.8, 0.933 6309.6, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	KD_Soil_Cl[cm3/g]	Soil K_d for Chlorine [cm^3/g]	usersuppliedpwisecdf 0.0, 0.0 0.010, 0.018 0.014, 0.036 0.019, 0.067 0.027, 0.115 0.037, 0.184 0.052, 0.274 0.072, 0.382 0.100, 0.500 0.139, 0.618 0.194, 0.726 0.270, 0.816 0.375, 0.885 0.4, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.
GENTPA	KD_Soil_C[cm3/g]	Soil K_d for Carbon [cm^3/g]	usersuppliedpwisecdf 1.12, 0.0 1.42, 0.067 2.36, 0.115 3.94, 0.184 6.6, 0.274 10.9, 0.382 18.2, 0.500 30.3, 0.618 50.4, 0.726 83.9, 0.816 139.8, 0.885 232.8, 0.933 299.0, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	KD_Soil_Se[cm3/g]	Soil K_d for Selenium [cm^3/g]	usersuppliedpwisecdf 36.0, 0.0 38.1, 0.184 42.9, 0.274 48.4, 0.382 54.6, 0.500 61.6, 0.618 69.4, 0.726 78.3, 0.816 88.2, 0.885 99.5, 0.933 100.0, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.
GENTPA	KD_Soil_Nb[cm3/g]	Soil K_d for Niobium [cm^3/g]	usersuppliedpwisecdf 33.0, 0.0 42.5, 0.067 70.8, 0.115 117.9, 0.184 196.4, 0.274 327.0, 0.382 544.6, 0.500 906.9, 0.618 1510.2, 0.726 2514.9, 0.816 4188.1, 0.885 6974.4, 0.933 8500.0, 1.0	Per Software Change Report 552, lognormal distributions using data from Sheppard and Thibault (1990) have been replaced by user-supplied piecewise distributions that simulate truncated lognormal distributions.
GENTPA	AnnualPrecipitation [m/yr]	Annual precipitation rate [m/yr]	constant 0.102	Annual precipitation in Amargosa Valley determined from data reported in the Bechtel SAIC Company, LLC (2003, Table 4.1-2).
GENTPA	AnnualIrrigation [m/yr]	Annual irrigation rate [m/yr]	constant ~~1.05~~ 1.12	Irrigation rate data are tabulated in Table 6.5-2 of Bechtel SAIC Company, LLC (200~~3~~4) showing irrigation rates for various crops applicable to the Yucca Mountain region. These rates were calculated using established agricultural formulas that incorporate data on local climate, soil, crops, and irrigation methods. For TPA code use, these crop-specific rates were used to derive representative values for crop categories consistent with the model inputs. The crop category-specific rates were averaged to derive the annual irrigation rate listed here (~~1.05~~ 1.12 m/yr).
GENTPA	SoilBulkDensity [g/cm3]	Soil bulk density [g/cm^3]	constant 1.5	Based on LaPlante and Poor (1997).

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
GENTPA	SoilVolumetric WaterContent	Soil volumetric water content [ml/cm^3]	constant 0.35	Data from Tanner (1991) for soils similar to Amargosa Valley farming soils.
GENTPA	TotalAnnual Evapotranspiration [m/yr]	Total annual evapo-transpiration [m/yr]	constant ~~1.07~~ 1.14	Using data in Bechtel SAIC Company, LLC (200~~3~~4), the average irrigation rate for all crop groups (see description of the Annual Irrigation rate of ~~1.05~~ 1.12 m/yr) and the annual precipitation in Amargosa Valley from data reported in the Bechtel SAIC Company, LLC (200~~3~~4), Table 4.1-2 (0.102 m/yr) were summed, and the mean overwatering rate for all crops reported in Table 6.9-1 (0.079 m/yr) was subtracted from this sum to estimate the evapotranspiration (because precipitation + irrigation - evapo-transpiration = overwatering). The resulting evapotranspiration is ~~1.07~~ 1.14 m/yr. This value was checked against U.S. Geological Survey estimates of deep percolation for farming locations in Amargosa Valley (U.S. Geological Survey, 2003) for additional confidence. U.S. Geological Survey concludes that 8 to 16 percent of irrigation water becomes deep percolation. Applying the low estimate to the average irrigation rate used to calculate evapotranspiration (1.05 m/yr × 0.08) results in a deep percolation estimate of 0.084 m/yr. This value compares with the aforementioned 0.079 value for overwatering reported by Bechtel SAIC Company, LLC (2003).
DCAGS	DepthOf Resuspendible Layer[cm]	Thickness of the upper soil layer that is available for resuspension [cm]	constant 0.3	Wiggs (1997) supports a 0.1–1cm range, with 1 cm being for poorly sorted, coarse-grained deposits (i.e., grain size on order of 1 cm). The 0.3-cm value seems reasonable, given that the tephra will likely have an average grain size on the order of 0.1 cm. Because the maximum entrainable particle size is 0.01 cm, the 0.1 cm-size ash will form an unentrainable lag deposit that shields finer particles from turbulent wind entrainment unless they can escape between the 0.1-cm particle interstices.
DCAGS	RateOfReductionOf MassLoading Factor[1/yr]	Rate at which the airborne mass load factor decreases with time from the initial value after the eruption [1/yr]	constant 0.07	Limited reduction in airborne mass loads measured on deposits 4 years after 1995 Cerro Negro eruption (Hill, et al., 2000). Assuming exponential decay (e.g., Anspaugh, et al., 1975), this relationship indicates a half-life for reduction in mass load on the order of 10 years.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
MASS LOADING AND OCCUPANCY FACTORS	AirborneMassLoad AboveFreshAsh BlanketHeavy Disturbance[g/m3]	Outdoor airborne mass load of resuspended ash due to heavy disturbance activities [g/m^3]	uniform 1.0e-3, 1.0e-2	Outdoor mass loads over ash deposits for heavy disturbance activities have been measured within this range. Measurements were taken four years after the 1995 Cerro Negro eruption in Nicaragua at a height of 1.5 m above the tephra deposits located about 5 km from the vent (Hill, et al., 2000). Digging and driving over deposits resulted in airborne mass loads of ~10^{-2} g/m^3, which was assigned as the maximum value. Walking over deposits resulted in airborne mass loads of ~10^{-3} g/m^3, which was assigned as the minimum value. Range also supported by posteruption measurements near Montserrat volcano by Searl, et al. (2002).
MASS LOADING AND OCCUPANCY FACTORS	AirborneMassLoad AboveFreshAsh BlanketLight Disturbance[g/m3]	Outdoor airborne mass load of resuspended ash due to light disturbance activities [g/m^3]	uniform 1.0e-4, 1.0e-3	Outdoor mass loads over ash deposits for light disturbance activities have been measured within this range. Measurements were taken four years after the 1995 Cerro Negro eruption in Nicaragua at a height of 1.5 m above the tephra deposits located about 5 km from the vent (Hill et al., 2000). Walking over deposits resulted in airborne mass loads of ~10^{-3} g/m^3, which was assigned as the maximum value. Airborne mass loads over undisturbed deposits were ~10^{-4} g/m^3 in 4 ± 2 m/s winds, which was assigned as the minimum value. Range also supported by posteruption measurements near Montserrat volcano by Searl, et al. (2002).
MASS LOADING AND OCCUPANCY FACTORS	AirborneMassLoad OutsideHeavy Disturbance[g/m3]	Outdoor airborne mass load of resuspended soil due to heavy disturbance activities [g/m^3]	constant 0.0007	Updated based on Software Change Request 654.
MASS LOADING AND OCCUPANCY FACTORS	AirborneMassLoad OutsideLight Disturbance[g/m3]	Outdoor airborne mass load of resuspended soil due to light disturbance activities [g/m^3]	constant 0.0001	Updated based on Software Change Request 654.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
MASS LOADING AND OCCUPANCY FACTORS	AirborneMass LoadInsideHeavy Disturbance[g/m3]	Indoor airborne mass load of resuspended soil and ash due to heavy disturbance activities [g/m^3]	triangular 1.0e-4, 5.0e-4, 1.0e-3	Indoor mass loads recommended for NRC screening dose calculations involving building renovation and residential exposure scenarios are discussed in a literature summary by Kennedy and Strenge (1992). They describe a range of 0.00005 to 0.0001 g/m^3 as representing longer term average concentrations that account for airborne dust from nonradioactive sources. They further consider the range a prudently conservative estimate for radioactive dust loadings in the workplace or household. Because fine ash particles are expected to elevate normal dust loadings and this parameter is for heavy disturbance conditions, we take the recommendation of 0.0001 g/m^3 as the lower end of a triangular distribution that extends to a maximum value that is equal to the low end of outdoor mass loading for fresh ash (0.001 g/m^3) described above, with the midpoint of this range (0.0005 g/m^3) assumed to be a reasonably conservative mode of a triangular distribution, selected to avoid overemphasizing the extreme high and low ends of the range.
MASS LOADING AND OCCUPANCY FACTORS	AirborneMassLoad InsideLight Disturbance[g/m3]	Indoor airborne mass load of resuspended soil and ash due to light disturbance activities [g/m^3]	triangular 1.0e-5, 5.0e-5, 1.0e-4	Indoor mass loads recommended for NRC screening dose calculations involving building renovation and residential exposure scenarios are discussed in a literature summary by Kennedy and Strenge (1992). They describe a range of 0.00005 to 0.0001 g/m^3 as representing longer-term average concentrations that account for airborne dust from nonradioactive sources. They further consider the range a prudently conservative estimate for radioactive dust loadings in the workplace or household. Because this parameter is for light disturbance conditions that span a range of disturbance conditions (including no disturbance at all), the recommendation in Kennedy and Strenge (1992) of 0.0001 g/m^3 is selected as the upper end of a triangular distribution that extends to a minimum value (0.00001 g/m^3) that encompasses a dust loading representing relatively clean air (0.00002 g/m^3) (Kennedy and Strenge, 1992), with the midpoint of this range (0.00005 g/m^3) assumed to be a reasonably conservative mode of a triangular distribution, selected to avoid overemphasizing the extreme high and low ends of the range.
MASS LOADING AND OCCUPANCY FACTORS	AirborneMassLoad Offsite[g/m3]	Offsite airborne mass load of contaminated particles [g/m^3]	constant 0	Offsite locations are assumed to be free of contamination.

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the Total-system Performance Assessment (TPA) Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
MASS LOADING AND OCCUPANCY FACTORS	OccupancyFraction OutsideHeavy Disturbance[]	Fraction of time receptor spends outdoors with heavy disturbance [unitless]	constant 0.125	Based on an assumption of 2.75 hr/day of moderate work and 0.25 hr/day of hard work outdoors (Mohanty, et al., 2005, Chapter 5).
MASS LOADING AND OCCUPANCY FACTORS	OccupancyFraction OutsideLight Disturbance[]	Fraction of time receptor spends outdoors with light disturbance [unitless]	constant 0.084	Based on an assumption of 2 hr/day of light work outdoors (Mohanty, et al., 2005, Chapter 5).

Table 17-1. Reference Data Sheet for Pathway and Dose Calculations in the TPA Version 5.1 Code (continued)				
Input Block in *Tpa.inp*	**Parameter Name**	**Description**	**Distribution Type and Parameter Value(s)**	**Remarks**
MASS LOADING AND OCCUPANYC FACTORS	OccupancyFractin InsideHeavy Disturbance[][	Fraction of time receptor spends indoors with heavy disturbance	constant 0.104	Based on an assumption of 2 hr/day of moderate work and 0.5 hr/day of hard work indorrs (Mohanty, et al., 2005, Chapter 5).
MASS LOADING AND OCCUPANCY FACTORS	OccupancyFraction InsideLight Distance[][	Fraction of time receptor spends indoors with light disturbance [unitless]	constant 0.583	Based on an assumption of 8 hr/day sleeping, 3 hr/day sedentary, and 3 hr/day of light work indoors (Mohanty et al., 2005, Chapter 5).
MASS LOADING AND OCCUPANCY FACTORS	OccupancyFraction Offsite[][	Fraction of time receptor spends offsite [unitless]	constant 0.104	Based on an assumption of 1.25 hr/day outdoors and 1.25 hr/day indoors offsite (Mohanty, et al., 2005, Chapter 5).

Attachment C

ggenii.def

```
######################### Program GENII Input File ############ 28 Feb 07 ####
Title: ~~tpa4.0 input using genii w/ 93 update and CNWRA 97-009 data files~~ GENTPA
Biosphere Model Input File for TPA Version 5.1 for Groundwater Pathways
       \GENII\tpa.in                          Created on 02-28-2007 at 17:35
OPTIONS========================= Default ====================================
T    Near-field scenario?      (Far-field)    NEAR-FIELD: narrowly-focused
F    Population dose?         (Individual)                release, single site
F    Acute release?             (Chronic)     FAR-FIELD:  wide-scale release,
     Maximum Individual data set used                     multiple sites
                              Complete                                Complete
TRANSPORT OPTIONS============ Section   EXPOSURE PATHWAY OPTIONS===== Section
F  Air Transport                  1     F  Finite plume, external       5
F  Surface Water Transport        2     T  Infinite plume, external     5
F  Biotic Transport (near-field)  3,4   T  Ground, external             5
F  Waste Form Degradation (near)  3,4   F  Recreation, external         5
                                        T  Inhalation uptake            5,6
REPORT OPTIONS=======================   T  Drinking water ingestion     7,8
T  Report AEDE only                     F  Aquatic foods ingestion      7,8
T  Report by radionuclide               T  Terrestrial foods ingestion  7,9
T  Report by exposure pathway           T  Animal product ingestion     7,10
F  Debug report on screen               T  Inadvertent soil ingestion

INVENTORY ##################################################################

 3   Inventory input activity units: (1-pCi  2-uCi  3-mCi  4-Ci  5-Bq)
 0   Surface soil source units (1- m2  2- m3  3- kg)
     Equilibrium question goes here

     --------|----Release Terms------|----------Basic Concentrations---------|
     Use when|  transport selected   |  near-field scenario, optionally      |
     --------|-----------------------|---------------------------------------|
     Release |        Surface Buried |        Surface Deep    Ground  Surface|
     Radio-  |Air     Water   Waste  |Air     Soil    Soil    Water   Water  |
     nuclide |/yr     /yr     /m3    |/m3     /unit   /m3     /L      /L     |
     --------|------- ------- -------|------- ------- ------- ------- -------|
     C 14                                                     1.0E+00
     CL36                                                     1.0E+00
     NI59                                                     1.0E+00
     NI63                                                     1.0E+00
     SE79                                                     1.0E+00
     SR90                                                     1.0E+00
     ZR93                                                     1.0E+00
     NB94                                                     1.0E+00
     MO93                                                     1.0E+00
     TC99                                                     1.0E+00
     PD107                                                    1.0E+00
     AG108M                                                   1.0E+00
     SN121M                                                   1.0E+00
     SN126                                                    1.0E+00
     I 129                                                    1.0E+00
     CS135                                                    1.0E+00
     CS137                                                    1.0E+00
     SM151                                                    1.0E+00
     PB210                                                    1.0E+00
     RA226                                                    1.0E+00
     AC227                                                    1.0E+00
     TH229                                                    1.0E+00
     TH230                                                    1.0E+00
     PA231                                                    1.0E+00
     U 232                                                    1.0E+00
     U 233                                                    1.0E+00
     U 234                                                    1.0E+00
     U 235                                                    1.0E+00
     U 236                                                    1.0E+00
     U 238                                                    1.0E+00
     NP237                                                    1.0E+00
     PU238                                                    1.0E+00
     PU239                                                    1.0E+00
```

```
     PU240                                                    1.0E+00
     PU241                                                    1.0E+00
     PU242                                                    1.0E+00
     AM241                                                    1.0E+00
     AM242M                                                   1.0E+00
     AM243                                                    1.0E+00
     CM243                                                    1.0E+00
     CM244                                                    1.0E+00
     CM245                                                    1.0E+00
     CM246                                                    1.0E+00

     --------|----Derived Concentrations-----|
     Use when|   measured values are known   |
     --------|-------------------------------|
     Release |Terres. Animal  Drink   Aquatic|
     Radio-  |Plant   Product Water   Food   |
     nuclide |/kg     /kg     /L      /kg    |
     --------|------- ------- ------- -------|

TIME ##########################################################################

1    Intake ends after (yr)
50   Dose calc. ends after (yr)
0    Release ends after (yr)
0    No. of years of air deposition prior to the intake period
0    No. of years of irrigation water deposition prior to the intake period

FAR-FIELD SCENARIOS (IF POPULATION DOSE) ######################################

0          Definition option: 1-Use population grid in file POP.IN
0                             2-Use total entered on this line

NEAR-FIELD SCENARIOS ##########################################################

           Prior to the beginning of the intake period: (yr)
0            When was the inventory disposed?  (Package degradation starts)
0            When was LOIC?  (Biotic transport starts)
1.0        Fraction of roots in upper soil (top 15 cm)
0          Fraction of roots in deep soil
0.0        Manual redistribution: deep soil/surface soil dilution factor
0          Source area for external dose modification factor (m2)
TRANSPORT #####################################################################
           ====AIR TRANSPORT=====================================SECTION 1=====
                   0-Calculate PM            |0        Release type (0-3)
 1         Option: 1-Use chi/Q or PM value   |F        Stack release (T/F)
                   2-Select MI dist & dir    |0        Stack height (m)
                   3-Specify MI dist & dir   |0        Stack flow (m3/sec)
0          Chi/Q or PM value                 |0        Stack radius (m)
0          MI sector index (1=S)             |0        Effluent temp. (C)
0          MI distance from release point (m)|0        Building x-section (m2)
T          Use jf data, (T/F) else chi/Q grid|0        Building height (m)

           ====SURFACE WATER TRANSPORT==========================SECTION 2=====
0          Mixing ratio model: 0-use value, 1-river, 2-lake
0          Mixing ratio, dimensionless
0          Average river flow rate for: MIXFLG=0 (m3/s), MIXFLG=1,2 (m/s),
0          Transit time to irrigation withdrawl location (hr)
           If mixing ratio model > 0:
0            Rate of effluent discharge to receiving water body (m3/s)
0            Longshore distance from release point to usage location (m)
0            Offshore distance to the water intake (m)
0            Average water depth in surface water body (m)
0            Average river width (m), MIXFLG=1 only
0            Depth of effluent discharge point to surface water (m), lake only

           ====WASTE FORM AVAILABILITY==========================SECTION 3=====
0          Waste form/package half life, (yr)
0          Waste thickness, (m)
0          Depth of soil overburden, m

           ====BIOTIC TRANSPORT OF BURIED SOURCE================SECTION 4=====
T          Consider during inventory decay/buildup period (T/F)?
T          Consider during intake period (T/F)?   | 1-Arid non agricultural
```

```
0          Pre-Intake site condition..............| 2-Humid non agricultural
                                                  | 3-Agricultural

EXPOSURE ##########################################################################

           ====EXTERNAL EXPOSURE================================SECTION 5=====
           Exposure time:                 |   Residential irrigation:
~~3384.0~~0   Plume (hr)                  | T        Consider: (T/F)
~~1800.0~~1832.0 Soil contamination (hr)  | 1        Source: 1-ground water
0            Swimming (hr)                |                  2-surface water
0            Boating (hr)                 | 58.0     Application rate (in/yr)
0            Shoreline activities (hr)    | 9.0      Duration (mo/yr)
0          Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)
0          Transit time for release to reach aquatic recreation (hr)
0          Average fraction of time submersed in acute cloud (hr/person hr)

           ====INHALATION=======================================SECTION 6=====
~~4200.0~~4843.0 Hours of exposure to contamination per year
1          0-No resus-  1-Use Mass Loading          2-Use Anspaugh model
.0001        pension      Mass loading factor (g/m3)   Top soil available (cm)

           ====INGESTION POPULATION============================SECTION 7=====
0          Atmospheric production definition (select option):
2            0-Use food-weighted chi/Q, (food-sec/m3), enter value on this line
             1-Use population-weighted chi/Q
             2-Use uniform production
             3-Use chi/Q and production grids (PRODUCTION will be overridden)
0          Population ingesting aquatic foods, 0 defaults to total (person)
0          Population ingesting drinking water, 0 defaults to total (person)
F          Consider dose from food exported out of region (default=F)

           Note below: S* or Source: 0-none, 1-ground water, 2-surface water
                                     3-Derived concentration entered above
           ==== AQUATIC FOODS / DRINKING WATER INGESTION=========SECTION 8====

F          Salt water? (default is fresh)

           USE        TRAN-  PROD-    -CONSUMPTION- |
           ?   FOOD   SIT    UCTION   HOLDUP   RATE |
           T/F TYPE   hr     kg/yr    da       kg/yr |      DRINKING WATER
           --- ------ -----  -------  ------   ----- |-------------------------
           F   FISH    0.00  0.0E+00   0.00     0.0 | 1       Source (see above)
           F   MOLLUS  0.00  0.0E+00   0.00     0.0 | F       Treatment? T/F
           F   CRUSTA  0.00  0.0E+00   0.00     0.0 | 0.0     Holdup/transit(da)
           F   PLANTS  0.00  0.0E+00   0.00     0.0 | 730.0   Consumption (L/yr)

           ====TERRESTRIAL FOOD INGESTION=======================SECTION 9=====

           USE        GROW   --IRRIGATION--          PROD-    --CONSUMPTION--
           ?   FOOD   TIME   S RATE   TIME    YIELD  UCTION   HOLDUP   RATE
           T/F TYPE   da     * in/yr  mo/yr   kg/m2  kg/yr    da       kg/yr
           --- ------ -----  - -----  -----   -----  -------  ------   ------
           T   LEAF V 75.00  1  60.0   3.0     2.0    0.0E+00    1.0      6.0
           T   ROOT V 80.00  1  60.0   5.0     4.0    0.0E+00   14.0     26.0
           T   FRUIT 160.00  1  60.0   2.5     3.0    0.0E+00   14.0     23.0
           T   GRAIN 200.00  1  60.0   5.0     0.54   0.0E+00   14.0     34.0

           ====ANIMAL PRODUCTION CONSUMPTION====================SECTION 10====

           ---HUMAN---- TOTAL   DRINK   -------------STORED FEED-------------
USE        CONSUMPTION  PROD-   WATER   DIET  GROW  -IRRIGATION--        STOR-
?   FOOD   RATE  HOLDUP UCTION  CONTAM  FRAC- TIME  S RATE  TIME   YIELD AGE
T/F TYPE   kg/yr   da    kg/yr  FRACT.  TION   da   * in/yr mo/yr  kg/m3 da
--- ------ ------ ----- ------ -------  ----  ----  - ----- -----  ----- -----
T   BEEF     29.5  20.0  29.50    1.00  0.00  30.0  1  60.0  5.50   1.23  20.0
T   POULTR    0.8  20.0   0.00    1.00  1.00  75.0  1  60.0  5.00   0.54  14.0
T   MILK    100.0   1.0 100.00    1.00  0.00  30.0  1  60.0  5.50   1.23  20.0
T   EGG       3.0   1.0   3.00    1.00  1.00  75.0  1  60.0  5.00   0.54  14.0
                                         -------------FRESH FORAGE------------
    BEEF                                 0.56  46.0  1  60.0  5.50   1.23   1.0
    MILK                                 0.56  46.0  1  60.0  5.50   1.23   1.0

##########################################################################
```

Attachment D

ggeniis.def

```
######################### Program GENII Input File ############ 28 Feb 07 ####
Title: ~~tpa5.0 dcags input using genii w/ 93 update and CNWRA 97-009 data files~~GENTPA
Biosphere Model Input File for TPA Version 5.1 for Ground Surface Pathways
       \GENII\tpa.in                            Created on 02-28-2007 at 14:16
OPTIONS======================== Default ====================================
T    Near-field scenario?      (Far-field)    NEAR-FIELD: narrowly-focused
F    Population dose?         (Individual)                release, single site
F    Acute release?             (Chronic)     FAR-FIELD:  wide-scale release,
     Maximum Individual data set used                     multiple sites
                                Complete                                  Complete
TRANSPORT OPTIONS============ Section   EXPOSURE PATHWAY OPTIONS===== Section
F  Air Transport                  1     F  Finite plume, external       5
F  Surface Water Transport        2     T  Infinite plume, external     5
F  Biotic Transport (near-field)  3,4   T  Ground, external             5
F  Waste Form Degradation (near)  3,4   F  Recreation, external         5
                                        T  Inhalation uptake            5,6
REPORT OPTIONS=======================   T  Drinking water ingestion     7,8
T  Report AEDE only                     F  Aquatic foods ingestion      7,8
T  Report by radionuclide               T  Terrestrial foods ingestion  7,9
T  Report by exposure pathway           T  Animal product ingestion     7,10
F  Debug report on screen               T  Inadvertent soil ingestion

INVENTORY ##################################################################

 4   Inventory input activity units: (1-pCi  2-uCi  3-mCi  4-Ci  5-Bq)
 1   Surface soil source units (1- m2  2- m3  3- kg)
     Equilibrium question goes here

     --------|----Release Terms------|----------Basic Concentrations---------|
     Use when|  transport selected   |  near-field scenario, optionally      |
     --------|-----------------------|---------------------------------------|
     Release |        Surface Buried |        Surface Deep    Ground  Surface|
     Radio-  |Air     Water   Waste  |Air     Soil    Soil    Water   Water  |
     nuclide |/yr     /yr     /m3    |/m3     /unit   /m3     /L      /L     |
     --------|------- ------- -------|------- ------- ------- ------- -------|
     C 14                                     1.0E+00
     CL36                                     1.0E+00
     NI59                                     1.0E+00
     NI63                                     1.0E+00
     SE79                                     1.0E+00
     SR90                                     1.0E+00
     ZR93                                     1.0E+00
     NB94                                     1.0E+00
     MO93                                     1.0E+00
     TC99                                     1.0E+00
     PD107                                    1.0E+00
     AG108M                                   1.0E+00
     SN121M                                   1.0E+00
     SN126                                    1.0E+00
     I 129                                    1.0E+00
     CS135                                    1.0E+00
     CS137                                    1.0E+00
     SM151                                    1.0E+00
     PB210                                    1.0E+00
     RA226                                    1.0E+00
     AC227                                    1.0E+00
     TH229                                    1.0E+00
     TH230                                    1.0E+00
     PA231                                    1.0E+00
     U 232                                    1.0E+00
     U 233                                    1.0E+00
     U 234                                    1.0E+00
     U 235                                    1.0E+00
     U 236                                    1.0E+00
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     U 238                                    1.0E+00
     NP237                                    1.0E+00
     PU238                                    1.0E+00
     PU239                                    1.0E+00
     PU240                                    1.0E+00
     PU241                                    1.0E+00
     PU242                                    1.0E+00
     AM241                                    1.0E+00
     AM242M                                   1.0E+00
     AM243                                    1.0E+00
     CM243                                    1.0E+00
     CM244                                    1.0E+00
     CM245                                    1.0E+00
     CM246                                    1.0E+00

     --------|----Derived Concentrations-----|
     Use when|   measured values are known   |
     --------|-------------------------------|
     Release |Terres. Animal  Drink   Aquatic|
     Radio-  |Plant   Product Water   Food   |
     nuclide |/kg     /kg     /L      /kg    |
     --------|------- ------- ------- -------|

TIME ##########################################################################

1    Intake ends after (yr)
50   Dose calc. ends after (yr)
0    Release ends after (yr)
0    No. of years of air deposition prior to the intake period
0    No. of years of irrigation water deposition prior to the intake period

FAR-FIELD SCENARIOS (IF POPULATION DOSE) ######################################

0          Definition option: 1-Use population grid in file POP.IN
0                             2-Use total entered on this line

NEAR-FIELD SCENARIOS ##########################################################

           Prior to the beginning of the intake period: (yr)
0            When was the inventory disposed?  (Package degradation starts)
0            When was LOIC?  (Biotic transport starts)
1.0        Fraction of roots in upper soil (top 15 cm)
0          Fraction of roots in deep soil
0.0        Manual redistribution: deep soil/surface soil dilution factor
0          Source area for external dose modification factor (m2)
TRANSPORT #####################################################################
           ====AIR TRANSPORT=================================SECTION 1=====
                   0-Calculate PM            |0        Release type (0-3)
 1         Option: 1-Use chi/Q or PM value   |F        Stack release (T/F)
                   2-Select MI dist & dir    |0        Stack height (m)
                   3-Specify MI dist & dir   |0        Stack flow (m3/sec)
0          Chi/Q or PM value                 |0        Stack radius (m)
0          MI sector index (1=S)             |0        Effluent temp. (C)
0          MI distance from release point (m)|0        Building x-section (m2)
T          Use jf data, (T/F) else chi/Q grid|0        Building height (m)

           ====SURFACE WATER TRANSPORT=========================SECTION 2=====
0          Mixing ratio model: 0-use value, 1-river, 2-lake
0          Mixing ratio, dimensionless
0          Average river flow rate for: MIXFLG=0 (m3/s), MIXFLG=1,2 (m/s),
0          Transit time to irrigation withdrawl location (hr)
           If mixing ratio model > 0:
0            Rate of effluent discharge to receiving water body (m3/s)
0            Longshore distance from release point to usage location (m)
0            Offshore distance to the water intake (m)
0            Average water depth in surface water body (m)
0            Average river width (m), MIXFLG=1 only
0            Depth of effluent discharge point to surface water (m), lake only

           ====WASTE FORM AVAILABILITY=========================SECTION 3=====
0          Waste form/package half life, (yr)
0          Waste thickness, (m)
0          Depth of soil overburden, m
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            ====BIOTIC TRANSPORT OF BURIED SOURCE================SECTION 4=====
T           Consider during inventory decay/buildup period (T/F)?
T           Consider during intake period (T/F)?    | 1-Arid non agricultural
0           Pre-Intake site condition..............| 2-Humid non agricultural
                                                    | 3-Agricultural

EXPOSURE ######################################################################

            ====EXTERNAL EXPOSURE================================SECTION 5=====
            Exposure time:                  |   Residential irrigation:
~~3384.0~~0   Plume (hr)                    | T        Consider: (T/F)
~~1800.0~~1832.0 Soil contamination (hr)    | 1        Source: 1-ground water
0             Swimming (hr)                 |                  2-surface water
0             Boating (hr)                  | 58.0     Application rate (in/yr)
0             Shoreline activities (hr)     | 9.0      Duration (mo/yr)
0           Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)
0           Transit time for release to reach aquatic recreation (hr)
0           Average fraction of time submersed in acute cloud (hr/person hr)

            ====INHALATION=======================================SECTION 6=====
~~4200.0~~4843.0 Hours of exposure to contamination per year
1           0-No resus-  1-Use Mass Loading          2-Use Anspaugh model
.0001         pension      Mass loading factor (g/m3)   Top soil available (cm)

            ====INGESTION POPULATION=============================SECTION 7=====
0           Atmospheric production definition (select option):
2             0-Use food-weighted chi/Q, (food-sec/m3), enter value on this line
              1-Use population-weighted chi/Q
              2-Use uniform production
              3-Use chi/Q and production grids (PRODUCTION will be overridden)
0           Population ingesting aquatic foods, 0 defaults to total (person)
0           Population ingesting drinking water, 0 defaults to total (person)
F           Consider dose from food exported out of region (default=F)

            Note below: S* or Source: 0-none, 1-ground water, 2-surface water
                                      3-Derived concentration entered above
            ==== AQUATIC FOODS / DRINKING WATER INGESTION=========SECTION 8====

F           Salt water? (default is fresh)

            USE        TRAN-  PROD-    -CONSUMPTION- |
            ?   FOOD   SIT    UCTION   HOLDUP   RATE |
            T/F TYPE   hr     kg/yr    da       kg/yr |      DRINKING WATER
            --- ------ -----  -------  ------   ----- |-------------------------
            F   FISH    0.00  0.0E+00    0.00     0.0 | 1       Source (see above)
            F   MOLLUS  0.00  0.0E+00    0.00     0.0 | F       Treatment? T/F
            F   CRUSTA  0.00  0.0E+00    0.00     0.0 | 0.0     Holdup/transit(da)
            F   PLANTS  0.00  0.0E+00    0.00     0.0 | 730.0   Consumption (L/yr)

            ====TERRESTRIAL FOOD INGESTION=======================SECTION 9=====

            USE        GROW   --IRRIGATION--            PROD-    --CONSUMPTION--
            ?   FOOD   TIME   S RATE   TIME    YIELD    UCTION   HOLDUP   RATE
            T/F TYPE   da     * in/yr  mo/yr   kg/m2    kg/yr    da       kg/yr
            --- ------ -----  - -----  -----   -----    -------  ------   ------
            T   LEAF V 75.00  1  60.0   3.0      2.0    0.0E+00    1.0      6.0
            T   ROOT V 80.00  1  60.0   5.0      4.0    0.0E+00   14.0     26.0
            T   FRUIT 160.00  1  60.0   2.5      3.0    0.0E+00   14.0     23.0
            T   GRAIN 200.00  1  60.0   5.0      0.54   0.0E+00   14.0     34.0

            ====ANIMAL PRODUCTION CONSUMPTION====================SECTION 10====

            ---HUMAN---- TOTAL   DRINK   -------------STORED FEED--------------
USE         CONSUMPTION  PROD-   WATER   DIET  GROW  -IRRIGATION--        STOR-
?   FOOD    RATE  HOLDUP UCTION  CONTAM  FRAC- TIME  S RATE  TIME   YIELD AGE
T/F TYPE    kg/yr   da   kg/yr   FRACT.  TION   da   * in/yr mo/yr  kg/m3 da
--- ------  ------ ----- ------  -------  ----  ----  - ----- -----  ----- -----
T   BEEF      29.5  20.0  29.50    1.00  0.00  30.0  1  60.0  5.50   1.23  20.0
T   POULTR     0.8  20.0   0.00    1.00  1.00  75.0  1  60.0  5.00   0.54  14.0
T   MILK    100.0   1.0 100.00    1.00  0.00  30.0  1  60.0  5.50   1.23  20.0
T   EGG       3.0   1.0   3.00    1.00  1.00  75.0  1  60.0  5.00   0.54  14.0
                                         -------------FRESH FORAGE------------
    BEEF                                 0.56  46.0  1  60.0  5.50   1.23   1.0
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    MILK                                0.56  46.0  1  60.0  5.50   1.23   1.0
##############################################################################
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Attachment E

Description of Acceptance Tests

Test Plan Name: *rgwsap.tpa* bug fix and value changes

Tested By: Jose M. Menchaca | Date: 06/11/2007

Host Machine: "TPA" 64 bit Microsoft Windows Server | Host OS: Microsoft Windows Ver 5.2

Baseline Version: TPA51betaY | Test Version: TPA51betaZ and TPA51

Process Level (PL) Tests

PL-1 Name:

Path for run directory: D:\public\jmenchaca\tpa51betaY (tpa.cnwra.swri.edu)
D:\public\jmenchaca\tpa51betaZ (tpa.cnwra.swri.edu)
D:\public\jmenchaca\tpa51 (tpa.cnwra.swri.edu)

Path for archive directory: On attached CD:
\tpa51betaY
\tpa51betaZ
\tpa51

Environment variable: TPA_TEST = Y:\tpabetaZ (Y: is "Alby")
TPA_DATA = Y:\tpabetaZ (Y: is "Alby")

Special input files or modifications to input files required:

tpa.inp modifications required:

Test 1. StopAtRealization set to 2 instead of 1

Test 3. OutputMode = 1 and SelectAppendFile = 8

Special diagnostic code modifications required: NONE

Program modes to be used: NONE

Utility scripts needed to perform the test: NONE

Utility codes needed in the analysis of the test data: Excel®

Test Description: The objective of the test is to verify that an averaging error in the *rgwsap.tpa* output file is corrected.

There are no special assumptions necessary for running this test.

There are no constraints applied to the execution of this test.

Test 1: *rgwsap.tpa* averaging

Execute a 2 realization basecase tpa run. Using Excel®, read in the *rgwnapdw.tpa* file and verify

that for years having release, that the sum of all radionuclide doses for that year is equal to the "Drinking Water" (DW) column in the *rgwsap.tpa* output file.

The test passes if the the sum of all radionuclide doses in a given year of the *rgwnapdw.tpa* file is the same as the DW column in the *rgwsap.tpa* output file.

Test Results:

sum of average radionuclide dose = total average dose: **PASS**

Test 2: Unitless parameter changes.

Verify that the units of the three Near Field Environment (NFENV) parameters **FractionOfCondensateRemoved**, **FractionOfCondensateTowardRepository**, and **FractionOfCondensateTowardRepositoryRemoved** are changed from [1/yr] to unitless indicated by [].

An inspection of the three input parameters in the *tpa.inp* input file will verify conformance to the above requirement. This can be done using the DOS "Find" utility. The following line

find "FractionOfCondensate" tpa51betaZ\tpa.inp

will display the units of the three FractionOfCondensate parameters..

The test passes if the three parameters have no units.

Test Results:

Unitless FractionOfCondensate parameters: **PASS**

Test 3: *uzft.ech* header alignment

Verify that the headers of the radionuclide EBS release section of the *uzft.ech* output file are properly aligned. This can be done using the gvim editor in ":set nowrap" mode. The "nowrap mode is needed to properly view the column allignment.

The test passes if the header information properly aligns with the data below it.

Test Results:

uzft.ech header alignment: **PASS**

Test 4: Numerical Recipe disclaimer

Verify that a Numerical Recipe disclaimer has been added to the **tred2()** and **tqli()** subroutines in the ITYM *uncertain.f* file. This can be done with a visual inspection using the gvim editor.

The test passes if the Numerical Recipe disclaimer is present.

Test Results:

uzft.ech header alignment: **PASS**

Test 5: Update *utpa.inp, ggenii.def* and *ggeniis.def* data files

Verify that the data as outlined in Attachments B, C, and D are incorporated into the *tpa.inp, ggenii.def,* and *ggeniis.def* files. This can be done by visual inspection using the gvim editor.

The test passes if the data has been properly incorporated.

Test Results:

Data update: **PASS**

Test 6: Solubility values for Mo and Ag in *tpa.inp*

Verify that the solubility values for Molybdenum (Mo) and Silver (Ag) are the same as the Lead (Pb) values in the *tpa.inp* input file. This can be done by visual inspection using the gvim editor.

The test passes if the solubility values for Mo and Ag are the same as Pb.

Test Results:

Solubility values: **PASS**

Test 7: Spelling error in *climato1.dat*

Verify that the spelling of generator has been changed from "genereator" in the *clilmato1.dat* input file. This can be done by visual inspection using the gvim editor.

The test passes if the spelling of generator is correct.

Test Results:

Generator spelling: **PASS**