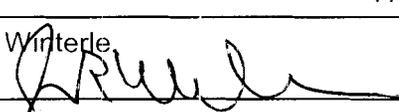


**Software Release Notice
Developed or Modified Software**

1. Software Name and Project Number:: TPA (Total-System Performance Assessment)		Version: 5.1b
2. Software Function: Conduct post-closure performance calculations of the potential geologic repository at Yucca Mountain, Nevada, as an aid to developing risk insights.		
3. Summary of Actions: <input type="checkbox"/> New Software <input checked="" type="checkbox"/> Update to Existing Software <input type="checkbox"/> Software Retirement		
4. Software Development		
4a. Software Requirements Description (SRD)	Date Approved: ___ June 11, 2007 ___	
4b. Software Development Plan (SDP)	Date Approved: ___ May 10, 2005 ___	
4c. Software Change Report (SCR) Nos: _ See Attachment A.		
4d. User's Guide Date	Date Approved ___ July 27, 2007 <i>(revised November 2007)</i>	
4e. Enclosed: <input checked="" type="checkbox"/> Copy of Program Title Block <input checked="" type="checkbox"/> Sample Source Code Header Block		
Developer: R. Janetzke		Date: November 14, 2007
Remarks:		
5. Software Installation		
5a. Computer Platform(s): Personal Computer	5b. Operating System(s): Windows/XP	5c. Programming Language(s): Lahey Fortran LF95
5d. Installation Testing:	<input checked="" type="checkbox"/> Passed	Testing Performed on: November 14, 2007
Description of Testing Performed:		
5e. Archive Copy:	<input checked="" type="checkbox"/> Enclosed	<input type="checkbox"/> Not Available, Why:
Installation Performed by: R. Janetzke		Date: November 14, 2007
Remarks:		
6. Software Assessment		
6a. Acceptance Testing: <input type="checkbox"/> Enclosed <input type="checkbox"/> Documented in Scientific Notebook No. _____ <input checked="" type="checkbox"/> Documented in SCRs (see above) _____		
6b. Validation Status: <input checked="" type="checkbox"/> Full Validation <input type="checkbox"/> Limited Validation Date of Validation: _____ <input type="checkbox"/> Not Validated, Explain: <i>No changes made from validated version 5.1a.</i>		
Software Developer: R. Janetzke		Date: 11-14-07
Remarks:		
7. Approval		
Manager: J. Wirtler 		Date: <i>11/15/07</i>
Remarks:		
7. QA Verification		
SRN Number: <i>438</i>		
Software Custodian <i>H/Smit</i>		Date: <i>11/16/07</i> <i>LJS</i>
Remarks:		

Attachment A

4c. Software Change Report (SCR) Nos:

696

```
=====
exec: Welcome to TPA Version 5.1b
Job started: Tue Nov 13 13:21:37 2007
=====
```

REPOSITORY DESIGN INFORMATION

Subarea #	Area [m ²]	Waste [MTU]	Number of WP
1	224091.0	3025.5	526
2	448476.0	6108.4	1062
3	1241313.5	16703.3	2904
4	775953.1	10313.0	1793
5	605892.0	8351.7	1452
6	152357.0	1972.9	343
7	318122.0	4003.3	696
8	439350.0	5355.0	931
9	305880.0	4158.6	723
10	747165.5	10048.4	1747

Total Area [acre] = 1299.382289078371
Total Buried Waste [MTU] = 70040.000000000000
Repository AML [MTU/acre] = 53.90253552684494
Watts per MTU [W/MTU] = 1327.684245650000
Watts per linear meter of drift [W/m] = 1450.448314791551

Specified Global Parameters:

Compliance Period = 10000.0 (yr)
Maximum Simulation Time = 10000.0 (yr)
Number Of Realizations = 500
Number Of Subareas = 10
Volcanism scenario = 0 (yes=1, no=0)
Faulting scenario = 0 (yes=1, no=0)
Mechanical failure scenarios:
Seismicity = 0 (yes=1, no=0)
Drift Degradation = 1 (yes=1, no=0)
Distance to Receptor Group = 18.0 (km)

>>> CAUTION: CHECKING OF NUCLIDES AND CHAINS IS DISABLED <<<
>>> You may not be using the standard chains specified <<<
>>> in the invent module. <<<
>>> (see "CheckNuclidesAndChains(yes=1,no=0)" in tpa.inp)<<<

The specified path for data = d:\ronj-tpa51b\
The specified path for codes = d:\ronj-tpa51b\

To modify global parameters or the path, stop code execution using control-C

```
-----
subarea 1 of 10 realization 1 of 500
-----
exec: calling uzflow
```

C Program Name: TPA - Total-System Performance Assessment Code
C File Name: array.f
C File Date: 06/16/07
C Release Version: 5.1
C
C Client Name: USNRC
C U. S. Nuclear Regulatory Commission
C NRC Office of Nuclear Material Safety and
Safeguards
C Division of High Level Waste Repository Safety
C
C Contract Number: NRC 02-02-012
C
C NRC Contact: Chris Grossman (301) 492-3177
C
C CNWRA Contact: Ron Janetzke (210) 522-3318
C Center for Nuclear Waste Regulatory Analyses
C San Antonio, Texas 78238-5166
C
C Documentation: "Total-System Performance Assessment (TPA)
C Version 5.1 User Guide",
C Center for Nuclear Waste Regulatory Analyses
C
C NUREG-Series Designator: N/A

C = = = = =

C D I S C L A I M E R

C = = = = =

C "This computer code/material was prepared as an account of work
C performed by the Center for Nuclear Waste Regulatory Analyses (CNWRA)
C for the Division of High Level Waste Repository Safety of the Nuclear
C Regulatory Commission (NRC), an independent agency of the United
States
C Government. Neither the developer(s) of the code nor any of their
C sponsors make any warranty, expressed or implied, or assume any legal
C liability or responsibility for the accuracy, completeness, or
C usefulness of any information, apparatus, product or process
C disclosed, or represent that its use would not infringe on privately-
C owned rights."

C "In no event unless required by applicable law will the sponsors
C or those who have written or modified this code, be liable for
C damages, including any lost profits, lost monies, or other special,
C incidental or consequential damages arising out of the use or
C inability to use the program (including but not limited to loss of
C data or data being rendered inaccurate or losses sustained by third
C parties or a failure of the program to operate with other programs),
C even if you have been advised of the possibility of such damages or
C for any claim by any other party."

C = = = = =

C CONTENTS: The array utility module consists of the following
C subroutines and functions:
C
C subroutine zero - zero out a vector
C subroutine zeroi - zero out an integer vector
C subroutine clearchar - clear character name to ' '

```
c          subroutine initr - set real vector equal to a constant
real
c          subroutine scale - scale a vector
c          subroutine scopy - scale and copy vector
c          subroutine acopy - scale and copy vector to a new vector
c          subroutine addto - add one vector to another
c          subroutine isoneofset - determines if iquery is part of a
set
c          function ainterl - interpolates from (time, value) data
c          subroutine checkinorder - determine if array list is
ordered
c          subroutine checkforduplicates - determine if real ordered
list has duplicates
c          subroutine icheckforduplicates - determine if integer
ordered list has duplicates
c          subroutine sortqr - pointer-based ascending sort
c          subroutine maplist - maps data from input array to output
array
c          subroutine maptimeofevent - map "timeofevent" onto TPA
time step
c
c  HISTORY:  R. Manteufel (initial version)
c           S. Mohanty, R. Janetzke, R. Rice (versions through 5.0)
c           R. Rice (version 5.0 validation tests added 05/31/03)
c           R. Janetzke 6-11-06; SCR-609
c
```

SOFTWARE CHANGE REPORT (SCR)

1. SCR No. (Software Developer Assigns): SCR 696	2. Software Title and Version: TPA 5.1a	3. Project No: 20.14002.01.201
4. Affected Software Module(s), Description of Problem(s): <i>tpa.inp, readme, mechdrive.f, driftdrive.f, driftfail.f, exec.f.</i> Update the following parameters to a constant 5.5: MatrixKD_CHnzNb [m3/kg] MatrixKD_PPwNb [m3/kg] MatrixKD_UCFNb [m3/kg] MatrixKD_BFwNb [m3/kg] Update the following to a constant 54300. ImmobileRd_STFF_Nb		
5. Change Requested by: J. McMurry		Date: 5-31-2007
6. Change Authorized by (Software Developer): R. Janetzke		Date: 11-8-2007
7. Description of Change(s) or Problem Resolution (If changes not implemented, please justify): Specified changes made to the parameters values in the <i>tpa.inp</i> file.		
8. Implemented by: R. Janetzke		Date: 11-10-2007
9. Code Review Needed (see TOP-018, 5.4.7) Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> <i>(Determined by Software Developer. Code reviews should be performed for modifications with significant risks of code errors. Indicate selection with <input checked="" type="checkbox"/>).</i> Describe any errors detected and their resolution (If no errors are found, indicate with "None".):		
Code review accomplished by: N/A		Date: N/A
10. Description of Acceptance Tests: No significant code changes made. No testing required. Data review only. Parameter values in <i>tpa.inp</i> file were correctly revised as described in Attachment A. Also reviewed for consistency with TPA Version 5.1 User Guide, Change 1, which is being updated concurrently to reflect this software change.		
11. Tested by: J. Winterle		Date: 11/13/07

UPDATE REQUIREMENTS for TPA.INP

SCR 696

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	UZFT	MatrixKD_CHnzNb [m3/kg]	Used for calculating Nb travel time.	Constant	0.55		
MODIFY TO	UZFT	MatrixKD_CHnzNb [m3/kg]		Constant	5.5	See Attachment A	McMurry
MODIFY FROM	UZFT	MatrixKD_PPwNb [m3/kg]	Used for calculating Nb travel time.	Constant	0.55		
MODIFY TO	UZFT	MatrixKD_PPwNb [m3/kg]		Constant	5.5	See Attachment A	McMurry
MODIFY FROM	UZFT	MatrixKD_UCFNb [m3/kg]	Used for calculating Nb travel time.	Constant	0.55		

<i>MODIFY TO</i>	UZFT	MatrixKD_UCFNb[m3/kg]		Constant	5.5	See Attachment A	McMurry
<i>MODIFY FROM</i>	UZFT	MatrixKD_BFwNb[m3/kg]	Used for calculating Nb travel time.	Constant	1.05		
<i>MODIFY TO</i>	UZFT	MatrixKD_BFwNb[m3/kg]		Constant	5.5	See Attachment A	McMurry
<i>MODIFY FROM</i>	SZFT	ImmobileRd_STFF_Nb	Used for calculating Nb travel time.	Constant	10400.0		
<i>MODIFY TO</i>	SZFT	ImmobileRd_STFF_Nb		Constant	5.5	See Attachment A	Bertetti

Attachment A

MatrixKD_CHnzNb [m³/kg]

Previous data selection reference was Table 2a in BSC (2001).

Modified value:

There are few sorption data for niobium under the expected conditions. Based on the trivalent chemical analogy, K_D s for americium are substituted for niobium K_D s. The revised parameter value is taken from Appendix A, Section A8.1, of BSC (2004), which gives americium K_D values for sorption onto devitrified and zeolitic tuffs at Yucca Mountain as a truncated normal distribution from 1.0 to 10.0 m³/kg, with a mean value of 5.5 m³/kg and a standard deviation of 1.5 m³/kg. The data from BSC (2004) were chosen because they represent a large set of sorption data directly relevant to the Calico Hills zeolitic tuff. Given the expected low risk significance of niobium transport in total system performance, a mean K_D value of 5.5 m³/kg (constant value), rather than the entire truncated normal distribution, is considered adequate to represent niobium sorption in the model.

MatrixKD_PPw_Nb [m³/kg]

Previous data selection reference was Table 2a in BSC (2001).

Modified value:

There are few sorption data for niobium under the expected conditions. Based on the trivalent chemical analogy, K_D s for americium are substituted for niobium K_D s. The revised parameter value is taken from Appendix A, Section A8.1, of BSC (2004), which gives americium K_D values for sorption onto devitrified and zeolitic tuffs at Yucca Mountain as a truncated normal distribution from 1.0 to 10.0 m³/kg, with a mean value of 5.5 m³/kg and a standard deviation of 1.5 m³/kg. The data from BSC (2004) were chosen because they represent a large set of sorption data directly relevant to the Prow Pass welded tuff, which has devitrified and zeolitic characteristics with respect to sorption. Given the expected low risk significance of niobium transport in total system performance, a mean K_D value of 5.5 m³/kg (constant value), rather than the entire truncated normal distribution, is considered adequate to represent niobium sorption in the model.

MatrixKD_UCF_Nb [m³/kg]

Previous data selection reference was Table 2a in BSC (2001).

Modified value:

There are few sorption data for niobium under the expected conditions. Based on the trivalent chemical analogy, K_D s for americium are substituted for niobium K_D s. The revised parameter value is taken from Appendix A, Section A8.1, of BSC (2004), which gives americium K_D values for sorption onto devitrified and zeolitic tuffs at Yucca Mountain as a truncated normal

distribution from 1.0 to 10.0 m³/kg, with a mean value of 5.5 m³/kg and a standard deviation of 1.5 m³/kg. The data from BSC (2004) were chosen because they represent a large set of sorption data directly relevant to the Upper Crater Flat tuffs, which have devitrified and zeolitic characteristics with respect to sorption. Given the expected low risk significance of niobium transport in total system performance, a mean K_D value of 5.5 m³/kg (constant value), rather than the entire truncated normal distribution, is considered adequate to represent niobium sorption in the model.

MatrixKD_BFw_Nb [m³/kg]

Previous data selection reference was Table 2a in BSC (2001).

Modified value:

There are few sorption data for niobium under the expected conditions. Based on the trivalent chemical analogy, K_D s for americium are substituted for niobium K_D s. The revised parameter value is taken from Appendix A, Section A8.1, of BSC (2004), which gives americium K_D values for sorption onto devitrified and zeolitic tuffs at Yucca Mountain as a truncated normal distribution from 1.0 to 10.0 m³/kg, with a mean value of 5.5 m³/kg and a standard deviation of 1.5 m³/kg. The data from BSC (2004) were chosen because they represent a large set of sorption data directly relevant to the Bullfrog welded tuff, which appears to have a large proportion of devitrified zones. Given the expected low risk significance of niobium transport in total system performance, a mean K_D value of 5.5 m³/kg (constant value), rather than the entire truncated normal distribution, is considered adequate to represent niobium sorption in the model.

ImmobilRd_STFF_Nb

Using an analogy between expected trivalent species Nb³⁺ and Am³⁺, the Am Rf is substituted for Nb. Values in SZFT AMR (Bechtel SAIC Company, LLC, 2003a) for Am sorption in STFF are 1.0 to 10.0 m³/kg with a truncated normal distribution (mean = 5.5, stdev = 1.5). The mean ("expected") KD value of 5.5 m³/kg for the devitrified layers is used and has been converted to an Rf of 54,300 assuming a bulk density of 1,976 kg/m³ and porosity of 0.20 for the STFF.

REFERENCES

BSC, 2001: "Unsaturated Zone and Saturated Zone Transport Properties (U0100)." ANL-NBS-HS-000019, Rev 00, ICN 02. [Table 2a]. Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2001.

BSC, 2004: "Radionuclide Transport Models Under Ambient Conditions." MDL-NBS-HS-000008 Rev 02 [Appendix A, Section A8.1]. Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2004.