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SOFTWARE RELEASE NOTICE

01. SRN Number: PA-SRN-147		
02. Project Title: Uranium Recovery		Project No. 20-8265-011
03. SRN Title: Radon, Version 1.2		
04. Originator/Requestor: James Weldy		Date: 06/06/97
05. Summary of Actions		
<ul style="list-style-type: none"><input checked="" type="checkbox"/> Release of new software<input type="checkbox"/> Release of modified software:<ul style="list-style-type: none"><input type="checkbox"/> Enhancements made<input type="checkbox"/> Corrections made<input type="checkbox"/> Change of access software<input checked="" type="checkbox"/> Software Retirement <i>per PMackin 12/6/2001</i>		
06. Persons Authorized Access		
Name	RO/RW	A/C/D
James Weldy	RW	A
Pat Mackin	RW	A
07. Element Manager Approval: <i>PCH</i>		Date: <i>6/6/97</i>
08. Remarks: Acquired code from NRC in May 1997.		

SOFTWARE SUMMARY FORM

01. Summary Date: 06/06/97	02. Summary prepared by (Name and phone) James Weldy, (210) 522-6800	03. Summary Action: New	
04. Software Date: 02/02/89	05. Short Title: Radon , Version 1.2		
06. Software Title: Radon - Version 1.2		07. Internal Software ID: None	
08. Software Type: <input type="checkbox"/> Automated Data System <input checked="" type="checkbox"/> Computer Program <input type="checkbox"/> Subroutine/Module	09. Processing Mode: <input checked="" type="checkbox"/> Interactive <input type="checkbox"/> Batch <input type="checkbox"/> Combination	10. APPLICATION AREA a. General: <input checked="" type="checkbox"/> Scientific/Engineering <input type="checkbox"/> Auxiliary Analyses <input type="checkbox"/> Total System PA <input type="checkbox"/> Subsystem PA <input type="checkbox"/> Other b. Specific: Seismic Hazard Characterization	
11. Submitting Organization and Address: CNWRA/SwRI 6220 Culebra Road San Antonio, TX 78228		12. Technical Contact(s) and Phone: Dan Rom (301) 415-6704	
13. Narrative: Calculates the Radon flux emanating from a set concentration of contaminated soil covered by at least one cover material.			
14. Computer Platform(s) PC and SUN-Sparc 10	15. Computer Operating System: DOS, UNIX	16. Programming Language(s): Basic, FORTRAN	17. Number of Source Program Statements: 404, 759
18. Computer Memory Requirements: 256K	19. Tape Drives: N/A	20. Disk/Drum Units: 1 Floppy Disk Drive	21. Graphics: No
22. Other Operational Requirements: N/A			
23. Software Availability: <input checked="" type="checkbox"/> Available <input type="checkbox"/> Limited <input type="checkbox"/> In-House ONLY		24. Documentation Availability: <input checked="" type="checkbox"/> Available <input type="checkbox"/> Inadequate <input type="checkbox"/> In-House ONLY	
Software Custodian: <u><i>James Weldy</i></u> Date: <u>6/6/97</u>			

Version 1.2 - Feb. 2, 1989 - G.F. Birchard tel.# (301)492-7000
U.S. Nuclear Regulatory Commission Office of Research

RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

Benchmark of Radon.f code vs. Sample Calculation in Regulatory Guide 3.64
CONSTANTS

RADON DECAY CONSTANT 2.10000E-06 s⁻¹
RADON WATER/AIR PARTITION COEFFICIENT 0.260000
SPECIFIC GRAVITY OF COVER & TAILINGS 2.65000

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS 3
DESIRED RADON FLUX LIMIT 20.0000pCi m⁻² s⁻¹
NO. OF THE LAYER TO BE OPTIMIZED 3
DEFAULT SURFACE RADON CONCENTRATION 0. pCi l⁻¹
RADON FLUX INTO LAYER 1 0. pCi m⁻² s⁻¹
SURFACE FLUX PRECISION 1.00000E-03 pCi m⁻² s⁻¹
LAYER # 1

THICKNESS (cm) 500.000
POROSITY 0.440000
MEASURED MASS DENSITY 1.48400 g cm⁻³
MEASURED SOURCE TERM CONCENTRATION 5.73000E-04 pCi cm⁻³ s⁻¹
WEIGHT % MOISTURE 11.7000%
MOISTURE SATURATION FRACTION 0.394609
MEASURED DIFFUSION COEFFICIENT 1.30000E-02cm² s⁻¹

LAYER # 2

THICKNESS (cm) 50.0000
POROSITY 0.300000
MEASURED MASS DENSITY 1.85500 g cm⁻³
MEASURED SOURCE TERM CONCENTRATION 0. pCi cm⁻³ s⁻¹
WEIGHT % MOISTURE 6.30000%
MOISTURE SATURATION FRACTION 0.389550
MEASURED DIFFUSION COEFFICIENT 7.80000E-03cm² s⁻¹

LAYER # 3

THICKNESS (cm) 100.0000
POROSITY 0.370000
MEASURED MASS DENSITY 1.66950 g cm⁻³
MEASURED SOURCE TERM CONCENTRATION 0. pCi cm⁻³ s⁻¹
WEIGHT % MOISTURE 5.40000%
MOISTURE SATURATION FRACTION 0.243657
MEASURED DIFFUSION COEFFICIENT 2.20000E-02cm² s⁻¹

DATA SENT TO THE FILE 'RNDATA' ON DRIVE A:

*Installation
Test.*

This installation test was
run on May 18th, 1997 to
test that the FORTRAN translation
of the RADON code performs calculations
correctly. The results of the testing
match the sample calculation in Reg.
Guide 3.64 within less than 0.1%,
and are appropriate to show that the
code is performing correctly.

James L. Welly

5/a

N	F01	CN1	ICOST	CRITJ	ACC
3	0.000E+00	0.000E+00	3	2.000E+01	1.000E-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000E+02	1.300E-02	4.400E-01	5.730E-04	3.946E-01	1.484E+00
2	5.000E+01	7.800E-03	3.000E-01	0.000E+00	3.896E-01	1.855E+00
3	1.000E+02	2.200E-02	3.700E-01	0.000E+00	2.437E-01	1.669E+00

BARE SOURCE FLUX FROM LAYER 1 198.366 pCi m⁻² s⁻¹

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m ⁻² s ⁻¹)	EXIT CONC. (pCi l ⁻¹)
1	5.000E+02	7.691E+01	1.670E+05
2	5.000E+01	4.524E+01	4.430E+04
3	1.490E+02	2.001E+01	0.000E+00

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-----*****! RADON !*****-----

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

Benchmarking of RADON.BAS vs. Sample Problem in Regulatory Guide 3.64 (Task WM 5
03-4) "Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Co
vers"

CONSTANTS

RADON DECAY CONSTANT	.0000021	s ⁻¹
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	3	
DESIRED RADON FLUX LIMIT	20	pCi m ⁻² s ⁻¹
NO. OF THE LAYER TO BE OPTIMIZED	3	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l ⁻¹
RADON FLUX INTO LAYER 1	0	pCi m ⁻² s ⁻¹
SURFACE FLUX PRECISION	.001	pCi m ⁻² s ⁻¹

LAYER INPUT PARAMETERS

LAYER 1

THICKNESS	500	cm
POROSITY	.44	
MEASURED MASS DENSITY	1.484	g cm ⁻³
MEASURED SOURCE TERM CONCENTRATION	5.7300000000000001	D-04
pCi cm ⁻³ s ⁻¹		
WEIGHT % MOISTURE	11.7	%
MOISTURE SATURATION FRACTION	.395	
MEASURED DIFFUSION COEFFICIENT	.013	cm ² s ⁻¹

This installation test was run on
May 18th, 1997 to test that the
RADON code received from the NRC
was performing correctly. The results
of this run match the results of the
Sample calculation in Reg. Guide 3.64 within
less than 0.1% and are appropriate
to show that the code is performing
correctly.

James R. Wilby

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LAYER 2

THICKNESS	50	cm
POROSITY	.3	
MEASURED MASS DENSITY	1.855	g cm ⁻³
MEASURED SOURCE TERM CONCENTRATION	0	pCi cm ⁻³ s ⁻¹
WEIGHT % MOISTURE	6.3	%
MOISTURE SATURATION FRACTION	.390	
MEASURED DIFFUSION COEFFICIENT	.0078	cm ² s ⁻¹

LAYER 3

THICKNESS	100	cm
POROSITY	.37	
MEASURED MASS DENSITY	1.6695	g cm ⁻³
MEASURED SOURCE TERM CONCENTRATION	0	pCi cm ⁻³ s ⁻¹
WEIGHT % MOISTURE	5.4	%
MOISTURE SATURATION FRACTION	.244	
MEASURED DIFFUSION COEFFICIENT	.022	cm ² s ⁻¹

DATA SENT TO THE FILE 'RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC	
3	0.000D+00	0.000D+00	3	2.000D+01	1.000D-03	

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	1.300D-02	4.400D-01	5.730D-04	3.946D-01	1.484
2	5.000D+01	7.800D-03	3.000D-01	0.000D+00	3.895D-01	1.855
3	1.000D+02	2.200D-02	3.700D-01	0.000D+00	2.437D-01	1.670

BARE SOURCE FLUX FROM LAYER 1: 1.984D+02 pCi m⁻² s⁻¹

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m ⁻² s ⁻¹)	EXIT CONC. (pCi l ⁻¹)
1	5.000D+02	7.691D+01	1.670D+05
2	5.000D+01	4.524D+01	4.430D+04
3	1.490D+02	2.001D+01	0.000D+00