Idaho Cleanup Project

Idaho Nuclear Technology and Engineering Center Tank Farm Closure Draft 3116 Waste Determination

Presentation to the Nuclear Regulatory Commission Staff

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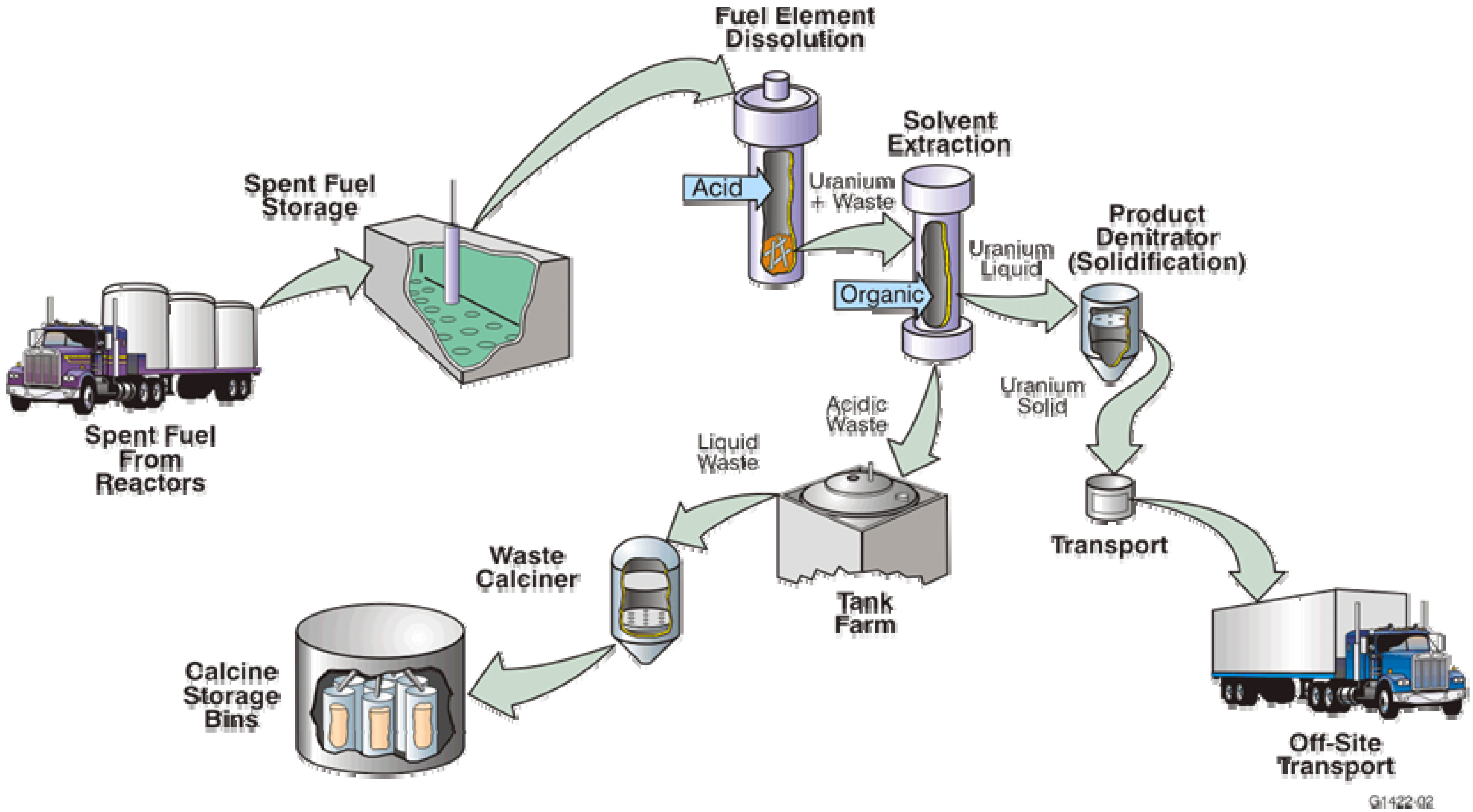
- *Purpose: To provide an overview of the Draft 3116 Determination and address questions concerning the Performance Assessment or the Draft 3116 Determination*

Draft 3116 Determination Contents

- ***Introduction and Purpose***
- ***Background***
  - ***Overview of Tank Farm Design and Tank Waste Generation and Management***
  - ***Overview of Tank Cleaning Results to Date***
  - ***Development of Estimates of Residual Waste at Closure***
- ***Section 3116 of the National Defense Authorization Act***
  - ***Does the Waste Require Permanent Isolation in a Deep Geologic Repository?***
  - ***Has the Waste Had Highly Radioactive Radionuclides Removed to the Maximum Extent Practical?***
    - ***Identification of Highly Radioactive Radionuclides***
    - ***Evaluation of Radionuclide Removal to the Maximum Extent Practical***
- ***What are the Radionuclide Concentrations in the Final Waste Form (with Reference to Class C Low Level Waste Concentration Limits)?***
- ***Will the Waste Be Disposed of in Accordance with Performance Objectives in 10 CFR Part 61, Subpart C (for Low-Level Waste Disposal)?***
- ***State-Approved Closure Plans***
- ***Conclusions***

Overview of the Generation of TFF Waste

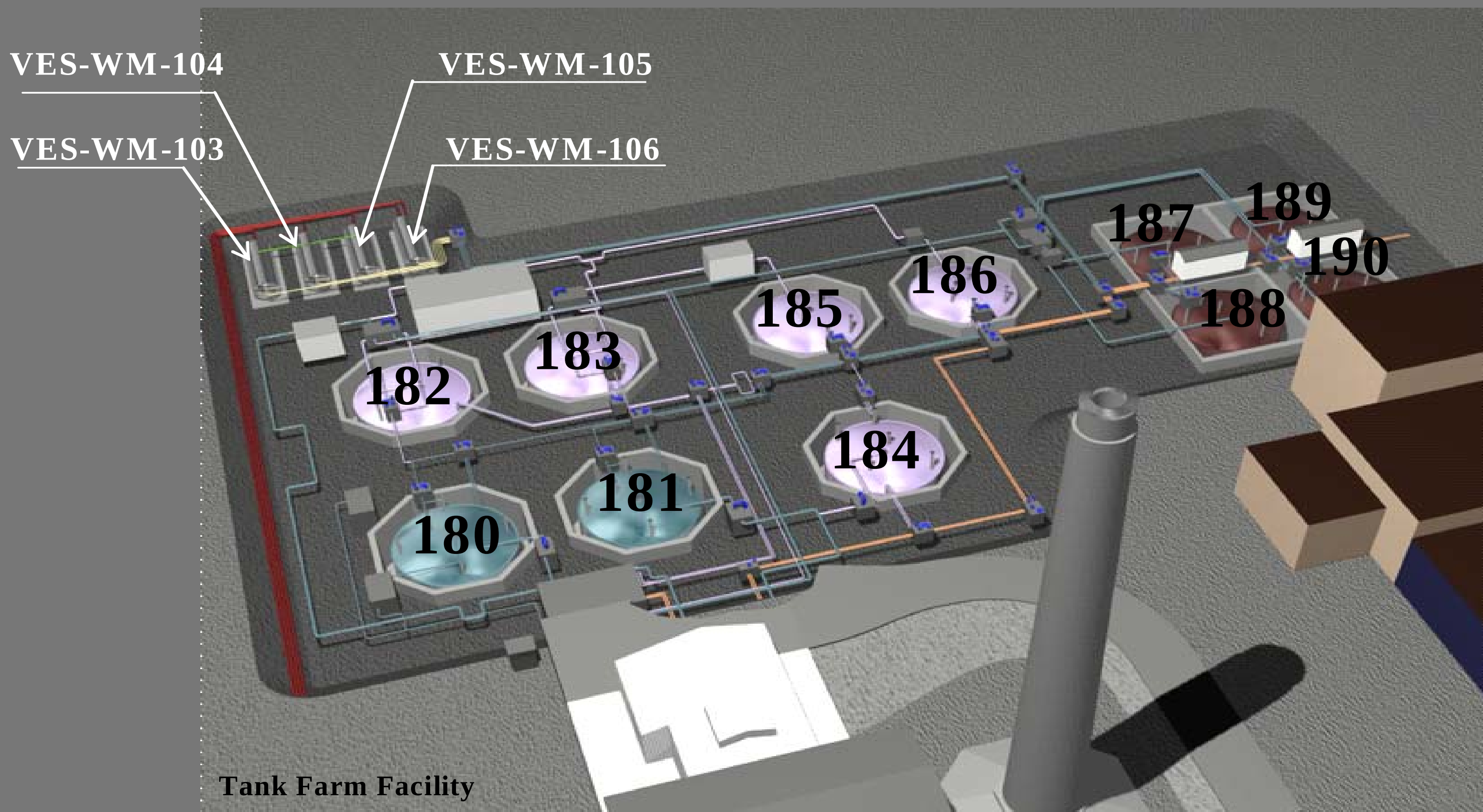
Historical Material Flow – Idaho Nuclear Technology and Engineering Center (INTEC)



Idaho TFF Waste

- ***Several types of waste have been stored in TFF:***
  - ***Reprocessing wastes (1st, 2nd, 3rd cycle wastes)***
  - ***Decontamination solutions from cleanup of equipment and facilities***
  - ***Laboratory wastes***
  - ***Off-gas cleanup scrub solutions***
  - ***Condensate from tank farm transfer equipment***
  - ***Contaminated facility sump water***
  - ***Other low activity miscellaneous plant wastes***
- ***Segregation in tank farm by activity level/chemistry***
- ***Evaporator systems used to minimize needed storage space***
- ***~9 million gallons of waste sent to TFF over history***

INTEC TANK FARM CLOSURE



- Octagon Vaults: WM-180, WM-181
- Pillar and Panel Vaults: WM-182, WM-183, WM-184, WM-185, WM-186
- Square Vaults: WM-187, WM-188, WM-189, WM-190

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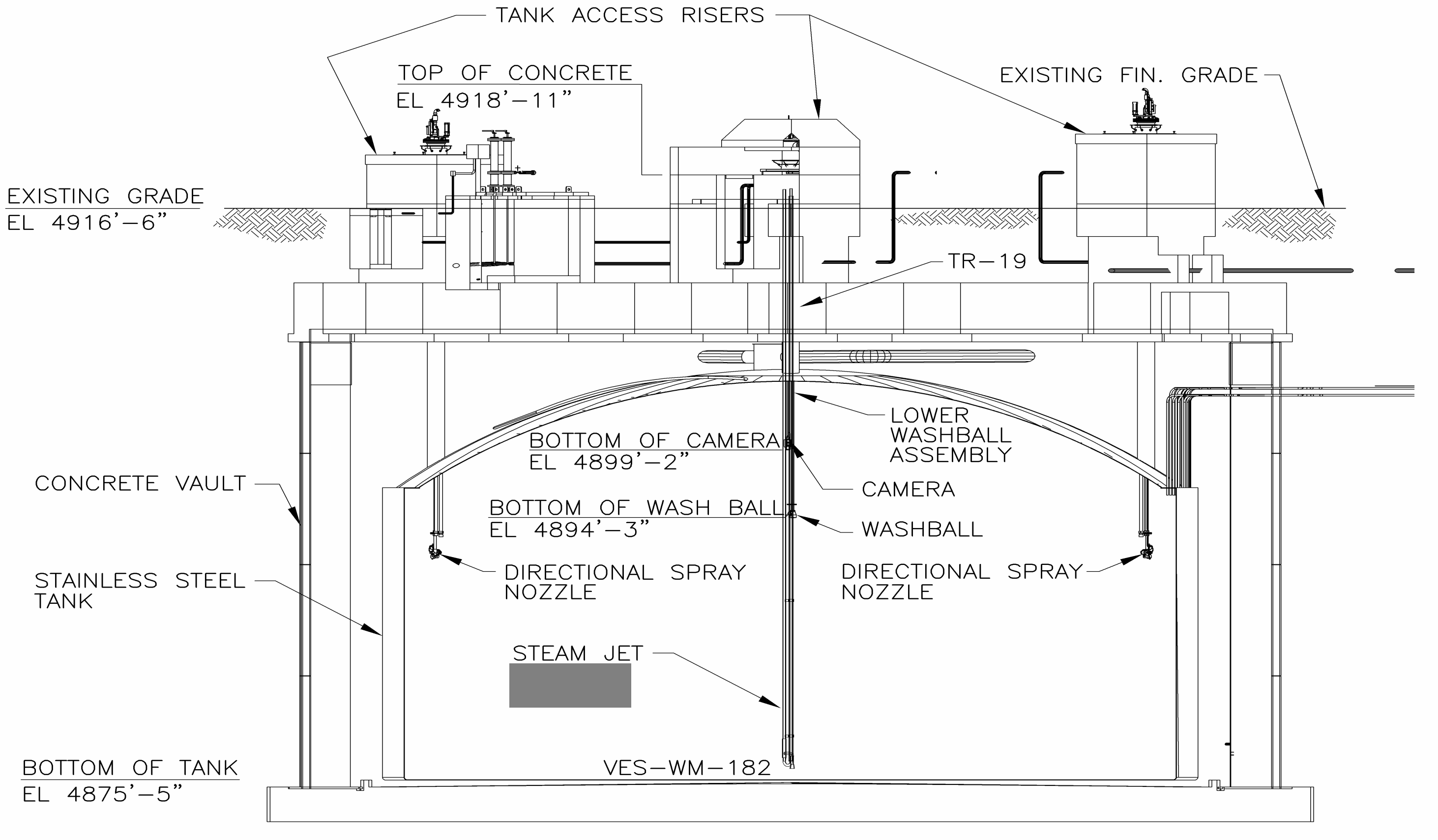
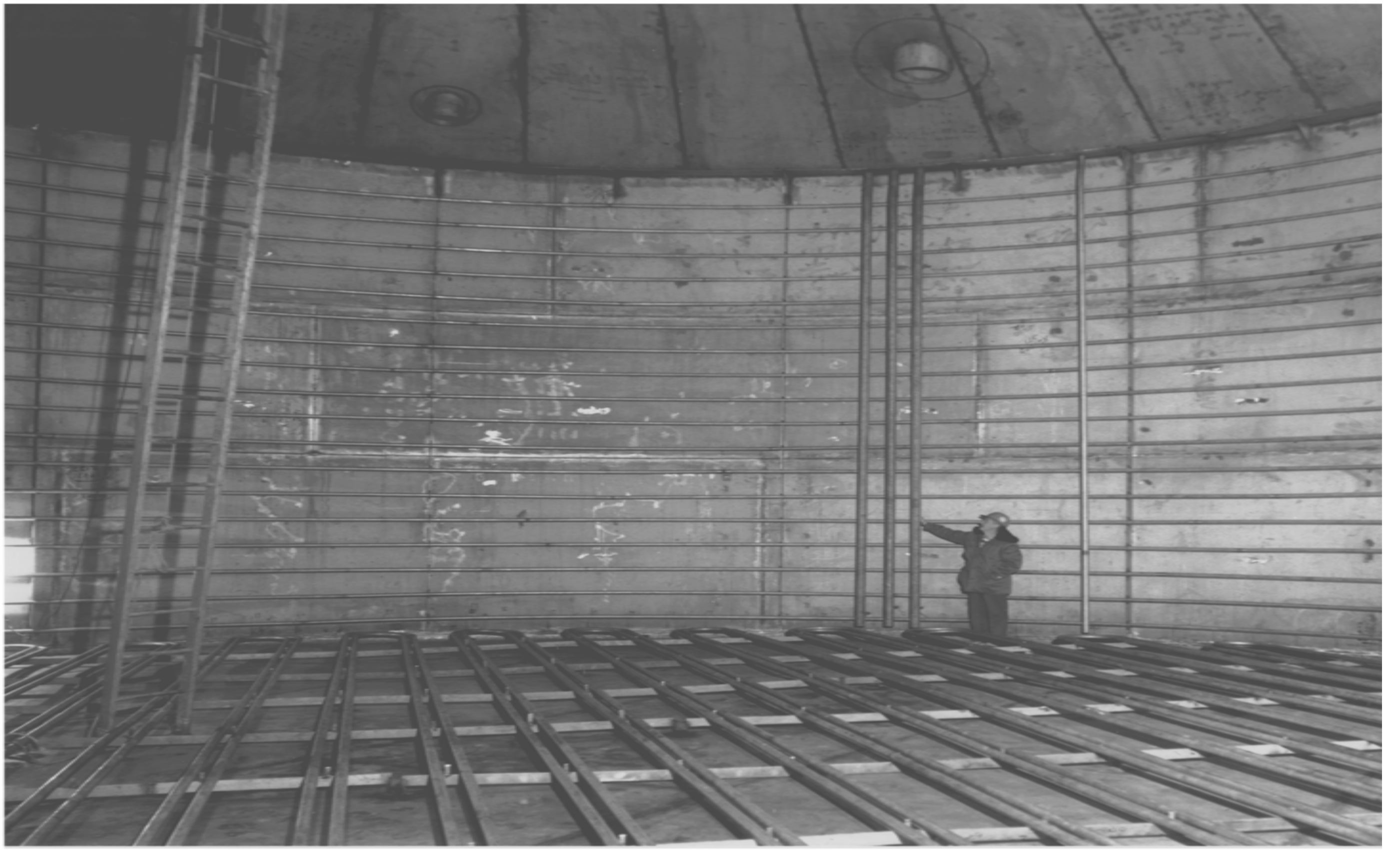
Cross-Section of 300,000-Gallon Tank



Construction Photo of Tank WM-185



Overview of Tank Cleaning Results

- *Seven 300,000 gallon tanks and all four small tanks have been cleaned*
- *The waste is consolidated in three 300,000 gallon tanks*
- *Tank WM-190 has never been used and is used as an emergency spare tank.*

Post-Cleaning Data Summary

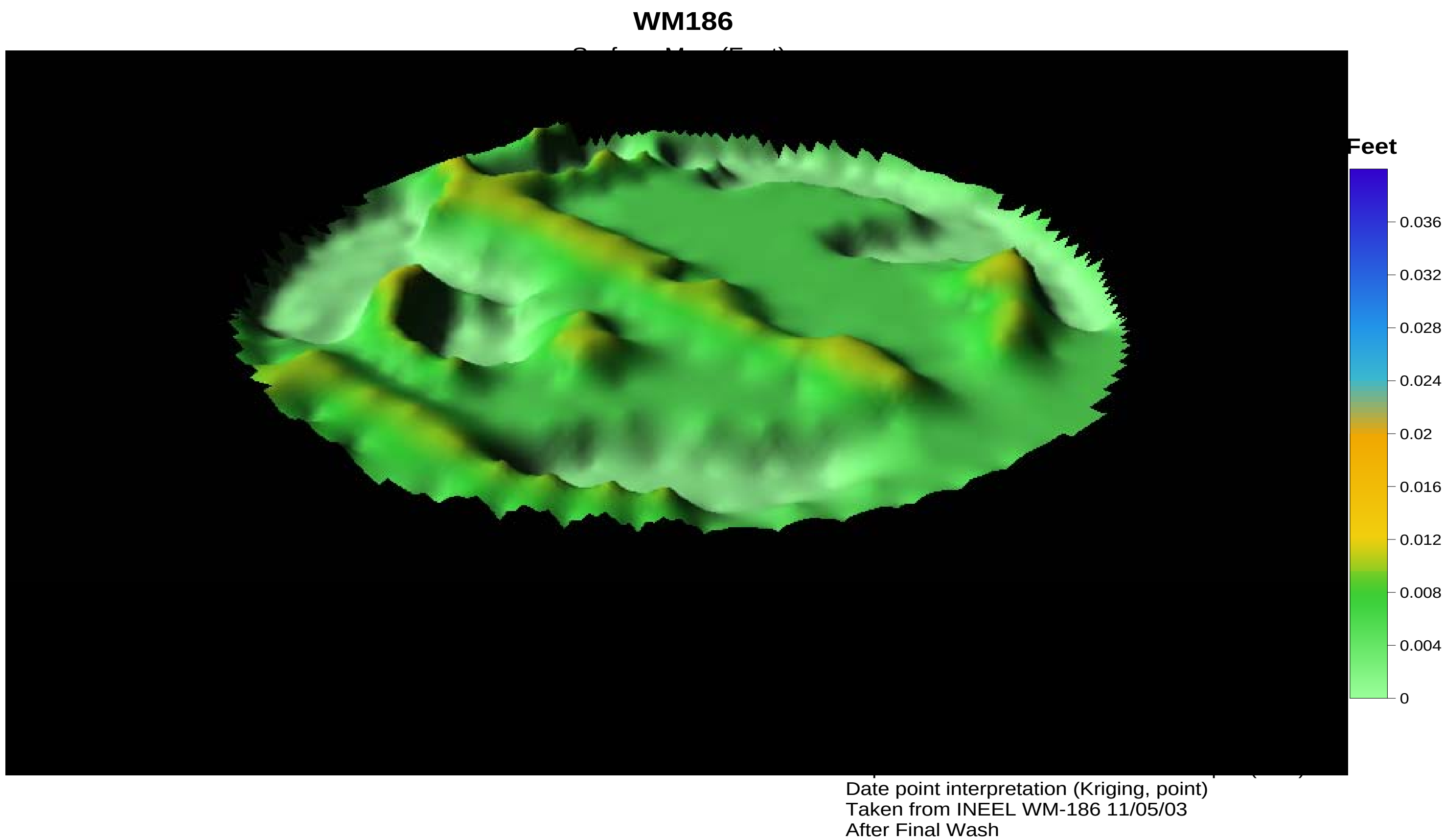
- *Tank washing is performed until monitoring of the exiting rinse water and remote visual inspection of the tank interior indicates that significant amounts of waste are no longer being removed during cleaning*
- *Sampling and Analysis Plans developed using the Data Quality Objectives (DQO) process*
- *The samples are analyzed for radionuclides and hazardous constituents*
- *Radionuclide concentrations have been reduced to levels well within the inventory modeled in the performance assessment*
- *Tank cleaning and sampling approaches are successful and efficient*
- *Independent sample data validation is performed and Data Quality Assessment (DQA) reports are issued as validated data become available*

Development of Estimates of Residual Waste

Estimation of Remaining Tank Inventory After Washing is Completed

- ***Analysis of samples allowed direct calculation of curies in the remaining tank <u>liquids</u>***
- ***Limited amount of remaining solids routinely resulted in samples which held too few solids to allow direct analysis. (Tank samples produced a few grams of solids from tank WM-183)***
- ***The ORIGEN2 model results modified by ^{137}Cs analytical data was used to estimate radionuclides not detected in liquids or solids.***
- ***Video inspection of tank internals was performed to map out estimates of depth of remaining residual solids across tank bottoms***
  - ***Used tank internal structures of known height as reference points***
- ***Auto-CAD and "Kreiging" software models were used to plot contour maps and provide a solids volume and mass estimates for each tank.***
- ***Laboratory analysis of pre-wash ^{137}Cs data, and post-wash analytical date were combined with estimates of remaining solids volume and mass estimates, allowed calculation of the curies in the remaining solid particles.***
- ***Radionuclides detected in solid sample ^{137}Cs, ^{241}Am, ^{60}Co, ^{94}Nb, ^{238}Pu, ^{239}Pu, ^{125}Sb, ^{90}Sr, ^{234}U, ^{99}Tc, ^{129}I***

Example Contour Plot



Estimates of Curies Remaining in 300,000 Gallon Tanks

Tank Condition	Solids Activity (Ci)*	Liquid Activity (Ci)	Total Tank Activity (Ci)
WM-182 Post-Decontamination	2,391	3	2,394
WM-183 Post-Decontamination	1,355	8	1,363
WM-184 Post-Decontamination	1,077	<1	1,077
WM-185 Post-Decontamination	1,391	<1	1,391
WM-186 Post-Decontamination	646	<1	646
WM-181 Post-Decontamination	475	<1	475
WM-180 Post-Decontamination	1,047	<1	1,047
*Estimated based on WM-183 solids			

Estimates of Curies Remaining in 30,000 Gallon Tanks

Tank	Solids Activity (Ci)	Liquids Activity (Ci)	Total Tank Activity (Ci)
WM-103 Post Decontamination	36	<1	36
WM-104 Post Decontamination	36	<1	36
WM-105 Post Decontamination	36	<1	36
WM-106 Post Decontamination	36	<1	36

Sandpad Inventory Development

- *The total radioactivity is estimated at 3,850 Ci for each of the Sandpads.*
- *Inventory of Sandpad is based on 1962 back siphon events.*
- *The radionuclide concentrations were modeled using ORIGEN2 assuming a typical fuel type which was reprocessed, with typical burnup as the source of the waste.*
- *Data collected for ^{137}Cs from the tank one month prior to the event was used to modify the modeled results.*
- *Waste was in the vaults approximately 24 hours*
- *A one dimensional diffusion calculation was used for transfer of radionuclide into and out of the sand.*
- *FORTRAN computer code was developed to model radioactive decay and then flushing of the sand pad based on partition coefficients and the volume of sand, void space, and residual saturation.*

Piping Inventory

- *Pieces of horizontal and vertical process piping were cut from Tank WM-182*
- *Pieces were then cut to 18 inch section using a wheel cutter.*
- *Demineralized water was filled each pipe*
- *The water was decanted and sampled for metals*
- *The metals data was used to conservatively estimate radionuclide inventory*
- *Total length of pipe in the TFF contains approximately 15.5 kg (30 Ci) of residual.*

Summary of Estimate of Residual Waste at Closure

- *Estimates were developed for use in the Draft 3116 Determination*
  - ***Used to address whether highly radioactive radionuclides have been removed to the maximum extent practical***
  - ***Used to estimate the final radionuclide concentrations in the closed tank farm tanks, vaults, and ancillary equipment***
  - ***Used in the performance assessment to evaluate whether closure could be completed within the performance objectives in 10 CFR 61, Subpart C***
- *Estimates are based upon sample analysis for those nuclides able to be detected, and upon computer modeling for those nuclides which could not be detected*
- *For large tanks, largest inventory to date is ~2,394 curies per tank*
- *For smaller tanks, largest inventory to date is ~36 curies per tank*
- *For vaults, the conservative estimate of contaminated sandpads is used - ~ 3,850 Ci for each contaminated sandpad (for tanks WM-185 and WM-187)*
- *Transfer piping - ~30 curies*

Basis of the Draft 3116 Determination

- *Section 3116 of the National Defense Authorization Act*
  - ***Does the Waste Require Permanent Isolation in a Deep Geologic Repository?***
  - ***Has the Waste Had Highly Radioactive Radionuclides Removed to the Maximum Extent Practical?***
    - ***Identification of Highly Radioactive Radionuclides***
    - ***Evaluation of Radionuclide Removal to the Maximum Extent Practical***
  - ***Does the waste exceed concentration limits for Class C low-level waste as set out in Section 61.55 of title 10, Code of Federal Regulations, and will be disposed of—***
    - ***(i) in compliance with the performance objectives set out in subpart C of part 61 of title 10, Code of Federal Regulations; and***
    - ***(ii) pursuant to a State-approved closure plan or State-issued permit, authority for the approval or issuance of which is conferred on the State outside of this section;***

Waste Has Had Highly Radioactive Radionuclides Removed to the Maximum Extent Practical

Strategy for Identification of Highly Radioactive Radionuclides

- *DOE views “highly radioactive radionuclides” to be those radionuclides that, using a risk-informed approach, contribute most significantly to radiological risk to workers, the public, and the environment.*
- *The inventory of radionuclides in the TFF was used as a starting point*
- *Included all radionuclides from Tables 1 and 2 of 10 CFR 61.55*
- *Added any additional radionuclides that are shown to be important in the performance assessment.*

Screening of Radionuclides In the Performance Assessment

- *Radionuclides for groundwater analysis were screened using a 5-year half-life and radionuclides in short decay chains were eliminated from further analysis since the parent and progeny each have half-lives of less than 5 years:*
- *Additional radionuclides were screened since their half-lives indicate that they are either stable or have such long half-lives the contribution, to dose would be insignificant.*
- *The concentrations of radionuclides in the waste pore water that would give an annual effective dose equivalent of 4 mrem/yr from consumption of 70 oz/d (i.e., 200 gal/yr) of contaminated water.*
- *Releases and groundwater concentrations were previously analyzed by numerical modeling and calculation of the dose.*
- *Radionuclides from the Intruder scenarios were screened based on half life and results of the dose assessment*

List of Highly Radioactive Radionuclides

Radionuclide	Radionuclide Half-Life (yr)	Long-Term Radiation Hazards	Short-Term Radiation Hazards
^{241}Am	4.3E+02	X	
^{14}C	5.7E+03	X	
^{242}Cm	4.5E–01	X	
^{60}Co	5.3E+00		X
^{137}Cs	3.0E+01		X
^{137m}Ba	4.9E–06		X
^{3}H	1.2E+01		X
^{129}I[a]	1.6E+07	X	
^{94}Nb	2.0E+04	X	
^{59}Ni	7.5E+04	X	
^{63}Ni	1.0E+02		X
^{237}Np	2.1E+06	X	
^{238}Pu	8.8E+01	X	
^{239}Pu[a]	2.4E+04	X	
^{240}Pu	6.6E+03	X	
^{241}Pu	1.4E+01	X	
^{242}Pu	3.8E+05	X	
^{90}Sr	2.9E+01		X
^{90}Y	7.3E–03		X
^{99}Tc	2.1E+05	X	

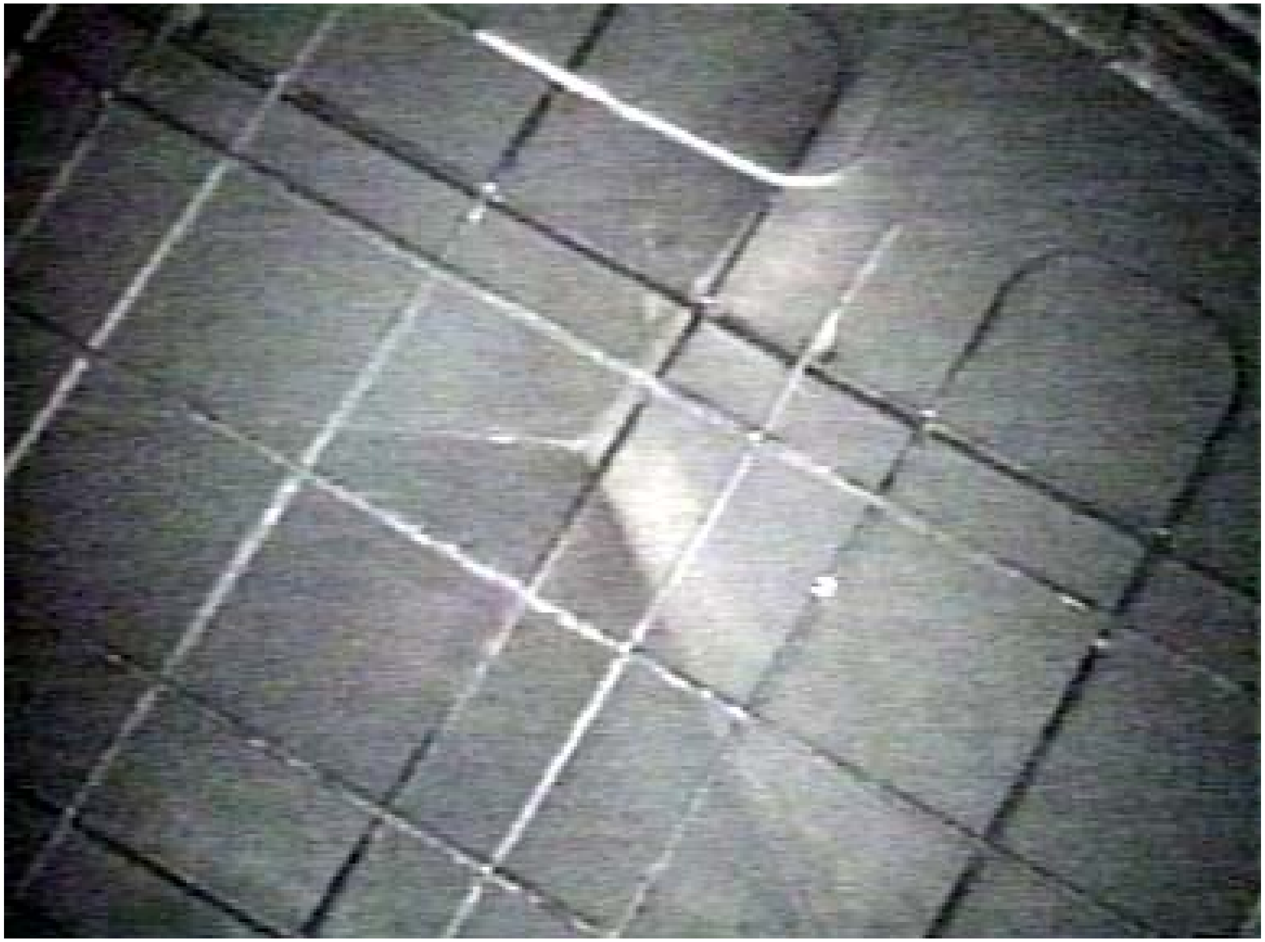
Radionuclide Removal to the Maximum Extent Practical

- ***The Draft 3116 Determination presents the information pertinent to removal to the maximum extent practical.***
  - *The waste stored in the TFF was calcined and is now stored in bin sets waiting final disposition.*
  - *Various tank cleaning technologies were reviewed for applicability to the TFF tanks.*
  - *The tank waste was removed to the heel*
  - *The tanks were repeatedly washed using a wash ball and directional nozzles*
  - *The effluent was monitored using a radiation detector. This monitoring provided an indication of when the washing reached a point of diminishing returns.*
  - *Washing was monitored by video cameras.*
  - *Samples of the residuals were collected based on a sampling and analysis plan using the Data Quality Objectives process.*
  - *Data Quality Assessments were prepared to review data and present results.*
  - *Estimates of the remaining inventory were documented in engineering design files.*
  - *Radiation doses from the various scenarios were estimated using a scaling methodology documented in an Engineering Design File.*
  - *Estimate of residual inventory at closure was compared against an estimate of total curies at INTEC*
  - *Estimate at closure assumes similar cleaning results for the four remaining tanks*

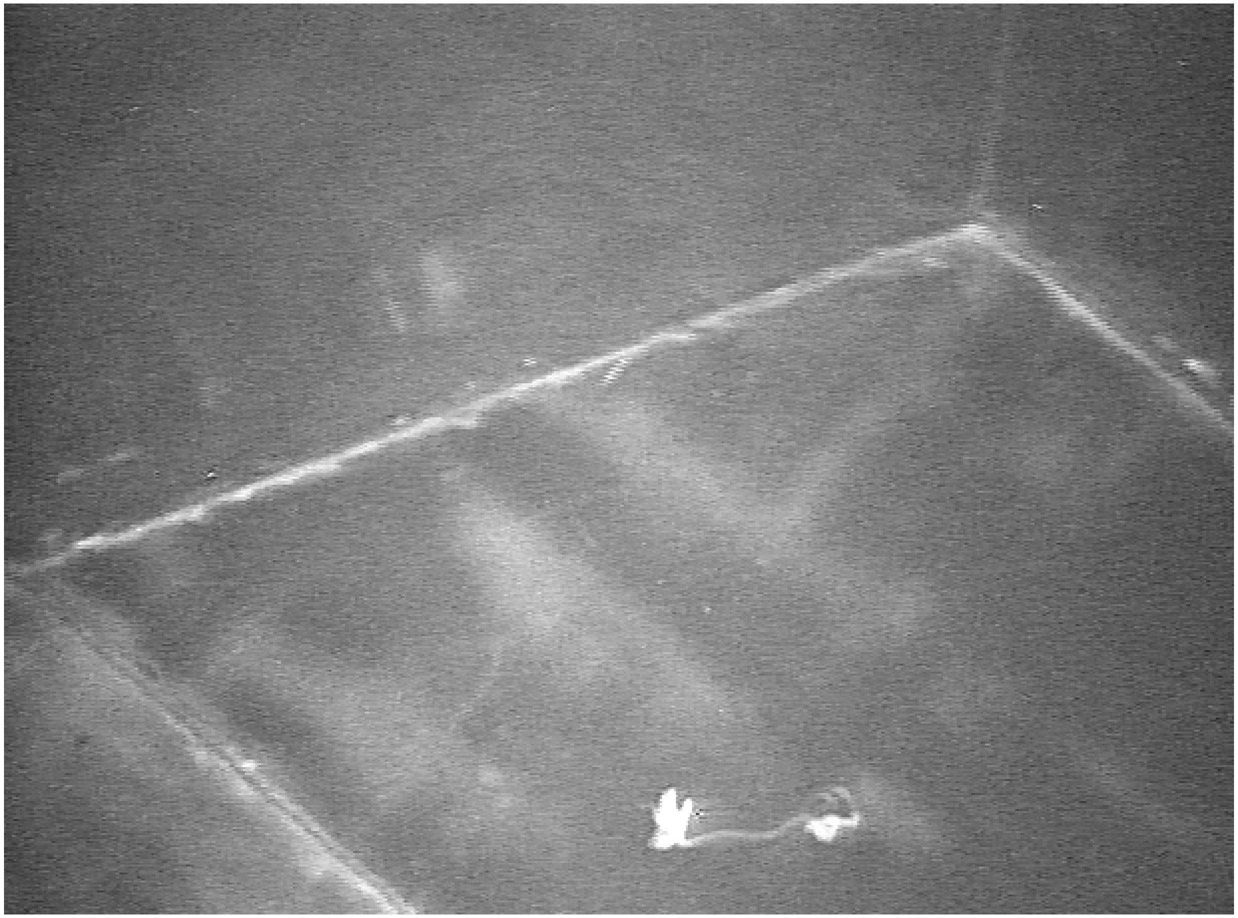
Percentage of Highly Radioactive Radionuclides Removed (from all tanks and ancillary equipment)

Radionuclides	Total Ci Generated at INTEC	Residual Ci in Tanks at Closure	Percent Removed at Closure
^{241}Am	9.28E+03	6.97E+00	99.92%
^{137m}Ba	8.95E+06	1.19E+04	99.87%
^{14}C	2.91E–02	3.85E–05	99.87%
^{242}Cm	1.51E+01	1.00E–02	99.93%
^{60}Co	1.67E+03	4.79E–01	99.97%
^{137}Cs	9.46E+06	1.19E+04	99.87%
^{129}I	6.01E+00	5.87E–03	99.90%
^{3}H	7.13E+03	5.43E+00	99.92%
^{94}Nb	1.54E+03	1.60E+00	99.90%
^{59}Ni	3.71E+03	1.90E–01	99.99%
^{63}Ni	4.36E+05	2.17E+01	99.99%
^{237}Np	7.53E+01	3.57E–01	99.53%
^{238}Pu	1.07E+05	9.08E+01	99.92%
^{239}Pu	2.83E+03	2.90E+01	98.98%
^{240}Pu	1.46E+03	1.09E+01	99.25%
^{241}Pu	4.73E+04	1.52E+02	99.68%
^{242}Pu	3.94E+00	7.60E–03	99.81%
^{90}Sr	8.42E+06	6.78E+02	99.99%
^{99}Tc	3.67E+03	5.79E+00	99.84%
^{90}Y	8.42E+06	6.75E+02	99.99%
Total (Ci)	3.59E+07	2.58E+04	99.93%

Tank WM-180 After Cleaning (Tank bottom)

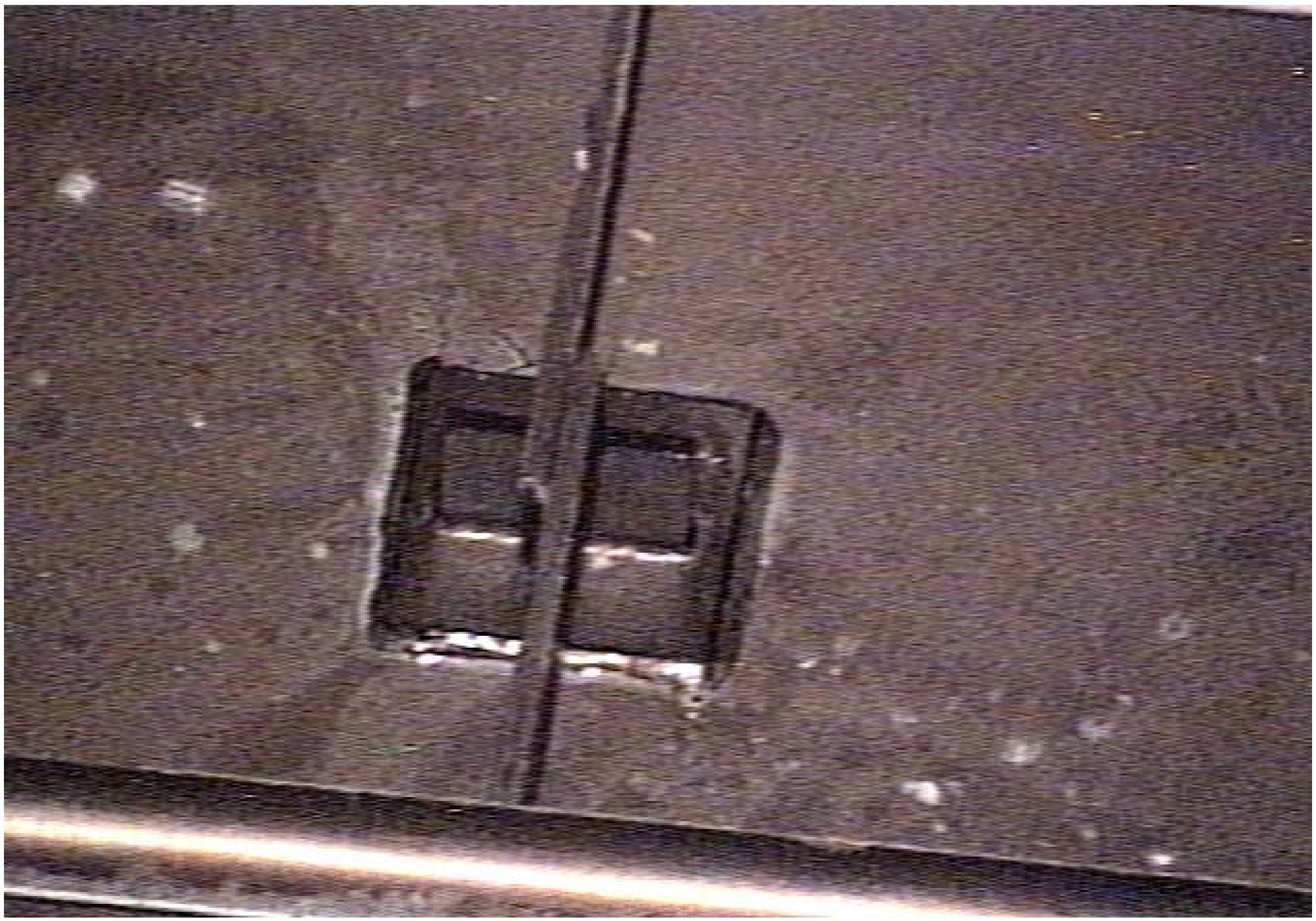


Tank WM-181 After Cleaning (Tank bottom)



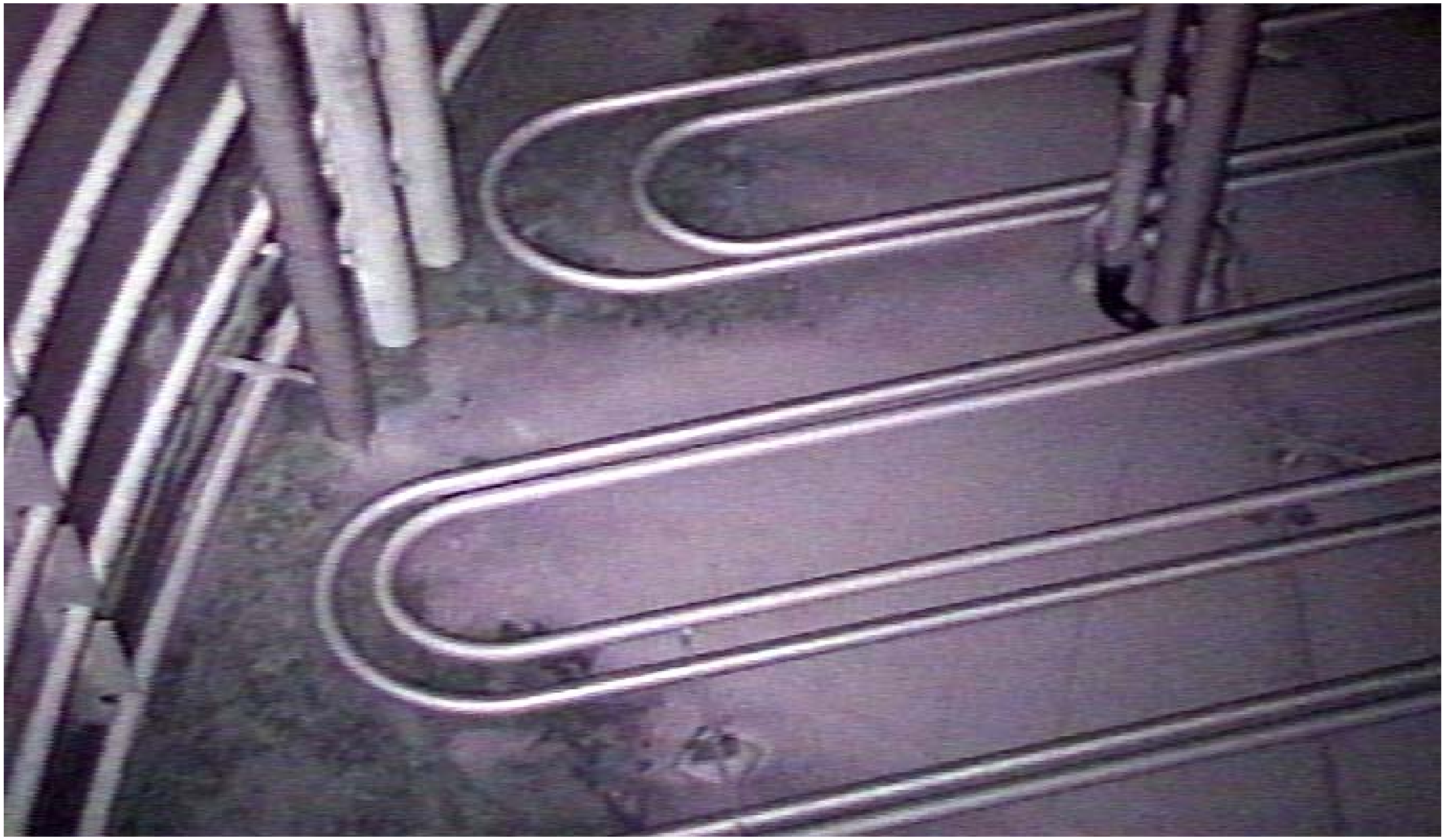
Tank WM-182 After Tank Cleaning (Tank bottom)

Tank WM-183 After Cleaning (Tank bottom base plate)

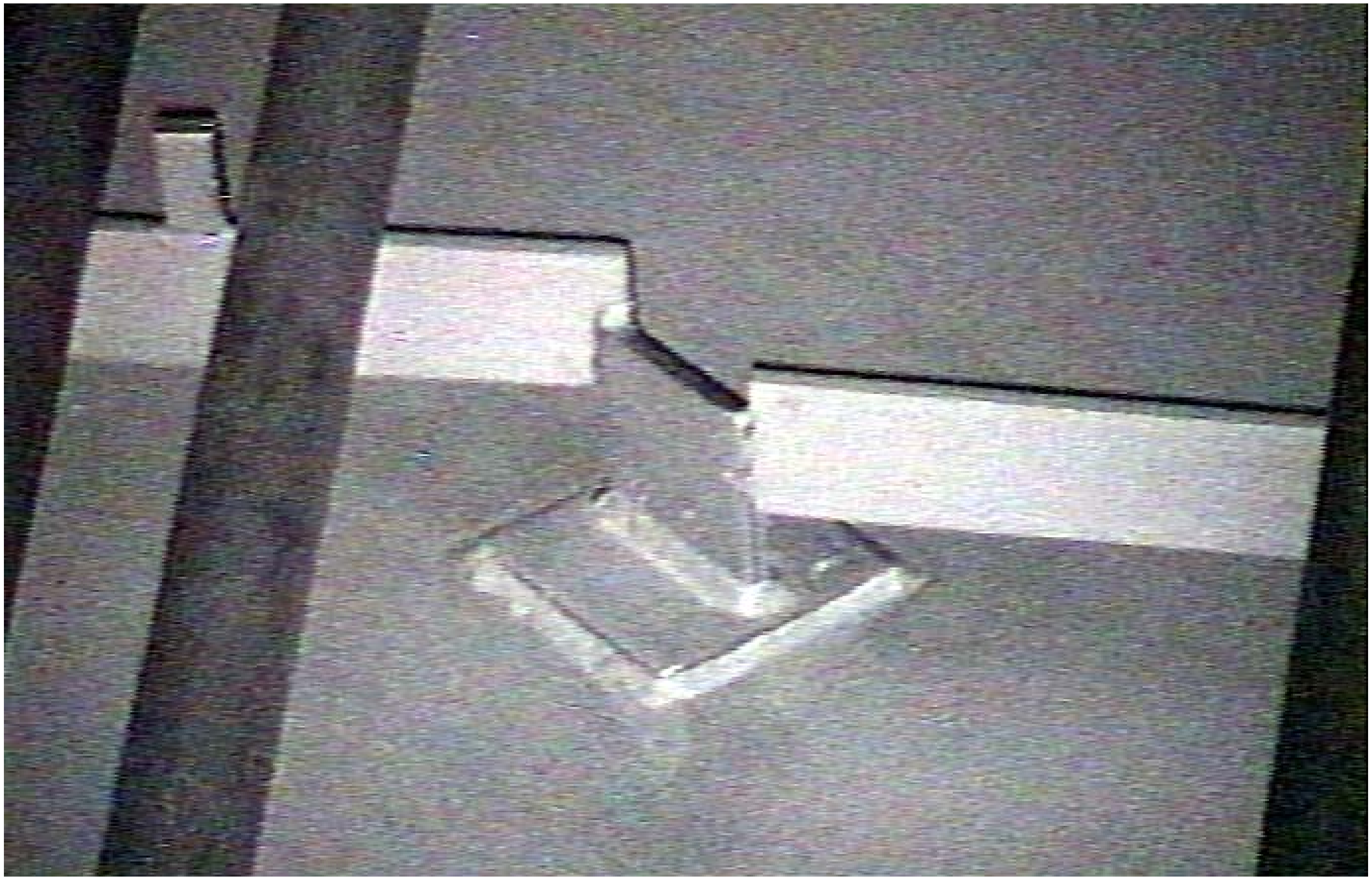


Tank WM-184 After Cleaning *(Tank bottom)*

Tank WM-185 After Cleaning (Tank bottom)



Tank WM-185 After Cleaning (Tank bottom base plate)



Tank WM-186 After Cleaning *(Tank bottom)*

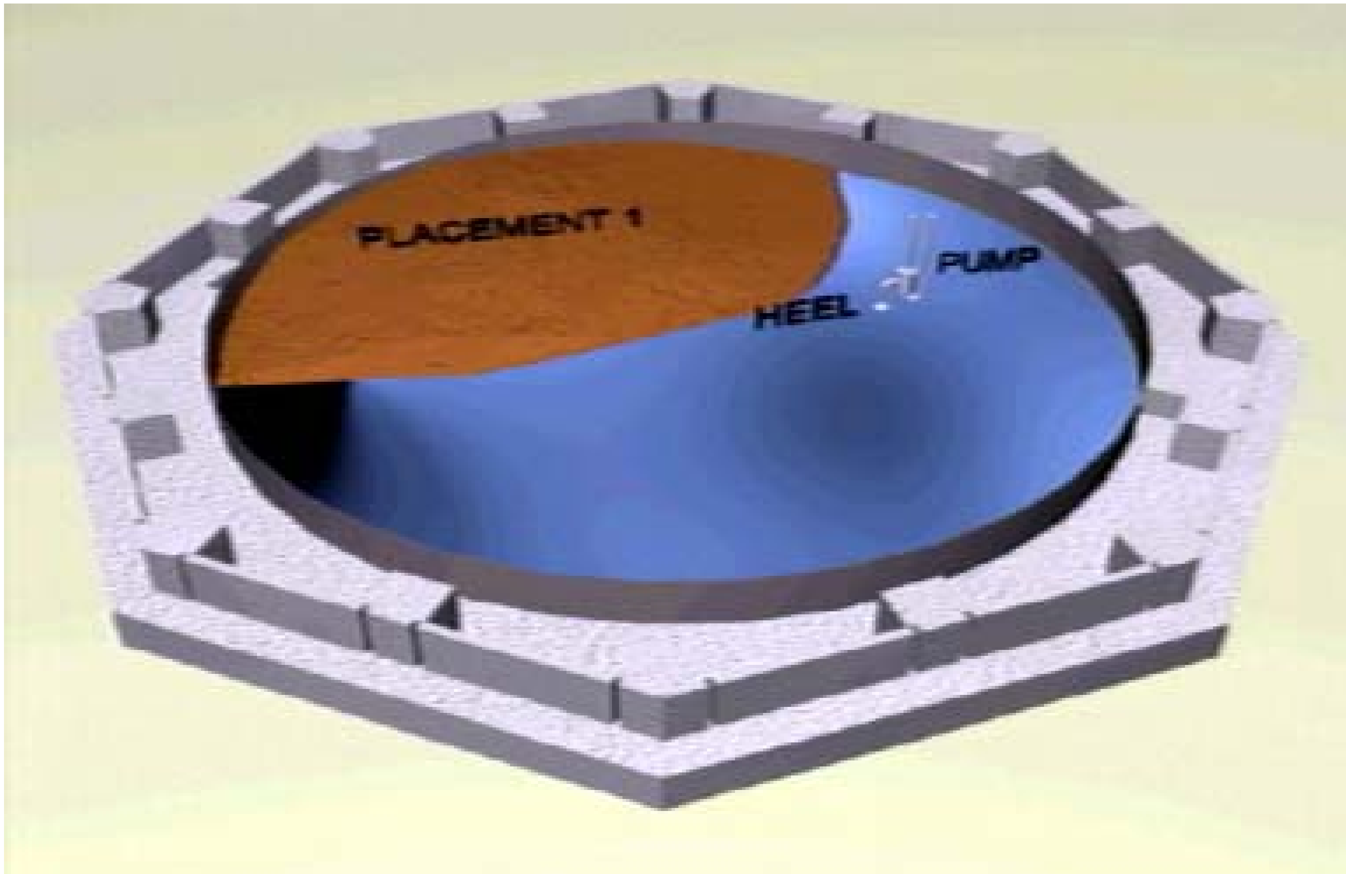
Radionuclide Concentrations of Stabilized Waste

Radionuclide Concentrations in the Final Waste Form

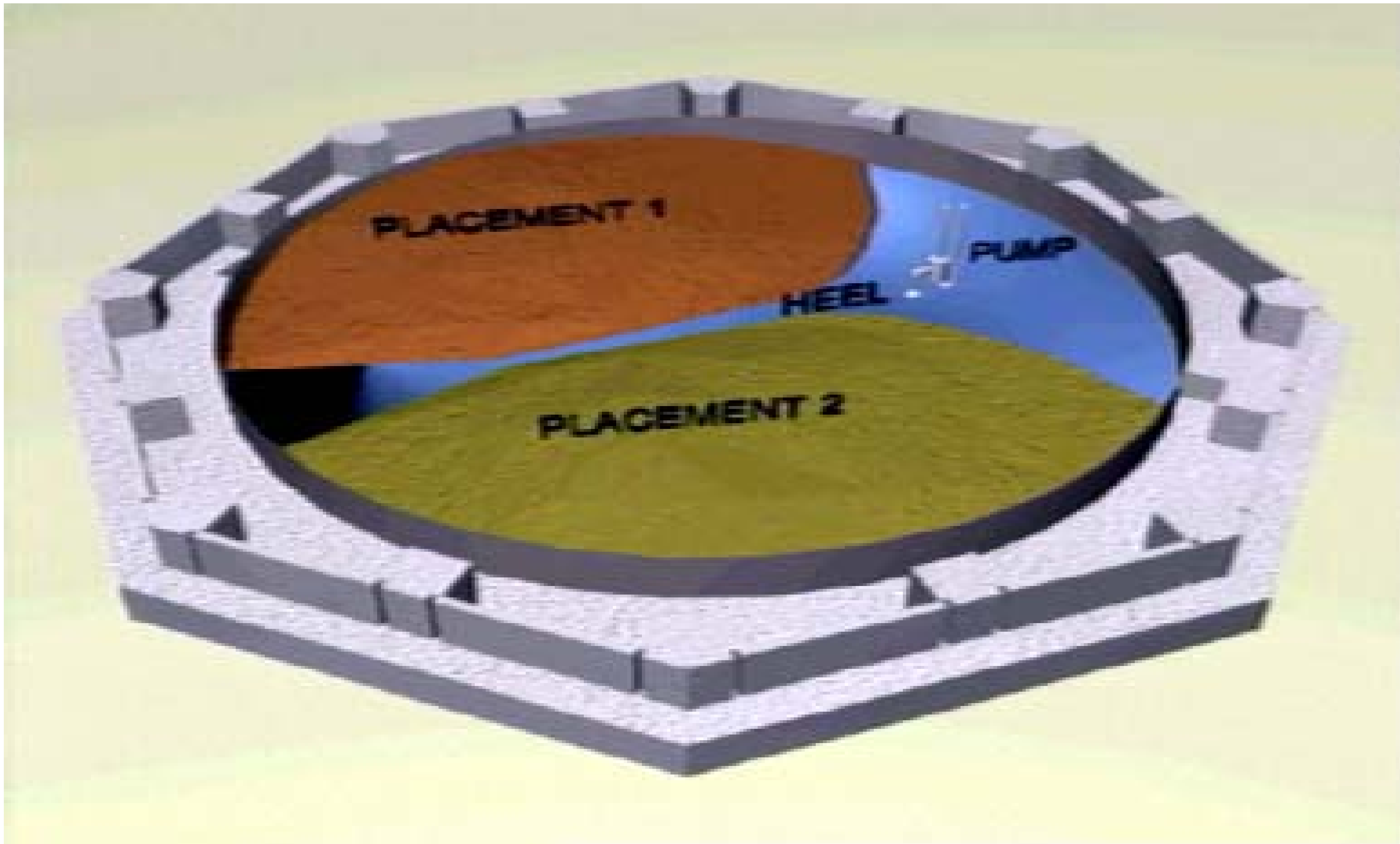
- *Using estimates of residual waste at closure, the concentrations of residuals in the Tank Farm components after grouting are calculated and shown along with the 10 CFR 61.55 Class C concentration limits*
- *Concentrations for various levels of grout are shown for comparison*
  - ***Complete mixing of the grout with the remaining residuals is not predicted or assumed***
  - ***Mock-up testing and engineering considerations indicate that a certain amount of grout, strategically poured in several placement locations in the tank, will effectively stabilize any remaining residuals and may provide an ability to remove some portion of any residual waste remaining after water cleaning is complete.***

Mock-up Demonstration

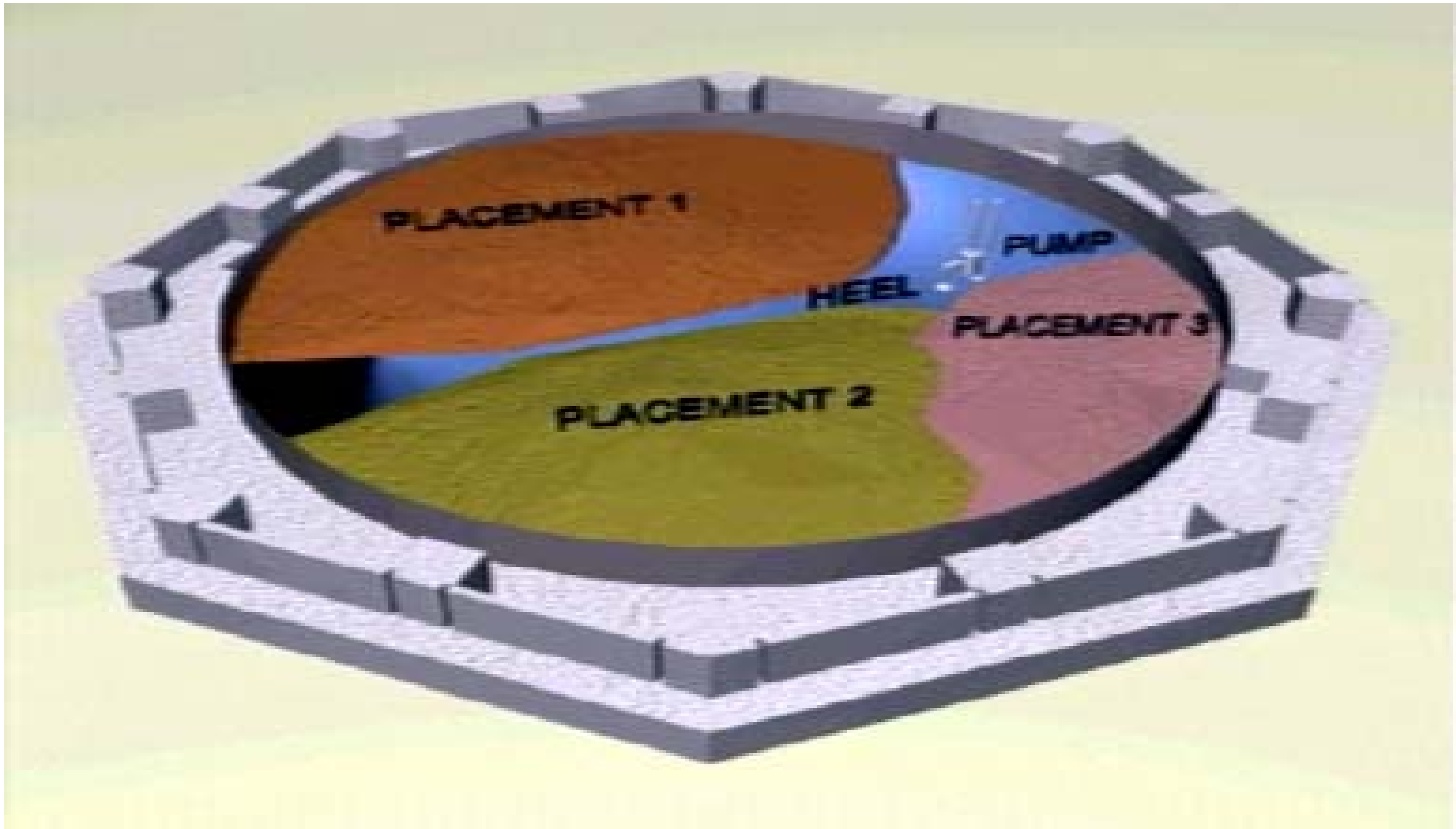
Placement 1



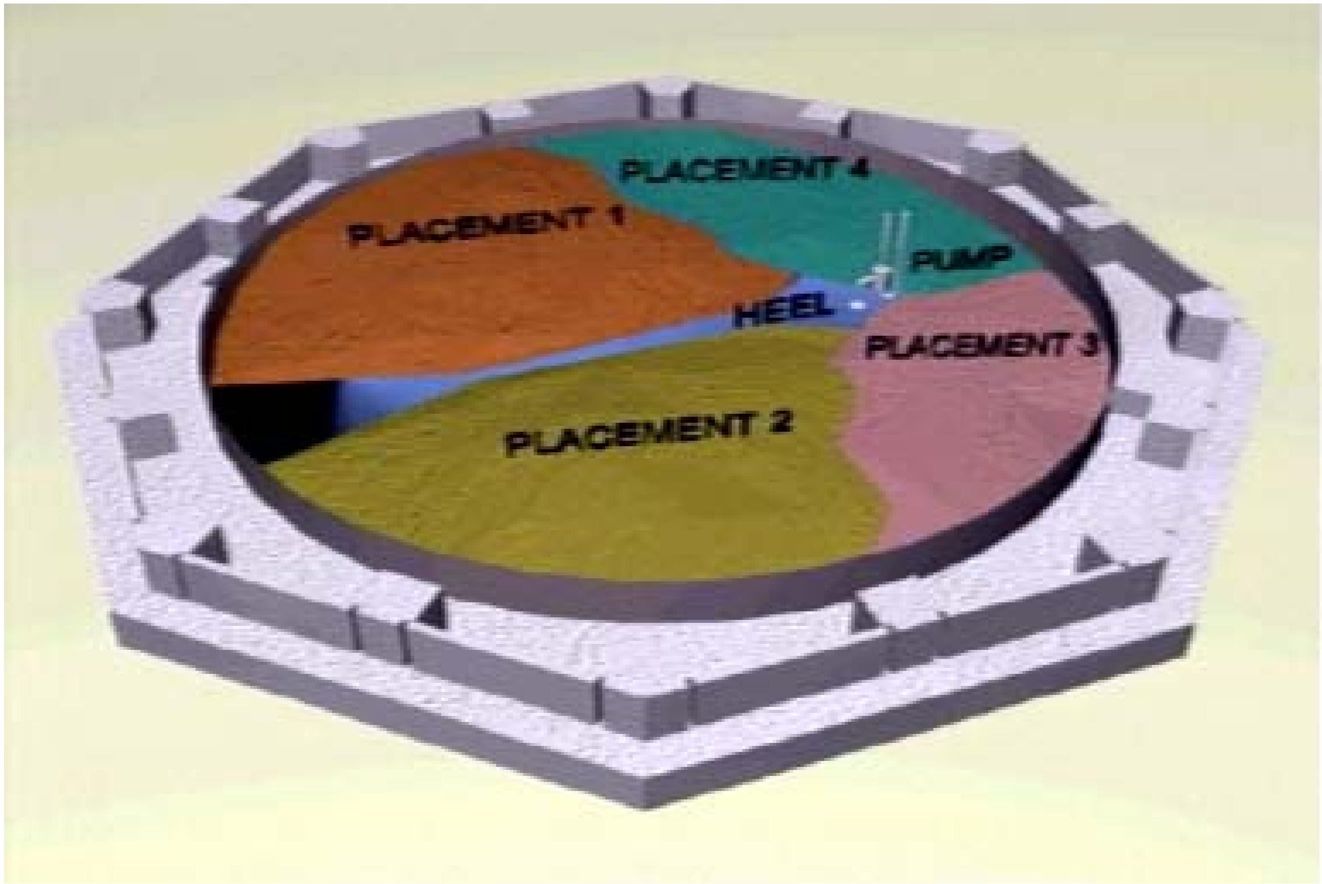
Placement 2



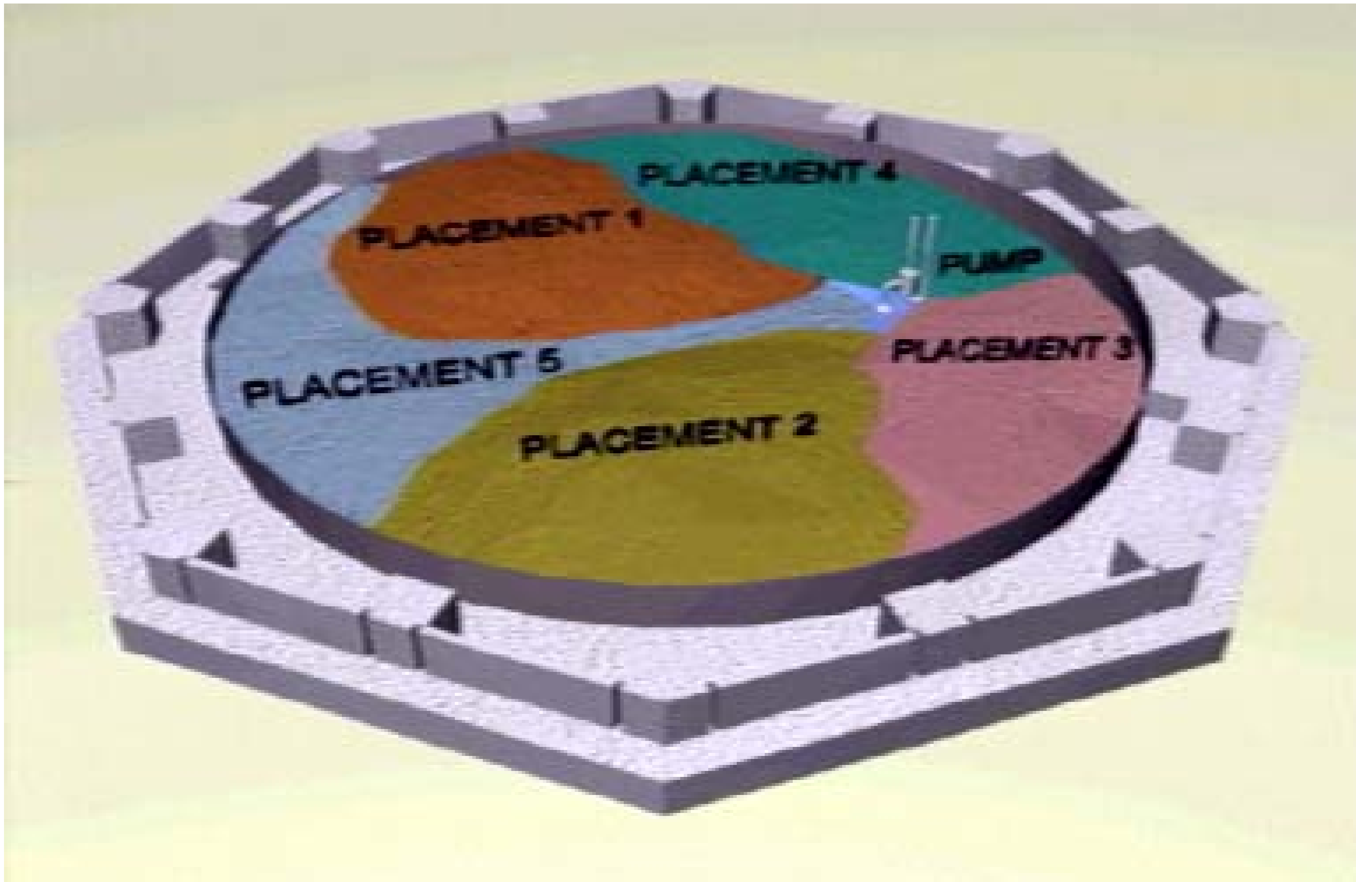
Placement 3



Placement 4



Placement 5


PLACEMENT 4
PLACEMENT 1
PUMP
PLACEMENT 5
PLACEMENT 3
PLACEMENT 2

Demonstration of Radionuclide Concentrations in the Final Waste Form

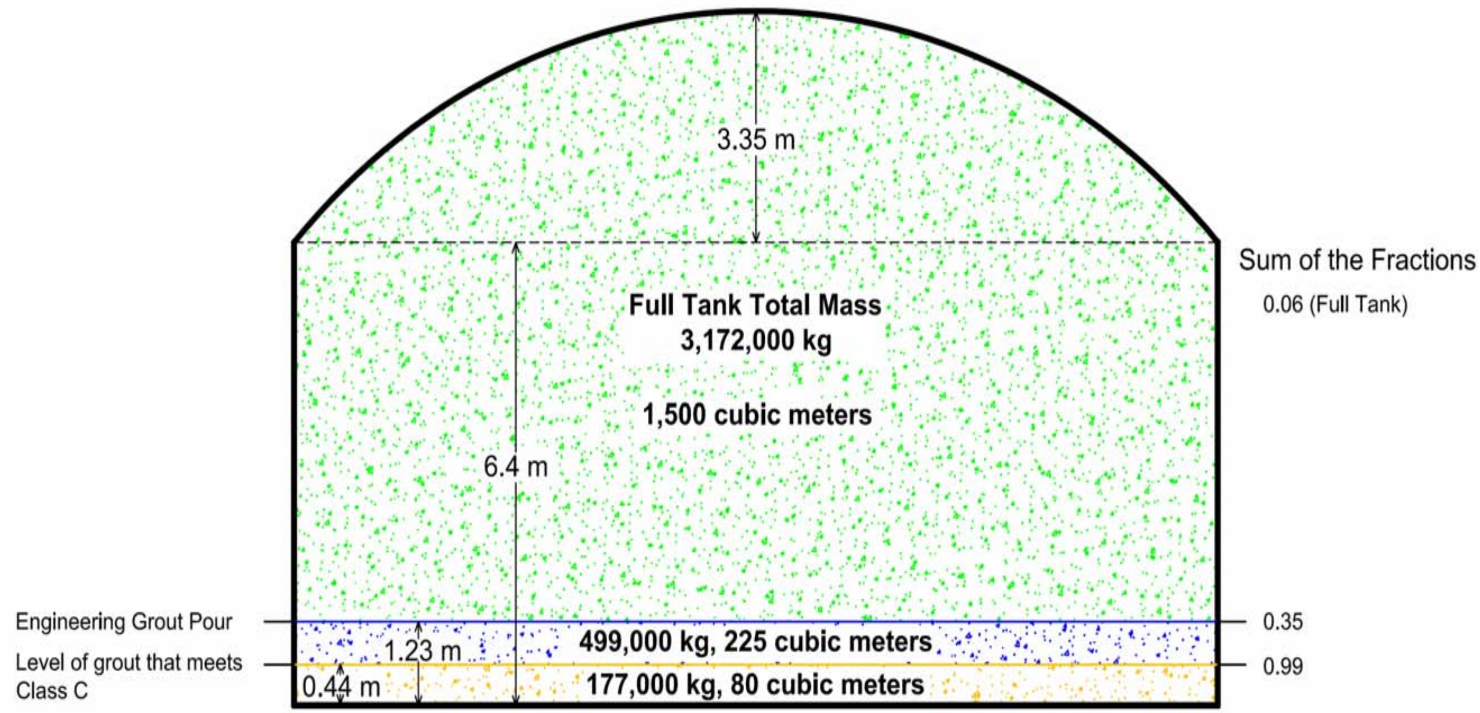
- *The DOE is not deciding in the Draft 3116 Determination whether the waste does or does not exceed the concentration limits for Class C LLW since there is no clearly applicable NRC guidance on applying the concentration limits set out in 10 CFR 61.55 to situations like the TFF tank system.*

- *To calculate concentrations, the estimates of residual waste at closure are averaged over various volumes of grout -*
  - *The volume at Class C concentrations*
  - *The volume shown by mock-up testing and engineering considerations to be needed for proper stabilization of residuals and to allow for additional waste removal*
  - *The volume needed to completely fill the tank structure*

Mock-up Results

Mock-up Results

Estimates of Waste Concentrations in Large Tanks

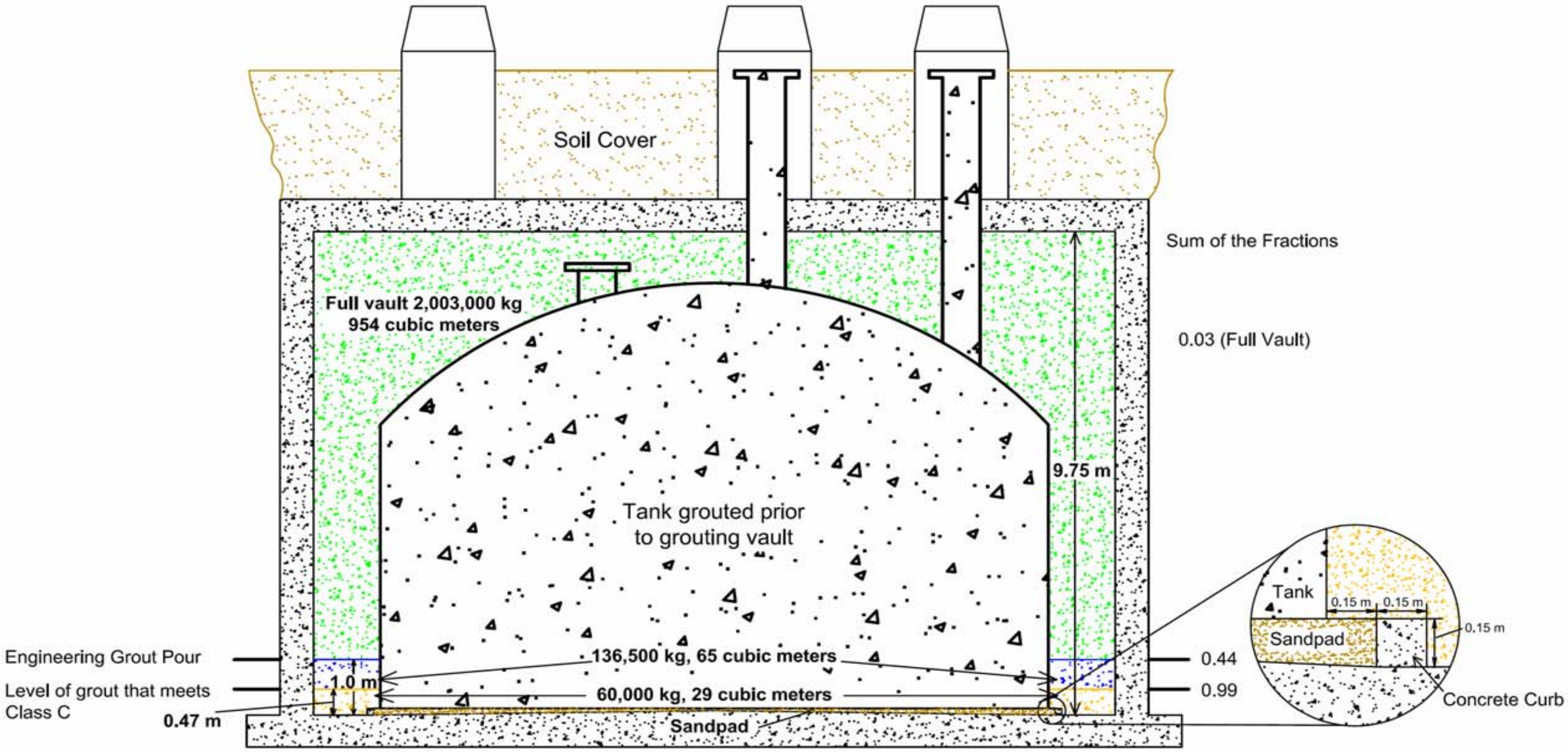


Cross-sectional view of 300,000-gal tank.

Sum of the Fractions for Large Tanks

Radionuclide	Half-Life (yr)	Tank Inventory (Ci)	Tank Inventory in Ci/m^3	Tank Inventory in nCi/g	Class C Concentration Limit (Ci/m^3 or nCi/g)	Fraction of Class C Concentration Limit
^{241}Am	4.3E+02	4.2E-01		8.5E-01	100	0.0085
^{14}C	***5.7E+03***	***5.0E–06***	***2.2E–08***		***8***	***0.0000000027***
^{242}Cm	4.5E–01	1.3E–03		2.6E–03	20,000	0.00000013
^{129}I	***1.6E+07***	***7.7E–04***	***3.4E–06***		***0.08***	***0.000043***
^{94}Nb	***2.0E+04***	***2.1E–01***	***9.1E–04***		***0.2***	***0.0045***
^{59}Ni	***7.5E+04***	***2.5E–02***	***1.1E–04***		***220***	***0.00000050***
^{237}Np	2.1E+06	4.7E–02		9.4E–02	100	0.00094
^{238}Pu	8.8E+01	1.1E+01		2.3E+01	100	0.23
^{239}Pu	2.4E+04	3.4E+00		6.8E+00	100	0.068
^{240}Pu	7.0E+03	1.4E+00		2.7E+00	100	0.027
^{241}Pu	1.4E+01	1.9E+01		3.9E+01	3,500	0.011
^{242}Pu	3.8E+05	9.9E–04		2.0E–03	100	0.000020
^{99}Tc	***2.1E+05***	***7.6E–01***	***3.4E–03***		***3***	***0.0011***
				Sum of the Fractions		**0.35**

Estimates of Waste Concentrations in Vaults

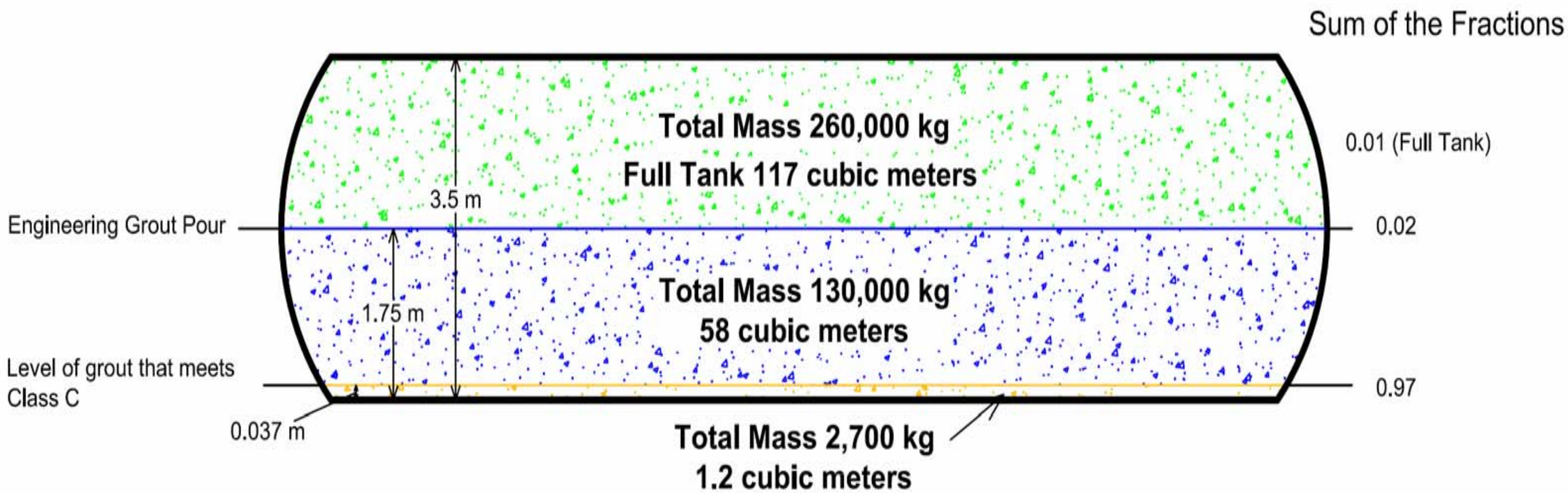


Cross-sectional view of typical tank and vault. Calculations are based on dimensions of the smallest tank vault and the highest detected amount of radioactivity (from Tank WM-182).

Sum of the Fractions for Vaults/Sandpads

Radionuclide	Half-Life (yr)	Sandpad Inventory (Ci)[b]	Sandpad Inventory in Ci/m^3	Sandpad Inventory in nCi/g	Class C Concentration Limit (Ci/m^3 or nCi/g)[c]	Fraction of Class C Concentration Limit
^{241}Am	4.3E+02	1.9E+00		1.4E+01	100	0.14
^{14}C	***5.7E+03***	***3.9E–07***	***6.0E–09***		***8***	***0.00000000075***
^{242}Cm	4.5E–01	1.4E–05		1.0E–04	20,000	0.0000000051
^{129}I	***1.6E+07***	***1.1E–06***	***1.7E–08***		***0.08***	***0.00000021***
^{94}Nb	***2.0E+04***	***2.3E–02***	***3.5E–04***		***0.2***	***0.0018***
^{237}Np	2.1E+06	3.7E–04		2.7E–03	100	0.000027
^{238}Pu	8.8E+01	2.1E+00		1.5E+01	100	0.15
^{239}Pu	2.4E+04	1.6E+00		1.2E+01	100	0.12
^{240}Pu	7.0E+03	3.5E–01		2.6E+00	100	0.026
^{241}Pu	1.4E+01	2.3E+00		1.7E+01	3,500	0.0048
^{242}Pu	3.8E+05	5.7E–05		4.2E–04	100	0.0000042
^{99}Tc	***2.1E+05***	***2.0E–12***	***2.1E–15***		***3***	***0.000000000000000071***
				Sum of the Fractions		**0.44**

Estimates of Waste Concentrations in Small Tanks



Cross-sectional view of 30,000-gal tank.

Sum of the Fractions for Small Tanks

Radionuclide	Half-Life (yr)	Average 30,000-gal Tank Inventory (Ci)	Average 30,000-gal Tank Inventory in Ci/m^3	Average 30,000-gal Tank Inventory in nCi/g	Class C Concentration Limit (Ci/m^3 or nCi/g)	Fraction of Class C Concentration Limit
^{241}Am	4.3E+02	6.4E–03		4.9E–02	100	0.00049
^{14}C	***5.7E+03***	***1.1E–07***	***1.9E–09***		***8***	***0.00000000024***
^{242}Cm	4.5E–01	2.0E–05		1.5E–04	20,000	0.0000000077
^{129}I	***1.6E+07***	***1.2E–05***	***2.0E–07***		***0.08***	***0.0000025***
^{94}Nb	***2.0E+04***	***3.1E–03***	***5.3E–05***		***0.2***	***0.00027***
^{59}Ni	***7.5E+04***	***3.8E–04***	***6.5E–06***		***220***	***0.000000030***
^{237}Np	2.1E+06	7.1E–04		5.5E–03	100	0.000055
^{238}Pu	8.8E+01	1.7E–01		1.3E+00	100	0.013
^{239}Pu	2.4E+04	5.1E–02		4.0E–01	100	0.0040
^{240}Pu	7.0E+03	2.0E–02		1.6E–01	100	0.0016
^{241}Pu	1.4E+01	2.9E–01		2.3E+00	3,500	0.00065
^{242}Pu	3.8E+05	1.5E–05		1.1E–04	100	0.0000011
^{99}Tc	***2.1E+05***	***1.2E–02***	***2.0E–04***		***3***	***0.000066***
					Sum of the Fractions	**0.020**

Sum of the Fractions for Piping

Radionuclide	Half-Life (yr)	Piping Inventory (Ci)[b]	Piping Inventory in Ci/m^3	Piping Inventory in nCi/g	Class C Concentration Limit (Ci/m^3 or nCi/g)[c]	Fraction of Class C Concentration Limit
^{241}Am	4.3E+02	5.3E–03		1.7E–01	100	0.0017
^{14}C	***5.7E+03***	***6.2E–08***	***7.1E–09***		***8***	***0.00000000089***
^{242}Cm	4.5E–01	1.7E–05		5.3E–04	20,000	0.000000026
^{129}I	***1.6E+07***	***9.7E–06***	***1.1E–06***		***0.08***	***0.000014***
^{94}Nb	***2.0E+04***	***2.6E–03***	***2.9E–04***		***0.2***	***0.0015***
^{59}Ni	***7.5E+04***	***3.1E–04***	***3.6E–05***		***220***	***0.00000016***
^{237}Np	2.1E+06	5.9E–04		1.9E–02	100	0.00019
^{238}Pu	8.8E+01	1.4E–01		4.6E+00	100	0.046
^{239}Pu	2.4E+04	4.3E–02		1.4E+00	100	0.014
^{240}Pu	7.0E+03	1.7E–02		5.4E–01	100	0.0054
^{241}Pu	1.4E+01	2.4E–01		7.8E+00	3,500	0.0022
^{244}Pu	3.8E+05	1.2E–05		4.0E–04	100	0.0000040
^{99}Tc	***2.1E+05***	***9.6E–03***	***1.1E–03***		***3***	***0.00036***
					Sum of the Fractions	**0.071**

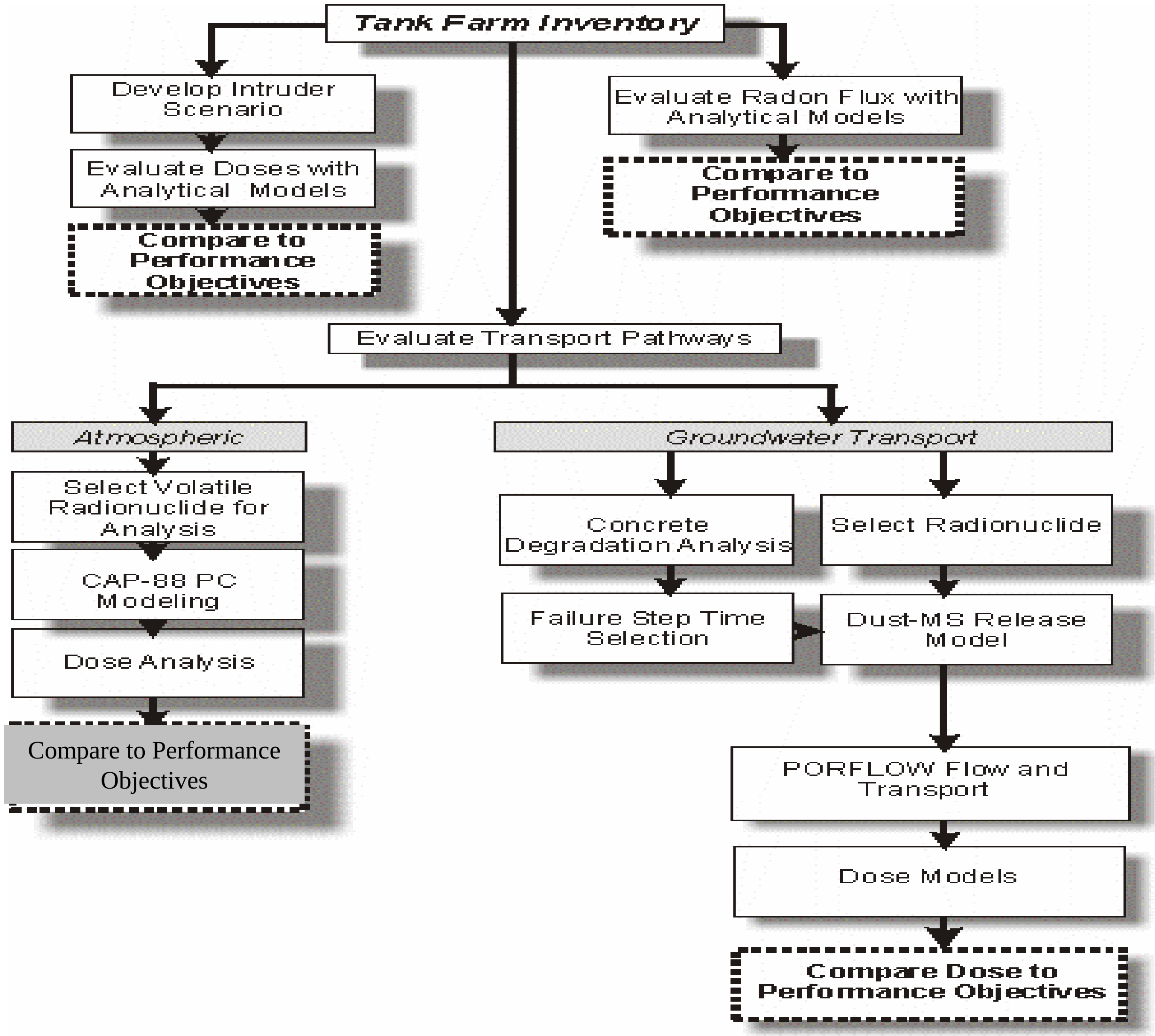
Waste will be Disposed of in Accordance With Performance Objective in 10 CFR 61, Subpart C

Disposal in Accordance with Performance Objectives

- *A draft Performance Assessment was developed in 2002, prior to any tank cleaning results, as a part of a DOE Closure Plan – it assumed only limited cleaning success.*
- *NRC reviewed the Performance Assessment in 2002.*
- *DOE has used that Performance Assessment, updated with additional analysis and actual estimates of residual waste, as the basis for demonstrating that tank closures could be completed in accordance with the performance objectives in 10 CFR 61, Subpart C.*
- *The Performance Assessment includes the intruder scenarios*

PA Analysis

Strategy and Components



Performance Assessment: Major Elements

Public Receptors

- *Groundwater all-pathways (direct ingestion, contaminated milk, meat, vegetables, etc.)*
- *Airborne emissions (all –pathways)*

Intruder Analysis

- *Acute Drilling Scenario*
- *Acute Construction Scenario*
- *Chronic Drilling Scenario*
- *Chronic Construction Scenario*

Performance Assessment Results

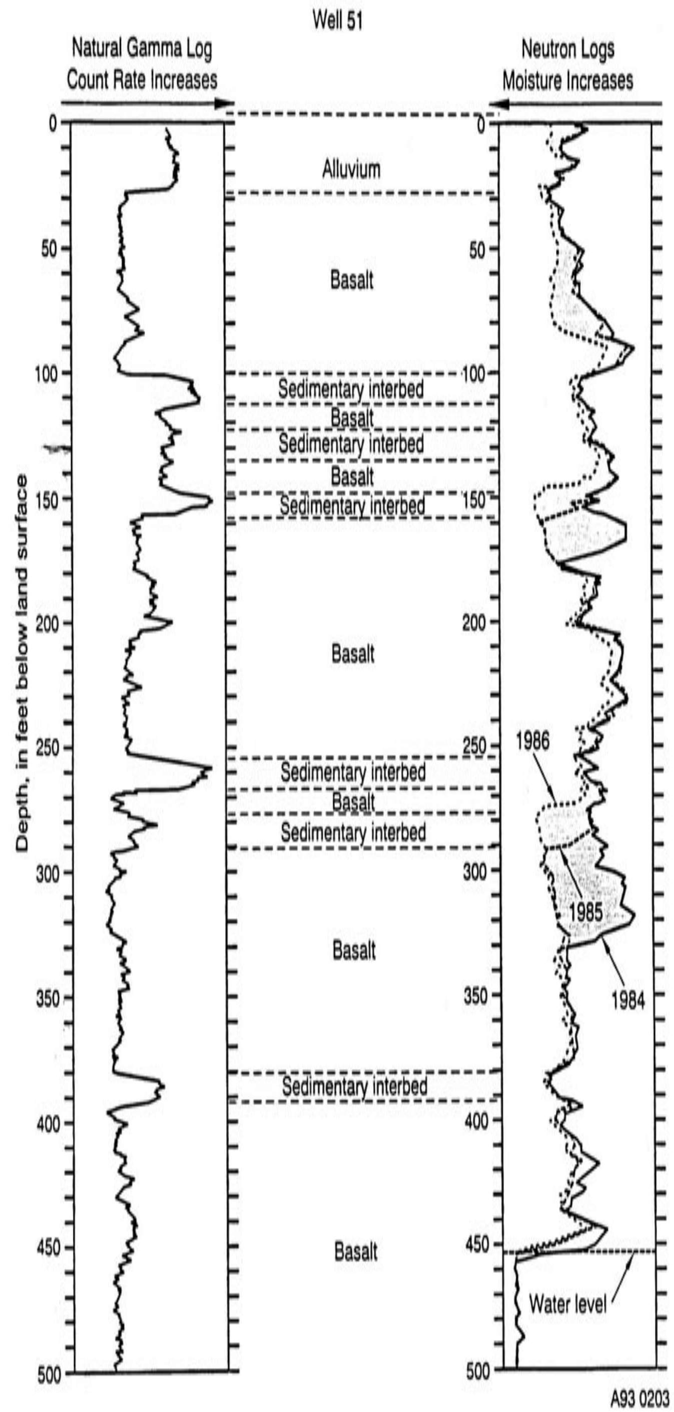
Performance Objectives	PA Results	Current Estimate of Residual at Closure[2,3]
All-pathways dose to the public (Not exceeding 25 mrem/yr)	1.86 mrem/yr[1]	0.46 mrem/yr
Acute-drilling scenario (less than 500 mrem)	232 mrem	152 mrem
Acute-construction scenario (less than 500 mrem)	0.80 mrem	0.23 mrem
Chronic post-drilling scenario (less than 500 mrem/yr)	91.1 mrem/yr	25 mrem/yr
Chronic post-construction scenario (less than 500 mrem/yr)	26.1 mrem/yr	3.15 mrem/yr

Notes:

1. The groundwater pathway contributed 1.35 mrem/yr.

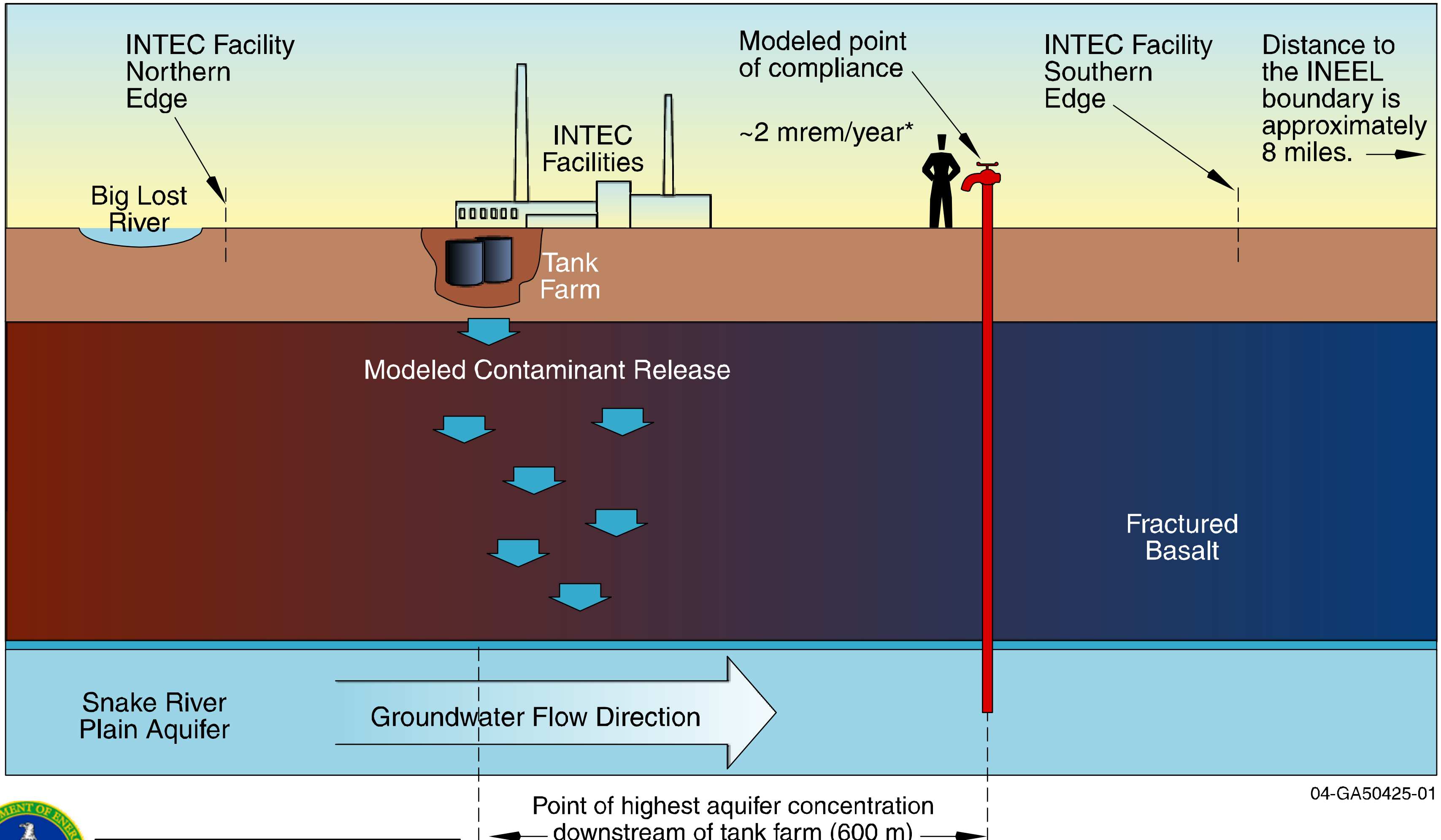
2. The peak annual dose to the thyroid is approximately 6 mrem/yr compared to the 10 CFR 61.41 limit of 75 mrem/yr.

3. The peak annual dose to any other organ is approximately 0.15 mrem/yr compared to the 10 CFR 61.41 limit of 25 mrem/yr.



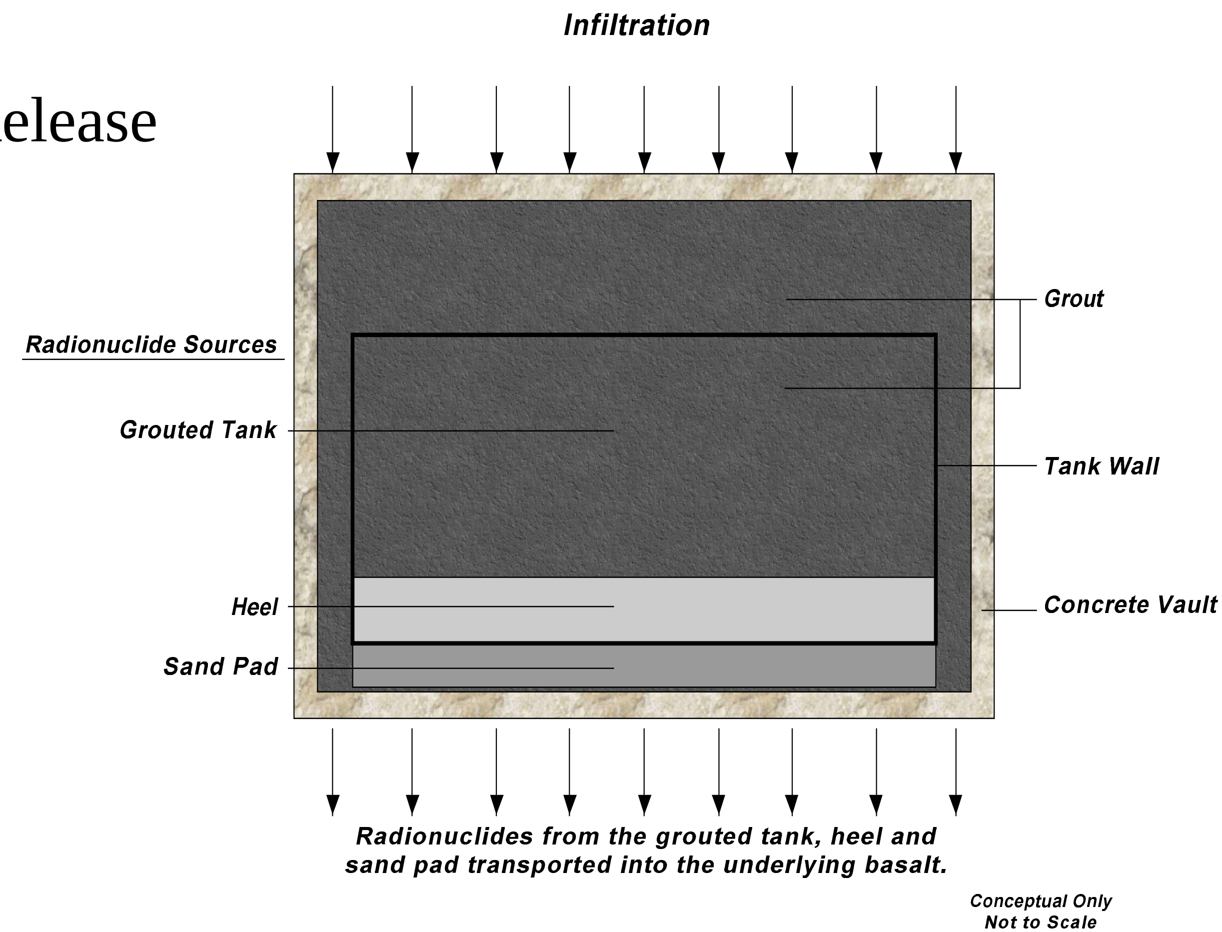
Gamma and Neutron well log

Groundwater Pathway (All Pathways Dose)



*Based on 2003 Performance Assessment

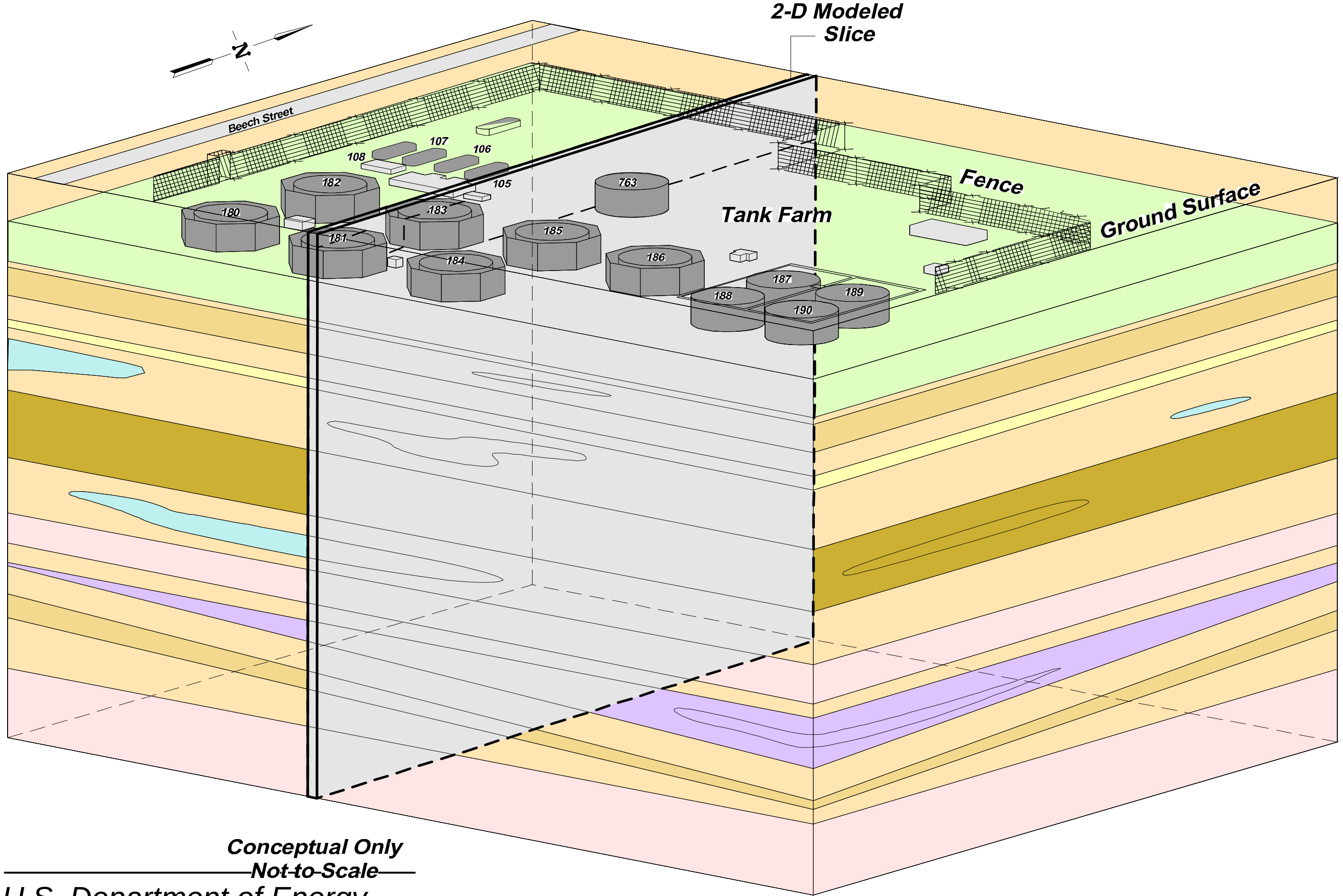
Contaminant Release Model

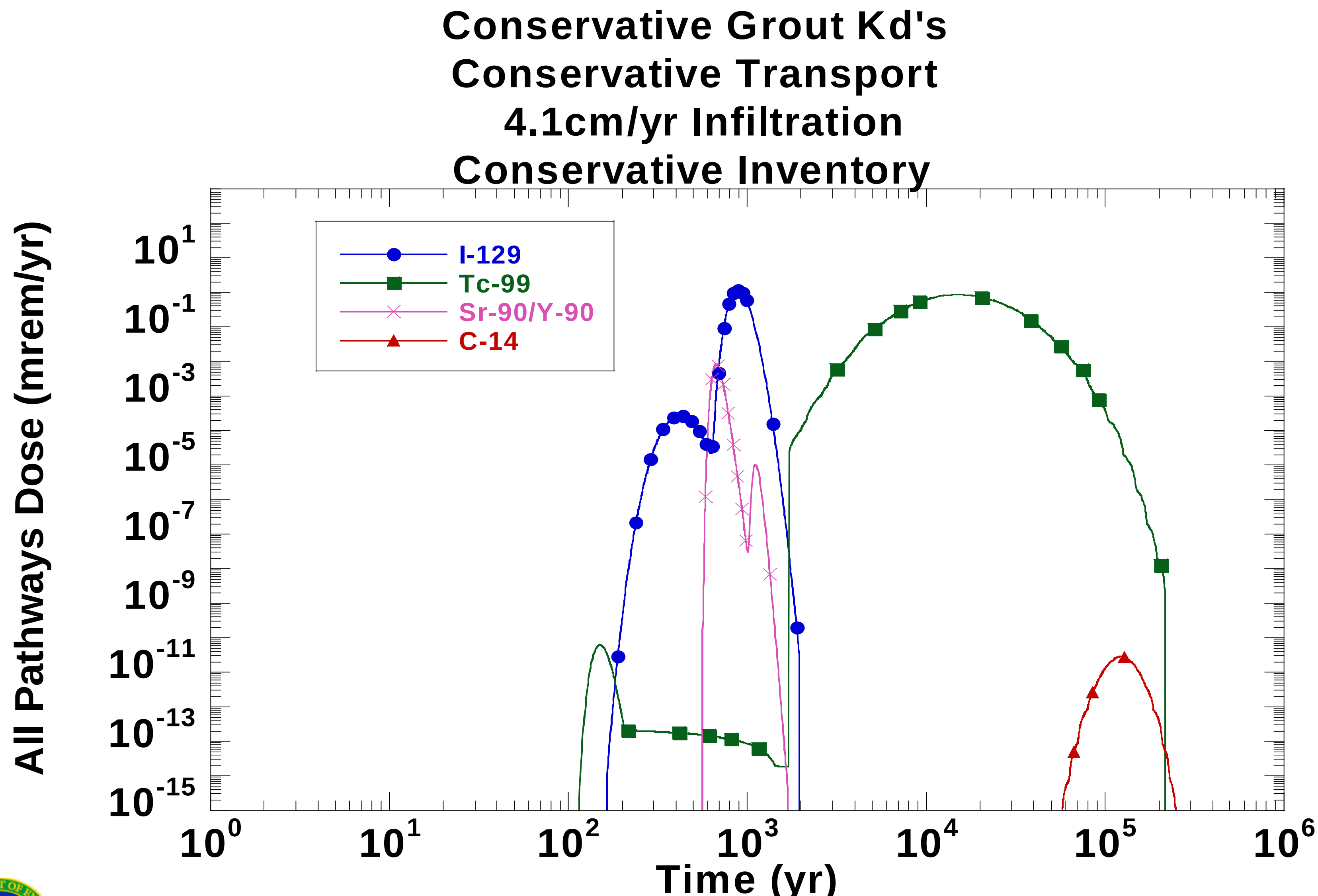


Model assumes:

- Outer vault grout fails at 100 years
- Tank and tank grout fail at 500 years
- Piping fails at 500 years

Two-dimensional Modeling Slice Used in PORFLOW




Conservative Grout Kd's
Conservative Transport
4.1cm/yr Infiltration
Conservative Inventory
I-129
Tc-99
Sr-90/Y-90
C-14
All Pathways Dose (mrem/yr)
10^{1}
10^{-1}
10^{-3}
10^{-5}
10^{-7}
10^{-9}
10^{-11}
10^{-13}
10^{-15}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
10^{6}
Time (yr)

All Pathways Dose Description

- *Period of analysis (groundwater pathway) in the Performance Assessment was 1,000 years. As part of uncertainty analysis modeled to determine if other significant peaks appeared well beyond 10,000 years*
- *The Institutional control period is assumed in the performance assessment to be 100 years based on the site specific land use plan.*
- *An engineered surface barrier (cap) is not included in the analysis*
- *Sensitivity and Uncertainty analysis performed*

Uncertainty/Sensitivity Analysis

- *Analysis confirmed that model results driven by inputs of :*
- *Radiological source term in tank residuals*
  - *Infiltration Rates (for conservatism, assumed no final cap)*
  - *Sorption Coefficients (K_d values)*
- *In addition to the "Conservative Case" Scenario used, three additional groundwater pathway analyses performed using varied inputs for these important parameters (used to build different scenarios)*
  - *Worst Case Scenario*
  - *Realistic Case Scenario*
  - *Best Case Scenario*
- *Results demonstrated that actual tank closure impacts are likely to be less than the reported Performance Assessment doses*

Uncertainty Analysis Inventory Assumptions

	Best Scenario	Realistic Scenario	Conservative Scenario	Worst-Case Scenario
Solid Radionuclide Inventory	50% Reduction from worst-case	25% Reduction from worst-case	10% Reduction from worst-case	Depicts SBW (undiluted tank-heel residual)
Liquid Radionuclide Inventory	95% Reduction from worst-case	80% Reduction from worst-case	50% Reduction from worst-case	Depicts SBW (undiluted tank-heel residual)

Uncertainty Analysis Results

Groundwater Scenario	*Drinking Water Dose (mrem/yr)*	*All-pathway Groundwater Dose (mrem/yr)*
Worst Case	*23.1*	*85.8*
Conservative Case	*0.77*	*1.35*
Realistic Case	*0.04*	*0.07*
Best Case	*0.03*	*0.04*

Overview of the parameter values for the sensitivity/uncertainty analysis

	Measured Item	Best Scenario	Realistic Scenario	Conservative Scenario	Worst-Case Scenario
Solid Radionuclide Inventory		50% reduction from worst case	25% reduction from worst case	10% reduction from worst case	Depicts sodium-bearing waste (undiluted tank-heel residual)
Liquid Radionuclide Inventory		95% reduction from worst case	80% reduction from worst case	50% reduction from worst case	Depicts sodium-bearing waste (undiluted tank-heel residual)
Infiltration		1.1 cm/yr	1.1 cm/yr	4.1 cm/yr	12.4 cm/yr
Grout Sorption Coefficients (m^3/kg)	C	10	10	5.0	1.0
	I	0.03	0.03	0.008	0.002
	Sr	0.006	0.006	0.003	0.001
	Tc	5	5	2.5	1
Sand Pad Sorption Coefficients (m^3/kg)	C	0.005	0.005	0.005	0.005
	I	0.001	0.001	0.001	0.001
	Sr	0.015	0.015	0.015	0.015
	Tc	0.0001	0.0001	0.0001	0.0001
Concrete Vault Sorption Coefficients (m^3/kg)	C	10	10	5	1
	I	0.03	0.03	0.008	0.002
	Sr	0.006	0.006	0.003	0.001
	Tc	0.001	0.001	0.001	0.001

Overview of the parameter values for the sensitivity/uncertainty analysis (cont)

	Measured Item	Best Scenario	Realistic Scenario	Conservative Scenario	Worst-Case Scenario
Unsaturated Zone Longitudinal Dispersivities (m)	Sediment	0.52	0.52	0.29	0.052
	Basalt	3.36	3.36	1.85	0.34
Unsaturated Zone Transverse Dispersivities (m)	Sediment	0.26	0.26	0.14	0.026
	Basalt	1.7	1.7	0.94	0.17
Interbed Sediment Sorption Coefficients (mL/g)	C	20	20	10	2
	I	5	5	0.1	0.01
	Sr	24	24	18	12
	Tc	0.1	0.1	0.01	0
Basalt Sorption Coefficients (mL/g)	C	7.1	7.1	5.0	1.7
	I	1	1	0.1	0
	Sr	13	13	6	1
	Tc	0.24	0.24	0.01	0

a. Conservative-case used in dose analysis is highlighted in yellow; green shows the worst-case scenario with the conservative inventory.

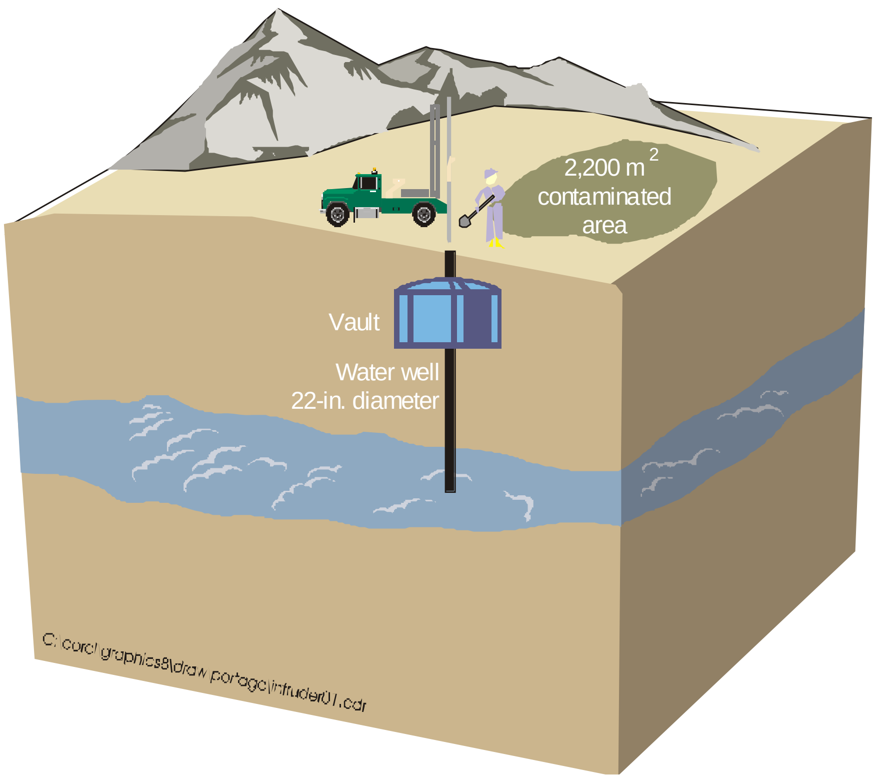
Parameterization				All-Pathways Dose (yr post-closure) (mrem/yr)				
Grout K_d	Transport K_d	Infiltration	Inventory	^{129}I	^{99}Tc	$^{90}Sr/^{90}Y$	^{14}C	Total (yr post-closure)
Worst-Case	Worst-Case	12.4	Worst-Case	40.4 (538)	7.52 (2370)	85.8 (294)	0.04 (1.41E+04)	85.8 (294)
			Conservative	15.2	6.98	85.8	0.02	85.8
			Realistic	11.7	0.630	85.8	0.008	85.8
			Best	7.76	0.38	85.8	0.002	85.8
Worst-Case	Worst-Case	4.1	Worst-Case	15.9 (607)	2.65 (5060)	15.0 (342)	4.95E–04 (3.78E+04)	15.9 (607)
			Conservative	5.97	2.46	15.0	2.48E–04	15.0 (342)
			Realistic	4.61	0.22	15.0	9.94E–05	15.0
			Best	3.05	0.13	15.0	2.48E–05	15.0
Worst-Case	Worst-Case	1.1	Worst-Case	4.65 (884)	0.685 (1.75E+04)	0.18 (461)	4.31E–09 (1.0E+05)	4.65 (884)
			Conservative	1.75	0.64	0.18	2.16E–09	1.75
			Realistic	1.35	0.06	0.18	8.66E–10	1.35
			Best	0.89	0.03	0.18	2.16E–10	0.89
Conservative	Conservative	12.4	Worst-Case	9.98 (635)	3.29 (4270)	0.12 (453)	2.01E–05 (5.53E+04)	9.98 (635)
			Conservative	3.75	3.05	0.12	1.01E–05	3.75
			Realistic	2.89	0.28	0.12	4.03E–06	2.89
			Best	1.92	0.16	0.12	1.01E–06	1.92
Conservative	Conservative	4.1	Worst-Case	3.59 (890)	0.94 (1.46E+04)	0.006 (551)	5.75E–11 (1.22E+05)	3.59 (890)
			Conservative	1.35	0.87	0.006	2.88E–11	1.35
			Realistic	1.04	0.08	0.006	1.15E–11	1.04
			Best	0.69	0.05	0.006	2.88E–12	0.69

Grout K_d	Transport K_d	Infiltration	Inventory	^{129}I	^{99}Tc	$^{90}Sr/^{90}Y$	^{14}C	Total (yr post-closure)
Conservative	Conservative	1.1	Worst-Case	0.86 (1890)	0.25 (4.13E+04)	1.68E–06 (891)	0	0.86 (1890)
			Conservative	0.32	0.23	1.68E–06	0	0.32
			Realistic	0.25	0.21	1.68E–06	0	0.25
			Best	0.17	0.01	1.68E–06	0	0.17
Realistic/Best	Realistic/Best	12.4	Worst-Case	2.61 (1060)	1.62 (8100)	2.36E–04 (856)	2.23E–8 (9.14E+04)	2.61 (1060)
			Conservative	0.98	1.50	2.36E–04	1.11E–08	1.5
			Realistic	0.76	0.14	2.36E–04	4.47E–09	0.76
			Best	0.50	0.08	2.36E–04	1.11E–09	0.50
Realistic/Best	Realistic/Best	4.1	Worst-Case	0.87 (1960)	0.5 (2.33E+04)	1.75E–06 (988)	9.02E–17 (1.83E+05)	0.87(1960)
			Conservative	0.33	0.46	1.75E–06	4.51E–17	0.46
			Realistic	0.25	0.04	1.75E–06	1.81E–17	0.25
			Best	0.17	0.02	1.75E–06	4.52E–18	0.17
Realistic/Best	Realistic/Best	1.1	Worst-Case	0.24 (5670)	0.11 (8.05E+04)	5.65E–12 (1310)	0	0.24 (5670)
			Conservative	0.088	0.1	5.65E–12	0	0.10
			Realistic	0.068	0.009	5.65E–12	0	0.07
			Best	0.045	0.005	5.65E–12	0	0.04

Well Drilling Intruder Scenarios

- *The acute drilling intruder and the chronic drilling scenario are shown because they predict much greater doses than the other intruder scenarios examined.*
- *The acute and chronic intruder construction scenarios were also evaluated.*

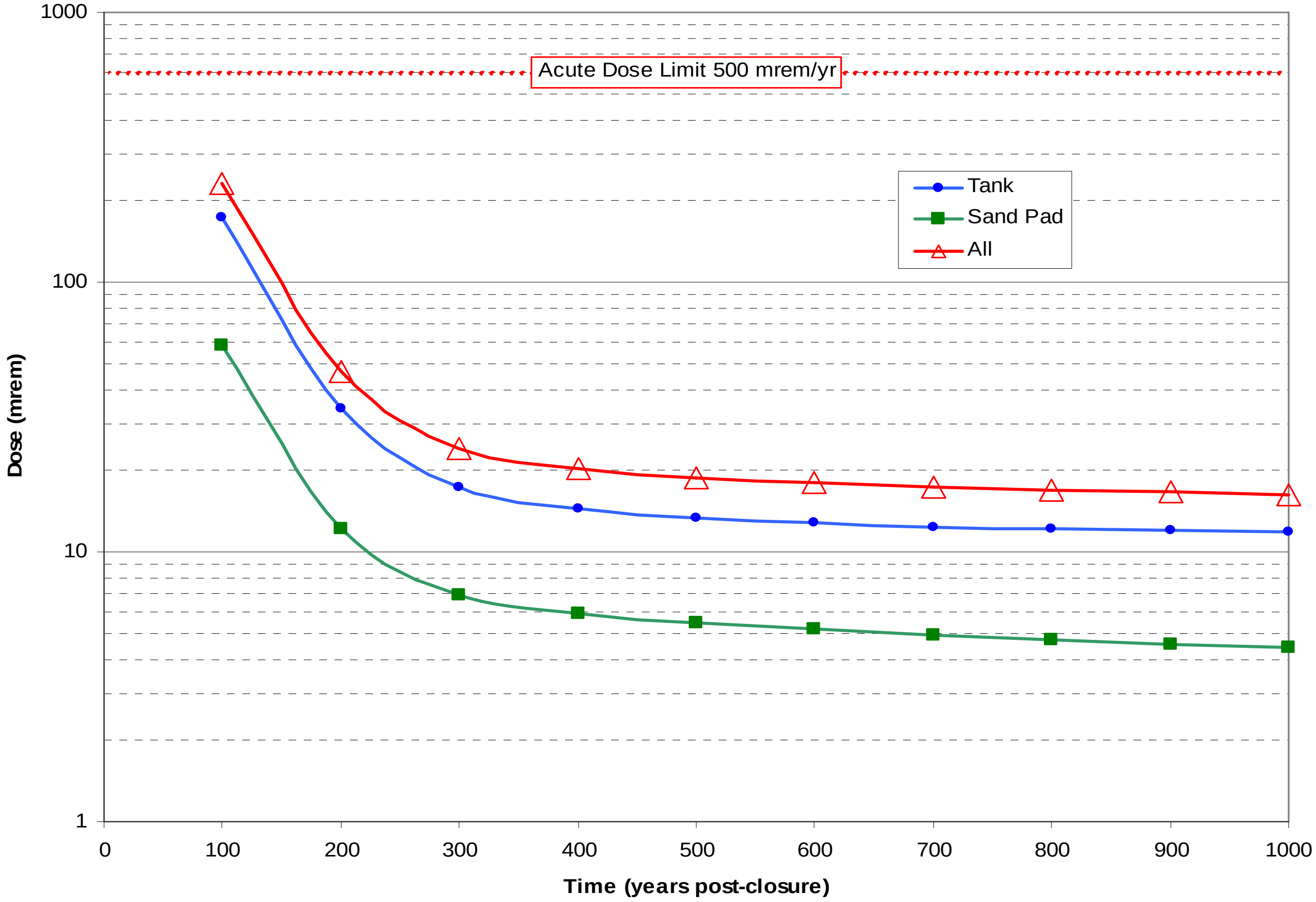
Acute Drilling Intruder Scenario



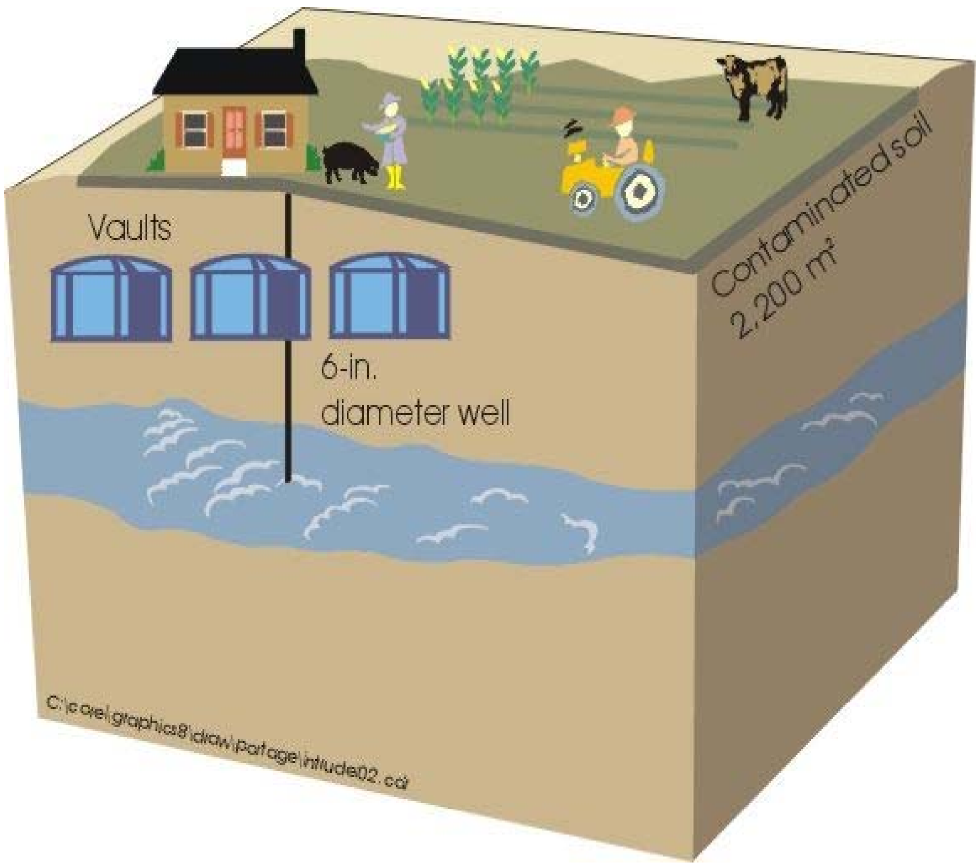
- *22 inch well*
- *160 days of exposure*
- *2,200 m² of contaminated soil*
- *100 years after closure*
- *Direct radiation,*
- *Inhalation*
- *Inadvertent ingestion*

- *PA dose = 232 mrem*
- *Scaled dose = 152 mrem*

Acute Intruder Dose by Year

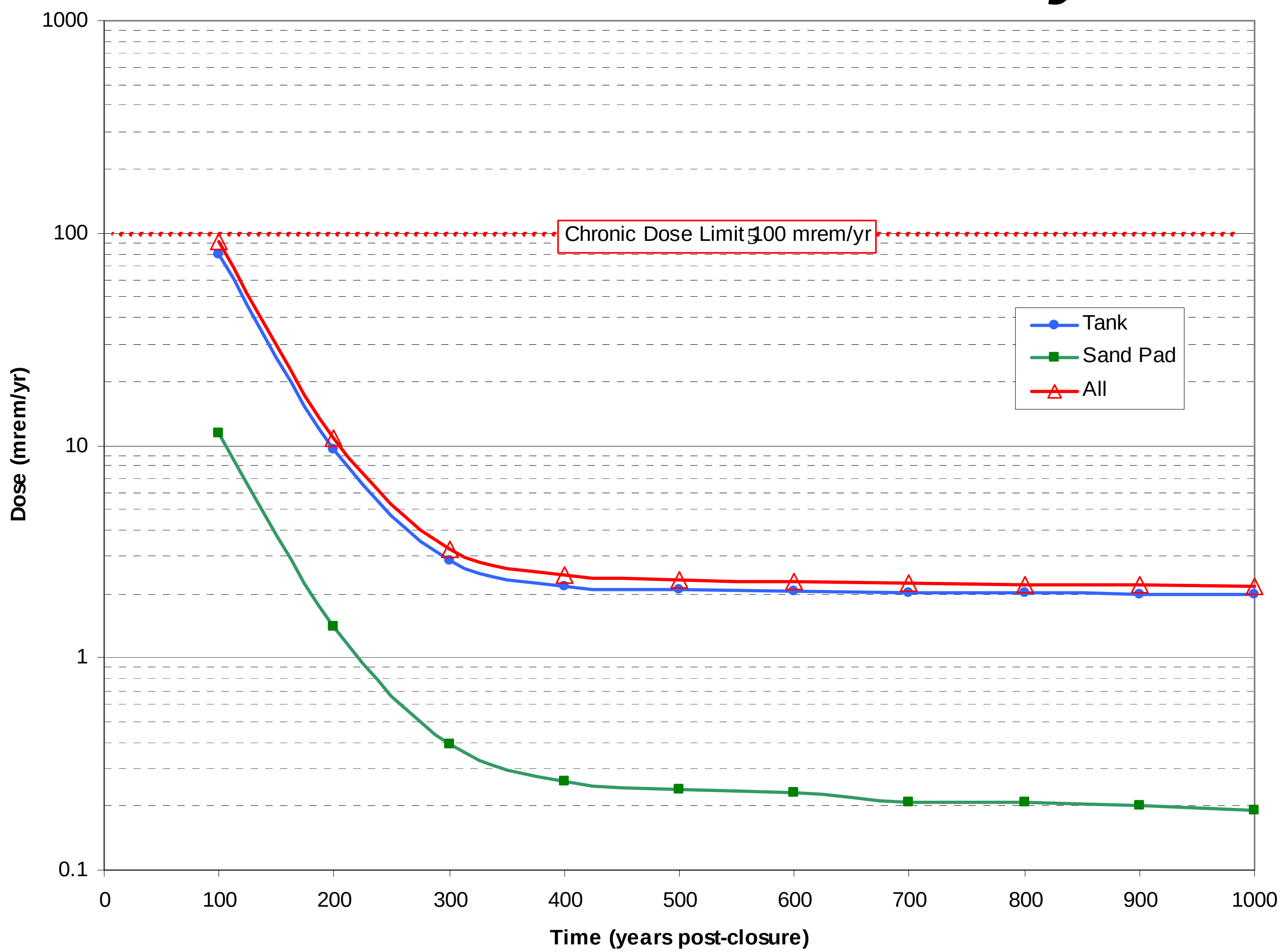


Chronic Drilling Scenario



- 6 inch well
- 2,200 m^2 of contaminated soil
- 100 years
- Direct radiation,
- Inhalation
- Inadvertent ingestion
- Contaminated food products from the garden
- Beef and milk cattle consuming contaminated forage
- PA dose = 91 mrem
- Scaled dose = 25 mrem

Chronic Intruder Dose by Year



Recommendations From Previous Consultation

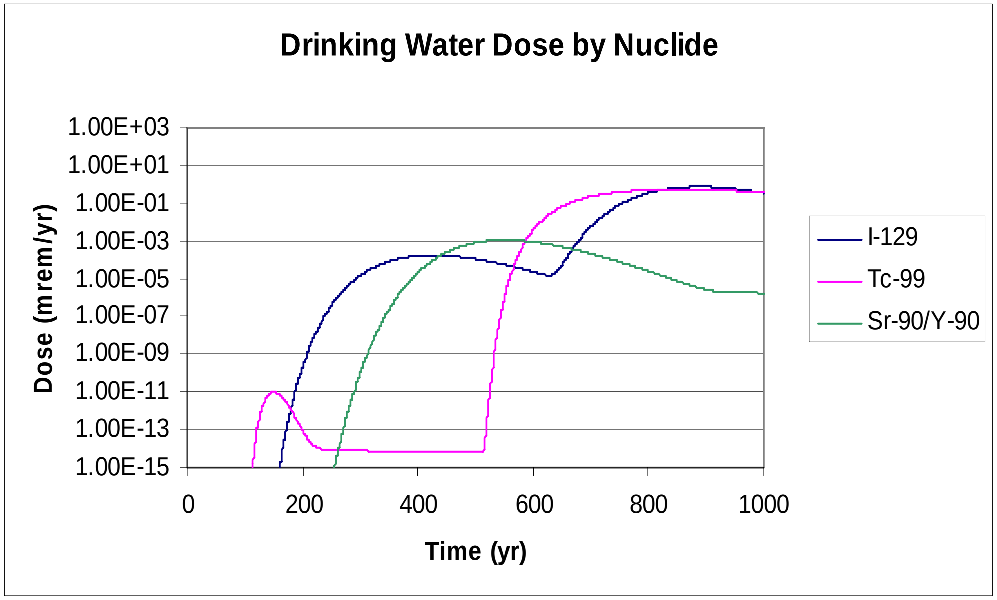
Recommendations	***DOE Actions***
Sampling of the radiological composition of residual materials should be completed	*Characterization of the tank contents is updated as tanks are cleaned.*
DOE should follow its current plan for cessation of tank flushing only after removal of residual activity from the tank becomes insignificant.	*DOE Idaho has followed the recommendation. Tank flushing only be stopped after removal of residual activity from the tanks becomes insignificant.*
DOE Idaho should investigate methods for measuring or better estimating the contaminated sandpad radionuclide inventories.	*DOE has considered alternative options however, no sampling method either by direct or indirect means has been found, which is either practical or would provide data of known quality.*
If sampling after tank cleaning indicates that the source term is significantly larger than that used in the current PA, then the PA should be reevaluated.	*All tank samples after cleaning indicate that the residual waste inventory at closure is much less than assumed. A method to calculate radiation dose based on inventories of cleaned tanks has been developed.*

Recommendations (cont.)

Recommendations	***DOE Actions***
DOE should consider expanding its literature review or conducting laboratory testing to provide additional confidence for sorption coefficient values.	*DOE Idaho has completed an additional sorption coefficient report.*
If retardation of ^{99}Tc in the degraded concrete layer at the base of the tanks provides a significant performance effect, a technical basis should be established.	*Originally, an oxidizing sorption coefficient was used for the vault concrete, while a reducing sorption coefficient was assumed for the grouted waste.*
As cleaning and closure of tanks progress, the closure strategy for each tank should be refined	*The cleaning and closure method has been refined such that efficiencies in removal of the residuals are being obtained.*
Future PA analyses should evaluate the sensitivity of the results to the use of oxidizing condition distribution coefficients for grout.	*Additional analysis has been performed to understand the transport time to the aquifer and the resulting dose from ^{99}Tc if oxidizing conditions are assumed for the grouted waste in the tanks.*

Oxidizing Conditions in the Tank

- *Kd of 0.05 mL/g for ^{99}Tc*
- *Peak dose at 842 years*
- *Dose from ^{99}Tc = 0.54 mrem/yr*
- *Post cleaning inventory from WM-182 in two tanks and a sandpad.*



Other Information in the Draft 3116 Waste Determination

- *Section 7 includes a discussion of compliance with 10 CFR 61.43, "Protection of Individuals During Operations."*
- *Section 7 includes a discussion of compliance with 10 CFR 61.44, "Long Term Stability of Disposal Site."*
- *Section 8 describes DOE's compliance with State approved Closure plans.*

Conclusions

- *The stabilized TFF residuals and TFF tank system are not HLW based on the considerations set forth in Section 3116(a) of the NDAA and may be disposed of as LLW at the INL Site in accordance with Section 3116 of the NDAA. This draft 3116 Determination will be finalized after the DOE has completed consultation with the NRC, and although not required by Section 3116, after public review and comment.*