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1	HNF-3858		0	Mitigated Subsurface Transfer Line Leak Resulting in a Surface Pool	NA	1,2	1	1

16. KEY

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E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information	4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment	4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

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(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN	(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN
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18.	19.	20.	21. DOE APPROVAL (if required)
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S

Mitigated SubsurfaceTransfer Line Leak Resulting in a Surface Pool

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Abstract: This analysis evaluates the mitigated consequences of a potential waste transfer spill from an underground pipeline. The spill forms a surface pool. One waste composite, a 67% liquid, 33% solid, from a single shell tank is evaluated. Even drain back from a very long pipeline (50,000 ft), does not pose dose consequences to the onsite or offsite individual above guideline values.

Karen L. Holand 2/8/99
Release Approval Date

FEB 08 1999
DATE: HANFORD RELEASE
STA: 37 ID: 21
Release Stamp

Approved for Public Release

Mitigated Subsurface Transfer Line Leak Resulting in a Surface Pool

List of Terms

AB	Authorization Basis
BIO	Basis for Interim Operation
DST	Double Shell Tanks
EDE	Effective Dose Equivalent
MEI	Maximum Exposed Individual
RRF	Respirable Release Fraction
SOF	Sum of Fractions
SST	Single Shell Tanks
TWRS	Tank Waste Remediation System
X/Q	Chi over Q

Mitigated Subsurface Transfer Line Leak Resulting in a Surface Pool

1.0 Purpose

The purpose of this document is to evaluate the mitigated consequences of a subsurface waste transfer leak that result in the formation of a surface pool. The pool forms during pumping and while the waste drains out of the transfer line after the transfer pump is shut off. This analysis looks at waste composition of 67% liquid, 33% solid from a single shell tank. No credit is taken for any containment of the waste in a pit or box.

2.0 Means of Mitigation

This analysis provides conservative dose estimates for leaks to the surface during waste transfer operations with mitigation. The mitigation credited in this analysis includes engineered barriers and administrative controls. Transfer operations without this mitigation may not be bounded by these results. These controls are:

With the exception of wind induced resuspension from soil, all sources of aerosol generation (e.g., liquid spray, splatter and splashing) are confined (see Limiting Control for Operation 3.1.3 and Administrative Control 5.22 in HNF-SD-WM-TSR-006, 1998).

Preventative configuration controls prevent high volume leaks (i.e., >50 gpm) (see Administrative Control 5.12 in HNF-SD-WM-TSR-006, 1998).

Leak detection occurs within 30 minutes after start of leak via a radiation survey (see Administrative Control 5.12 in HNF-SD-WM-TSR-006, 1998).

Transfer pump shutdown occurs within 30 minutes of leak detection (see Limiting Control for Operation 3.1.3 in HNF-SD-WM-TSR-006, 1998).

Onsite exposure to the surface pool is limited to one hour by emergency response procedures for evacuation of onsite personnel at risk (see Administrative Control 5.14 in HNF-SD-WM-TSR-006, 1998).

Exposure due to dry resuspension is prevented by emergency response procedures for leakage containment and removal (see Administrative Control 5.14 in HNF-SD-WM-TSR-006, 1998).

3.0 Representative Accident

The accident represented here is a 50 gpm waste transfer leak from a subsurface or bermmed transfer pipeline. Leak detection is accomplished via surveillance controls. The transfer pump is shut off 30 minutes after leak detection and exposure to onsite personnel is limited to one hour.

Abatement measures are taken to prevent dry resuspension from the exposed surface of the spill. Releases occur due to wet resuspension and gamma-ray shine from a waste composition of 67% liquid, 33% solid from a single shell tank.

4.0 Source Term

There are two sources of exposure from this event. One is the direct gamma-ray exposure to those in the vicinity of the spill. The other is the transport of aerosols downwind.

4.1 Leak Volume

One transfer control currently relied upon to mitigate the consequences of a leak is a transfer pump shutdown. When the pump is turned off the leak may continue because there is still the potential for siphoning and drain back of waste contained in piping at higher elevations than the leak location. The leak rate should never exceed the level achieved when the pump was running (i.e., 50 gpm), but for conservatism it is not assumed to be less.

Transfer lines are typically constructed of 3-in schedule 40 pipe, which hold a liquid volume of 0.384 gal/ft. This analysis conservatively assumes that 100% of the contents of a 50,000-ft run of 3-in schedule 40 pipe, drains back through the leak opening at a rate of 50 gpm. This pipe length is greater than any intended for use.

The total leak volume includes the amount pumped out before leak detection, the amount leaked after leak detection but before the pump is shut off 30 minutes later, and the drain back volume. It is slightly conservative to assume that no waste remains confined but that it all contributes to a surface pool.

There are two leak volumes to consider. The first is for the onsite maximum exposed individual (MEI). His exposure is limited to the one-hour leak of which 100% is assumed to form a surface pool. The second is for the offsite MEI. His exposure period is 24 hours, which is more than sufficient time for draining the entire transfer line at 50 gpm. The offsite MEI is then exposed to the 3,000 gal pumped out plus the drain back quantity. For simplicity, doses for both the 1 hr and 24 hr exposures are conservatively calculated for the maximum pool dimension obtained in those time frames.

4.2 Gamma-ray Exposure

A conservative gamma-ray exposure estimate is made assuming an idealistic case of a circular contaminated area of soil with an onsite receptor located 100 m from its center. This approach is typical of most TWRS BIO supporting analyses (Hall 1996a, Hall 1996b, and Van Vleet 1997) and meets the definition of maximum onsite individual in HNF-PRO-517. Of course, the actual spill shape would depend upon local conditions.

The area of the source depends upon the amount of spreading assumed. Even in the ideal case of a perfectly flat area, this would be a function of waste viscosity, surface porosity and moisture content, ambient temperature, etc. A spreading factor of 8.7 ft^{-1} has been used in a number of TWRS BIO supporting analyses (Hall, 1996a, Van Vleet, 1997). This spreading factor was calculated by dividing the surface area of contaminated soil by the estimated spill volume of an actual event. The event occurred at Hanford S farm in 1973 where an estimated 8,600 gal of liquid waste spilled onto the surface (ARH-2977 RD, 1974). The depth of soil contamination varied between 2 in and 18 in. It is typically assumed that there is no immediate infiltration into the soil due to the possibility of ice or salt formation when a saturated waste solution comes into contact with a colder environment. The presence of blacktop or concrete surfaces could also promote formation of a surface pool. This is a conservative assumption as allowing the waste to infiltrate into the soil reduces the gamma-ray shine by approximately a factor of 4 (assuming a void fraction of 0.4).

Because the exact location of the leak can not be predicted, nor can the ambient or surface condition be known, no credit for infiltration is taken.

4.3 Exposure due to Inhalation of Respirable Aerosols

Respirable sized liquid aerosols can be created any time a liquid is exposed to shear forces. The types of releases that have typically been considered for waste transfers have been categorized as a spray, splash and splatter, or resuspension due to wind. The latter case is actually based on measurements from ponds experiencing wave action, which is another form of splash and splatter. The dominant mechanism by far is a spray. All such analyses of unmitigated spray releases of Hanford tank waste directly into the environment yield unacceptable results. These analyses are very conservative. They usually assume maximum pressures, a viscosity equal to that of water, optimum crack widths, and take no credit for plugging due to suspended solids. Nevertheless, it is difficult to prove these optimal conditions can not exist. Hence it has already been concluded that a spray release directly into the atmosphere must always be prevented or mitigated by a confinement barrier. See Section 2.0.

4.3.1 Aerosol Generation Due to Splashing and Splattering

TWRS AB supporting analyses have also made use of a splash/splatter source term to represent liquid waste falling onto a surface out in the open. Hall (1996a) makes use of a respirable release fraction (RRF) of 4E-5 taken from Section 3.2.3.2 of DOE (1994) which is the recommended value for slurries based on a 1 liter sample dropped from a height of 3 m. Jones (1998) used a RRF of 5E-7 taken from the same reference but for a 1 L UNH solution dropped from a height of 1 m. Himes (1997) uses an

Archimedes relationship to calculate the respirable aerosol from a falling vertical jet of liquid from height H. Although the application of these values yields small aerosol quantities in comparison to an open spray, it can become a dominant factor when the spray release is mitigated. DOE (1994) referenced measurements are based on one liter or smaller samples and the trend is a decrease in the release fraction for an increase in sample size. It is very conservative to use these values when applying them to large volume releases such as the several thousand gallon releases typically considered in waste transfer consequence analysis. When mitigation is provided such that these splash and splatter releases occur within a confinement, it is better to base the release on the aerosol escaping the confinement as opposed to the aerosol generation rate. In the event that a confinement overflows, its physical orientation must not allow waste material to spill freely from a height and splatter against the waste below (see Section 2.0). It is believed that the various pits and boxes used in Hanford waste transfers, together with supplementary confinement as described in HNF-2329, meet this criteria. Waste overflowing a pit or box and running down a short vertical wall section should not cause the aerosol fractions observed in Mishima's referenced liquid drop studies. Instead, it is proposed that the multitude of aerosol generating mechanisms which occur within such a confinement be represented by a value more representative of the quantity escaping the confinement. This is the approach taken in Hall (1996c) that provides a bounding analysis for very large confinement structures.

4.3.2 Aerosol Resuspended from Waste Material Exposed to Wind

Aerosol generated from wind induced resuspension has also been considered in TWRS AB supporting analyses (Hall 1996a, Jones 1998, Hall 1996b, Van Vleet 1997). The consensus of these analyses is that resuspension would be worse once the spill had dried. For the one-hour onsite MEI exposure period considered in the mitigated analysis, it is expected that wet conditions characterize the spill. What is more difficult to assign is the resuspension rate appropriate for such conditions. The value used in the above referenced analyses is 2E-10 kg/m^2-s. This value is intended to represent a low wind speed condition, consistent with the conservative low wind speed X/Q applied in the dose estimate. It is probably conservative in that it actually represents wave action occurring in ponds of water. It is difficult to visualize waves on a relatively shallow waste spill of material more viscous than water, soaking into the ground, solidifying as it cools. However, there may be other mechanisms at work such as the release of entrained gas that could result in a release of aerosols even under stagnant conditions. Hence, this value is retained here in the absence of any better data, for consistency with the referenced analyses, and the fact that it contributes less than a tenth of the dose to the onsite MEI due to gamma-ray exposure. The onsite MEI is the controlling receptor in this mitigated analysis.

TWRS AB analyses have also considered dry resuspension (Jones 1998, Hall 1996b, Van Vleet 1997). All three analyses use a RRF = 8.4E-5 from DOE Section 3.2.4.4 (1994) which is applied to the entire spill quantity. Jones (1998) does not include dry resuspension in offsite doses because emergency response procedures are credited with leakage containment and removal (see Section 2.0). The same control is assumed in this mitigated analysis and dry resuspension is not included in any onsite or offsite dose consequence.

5.0 Consequence Analysis

This analysis estimates radiological and toxicological consequences below the currently approved authorization basis provided in Hall (1996b). The radiological and toxicological dose calculation methodology of Van Keuren (1996a, b) was used. The calculations were performed with the aid of a spreadsheet and are included in Appendix A. Even with waste drain back from a very long pipeline (50,000 ft), the dose from the resultant pool is bounded by Hall (1996 b). Results are summarized as follows.

67/33 SST Leak Forming Surface Pool
One-hour leak quantity = 3000 gal
Twenty-four-hour leak quantity = 22,200 gal
Applicable Transfer Line Length = 50,000 ft

Radiological Consequence Calculations

Pathway	Onsite MEI EDE (Sv)	Offsite MEI EDE (Sv)
Inhalation	1.5E-04	1.36E-05
Ingestion	NA	8.72E-07
Gamma-ray	1.33E-03	NA
Total	1.48E-03	1.44E-05
Anticipated Guideline	5.00E-03	1.00E-03

Toxicological Consequence Calculations

Pathway	Onsite MEI EDE (SOF)	Offsite MEI (SOF)
Inhalation	9.10E-04	1.25E-05
Anticipated Guideline	1.00E+00	1.00E+00

6.0 References

ARH-2977 RD, 1974, *Report On the Cleanup Activities Following the 241-S Tank Farm Contamination Occurrence at the Hanford Reservation*, Atlantic Richfield Hanford Company, Richland, Washington.

DOE, 1994, *Airborne Release Fractions/Rates and Respirable Fraction for Nonreactor Nuclear Facilities*, DOE-HDBK-3010-94, U. S. Department Of Energy, Washington D.C.

Hall, B. W., 1996a, *Calculation Notes for Surface Leak Resulting in Pool, TWRS FSAR Accident Analysis*, WHC-SD-WM-CN-049, Rev 0, Westinghouse Hanford Co., Richland, Washington.

Hall, B. W., 1996b, *Calculation Notes for Subsurface Leak Resulting in Pool, TWRS FSAR Accident Analysis*, WHC-SD-WM-CN-057, Rev 0, Westinghouse Hanford Co., Richland, Washington.

Hall, B. W., 1996c, *Calculation Notes for in Support of TWRS FSAR Spray Leak Accident Analysis*, WHC-SD-WM-CN-048, Rev 0, Westinghouse Hanford Co., Richland, Washington.

Himes, D. A., 1997, *Radiological and Toxicological Consequences of a Worst-Case Spray Leak Related to Project W-320*, HNF-SD-WM-CN-102, Rev 0, Fluor Daniel Northwest Inc., Richland, Washington.

HNF-SD-WM-BIO-001, 1998, *Tank Waste Remediation System Basis for Interim Operation,* Rev. 1, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-SD-WM-TSR-006, 1998, *Tank Waste Remediation System Technical Safety Requirements,* Rev. 0-P, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-2329, 1997, *Calculation for Supplemental Covers On Structures Smaller Than 241-A-A,* Fluor Daniel Hanford, Inc., Richland, Washington.

Jones, G. L., 1998, *Calculation Notes for Surface Leak Resulting in Pool, TWRS FSAR Accident Analysis,* WHC-SD-WM-CN-049, Rev. 0-B, Duke Engineering Services Hanford, Richland, Washington.

Van Keuren, J. C. 1996a, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use In Safety Analysis Consequence Assessments*, WHC-SD-WM-SARR-016, Rev 2, Westinghouse Hanford Co., Richland, Washington.

Van Keuren, J. C. 1996b, *Toxic Chemical Considerations for Tank Farm Releases*, WHC-SD-WM-SARR-011, Rev 2, Westinghouse Hanford Co., Richland, Washington.

Van Vleet, R. J., 1997, *Consequences of a Radioactive Surface Pool Resulting from Waste Transfer Operations between Tanks 241-C-106 and 241-AY-102*, WHC-SD-WM-CN-110, Rev 0, Westinghouse Hanford Co., Richland Washington.

PEER REVIEW CHECKLIST

Document Reviewed: Mitigated Subsurface Transfer Line Leak Resulting in a Surface Pool
Author: David L. Scott
Scope of Review: Entire Document

Yes	No	NA	
[ ]	[ ]	[X]	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
[X]	[ ]	[ ]	Problem completely defined.
[X]	[ ]	[ ]	Accident scenarios developed in a clear and logical manner.
[X]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[X]	[ ]	[ ]	Computer codes and data files documented.
[X]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[X]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[ ]	[ ]	[X]	Mathematical derivations checked including dimensional consistency of results.
[X]	[ ]	[ ]	Models appropriate and used within range of validity or use outside range of established validity justified.
[X]	[ ]	[ ]	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
[X]	[ ]	[ ]	Software input correct and consistent with document reviewed.
[X]	[ ]	[ ]	Software output consistent with input and with results reported in document reviewed.
[X]	[ ]	[ ]	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[X]	[ ]	[ ]	Safety margins consistent with good engineering practices.
[X]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[X]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.
[ ]	[ ]	[X]	Format consistent with appropriate NRC Regulatory Guide or other standards
[ ]	[ ]	[X]	Review calculations, comments, and/or notes are attached.
[X]	[ ]	[ ]	**Document approved.**

D.A. Himes [signature] 1/21/99
Reviewer (Printed Name and Signature) Date

HEDOP REVIEW CHECKLIST

Document Reviewed: Mitigated Subsurface Transfer Line Leak Resulting in a Surface Pool
Author: David L. Scott
Scope of Review: Entire Document

YES	NO*	N/A		
[X]	[ ]	[ ]	1.	A detailed technical review and approval of the environmental transport and dose calculation portion of the analysis has been performed and documented.
[X]	[ ]	[ ]	2.	Detailed technical review(s) and approval(s) of scenario and release determinations have been performed and documented.
[ ]	[ ]	[X]	3.	HEDOP-approved code(s) were used.
[ ]	[ ]	[X]	4.	Receptor locations were selected according to HEDOP recommendations.
[X]	[ ]	[ ]	5.	All applicable environmental pathways and code options were included and are appropriate for the calculations.
[X]	[ ]	[ ]	6.	Hanford site data were used.
[X]	[ ]	[ ]	7.	Model adjustments external to the computer program were justified and performed correctly.
[X]	[ ]	[ ]	8.	The analysis is consistent with HEDOP recommendations.
[ ]	[ ]	[X]	9.	Supporting notes, calculations, comments, comment resolutions, or other information is attached. (Use the "Page 1 of X" page numbering format and sign and date each added page.)
[X]		[ ]	**10.**	**Approval is granted on behalf of the Hanford Environmental Dose Overview Panel.**

* All "NO" responses must be explained and use of nonstandard methods justified.

D.A. Himes [signature] 1/21/99
HEDOP-Approved Reviewer (Printed Name and Signature) Date

COMMENTS (add additional signed and dated pages if necessary):

APPENDIX A - Spreadsheet Consequence Calculations

The following pages include spreadsheet results representing a 67% liquid, 33% solid waste composition from a single shell tank. Drain back volume is from a transfer line having a length of 50,000 ft. Unit liter dose, toxic sum of fractions, and bremsstrahlung gamma-ray spectra for Sr-90 were taken from Van Keuren (1996a, 1996b). Onsite exposure due to material resuspended from a surface pool use the uncorrected X/Q since plume meander may not be applicable to an area source. Gamma-ray shine doses are ratioed by the surface pool volume against the 1,200-gal spill (a 95% liquid, 5% solid DST waste) assumed in the Microshield and Microskyshine output files also attached. This is appropriate since the onsite MEI distance is far enough (i.e., 100 m) to cause the relationship between source quantity and dose to be approximately linear. Gamma-ray shine doses are also ratioed by the Cs-137 concentration against the base case concentration (a 95% liquid, 5% solid DST waste) since Cs-137 dominates the gamma-ray shine dose.

67/33 SST Leak from Clean Out Box

SST Radiological Unit Liter Doses

Waste Type	Inhalation (Sv/L)	Ingestion (Sv-m^3/s-L)
SST Liquids	1.1E+04	5.2E-02
SST Solids	2.2E+05	4.1E+00
67/33 Composite	8.0E+04	1.4E+00

SST Continuous Release SOF Multipliers (s/L)

	Anticipated Frequency		Unlikely Frequency		Extremely Unlikely Frequency	
Waste Type	Onsite	Offsite	Onsite	Offsite	Onsite	Offsite
SST Liquids	9.6E+03	8.0E+00	7.5E+02	8.0E+00	2.0E+02	6.2E-01
SST Solids	4.0E+04	9.4E+01	2.1E+04	3.3E+01	1.0E+03	1.7E+01
67/33 Composite	2.0E+04	3.6E+01	7.4E+03	1.6E+01	4.6E+02	6.0E+00

Dispersion Coefficients (s/m3)

	Onsite	Offsite
99.5%	3.41E-02	2.83E-05
99.5% w/ PM	1.13E-02	2.12E-05

Breathing Rates (m3/s)

light activity	3.3E-04
24-hr average	2.7E-04

67/33 SST Leak Forming Surface Pool (Drainback Pipe Length is 50,000 ft)

Source Term

Parameter	English Units	Metric Units	
Waste Density		1.40E+00 kg/L	based on past BIO practice
Soil Density		1.6 kg/L	
Leak flow rate	5.00E+01 gpm ✓		given
Time for leak detector alarm	0.00E+00 min		given
Time before transfer pump shut down	6.00E+01 min ✓		given
Pumped spill volume	3.00E+03 gal		
Drainback pipe length	5.00E+04 ft ✓		given
Pipe ID	3.07E+00 in		given
Drainback volume	1.92E+04 gal		
Drainback leak rate	5.00E+01 gpm ✓		
Total spill volume	2.22E+04 gal	8.40E+04 L	
Total spill duration	4.44E+02 min	2.66E+04 s	7.40E+00 hr
1 hr surface pool spill volume	3.00E+03 gal	1.14E+01 m3	
Spreading factor	8.70E+00 ft-1		based on past BIO practice
Pool area	3.49E+03 ft2	3.25E+02 m2	
Pool radius	3.33E+01 ft	1.02E+01 m	
Wet resuspension flux		2.00E-10 kg/m2-s	based on past BIO practice
Aerosol release rate from wet resuspension		4.64E-08 L/s	
Aerosol released from 1 hr wet resuspension		1.67E-04 L	onsite evacuation control
24 hr surface pool spill volume	2.22E+04 gal	8.40E+01 m3	
Spreading factor	8.70E+00 ft-1		based on past BIO practice
Pool area	2.58E+04 ft2	2.40E+03 m2	
Pool radius	9.07E+01 ft	2.77E+01 m	
Wet resuspension flux		2.00E-10 kg/m2-s	based on past BIO practice
Aerosol release rate from wet resuspension		3.43E-07 L/s	
Aerosol released from 24 hr wet resuspension		2.96E-02 L	leakage containment and removal control
Confined volume	0.00E+00 ft3	0.00E+00 m3/vol	limiting assumption
Confined volume exchange rate		6.00E+00 vol/hr	reasonable assumption
Confined volume aerosol concentration		1.00E+02 mg/m3	reasonable assumption
Aerosol release rate from confined volume		0.00E+00 L/s	
Aerosol release from 1 hr confined volume release		0.00E+00 L	
Aerosol release from 24 hr confined volume release		0.00E+00 L	
Peak 1 hr aerosol release rate		4.64E-08 L/s	
Peak 24 hr aerosol release rate		3.43E-07 L/s	
Total 1 hr aerosol release		1.67E-04 L	
Total 24 hr aerosol release		2.96E-02 L	

KW

67/33 SST Leak Forming Surface Pool

Applicable Transfer Line Length = 50000 ft

Radiological Consequence Calculations

Pathway	Onsite MEI EDE (Sv)	Offsite MEI EDE (Sv)
Inhalation	1.50E-04	1.36E-05
Ingestion	NA	8.72E-07
Gamma-ray	1.33E-03	NA
Total	1.48E-03	1.44E-05
Anticipated Guideline	5.00E-03	1.00E-03

PM not used for onsite surface pool release

Gamma multiplier = 0.81

Toxicological Consequence Calculations

Pathway	Onsite MEI (SOF)	Offsite MEI (SOF)
Inhalation	9.10E-04	1.25E-05
Anticipated Guideline	1.00E+00	1.00E+00

KN

Material at Risk 4.54E+03 L

SST Gamma Producing Isotopes (Bq/L)

Waste Type	Co-60	Sr-90	Cs-137	Eu-154	Eu-155
SST Liq.	9.50E+06	1.10E+10	2.20E+10	2.40E+09	5.90E+07
SST Sol.	4.20E+08	1.60E+12	1.00E+11	5.80E+09	5.00E+06
67/33 Composite	1.45E+08	5.35E+11	4.77E+10	3.52E+09	4.12E+07

Pool Isotopic Inventory (Ci)

Isotope	Co-60	Sr-90	Cs-137	Eu-154	Eu-155
	1.78E+01	6.57E+04	5.86E+03	4.32E+02	5.05E+00

Energy Spectra for 1-Ci of Given Isotopes

Photons per Second					
MeV	Co-60	Sr-90	Cs-137	Eu-154	Eu-155
0.015		7.80E+08			
0.025		4.00E+08			
0.035		2.60E+08			
0.045		1.80E+08			
0.055		1.40E+08			
0.065		1.10E+08			
0.075		8.90E+07			
0.085		7.40E+07			
0.095		6.30E+07			7.65E+09
0.15		3.30E+08		1.50E+10	
0.25		1.30E+08		2.53E+09	
0.35		6.90E+07			
0.475		5.50E+07		2.65E+09	
0.65	6.04E+06	3.50E+07	3.15E+10		
0.825		1.40E+07		1.54E+10	
1		9.80E+06		1.05E+10	
1.225	7.40E+10	5.50E+06		1.37E+10	
1.475		2.10E+06			
1.7		5.30E+05		1.30E+09	
1.9		1.40E+05			
2.1		1.50E+04			
2.3		8.30E+01			

Cs-137 $\frac{67/33 \text{ SST}}{95/5 \text{ DST}} = \frac{5.86E+3}{7.24E+3} = \boxed{0.81}$

KN

67/33 SST

Combined Energy Spectra (Photons per Second)

	Isotope	Co-60	Sr-90	Cs-137	Eu-154	Eu-155
	Activity (Ci)	1.78E+01	6.57E+04	5.86E+03	4.32E+02	5.05E+00
MeV	Total	Co-60	Sr-90	Cs-137	Eu-154	Eu-155
0.015	5.12E+13	0	5.12392E+13	0	0	0
0.025	2.63E+13	0	2.62765E+13	0	0	0
0.035	1.71E+13	0	1.70797E+13	0	0	0
0.045	1.18E+13	0	1.18244E+13	0	0	0
0.055	9.20E+12	0	9.19679E+12	0	0	0
0.065	7.23E+12	0	7.22605E+12	0	0	0
0.075	5.85E+12	0	5.84653E+12	0	0	0
0.085	4.86E+12	0	4.86116E+12	0	0	0
0.095	4.18E+12	0	4.13855E+12	0	0	38647590268
0.15	2.81E+13	0	2.16781E+13	0	6.47028E+12	0
0.25	9.63E+12	0	8.53987E+12	0	1.09198E+12	0
0.35	4.53E+12	0	4.5327E+12	0	0	0
0.475	4.76E+12	0	3.61302E+12	0	1.14535E+12	0
0.65	1.87E+14	107355264.7	2.2992E+12	1.84481E+14	0	0
0.825	7.58E+12	0	9.19679E+11	0	6.66E+12	0
1	5.19E+12	0	6.43775E+11	0	4.54545E+12	0
1.225	7.60E+12	1.31628E+12	3.61302E+11	0	5.91755E+12	0
1.475	1.38E+11	0	1.37952E+11	0	0	0
1.7	5.98E+11	0	34816413351	0	5.63578E+11	0
1.9	9.20E+09	0	9196788432	0	0	0
2.1	9.85E+08	0	985370189.2	0	0	0
2.3	5.45E+06	0	5452381.714	0	0	0

KN

Material at Risk 4.54E+03 L 1200 gal.

DST Gamma Producing Isotopes (Bq/L)

Waste Type	Co-60	Sr-90	Cs-137	Eu-154	Eu-155
DST Liq.	7.00E+06	4.60E+09	5.90E+10	4.20E+07	0
DST Sol.	1.50E+07	5.20E+10	5.90E+10	3.00E+08	0
95/5 Composite	7.40E+06	6.97E+09	5.90E+10	5.49E+07	0.00E+00

Pool Isotopic Inventory (Ci)

Isotope	Co-60	Sr-90	Cs-137	Eu-154	Eu-155
	9.08E-01	8.55E+02	7.24E+03	6.74E+00	0.00E+00

Energy Spectra for 1-Ci of Given Isotopes

Photons per Second					
MeV	Co-60	Sr-90	Cs-137	Eu-154	Eu-155
0.015		7.80E+08			
0.025		4.00E+08			
0.035		2.60E+08			
0.045		1.80E+08			
0.055		1.40E+08			
0.065		1.10E+08			
0.075		8.90E+07			
0.085		7.40E+07			
0.095		6.30E+07			7.65E+09
0.15		3.30E+08		1.50E+10	
0.25		1.30E+08		2.53E+09	
0.35		6.90E+07			
0.475		5.50E+07		2.65E+09	
0.65	6.04E+06	3.50E+07	3.15E+10		
0.825		1.40E+07		1.54E+10	
1		9.80E+06		1.05E+10	
1.225	7.40E+10	5.50E+06		1.37E+10	
1.475		2.10E+06			
1.7		5.30E+05		1.30E+09	
1.9		1.40E+05			
2.1		1.50E+04			
2.3		8.30E+01			

KN

Combined Energy Spectra (Photons per Second)

	Isotope	Co-60	Sr-90	Cs-137	Eu-154	Eu-155
	Activity (Ci)	9.08E-01	8.55E+02	7.24E+03	6.74E+00	0.00E+00
MeV	Total	Co-60	Sr-90	Cs-137	Eu-154	Eu-155
0.015	6.67E+11	0	6.67086E+11	0	0	0
0.025	3.42E+11	0	3.42095E+11	0	0	0
0.035	2.22E+11	0	2.22362E+11	0	0	0
0.045	1.54E+11	0	1.53943E+11	0	0	0
0.055	1.20E+11	0	1.19733E+11	0	0	0
0.065	9.41E+10	0	94076162162	0	0	0
0.075	7.61E+10	0	76116167568	0	0	0
0.085	6.33E+10	0	63287600000	0	0	0
0.095	5.39E+10	0	53879983784	0	0	0
0.15	3.83E+11	0	2.82228E+11	0	1.00857E+11	0
0.25	1.28E+11	0	1.11181E+11	0	17021480886	0
0.35	5.90E+10	0	59011410811	0	0	0
0.475	6.49E+10	0	47038081081	0	17853423616	0
0.65	2.28E+14	5480143.2	29933324324	2.27992E+14	0	0
0.825	1.16E+11	0	11973329730	0	1.03814E+11	0
1	7.92E+10	0	8381330811	0	70853227784	0
1.225	1.64E+11	67192000000	4703808108	0	92241229135	0
1.475	1.80E+09	0	1795999459	0	0	0
1.7	9.24E+09	0	453276054.1	0	8784911043	0
1.9	1.20E+08	0	119733297.3	0	0	0
2.1	1.28E+07	0	12828567.57	0	0	0
2.3	7.10E+04	0	70984.74054	0	0	0

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MicroSkyshine*
=============

(Nuclear & Radiological Safety Analysis - 1.16-007)

Page: 1 File Ref: ________
File: Date: ___/___/___
Run: 9:12 a.m. By: ________
: December 21, 1998 Checked: ________

CASE: 1,200 gal Spill of 95/5 DST Waste

GEOMETRY: Vertical cylinder area source behind a wall

DIMENSIONS (meters):

Distance between wall and detector...........	X	80.
Depth of source behind wall.................	Y	1.
Offset of detector..........................	Z	0.
Depth of dose point.........................	H	1.
Distance between center of source and wall...	R1	20.
Thickness of cover slab.....................	T1	0.
Thickness of second shield..................	T2	0.
Radius of source............................	W	6.43
Height of source............................	L	0.035052

INTEGRATION PARAMETERS:

Number of Radial Segments....................	M	5
Number of Circumferential Segments...........	N	5
Number of Vertical Segments..................	C	5
Quadrature Order...........................		16

MATERIAL DENSITIES (g/cc):

Ambient air: .0012

Material	Cover Slab	Lower Shield	Volume Source
Air			
Water			
Concrete			1.4
Iron			
Lead			
Zirconium			
Urania			

Buildup factor based on: CONCRETE.

*MicroSkyshine, Grove Engineering, Inc., Rockville, Maryland

CASE: 1,200 gal Spill of 95/5 DST Waste

SOURCE NUCLIDES:

Source was entered by energy groups.

RESULTS:

Group #	Energy (mev)	Activity (photons/sec)	Dose point rads/photon	Dose rate (mr/hr)
1	1.70	9.240e+09	5.615e-20	2.139e-03
2	1.48	1.800e+09	5.508e-20	4.088e-04
3	1.23	1.640e+11	6.129e-20	4.145e-02
4	1.00	7.920e+10	6.192e-20	2.022e-02
5	.82	1.160e+11	5.904e-20	2.824e-02
6	.65	2.280e+14	6.083e-20	5.719e+01
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
	TOTALS:	2.284e+14		5.728e+01

MicroShield 4.00 - Serial #4.00-00128
Westinghouse Hanford Company

Page	: 1	File Ref:	________
DOS File:	DST-POOL.MS4	Date:	__/__/__
Run Date:	December 21, 1998	By:	________
Run Time:	9:16 a.m. Monday	Checked:	________
Duration:	0:00:01		

Case Title: 1,200 gal Spill of 95/5 DST Waste

GEOMETRY 8 - Cylinder Volume - End Shields

	centimeters	feet and inches	
Dose point coordinate X:	10000.0	328.0	1.0
Dose point coordinate Y:	100.0	3.0	3.4
Dose point coordinate Z:	0.0	0.0	.0
Cylinder height:	3.5052	0.0	1.4
Cylinder radius:	643.0	21.0	1.1
Air Gap:	96.4948	3.0	2.0
Side Clad:	8000.0	262.0	5.6

Source Volume: 4.55286e+6 cm^3 160.783 cu ft. 277833. cu in.

MATERIAL DENSITIES (g/cm^3)

Material	Source Shield	Air Gap	Side Clad Shield	Immersion Shield
Air		0.00122		0.00122
Concrete	1.4		1.4	

BUILDUP
Method: Buildup Factor Tables
The material reference is Source

INTEGRATION PARAMETERS

	Quadrature Order
Radial	10
Circumferential	10
Axial (along Z)	10

SOURCE WAS ENTERED AS ENERGIES ONLY

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Page : 2
DOS File: DST-POOL.MS4
Run Date: December 21, 1998
Run Time: 9:16 a.m. Monday
Title : 1,200 gal Spill of 95/5 DST Waste

=============================== RESULTS ===============================

Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.65	2.280e+014	1.164e+003	4.429e+003	2.261e+000	8.599e+000
0.825	1.160e+011	9.251e-001	3.104e+000	1.753e-003	5.882e-003
1.0	7.920e+010	9.045e-001	2.756e+000	1.667e-003	5.081e-003
1.225	1.640e+011	2.735e+000	7.573e+000	4.842e-003	1.340e-002
1.475	1.800e+009	4.237e-002	1.081e-001	7.161e-005	1.827e-004
1.7	9.240e+009	2.823e-001	6.807e-001	4.585e-004	1.106e-003
TOTAL:	2.284e+014	1.169e+003	4.443e+003	2.269e+000	8.624e+000

KN

DISTRIBUTION SHEET

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		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
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