SEP 17 1996

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1	1	Design Authority	D. R. Precechtel	7/13/96	R3-48	3		K. W. Bergsman			R3-48
		Design Agent				3		T. R. Pauly			X3-85
		Cog. Eng. F. J. Muller		7/13/96	R3-85						
		Cog. Mgr. F. W. Moore		7/13/96	X3-85						
		QA									
		Safety									
		Env.									

18. Signature of EDT Originator D. R. Precechtel Date: 9/13/96		19. Authorized Representative Date for Receiving Organization C. J. Bergman Date: 9/13/96		20. Design Authority/ Cognizant Manager C. J. Bergman Date: 9/13/96		21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
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Sludge Removal Project Weasel Pit Requirements

D. R. Precechte1

Westinghouse Hanford Company, Richland, WA 99352

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Abstract: This document defines some technical requirements based on design concerns related to storage of K East Basin Sludge in the Weasel Pit.

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SLUDGE REMOVAL PROJECT WEASEL PIT REQUIREMENTS

September 1996

D. R. Precechtel
S. A. Brisbin
M. A. Jensen
R. A. Schwarz

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**SLUDGE REMOVAL PROJECT
SLUDGE MANAGEMENT REQUIREMENTS**

1.0 INTRODUCTION

The 105 K East Basin fuel storage pool contains about 50 m3 of sludge. Current plans call for retrieval of this sludge to the Weasel Pit for storage and then transport to a Tank Waste Remediation System (TWRS) double-shell tank (DST) in the year 2000. Storage of this sludge in the Weasel Pit must accommodate concerns for:

- Criticality
- Shielding
- Operator dose commitment
- Gas evolution

These factors will influence how the sludge is stored, moved, and transported. The technical requirements on the Sludge Removal System accommodate these concerns are compiled herein.

2.0 CRITICALITY

The sludge stored in the Weasel Pit is critically safe due to the geometry and restrictions on fuel particle size. The width of the Weasel Pit (5' 6") is less than the infinite slab thickness required to achieve at K effective of 0.98 with uniform dispersion of 1.28 cm (0.5 inch) diameter fuel particles. Sludge was passed through a 0.64 cm (0.25 inch) screen when transferred into the Weasel Pit. Extensive sampling in the Weasel Pit and the main basin has not revealed any particles larger than 254 μ m (10 mils). Corrosion of the fuel in the basin does not generate large fuel particles. Therefore, the Weasel Pit is considered critically safe for continuation of current practices. There are no limits on sludge depth in the Weasel Pit due to criticality limits. These conclusions are based on the criticality review provided in Appendix A.

3.0 DOSE RATES

Sludge accumulations in the Weasel Pit have the potential to increase the dose to K Basin operators and the particular, to operators working around the Weasel Pit. A clean water depth of 1.8 m (6 ft) over the sludge will assure no significant increase in dose to the operators. More significant is the dose from the cesium in the "clear water" over the sludge due to pumping in new sludge, debris removal activities, or anything that disturbs the sludge. Use of shielding and/or access restrictions should be considered when the sludge is disturbed. These conclusions are derived from the dose calculations provided in Appendix B.

The dose from a pipe filled with sludge is sufficiently high to warrant use of shielding and/or access restrictions when pumping sludge through above water piping/hose. Any submerged pipe or hose containing sludge should be at least 0.9 m (3 ft) underwater to avoid contributing to operator dose. These conclusions are derived from the dose calculations provided in Appendix C.

4.0 GAS EVOLUTION IN THE WEASEL PIT

Observation on unacceptable gas retention behavior from under thick layers of sludge in TWRS tanks has been applied to the Weasel Pit. As long as the sludge depth is not more than 5.5 m (11 ft), the data would suggest that significant flammable gas will not be trapped and subject to sudden release, with risk to the operators. These conclusions are derived from the analysis provided in Appendix D.

5.0 CONCLUSIONS

Sludge depths in the Weasel Pit should be maintained at less than 3.3 m (11 ft) both for dose management and gas retention concerns. The ability of 1.8 m (6 ft) of water over 3.3 m (11 ft) of sludge to successfully settle sludge and not result in excess doses at the surface has yet to be demonstrated.

Piping and hoses containing sludge should be maintained under at least 0.9 m (3 ft) of water to avoid any significant operator dose commitment.

The sludge management plans discussed in Appendix E suggest the need to use both the Weasel Pit and the Weasel Pit channel to store sludge to meet the above requirements.

APPENDIX A

CRITICALITY

M. A. Jensen

Westinghouse
Hanford CompanyInternal
Memo

From: Standards and Requirements
 Phone: 373-1353 X3-79
 Date: July 11, 1996
 Subject: K EAST WEASEL PIT SLUDGE

2A100-96.038

To: ~~Mr. D. R. Precechtel~~ R3-48

cc: C. L. Bennett X3-79
 C. DeFigh-Price X3-79
 J. C. Hamrick X3-71
 D. O. Hess X3-80
 SNF Project Files R3-11
 MAJ File/LB X3-79

Reference 1: Wittekind, W. D. 1993, *MCNP Calculations of K-infinity for 100KE Basin Sludge Samples*, WHC-SD-NR-CSER-008 Rev 1, Westinghouse Hanford Company, Richland, WA.

I have performed a criticality safety review of the proposed extension of the volume of the weasel pit available for receiving sludge pumped from the main basin.

Appendix A of Reference 1 modeled the weasel pit as an infinite slab composed of 3.0 g/cm³ 0.95 wt% UO₂ sludge with embedded 0.25 inch 0.95 wt% uranium rods. The sludge density and lattice spacing of the rods within the sludge were chosen to maximize reactivity. This model is conservative because the enrichment chosen does not take credit for burnup, ignores the presence of fission products which may act as neutron poisons, and because actual weasel pit sludge density is not optimum. It was found that a slab infinite in two dimensions and limited to a height of 69 inches would have a multiplication factor (k_{eff}) less than the limiting value of 0.98. The weasel pit dimensions are 32'8" in length, 5'6" in width (66"), and approximately 20' deep. The reference stated that with the finite dimensions of the weasel pit, no slab height could attain a $k_{eff} = 0.98$.

The existing analysis from Reference 1 will remain bounding if the length of the weasel pit used for sludge retention is extended from the current sludge screen (approximately 24 feet) out to the basin entrance (approximately 32'8"). This is because the maximum width of the weasel pit is 66 inches; which is less than the slab height of 69 inches. The other two dimensions (32'8" length and approximately 20 feet depth) are the two "infinite" dimensions. The pit is modeled as an infinite vertical slab, with the pit width being the limiting dimension.

D. R. Precechtel
Page 2
July 11, 1996

2A100-96.038

Sludge from any location in the K East basin may be pumped to the weasel pit without any restrictions beyond limiting the size of uranium pieces to 0.25 inches in diameter or less. This authorization does not apply to K West, which has not had an analysis of its potentially higher-enriched sludge.

If you have any questions please contact me on 373-1353.

M. A. Jensen, Criticality Safety Representative
Standards and Requirements

Concurrence:

D. O. Hess
Spent Nuclear Fuel Project Safety

skr

APPENDIX B
WEASEL PIT RATES
R. A. Schwarz

**Westinghouse
Hanford Company**
**Internal
Memo**

From: Criticality and Shielding
 Phone: 376-5977 H0-35
 Date: July 17, 1996
 Subject: DOSE RATES IN THE K BASIN WEASEL PIT

8M730-RAS-96-005

To: D. R. Precechtel

~~X3-85~~ R3-48

cc: C. J. Alderman R3-48
 K. H. Bergsman R3-48
 J. Greenborg H0-35
 G. S. Hunacek X3-79
 J. S. Lan H0-35
 T. D. Merkling R3-09
 F. W. Moore X3-85
 F. J. Muller X3-85
 A. L. Ramble H0-35
 D. L. Schifferl X3-74
 RAS File/LB H0-35

Attached is the dose rate calculation for sludge contained in the K Basin Weasel Pit. Also attached to this document is the review checklist for the shielding analysis that has been filled out by the reviewer. It is understood that this information will be placed directly into a supporting document without any changes.

R. A. Schwarz
 R. A. Schwarz
 Advanced Scientist

Concurrence:

J. Greenborg
 J. Greenborg, Manager

11p

Attachments

Dose Rates in the K Basin Weasel Pit

R. A. Schwarz

July 1996

1.0 INTRODUCTION

Dose rate calculations have been made for sludge and activated water contained in the Weasel Pit at K Basin as requested by the document in reference 1. Dose rates were calculated for sludge covered with water, where the source in the water source consists of either standing water or water that has been agitated by pumping. Figure 1 shows a diagram of the shielding configuration and the location of the dose points. The total depth of the sludge and water is 17 feet. The sludge depth was varied from 0 to 17 feet with water filling in on top of the sludge to maintain a constant sludge/water depth of 17 feet. Dose rates were calculated at 18 in. and 48 in. above the floor grate. The floor grate is 4 feet above the top of the water. All dose rate calculations were made using the Isoshld-PC computer code (Reference 2).

2.0 SUMMARY

Table 1 summarizes the dose rates at 18 in. above the grate. Table 2 summarizes the dose rates at 48 in. above the grate. When there is 6 feet or more of water above the sludge, the dose rate is dominated by the water source term which will produce a dose rate of 0.8 mrem/hr at 18 in. for standing water and a dose rate of 7 mrem/hr at 18 in. for agitated water. When the amount of water above the sludge is less than 6 feet, the sludge dose rates will start to dominate the dose rate. For the worst case conditions of 17 feet of sludge, the dose rate at 18 in. is 31.5 rem/hr and at 48 in. is 21.5 rem/hr.

Figure 2 shows a plot of the dose rates at 18 in. above the grate as a function of water depth. Both the individual contributions to the dose rate and the total sludge and water dose rate is plotted. Figure 3 shows a plot of the dose rates at 48 in. above the grate.

3.0 SOURCE

The source for the sludge was obtained from Table 4.3 of Reference 3. The mean values listed in this table was used for the sludge source. For cases where a mean value is not listed, the average of the maximum and minimum value was used. Table 3 lists the isotopic inventories (microcuries/cc) used for the sludge source. A density of 1.4 g/cc was used as listed in Table 4.2 of Reference 3 (density of 1.39 g/cc).

The source term for the water before and during the pumping of the water was obtained from Reference 4. Values were estimated from the histogram plots in this reference. The values for inside the Weasel Pit Screen were used. Table 4 lists the isotopic inventory (microcuries/cc) for the water before pumping. Table 5 lists the isotopic inventories while pumping (microcuries/cc).

It is conservatively assumed in Tables 3, 4 and 5 that the ^{137}Ba content is equal to the amount of ^{137}Cs . For Table 3 the ^{90}Y content is set equal to the ^{90}Sr content.

4.0 DOSE RATE AS A FUNCTION OF CESIUM 137 CONTENT IN THE WATER

Table 6 lists the dose rates at 18 in. and 48 in. as a function of ^{137}Cs content in the water. Figure 4 shows a plot of the dose rates presented in

Table 6. Notice that the dose rate scales with the ^{137}Cs content. Also shown in Figure 4 is the dose rate for both the standing water and agitated water (while pumping) at 18 in. above the grate. The water values are slightly higher than the 18 in. dose rate line because of other isotopes present in the water.

5.0 DOSE RATE FOR AN INFINITE WATER SOURCE

As an independent check, a dose rate calculation was made for a simulated infinite water source term. The source was modeled as 100,000 cm. by 100,000 cm. with a depth of 6 ft. The dose rate calculated at 18 in. was 3.05 mrem/hr and at 48 in. was 2.98 mrem/hr. This value compares well with current dose rate measurements above the K Basin water.

Notice that in Table 1, for 6 ft. of water, the dose rate is 0.768 mrem/hr. This dose rate is lower than the infinite case because of the dimensions of the Weasel Pit.

6.0 DOSE RATE CALCULATIONS

Table 7 lists summarizes all of the dose rate calculations made, the name of the input file and the Appendix that contains the input file.

The Weasel Pit was modeled as a rectangular solid with a width of 167.6 cm and a length of 995.7 cm. These dimensions are more conservative than the dimensions for the actual Weasel Pit which is irregularly shaped. In all cases, the dose rate is dominated by the ^{137}Cs . For the worst dose rate case of 17 ft. of sludge, 93 % of the dose rate is from ^{137}Cs .

7.0 REFERENCES

1. Memo, D. R. Precehtel to R. A. Schwarz, "Work Scope for the K Basin Weasel Pit Dose Rate Analysis," dated June 10, 1996.
2. P. D. Rittman, "ISO-PC Version 1.98 - User's Guide," WHC-SD-WM-UM-030, Rev. 0, 1995.
3. B. J. Makenas, editor, "Analysis of Sludge form Hanford K East Basin Floor and Weasel Pit," WHC-SP-1182, May 1996.
4. Memo, J. Mancilla, "KE Weasel Pit Water Sample Results," dated May 10, 1996.

Table 1. Dose Rate at 18 in. Above the Grate

Water depth (feet)	Sludge depth (feet)	Dose Rate (mrem/hr)				
		Water Before Pumping	Water During Pumping	Sludge	Water Before + Sludge	Water During + Sludge
17.0	0.00	7.68e-01	6.93e+00	0.00	7.68e-01	6.93e+00
8.5	8.50	7.68e-01	6.93e+00	2.96e-04	7.68e-01	6.93e+00
7.5	9.50	7.68e-01	6.93e+00	1.96e-03	7.70e-01	6.93e+00
6.5	10.50	7.68e-01	6.93e+00	1.47e-02	7.82e-01	6.94e+00
6.0	11.00	7.68e-01	6.93e+00	4.23e-02	8.10e-01	6.97e+00
5.5	11.50	7.68e-01	6.92e+00	1.25e-01	8.93e-01	7.05e+00
4.5	12.50	7.68e-01	6.92e+00	1.17e+00	1.94e+00	8.10e+00
3.5	13.50	7.67e-01	6.92e+00	1.18e+01	1.25e+01	1.87e+01
2.5	14.50	7.65e-01	6.89e+00	1.23e+02	1.23e+02	1.29e+02
1.5	15.50	7.36e-01	6.62e+00	1.28e+03	1.28e+03	1.29e+03
0.5	16.50	4.63e-01	4.15e+00	1.25e+04	1.25e+04	1.25e+04
0.0	17.00	0.00	0.00	3.15e+04	3.15e+04	3.15e+04

Table 2. Dose Rate at 48 in. Above the Grate

Water depth (feet)	Sludge depth (feet)	Dose Rate (mrem/hr)				
		Water Before Pumping	Water During Pumping	Sludge	Water Before + Sludge	Water During + Sludge
17.0	0.00	5.25e-01	4.73e+00	0.00	5.25e-01	4.73e+00
8.5	8.50	5.25e-01	4.73e+00	2.58e-04	5.25e-01	4.73e+00
7.5	9.50	5.25e-01	4.73e+00	1.69e-03	5.26e-01	4.73e+00
6.5	10.50	5.25e-01	4.73e+00	1.26e-02	5.37e-01	4.75e+00
6.0	11.00	5.25e-01	4.73e+00	3.60e-02	5.61e-01	4.77e+00
5.5	11.50	5.25e-01	4.73e+00	1.06e-01	6.30e-01	4.84e+00
4.5	12.50	5.25e-01	4.73e+00	9.78e-01	1.50e+00	5.71e+00
3.5	13.50	5.24e-01	4.73e+00	9.65e+00	1.02e+01	1.44e+01
2.5	14.50	5.22e-01	4.71e+00	9.83e+01	9.88e+01	1.03e+02
1.5	15.50	5.00e-01	4.50e+00	9.94e+02	9.95e+02	9.99e+02
0.5	16.50	3.03e-01	2.71e+00	9.04e+03	9.04e+03	9.04e+03
0.0	17.00	0.00	0.00	2.15e+04	2.15e+04	2.15e+04

Table 3. Sludge Source Term (microcuries/cc)

Isotope	Amount (microcuries/cc)
Co 60	9.43E-1
Sr 90	1.79E+2
Y 90 ¹	1.79E+2
Nb 94	2.31E-1
Ru 106	8.61E+0
Rh 106	8.61E+0
Sb 125	1.89E+0
Cs 134	4.61E-1
Cs 137	2.11E+2
Ba 137m ²	2.11E+2
Ce 144	5.90E+0
Pr 144	5.90E+0
Eu 152	3.58E-1
Eu 154	1.59E+0
Eu 155	7.19E-1
Bi 212	1.81E+0
Ra 226	1.13E+1
U 233	2.03E-2
U 234	2.44E-2
U 235	7.91E-4
U 238	1.73E-2
Np 237	1.41E-3
Pu 238	8.62E-1
Pu 239	8.88E+0
Pu 240	8.88E+0
Am 241	8.98E+0
Cm 243	6.46E+0
Cm 244	6.46E+0
Total	

¹ Assumed equal to ⁹⁰Sr
² Assumed equal to ¹³⁷Cs

Table 4. Source Term for Water Before Pumping (microcuries/cc)

Isotope	Amount (microcuries/cc)
Co 60	1.0E-5
Cs 134	1.2E-6
Cs 137	4.0E-3
Ba 137m ¹	4.0E-3
Eu 154	1.0E-5
Eu 155	1.0E-5
Total	8.0E-3

¹ Assumed equal to ¹³⁷Cs

Table 5. Source Term for Water While Pumping (microcuries/cc)

Isotope	Amount (microcuries/cc)
Co 60	6.4E-4
Cs 134	5.8E-6
Cs 137	3.3E-2
Ba 137m ¹	3.3E-2
Eu 154	6.9E-4
Eu 155	5.0E-4
Total	7.6E-2

¹ Assumed equal to ¹³⁷Cs

Table 6. Dose Rate as a function of Cs 137 content.

Amount of ¹³⁷ Cs (microcuries/L)	Dose Rate (mrem/hr)	
	18 in.	48 in.
1	0.020	0.014
10	1.90	1.30
20	3.80	2.59
30	5.69	3.89
40	7.58	5.18
50	9.47	6.47
60	11.4	7.76
70	13.3	9.06
80	15.2	10.4
90	17.0	11.6
100	18.9	12.9

Table 7. Isoshld-PC Input Files.

File Name	Description	Appendix
water.in	Dose rates from water before pumping. Water depth varied from 0.5 ft. to 17 ft.	A
pump.in	Dose rates from water while pumping. Water depth varied from 0.5 ft. to 7 ft.	B
sldg.in	Dose rates from the sludge with a water shield above the sludge. Sludge depth varied from 8.5 ft. to 16.5 ft.	C
allsldg.in	Dose rates from 17 ft. of sludge.	D
waterinf.in	Dose Rates from a 100,000 cm. by 1000,000 cm. water source.	E
cstrange.in	Dose rate as a function of ¹³⁷ Cs content. ¹³⁷ Cs varied from 1 microcurie/L to 100 microcuries/L.	F

Figure 1. Figure Showing Shielding Configuration and Dose Points

Figure 2. Dose Rates at 18 in. Above the Grate.

Figure 3. Dose Rates at 48 in. Above the Grate.

Figure 4. Dose Rate as a Function of Cesium Content.

Appendix A. Isoshld-PC input file water.in

```

0      2 Dose Rate for K basin water, before pumping
17 feet of water
&Input Next= 1, Option= 1, Dunit=1, Iconc=1,
  Igeom= 10, Slth= 995.68, Y=167.64,
  Npsi=17, Ntheta= 100, Delr= 5, X(1)= 685.8, 762,
  Nshld= 1, Jbuf= 1, T(1)= 518.16,
  Weight(472)=.00001,
  Weight(319)=.0000012,
  Weight(335)=0.004, Weight(336)=0.004,
  Weight(415)=0.00001, Weight(418)=0.00001 &
1 Water 1 1.0
8.5 feet of water
&Input Next= 4, T(1)=259.08, X(1)=426.72, 502.92 &
7.5 feet of water
&Input Next= 4, T(1)=228.6, X(1)=396.24, 472.44 &
6.5 feet of water
&Input Next= 4, T(1)=198.12, X(1)=365.76, 441.96 &
6.0 feet of water
&Input Next= 4, T(1)=182.88, X(1)=350.52, 426.72 &
5.5 feet of water
&Input Next= 4, T(1)=167.64, X(1)=335.28, 411.48 &
4.5 feet of water
&Input Next= 4, T(1)=137.16, X(1)=304.8, 381.0 &
3.5 feet of water
&Input Next= 4, T(1)=106.68, X(1)=274.32, 350.52 &
2.5 feet of water
&Input Next= 4, T(1)=76.2, X(1)=243.84, 320.04 &
1.5 feet of water
&Input Next= 4, T(1)=45.72, X(1)=213.36, 289.56 &
0.5 feet of water
&Input Next= 4, T(1)=15.24, X(1)=182.88, 259.08 &
END OF RUN
&Input Next= 6 &

```


Appendix B. Isoshld-PC input file pump.in

```

0      2 Dose Rate for K basin water, while pumping
17 feet of water
&Input Next= 1, Option= 1, Dunit=1, lconc=1,
  Igeom= 10, S1th= 995.68, Y=167.64,
  Npsi=17, Ntheta= 100, Delr=5, X(1)= 685.8, 762,
  Nshld= 1, Jbuf= 1, T(1)= 518.16,
  Weight(472)=0.00064,
  Weight(319)=.0000058,
  Weight(335)=0.033, Weight(336)=0.033,
  Weight(415)=0.00069, Weight(418)=0.0005 &
1 Water 1 1.0
8.5 feet of water
&Input Next= 4, T(1)=259.08, X(1)=426.72, 502.92 &
7.5 feet of water
&Input Next= 4, T(1)=228.6, X(1)=396.24, 472.44 &
6.5 feet of water
&Input Next= 4, T(1)=198.12, X(1)=365.76, 441.96 &
6.0 feet of water
&Input Next= 4, T(1)=182.88, X(1)=350.52, 426.72 &
5.5 feet of water
&Input Next= 4, T(1)=167.64, X(1)=335.28, 411.48 &
4.5 feet of water
&Input Next= 4, T(1)=137.16, X(1)=304.8, 381.0 &
3.5 feet of water
&Input Next= 4, T(1)=106.68, X(1)=274.32, 350.52 &
2.5 feet of water
&Input Next= 4, T(1)=76.2, X(1)=243.84, 320.04 &
1.5 feet of water
&Input Next= 4, T(1)=45.72, X(1)=213.36, 289.56 &
0.5 feet of water
&Input Next= 4, T(1)=15.24, X(1)=182.88, 259.08 &
END OF RUN
&Input Next= 6 &

```

Appendix C. Isoshld-PC input file slgd.in

```
0      2 Dose Rate for sludge, buildup in water
```

```
8.5 feet of sludge
```

```
&Input Next= 1, Option= 1, Dunit=1, Iconc=1,
Igeom= 10, Slth= 995.68, Y=167.64,
Npsi=17, Ntheta= 100, Delr= 5, X(1)= 685.8, 762,
Nshld= 2, Jbuf= 2, T(1)=259.08, T(2)=259.08
Weight(472)=.943,
Weight(335)=211, Weight(336)=211,
Weight(319)=0.461,
Weight(415)=1.59,
Weight(418)=0.719,
Weight(376)=5.897, Weight(377)=5.897,
Weight(111)=0.231,
Weight(170)=8.614, Weight(172)=8.614,
Weight(485)=11.3,
Weight(525)=1.81,
Weight(408)=0.358,
Weight(269)=1.89,
Weight(496)=8.98,
Weight(493)=8.88, Weight(494)=8.88,
Weight(492)=0.862,
Weight(502)=0.00141,
Weight(506)=6.46, Weight(500)=6.46,
Weight(82) =179, Weight(84) =179,
Weight(519)=2.03e-2,
Weight(520)=2.44e-2,
Weight(476)=7.91e-4,
Weight(526)=1.73e-2 &
```

```
1 Water 1 1.4 1.0
```

```
9.5 feet of sludge
```

```
&Input Next= 4, T(1)=289.56, T(2)=228.60 &
```

```
10.5 feet of sludge
```

```
&Input Next= 4, T(1)=320.04, T(2)=198.12 &
```

```
11.0 feet of sludge
```

```
&Input Next= 4, T(1)=335.28, T(2)=182.88 &
```

```
11.5 feet of sludge
```

```
&Input Next= 4, T(1)=350.52, T(2)=167.64 &
```

```
12.5 feet of sludge
```

```
&Input Next= 4, T(1)=381.00, T(2)=137.16 &
```

```
13.5 feet of sludge
```

```
&Input Next= 4, T(1)=411.48, T(2)=106.68 &
```

```
14.5 feet of sludge
```

```
&Input Next= 4, T(1)=441.96, T(2)= 76.20 &
```

```
15.5 feet of sludge
```

```
&Input Next= 4, T(1)=472.44, T(2)= 45.72 &
```

```
16.5 feet of sludge
```

```
&Input Next= 4, T(1)=502.92, T(2)= 15.24 &
```

```
END OF RUN
```

```
&Input Next= 6 &
```

Appendix D. Isoshld-PC input file allslgd.in

```

0      2 Dose Rate for sludge, buildup in water
17 feet of sludge
&Input Next= 1, Option= 1, Dunit=1, Iconc=1,
  Igeom= 10, S1th= 995.68, Y=167.64,
  Npsi=20, Ntheta= 100, Delr=5, X(1)= 685.8, 762,
  Nshld= 1, Jbuf= 1, T(1)=518.16
  Weight(472)=.943,
  Weight(335)=211, Weight(336)=211,
  Weight(319)=0.461,
  Weight(415)=1.59,
  Weight(418)=0.719,
  Weight(376)=5.897, Weight(377)=5.897,
  Weight(111)=0.231,
  Weight(170)=8.614, Weight(172)=8.614,
  Weight(485)=11.3,
  Weight(525)=1.81,
  Weight(408)=0.358,
  Weight(269)=1.89,
  Weight(496)=8.98,
  Weight(493)=8.88, Weight(494)=8.88,
  Weight(492)=0.862,
  Weight(502)=0.00141,
  Weight(506)=6.46, Weight(500)=6.46,
  Weight(82) =179, Weight(84) =179,
  Weight(519)=2.03e-2,
  Weight(520)=2.44e-2,
  Weight(476)=7.91e-4,
  Weight(526)=1.73e-2 &
1 Water 1 1.4
END OF RUN
&Input Next= 6 &

```

Appendix E. Isoshld-PC input file waterinf.in

```
0      2 Dose Rate for K basin water, 10000 by 10000
17 feet of water
&Input Next= 1, Option= 1, Dunit=1, Iconc=1,
  Igeom= 10, Slth= 100000, Y=100000,
  Npsi=1000, Ntheta= 1000, Delr= 5, X(1)= 350.52, 425.82,
  Nshld= 1, Jbuf= 1, T(1)= 182.88,
  Weight(472)=.00001,
  Weight(319)=.0000012,
  Weight(335)=0.004, Weight(336)=0.004,
  Weight(415)=0.00001, Weight(418)=0.00001 &
1 Water 1 1.0
END OF RUN
&Input Next= 6 &
```

Appendix F. Isoshld-PC input file csrange.in

```

0      2 Dose Rate for K basin water, before pumping
17 feet of water - 1 microcurie/Liter
&Input Next= 1, Option= 1, Dunit=1, Iconc=1,
Igeom= 10, S1th= 995.68, Y=167.64,
Npsi=17, Ntheta= 100, Delr= 5, X(1)= 685.8, 762,
Nshld= 1, Jbuf= 1, T(1)= 518.16,
Weight(472)=.00001,
Weight(319)=.0000012,
Weight(335)=0.001, Weight(336)=0.001,
Weight(415)=0.00001, Weight(418)=0.00001 &
1 Water 1 1.0
17 feet of water - 10 microcurie/Liter
&Input Next= 4, Weight(335)=0.01, Weight(336)=0.01 &
17 feet of water - 20 microcurie/Liter
&Input Next= 4, Weight(335)=0.02, Weight(336)=0.02 &
17 feet of water - 30 microcurie/Liter
&Input Next= 4, Weight(335)=0.03, Weight(336)=0.03 &
17 feet of water - 40 microcurie/Liter
&Input Next= 4, Weight(335)=0.04, Weight(336)=0.04 &
17 feet of water - 50 microcurie/Liter
&Input Next= 4, Weight(335)=0.05, Weight(336)=0.05 &
17 feet of water - 60 microcurie/Liter
&Input Next= 4, Weight(335)=0.06, Weight(336)=0.06 &
17 feet of water - 70 microcurie/Liter
&Input Next= 4, Weight(335)=0.07, Weight(336)=0.07 &
17 feet of water - 80 microcurie/Liter
&Input Next= 4, Weight(335)=0.08, Weight(336)=0.08 &
17 feet of water - 90 microcurie/Liter
&Input Next= 4, Weight(335)=0.09, Weight(336)=0.09 &
17 feet of water - 100 microcurie/Liter
&Input Next= 4, Weight(335)=0.1, Weight(336)=0.1 &
END OF RUN
&Input Next= 6 &

```

CHECKLIST FOR INDEPENDENT TECHNICAL REVIEW

NUMBER: 8M730-RAS-96-005

DOCUMENT REVIEWED Dose Rates in the K Basin Weasel Pit

AUTHOR(s) R. A. Schwarz

I. Method(s) of Review

- (✓) Input data checked for accuracy
- (✓) Independent calculation performed
 - () Hand calculation
 - (✓) Alternate computer code: MCNP POINT KERNAL, MICROSHIELD
- () Comparison to experiment or previous results
- () Alternate method (define) _____

II. Checklist (either check or enter NA if not applied)

- (✓) Task completely defined
- (✓) Activity consistent with task specification
- (✓) Necessary assumptions explicitly stated and supported
- (✓) Resources properly identified and referenced
- (✓) Resource documentation appropriate for this application
- (✓) Input data explicitly stated
- (✓) Input data verified to be consistent with original source
- (✓) Geometric model adequate representation of actual geometry
- (✓) Material properties appropriate and reasonable
- (NA) Mathematical derivations checked including dimensional consistency
- (NA) Hand calculations checked for errors
- (✓) Assumptions explicitly stated and justified
- (✓) Computer software appropriate for task and used within range of validity
- (NA) Use of resource outside range of established validity is justified
- (✓) Software runstreams correct and consistent with results
- (✓) Software output consistent with input
- (NA) Results consistent with applicable previous experimental or analytical findings
- (✓) Results and conclusions address all points and are consistent with task requirements and/or established limits or criteria
- (NA) Conclusions consistent with analytical results and established limits
- (NA) Uncertainty assesment appropriate and reasonable
- () Other (define) _____

III. Comments:

IV. REVIEWER:

Victor Roetman

DATE: 17 July 1996

APPENDIX C
SLUDGE PIPING DOSE RATES
R. A. Schwarz

**Westinghouse
Hanford Company****Internal
Memo**

From: Criticality and Shielding
Phone: 376-5977 H0-35
Date: August 5, 1996
Subject: DOSE RATES FOR SLUDGE INSIDE A PIPE

8M730-RAS-96-006

To: D. R. Precechtel ~~X3-85~~ R3-48

cc: C. J. Alderman R3-48
K. H. Bergsman R3-48
J. Greenberg H0-35
G. S. Hunacek X3-79
T. D. Merkling R3-09
F. W. Moore X3-85
F. J. Muller X3-85
A. L. Ramble A3-38
D. L. Schifferl X3-74
RAS File/LB H0-35

Attached is the dose rate calculation for sludge contained in a pipe. Also attached to this document is the review checklist for the shielding analysis that has been filled out by the reviewer. It is understood that this information will be placed directly into a supporting document without any changes.

R. A. Schwarz
Advanced Scientist

Concurrence:

J. Greenberg, Manager

11p

Attachments

Dose Rates for Sludge inside a Pipe

R. A. Schwarz

August 1996

1.0 INTRODUCTION

Dose rate calculations have been made for K Basin sludge contained inside a pipe as requested by the document in reference 1. Dose rates were calculated for a plastic pipe filled with sludge located underneath a water shield and for sludge inside a metal pipe. The pipe was assumed to have a length of 1000 cm to approximate an infinite pipe source term. Figure 1 shows a diagram of the different source and shielding configurations and the location of the dose points.

For the plastic pipe located under the water, the diameter of the source pipe was varied between 1, 1.5, and 2 inches. This pipe was then positioned at different depths within the water. The water depth was varied between 0.5, 1.0, 1.5, 2.0, 3.0 feet. Above the water is a 4 foot air gap representing the region between the water and the floor grating. Dose rates were then calculated at 18 in. and 48 in. above the floor grate.

For the steel pipe, the diameter of the source pipe was varied between 1, 1.5, and 2 inches. The steel pipe was then varied between 2.375, 3.5, and 4.5 inches O.D. with different pipe thicknesses analyzed for each pipe. For a pipe with an O.D. of 2.375 inches, the thickness of the pipe was 0.154, 0.218, 0.343, or 0.436 inches. For a pipe with an O.D. of 3.5 inches, the thickness of the pipe was 0.216, 0.300, 0.438, or 0.600 inches. For a pipe with an O.D. of 4.5 inches, the thickness of the pipe was 0.237, 0.337, 0.438, 0.531, or 0.674 inches. For each pipe analyzed, the dose rate was calculated at the surface and at 0.5 meters and 1 meter above the center of the pipe.

All dose rate calculations were made using the Isoshld-PC computer code (Reference 2).

2.0 SUMMARY

A dose rate of 0.5 mrem/hr is the target dose rate that must be achieved. For a plastic pipe under water, the dose rate will be less than or equal to 0.52 mrem/hr (2.0 in. sludge source, 18 in. above the grate) when 3 feet of water is covering the pipe.

The dose rate for sludge in a metal pipe will be significantly greater than 0.5 mrem/hr. The minimum surface dose rate is 753 mrem/hr. The minimum dose rate at 0.5 meters is 648 mrem/hr. The minimum dose rate at 1 meter is 50.1 mrem/hr.

To further reduce the dose rates for the metal pipes, additional lead shielding must be placed around the pipe. 7.5 to 10 cm of lead will be required to reduce the dose rate to less than 0.5 mrem/hr at 0.5 and 1 meter above the pipe.

3.0 SOURCE

The source for the sludge was obtained from Table 4.3 of Reference 3. The source is the same as that used for the dose rate calculations reported in Reference 4. A density of 1.4 g/cc was used for the sludge density. The water used as a shield for the results in Tables 1 and 2 is assumed to be non-radioactive.

4.0 DOSE RATES FOR A PLASTIC PIPE UNDER WATER

Table 1 summarizes the dose rates at 18 in. above the grate for the plastic pipe. Table 2 summarizes the dose rates at 48 in. above the grate for the plastic pipe. To keep the dose rate less than 0.5 mrem/hr at 18 in., the depth of water above the pipe must be at least 3.0 ft. Even with 3.0 ft. of water the dose rate is 0.521 mrem/hr for a source pipe with a diameter of 2.0 in.

Figure 2 shows a log plot of the dose rates presented in Table 1. The dose rate as a function of water thickness is linear on a log scale. As can be seen from this graph and the data from Tables 1 and 2, the dose rate is reduced by about a factor of 10 for every foot of water added as a shield above the pipe. Using this relationship, it is possible to determine the dose rate as a function of the depth of water for water depths not included in Tables 1 and 2. The relationship between dose rate and water depth is given by the following equation.

$$D_2 = 10^{\log(D_1) - 0.97(t_2 - t_1)}$$

where:

D_2 = The dose rate you want to determine (mrem/hr).

D_1 = The known dose rate (mrem/hr) from Table 1 or 2.

t_1 = The water depth (ft.) for D_1 .

t_2 = The water depth (ft.) for which you want the dose rate.

0.97 = Average constant derived from the slope of the lines in

Figure 2. Actual values vary from 0.96 to 0.98.

For example given that the dose rate for a 2.0 in sludge pipe inside under 1 ft. of water is 52.7 at 18 in. (Table 1), the above equation can be used to estimate the dose rate for a pipe under 3 ft. of water.

$$10^{\log(52.7) - 0.97(3 - 1)} = 0.605$$

This value compares well with the 0.521 mrem/hr value from Table 1. The dose half thickness of water is about 0.31 feet.

Furthermore, since all of the lines shown in Figure 2 have approximately the same slope, the dose rate for different sludge pipe diameters differs by a single scaling factor. This scaling factor is approximately equal to the ratio of the cross sectional areas of the source pipe. In going from a 1.0 in. sludge pipe to a 1.5 in. sludge pipe the dose rate is increased by a factor of 2.2 ($.75^2/.5^2=2.25$). In going from a 1.0 in. sludge pipe to a 2.0 in. sludge pipe, the dose rate is increased by a factor of 3.9 ($1^2/.5^2=4.0$). This relationship also shows that the dose rates are roughly proportional to the source term (implying little self shielding in the sludge) so the dose rates are proportional to the amount of sludge in the pipe.

5.0 DOSE RATES FOR A STEEL PIPE

Table 3 lists the surface dose rates calculated for a steel pipe surrounding a sludge pipe. Three different steel pipes (2.375, 3.5, 4.5 in. O.D.) were used with the three different source terms (1.0, 1.5, 2.0 in. O.D. sludge pipe). The values for a 2.0 in. sludge pipe with a 2.375 in. steel pipe are not

entered for a thickness of .218, .343, and .436 in. because the inside diameter of these pipes is not large enough to hold a 2.0 in. sludge pipe.

Figure 3 shows a log plot of the surface dose rate as a function of steel thickness. This is a graphical representation of the information provided in Table 3. The change in dose rate as a function of steel thickness is a straight line when displayed on a log plot.

Table 4 lists the dose rate at 0.5 meters above the center of the pipe. Figure 4 shows a log plot of the dose rate at 0.5 meters above a metal pipe. This is a graphical representation of the information provided in Table 4. Notice that the dose rate as a function of steel thickness for each source all lie on the same line. This was not true for the surface dose rate because the dose point is much closer to the source and the source geometry will affect the surface dose rate.

Table 5 lists the dose rate at 1 meter above the center of the pipe. Figure 5 shows a log plot of the dose rate at 1 meter above the steel pipe. This is a graphical representation of the information provided in Table 5. Notice that the dose rate as a function of steel thickness for each source lie on the same line when plotted on a log scale.

Because the slope of the lines in Figures 3, 4, and 5 are the same, an equation can be developed that will predict the dose rate for an arbitrary steel thickness given a dose rate for a steel thickness that is include in Tables 3 through 5:

$$D_2 = 10^{[\log(D_1) - 0.45(t_2 - t_1)]}$$

where:

D_2 = The dose rate you want to determine (mrem/hr)

D_1 = The known dose rate (mrem/hr) from Table 3, 4 or 5.

t_1 = The steel thickness (in.) for D_1 .

t_2 = The steel thickness (in.) for which you want the dose rate.

0.45 = Average constant derived from the slope of the lines in

Figures 3, 4 and 5. Actual values vary from 0.42 to 0.49.

For example given that the dose rate for a 2.0 in sludge pipe inside a .216 in. thick steel pipe is 608 (Table 4), the above equation can be used to estimate the dose rate for a 0.6 in. thick pipe.

$$10^{[\log(608) - 0.45*(.6 - .216)]} = 408$$

This value compares well with the 399 mrem/hr value from Table 4. The dose half thickness for steel is about 0.67 in.

6.0 DOSE RATES FOR A STEEL PIPE WITH LEAD SHIELDING ADDED

All of the dose rates presented in Table 3 through 5 are above the 0.5 mrem/hr desirable dose rate. To reduce these dose rates, a lead shield can be added to the steel pipe. Table 6 lists the amount of lead required to reduce the dose rate for each pipe to less than 0.5 mrem/hr. The minimum steel thickness was used for each pipe since this will bound the other thicknesses. The lead

shield was determined to the nearest 0.5 centimeters. Included in Table 6 is the dose rate calculated at 0.5 and 1 meter when the lead shield is in place. All of these values are equal to or less than 0.5 mrem/hr. The dose half thickness of lead is about 1.2 cm.

7.0 DOSE RATE CALCULATIONS

Table 7 summarizes all of the dose rate calculations made and includes the name of the input file and the Appendix that contains the input file.

8.0 REFERENCES

1. Memo, D. R. Precechtel to R. A. Schwarz, "Work Scope for the K Basin Weasel Pit Dose Rate Analysis," dated June 10, 1996.
2. P. D. Rittman, "ISO-PC Version 1.98 - User's Guide," WHC-SD-WM-UM-030, Rev. 0, 1995.
3. B. J. Makenas, editor, "Analysis of Sludge from Hanford K East Basin Floor and Weasel Pit," WHC-SP-1182, May 1996.
4. Memo, R. A. Schwarz to D. R. Precechtel, "Dose Rates in the K Basin Weasel Pit," 8M730-RAS-96-005, dated July 17, 1996.

Table 1. Dose Rates (mrem/hr) 18 in. Above the Grate for a Pipe Under Water

Water depth (ft.)	Pipe Diameter		
	1.0 in.	1.5 in.	2.0 in.
0.50	3.79e+01	8.44e+01	1.48e+02
1.00	1.35e+01	3.00e+01	5.27e+01
1.50	4.40e+00	9.78e+00	1.72e+01
2.00	1.39e+00	3.08e+00	5.42e+00
3.00	1.34e-01	2.97e-01	5.21e-01

Table 2. Dose Rates (mrem/hr) 48 in. Above the Grate for a Pipe Under Water

Water depth (ft.)	Pipe Diameter		
	1.0 in.	1.5 in.	2.0 in.
0.50	2.55e+01	5.68e+01	1.00e+02
1.00	9.55e+00	2.13e+01	3.74e+01
1.50	3.21e+00	7.13e+00	1.25e+01
2.00	1.03e+00	2.29e+00	4.03e+00
3.00	1.03e-01	2.28e-01	4.00e-01

Table 3. Surface Dose Rates (mrem/hr) for a Metal Pipe.

Shield Pipe Dimensions	Sludge Pipe Diameter		
	1.0 in.	1.5 in.	2.0 in.
2.375 in. O.D., 0.154 in. thick	2.23e+03	4.88e+03	8.51e+03
2.735 in. O.D., 0.218 in. thick	2.09e+03	4.56e+03	-----
2.375 in. O.D., 0.343 in. thick	1.83e+03	3.98e+03	-----
2.375 in. O.D., 0.436 in. thick	1.65e+03	3.58e+03	-----
3.5 in. O.D., 0.216 in. thick	1.54e+03	3.33e+03	5.73e+03
3.5 in. O.D., 0.300 in. thick	1.41e+03	3.05e+03	5.22e+03
3.5 in. O.D., 0.438 in. thick	1.21e+03	2.62e+03	4.47e+03
3.5 in. O.D., 0.600 in. thick	1.01e+03	2.18e+03	3.71e+03
4.5 in. O.D., 0.237 in. thick	1.22e+03	2.63e+03	4.51e+03
4.5 in. O.D., 0.337 in. thick	1.10e+03	2.36e+03	4.04e+03
4.5 in. O.D., 0.438 in. thick	9.81e+02	2.11e+03	3.61e+03
4.5 in. O.D., 0.531 in. thick	8.85e+02	1.91e+03	3.24e+03
4.5 in. O.D., 0.674 in. thick	7.53e+02	1.62e+03	2.75e+03

Table 4. Dose Rates (mrem/hr) at 0.5 Meters above a Metal Pipe.

Shield Pipe Dimensions	Sludge Pipe Diameter		
	1.0 in.	1.5 in.	2.0 in.
2.375 in. O.D., 0.154 in. thick	1.76e+02	3.80e+02	6.48e+02
2.375 in. O.D., 0.218 in. thick	1.66e+02	3.57e+02	-----
2.375 in. O.D., 0.343 in. thick	1.45e+02	3.12e+02	-----
2.375 in. O.D., 0.436 in. thick	1.31e+02	2.82e+02	-----
3.5 in. O.D., 0.216 in. thick	1.66e+02	3.57e+02	6.08e+02
3.5 in. O.D., 0.300 in. thick	1.52e+02	3.27e+02	5.56e+02
3.5 in. O.D., 0.438 in. thick	1.31e+02	2.82e+02	4.79e+02
3.5 in. O.D., 0.600 in. thick	1.10e+02	2.35e+02	3.99e+02
4.5 in. O.D., 0.237 in. thick	1.62e+02	3.50e+02	5.95e+02
4.5 in. O.D., 0.337 in. thick	1.46e+02	3.14e+02	5.35e+02
4.5 in. O.D., 0.438 in. thick	1.31e+02	2.82e+02	4.79e+02
4.5 in. O.D., 0.531 in. thick	1.18e+02	2.54e+02	4.31e+02
4.5 in. O.D., 0.674 in. thick	1.01e+02	2.16e+02	3.67e+02

Table 5. Dose Rates (mrem/hr) at 1 Meter above a Metal Pipe.

Shield Pipe Dimensions	Sludge Pipe Diameter		
	1.0 in.	1.5 in.	2.0 in.
2.375 in. O.D., 0.154 in. thick	8.55e+01	1.85e+02	3.17e+02
2.375 in. O.D., 0.218 in. thick	8.09e+01	1.75e+02	-----
2.375 in. O.D., 0.343 in. thick	7.17e+01	1.55e+02	-----
2.375 in. O.D., 0.436 in. thick	6.51e+01	1.40e+02	-----
3.5 in. O.D., 0.216 in. thick	8.11e+01	1.75e+02	2.99e+02
3.5 in. O.D., 0.300 in. thick	7.49e+01	1.61e+02	2.75e+02
3.5 in. O.D., 0.438 in. thick	6.50e+01	1.40e+02	2.37e+02
3.5 in. O.D., 0.600 in. thick	5.45e+01	1.17e+02	1.98e+02
4.5 in. O.D., 0.237 in. thick	7.95e+01	1.72e+02	2.93e+02
4.5 in. O.D., 0.337 in. thick	7.22e+01	1.55e+02	2.65e+02
4.5 in. O.D., 0.438 in. thick	6.50e+01	1.40e+02	2.37e+02
4.5 in. O.D., 0.531 in. thick	5.88e+01	1.26e+02	2.14e+02
4.5 in. O.D., 0.674 in. thick	5.01e+01	1.08e+02	1.82e+02

Table 6. Lead Thickness required to Reduce Dose Rate to Less than 0.5 mrem/hr

Shield Pipe Dimensions	0.5 meters		1 meter	
	Lead thick (cm)	dose rate (mrem/hr)	Lead thick (cm)	dose rate (mrem/hr)
2.375 in. O.D., 0.154 in. thick, 1.0 in. O.D. Sludge Pipe	8.50	0.37	7.50	0.42
2.375 in. O.D., 0.154 in. thick, 1.5 in. O.D. Sludge Pipe	9.50	0.34	8.50	0.39
2.375 in. O.D., 0.154 in. thick, 2.0 in. O.D. Sludge Pipe	10.00	0.38	9.00	0.44
3.5 in. O.D., 0.216 in. thick, 1.0 in. O.D. Sludge Pipe	8.50	0.34	7.50	0.39
3.5 in. O.D., 0.216 in. thick, 1.5 in. O.D. Sludge Pipe	9.00	0.48	8.50	0.36
3.5 in. O.D., 0.216 in. thick, 2.0 in. O.D. Sludge Pipe	10.00	0.35	9.00	0.40
4.5 in. O.D., 0.237 in. thick, 1.0 in. O.D. Sludge Pipe	8.00	0.50	7.50	0.38
4.5 in. O.D., 0.237 in. thick, 1.5 in. O.D. Sludge Pipe	9.00	0.47	8.50	0.35
4.5 in. O.D., 0.237 in. thick, 2.0 in. O.D. Sludge Pipe	10.00	0.34	9.00	0.39

Table 7. Isoshld-PC Input Files.

File Name	Description	Appendix
pipesldg.in	Dose rates for a plastic pipe under water. Inner sludge pipe diameter of 1.0, 1.5, and 2.0 in., water depth of 0.5, 1.0, 1.5, 2.0, and 3.0 ft.	A
metal.in	Dose rates from a metal pipe. Inner sludge pipe diameter of 1.0, 1.5, and 2.0 in., metal pipe O.D. of 2.375, 3.5, and 4.5 in.	B
lead1.in	Dose rates 1.0 meter from a metal pipe with a lead shield added. Inner sludge pipe diameter of 1.0, 1.5, and 2.0 in., steel pipe O.D. of 2.375 in., 0.154 in. thick, lead thickness varied from 7.5 cm to 10 cm to reduce dose rate to less than 0.5 mrem/hr.	C
leadhalf.in	Same as leadhalf.in for dose rates at 1.0 meters above the center of the metal pipe.	D

Figure 1. Shielding Configuration and Dose Points

Figure 2. Dose Rates (mrem/hr) for a Pipe Under Water

Figure 3. Surface Dose Rates (mrme/hr) for a Steel Pipe.

Figure 4. Dose Rates (mrem/hr) at 0.5 Meters from a Steel Pipe.

Figure 5. Dose Rates (mrem/hr) at 1.0 Meters from a Steel Pipe.

Appendix A. ISOSHL-PC Input File pipesldg.in

```

0      2 Dose Rate for sludge in pipe under water
1.0 in. pipe, 0.5 ft. of water
&Input Next= 1, Option= 1, Dunit=1, Iconc=1,
Igeom= 8, Slth= 1000, Y=500,
Npsi=100, Ntheta= 100, Delr= 0.1, X(1)= 182.88, 259.08,
Nshld= 2, Jbuf= 2, T(1)=1.27, T(2)=13.97
Weight(472)=.943,
Weight(335)=211, Weight(336)=211,
Weight(319)=0.461,
Weight(415)=1.59,
Weight(418)=0.719,
Weight(376)=5.897, Weight(377)=5.897,
Weight(111)=0.231,
Weight(170)=8.614, Weight(172)=8.614,
Weight(485)=11.3,
Weight(525)=1.81,
Weight(408)=0.358,
Weight(269)=1.89,
Weight(496)=8.98,
Weight(493)=8.88, Weight(494)=8.88,
Weight(492)=0.862,
Weight(502)=0.00141,
Weight(506)=6.46, Weight(500)=6.46,
Weight(82) =179, Weight(84) =179,
Weight(519)=2.03e-2,
Weight(520)=2.44e-2,
Weight(476)=7.91e-4,
Weight(526)=1.73e-2 &
1 Water 1 1.4 1.0
1.5 in. pipe, 0.5 ft. of water
&Input Next= 4, T(1)=1.905, T(2)=13.335 &
2.0 in. pipe, 0.5 ft. of water
&Input Next= 4, T(1)=2.54, T(2)=12.7 &
1.0 in. pipe, 1.0 ft. of water
&Input Next= 4, T(1)=1.27, T(2)=29.21, X(1)=198.12, 274.32 &
1.5 in. pipe, 1.0 ft. of water
&Input Next= 4, T(1)=1.905, T(2)=28.575 &
2.0 in. pipe, 1.0 ft. of water
&Input Next= 4, T(1)=2.54, T(2)=27.94 &
1.0 in. pipe, 1.5 ft. of water
&Input Next= 4, T(1)=1.27, T(2)=44.45, X(1)=213.36, 289.56 &
1.5 in. pipe, 1.5 ft. of water
&Input Next= 4, T(1)=1.905, T(2)=43.815 &
2.0 in. pipe, 1.5 ft. of water
&Input Next= 4, T(1)=2.54, T(2)=43.18 &
1.0 in. pipe, 2.0 ft. of water
&Input Next= 4, T(1)=1.27, T(2)=59.69, X(1)=228.6, 304.8 &
1.5 in. pipe, 2.0 ft. of water
&Input Next= 4, T(1)=1.905, T(2)=59.055 &
2.0 in. pipe, 2.0 ft. of water
&Input Next= 4, T(1)=2.54, T(2)=58.42 &
1.0 in. pipe, 3.0 ft. of water
&Input Next= 4, T(1)=1.27, T(2)=90.17, X(1)=259.08, 335.28 &
1.5 in. pipe, 3.0 ft. of water
&Input Next= 4, T(1)=1.905, T(2)=89.535 &
2.0 in. pipe, 3.0 ft. of water
&Input Next= 4, T(1)=2.54, T(2)=88.9 &
END OF RUN
&Input Next= 6 &

```


Appendix B. ISOSHLD-PC Input File metal.in

```

0      2 Dose Rate for sludge in METAL pipe
1.0 in. pipe, 2.375 in. OD, .154 in. thick
&Input Next= 1, Option=1, Dunit=1, Iconc=1,
  Igeom= 8, Slth= 1000, Y=500,
  Npsi=100, Ntheta= 100, Delr= 0.1, X(1)= 4.02, 50, 100,
  Nshld= 3, Jbuf= 3, T(1)=1.27, T(2)=1.3551, T(3)=0.3912,
  Weight(472)=.943,
  Weight(335)=211, Weight(336)=211,
  Weight(319)=0.461,
  Weight(415)=1.59,
  Weight(418)=0.719,
  Weight(376)=5.897, Weight(377)=5.897,
  Weight(111)=0.231,
  Weight(170)=8.614, Weight(172)=8.614,
  Weight(485)=11.3,
  Weight(525)=1.81,
  Weight(408)=0.358,
  Weight(269)=1.89,
  Weight(496)=8.98,
  Weight(493)=8.88, Weight(494)=8.88,
  Weight(492)=0.862,
  Weight(502)=0.00141,
  Weight(506)=6.46, Weight(500)=6.46,
  Weight(82) =179, Weight(84) =179,
  Weight(519)=2.03e-2,
  Weight(520)=2.44e-2,
  Weight(476)=7.91e-4,
  Weight(526)=1.73e-2 &
Water 1 1.4
Air 3 0.00129
1 Iron 9 7.86
1.0 in. pipe, 2.375 in. OD, .218 in. thick
&Input Next= 4, T(2)=1.1925, T(3)=0.5537 &
1.0 in. pipe, 2.375 in. OD, .343 in. thick
&Input Next= 4, T(2)=0.875, T(3)=0.8712 &
1.0 in. pipe, 2.375 in. OD, .436 in. thick
&Input Next= 4, T(2)=0.6388, T(3)=1.1074 &
1.5 in. pipe, 2.375 in. OD, .154 in. thick
&Input Next= 4, T(1)=1.905, T(2)=0.7201, T(3)=0.3912 &
1.5 in. pipe, 2.375 in. OD, .218 in. thick
&Input Next= 4, T(2)=0.5575, T(3)=0.5537 &
1.5 in. pipe, 2.375 in. OD, .343 in. thick
&Input Next= 4, T(2)=0.2400, T(3)=0.8712 &
1.5 in. pipe, 2.375 in. OD, .436 in. thick
&Input Next= 4, T(2)=0.0038, T(3)=1.1074 &
2.0 in. pipe, 2.375 in. OD, .154 in. thick
&Input Next= 4, T(1)=2.54, T(2)=0.0851, T(3)=0.3912 &
1.0 in. pipe, 3.5 in. OD, .216 in. thick
&Input Next= 4, T(1)=1.27, T(2)=2.6264, T(3)=0.5486, X(1)=5.45, 50, 100 &
1.0 in. pipe, 3.5 in. OD, .300 in. thick
&Input Next= 4, T(2)=2.4130, T(3)=0.7620 &
1.0 in. pipe, 3.5 in. OD, .438 in. thick
&Input Next= 4, T(2)=2.0625, T(3)=1.1125 &
1.0 in. pipe, 3.5 in. OD, .600 in. thick
&Input Next= 4, T(2)=1.6510, T(3)=1.5240 &
1.5 in. pipe, 3.5 in. OD, .216 in. thick
&Input Next= 4, T(1)=1.905, T(2)=1.9914, T(3)=0.5486 &
1.5 in. pipe, 3.5 in. OD, .300 in. thick
&Input Next= 4, T(2)=1.7780, T(3)=0.7620 &
1.5 in. pipe, 3.5 in. OD, .438 in. thick
&Input Next= 4, T(2)=1.4275, T(3)=1.1125 &
1.5 in. pipe, 3.5 in. OD, .600 in. thick
&Input Next= 4, T(2)=1.0160, T(3)=1.5240 &
2.0 in. pipe, 3.5 in. OD, .216 in. thick
&Input Next= 4, T(1)=2.54, T(2)=1.3564, T(3)=0.5486 &
2.0 in. pipe, 3.5 in. OD, .300 in. thick
&Input Next= 4, T(2)=1.143, T(3)=0.7620 &
2.0 in. pipe, 3.5 in. OD, .438 in. thick
&Input Next= 4, T(2)=0.7925, T(3)=1.1125 &
2.0 in. pipe, 3.5 in. OD, .600 in. thick
&Input Next= 4, T(2)=0.3810, T(3)=1.5240 &
1.0 in. pipe, 4.5 in. OD, .237 in. thick
&Input Next= 4, T(1)=1.27, T(2)=3.843, T(3)=0.6020, X(1)=6.72, 50, 100 &

```

```

1.0 in. pipe, 4.5 in. OD, .337 in. thick
&Input Next= 4, T(2)=3.5890, T(3)=0.8560 &
1.0 in. pipe, 4.5 in. OD, .438 in. thick
&Input Next= 4, T(2)=3.3325, T(3)=1.1125 &
1.0 in. pipe, 4.5 in. OD, .531 in. thick
&Input Next= 4, T(2)=3.0963, T(3)=1.3487 &
1.0 in. pipe, 4.5 in. OD, .674 in. thick
&Input Next= 4, T(2)=2.733, T(3)=1.7120 &
1.5 in. pipe, 4.5 in. OD, .237 in. thick
&Input Next= 4, T(1)=1.905, T(2)=3.208, T(3)=0.6020 &
1.5 in. pipe, 4.5 in. OD, .337 in. thick
&Input Next= 4, T(2)=2.954, T(3)=0.8560 &
1.5 in. pipe, 4.5 in. OD, .438 in. thick
&Input Next= 4, T(2)=2.6975, T(3)=1.1125 &
1.5 in. pipe, 4.5 in. OD, .531 in. thick
&Input Next= 4, T(2)=2.4613, T(3)=1.3487 &
1.5 in. pipe, 4.5 in. OD, .674 in. thick
&Input Next= 4, T(2)=2.0980, T(3)=1.7120 &
2.0 in. pipe, 4.5 in. OD, .237 in. thick
&Input Next= 4, T(1)=2.54, T(2)=2.573, T(3)=0.6020 &
2.0 in. pipe, 4.5 in. OD, .337 in. thick
&Input Next= 4, T(2)=2.319, T(3)=0.8560 &
2.0 in. pipe, 4.5 in. OD, .438 in. thick
&Input Next= 4, T(2)=2.0625, T(3)=1.1125 &
2.0 in. pipe, 4.5 in. OD, .531 in. thick
&Input Next= 4, T(2)=1.8263, T(3)=1.3487 &
2.0 in. pipe, 4.5 in. OD, .674 in. thick
&Input Next= 4, T(2)=1.4630, T(3)=1.7120 &
END OF RUN
&Input Next= 6 &

```

Appendix C. ISOSHLD-PC Input File lead1.in

```

0      2 Dose Rate for sludge in pipe with lead shield at 1.0 meters
1.0 in. pipe, 2.375 in. OD, .154 in. thick, 7.5 cm of lead
&Input Next= 1, Option= 0, Dunit=1, Iconc=1,
Igeom= 8, Slth= 1000, Y=500,
Npsi=100, Ntheta= 100, Delr= .1, X(1)= 100,
Nshld= 4, Jbuf= 4, T(1)=1.27, T(2)=1.3551, T(3)=0.3912, T(4)=7.5,
Weight(472)=.943,
Weight(335)=211, Weight(336)=211,
Weight(319)=0.461,
Weight(415)=1.59,
Weight(418)=0.719,
Weight(376)=5.897, Weight(377)=5.897,
Weight(111)=0.231,
Weight(170)=8.614, Weight(172)=8.614,
Weight(485)=11.3,
Weight(525)=1.81,
Weight(408)=0.358,
Weight(269)=1.89,
Weight(496)=8.98,
Weight(493)=8.88, Weight(494)=8.88,
Weight(492)=0.862,
Weight(502)=0.00141,
Weight(506)=6.46, Weight(500)=6.46,
Weight(82) =179, Weight(84) =179,
Weight(519)=2.03e-2,
Weight(520)=2.44e-2,
Weight(476)=7.91e-4,
Weight(526)=1.73e-2 &
Water 1 1.4
Air 3 0.00129
Iron 9 7.86
1 Lead 14 11.35
1.5 in. pipe, 2.375 in. OD, .154 in. thick, 8.5 cm of lead
&Input Next= 4, T(1)=1.905, T(2)=0.7201, T(3)=0.3912, T(4)=8.5 &
2.0 in. pipe, 2.375 in. OD, .154 in. thick, 9.0 cm of lead
&Input Next= 4, T(1)=2.54, T(2)=0.0851, T(3)=0.3912, T(4)=9.0 &
1.0 in. pipe, 3.5 in. OD, .216 in. thick, 7.5 cm of lead
&Input Next= 4, T(1)=1.27, T(2)=2.6264, T(3)=0.5486, T(4)=7.5 &
1.5 in. pipe, 3.5 in. OD, .216 in. thick, 8.5 cm of lead
&Input Next= 4, T(1)=1.905, T(2)=1.9914, T(3)=0.5486, T(4)=8.5 &
2.0 in. pipe, 3.5 in. OD, .216 in. thick, 9.0 cm of lead
&Input Next= 4, T(1)=2.54, T(2)=1.3564, T(3)=0.5486, T(4)=9.0 &
1.0 in. pipe, 4.5 in. OD, .237 in. thick, 7.5 cm of lead
&Input Next= 4, T(1)=1.27, T(2)=3.843, T(3)=0.6020, T(4)=7.5 &
1.5 in. pipe, 4.5 in. OD, .237 in. thick, 8.5 cm of lead
&Input Next= 4, T(1)=1.905, T(2)=3.208, T(3)=0.6020, T(4)=8.5 &
2.0 in. pipe, 4.5 in. OD, .237 in. thick, 9.0 cm of lead
&Input Next= 4, T(1)=2.54, T(2)=2.573, T(3)=0.6020, T(4)=9.0 &
END OF RUN
&Input Next= 6 &

```

Appendix D. ISOSHL-PC Input File leadhalf.in

```

0      2 Dose Rate for sludge in pipe with lead shield at .5 meters
1.0 in. pipe, 2.375 in. OD, .154 in. thick, 8.5 cm of lead
&Input Next= 1, Option= 0, Dunit=1, Iconc=1,
Igeom= 8, Slth= 1000, Y=500,
Npsi=100, Ntheta= 100, Delr= .1, X(1)= 50,
Nshld= 4, Jbuf= 4, T(1)=1.27, T(2)=1.3551, T(3)=0.3912, T(4)=8.5,
Weight(472)=.943,
Weight(335)=211, Weight(336)=211,
Weight(319)=0.461,
Weight(415)=1.59,
Weight(418)=0.719,
Weight(376)=5.897, Weight(377)=5.897,
Weight(111)=0.231,
Weight(170)=8.614, Weight(172)=8.614,
Weight(485)=11.3,
Weight(525)=1.81,
Weight(408)=0.358,
Weight(269)=1.89,
Weight(496)=8.98,
Weight(493)=8.88, Weight(494)=8.88,
Weight(492)=0.862,
Weight(502)=0.00141,
Weight(506)=6.46, Weight(500)=6.46,
Weight(82) =179, Weight(84) =179,
Weight(519)=2.03e-2,
Weight(520)=2.44e-2,
Weight(476)=7.91e-4,
Weight(526)=1.73e-2 &
Water 1 1.4
Air 3 0.00129
Iron 9 7.86
Lead 14 11.35
1.5 in. pipe, 2.375 in. OD, .154 in. thick, 9.5 cm of lead
&Input Next= 4, T(1)=1.905, T(2)=0.7201, T(3)=0.3912, T(4)=9.5 &
2.0 in. pipe, 2.375 in. OD, .154 in. thick, 10.0 cm of lead
&Input Next= 4, T(1)=2.54, T(2)=0.0851, T(3)=0.3912, T(4)=10.0 &
1.0 in. pipe, 3.5 in. OD, .216 in. thick, 8.5 cm of lead
&Input Next= 4, T(1)=1.27, T(2)=2.6264, T(3)=0.5486, T(4)=8.5 &
1.5 in. pipe, 3.5 in. OD, .216 in. thick, 9.0 cm of lead
&Input Next= 4, T(1)=1.905, T(2)=1.9914, T(3)=0.5486, T(4)=9.0 &
2.0 in. pipe, 3.5 in. OD, .216 in. thick, 10.0 cm of lead
&Input Next= 4, T(1)=2.54, T(2)=1.3564, T(3)=0.5486, T(4)=10.0 &
1.0 in. pipe, 4.5 in. OD, .237 in. thick, 8.0 cm of lead
&Input Next= 4, T(1)=1.27, T(2)=3.843, T(3)=0.6020, T(4)=8.0 &
1.5 in. pipe, 4.5 in. OD, .237 in. thick, 9.0 cm of lead
&Input Next= 4, T(1)=1.905, T(2)=3.208, T(3)=0.6020, T(4)=9.0 &
2.0 in. pipe, 4.5 in. OD, .237 in. thick, 10.0 cm of lead
&Input Next= 4, T(1)=2.54, T(2)=2.573, T(3)=0.6020, T(4)=10.0 &
END OF RUN
&Input Next= 6 &

```

CHECKLIST FOR INDEPENDENT TECHNICAL REVIEW
 NUMBER: 8M730-RAS-96-006
 DOCUMENT REVIEWED Dose Rates for Sludge in a Pipe

AUTHOR(s) R. A. Schwarz

I. Method(s) of Review

- (✓) Input data checked for accuracy
- (✓) Independent calculation performed
 - () Hand calculation
 - (✓) Alternate computer code: MCNP POINT KERNAL, MICROSHIELD
- () Comparison to experiment or previous results
- () Alternate method (define) _____

II. Checklist (either check or enter NA if not applied)

- (✓) Task completely defined
- (✓) Activity consistent with task specification
- (✓) Necessary assumptions explicitly stated and supported
- (✓) Resources properly identified and referenced
- (✓) Resource documentation appropriate for this application
- (✓) Input data explicitly stated
- (✓) Input data verified to be consistent with original source
- (✓) Geometric model adequate representation of actual geometry
- (✓) Material properties appropriate and reasonable
- () Mathematical derivations checked including dimensional consistency
- (✓) Hand calculations checked for errors
- (✓) Assumptions explicitly stated and justified
- (✓) Computer software appropriate for task and used within range of validity
- () Use of resource outside range of established validity is justified
- (✓) Software runstreams correct and consistent with results
- (✓) Software output consistent with input
- () Results consistent with applicable previous experimental or analytical findings
- (✓) Results and conclusions address all points and are consistent with task requirements and/or established limits or criteria
- (✓) Conclusions consistent with analytical results and established limits
- () Uncertainty assesment appropriate and reasonable
- () Other (define) _____

III. Comments:

IV. REVIEWER: Victor Roetman DATE: 31 July 1996

APPENDIX D
GAS EVOLUTION IN WEASEL PIT
S. A. Brisbin

Westinghouse
Hanford CompanyInternal
Memo

From: Engineering Support
 Phone: 376-9180 R3-48
 Date: June 13, 1996
 Subject: EVALUATION OF GAS RETENTION IN 105 K EAST BASIN WEASEL PIT SLUDGE

SAB-96-002

To: ED R. Precechtel R3-48

cc: C. J. Alderman R3-48
 W. B. Barton R2-11
 K. H. Bergsman R3-48
 S. D. Estey R2-11
 M. D. Guthrie R1-43
 G. S. Hunacek X3-79
 L. M. McWethy R3-48
 F. J. Muller X3-85
 R. J. Nicklas R1-43
 D. L. Sherrell R3-86
 K Basins Project
 File X3-85
 SNF Project File R3-11
 SAB File/LB

Reference: WHC-SD-WM-TI-755, "An Analysis of Parameters Describing Gas Retention/Release Behavior in Double Shell Tank Waste,"
 Revision 0, dated 1996.

A question was raised regarding the potential for flammable gas (i.e. hydrogen) to be retained within the sludge stored in the 105 K East Basin Weasel Pit. Based upon the information provided in the reference, there does not appear to be a potential for unacceptable retention of gas within the 105 K East Basin Weasel Pit.

Tank Waste Remediation System (TWRS) Waste Tank Process Engineering performed an investigation to determine if new or additional control limits could be imposed to prevent adverse accumulations of gas within double-shell tank (DST) waste. The results of the investigation revealed that there is a clear link between the propensity of DST waste to retain gas and the depth of the waste classified as non-convective. The investigation also found that the best correlation of tank waste properties and the degree to which waste may retain and episodically release gas was determined by the product of the total solids (non-convective waste) volume and the specific gravity of the liquid (convective waste) in contact with the solids. The results, to date, show that no episodic gas releases have been observed in DSTs where the product of the total solids depth in inches multiplied by the specific gravity of the contacting liquid is less than 150. Conversely, for the six DSTs known to experience episodic gas releases, this product was always found to exceed 230. The results of that investigation are documented in the reference.

D. R. Precechtel
 Page 2
 June 13, 1996

Assuming that the referenced relationship applies to 105 K East Basin sludge and that the specific gravity of the contacting liquid is approximately 1.1, GRE behavior is indicated to be unlikely as long as the maximum depth of the solids does not exceed 136 inches (11 feet). Conversely, GRE behavior is indicated to be likely if the solids depth exceeds 209 inches (17 feet).

$$150 = 1.1 \times \text{maximum depth in inches}$$

$$\text{Maximum depth in inches} = 136$$

$$230 = 1.1 \times \text{solids depth in inches}$$

$$\text{Solids depth in inches} = 209$$

Current calculations indicate that the sludge depth in the Weasel Pit will not exceed 8.5 feet. Therefore, sludge storage in the Weasel Pit should not present a safety issue due to GRE behavior. Assuming that sludge will always be covered by at least 4 feet of water while stored in the basin and the basin water depth will not exceed 17.5 feet, it is not functionally possible to reach the solids depth where GRE behavior is likely.

If you have questions or comments regarding this memo, please contact me at 376-9180.

S. A. Brisbin

S. A. Brisbin, Advanced Engineer
 Engineering Support

tln

CONCURRENCE

S. D. Estey
 S. D. Estey

6/17/96
 Date

APPENDIX E
SLUDGE VOLUME MANAGEMENT
D. R. Precechtel

K BASIN SLUDGE MANAGEMENT**1.0 OBJECTIVES**

- 1.1 Determine the volume of sludge that can be stored in the Weasel Pit and also the volume using both the Weasel Pit and the Weasel Pit Channel.
- 1.2 Establish a sludge retrieval sequence and time phase.
- 1.3 Estimate the KE Basin sludge transfer rate to TWSR.
- 1.4 Create a time dependent chart for Weasel Pit sludge volume projections.

2.0 ASSUMPTIONS

- 2.1 Sludge volumes as shown in Table 2.1, page 2.10, of WHC-SD-SNF-TI-015, Rev. 0. Segregation Pit Discharge Chute sludge has already been pumped to Weasel Pit.
- 2.2 Weasel Pit used for interim storage of all sludge. Two cases are assumed:
 - a. Sludge is stored only in the Weasel Pit, with a volume of 56.1 m³ (17 feet) deep.
 - b. Sludge is stored in the Weasel Pit and the Weasel Pit channel with a volume of 79.1 m³ (17 feet) deep.
- 2.3 Assume the allowable sludge depth is half the water depth (16 feet nominal, 17 feet water level increased for dose reduction).

Sludge Storage Volumes, m³

<u>Depth</u>	<u>Weasel Pit</u>	<u>Weasel Pit and Channel</u>
8.0 feet	26.4	37.2
8.5 feet	28.05	39.53

3.0 REFERENCE CASE

Sludge management for the reference case assumes retrieval of floor sludge after fuel removal is complete and after rack removal. Sludge is removed after all fuel, debris, and non-permanent structures are first removed. The sludge is removed just after rack removal is completed in each bay. The sludge volumes in the Weasel Pit are calculated and shown in Attachment 1, assuming a 28 month removal campaign.

4.0 JUST-IN-TIME

Pre-cleaning the main bays before fuel movement could reduce turbidity and water born dose sources significantly during fuel removal. The basin would be given a final cleaning after fuel and rack removal. This Just-In-Time option was analyzed for both the nominal and the maximum expected sludge volumes. These results are shown in Attachments 2 and 3, both assuming a 12 month sludge removal campaign in the year 2000.

5.0 CONCLUSIONS

With the limitation on sludge depth being 3.3 m (11 feet), it is seen that both the Weasel Pit and channel are needed to assure having enough storage capacity for sludge for this just-in-time option. The performance of the Weasel Pit to function as a settling basin with 3.3 m (11 feet) of sludge must be confirmed to validate this option.

ATTACHMENT 1
KE BASIN SLUDGE MANAGEMENT, REFERENCE CASE
D.R. Precechtel

DESIGN CALCULATION

(1) Drawing _____ (2) Doc. No. _____ (3) Page 1 of 9
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject KE Basin Sludge Management
 (8) Originator D. R. Precechtel *D.R. Precechtel* Date 2/26/96
 (9) Checker L. M. McWethy *L.M. McWethy* Date 2/27/96

(10)

KE Basin Sludge Management

Calculations of sludge volume management for KE Basin.

1. Sludge volumes as shown in Table 2.1, page 2.10, of WHC-SD-SNF-TI-015, Rev. 0. Segregation pit sludge has already been pumped to weasel pit (see page 8).
2. Weasel pit used for interim storage of all sludge. Two cases are assumed:
 - a. Sludge is stored only in the weasel pit, with a volume of 52.8 m^3 (16 feet deep).
 - b. Sludge is stored in the weasel pit and the weasel pit channel with a volume of 74.4 m^3 (16 feet deep) (see page 9).
3. Assume the allowable sludge depth is half the water depth (16 feet nominal, 17 feet after water level increased for dose reduction).

Sludge Storage Volumes, m^3

Depth	Weasel pit	Weasel pit and channel
8.0'	26.4	37.2
8.5'	28.05	39.53

DESIGN CALCULATION

(1) Drawing _____ (2) Doc. No. _____ (3) Page 2 of 9
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject KE Basin Sludge Management
 (8) Originator D. R. Precechtel *D R Precechtel* Date 2/26/96
 (9) Checker L. M. McWethy *L M McWethy* Date 2/27/96

4. Sludge Removal Sequence				Total	
Date	Location	Added Volume(ft ³)	Added Volume(m ³)	Volume(m ³)	Volume(m ³)
1. 1/96	Weasel pit (#Seg. pit)	417.73	11.83	11.83	
2. 2/96-3/96	South load out pit	38.35	1.09	12.91	
3. 2/96	Debris removal floor sludge (canister cleaning) - Bay 2	30.00	0.85	13.76	
4. 10/96-12/96	Dummy elevator pit	48.50	1.37	15.13	
5. 1/97-6/97	Fuel repackage cleanup of floor sludge - Bay 1	127.42	3.61	18.74	
6. 1/97-8/97	MCO load out cleanup of floor sludge - Bay 1	63.71	1.80	20.55	
7. 4/98-10/98	Fuel canister sludge removal - Bay 1	92.33	2.614	23.16	
8. 10/98-5/99	Fuel canister sludge removal - Bay 2	92.33	2.614	25.77	
9. 5/99-1/00	Fuel canister sludge removal - Bay 3	92.33	2.614	28.39	
10. 2/99-9/99	Floor sludge removal - Bay 1	63.71	1.804	30.19	

DESIGN CALCULATION

(1) Drawing _____ (2) Doc. No. _____ (3) Page 3 of 9
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject KE Basin Sludge Management
 (8) Originator D. R. Precechte AD R. Precechte Date 2/21/96
 (9) Checker L. M. McElthy LM McElthy Date 2/27/96

4. Sludge Removal Sequence (Continued)

Date	Location	Added Volume(ft ³)	Added Volume(m ³)	Total Volume(m ³)
11. 9/99-5/00	Floor Sludge Removal - Bay 2	224.83	6.366	36.56
		254.83	7.216	43.77
12. 5/00-12/00	Floor Sludge Removal - Bay 3			
13. 12/99-11/00	Tech view pit	15.23	.43	52.01
	Weasel pit channel	53.79	1.52	
	North load out pit	221.59	6.27	

Notes:

- 1 Canister cleaning area - Bay 2 - 15'x8'x $\frac{1}{4}$ ' = 30 ft³
- 2 50% floor sludge removal - Bay 1 - $764.5/3 \times .5 = 127.42$ ft³
- 3 25% floor sludge removal - Bay 1 - $764.5/3 \times .25 = 63.71$ ft³
- 4 Assumes equal distribution of canister sludge per Bay -
 $276.99/3 = 92.33$ ft³

WHC-SD-SNF-DB-012, Rev. 0
DESIGN CALCULATION

(1) Drawing _____ (2) Doc. No. _____ (3) Page 4 of 9
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject KE Basin Sludge Management
 (8) Originator D. R. Precechtel *D.R. Precechtel* Date 2/26/96
 (9) Checker L. M. McWethy *L.M. McWethy* Date 2/27/96

(10)

5. Sludge Removal Sequence After 4/98
(Sludge volumes in m³)

Locations				
Date	Fuel Canister Sludge	Weasel Pit	Floor Sludge	Pit Sludge
4/98	Start Bay 1	20.55		
		+1.744		
8/98	2.614	22.29		
		+4.87		
10/98	Start Bay 2	23.16		
		+1.493		
2/99	2.614	24.658	Start Bay 1	
		+1.121		
		+7.773		
5/99	Start Bay 3	26.55	1.804	
		+1.307		
		+1.031		
9/99	2.614	28.89	Start Bay 2	
		+1.307		
		+3.183		
1/00	Finish fuel repacking	33.38	6.366	Start pit cleanup
		+3.183		
		+3.297		
5/00		39.855	Start Bay 3	8.224
		+6.185		
		+4.937		
11/00		50.98	7.216	Finish pit cleanup
		+1.031		
12/00		52.01	Finish floor cleanup	

- Notes:
- 20 month duration for canister sludge
7.84 m³ of canister sludge
 - 21 month duration to remove floor sludge
15.386 m³ of floor sludge
 - Pit cleanup 1/00 - 11/00
8.229 m³ of pit sludge

DESIGN CALCULATION

(1) Drawing _____ (2) Doc. No. _____ (3) Page 5 of 9
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject KE Basin Sludge Management
 (8) Originator D. R. Precechtel *D.R. Precechtel* Date 2/26/96
 (9) Checker L. M. McWethy *LMM/Wethy* Date 2/27/96

(10)

6. KE Basin Sludge Transfer Rate to TWRS

Nominal time to complete a sludge transfer

1.	Time to transfer sludge to transport package and take sample	5 days
2.	Time to complete sample analysis	10 days
3.	Time to off load at TWRS and return	5 days
	Total	20 days

Assume 28 months duration for sludge shipments.

Assume a 6m^3 shipping packageAssume sludge volume shipped is 52.01m^3

% Sludge	No. of shipments	Time per shipment-days
10	87	9.66
20	43.5	19.38
30	29	29.0

Conclude a sludge percentage of 20% is needed to accomplish sludge shipments with a single transport package. Two transports are being procured to allow for all uncertainties.

Nominal shipping Rate: $52.01/28 = 1.8575\text{m}^3/\text{month}$

DESIGN CALCULATION

(1) Drawing _____ (2) Doc. No. _____ (3) Page 6 of 9
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject KF Basin Sludge Management
 (8) Originator D. R. Precechtel *D. R. Precechtel* Date 2/26/96
 (9) Checker L. M. McWethy *L. M. McWethy* Date 2/27/97

(10) <u>7. Sludge Cleanup/Removal Sequences</u>				
<u>Date</u>	<u>Cumulative Sludge m³</u>	<u>Ref Removal</u>	<u>50% Early Cleanup</u>	<u>100% Early Cleanup</u>
01/96	11.83			
02/96	12.68			
03/96	13.77			
10/96	13.77			
12/96	15.14			
03/97	17		17	17
06/97	18.74			
08/97	20.55			
10/97	20.55		28.24	35.94
12/97	20.55			
04/98	20.55		28.24	35.94
08/98	22.29	22.29	29.98	37.68
10/98	23.16	19.45	30.85	38.55
02/99	24.66	13.52	32.35	40.04
05/99	26.55	9.84	33.85	41.16
09/99	28.89	4.75	35.68	42.47
01/00	33.38	1.81	38.58	43.78
05/00	39.86	0.85	43.46	47.07
11/00	50.98	0.83	51.49	52.01
12/00	52.01	0.00	52.01	52.01

DESIGN CALCULATION

(1) Drawing _____ (2) Doc. No. _____ (3) Page 7 of 9
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject KE Basing Sludge Management
 (8) Originator N. A. Gumbert Date 2/26/96
 (9) Checker LMMW/WHY Date 2/27/96

(10)

WHC-SD-SNF-TI-015, Rev. 0

Table 2.1. Sludge Volumes of K East Basin and Estimated Uncertainties

Location	Average Depth (in.)	Area (ft ²)	Volume (ft ³)	Positive Uncertainty	Negative Uncertainty	Minimum Volume (ft ³)	Maximum Volume (ft ³)
Tech View-North Chan	0.97	49.35	3.99	50%	50%	1.99	5.98
Tech View-South Chan	0.21	49.35	0.86	50%	50%	0.43	1.30
Tech View Pit	0.88	141.50	10.38	50%	50%	5.19	15.57
Weasel Pit Channel	12.00	53.79	53.79	20%	20%	43.03	64.55
Weasel Pit	39.00	112.30	364.98	20%	20%	291.98	437.97
North Loadout Pit	33.00	66.53	182.96	20%	50%	91.48	219.55
North Loadout Chan	20.00	23.18	38.63	20%	20%	30.91	46.36
South Loadout Pit	5.25	64.70	28.31	50%	50%	14.15	42.46
South Loadout Chan	5.25	22.95	10.04	50%	50%	5.02	15.06
Dummy Elevator Pit	6.00	97.00	48.50	50%	50%	24.25	72.75
Segregation Pit	2.00	316.50	52.75	50%	50%	26.38	79.13
Basin Floor	1.90	4,828.39	764.50	20%	20%	611.60	917.39
Canisters-Empty	0.22	754.70	13.84	20%	20%	11.07	16.60
Canisters-Full, Good	0.50	688.19	28.67	70%	70%	8.60	48.75
Canisters-Full, Breach	4.00	703.44	234.48	70%	70%	70.34	398.62
TOTALS (ft ³)			1,836.67			1,236.42	2,382.03
TOTALS (m ³)			52.01			35.01	67.45

(1) Drawing _____
 (2) Doc. No. _____
 (3) Page 8 of 9
 (4) Building KE Basin Sludge Management
 (5) Rev. _____
 (6) Job No. _____
 (7) Subject KE Basin Sludge Management
 (8) Originator W. J. Gendall
 Date 3/26/96
 (9) Checker J. M. M. Alsty
 Date 4/27/96

8/11/95

2.10

VOLUME OF WATER IN WEASEL PIT APPROX
HEIGHT OF WALLS IN WEASEL PIT = 20'-0"

DATE: 1-12-95
CADFILE: WPIT

ATTACHMENT 2

KE BASIN SLUDGE MANAGEMENT, NOMINAL JUST IN TIME CASE

D.R. Precechtel

DESIGN CALCULATION

(1) Drawing _____ (2) Doc. No. _____ (3) Page 1 of 9
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject KE Basin Sludge Management, Nominal - Just In Time
 (8) Originator D. R. Precechtel D.R. Precechtel Date 2/26/96
 (9) Checker L. M. McWethy L.M. McWethy Date 2/27/96

(10)

KE Basin Sludge Management

Calculations of sludge volume management for KE Basin.

1. Sludge volumes as shown in Table 2.1, page 2.10, of WHC-SD-SNF-TI-015, Rev. 0. Segregation pit sludge has already been pumped to weasel pit (see page 8).
2. Weasel pit used for interim storage of all sludge. Two cases are assumed:
 - a. Sludge is stored only in the weasel pit; with a volume of 52.8 m^3 (16 feet deep).
 - b. Sludge is stored in the weasel pit and the weasel pit channel with a volume of 74.4 m^3 (16 feet deep) (see page 9).
3. Assume the allowable sludge depth is half the water depth (16 feet nominal, 17 feet after water level increased for dose reduction).

Sludge Storage Volumes, m^3

Depth	Weasel pit	Weasel pit and channel
8.0'	26.4	37.2
8.5'	28.05	39.53

4. Sludge Removal Sequence

page 2/9

Just In Time Option, Nominal Sludge Volumes

	<u>Date</u>	<u>Location</u>	<u>Added Volume (ft3)</u>	<u>Added Volume (m3)</u>	<u>Total Volume (m3)</u>
1.	1/96	Weasel Pit (& Seg Pit)	417.73	11.83	11.83
2.	2/96- 3/96	South load out pit & channel	38.35	1.09	12.91
3.	2/96	Debris removal floor sludge (canister cleaning) - Bay 2 >1	30.00	0.85	13.76
4.	10/96-Dummy 12/96 Pit	Elevator	48.50	1.37	15.13
5.	1/97- 6/97	Fuel repackge cleanup of floor sludge - Bay 1 >2	127.42	3.61	18.74
6.	1/97- 8/97	MCO load out cleanup of floor sludge - Bay 1 >3	63.71	1.80	20.55
7.	4/98- 10/98	Fuel canister sludge removal - Bay 1 >4	92.33	2.614	23.16
8.	10/98-Fuel 5/99	canister sludge removal - Bay 2 >4	92.33	2.614	25.77
9.	5/99- 1/00	Fuel canister sludge removal - Bay 3 >4	92.33	2.614	28.39
10.	3/98- 9/98	60% Floor sludge removal - Bay 1	38.21	1.082	29.47
11.	9/98- 4/99	60% Floor sludge Removal - Bay 2	134.90	3.820	33.29
12.	4/99- 12/99	60% Floor sludge Removal - Bay 3	152.91	4.330	37.62
13.	12/99-Tech 11/00	View Pit Weasel Pit Chan.. North Load Out	15.23 53.79 221.59	0.43 1.52 6.27	45.84

3/9

pit & channel

14.	1/00- Finish floor	217.33	6.154	52.01
	5/00 sludge			
>1	Canister cleaning area - Bay 2 - 15'x8'x1/4' = 30 ft3			
>2	50% floor sludge removal - Bay 1 - $764.5/3 \times .5 = 127.43$ ft3			
>3	25% floor sludge removal - Bay 1 - $764.5/3 \times .25 = 63.71$ ft3			
>4	Assumes equal distribution of canister sludge per Bay -			
	$276.99/3 = 92.33$ ft3			

5. Sludge Removal Sequence After 4/98
(Sludge Volumes in m3)

page 4/9

Just In Time Option, Nominal Sludge Volumes

<u>Date</u>	<u>Locations</u>			
	<u>Fuel Canister Sludge</u>	<u>Weasel Pit</u>	<u>Floor Sludge</u>	<u>Pit Sludge</u>
3/98		20.55	start Bay 1	
4/98	start Bay 1	20.73	+ .18 (1.082)	
	(2.614)	+2.178	+ .902	
9/98		23.81	finish Bay 1	
			start Bay 2	
			(3.820)	
10/98	finish Bay 1	+ .436	+ .546	
	start Bay 2	24.792		
	(2.614)	+2.241	+3.274	
4/99		30.307	finish Bay 2	
			start Bay 3	
			(4.330)	
5/99	finish Bay 2	+ .373	+ .541	
	start Bay 3	31.221		
	(2.614)	+2.287	+3.789	
12/99		37.297	finish Bay 3	
		+ .327		
1/00	finish Bay 3	37.624	start floors	
			+6.154 (6.154)	start pits
			+3.290	(8.224)
5/00		47.068	finish floors	
			+4.934	
11/00		52.01		finish pits

- Notes:
- 20 month duration for canister sludge
7.84 m3 of canister sludge
 - 60% floor sludge cleanup a month in advance of fuel removal, finish cleaning after fuel and rack removal
 - Pit cleanup 1/00 - 11/00
8.229 m3 of pit sludge

6. KE Basin Sludge Transfer Rate to TWRS

Just In Time Option, Nominal Sludge Volume

Nominal time to complete a sludge transfer

1.	Time to transfer sludge to transport package and take sample	2.5 days
2.	Time to complete sample analysis	5 days
3.	Time to offload at TWRS and return	2.5 days
	Total	10 days

Assume a 6 m3 transport package

Assume sludge volume shipped is 52.01 m3

Assume 20 working days per month

Time Required for Shipping Sludge

		Time per Shipment in days	
		<u>Shipping Duration, months</u>	
% Sludge	No. of shipments	10	12
10	87	2.30	2.76
20	43.5	4.60	5.52
30	29	6.90	8.28
Nominal Shipping Rate: m3/month		5.20	4.33

Conclude that by averaging 20% sludge in each shipment, at least two transport packages must be running at all times. Availability of crews and vehicles suggests procurement of four transport packages to meet the goal of sludge removal in ten months.

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7. Sludge Cleanup/Removal Sequences

Just In Time Option, Nominal Sludge Volumes

<u>Date</u>	<u>Cumulative Sludge, m3</u>	<u>Net Weasel Pit Volume, m3</u>
01/96	11.83	11.83
12/97	20.55	20.55
04/98	20.73	20.73
9/98	23.81	23.81
10/98	24.79	24.79
04/99	30.31	30.31
05/99	31.22	31.22
12/99	37.30	37.30
01/00	37.62	37.62
05/00	47.07	29.73
11/00	52.01	8.668
01/01	52.01	0.00

Assumes 12 months to remove sludge

Assumes average sludge removal rate of 4.334 m3/month

DESIGN CALCULATION

(1) Drawing _____ (2) Doc. No. _____ (3) Page 8 of 9
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject KE Basin Sludge Management
 (8) Originator D. G. Chavakis Date 2/26/95
 (9) Checker JMM/Wethy Date 2/27/95

(10)

Table 2.1. Sludge Volumes of K East Basin and Estimated Uncertainties

Location	Average Depth (in.)	Area (ft ²)	Volume (ft ³)	Positive Uncertainty	Negative Uncertainty	Minimum Volume (ft ³)	Maximum Volume (ft ³)
Tech View-North Chan	0.97	49.35	3.99	50%	50%	1.99	5.98
Tech View-South Chan	0.21	49.35	0.86	50%	50%	0.43	1.30
Tech View Pit	0.88	141.50	10.38	50%	50%	5.19	15.57
Weasel Pit Channel	12.00	53.79	53.79	20%	20%	43.03	64.55
Weasel Pit	39.00	112.30	364.98	20%	20%	291.98	437.97
North Loadout Pit	33.00	66.53	182.96	20%	50%	91.48	219.55
North Loadout Chan	20.00	23.18	38.63	20%	20%	30.91	46.36
South Loadout Pit	5.25	64.70	28.31	50%	50%	14.15	42.46
South Loadout Chan	5.25	22.95	10.04	50%	50%	5.02	15.06
Dummy Elevator Pit	6.00	97.00	48.50	50%	50%	24.25	72.75
Segregation Pit	2.00	316.50	52.75	50%	50%	26.38	79.13
Basin Floor	1.90	4,828.39	764.50	20%	20%	611.60	917.39
Canisters-Empty	0.22	754.70	13.84	20%	20%	11.07	16.60
Canisters-Full, Good	0.50	688.19	28.67	70%	70%	8.60	48.75
Canisters-Full, Breach	4.00	703.44	234.48	70%	70%	70.34	398.62
TOTALS (ft ³)			1,836.67			1,236.42	2,382.03
TOTALS (m ³)			52.01			35.01	67.45

8/11/95

2.10

DESIGN CALCULATION

(1) Drawing _____ (2) Doc. No. _____ (3) Page 9 of 9
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject KE Basin Sludge Management
 (8) Originator D. A. Greenhalgh Date 2/26/96
 (9) Checker J. M. W. Jethy Date 2/27/96

WEASEL PIT INFORMATION

AREA= 164.17 SQUARE FEET

WATER DEPTH= 16'-0"

VOLUME OF WATER IN WEASEL PIT APPROXIMATELY= 2626.72 CU FT (74.39 m³)

HEIGHT OF WALLS IN WEASEL PIT= 20'-0"

DATE: 1-12-95
 CADFILE: WPIT

ATTACHMENT 3

KE BASIN SLUDGE MANAGEMENT, MAXIMUM JUST IN TIME CASE

D.R. Precechte1

DESIGN CALCULATION

(1) Drawing _____ (2) Doc. No. _____ (3) Page 1 of 9
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject KE Basin Sludge Management, Maximum - Just In Time
 (8) Originator D. R. Precechtel DR Precechtel Date 2/26/96
 (9) Checker L. M. McWethy LMcWethy Date 2/27/96

(10)

KE Basin Sludge Management

Calculations of sludge volume management for KE Basin.

1. Sludge volumes as shown in Table 2.1, page 2.10, of WHC-SD-SNF-TI-015, Rev. 0. Segregation pit sludge has already been pumped to weasel pit (see page 8).
2. Weasel pit used for interim storage of all sludge. Two cases are assumed:
 - a. Sludge is stored only in the weasel pit, with a volume of 52.8 m^3 (16 feet deep).
 - b. Sludge is stored in the weasel pit and the weasel pit channel with a volume of 74.4 m^3 (16 feet deep) (see page 9).
3. Assume the allowable sludge depth is half the water depth (16 feet nominal, 17 feet after water level increased for dose reduction).

Sludge Storage Volumes, m^3

Depth	Weasel pit	Weasel pit and channel
8.0'	26.4	37.2
8.5'	28.05	39.53

4. Sludge Removal Sequence

page 2/9

Just In Time Option, Maximum Sludge Volumes

	<u>Date</u>	<u>Location</u>	<u>Added Volume (ft3)</u>	<u>Added Volume (m3)</u>	<u>Total Volume (m3)</u>
1.	1/96	Weasel Pit (& Seg Pit)	517.10	14.64	14.64
2.	2/96- 3/96	South load out pit & channel	57.52	1.63	16.27
3.	2/96	Debris removal floor sludge (canister cleaning) - Bay 2 >1	36.00	1.02	17.29
4.	10/96- 12/96	Dummy Elevator Pit	72.75	2.06	19.35
5.	1/97- 6/97	Fuel repackage cleanup of floor sludge - Bay 1 >2	152.90	4.33	23.68
6.	1/97- 8/97	MCO load out cleanup of floor sludge - Bay 1 >3	76.45	2.17	25.85
7.	4/98- 10/98	Fuel canister sludge removal - Bay 1 >4	154.66	4.38	30.23
8.	10/98- 5/99	Fuel canister sludge removal - Bay 2 >4	154.66	4.38	34.61
9.	5/99- 1/00	Fuel canister sludge removal - Bay 3 >4	154.66	4.38	38.99
10.	3/98- 9/98	60% Floor sludge removal - Bay 1	45.87	1.23	40.28
11.	9/98- 4/99	60% Floor sludge Removal - Bay 2	161.88	4.58	44.87
12.	4/99- 12/99	60% Floor sludge Removal - Bay 3	183.48	5.20	50.06
13.	12/99- 11/00	Tech View Pit Weasel Pit Chan. North Load Out	22.85 64.55 265.91	.65 1.83 7.53	60.07

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pit & channel

14.	1/00- Finish floor	260.81	7.39	67.45
	5/00 sludge			

- >1 Canister cleaning area - Bay 2 - $15' \times 8' \times 0.3' = 36 \text{ ft}^3$
- >2 50% floor sludge removal - Bay 1 - $917.39/3 \times .5 = 152.90 \text{ ft}^3$
- >3 25% floor sludge removal - Bay 1 - $917.39/3 \times .25 = 76.45 \text{ ft}^3$
- >4 Assumes equal distribution of canister sludge per Bay -
 $463.97/3 = 154.66 \text{ ft}^3$

5. Sludge Removal Sequence After 4/98
(Sludge Volumes in m3)

page 4/9

Just In Time Option, Maximum Sludge Volumes

<u>Date</u>	<u>Locations</u>			
	<u>Fuel Canister Sludge</u>	<u>Weasel Pit</u>	<u>Floor Sludge</u>	<u>Pit Sludge</u>
3/98		25.845	start Bay 1	
			+ .216 (1.298)	
4/98	start Bay 1	26.061		
	(4.380)	+3.650	+1.082	
9/98		30.793	finish Bay 1	
			start Bay 2	
		+ .730	+ .655 (4.584)	
10/98	finish Bay 1	32.178		
	start Bay 2			
	(4.380)	+3.754	+3.929	
4/99		39.861	finish Bay 2	
			start Bay 3	
		+ .626	+ .650 (5.196)	
5/99	finish Bay 2	41.137		
	start Bay 3			
	(4.380)	+3.832	+4.546	
12/99		49.515	finish Bay 3	
		+ .548		
1/00	finish Bay 3	50.063	start floors	
			+7.385	
			+4.002	start pits
5/00		61.450	finish floors	(10.006)
			+6.004	
11/00		67.454		finish pits

- Notes:
1. 20 month duration for canister sludge
13.138 m3 of canister sludge
 2. 60% floor sludge cleanup a month in advance of fuel removal, finish cleaning after fuel and rack removal
 3. Pit cleanup 1/00 - 11/00
10.006 m3 of pit sludge

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6. KE Basin Sludge Transfer Rate to TWRS

Just In Time Option, Maximum Sludge Volume

Nominal time to complete a sludge transfer

1.	Time to transfer sludge to transport package and take sample	2.5 days
2.	Time to complete sample analysis	5 days
3.	Time to offload at TWRS and return	2.5 days
	Total	10 days

Assume a 6 m3 transport package
Assume sludge volume shipped is 67.45 m3
Assume 20 working days per month

Time Required for Shipping Sludge

Time per Shipment in days

Shipping Duration, months

% Sludge	No. of shipments	10	12
10	112	1.78	2.13
20	56	3.56	4.23
30	37.5	5.34	6.40
Nominal Shipping Rate: m3/month		6.75	5.62

Conclude that by averaging 20% sludge in each shipment, about three transport packages must be running at all times. Availability of crews and vehicles suggests procurement of four transport packages to meet the goal of sludge removal in ten months.

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7. Sludge Cleanup/Removal Sequences

Just In Time Option, Maximum Sludge Volumes

<u>Date</u>	<u>Cumulative Sludge, m3</u>	<u>Net Weasel Pit Volume, m3</u>
01/96	14.64	14.64
12/97	25.85	25.85
04/98	26.06	26.06
9/98	30.79	30.79
10/98	32.18	32.18
04/99	39.86	39.86
05/99	41.14	41.14
12/99	49.52	49.52
01/00	50.06	50.06
05/00	61.45	38.97
11/00	67.45	11.25
01/01	67.45	0.00

Assumes 12 months to remove sludge

Assumes average sludge removal rate of 5.621 m3/month

Weasel Pit Volume Projections

DESIGN CALCULATION

(1) Drawing _____ (2) Doc. No. _____ (3) Page 8 of 9
 (4) Building _____ (5) Rev. _____ (6) Job No. _____
 (7) Subject KE Basin Sludge Management
 (8) Originator D. A. Overholt Date 2/26/95
 (9) Checker JMM/WJH Date 2/27/95

(10)

WHC-SD-SNF-TI-015, Rev. 0

Table 2.1. Sludge Volumes of K East Basin and Estimated Uncertainties

Location	Average Depth (in.)	Area (ft ²)	Volume (ft ³)	Positive Uncertainty	Negative Uncertainty	Minimum Volume (ft ³)	Maximum Volume (ft ³)
Tech View-North Chan	0.97	49.35	3.99	50%	50%	1.99	5.98
Tech View-South Chan	0.21	49.35	0.86	50%	50%	0.43	1.30
Tech View Pit	0.88	141.50	10.38	50%	50%	5.19	15.57
Weasel Pit Channel	12.00	53.79	53.79	20%	20%	43.03	64.55
Weasel Pit	39.00	112.30	364.98	20%	20%	291.98	437.97
North Loadout Pit	33.00	66.53	102.96	20%	50%	91.48	219.55
North Loadout Chan	20.00	23.18	38.63	20%	20%	30.91	46.36
South Loadout Pit	5.25	64.70	28.31	50%	50%	14.15	42.46
South Loadout Chan	5.25	22.95	10.04	50%	50%	5.02	15.06
Dummy Elevator Pit	6.00	97.00	48.50	50%	50%	24.25	72.75
Segregation Pit	2.00	316.50	52.75	50%	50%	26.38	79.13
Basin Floor	1.90	4,828.39	764.50	20%	20%	611.60	917.39
Canisters-Empty	0.22	754.70	13.84	20%	20%	11.07	16.60
Canisters-Full, Good	0.50	688.19	28.67	70%	70%	8.60	48.75
Canisters-Full, Breach	4.00	703.44	234.48	70%	70%	70.34	398.62
TOTALS (ft ³)			1,836.67			1,236.42	2,382.03
TOTALS (m ³)			52.01			35.01	67.45

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2.10

(1) Drawing _____ (2) Doc. No. _____ (3) Page 9 of 9
(4) Building _____ (5) Rev. _____ (6) Job No. _____
(7) Subject KE Basin Sludge Management
(8) Originator N. G. Gumbert Date 2/26/96
(9) Checker L. M. W. J. J. Date 2/27/96

WEASEL PIT INFORMATION

AREA= 164.17 SQUARE FEET

WATER DEPTH= 16'-0"

VOLUME OF WATER IN WEASEL PIT APPROXIMATELY= 2626.72 CU FT
HEIGHT OF WALLS IN WEASEL PIT= 20'-0"

(74.39 m)

DATE: 1-12-95
CADFILE: WPIT

DISTRIBUTION SHEET

To	From	Page 1 of 1
Engineering Support	Engineering Support	Date 9/12/96
Project Title/Work Order		EDT No. 616144
Sludge Removal Project Weasel Pit Requirements		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
C. J. Alderman	R3-48	X			
K. H. Bergsman	R3-48	X			
S. A. Brisbin	R3-48	X			
J. R. Frederickson	R3-86	X			
E. W. Gerber	R3-86	X			
M. A. Jensen	X3-79	X			
F. W. Moore	X3-85	X			
F. J. Muller	X3-85	X			
M. J. Packer	R3-48	X			
T. R. Pauly	X3-85	X			
K. L. Pearce	R3-48	X			
C. C. Pitkoff	X3-85	X			
D. R. Precechtel	R3-48	X			
R. A. Schwarz	H0-35	X			
E. D. Takasumi	X3-85	X			
M. J. Wiemers	X3-85	X			
SNF Project File	R3-11	X			
Central Files (2)	A3-88	X			