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1	RPP-6307	N/A	0	Radiological Design Review Screening - Saltwell Pumping at 241-U-106 Distributor Pit	N/A	3	1	

16. KEY

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17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
		Design Authority N/A									
		Design Agent N/A									
1	1	Cog. Eng. D. J. Foust	David Foust	5/8/00							
		Cog. Mgr. N/A									
		QA N/A									
		Safety N/A									
		Env. N/A									

18.	19.	20.	21. DOE APPROVAL (if required)
D. J. Foust 5/8/00 Signature of EDT Originator / Date	N/A Authorized Representative for Receiving Organization / Date	K. W. Gray 5/8/00 Design Authority/ Cognizant Manager / Date	Ctrl No. N/A ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments

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BD-7400-172-1

Radiological Design Review Screening - Saltwell Pumping at 241-U-106 Distributor Pit

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U.S. Department of Energy Contract DE-AC06-99RL14047

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Key Words:
241-U-106; Saltwell; Radiological Design Review; Steel Cover Plate; Cover Block; Distributor Pit

Abstract:
This document provides the radiological design review screening for the 241-U-106 distributor pit cover block replacement with a steel cover plate.

5/11/00
Release Approval Date

DATE: HANFORD RELEASE
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MAY 15 2000
Release Stamp

Approved For Public Release

RPP-6307
Revision 0

Radiological Design Review Screening – Saltwell Pumping at 241-U-106 Distributor Pit

Prepared by: ______ 5/8/00
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Radiological Control Manager – Characterization & Stabilization Projects
Date

CH2M Hill Hanford Group Incorporated

May 5, 2000

Scope

This document provides the calculated basis for the level of radiological design review[1] required for the replacement of the existing 241-U-106 distributor pit 61 cm (24 inch) concrete cover block with one of the following options in order of priority:

- 5.1 cm (2") steel plate
- 7.6 cm (3") steel plate

The determination of the expected dose rate over the 241-U-106 distributor pit after the installation of various options is described. The existing concrete cover block must be replaced to facilitate access to the pit for saltwell pumping operations.

Also determined is the lifecycle dose differential due to this facility modification.

1. Calculations:

1.1. Baseline Dose Rate Determination

Based on current radiological survey report[2], without the saltwell screen installed, the maximum unshielded penetrating whole body dose rate over the distributor pit is 200 mrem/hr. Installation of the saltwell screen will reduce this dose rate to approximately 13 mR/hr as calculated by MicroShield[3] (Attachment 1), and installation of the saltwell pump will further reduce this dose rate primarily due to shielding provided by the 2.5 cm (1 inch) steel base plate of the pump. The dose rate with the pump installed is determined as follows:

- The majority of the penetrating radiation from the distributor pit is due the 0.662 Mev gamma emitted by the ^{137m}Ba daughter of ^{137}Cs.[4]
- The half-value layer for ^{137}Cs in iron is approximately 1.9 cm (0.75 inch).[5]

$$Dose\ Rate_{\max_{SteelShielded}} = Dose\ Rate_{\max_{Unshielded}} \times (.5)^n$$ where n = number of half-value layers

$$n = \frac{2.5\ cm}{1.9\ cm} = 1.3$$

$$Dose\ Rate_{\max_{pumpInstalled}} = \frac{13\ mrem}{hr} \times (.5)^{1.3} = \frac{5\ mrem}{hr}$$

Initiation of pumping activities will increase this dose rate. Previous experience with pumping activities indicates that dose rates may increase by as much as 300 mrem

1 RPP-MD-010, Rev. 0, December 22, 1999
2 IS001842, page 1, Item No. 1
3 MicroShield is a registered trademark of Grove Engineering Inc.
4 HNF-SD-WM-ER-636
5 Shleien, page192

per hour[6] with the commencement of pumping. Because the specific activity of ^{137}Cs is lower in U-106 than in the typical tank, pumping is estimated to increase the dose rate in the pit by no more than 200 mrem/hr This would make the dose rate in the pump pit 205 mrem per hour during pumping operations.

The estimated calculated dose rate over a 5.1 cm (2") steel cover plate when the pump is not in operation is as follows:

$$Dose\ Rate_{\max_{pumpinstaled}} = \frac{5\ mrem}{hr} \times (.5)^{\frac{5.1}{1.9}} = \frac{1\ mrem}{hr}$$

The estimated calculated dose rate over the pit with a total of 7.6 cm (3") of steel cover plate when the pump is not in operation is as follows:

$$Dose\ Rate_{\max_{pumpinstaled}} = \frac{5\ mrem}{hr} \times (.5)^{\frac{7.6}{1.9}} = \frac{.3\ mrem}{hr}$$

The estimated calculated dose rate over the 5.1 cm (2") steel cover plate during pumping operations is as follows:

$$Dose\ Rate_{\max_{pumpinstaled}} = \frac{205\ mrem}{hr} \times (.5)^{\frac{5.1}{1.9}} = \frac{32\ mrem}{hr}$$

The calculated dose rate over the pit with a total of 7.6 cm (3") of steel cover plate during pumping operations is as follows:

$$Dose\ Rate_{\max_{pumpinstaled}} = \frac{205\ mrem}{hr} \times (.5)^{\frac{7.6}{1.9}} = \frac{13\ mrem}{hr}$$

1.2. Life Cycle Exposure Differential

- Maximum personnel occupancy over the pump pit cover is estimated to be 5 minutes (0.08 hr) per week while pumping is in progress and 25 minutes (0.4 hr) per week when the pump is not in operation.[7]
- U-106 pumping schedule is 9 mo.[8] (39 weeks)
- Half-value layer for ^{137}Cs of concrete cover block to be replace by the carbon steel plates is 7.0 cm[9].
- Thickness of concrete cover block to be replaced is 61 cm (24").[10]

$$n = \frac{61\ cm}{7.0\ cm} = 8.7$$

The calculated dose rate over the existing 61 cm (24") concrete cover block while the pump is not in operation would be as follows:

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[6] Craft, September 1998
[7] McVey, January 1999
[8] Jaka, April 6, 2000
[9] Shleien, page 192
[10] Jaka, April 6, 2000

$$Dose\ Rate_{ConcreteShielded} = \frac{5\ mrem}{hr} \times (.5)^{8.7} = \frac{0\ mrem}{hr}$$

The calculated dose rate over the existing 61 cm (24") concrete cover block while the pump is operating would be as follows:

$$Dose\ Rate_{ConcreteShielded} = \frac{205\ mrem}{hr} \times (.5)^{8.7} = \frac{0.5\ mrem}{hr}$$

The net change in dose rate due to the installation of the 5.1 cm (2") steel cover plate while the pump is not in operation is as follows:

$$\frac{1\ mrem}{hr} - \frac{0\ mrem}{hr} = \frac{1\ mrem}{hr}$$

The net change in dose rate due to the installation of the 5.1 cm (2") steel cover plate while the pump is in operation is as follows:

$$\frac{32\ mrem}{hr} - \frac{0.5\ mrem}{hr} = \frac{31.5\ mrem}{hr}$$

The net change in dose rate due to the installation of the 7.6 cm (3") steel cover plate while the pump is not in operation is as follows:

$$\frac{0.3\ mrem}{hr} - \frac{0\ mrem}{hr} = \frac{0.3\ mrem}{hr}$$

The net change in dose rate due to the installation of the 7.6 cm (3") steel cover plate while the pump is in operation is as follows:

$$\frac{13\ mrem}{hr} - \frac{0.5\ mrem}{hr} = \frac{12.5\ mrem}{hr}$$

The total change in dose due to the replacement of the concrete cover blocks with the 5.1 cm (2") steel cover plate would be as follows:

$$\left[\left(\frac{31.5\ mrem}{hr} \times \frac{0.08\ hr}{week}\right) + \left(\frac{1\ mrem}{hr} \times \frac{0.4\ hr}{week}\right)\right] \times 39\ weeks = 114\ person - mrem$$

The total change in dose due to the replacement of the concrete cover blocks with the 7.6 cm (3") steel cover plate would be as follows:

$$\left[\left(\frac{12.5\ mrem}{hr} \times \frac{0.08\ hr}{week}\right) + \left(\frac{0.3\ mrem}{hr} \times \frac{0.4\ hr}{week}\right)\right] \times 39\ weeks = 44\ person - mrem$$

Since the pit cover must be removed and replaced as a normal part of saltwell pump installation, no additional exposure will be incurred as a result of installation and removal of the steel cover plate.

2. Conclusion

The calculated exposure increase due to the proposed installation of the 5.1 cm (2") carbon steel cover plate is 114 person-mrem for the life cycle of the project. The calculated exposure increase due to the proposed installation of the 7.6 cm (3") carbon steel cover plate is 44 person-mrem for the life cycle of the project. For these options, the calculated lifecycle exposure change is less than ±one person-rem. This calculated exposure is based on several conservative assumptions. Actual dose rates should be verified by field measurements after installation of the cover plate. Exposure may be further reduced by administratively limiting personnel occupancy over the cover plate.

3. References

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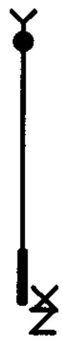
Page : 1
DOS File: U-106.MS5
Run Date: May 3, 2000
Run Time: 6:28:36 AM
Duration : 00:00:00

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: U-106SS
Description: Dose @ U-106 Heel Jet Pit w/Saltwell Screen
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions

Height	213.36 cm	7 ft 0.0 in
Radius	12.7 cm	5.0 in

Dose Points

	X	Y	Z
# 1	0 cm	1097.28 cm	0 cm
	0.0 in	36 ft	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	6597.345 in³	Water	1.2
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
Ba-137m	2.5773e+001	9.5359e+011	2.3839e+002	8.8205e+006
Cs-137	2.7244e+001	1.0080e+012	2.5200e+002	9.3240e+006

Buildup
The material reference is : Source

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0318	1.974e+10	5.674e-01	1.641e+00	4.727e-03	1.367e-02
0.0322	3.642e+10	1.081e+00	3.187e+00	8.699e-03	2.564e-02
0.0364	1.325e+10	5.339e-01	1.930e+00	3.033e-03	1.097e-02
0.6616	8.580e+11	2.378e+03	6.448e+03	4.609e+00	1.250e+01
TOTALS:	9.275e+11	2.380e+03	6.455e+03	4.626e+00	1.255e+01

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	D. J. Foust	Date 3/7/00
Project Title/Work Order		EDT No. 623381
RPP-6307, Rev. 0, Radiological Design Review Screening - Saltwell Pumping at 241-U-106 Distributor Pit		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
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K. W. Gray	S7-75	X			
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