Vamp™ Coverage Area for Personnel Protection (U)

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VAMPTM COVERAGE AREA FOR
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INTRODUCTION

The VAMP™ Area Radiation Monitors, in addition to functioning as radiation monitors for process upsets, as required by the OSR, provide monitoring in order to detect and alarm increasing radiation for the purpose of controlling exposure of personnel to radiation.

Operational Safety Requirements (DPW-86-103) requires that area radiation monitors be provided in the vicinity of all waste tanks to ensure safe operation. The proposed Operational Safety Requirements (WSRC RP-92-1044) establish the minimum number of area radiation monitors for operation and the maximum distance from the monitored location for the purpose of detecting potential leaks .

Article 553 of the DOE Radiological Control Manual indicates that area radiation monitors should be installed in frequently occupied locations with the potential for unexpected increases in dose rates and in remote locations where there is a need for local indication of dose rates prior to personnel entering remote locations.

Currently, there is no technical basis established for the use of the VAMP for limiting exposure of personnel in the F or H Tank Farms. This report will establish that basis, map current area radiation monitor locations and provide a list of recommended actions to correct situations where VAMP coverage may be inadequate in limiting exposure of personnel . In addition, the current reporting criteria described in the 9B5 Manual will be addressed in this report.

SUMMARY

The current location of area radiation monitors provide the coverage required by the OSR criteria and, with few exceptions, these monitors also provide the necessary coverage for personnel protection. The exceptions to the coverage for personnel protection are listed below along with the proposed action to bring the facility into compliance with the DOE Radiological Manual. The exceptions are based upon the assumptions, which HLWE believes are conservative, used to develop the coverage maps generated by Health Physics Technology (HPT).

No change to the 9B5 Manual reporting criteria relating to area radiation monitors is required.

No change to transfer procedures to provide additional VAMP coverage for personnel protection is required for a source term that is greater than that assumed in this report.

It is expected that this Technical Report will provide the basis for future assessment when changes to the facility are initiated.

DISCUSSION

Health Physics Technology performed an evaluation of the area radiation monitor coverage area in the SRS High Level Waste Tank Farms (Ref. 1). This evaluation used a dose of 300 mrem delivered in a 10 hour time period (30 mrem/hr at 10 feet) as a basis for determining the coverage. This rate was chosen by HPT and High Level Waste Engineering (HLWE) because 300 mrem/month is the SRS Administrative Control Guide limit. Included in the selection is the knowledge that weekly surveys of routinely occupied areas are performed by RCO per Procedure 147 of Manual 5Q1.2. Further, a daily/shift operational check of the VAMP is performed by Radiological Controls Operations (RCO) per Procedure 103A of Manual 5Q1.7 and by Operations per their Roundsheets.

The choice of spill type and amount was based upon selecting a waste concentration that would yield a high dose rate but have the smallest spill size. This small amount would be more difficult to detect by observation at some distance. A distance for the limit of observation was chosen as 10 feet. This means that it is assumed that a leak within ten (10) feet of a worker will be observed prompting a responsive action.

The selection of high heat supernate with a Cesium 137 content of $9.6 \text{ E}+00 \text{ Ci/gal}$ (Reference 2, Table 3-3) in a quantity of 0.06 gallons (about 8 ounces) provides a dose rate of 30 mrem/hr at 10 feet. This results in a single detection radius of 42 feet for those VAMPS located where the background is 0 - 5 mrem/hr, 34 feet for a background of 6 - 10 mrem/hr, and 30 feet for a background of 11 - 20 mrem/hr (Graph #1). The difference in radii versus background occurs since the VAMP nominal setpoints are:

- background + 2 mrem/hr for a background of 0 - 5 mrem/hr,
- background + 3 mrem for a background of 6 - 10 mrem/hr, and
- background + 4 mrem/hr for a background of 11 - 20 mrem/hr.

The source term chosen is an "average typical" value. It is not intended to be a limiting value for a waste concentration. A waste with a higher source term would initiate a VAMP alarm before 0.06 gallons were spilled with no significant change in the accumulated dose, while a lower source term would require a larger volume than the volume chosen.

Figures 1 through 10 of Ref. 1, attached, denote VAMP locations and were compiled from engineering drawings, the site map, and a walkdown of the facilities by HPT with facility personnel. Potential increased radiation sites outside the coverage areas such as valve houses, pumps, jets, etc., were identified during the evaluation and depicted on the figures listed below. Some tank top sites are identified using the riser identification.

Figures 11 through 20 of Ref. 1, attached, include the addition of the VAMP coverage areas to the maps and reflect the effect of shielding by structures/components. Using

these figures, a second series of walkdowns by facility engineering personnel identified additional potential leak sites that are outside the defined coverage areas. These additional sites were added to Table 1. With few exceptions, the background is ≤ 5 mrem/hr at current installations. Therefore, a 42 foot radius was used to define the coverage area for the purpose of this tabulation.

The probable sites for process upsets outside defined coverage, including those identified during facility engineering walkdowns, are listed in Table 1. Operational sketches (138-8 series) were used to identify the equipment located on the tank tops.

The current 9B5 Manual reporting criteria permits credit to be taken for a second area radiation monitor that is installed within five (5) feet of a degraded monitor.

Using the relationship of dose rate versus distance for a point source and ten versus five feet for the calculation:

$$R_2 = R_1 / (d_2 / d_1)^2$$

If the dose rate at 52 feet is 2 mrem/hr above background then the rate at 42 feet is approximately 3 mrem/hr. This ratio of 1.5 can then be applied to Graph 1 such that the rate at 10 feet is approximately 45 mrem/hr for a rate of 2 mrem/hr at 52 feet.

Although this increased rate would result in a higher accumulated dose with the assumptions presented in this document, HLWE and RCO conclude that this criteria is reasonable and justified based upon the following:

1. The risk associated with personnel exposure is low since once an area radiation monitor is determined to be inoperable, actions are procedurally initiated to either permanently replace the monitor, manually monitor, or install a portable monitor at that location. This minimizes the window of vulnerability that a particular area is without monitoring capability. If responding to an alarm condition, actions are initiated to stop transfers in the vicinity of the alarming monitor along with initiation of area surveys to determine existing conditions.
2. The assumption that personnel will remain within ten (10) feet of the postulated spill for a ten (10) hour period is considered conservative.

Once the following actions have been completed, it is the judgment of HLWE that the installed area radiation monitors will provide the monitoring intended by article 553 of the DOE Radiological Manual.

ACTIONS

Plant Modification Travelers (U-PMT-H-01266 and F-00569) have been issued for facility approval to install a VAMP(s) in the vicinity of the following components:

1. Tank 49 Valve Box
2. Tank 7 Transfer Line (riser 4) - Although there is no pump currently installed at riser 4, it is understood that Project S2081 will install a pump to be used for Waste Removal.
3. Tank 48/Process Building Transfer Lines.

As an interim measure, portable VAMPS will be installed at these locations. These PMTs and associated Work Requests will be prioritized and categorized by facility Work Scope Review Teams (WSRT) to determine priority and schedule.

REFERENCES:

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2. WSRC-RP-92-964, Justification For Continued Operation (U), April 1993.
3. W. C. Perkins and C. R. Lux, WSRC-TR-91-562, Releases From The Cooling-Water System In The Waste Tank Farm (U), January 27, 1992.
4. HLW Procedure 241-FH-156 T-R, Jetting From Waste Tank Annulus To A Waste Tank (U).
5. DPW-86-103, Operational Safety Requirements for Waste Management Operations, Rev. 1, February 23, 1989.
6. Rosenberger, K. H., ESH-HPT-93-0277, Waste Removal and Extended Sludge Processing, S2081 - Determination of Waste Spill Volumes to Alarm Gamma Monitors (U), May 28, 1994.
7. DPSTSA-200-10 SUP 18, ITP Safety Analysis Report, Table 2.7 Spent Wash Water (ITP).
8. Pike, J. A., HLW-HLE-94-0958, Tank Chemistry Report, October 1994 (U), November 18, 1994.
9. WSRC-RP-92-1044, Operational Safety Requirements, F- and H- Area High-Level Radioactive Waste Tank Farms (U).

TABLE 1

POTENTIAL RADIATION SITES (OUTSIDE DEFINED COVERAGE)

FIG	LOCATION	ITEM	NOTE	ACTION
11	TANK 35	HVAC	1	NONE
11	TANK 36	HVAC	1	NONE
11	TANK 36	VALVE HOUSE	5	NONE
11	TANK 37	HVAC	1	NONE
11	TANK 37	VALVE HOUSE	5	NONE
12	TANK 23	HVAC	1	NONE
12	TANK 24	TELESCOPING XFER JET	7	NONE
12	TANK 21	S. RISER (TRANSFER PUMP)	10	NONE
12	TANK 21	SE. RISER (SLURRY PUMP)	10	NONE
12	TANK 21	HVAC	1	NONE
12	TANK 22	S. RISER (TRANSFER PUMP)	10	NONE
12	TANK 22	SE. RISER (SLURRY PUMP)	10	NONE
12	TANK 22	HVAC	1	NONE
12	TANK 22	SW. RISER (SLURRY PUMP)	10	NONE
12	TANK 22	VALVE BOX	10	NONE
12	TANK 24	S. RISER (SLURRY PUMP)	8	NONE
12	TANK 24	HVAC	1	NONE
12	CTS	HVAC	1	NONE
12	TANK 32	A1 RISER (ANNULUS JET)	4	NONE
12	TANK 32	HVAC	1	NONE
12	TANK 29	HVAC	1	NONE
13	TANK 9	RISER 1 (TC WELL)	6	NONE
13	TANK 9	RISER 8 (PURGE INLET)	6	NONE
13	TANK 9	VALVE HOUSE	2	NONE
13	TANK 10	RISER 1 (SPRAY CHAMBER)	6	NONE
13	TANK 10	RISER 8 (SPRAY CHAMBER)	6	NONE
13	TANK 10	VALVE HOUSE	2	NONE
13	TANK 11	RISER 1 (SPRAY CHAMBER)	6	NONE
13	TANK 11	RISER 7 (BLANKED)	6	NONE
13	TANK 11	VALVE HOUSE	2	NONE
13	TANK 12	RISER 1 (SPRAY CHAMBER)	6	NONE
13	TANK 12	RISER 8 (SPRAY CHAMBER)	6	NONE
13	TANK 12	VALVE HOUSE	2	NONE
13	TANK 11	HVAC	1	NONE

TABLE 1 (cont.)

FIG	LOCATION	ITEM	NOTE	ACTION
13	CATCH TK	GANG VALVES	11	NONE
13	TANK 13	VALVE HOUSE (PARTIAL) *	5	NONE
13	TANK 14	HVAC (PARTIAL)	1	NONE
13	TANK 14	VALVE HOUSE	5	NONE
13	TANK 15	RISER 6 (INSPECTION PORT)	2	NONE
13	TANK 15	RISER 8 (SPRAY CHAMBER)	6	NONE
13	TANK 15	VALVE HOUSE	5	NONE
13	TANK 16	VALVE HOUSE	5	NONE
14	TANK 49	VALVE BOX		add vamp
14	TANK 48	TK 48 / PROCESS BLDG XFER LINES		add vamp
14	PP 5 & 6	HVAC	1	NONE
14	TANK 38	HVAC	1	NONE
14	TANK 39	HVAC	1	NONE
14	TANK 40	HVAC	1	NONE
14	TANK 41	HVAC	1	NONE
14	TANK 42	HVAC	1	NONE
14	TANK 43	HVAC	1	NONE
14	TANK 48	HVAC	1	NONE
14	TANK 49	HVAC	1	NONE
14	TANK 50	HVAC	1	NONE
14	TANK 51	HVAC	1	NONE
16	TANK 1	RISER 1 (SLURRY PUMP)	9	NONE
16	TANK 1	VALVE HOUSE	2	NONE
16	TANK 2	RISER 1 (SLURRY PUMP)	9	NONE
16	TANK 2	RISER 2 (ANNULUS JET INLET)	4	NONE
16	TANK 2	N. RISER (ANNULUS JET)	4	NONE
16	TANK 2	VALVE HOUSE	2	NONE
16	TANK 3	RISER 1 (SLURRY PUMP)	9	NONE
16	TANK 3	RISER 2 (ANNULUS JET INLET)	4	NONE
16	TANK 3	N. RISER (ANNULUS JET)	4	NONE
16	TANK 3	VALVE HOUSE	2	NONE
16	TANK 4	RISER 1 (SLURRY PUMP)	9	NONE
16	TANK 4	S. RISER (ANNULUS JET)	4	NONE
16	TANK 4	VALVE HOUSE	2	NONE
16	TANK 5	RISER 1 (SLURRY PUMP)	9	NONE
16	TANK 5	RISER 2 (ANNULUS JET INLET)	4	NONE

TABLE 1 (cont.)

FIG	LOCATION	ITEM	NOTE	ACTION
16	TANK 5	N. RISER (ANNULUS JET)	4	NONE
16	TANK 5	VALVE HOUSE	2	NONE
16	TANK 6	RISER 1 (SLURRY PUMP)	9	NONE
16	TANK 6	VALVE HOUSE	2	NONE
16	TANK 7	RISER 1 (NOT OBSERVED @ TK TOP)	3	NONE
16	TANK 7	TRANSFER LINE		add vamp
16	TANK 7	VALVE HOUSE	2	NONE
16	TANK 8	RISER 1 (SLURRY PUMP)	9	NONE
16	TANK 8	RISER 2 (INSPECTION PORT)	6	NONE
16	TANK 8	N. RISER (ANNULUS JET)	4	NONE
16	TANK 8	VALVE HOUSE	2	NONE
17	TANK 25	HVAC	1	NONE
17	TANK 26	HVAC	1	NONE
17	TANK 27	HVAC	1	NONE
17	TANK 28	HVAC	1	NONE
17	FDB-4	HVAC	1	NONE
17	TANK 44	HVAC	1	NONE
17	TANK 45	HVAC	1	NONE
17	TANK 46	HVAC	1	NONE
17	TANK 47	HVAC	1	NONE
17	EVAP	HVAC	1	NONE
18	TANK 18	NW RISER (SLURRY PUMP)	8	NONE
18	TANK 18	NE RISER (TRANSFER PUMP)	8	NONE
18	TANK 18	HVAC	1	NONE
18	CTS	HVAC	1	NONE
18	TANK 19	HVAC	1	NONE
18	TANK 20	HVAC	1	NONE
19	FDB-2	HVAC	1	NONE
19	TANK 33	RISER A4 (ANNULUS JET)	4	NONE
19	TANK 33	HVAC	1	NONE
19	TANK 34	RISER A4 (ANNULUS JET)	4	NONE
19	TANK 34	HVAC	1	NONE

* background 10 mrem/hr thus coverage radius of 34 feet

TABLE 1 NOTES:

1. HVAC structure is not required to be provided with continuous area radiation monitoring since the structure is not frequently occupied thus there is no requirement for continuous radiation monitoring.
2. No credible event could be postulated at this site which would cause an unexpected increase in dose rate. The siphoning of waste into the Cooling Water System is not considered credible for tanks 1 through 12 due to their elevation (Reference 3).
3. Although shown on operational sketches, no riser is observable at this location.
4. Jetting from a waste tank annulus requires establishing monitoring for radiation prior to and during the transfer (Reference 4). Permanent monitoring at these locations is not required.
5. No credible event could be postulated at this site which would cause an unexpected increase in dose rate, since a siphon mitigation program is required by reference 4 to prevent the occurrence of the postulated siphon event described in Reference 3.
6. No credible event could be postulated at this site which would cause an unexpected increase in dose rate. Maintenance activities will have appropriate RCO/RWP monitoring requirements.
7. Based upon the chemical analysis given in the October 1994 Tank Chemistry Report (Ref. 8), the gamma activity of the Tank 24 supernate was determined to be $2.07 \text{ E}+07 \text{ d/m/ml}$. This converts to a concentration of $3.5 \text{ E}-02 \text{ Ci/gal}$. This is comparable to the wash water of tank 21 as discussed in Note 10, below. The large quantity of liquid required to alarm the VAMP would be observable to personnel thus no additional VAMP installations are deemed necessary.
8. The pump at this location is not operable, thus no additional monitoring is justified. Slurry Pumps will not be operated until a improved top seal and secondary containment is installed.
9. Although the operational sketches indicate a Slurry Pump at this location, no Slurry Pump is installed on this tank, thus no additional monitoring is justified.
10. A review of a potential spill involving components at Tank 21 or 22 indicated that a significant quantity of liquid would have to be present before endangering personnel. A spill of approximately 75 gallons of tank 21 wash water (Cs-137 =

3.040 E-02 Ci/gal) would be required to alarm a VAMP at 50 feet. Since the source term associated with Tank 22 is smaller ($\text{Cs-137} = 2.5 \text{ E-03 } \mu\text{Ci/L}$) than that of Tank 21, an even larger spill is required (Ref. 6 & 7). A spill of this nature would be apparent to personnel and one would not be expected to linger at the spill site. Therefore, it is concluded that additional VAMP installations are not required at Tanks 21 and 22 for personnel protection.

11. The Catch Tank contents are reasonably clean water per Section 3.3.4.3 of Ref. 9. Therefore, no additional monitoring is required for personnel protection at the Catch Tank Gang Valves.

GRAPH 1

Dose Rate Versus Distance From a 0.06 Gallon Spill of High Heat Supernate

Figure is taken from Technical Support Group Calculation Number KHR0188.

ATTACHMENT TO

WSRC-TR-95-0004

**FIGURES 1 THROUGH 20
OF ESH-HPT-94-0154**

Figure 1
Area Radiation
Monitor Locations
H-Area Tank Farm
Old Hill West End

Figure 2
Area Radiation Monitor
Locations
H-Area Tank Farm
Old Hill East End

Figure 3
Area Radiation Monitor
Locations
H-Area Tank Farm
Type I and II Tanks

Figure 4
Area Radiation Monitor
Locations
H-Area Tank Farm
New Hill

Figure 5
Area Radiation Monitor
Locations
H-Area Tank Farm
East and West Pump Houses

Figure 6
Area Radiation Monitor
Locations
F-Area Tank Farm
Northeast Corner

Figure 7
Area Radiation Monitor
Locations
F-Area Tank Farm
Southwest Corner

Figure 8
Area Radiation Monitor
Locations
F-Area Tank Farm
Northwest Corner

Figure 9
Area Radiation Monitor
Locations
F-Area Tank Farm
Southeast Corner

Figure 10
Area Radiation Monitor
Locations
F-Area Tank Farm
Pumphouses

Figure 11
Area Radiation Monitor
Coverage Areas
H-Area Tank Farm
Old Hill West End

Figure 13
Area Radiation Monitor
Coverage Areas
H-Area Tank Farm
Type I and II Tanks

Figure 14
Area Radiation Monitor
Coverage Areas
H-Area Tank Farm
New Hill

Key

- * Monitor Location
- Detection Area With Background of 0-5 mrem/hr
- Detection Area With Background of 6-10 mrem/hr

Scale: 0' 20' 40' 60' 80'

Figure 15
Area Radiation Monitoring
Coverage Areas
H-Area Tank Farm
East and West Pump Houses

Figure 16
Area Radiation Monitor
Coverage Areas
F-Area Tank Farm
Northeast Corner

Figure 17
Area Radiation Monitor
Coverage Areas
F-Area Tank Farm
Southwest Corner

Figure 18
Area Radiation Monitor
Coverage Areas
F-Area Tank Farm
Northwest Corner

Figure 19
Area Radiation Monitor
Coverage Areas
F-Area Tank Farm
Southeast Corner

Key

* Monitor Location

○ Detection Area With
Background of 0-5 mrem/hr

● Detection Area With
Background of 6-10 mrem/hr

Scale: 0' 20' 40' 60'

Figure 20
Area Radiation Monitor
Coverage Areas
F-Area Tank Farm
Pumphouses