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Surface Radiological Investigations
at the Proposed SWSA 7 Site,
Oak Ridge National Laboratory,
Oak Ridge, Tennessee

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M. E. Murray
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HEALTH SCIENCES RESEARCH DIVISION

Surface Radiological Investigations at the Proposed SWSA 7 Site,
Oak Ridge National Laboratory, Oak Ridge, Tennessee

S. P. McKenzie
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Oak Ridge National Laboratory

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The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry, no matter how small, should be recorded to ensure the integrity of the financial statements. This includes not only sales and purchases but also expenses, income, and any other financial activity.

The second part of the document provides a detailed explanation of the accounting cycle. It outlines the ten steps involved in the process, from identifying the accounting entity to preparing financial statements. Each step is described in detail, with examples provided to illustrate the concepts.

The third part of the document discusses the various types of accounts used in accounting. It explains the difference between assets, liabilities, and equity accounts, as well as the classification of expenses and revenues. It also covers the concept of debits and credits, and how they are used to record transactions.

The fourth part of the document discusses the importance of adjusting entries. It explains how these entries are used to ensure that the financial statements reflect the true financial position of the company at the end of the accounting period. Examples are provided to show how adjusting entries are prepared.

The fifth part of the document discusses the preparation of financial statements. It explains how the adjusted trial balance is used to prepare the income statement, balance sheet, and statement of owner's equity. It also discusses the importance of comparing the financial statements to the company's performance and the industry as a whole.

The sixth part of the document discusses the importance of internal controls. It explains how these controls are used to prevent and detect errors and fraud, and to ensure the accuracy and reliability of the financial information. Examples are provided to show how internal controls are implemented.

The seventh part of the document discusses the importance of ethics in accounting. It explains how accountants are expected to act in a fair and honest manner, and to follow the principles of professional conduct. Examples are provided to show how ethical decisions are made.

The eighth part of the document discusses the importance of communication in accounting. It explains how accountants must be able to communicate effectively with their clients, colleagues, and the public. Examples are provided to show how communication is used in the accounting profession.

The ninth part of the document discusses the importance of technology in accounting. It explains how the use of computers and software has revolutionized the accounting profession, and how accountants must stay up-to-date on the latest technology. Examples are provided to show how technology is used in accounting.

The tenth part of the document discusses the importance of continuous learning in accounting. It explains how accountants must constantly update their skills and knowledge to stay relevant in a rapidly changing industry. Examples are provided to show how continuous learning is achieved.

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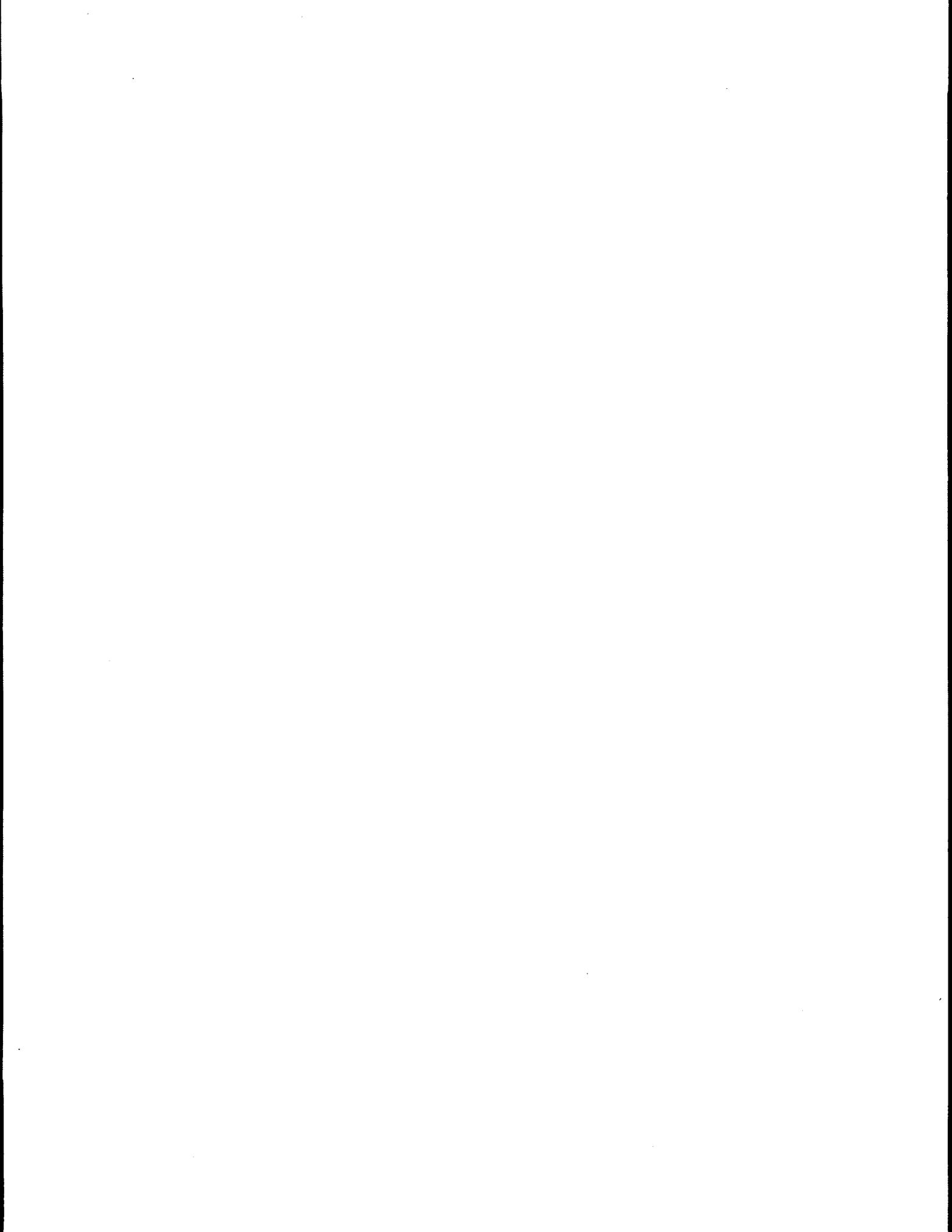
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ABSTRACT

A surface radiological investigation was conducted intermittently from June 1994 to June 1995 at the proposed site for Solid Waste Storage Area (SWSA) 7. Forty-two 10- by 10-ft plots were surveyed to give general coverage of the area and to give more thorough coverage of projected building sites and storage areas. Three additional plots were examined outside the SWSA 7 area.

Surface soil at the proposed SWSA 7 site contained many particles of insoluble strontium, which was most probably strontium titanate. No other major beta or gamma contaminants were found. The particles were widely distributed with greater numbers present in the southern part of the site and in the top 6 in. of soil. Two plots with no particles on the surface contained subsurface particles. Particles identified during this survey ranged up to 9700 dpm, but most were <1500 dpm. Activity seemed to be randomly distributed—that is, the hottest particles were not concentrated in any particular plots or at any particular soil depth.

The insoluble ^{90}Sr particles may have originated from SWSA 5 during the solid waste disposal of material from Building 3517 into the SWSA 5 trenches. This assumption is based on historical evidence and the following survey results:

1. the particles were present in much higher numbers near SWSA 5,
2. the particles were absent on top of Haw Ridge, and
3. the particles were absent on the north side of Haw Ridge toward the ORNL main plant area and Building 3517 where this material was originally produced.

It is recommended that any work in the SWSA 7 area that disturbs the ground should be closely monitored and preferably preceded by a surface survey of this type to define more precisely how closely the job will need to be monitored. When newly excavated soil dries, exposed particles can potentially become airborne and quickly become an inhalation hazard.

It is further recommended that Melton Valley be systematically surveyed to better define the pattern of particle deposition and the plume or plumes from which these particles were originally deposited. Systematic coverage could best be accomplished by surveying 1-m² plots, established at ~1000-ft intervals, radiating in various directions from the SWSA 5 boundary and extending beyond the outermost boundary of particle deposition.

1. INTRODUCTION

A surface radiological investigation was conducted intermittently from June 1994 to June 1995 at the proposed site for Solid Waste Storage Area (SWSA) 7. The survey was performed by the Measurement Applications and Development (MAD) Group, Health Sciences Research Division, Oak Ridge National Laboratory (ORNL) at the request of ORNL Waste Management and Remedial Action Division personnel.

Figure 1 shows the location of the proposed SWSA 7 site in relation to the ORNL main plant area and primary local roads.

The stimulus for this survey was provided by the location of this site in relation to earlier incidences. In June 1992 a man's trousers became contaminated with ^{90}Sr while he was reviewing work on top of the High Flux Isotope Reactor (HFIR) cooling tower. Radiation surveys identified ^{90}Sr on the roofs of older buildings at the HFIR site. Since no ^{90}Sr was found on buildings built between 1988 and 1990, the ^{90}Sr was thought to have been deposited prior to 1988 (Appendix A). Later in 1992, beta particles were identified on a bulldozer that had been used in a wooded area southwest of the Health Physics Research Reactor (HPRR) Access Road (Appendix A). A subsequent surface survey in the area revealed numerous minute particles that "could be easily missed by slow-speed scanning" (Appendix A). More recently in April 1995, ^{90}Sr particles were identified on the top side of ceiling tiles in the overhead area of a building in the HFIR Complex (Appendix A). Considering that the proposed SWSA 7 site was located between the HFIR complex and the HPRR Access Road, it was deemed prudent to investigate the possibility that beta particles might also be present at the SWSA 7 site.

A possible explanation for the presence of these particles has been provided by long-time ORNL employees and retirees.* Strontium-90 as the titanate was developed in the early 1960s as part of the Systems for Nuclear Auxiliary Power (SNAP) Program. The idea was to produce an insoluble compound of ^{90}Sr so that a capsule failure at sea would not result in contamination of the oceans. Most of the isotopic SNAP sources were used as weather stations in the arctic, as sonar beacons in the Atlantic, and as light beacons in the Chesapeake Bay.

Strontium titanate ($^{90}\text{SrTiO}_3$) was produced at the Fission Product Development Laboratory (Building 3517) in the ORNL main plant area. Waste from the process was loaded into a 1-in. lead-lined dumpster, which was transferred to SWSA 5 where it was dumped into a trench. Dumping allowed some particles to become airborne, which resulted in what was referred to as the "The Problem"—controlling the spread of particles at the SWSA. To minimize the spread of particles, special 3-in. lead-lined stainless steel dumpsters were fabricated that were smaller than regular dumpsters and could be lowered into the trench before dumping. This resulted in a contaminated dumpster and dumpster rack, which had to

*Material collected and provided by J. K. Williams of the Health Sciences Research Division, ORNL (See Appendix A).

be decontaminated. Around 1969, a cask was designed that was used to fill a 55-gal drum that could be later lowered into the trench, thus eliminating the particle problem.

Radiation detection instrumentation at that time was less sensitive than it is today. This was many years prior to the now common Geiger-Mueller (GM) pancake detectors. At that time, particles were detected with a GM end-window survey meter and picked up with tape for disposal. Particles of up to 20 mrad/h were detected, but the vast majority were smaller (Appendix A).

Considering the layout of the ridges around ORNL and the direction of the wind,* it was considered possible that some of the particles might have spread in the direction of HFIR, HPRR, and the proposed SWSA 7 site. Therefore, this surface radiological survey was undertaken to determine if the SWSA 7 site was radiologically contaminated and to what degree.

*Prevailing winds are generally up-valley from the southwest and west-southwest, or down-valley from the northeast and east-northeast. The pattern is the result of the channeling effect of the ridges. Winds in the valleys tend to follow the ridges, with limited cross-ridge flow. Any material released in the valley winds would tend to stay within the valley.¹

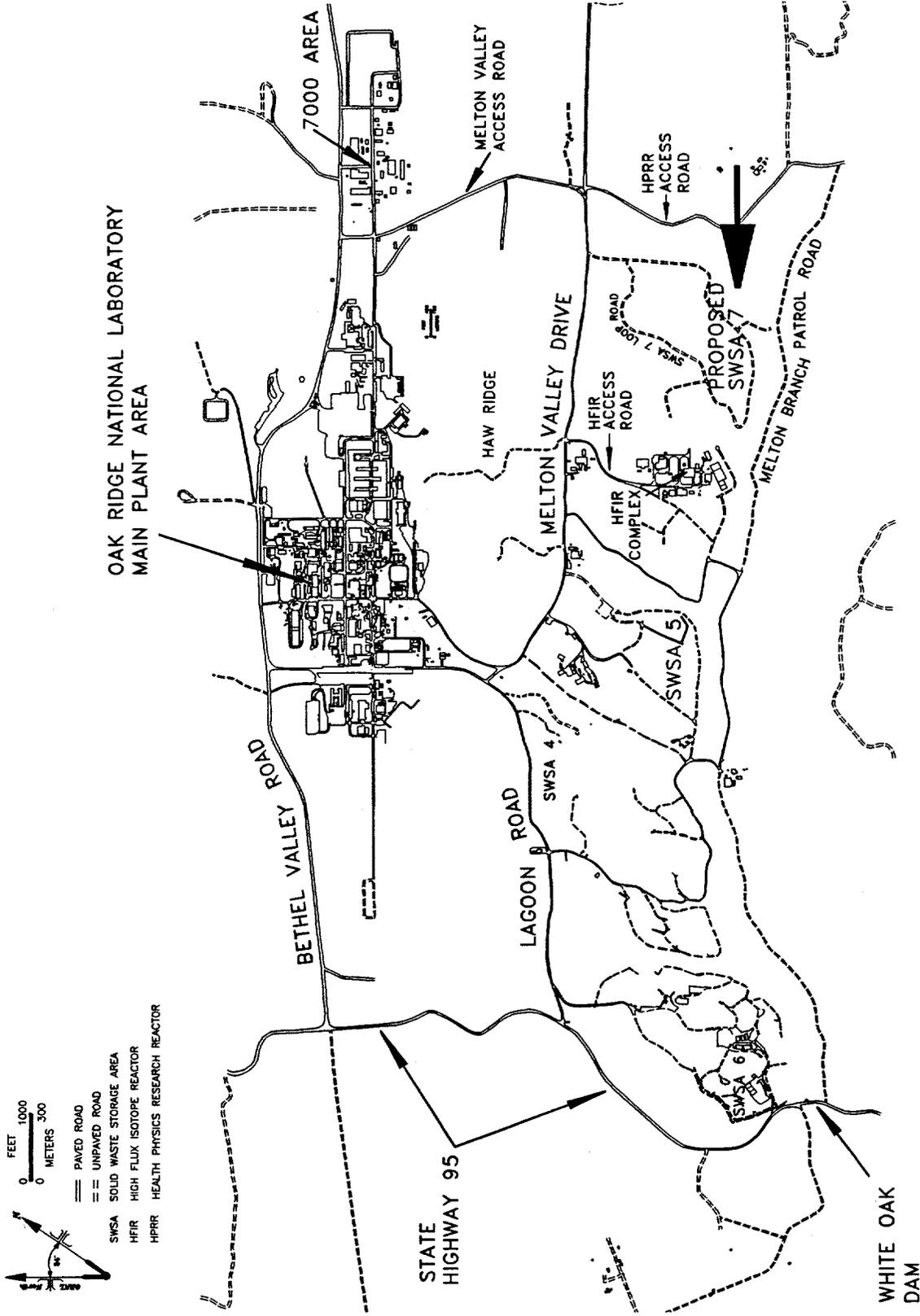


Fig. 1. Diagram showing general location of the proposed SWSA 7 site.

2. SURVEY METHODS

A description of typical methods and instrumentation providing guidance for the conduct of this survey is presented in *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*.² Guidelines for the use and calibration of instruments are given in *Measurement Applications and Development Group Guidelines*.³ All direct-measurement results presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations measured in environmental samples.

2.1 GAMMA RADIATION

Surface gamma radiation was measured with a sodium iodide (NaI) scintillation probe connected to a Victoreen Model 490 Thyac III ratemeter. Because NaI gamma scintillators are energy-dependent, measurements of gamma radiation levels made with these instruments must be normalized to pressurized ionization chamber (PIC) measurements to estimate gamma exposure rates. The function developed for these conversions is

$$y = CF \times x$$

where

y = the exposure rate ($\mu\text{R/h}$),

CF = the slope of the regression line calculated by plotting a selected number of PIC measurements ($\mu\text{R/h}$) vs scintillometer measurements (kcpm) at the same locations,

x = the scintillometer measurements in thousand counts per minute (kcpm).

At this site, CF = 3 .

2.2 BETA-GAMMA RADIATION

A Bicon miniscaler/ratemeter with a Geiger-Mueller (GM) pancake detector was used to detect beta-gamma radiation. After characterization of the detectors with known beta fields,⁴ beta radiation detection levels in counts per minute were converted to dose rates in millirads per hour using the following relationship:

$$2500 \text{ cpm} = 1 \text{ mrad/h} .$$

The absolute efficiency of the pancake probe when using a ⁹⁰Sr point source is ~44%. Therefore, detection levels in counts per minute were converted to disintegrations per minute using the following relationship:

$$\text{cpm}/0.44 = \text{dpm} .$$

The absolute efficiency of the pancake probe for detection of gamma radiation is ~1%. Therefore, surface scans with the pancake probe in the open position are referred to as "beta scans."

2.3 SURVEY PLOTS

Forty-two 10- by 10-ft survey plots were randomly staked off to give general coverage of the proposed SWSA 7 area and to give more thorough coverage of projected building sites and storage areas. General locations of the 42 plots are shown in Fig. 2.

When it was determined that hot particles were widely distributed throughout the proposed SWSA 7 site, three additional plots (Plots 43, 44, and 45) were established in an attempt to determine where the particles had originated.

There were two possible points of origin: (1) Building 3517 where the particles were produced or (2) SWSA 5 where the particles were disposed of. Building 3517 is located in the ORNL main plant complex in Bethel Valley. SWSA 5 is located in Melton Valley, which is separated from Bethel Valley by Haw Ridge. Therefore, a 5- by 5-ft plot was staked off on the north side of Haw Ridge (Plot 44) near the main plant area, another on top of Haw Ridge (Plot 45), and a third near SWSA 5 (Plot 43). The plot near SWSA 5 was reduced to 5- by 1-ft after the particle count began. General locations of Plots 43, 44, and 45 are shown in Fig. 3.

2.4 SURVEY PROCEDURES

General survey procedure for the first 36 plots:

1. A surface gamma scan was conducted at the undisturbed plot.
2. A surface beta scan was conducted at the undisturbed plot to obtain a record of typical plot beta levels.
3. All elevated spots (particles) at least 230 dpm (100 cpm)* above typical plot beta-gamma levels were flagged and the count rate recorded.
4. The top layer of leaves representing roughly one year's leaf fall was raked away.
5. The beta scan was repeated on the lightly raked plot.
6. All elevated spots were identified, the count rate determined and recorded.
7. The plot was raked to the bare ground and the beta scan repeated.
8. All elevated spots were again identified, counted, and recorded.
9. A final gamma scan was conducted over the thoroughly raked plot.

*Some survey teams identified particles >455 dpm (200 cpm). The general tendency of the survey team was to raise the lower limit for classifying a particle as a "hot" particle in plots that contained large numbers of particles.

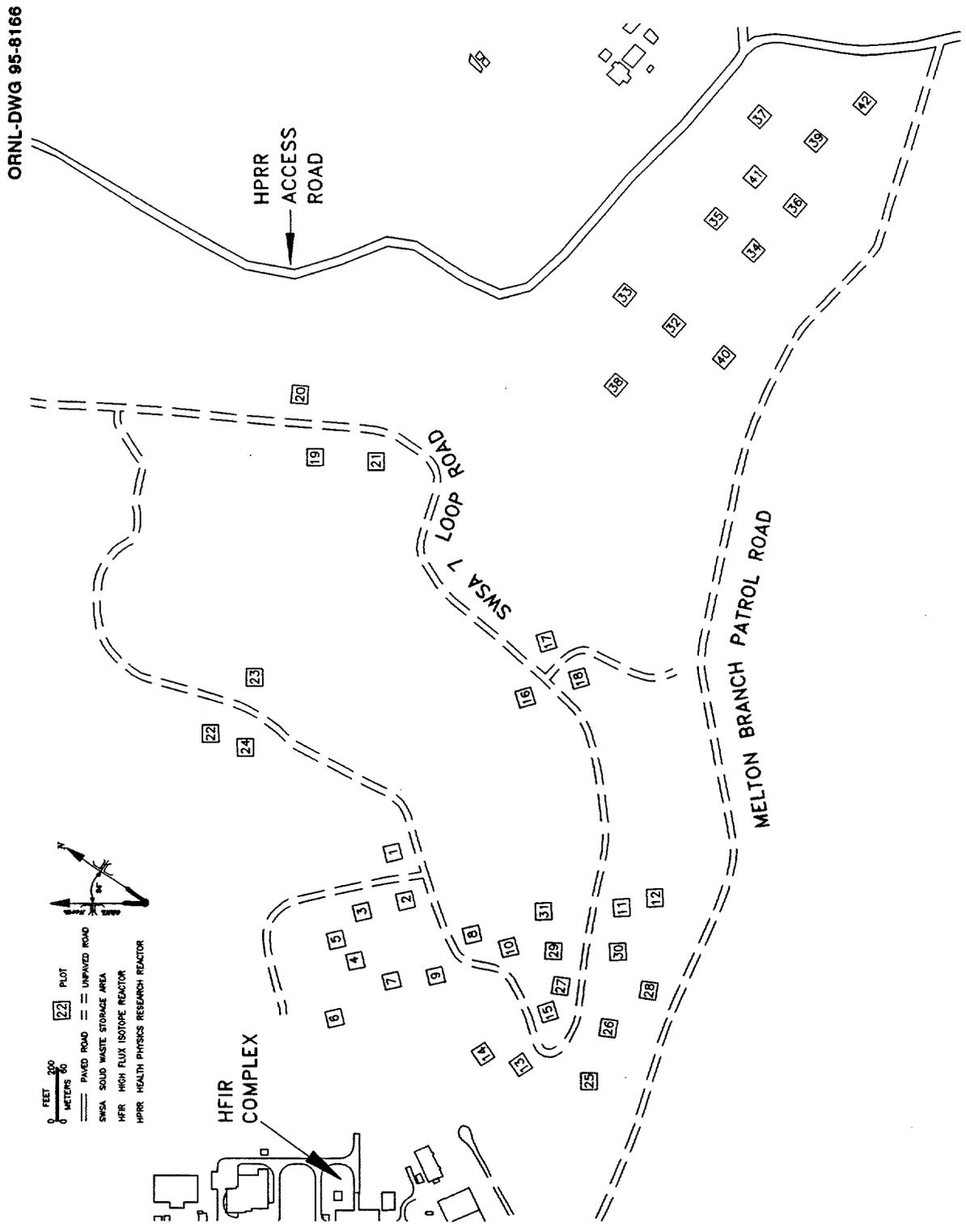


Fig. 2. Diagram showing general location of 42 survey plots at the proposed SWSA 7 site. [Plots enlarged (-6x) for visibility on this drawing.]

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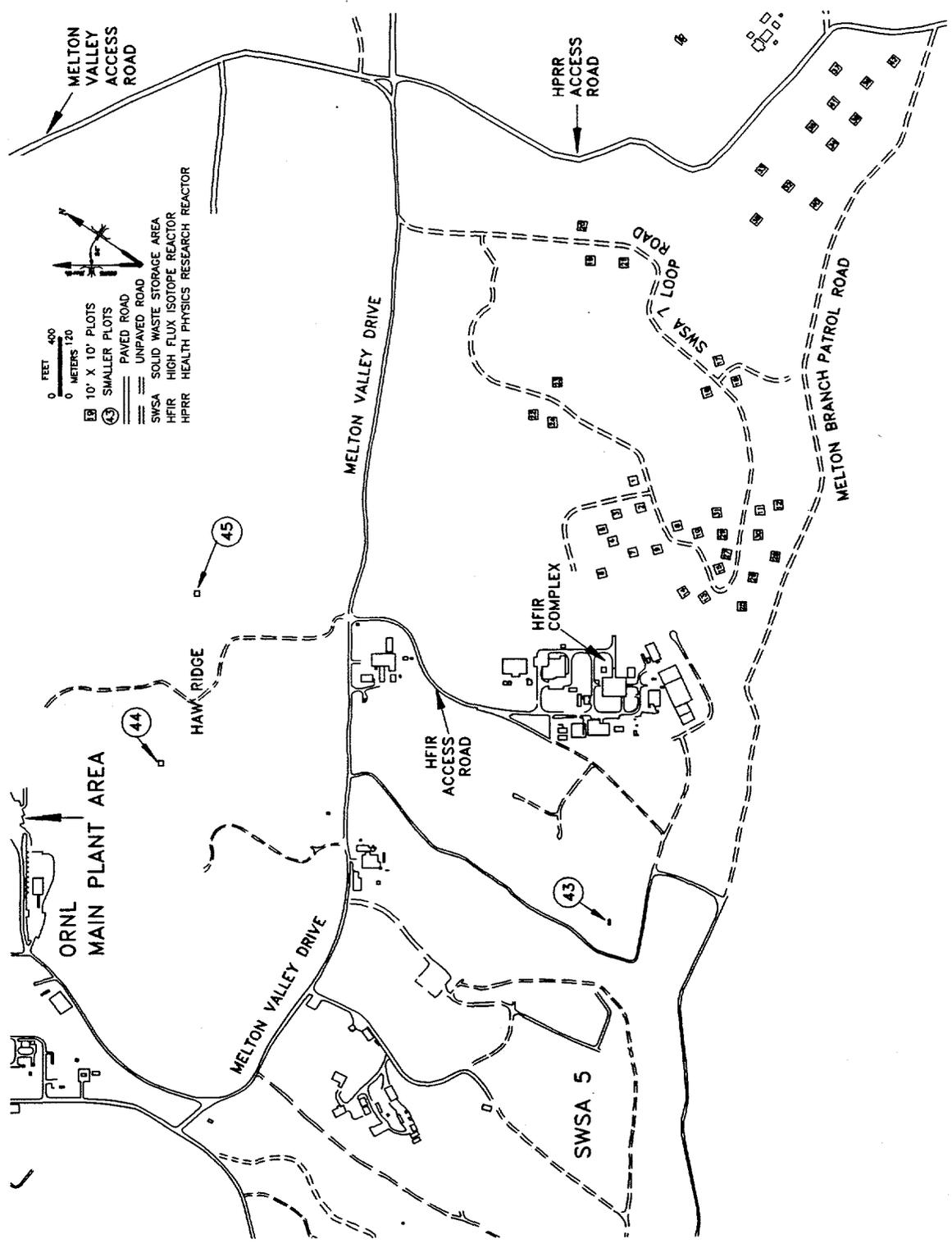


Fig. 3. Diagram showing location of plots 43, 44, and 45 in relation to SWSA 5 and the original 42 survey plots.
 [Plots enlarged (~6x) for visibility on this drawing.]

Beginning with Plot 36, survey procedures were revised to omit the first beta scan. Previously identified particles had been mainly located in the soil rather than on top of the leaves. Plots 36 through 42 were lightly raked and only the final two beta scans conducted. Therefore, steps 2 and 3 of the previously listed survey procedures were omitted for Plots 36 through 42, 44, and 45. Survey procedures at Plot 43 included Steps 1, 4, 6, and 9 before proceeding to the depth profile described below.

All elevated particles identified in Plots 1 through 31 were collected as composite sample material. At that point it was determined that enough sample material had been obtained, and particles identified in Plots 32 through 43 were left in place.

2.5 DEPTH PROFILES

In order to determine how deep the particles were buried, depth profiles were conducted on Plots 6, 13, 18, 39, and 43. Soil was systematically scraped away (usually 1 or 2 in. at a time) and particle counts were repeated at each depth until the particle count decreased significantly.

2.6 ENVIRONMENTAL SAMPLE

Particles from Plot 27 were isolated and combined into a single sample that was submitted to ORNL Chemical and Analytical Services Division for analysis of gross beta, ^{90}Sr , and ^{90}Y . Particles for Plot 27 were also submitted for analysis on the HNU X-Ray System 5000.

3. SURVEY RESULTS

3.1 GAMMA EXPOSURE RATES

Background gamma exposure rates measured in uncontaminated areas on the Oak Ridge Reservation generally range from 10 to 17 $\mu\text{R}/\text{h}$ at the ground surface.⁵ Similar levels ranging from 7 to 20 $\mu\text{R}/\text{h}$ were measured at the proposed SWSA 7 site (Table 1). No elevated gamma radiation levels were found in any of the plots either before the plot was disturbed or after the plot was raked to the bare ground. No gamma activity was associated with any of the hot particles.

3.2 BETA ACTIVITY RANGES

Results of the three beta scans are shown in Table 2. Beta activity of individual particles is excluded from this table, although the number of particles identified after the surface beta scan is included. In general, beta activity ranged within the typical background levels [75 to 200 dpm (30 to 90 cpm)] when no particles or only a few particles were present. The presence of numerous hot particles tended to increase beta activity ranges above typical background levels.

3.3 PARTICLES

Total number of particles per plot and average and maximum particle activity are shown in Table 3. Particle activity ranged up to 9700 dpm (Table 3), but most particles were <1500 dpm (Fig. 4). Activity seemed to be randomly distributed—that is, the hottest particles were not concentrated in any particular plots or at any particular soil depth.

In Fig. 5, the total number of particles identified in each plot has been placed on an area drawing to show that the largest numbers of particles were located at the southern end of the proposed SWSA 7 site. The plot on top of Haw Ridge and on the north side of Haw Ridge contained no hot particles.* A single scan after a light raking at Plot 43 near SWSA 5 produced ~5 particles per ft^2 (Table 4). Thus, it can be estimated that >500 hot particles can be found at the surface in a 10- by 10-ft plot near SWSA 5.

Using data from various sources,^{6,7} the typical particle at SWSA 7 was calculated to be $\sim 5.5 \times 10^{-12} \text{ cm}^3$ with a diameter of ~ 0.02 microns. (See Appendix B.)

*Similar results were noted by personnel from the ORNL Office of Radiation Protection in earlier surveys (personal communication, W. C. Hayes, Office of Radiation Protection, ORNL, to S. P. McKenzie, Health Sciences Research Division, ORNL, May 1995).

Table 1. Surface gamma exposure rates at survey plots

Plot No.	Size (ft)	Surface gamma exposure rates ^a ($\mu\text{R/h}$)	Final surface gamma exposure rates ^b ($\mu\text{R/h}$)
1	10×10	9-10	8-10
2	10×10	12-15	12-15
3	10×10	11-14	10-15
4	10×10	10-12	10-12
5	10×10	9-12	9-12
6	10×10	10-12	10-12
7	10×10	12-16	14-16
8	10×10	12-15	12-18
9	10×10	12-19	12-20
10	10×10	12-20	9-14
11	10×10	9-14	10-14
12	10×10	9-12	10-14
13	10×10	10-14	10-12
14	10×10	10-14	11-13
15	10×10	11-13	10-14
16	10×10	10-13	10-11
17	10×10	8-11	9-12
18	10×10	10-13	10-13
19	10×10	8-12	9-11
20	10×10	9-12	10-12
21	10×10	10-12	10-12
22	10×10	10-13	10-12
23	10×10	9-11	10-13
24	10×10	10-12	10-13
25	10×10	9-12	10-12
26	10×10	9-12	8-11

Table 1 (continued)

Plot No.	Size (ft)	Surface gamma exposure rates ^a (μ R/h)	Final surface gamma exposure rates ^b (μ R/h)
27	10×10	9-12	9-12
28	10×10	8-11	8-10
29	10×10	7-11	9-11
30	10×10	8-10	8-9
31	10×10	8-10	10-12
32	10×10	8-10	8-10
33	10×10	8-9	8-10
34	10×10	8-12	8-12
35	10×10	8-10	8-12
36	10×10	8-11	9-10
37	10×10	9-12	10-12
38	10×10	10-12	8-11
39	10×10	10-12	10-14
40	10×10	8-10	8-9
41	10×10	10-14	9-10
42	10×10	9-14	9-11
43	5×1	10-12	6-8 ^c
44	5×5	10-12 ^d	10-12
45	5×5	8-9 ^d	8-10

^aGamma scan at undisturbed plot.

^bGamma scan after plot raked to bare ground.

^cGamma exposure rates at depth of 6 in.

^dAfter plot raked lightly.

Table 2. Beta activity ranges (excluding hot particles) and number of particles identified after each beta scan at survey plots

Plot No.	Beta activity range, 1st scan ^a (dpm)	No. particles identified after 1st beta scan ^b	Beta activity range, 2nd scan ^c (dpm)	No. particles identified after 2nd beta scan ^b	Beta activity range, 3rd scan ^d (dpm)	No. particles identified after 3rd beta scan ^b
1	100-140	0	86-150	2	100-200	1
2	91-140	0	98-130	1	91-160	1
3	75-140	0	91-140	0	100-160	0
4	100-140	0	110-160	0	98-150	2
5	100-200	0	95-170	0	100-190	2
6	100-160	1	110-160	1	98-180	3
7	100-170	0	120-160	0	110-160	2
8	87-120	1	110-160	1	100-140	2
9	120-150	1	120-160	1	120-160	1
10	120-160	2	130-160	1	130-160	2
11	98-130	0	100-140	0	120-140	1
12	130-160	1	140-180	4	120-150	1
13	170-200	6	190-220	11	190-220	6
14	180-200	7	180-210	6	200-220	13
15	200-280	24	210-260	18	200-250	14
16	110-140	0	86-120	0	86-140	2
17	100-140	0	120-150	0	110-140	2
18	130-170	0	120-200	1	130-230	2
19	110-180	0	120-160	0	95-180	2
20	120-160	0	140-190	0	130-200	0
21	120-180	0	120-180	0	120-230	0
22	120-180	0	110-180	0	130-190	0
23	100-140	1	100-170	0	120-190	0
24	110-200	0	110-160	0	110-180	0

Table 2 (continued)

Plot No.	Beta activity range, 1st scan ^a (dpm)	No. particles identified after 1st beta scan ^b	Beta activity range, 2nd scan ^c (dpm)	No. particles identified after 2nd beta scan ^b	Beta activity range, 3rd scan ^d (dpm)	No. particles identified after 3rd beta scan ^b
25	160-210	0	140-310	6	130-320	16
26	120-300	2	130-230	6	130-280	31
27	120-270	5	120-330	4	130-420	33
28	100-240	6	120-200	4	110-420	43
29	86-160	1	93-210	4	130-380	26
30	91-180	0	110-160	2	120-180	9
31	92-160	2	91-200	7	110-190	3
32	87-140	0	100-150	0	120-180	7
33	110-150	0	91-230	3	120-210	4
34	95-160	0	110-160	15	98-180	16
35	98-160	0	100-160	4	110-160	15
36	<i>f</i>	<i>f</i>	140-200	11	150-200	16
37	<i>f</i>	<i>f</i>	110-190	4	120-200	5
38	<i>f</i>	<i>f</i>	130-180	8	110-160	8
39	<i>f</i>	<i>f</i>	130-220	10	140-210	9
40	<i>f</i>	<i>f</i>	110-160	4	100-160	8
41	<i>f</i>	<i>f</i>	77-140	2	110-180	3
42	<i>f</i>	<i>f</i>	120-200	4	150-230	7
43	<i>f</i>	<i>f</i>	<i>g</i>	<i>g</i>	<i>g</i>	<i>g</i>
44	<i>f</i>	<i>f</i>	110-270	0	100-280	0
45	<i>f</i>	<i>f</i>	93-170	0	110-170	0

^aBeta activity range at undisturbed plot.

^bActivity of hot particles shown in Table 3.

^cBeta activity range after top layer of leaves (representing ~1 year's leaf fall) raked away.

^dBeta activity range after plot raked to bare ground.

^eSurvey procedures revised to omit beta scan before leaves raked.

^fSee Table 4.

Table 3. Beta-gamma dose rates, number of hot particles, and activity of hot particles at 42 10- by 10-ft survey plots at the proposed SWSA 7 site

Plot No.	Beta-gamma dose rates ^a (mrad/h)	Number hot particles				Particle activity (dpm)	
		Scan 1 ^b	Scan 2 ^c	Scan 3 ^d	Total	Average	Maximum
1	0.02-0.04	0	2	1	3	1100	1400
2	0.02-0.03	0	1	1	2	1500	2400
3	0.01-0.03	0	0	0	0	<i>e</i>	<i>e</i>
4	0.02-0.03	0	0	2	2	1000	1400
5	0.02-0.04	0	0	2	2	1200	1500
6	0.02-0.03	1	1	3	5	710	2000
7	0.02-0.03	0	0	2	2	2300	2400
8	0.02-0.03	1	1	2	4	590	900
9	0.02-0.03	1	1	1	3	930	1100
10	0.02-0.03	2	1	2	5	3400	9600
11	0.02-0.03	0	0	1	1	700	700
12	0.02-0.03	1	4	1	6	1600	2700
13	0.03-0.04	6	11	6	23	1100	3300
14	0.03-0.04	7	6	13	26	850	2300
15	0.04-0.05	24	18	14	56	1100	4900
16	0.02-0.03	0	0	2	2	1200	2000
17	0.02-0.03	0	0	2	2	1600	2400
18	0.02-0.04	0	1	2	3	2600	5800
19	0.02-0.03	0	0	2	2	1400	1900
20	0.02-0.04	0	0	0	0	<i>e</i>	<i>e</i>
21	0.02-0.04	0	0	0	0	<i>e</i>	<i>e</i>
22	0.02-0.03	0	0	0	0	<i>e</i>	<i>e</i>
23	0.02-0.03	1	0	0	1	870	870
24	0.02-0.04	0	0	0	0	<i>e</i>	<i>e</i>
25	0.02-0.06	0	6	16	22	1800	9500
26	0.02-0.05	2	6	31	39	1600	4000
27	0.02-0.07	5	4	33	42	1300	9700
28	0.02-0.07	6	4	43	53	1500	5500

Table 3 (continued)

Plot No.	Beta-gamma dose rates ^a (mrad/h)	Number hot particles			Particle activity (dpm)		
		Scan 1 ^b	Scan 2 ^c	Scan 3 ^d	Total	Average	Maximum
29	0.02-0.07	1	4	26	31	660	1900
30	0.02-0.03	0	2	9	11	760	1900
31	0.02-0.03	2	7	3	12	400	900
32	0.02-0.03	0	0	7	7	680	1100
33	0.02-0.04	0	3	4	7	1400	2400
34	0.02-0.03	0	15	16	31	1200	5700
35	0.02-0.03	0	4	15	19	730	1500
36	0.02-0.03	<i>f</i>	11	16	27	840	3700
37	0.02-0.04	<i>f</i>	4	5	9	840	1700
38	0.02-0.03	<i>f</i>	8	8	16	790	2500
39	0.02-0.04	<i>f</i>	10	9	19	1000	3100
40	0.02-0.03	<i>f</i>	4	8	12	1100	5000
41	0.01-0.03	<i>f</i>	2	3	5	810	5100
42	0.02-0.04	<i>f</i>	4	7	11	810	2600

^aCompilation of beta-gamma scans, excluding hot spots.

^bScan 1 conducted on top of leaves.

^cScan 2 conducted with top layer of leaves raked away.

^dScan 3 conducted with plot raked to bare ground.

^eNot applicable.

^fSurvey procedures revised to exclude Scan 1.

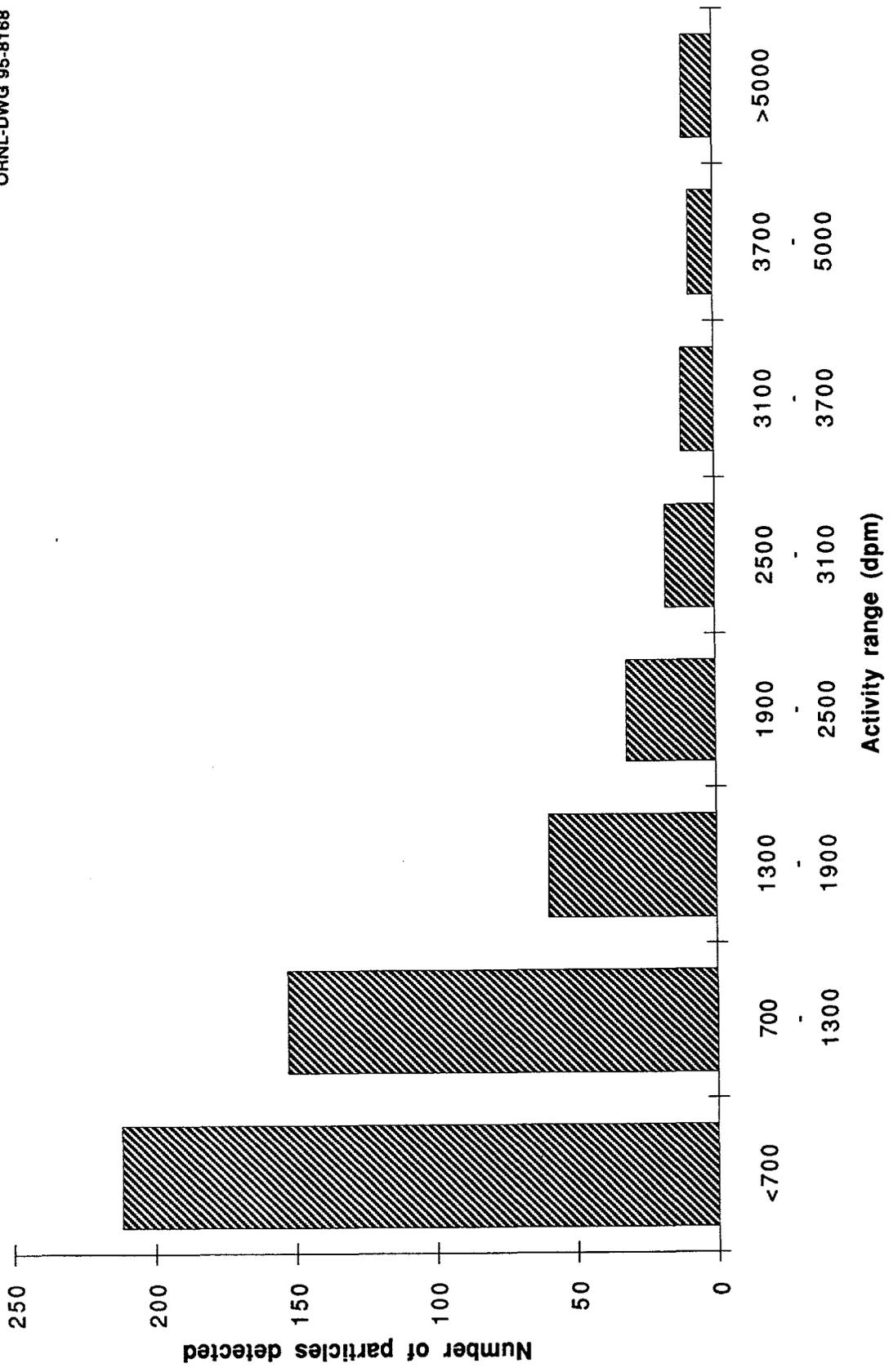


Fig. 4. Distribution of particle intensity for surface ⁹⁰Sr particles detected in survey plots.

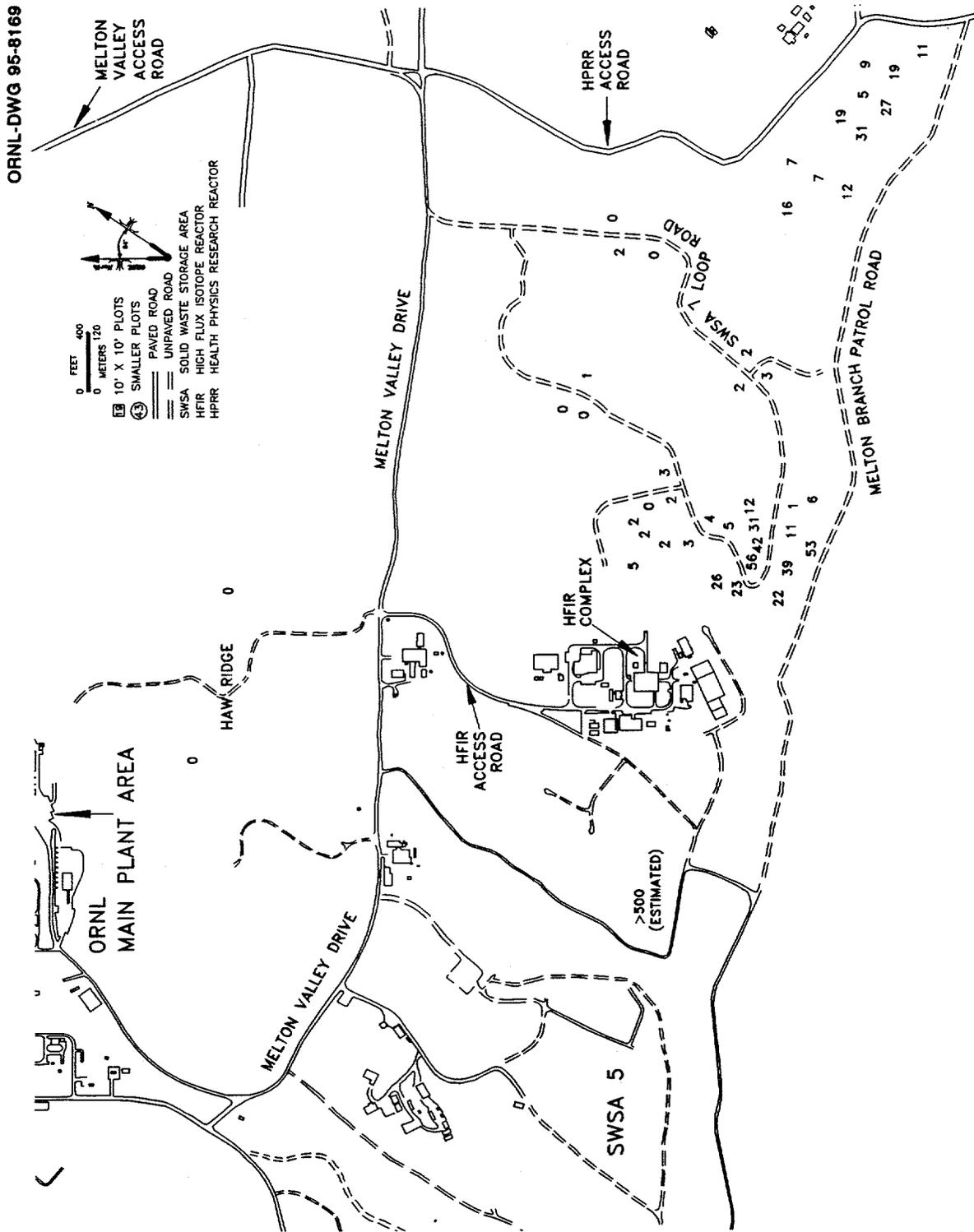


Fig. 5. Total number of particles per 100 ft² found near the surface at 42 locations at the proposed SWSA 7 site, at 1 location near SWSA 5, and at 2 locations on Haw Ridge.

3.4 DEPTH PROFILES

Results of the depth profiles of Plots 13, 6, 18, and 39 are shown in Tables 5, 6, 7, and 8, respectively. It should be noted that Plot 18 showed only a few particles when originally surveyed (Table 3) at a time when the soil was damp. However, particles were located at deeper levels (Table 7), indicating that even plots with no apparent surface hot particles may have particles below the surface.

In general, particles were distributed throughout the top few inches of soil but decreased noticeably at depths of 6 in. Although no samples were taken below 6 in., it is believed that most of the particles are located at or above 6 in. Because it is doubtful that 6 in. of soil has accumulated since the release of these particles, it is highly probably that the particles migrated to their present depths.

**Table 4. Number of particles and activity at various depths in Plot 43
(5 × 1 ft)**

Depth	Number of particles per 5 ft ²	No. of particles per 100 ft ² (calculated)	Particle activity (dpm)
Surface ^a	25	500	340-5700
Depth of 2 in.	45	900	680-7300
Depth of 4 in.	20	400	460-3000
Depth of 6 in. ^b	6	120	460-3100

^aGamma exposure rates at surface ranged from 10 to 12 μ R/h.

^bGamma exposure rates at depth of 6 in. ranged from 6 to 8 μ R/h.

**Table 5. Number of particles and activity at various depths in Plot 13
(10 × 10 ft)**

Depth	Number of particles per 100 ft ²	Particle activity (dpm)
Bare ground surface ^a	17	460-3900
Top 1/4 in. of soil	~9 ^b	460-2700
Depth of 1/4 in.	33	480-6800
Depth of 1/2 in.	27	400-4400
Depth of 1 in.	37	400-3800
Depth of 2 in.	57	300-2900
Depth of 3 in.	53	400-2300
Depth of 6 in.	17	320-3400

^aNewly fallen leaves raked away.

^bTop 1/4 in. of soil examined after it was removed. Data not directly comparable to surface scan data.

**Table 6. Number of particles and activity at various depths in Plot 6
(10 × 10 ft)**

Depth	Number of particles per 100 ft ²	Particle activity (dpm)
Bare ground surface ^a	5	610-1900
Depth of 2 in.	10	320-3700
Depth of 4 in.	1	680

^aNewly fallen leaves raked away.

**Table 7. Number of particles and activity at various depths in Plot 18
(10 × 10 ft)**

Depth	Number of particles per 100 ft ²	Particle activity (dpm)
Bare ground surface ^a	30	340-1800
Top 2 in. of soil	-20 ^b	c
Depth of 2 in.	31	340-5700
Next 4 in. of soil	-25 ^b	c
Depth of 6 in.	3	460-1900

^aNewly fallen leaves raked away.

^bTop 2 in. of soil examined after it was removed. Data not directly comparable to surface scan data.

^cNo data.

**Table 8. Number of particles and activity at various depths in Plot 39
(10 × 10 ft)**

Depth	Number of particles per 100 ft ²	Particle activity (dpm)
Bare ground surface ^a	53	460-2700
Top 4 in. of soil	-20 ^b	c
Depth of 4 in.	18	340-5700

^aSoil very dry at time of this survey (April 11, 1995). Previously surveyed on February 22, 1995, when soil surface was wet; only 19 particles detected at that time.

^bTop 4 in. of soil examined after it was removed. Data not directly comparable to surface scan data.

^cNo data.

Figure 6 shows the number of particles at various depths for Plots 6, 13, and 43. The graph in Fig. 6 shows the curves of best fit for data in Tables 4, 5, and 6. Plots 18 and 39 (Tables 7 and 8) were not included because less data were collected at these locations. For Plots 6, 13, and 43, the number of particles per 100 ft² was integrated at 1/4-in. intervals over a depth of 6 in. (total area covered 10 × 10 × 0.5 ft). Results produced an estimated total of 100 particles in Plot 6 (located near HFIR in the northwest part of SWSA 7) and 1000 particles in Plot 39 (located in the southeast part of SWSA 7). Plot 43 located near SWSA 5 (a possible source of the particles) contained an estimated total of 13,000 particles.

3.5 UNDETECTED PARTICLES

It is estimated* that this survey missed ~30% of the particles present in any given plot or at any given depth. It was impossible to detect particles obscured by leaves, twigs, rocks, or pieces of soil. It was also impossible to detect particles during wet-soil conditions. Plots that were revisited during dry-soil conditions always contained more particles. For example, Plot 39 contained 19 particles when the soil surface was wet, and 53 when the soil surface was dry (Table 8).

3.6 ANALYTICAL RESULTS

Results of radionuclide analysis of a composite sample of particles collected in Plot 27 are shown in Table 9. Strontium-90 and ⁹⁰Y are present in equal quantities of 73,000 ± 3000 pCi/g and, therefore, in equilibrium. Strontium-90 with a relatively long half-life (29 years) decays to ⁹⁰Y with a relatively short half-life (64 hours). Given pure ⁹⁰Sr on day 0, it would take ~30 days for the relative activity of the ⁹⁰Sr and ⁹⁰Y to reach equilibrium. Thus, it can be concluded that it has been more than 30 days since the ⁹⁰Sr particles were produced indicating that the particles have been in the soil for more than 30 days. Furthermore, the ⁹⁰Sr concentration plus the ⁹⁰Y concentration is roughly (within the margin of error) equal to the gross beta (150,000 ± 3000 pCi/g), indicating that no other major beta emitters were present.

Table 9. Results of radiological analysis of particles from Plot 27

Radionuclide	Concentration (pCi/g)
Gross beta	150,000 ± 3,000
⁹⁰ Sr	73,000 ± 3,000
⁹⁰ Y	73,000 ± 3,000

Results of analysis of composite particles from Plot 27 by the HNU X-Ray System 5000 Spectrum Plotting Program are shown in Fig. 7. An expanded view of a portion of Fig. 7 is shown in Fig. 8. These figures show distinct peaks for titanium, which is present in amounts far greater than the minute levels normally found in the earth's crust. Results of this analysis led to the conclusion that the particles are most probably strontium titanate.

*Estimate based on best professional judgment.

ORNL-DWG 95-8170

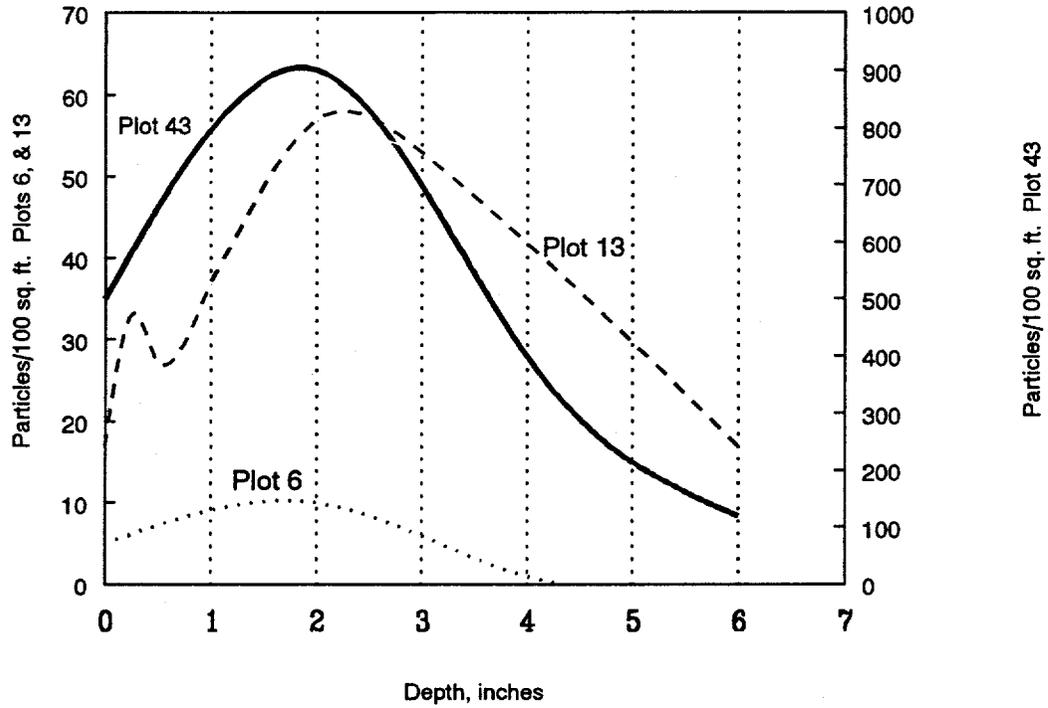


Fig. 6. Number of particles identified at various depths in Plots 6, 13, and 43. Graph shows the curves of best fit for data in Tables 4, 5, and 6.

HNU X-RAY System 5000
Spectrum Plotting Program
Printplot V3.000

Sample ID: PM14092 (J.Allred:Block 27) #2

Energy Range: 0 - 40 keV 10 eV/ch

Preset: Live Time 200 Seconds

Real Time: 247.27 Sec. Live Time: 200.00 Sec.

18X Deadtime 2655 Counts/Second

Acquisition date: 21-Dec-94 Acquisition time: 22:25:21

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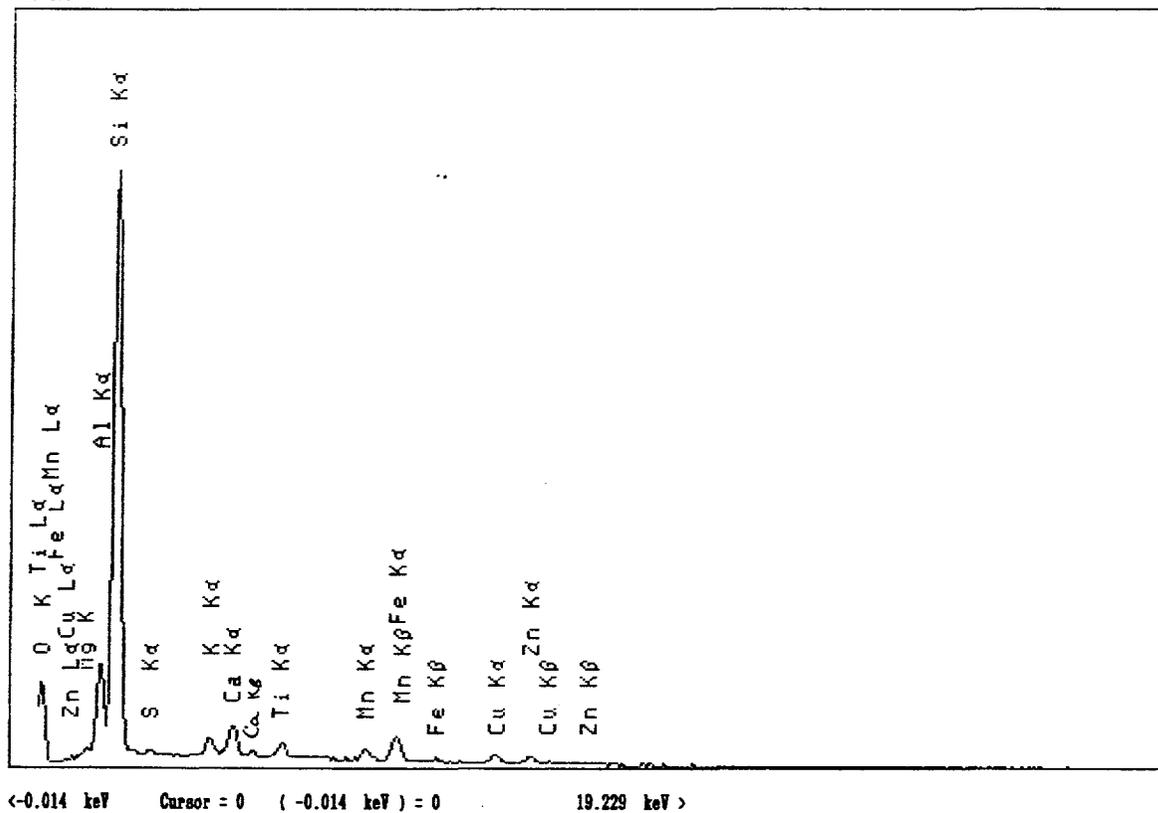


Fig. 7. Results of analysis of particles from Plot 27 with the HNU X-Ray System 5000.

HNU X-RAY System 5000
Spectrum Plotting Program
Printplot V3.000

Sample ID: PH14092 (J.Allred:Block 27) #2

Energy Range: 0 - 40 keV 10 eV/ch

Preset: Live Time 200 Seconds

Real Time: 247.27 Sec. Live Time: 200.00 Sec.

18% Deadtime 2655 Counts/Second

Acquisition date: 21-Dec-94 Acquisition time: 22:25:21

Cfs 1K

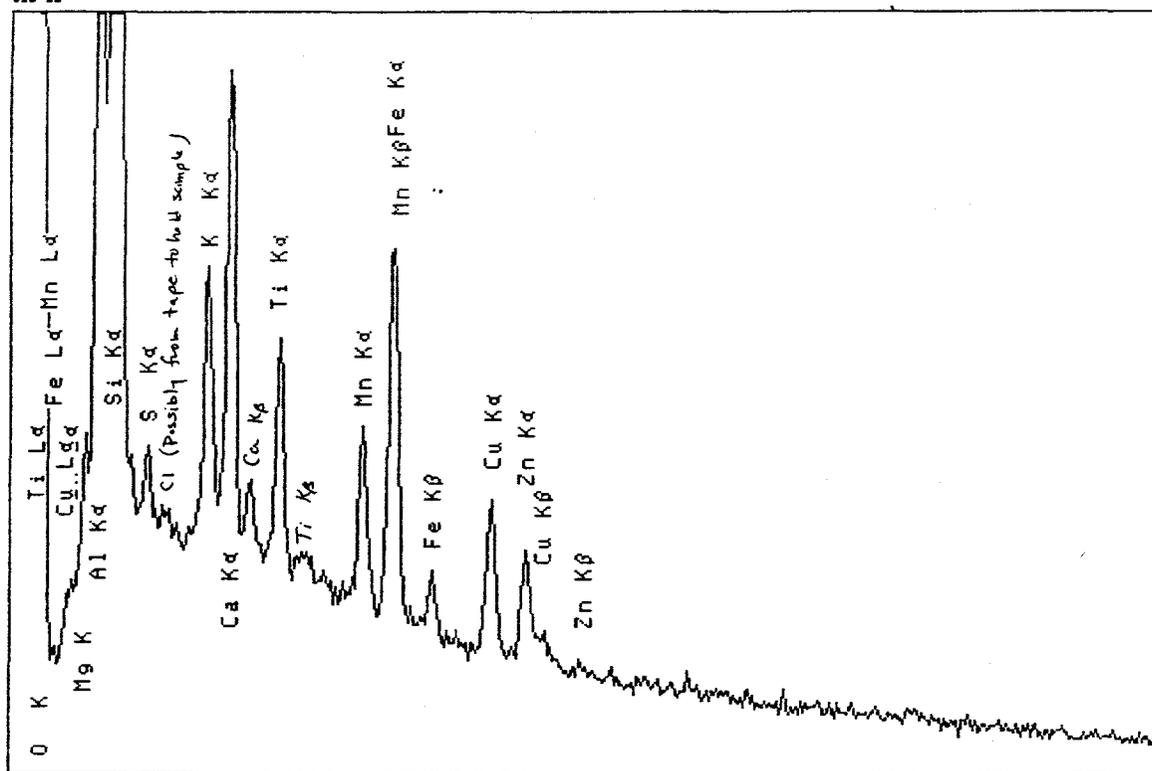


Fig. 8. Expanded view of a portion of Fig. 7 showing presence of titanium.

4. CONCLUSIONS AND RECOMMENDATIONS

Surface soil at the proposed SWSA 7 site contained many particles of insoluble strontium, which is most probably strontium titanate. No other major beta or gamma contaminants were found. The particles were widely distributed with greater numbers present in the southern part of the site and in the top 6 in. of soil. Two plots with no particles on the surface contained subsurface particles. Particles identified during this survey ranged up to 9700 dpm but most were <1500 dpm. Activity seemed to be randomly distributed—that is, the hottest particles were not concentrated in any particular plots or at any particular soil depth. Based on radionuclide analysis and the vertical distribution of particles in the soil, the ⁹⁰Sr is believed to have been in the soil for some time.

The particles may have originated from SWSA 5 during the disposal process. This assumption is based on historical evidence and the following survey results:

1. the particles were present in much higher numbers near SWSA 5,
2. the particles were absent on top of Haw Ridge, and
3. the particles were absent on the north side of Haw Ridge toward the ORNL main plant area and Building 3517 where the particles were originally produced.

It is recommended that any work in the SWSA 7 area that disturbs the ground should be closely monitored and preferably preceded by a surface survey of this type to define more precisely how closely the job will need to be monitored. When newly excavated soil dries, exposed particles can potentially become airborne and quickly become an inhalation hazard.

It is further recommended that Melton Valley be systematically surveyed to better define the pattern of particle deposition and the plume or plumes from which these particles were originally deposited. Systematic coverage could best be accomplished by surveying 1-m² plots, established at ~1000-ft intervals, radiating in various directions from the SWSA 5 boundary and extending beyond the outermost boundary of particle deposition.

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2. T. E. Myrick, B. A. Berven, W. D. Cottrell, W. A. Goldsmith, and F. F. Haywood, *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., April 1987.
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4. R. L. Coleman, *Beta Dose Rate Evaluations with a Geiger-Mueller Pancake Detector*, M.S. Thesis, Univ. of Tenn., August 1993.
5. M. S. Uziel, P. F. Tiner, and J. K. Williams, *Surface Radiological Investigations at Environmental Research Area 11, ^{137}Cs - and ^{60}Co -Contaminated Plots, at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, ORNL/ER-138, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., February 1993.
6. C. L. Ottinger and R. W. Schaich, *Hazards Report for Building 3517 Fission Products Development Laboratory*, ORNL/TM-753, Rev., Union Carbide, Corp., Oak Ridge Natl. Lab., February 1965.
7. *Radioactive Release from Radionuclide Power Sources. VIII. Release from Fully-Fueled Strontium Titanate and Strontium Oxide to Seawater*, NRDL-TR-88-135, U.S. Naval Radiological Defense Laboratory, San Francisco, August 1968.

Appendix A

REFERENCES FOR HISTORICAL INFORMATION

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry, no matter how small, should be recorded to ensure the integrity of the financial statements. This includes not only sales and purchases but also expenses, income, and transfers.

The second part of the document provides a detailed breakdown of the accounting cycle. It outlines the ten steps involved in the process, from identifying the accounting entity to preparing financial statements. Each step is explained in detail, with examples provided to illustrate the concepts.

The third part of the document focuses on the classification of accounts. It discusses the different types of accounts, such as assets, liabilities, equity, revenue, and expense accounts, and how they are used to record and summarize business transactions.

The fourth part of the document covers the process of journalizing and posting. It explains how transactions are recorded in the journal and then posted to the ledger accounts. This process is essential for maintaining the double-entry system and ensuring that the books are balanced.

The fifth part of the document discusses the preparation of financial statements. It outlines the steps involved in calculating the net income, preparing the balance sheet, and the income statement. It also provides examples of how these statements are prepared and presented.

The sixth part of the document covers the closing process. It explains how the temporary accounts (revenue, expense, and dividend accounts) are closed to the permanent accounts (assets, liabilities, and equity accounts) at the end of the accounting period. This process is necessary to reset the temporary accounts for the next period.

The seventh part of the document discusses the importance of adjusting entries. It explains how these entries are used to record accruals, deferrals, and other adjustments that are necessary to ensure that the financial statements are accurate and reflect the true financial position of the business.

The eighth part of the document covers the process of reconciling the bank statement. It explains how the bank statement is compared to the company's records to identify any discrepancies and correct them. This process is essential for ensuring that the cash balance is accurate.

The ninth part of the document discusses the importance of internal controls. It outlines the various measures that can be taken to prevent and detect errors and fraud, such as segregation of duties, authorization, and regular audits.

The tenth part of the document covers the final steps of the accounting process, including the preparation of the final financial statements and the closing of the books. It emphasizes the importance of accuracy and transparency in all aspects of the accounting process.

April 29, 1993

L. Holder, Jr., 3001, MS-6029

Results of Radiological Walkover Survey of HPRR Access Road Areas

As you requested, a radiological walkover survey of selected ground areas on sides of the HPRR Access Road and on the road surface was conducted intermittently from January 1993 through March 1993. The survey site is located near the Hazardous Waste Management Area (Fig. 1). This survey was performed by the Measurement Applications and Development (MAD) Group of the Health and Safety Research Division (HASRD) of Oak Ridge National Laboratory (ORNL).

As you know, there have been recent findings of beta-radiation contamination in a wooded area southwest of the HPRR Access Road by ORNL Radiation Protection personnel (see Fig. 1). In addition, attached is the "official" occurrence report describing this incident. Laboratory analysis results of an environmental sample collected by ORNL Radiation Protection personnel demonstrate the presence of strontium. Because the contaminant was found to be insoluble, it is likely in the form of strontium-90 titanate¹ ($^{90}\text{SrTiO}_3$), strontium-90 orthotitanate ($^{90}\text{Sr}_2\text{TiO}_4$), and/or strontium-90 fluoride ($^{90}\text{SrF}_2$). Recent conversations with several individuals with past experience or knowledge in the disposal of solid wastes contaminated with these compounds suggests that during some instances, contamination was likely dispersed into the air and ultimately deposited outside the confines of the disposal area. Additionally, recent contamination findings of this nature indicate a probable plume of contamination from occurrences during the transportation and disposal of this material into SWSA 5. Several occurrence reports describe this variety of contamination as "legacy" waste. Attached are letters and occurrence reports that imply probable airborne occurrences. Obviously, additional information is needed to verify this assertion.

¹An excellent discussion of the process development of strontium-90 titanate is described in: C. L. Ottinger and R. W. Schaich, "Hazards Report for Building 3517 Fission Products Development Laboratory," ORNL/TM-753, Rev., (February 1965).

April 29, 1993

Page 1 of 3

MAD group survey efforts include surface gamma and beta-gamma radiation scans of the mowed area on each side of the road, a beta-gamma scan of the road surface using Ludlum™ gas flow proportional floor monitors, and the collection of one surface soil sample for radiological screening analysis. The gamma and beta-gamma scans each covered a total area of ~48,000 ft² (comprising ~1800 linear feet along both the east and west sides of the road). The road scan covered ~14,000 ft² of road area adjacent to the entrance to the wooded region where contamination was initially found by ORNL Radiation Protection. Figure 1 depicts the survey area with locations of surface hot spots. Results of surface scanning revealed 11 hot spots of beta-radiation contamination along the roadside with corresponding surface dose rates ranging from 0.04 to 1 mrad/h. The cluster of hot spots found north of guard post 23 appears to be located at an old vehicle turnaround point. This contamination may have been the result of a contaminated vehicle or, possibly, the remains of a contaminated animal rather than airborne origin. (The contamination appears to be minute particles that can be easily missed by slow-speed scanning). No contamination was detected on the scanned portion of the HPRR Access Road.

Gamma spectroscopy screening analysis of a soil sample collected at the location of the 1-mrad/h spot revealed no gamma-emitting contaminants. Although no laboratory analysis of beta-emitting radionuclides have been conducted on this sample, it is probable the contaminant is strontium. Beta-gamma measurements taken at the ground surface after the sample was collected indicate typical background levels (i.e., all contaminants had been removed).

Slight elevations of gamma exposure rates (up to 16 μ R/h at some locations) can be attributed to naturally occurring radionuclides in soil. Shale in soil may contain elevated concentrations of uranium that can be detected as elevated gamma exposure rates (using survey instruments with low-range sensitivity), particularly at locations of surface shale outcroppings.

With regard to past airborne contamination occurrences at ORNL, I've attached two reports describing the occurrence of airborne "specks" of uranium dioxide (UO₂) from the old pile building stack, generally referred to as the "Particle Problem." A third reference to particulate air contamination at ORNL is provided in the footnote.² In addition, a 1945 report describing air monitoring at Site "X" is attached. The intent here is to further demonstrate the importance of (1) reviewing historical literature and (2) conducting interviews with key personnel involved in these operations to help draw correlations to seemingly isolated, "legacy" waste findings.

²J. S. Cheka and H. J. McAlduff, "Particulate Air Contamination at ORNL," Health Physics Division, ORNL-283 (June 30, 1949).

Therefore, I feel it is imperative that we request a meeting with individuals who have knowledge in these matters. We are most fortunate that some of these individuals are still at ORNL. It would be prudent to talk with key people such as J. Bolinsky, Jr., W. D. Cottrell, C. L. Ottinger, J. A. Setaro, and others.

I hope this information will be useful in any future development in these areas. I am particularly interested in the location of the proposed Advanced Neutron Source (ANS) facility. Specifically, if there has been airborne contamination in this region, is the ANS in the plume route?

Please feel free to contact Peggy Tiner (4-5379) or myself (4-7752) should you have any questions or comments.



J. K. Williams, ORNL, Bldg. 7503, MS-6382

cc B. A. Berven, 4500S, MS-6124
 R. V. Bishop, 7503, MS-6382
 J. Bolinsky, Jr., 7831, MS-6388
 T. W. Burwinkle, 3001, MS-6028
 W. D. Cottrell, 7503, MS-6382
 J. W. Evans, 1506, MS-6034
 R. D. Foley, 7503, MS-6382
 H. R. Gaddis, 3001, MS-6029
 G. D. Kerr, 7509, MS-6383
 B. L. Kimmel II, 7078-A, MS-6402
 R. C. Mason, 3047, MS-6023
 L. E. McNeese, 3047, MS-6023
 C. E. Nix, 6026-C, MS-6395
 C. L. Ottinger, 7965-B, MS-6385
 R. E. Rodriguez, 7503, MS-6382
 J. A. Setaro, 4500N, MS-6275
 R. E. Swaja, 7509, MS-6383
 P. F. Tiner, 7503, MS-6382
 M. S. Uziel, 7503, MS-6382
 C. K. Valentine, Jr., 6026-C, MS-6395

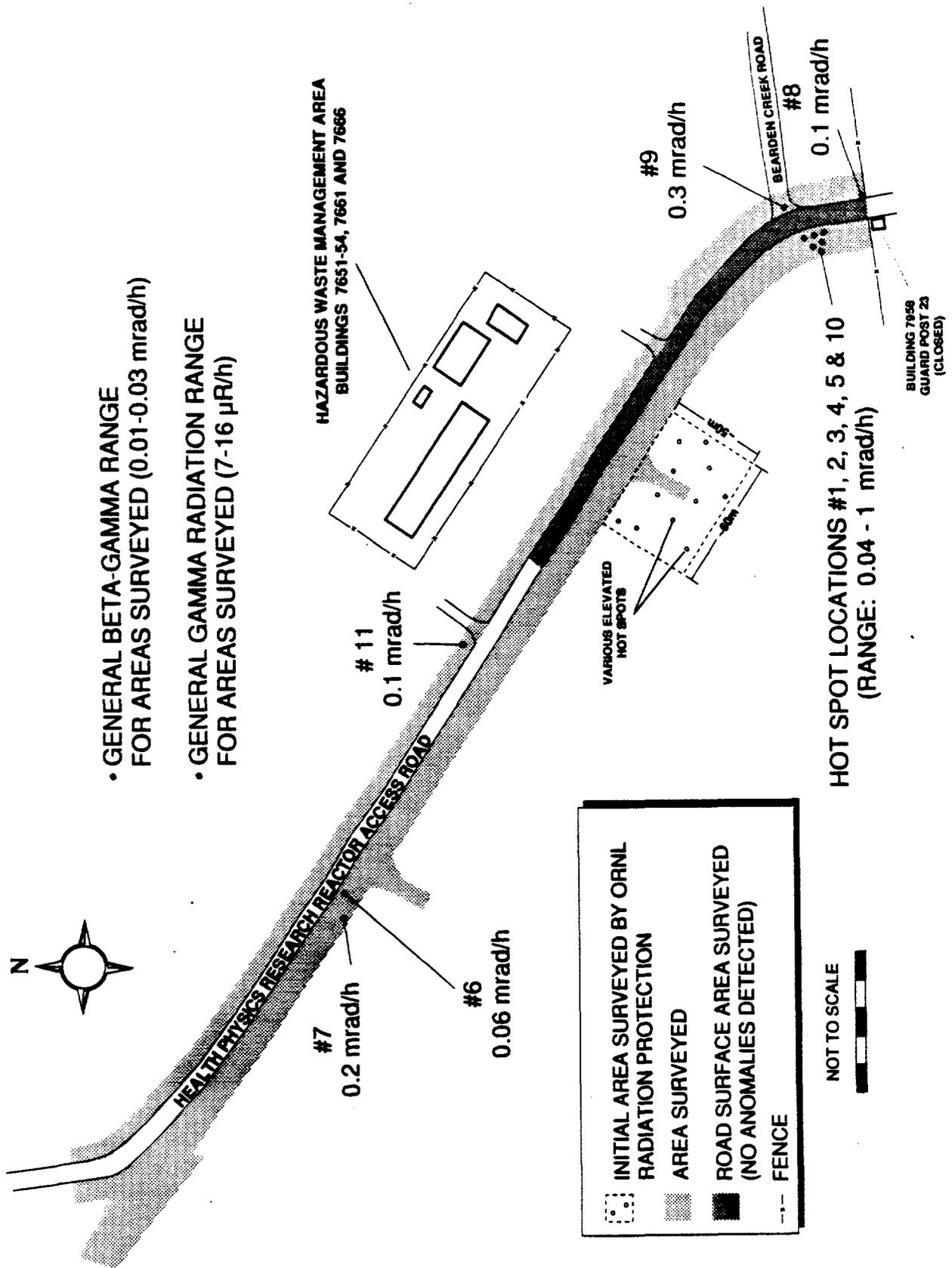


Fig. 1. Diagram of survey areas with locations of surface hot spots near HPRR Access Road.

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

April 1, 1993

R. V. Bishop, 7503, MS-6382

Information Regarding Strontium Titanate Contamination

On March 25, 1993, I spoke with Mr. Charlie Guinn, a retired ORNL health physicist who now resides in Oak Ridge, regarding his past experience with strontium titanate contamination. Mr. Guinn provided some interesting information and said "this strontium titanate stuff was a serious thing...it could be gone (disperse) in a hurry." I told him there have been some recent findings of strontium titanate near the HFIR Cooling Tower and HPRR Access Road (DOSAR area). He said he personally never found this type of contaminant at these locations; however, it was possible a plume from SWSA-5 could have reached these remote areas.

Mr. Guinn was involved with many aspects of health physics coverage including the transportation and disposal of this material from Building 3517 to burial sites such as SWSA-5. One incident he recalled was transporting this material on top of a carrier traveling east on Melton Valley Drive to SWSA-5. Just as the truck crossed White Oak Creek and started up the hill, a container fell off the truck, spreading the material on the road and along the sides of the road. (Although he was unable to recall the year of this incident, he said it did occur about 30 minutes before the end of the shift). Cleanup measures included vacuum cleaning the road surface.

I thought you'd be interested in this information.

I sincerely appreciate you and Joe Setaro's help in sharing information related to our (MAD Group) scoping survey efforts on the Oak Ridge Reservation. If possible, I would like to get a copy of the "official" occurrence reports filed by ORNL Radiation Protection for the strontium titanate occurrences at the (1) HFIR Cooling Tower and (2) HPRR Access Road. Additionally, any information with regard to the Sr-titanate contamination plume is most appreciated.



J. K. Williams, 7503, MS-6382, (4-7752)

cc: W. D. Cottrell, 7503, MS-6382
R. D. Foley, 7503, MS-6382
J. A. Setaro, 4500N, MS-6275
C. S. Sims, 4500S, MS-6106
R. E. Swaja, 7503, MS-7503
P. F. Tiner, 7503, MS-6382

Sept. 1, 1992

NOTE: Internal Correspondence from J. A. Setaro,
Central Management, ORNL, to C. S. Sims,
Office of Radiation Protection, ORNL

Steve,

Strontium-90 as the titanate was developed in the early 1960s as a part of the SNAP (Systems for Nuclear Auxiliary Power) Program. The idea was to produce an insoluble compound of Sr-90 for use in thermoelectric generators. The compound should be insoluble so that a capsule failure at sea would not result in massive contamination of the oceans. Most of the Isotopic SNAP sources were used as weather stations in the arctic, sonar beacons in the Atlantic, light beacons in the Chesapeake Bay, etc. We even went so far as to use Hasteloy-C as capsule material since this material was most resistant to salt water corrosion.

Sr-titanate was produced at the Fission Produce Development Laboratory (Building 3517). Waste from the process was loaded out and sent to SWSA 5. The first method of transfer was to load out cans of waste (contaminated with Sr-titanate) into a one inch lead lined dumpster, which was cleaned and transferred to the SWSA where it was dumped into the trench. This resulted in contamination control problems at the SWSA (particles). The people at 3517 then commissioned the fabrication of a special 3 inch lead, stainless steel clad dumpster which was much smaller than the regular dumpster and could be lowered into the trench before dumping so that spread of particles would be minimized. This resulted in a contaminated dumpster and dumpster rack, however, which had to be decontaminated at the SWSA or wrapped for transfer back to 3517. Finally, in around 1969, Sam Gheesling designed a cask that would use a 55 gallon drum in a bottom discharge carrier that could be loaded from the top of a cell at 3517 (the carrier would not go into the cell) and the drum would be checked for contamination prior to being loaded into the carrier. This seemed to solve the contamination problem at the SWSA since the carrier would be positioned over a "Well" and the drum lowered into the well where it would be backfilled with earth or concrete.

As a point of interest, in the early 1970s, Sr-titanate was replaced by Sr-flouride, which was produced at Hanford and shipped into ORNL. The flouride was also an insoluble form of strontium, according to C.L. Ottinger, who was in charge of the operation at that time. The reason I mention this is that we are assuming that the particles are

Sr-titanate when they might possibly be Sr-flouride. The origin would be the same, however. Both were worked at 3517 and waste transferred to the SWSAs.

Assuming that Sr particles were spread at the SWSAs, they would be very hard to detect except with an end-window GM-survey meter (this was many years prior to the use of pancake probes at ORNL). During several contamination incidents at 3517, detection of particles was missed by normal smearing and the individual particles had to be detected by end-window and picked up with tape for disposal. Particles of up to 20 mRad/hr were detected, but the vast majority were smaller. This situation was called "THE Problem" by Ottinger.

Looking at the way the ridges around the Lab run and the direction of wind (which I think usually goes from the Northwest to the Southeast), I would suspect that particles would spread along the southern ridges, not Haw Ridge. This could result in some particles being deposited in the HFIR area and even whipping around the ridge to the DOSAR area as the winds try to go toward the lake. This is only my theory, however, and I suggest that you confirm wind directions with Frank Kornegay (I tried to contact Frank, but he was unavailable).

Hope this is the information you were looking for.

Joe Setaro

OCCURRENCE REPORT

High Flux Isotope Reactor

(Name of Facility)

Category "A" Reactors

(Facility Function)

Oak Ridge National Laboratory / Martin Marietta Energy Systems, Inc.

(Name of laboratory, site or organization)

Name: Stinnett, Regina M.
Title: Manager
Telephone No.: (615)576-5013

(Facility Manager/Designee)

Name: C H HELTON
Title: SHIFT SUPERVISOR
Telephone No.: (615)576-5016

(Originator)

Name:
Date:

(Authorized Classifier (AC))

1. OCCURRENCE REPORT NUMBER: ORO--MMES-X10HFIR-1992-0036
Personal Clothing Contamination

2. REPORT TYPE AND DATE:	Date	Time
[] Notification	06/02/1992	1342 MTZ
[] 10 Day	06/19/1992	0914 MTZ
[] 10 Day Update		
[X] Final	11/23/1992	0904 MTZ

3. OCCURRENCE CATEGORY:
[] Emergency [] Unusual [X] Off-Normal [] Cancelled

4. DIVISION OR PROJECT:
Research Reactors

5. DOE PROGRAM OFFICE:
NE - Nuclear Energy

6. SYSTEM, BLDG., OR EQUIPMENT:
7902

7. UCNI?:
No

8. PLANT AREA:
HFIR Cooling Tower

9. DATE AND TIME DISCOVERED:
06/02/1992 1010 (ETZ)

10. DATE AND TIME CATEGORIZED:
06/02/1992 1140 (ETZ)

11. DOE NOTIFICATION:
06/02/1992 1320 (ETZ) J CANNON DOE-HQ
12. OTHER NOTIFICATIONS:
06/02/1992 1320 (ETZ) H R FAIR DOE-OR
06/02/1992 1320 (ETZ) M B FARRAR RRD
06/02/1992 1320 (ETZ) R J ROBSON ORNL LSS

13. SUBJECT OR TITLE OF OCCURRENCE:
Personal Clothing Contamination

14. NATURE OF OCCURRENCE:
04) Personnel Radiation Protection
B. Personnel Contamination

15. DESCRIPTION OF OCCURRENCE:
An engineer had been reviewing work on top of the HFIR cooling tower. The HFIR cooling tower was not posted as a radiological area. The individual was required to kneel on one knee to inspect piping inside a hatch. After completing the review, the individual came off to the cooling tower and proceeded to the HFIR building PCM-1B to survey himself. A PCM-1B alarm was annunciated. Health Physics personnel were notified. A survey found up to 30,000 dpm/100 cm² of beta emitter on the leg of his personal trousers. (This level exceeds the lower limit for reporting in DOE 5480.11, which is 1000 dpm/100 cm² for beta/gamma.)

16. OPERATING CONDITIONS OF FACILITY AT TIME OF OCCURRENCE:
The end-of-cycle 307 refueling outage was in progress.

17. ACTIVITY CATEGORY:
Maintenance

18. IMMEDIATE ACTIONS TAKEN AND RESULTS:
The trousers could not be readily decontaminated and were therefore confiscated by the health physics technician (HP).

HPs surveyed the cooling tower and the individual's path to the PCM-1B.

19. DIRECT CAUSE:
7) EXTERNAL PHENOMENA
A. Weather or Ambient Condition

20. CONTRIBUTING CAUSE(S):

21. ROOT CAUSE:
6) MANAGEMENT PROBLEM
A. Inadequate Administrative Control

22. DESCRIPTION OF CAUSE:

An analysis of the contaminated trousers revealed that the contamination was strontium-90 (Sr-90). Sr-90, which is a pure beta emitter, has been discovered in areas surrounding the HFIR site. Also, radiation surveys of 1990-92 have shown Sr-90 on the roofs of the older buildings at the HFIR site.

A survey has recently been conducted of the roofs of two buildings that were built on the HFIR site between 1988 and 1990. This survey showed no Sr-90 contamination on either building. It was concluded from this evidence that the HFIR cooling tower top deck and the roofs of the older HFIR buildings were contaminated prior to 1988. It is not known why the contamination is on the cooling tower top deck. Based on studies conducted by the Office of Environmental Compliance during the 1980s, wildlife that has dwelled in a legacy contaminated spill area may have deposited contamination on the tower through biological means or that windborne dust from a legacy contaminated spill area is responsible. Thus, the direct cause of the occurrence is attributed to external phenomena (External/Phenomena/Weather or Ambient Condition). Weather, ambient conditions, or wildlife moved the contaminant to the top of the cooling tower.

The top deck of the cooling tower has been posted as a contamination area. All buildings that have contaminated roofs have also been posted as contamination areas. These areas and all building roofs require Health Physics notification and approval prior to entry.

The HFIR Decontamination Team, the action team for the proposed HFIR decontamination effort, is investigating the feasibility of decontaminating the roofs of HFIR site buildings. This effort would be part of the comprehensive decontamination of the HFIR site buildings.

Because current radiological practices follow stringent guidelines, past radiological practices are responsible for the incident. Radioactive materials, including Sr-90, are present in areas surrounding the HFIR site. The Environmental Restoration Division is performing comprehensive scoping surveys as part of the Remedial Investigation/Feasibility Study (RIFS) for the entire ORNL site. The root cause of the occurrence is attributed to poor radiological practices of the past (Management Problem/Inadequate Administrative Control).

23. EVALUATION: (By Facility Manager/Designee)

This occurrence was the result of poor radiological practices of the past. Because the top of the HFIR cooling tower is now a contamination area, with C-zone rubber overshoes required, the probability of similar occurrences is minimal.

24. IS FURTHER EVALUATION REQUIRED?:

Yes []

No [X]

25. CORRECTIVE ACTIONS:

(* = Date added/revised since final report was signed off)

- 01) Post the roof of the HFIR cooling tower as a contamination area.

TARGET COMPLETION DATE: 06/02/1992 COMPLETION DATE: 06/16/1992

- 02) Include this contamination in the next quarterly ALARA Self-Assessment Program Summary.

TARGET COMPLETION DATE: 10/30/1992 COMPLETION DATE: 11/09/1992

26. IMPACT ON ENVIRONMENT, SAFETY AND HEALTH:

None

27. PROGRAMMATIC IMPACT:

None

28. IMPACT UPON CODES AND STANDARDS:

None

29. FINAL EVALUATION AND LESSONS LEARNED:

The occurrence resulted from poor radiological practices of the past. Posting the HFIR cooling tower roof as a contamination area with C-zone rubber overshoes required should minimize further occurrences. However, contaminations from Sr-90 are possible in other nonradiological areas. Contaminations of this type are difficult to prevent.

30. SIMILAR OCCURRENCE REPORT NUMBERS:

- 1) ORO--MMES-X10HFIR-1992-0018
2) ORO--MMES-X10HFIR-1992-0039
3) ORO--MMES-X10HFIR-1992-0046

31. DOE FACILITY REPRESENTATIVE INPUT:

Entered by:

Date:

32. DOE PROGRAM MANAGER INPUT:

Entered by:

Date:

33. SIGNATURES:

Approved by: Stinnett, Regina M.
Facility Manager/Designee

Date: 11/11/1992
Telephone No.: (615) 576-5013

33. SIGNATURES:

(continued)

Approved by: MORRIS, GLENN W.

Date: 11/23/1992

DOE Facility Representative/Designee Telephone No.: (615)574-8645

Approved by: CANNON, JAMES M.

Date: 11/23/1992

DOE Program Manager/Designee

Telephone No.: (301)903-5016

OCCURRENCE REPORT

Central Engineering (ORNL Site)

(Name of Facility)

Balance-of-Plant

(Facility Function)

Oak Ridge National Laboratory / Martin Marietta Energy Systems, Inc.

(Name of laboratory, site or organization)

Name: Long, Jeffrey A.
Title: Occurrence Reporting Manager
Telephone No.: (615)574-7278

(Facility Manager/Designee)

Name: A V PANYA
Title: CIVIL/SITE ENGINEER
Telephone No.: (615)241-2835

(Originator)

Name:
Date:

(Authorized Classifier (AC))

1. OCCURRENCE REPORT NUMBER: ORO--MMES-CENTENGX10-1992-0001
BETA/GAMMA CONTAMINATION FOUND ON BULLDOZER

2. REPORT TYPE AND DATE:

	Date	Time
[] Notification	08/06/1992	1110 MTZ
[] 10 Day	08/20/1992	1220 MTZ
[] 10 Day Update		
[X] Final	03/04/1993	1223 MTZ

3. OCCURRENCE CATEGORY:
[] Emergency [] Unusual [X] Off-Normal [] Cancelled

4. DIVISION OR PROJECT:
ORNL SITE ENGRING

5. DOE PROGRAM OFFICE:
ER - Energy Research

6. SYSTEM, BLDG., OR EQUIPMENT:
7575

7. UCNI?:
No

8. PLANT AREA:
SWSA 7 AREA

9. DATE AND TIME DISCOVERED:
08/05/1992 0830 (ETZ)

10. DATE AND TIME CATEGORIZED:
08/05/1992 1315 (ETZ)

11. DOE NOTIFICATION:

12. OTHER NOTIFICATIONS:

08/06/1992	1300 (ETZ)	R O HULTGREN	SITE REP
08/06/1992	1300 (ETZ)	D A LANE	OR-EOC

13. SUBJECT OR TITLE OF OCCURRENCE:

BETA/GAMMA CONTAMINATION FOUND ON BULLDOZER

14. NATURE OF OCCURRENCE:

02) Environmental
C. Radioactive/Hazardous Material Contamination

15. DESCRIPTION OF OCCURRENCE:

On Wednesday, August 5, 1992, at approximately 8:30 AM, two HP representatives discovered Beta/Gamma contamination ranging from 1000 to 4000 D.P.M. on a bulldozer that had completed work at the site of the Class III/IV Above Grade Storage Facility, located by the HPRR Access Road directly across from the HWMA. The bulldozer has been clearing trees and brush from the site to allow a drilling rig from Ogden Environmental Services access to 13 locations to be drilled. Bulldozing and drilling operations had begun Monday morning and were completed Tuesday afternoon.

Contamination was limited to 5 locations where soil dried on the bulldozer's treads. Reading of 1000, 1000, 1200, 3200, and 4000 D.P.M. were recorded. No Alpha contamination was detected. HP surveys of the drilling rig and the soil samples found no contamination.

16. OPERATING CONDITIONS OF FACILITY AT TIME OF OCCURRENCE:

Subsurface Drilling Operations -- Normal

17. ACTIVITY CATEGORY:

Construction

18. IMMEDIATE ACTIONS TAKEN AND RESULTS:

The following was checked by HP representatives and no contamination was found:

Personnel
Drill Rig
Soil Samples

Waste Management Operations was contacted and requested to evaluate the equipment to recommend proper decontamination process.

On Friday, August 7, 1992 at approximately 9:15 a.m., Chemical Operations personnel performed an on-site decontamination of

18. IMMEDIATE ACTIONS TAKEN AND RESULTS: (continued)
the bulldozer, in the presence of two HP representatives who
had discovered the contamination.

19. DIRECT CAUSE:
1) EQUIPMENT/MATERIAL PROBLEM
F. Contamination

20. CONTRIBUTING CAUSE(S):

21. ROOT CAUSE:
7) EXTERNAL PHENOMENA
A. Weather or Ambient Condition

22. DESCRIPTION OF CAUSE:
The cause of the incident has been attributed to small
concentrations of surface contamination, possibly animal feces
or wind borne particulates, that were encountered by the
bulldozer and subsequently displaced during the clearing
operations.

23. EVALUATION: (By Facility Manager/Designee)
On Monday, August 3, 1992 the bulldozer was surveyed and
determined to be clean by Health Physics prior to beginning
work at the site.

This incident has prompted Health Physics to initiate a survey
of the proposed site to further determine the origin and
extent of the beta/gamma contamination.

24. IS FURTHER EVALUATION REQUIRED?: Yes [] No [X]

25. CORRECTIVE ACTIONS:
(* = Date added/revised since final report was signed off)

01) Two chemical operations personnel performed on-site
decontamination of the bulldozer in the presence of health
physics personnel.

TARGET COMPLETION DATE: 08/07/1992 COMPLETION DATE: 08/07/1992

02) Health Physics to conduct survey of the proposed site to
attempt to determine origin and extent of beta/gamma
contamination. Results revealed contamination at several
other locations spread throughout the area. Readings were 2
000 to 45,000 dpm - isotopes unknown. Origin of the
contamination was not discernable.

TARGET COMPLETION DATE: 09/28/1992 COMPLETION DATE: 09/28/1992

26. IMPACT ON ENVIRONMENT, SAFETY AND HEALTH:

Health Physics conducted a survey of the site and discovered pockets of contamination throughout the area. The exact source of the contamination remains unknown.

27. PROGRAMMATIC IMPACT:

The consequences of this incident included the delay in releasing the bulldozer from the ORNL Reservation and a re-evaluation of the site to consider potential contamination.

28. IMPACT UPON CODES AND STANDARDS:

None

29. FINAL EVALUATION AND LESSONS LEARNED:

The involved site was considered to be free of contamination. During the investigation of this incident, it was attributed to animal feces or wind borne particulates. These types of phenomena within ORNL boundaries cannot be fully controlled, hence this type of occurrence will most likely reoccur.

All equipment being used within ORNL boundaries must be monitored before removal from the site. This monitoring has proven successful in finding and controlling contaminated equipment and will continue.

30. SIMILAR OCCURRENCE REPORT NUMBERS:

1) None

31. DOE FACILITY REPRESENTATIVE INPUT:

Entered by:

Date:

32. DOE PROGRAM MANAGER INPUT:

Entered by:

Date:

33. SIGNATURES:

Approved by: Long, Jeffrey A.
Facility Manager/Designee

Date: 02/18/1993
Telephone No.: (615)574-5324

Approved by: BRANTON, MICHELE G.
DOE Facility Representative/Designee

Date: 02/24/1993
Telephone No.: (615)576-8801

Approved by: DESAI, JITENDRA M.
DOE Program Manager/Designee

Date: 03/04/1993
Telephone No.: (202)586-9743

APPENDIX A

RRD-HP-6

Rev. 1

Page 5 of 5

Number: CP-1

RADIOLOGICAL AWARENESS REPORT

Description of Event:

Bulldozer used inside SWIA 7, a category II area, was found to be contaminated. Highest reading was 4,500 dpm/lm on R-V. No other contamination was found. GR Tech was aware of bulldozer.
Please see attached survey

Characterization of Event:

Skin Contamination Clothing Contamination Nasal Contamination
 Area Contamination Dosimetry RWP Violation
 Exceeding Admin. Limits Other Equipment contamination

Name: NA

Division: NA

Employee Number: _____

Date of Event: 08/05/92

Time: 1022

Date Reported: 08/05/92

Time: 1220

Immediate Corrective Action:

GR Tech employees involved with work at this location were checked and found free of contamination. Bulldozer used at this location was checked and it was found free of contamination.

Suggested Long Term Corrective Action:

Area should be considered as a category II area unless proven otherwise.

Prepared By: W.C. Hayes

Acknowledged by: M.E. Baldwin 8-6-92
RRD RCO
FCH

BUILDING NA LOCATION SWSA 7 DATE 8/5/92 SURVEYOR D.E. T

SMEAR SURVEY: Alpha Beta/Gamma Beta PROBE SURVEY: Alpha Beta/Gamma BE

INSTRUMENTS: 300AP 3652-17B COUNTERS: CTA02R CTB02S BACKGROUND SURVEY: BETA/GAMMA N

40000 cpm
40000 cpm
40000 cpm

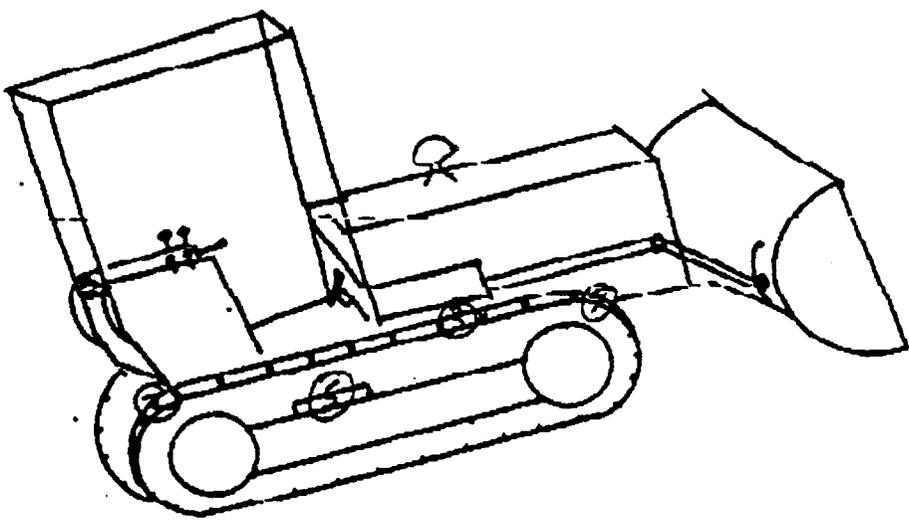
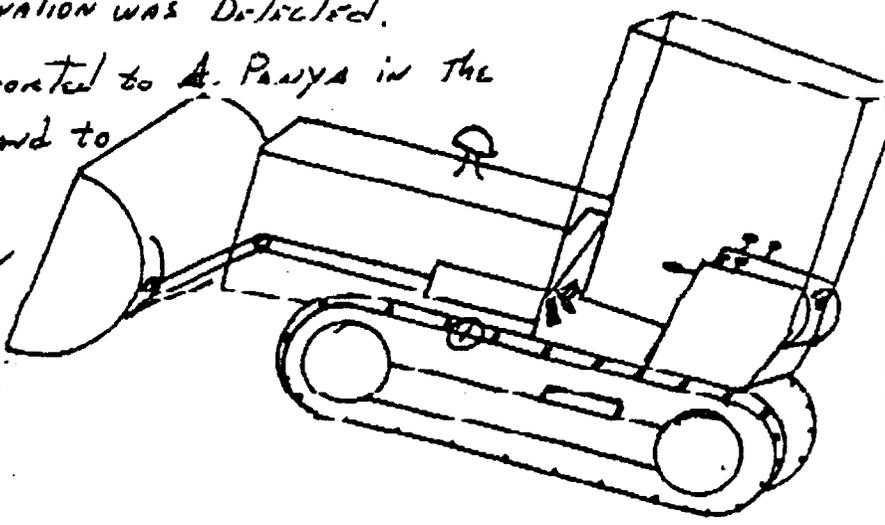
Direct B-X Peak of Bull Dozer showed contamination
Readings of approx. 4,000 D.P.M. Contamination was contain

A	B
1	14000
2	31000
3	31000
4	42000
5	34200
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30
31	31
32	32
33	33

The tracks of the Dozer.

No. Alpha Contamination was Detected.

Findings were Reported to A. Panaya in the
Engineering Dept. and to
JERRY GRAY and
RON MLEKODAJ in
The Rad Protection
Surveillance section.



- NTN** Neutron Monitor
- (A)** Airborne Radioactivity
- (A)** Alpha Probe Location
- (S)** Smear Location
- (C)** Contact Beta/Gamma Dose Rate
- (F)** Fast Neutron Dose Rate

- (CAM)** Continuous Air Monitor
- (CAAM)** Contia. Alpha Air Mon.
- (LMA)** Lab Monitor Alpha
- (LMB)** Lab Monitor Beta/Gam.
- (MCU)** Monitor Control Unit
- (MDC)** Monitor Chamber
- (MNU)** Monitor

- RAD** - Radiation Area
- H.RAD** - High Radiation Area
- V.H.RAD** - Very High Radiation
- CON** - Contamination Area

BUILDING N/A LOCATION SWSA 7 DATE 8/7/92 SURVEYOR J.F. TRU

SHEAR SURVEY: Alpha Beta/Gamma Beta PROBE SURVEY: Alpha Beta/Gamma BETA

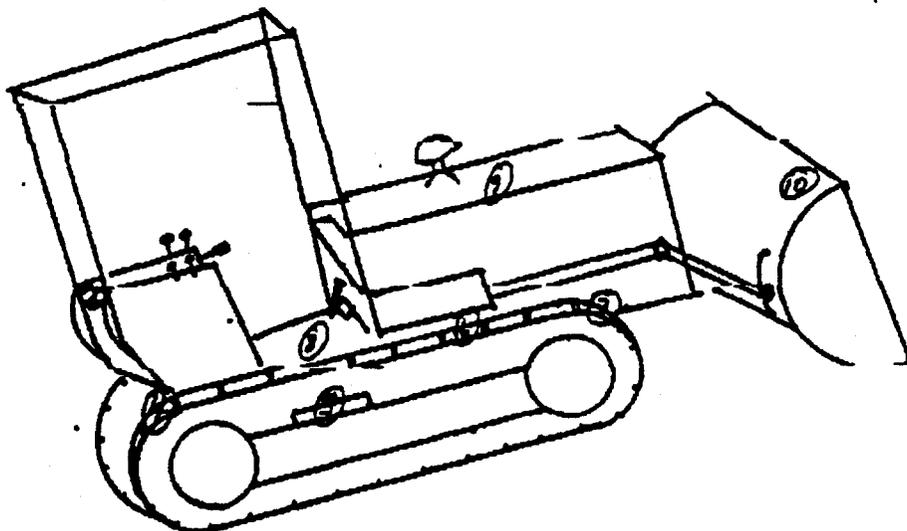
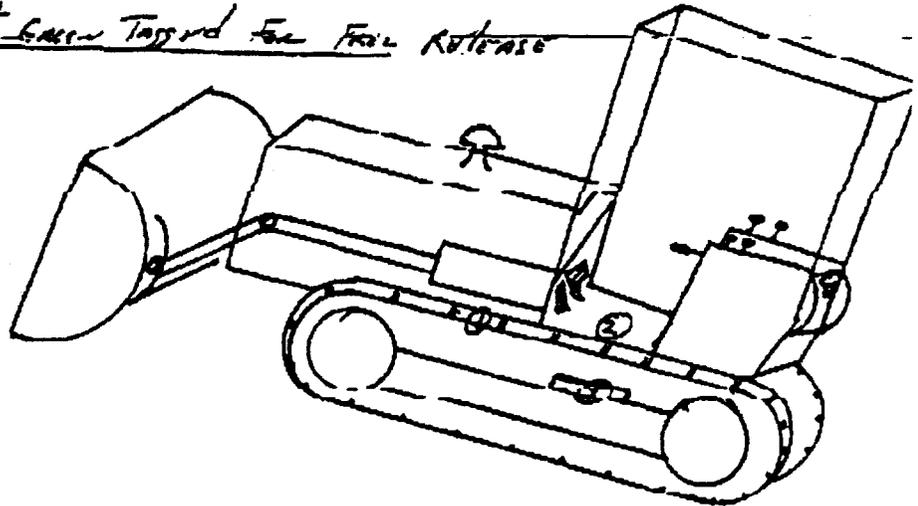
INSTRUMENTS: 2652-127 2652-26P COUNTERS: CH222 CH225 BACKGROUND SURVEY: BETA/GAMMA NE

Give only D&D on shear and MD&A

_____ spm/100 cm² α
_____ spm/100 cm² β

Direct Frisk (B-8, α) of Dozer showed no detectable contamination. Shear locations are numbered and showed no detectable activity.

Equipment Given Tagged For Final Release



α	β
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30
31	31
32	32
33	33

- NTM** Neutron Monitor
- (A)** Airborne Radioactivity
- (α)** Alpha Probe Location
- (β)** Shear Location
- β @** Contact Beta/Gamma
- β @** 1 Foot Dose Rate
- β** Fast Neutron Dose Rate
- β** Beta/Gamma Dose Rate

- CAM** Continuous Air Monitor
- CAAM** Contin. Alpha Air Mon.
- LMA** Lab Monitor Alpha
- LMB** Lab Monitor Beta/Gam.
- MCU** Monitor Control Unit
- MDC** Monitor Chamber
- MON** Monitor
- REGULATED AREA**

- RAD** - Radiation Area
- H.RAD** - High Radiation Area
- V.H.RAD** - Very High Radiation Area
- CON** - Contamination Area
- RAD/CON** - Radiation & Contam

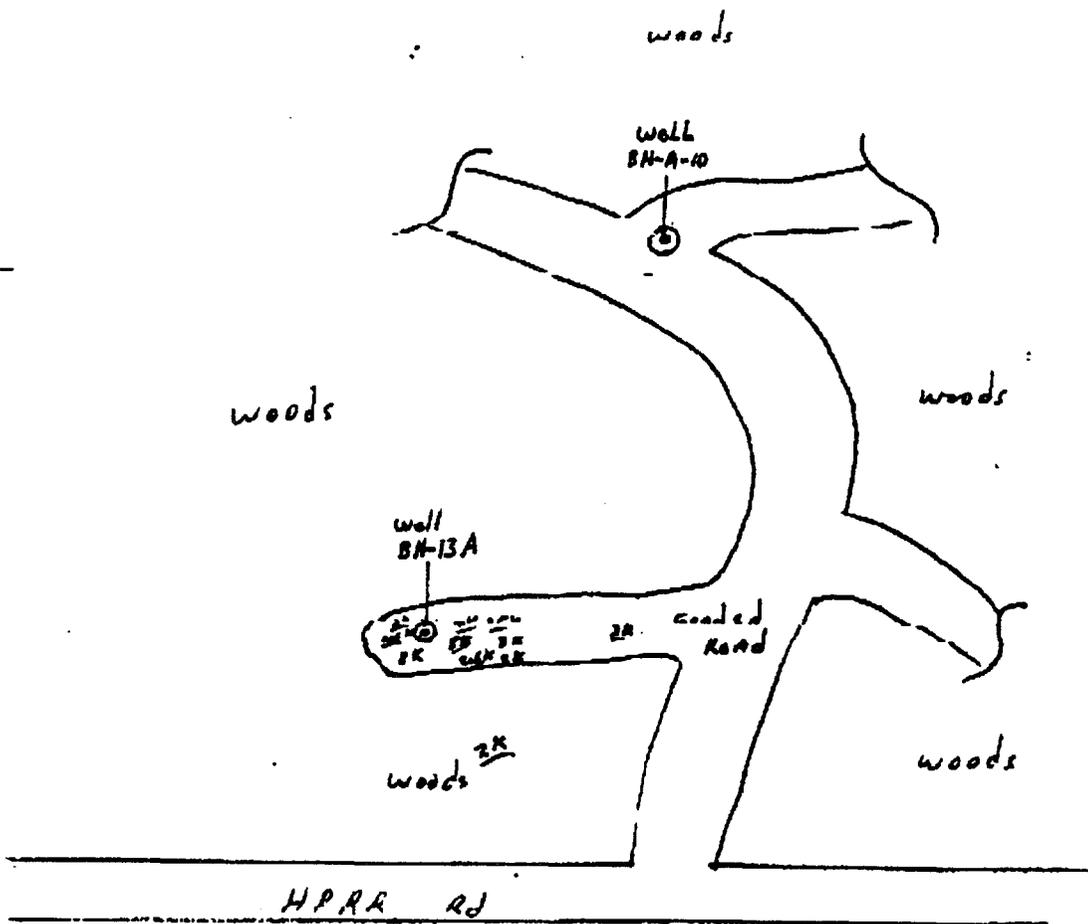
BUILDING N/A LOCATION SWSA 7 DATE 8/7/82 SURVEYOR J.S. Iwinski

SMEAR SURVEY: Alpha Beta/Gamma Beta PROBE SURVEY: Alpha Beta/Gamma BETA
 INSTRUMENTS: 2552-268 COUNTERS: _____ BACKGROUND SURVEY: BETA/GAMMA NEUTRON

Give only C&D on report over MDA:

Vertical 15-8' Frisk of Graded Road and wooded area showed contamination readings of 2K-25K D.P.M. Contamination appears to be spread throughout the area and not concentrated around a specific area.

A	B
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30
31	31
32	32
33	33



* See Results of Analysis dated Aug. 10 1982

- NTM** Neutron Monitor
- (A)** Airborne Radioactivity
- (A)** Alpha Probe Insertion
- (S)** Smear Location
- (S)** Contact Beta/Gamma
- (S)** 1 Foot Dose Rate
- (F)** Fast Neutron Dose Rate
- (S)** Beta/Gamma Dose Rate

- CAM** Continuous Air Monitor
- CAAM** Contin. Alpha Air Mon.
- LMA** Lab monitor Alpha
- LMB** Lab Monitor Beta/Gam.
- (MCU)** Monitor Control Unit
- (MOC)** Monitor Chamber
- (MNU)** Monitor
- ()** REGULATED AREA

- RAD** - Radiation Area
- H.RAD** - High Radiation Area
- V.H.RAD** - Very High Radiation Area
- CON** - Contamination Area
- RAD/CON** - Radiation & Contamination Area

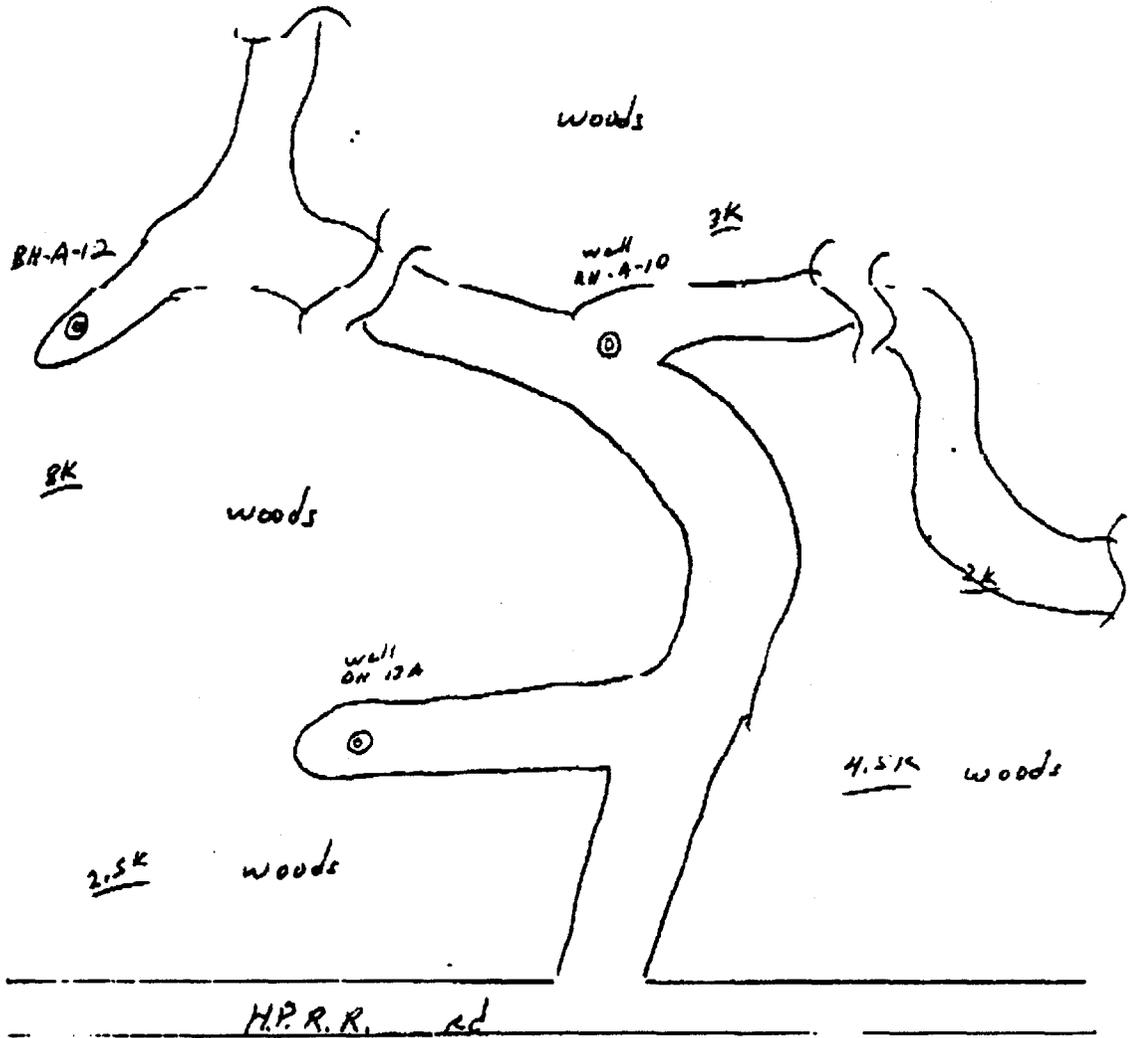
BUILDING N/A LOCATION SWSA 7 DATE 8/10/92 SURVEYOR J.F. IRLWIN

SMEAR SURVEY: Alpha Beta/Gamma Beta PROBE SURVEY: Alpha Beta/Gamma BETA
INSTRUMENTS: 7001-1712 COUNTERS: _____ BACKGROUND SURVEY: BETA/GAMMA NEUTRON

Give only Dtd as count over MDAs
_____ cps/100 sq ft
_____ cps/100 sq ft

DIRECT B-D FRISK OF WOODED AREA SHOWED CONTAMINATION READINGS OF 2.5K - 8K D.P.M. CONTAMINATION APPEARS TO BE SPREAD THROUGHOUT THE AREA.

A	B
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30
31	31
32	32
33	33



- NTM** Neutron Monitor
- (A)** Airborne Radioactivity
- (A)** Alpha Probe Location
- (O)** Smear Location
- β @** Contact Beta/Gamma Dose Rate
- β @** 1 Foot Beta/Gamma Dose Rate
- (n)** Fast Neutron Dose Rate
- β** Beta/Gamma Dose Rate

- CAM** Continuous Air Monitor
- CAAM** Contin. Alpha Air Mon.
- LMA** Lab Monitor Alpha
- LCM** Lab Monitor Beta/Gam.
- MUC** Monitor Control Unit
- MOC** Monitor Chamber
- MON** Monitor
- REGULATED AREA

- RAD** - Radiation Area
- H.RAD** - High Radiation Area
- V.H.RAD** - Very High Radiation Area
- CON** - Contamination Area
- RAD/CON** - Radiation & Contamination

BUILDING N/A LOCATION SUSA 7

DATE 8/10/92 SURVEYOR J.P. IRW

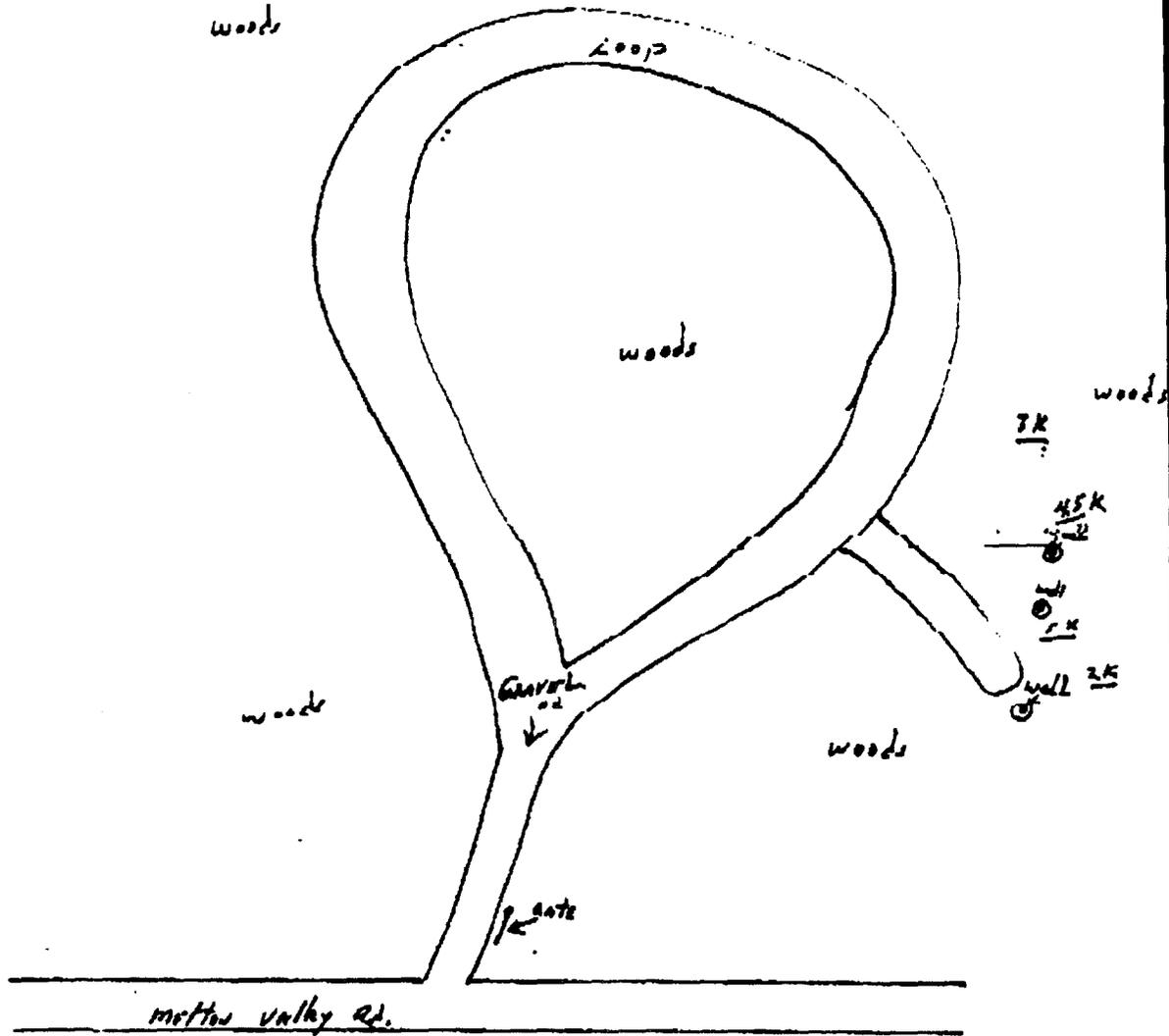
SMEAR SURVEY: Alpha Beta/Gamma Beta PROBE SURVEY: Alpha Beta/Gamma BETA

INSTRUMENTS: 4022-26P COUNTERS: _____ BACKGROUND SURVEY: BETA/GAMMA NEUTRON

One only D&D to smear over MDA:

Direct B-G Peak of wooded area showed contamination
 Readings of 2K - 5K D.P.M.
 Contamination appears to be spread through the area

A	B
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30
31	31
32	32
33	33



- NTM** Neutron Monitor
- (A) Airborne Radioactivity
 - (α) Alpha Probe Location
 - (S) Smear Location
 - (f) Contact Beta/Gamma
 - (f) 1 Foot Dose Rate
 - (f) Fast Neutron Dose Rate
 - (f) Beta/Gamma Dose Rate

- (CAM) Continuous Air Monitor
- (CAAM) Contin. Alpha Air Mon.
- (LMA) Lab Monitor Alpha
- (LMB) Lab Monitor Beta/Gam.
- (MCU) Monitor Control Unit
- (MGC) Multichannel Chamber
- (MON) Monitor
- REGULATED AREA

- RAD** - Radiation Area
- H.RAD - High Radiation Area
 - V.H.RAD - Very High Radiation Area
 - CON - Contamination Area
 - RAD/CON - Radiation & Contamination Area

RO--MMES-X10HFIR-1995-0009

Final Report
Page 1 of 6

OCCURRENCE REPORT

X10HFIR - High Flux Isotope Reactor

(Name Of Facility)

Category "A" Reactors

(Facility Function)

Oak Ridge National Laboratory

(Name of Laboratory Site or Organization)

Name: J E LEE
Title: HFIR PLANT MANAGER
Telephone No. (615)574-8288

(Facility Manager/Designee)

Name: D E BREWER
Title: SHIFT TECH ADVISOR
Telephone No. (615)241-3075

(ORIGINATOR)

1. OCCURRENCE REPORT NUMBER: ORO--MMES-X10HFIR-1995-0009
Action Item Reference ID: I0023631 - HFIR-95-009
Source ID Number:2. REPORT TYPE AND DATE: Date Time

[] Notification Report 04/05/1995 15:41
[] 10 Day Report 04/18/1995 15:53
[] 10 Day Update (latest)
[X] Final Report 05/19/1995 10:09

3. OCCURRENCE CATEGORY:

[] Emergency
[] Unusual
[X] Off-Normal
[] Non-Routine
[] Void4. DIVISION OR PROJECT:
Research Reactors5. DOE PROGRAM OFFICE:
NE - Nuclear Energy

OCCURRENCE REPORT

6. SYSTEM, BLDG., OR EQUIPMENT:
7910
7. UCNI?
NO
8. PLANT AREA:
HFIR
9. DATE AND TIME DISCOVERED:
04/04/1995 08:00
10. DATE AND TIME CATEGORIZED:
04/04/1995 15:30
11. DATE AND TIME OF DOE NOTIFICATION:
04/04/1995 15:45 G W MORRIS / DOE-OR
12. DATE AND TIME OF OTHER NOTIFICATIONS:

13. SUBJECT OR TITLE OF OCCURRENCE:

Contamination from Past Activities

14. NATURE OF OCCURRENCE:

1D Loss of Control of Radioactive Material

15. DESCRIPTION OF OCCURRENCE:

During a prejob survey in the overhead of Building 7910, four particles were discovered on the top side of a ceiling tile in Room 17. These particles ranged from 3000 to 6000 dpm/100 cm² beta-gamma. Similar particles were found on top of ceiling tiles in the east hallway (near the women's bathroom) and in Room 21. The majority of the measured activity was beta radiation. The contamination was removed with tape and sent off for isotopic analysis.

16. OPERATING CONDITIONS OF FACILITY AT TIME OF OCCURRENCE:

The reactor was operating at 85 MW.

17. ACTIVITY CATEGORY:

Inspection /Monitoring

18. IMMEDIATE ACTIONS TAKEN AND RESULTS:

Press Release Anticipated: NO

A survey of the lunchroom, including vending machines, chairs, table tops, horizontal surfaces, random wall surfaces, and lunchroom contents, revealed one 2000-dpm fixed beta-gamma particle.

Other surveys of the horizontal surfaces in rooms and hallways of Building 7910 revealed:

OCCURRENCE REPORT

- (1) 3300-dpm beta-gamma particle in the floor near the door of Room 18
- (2) 9000-dpm beta-gamma particle on a file cabinet in Room 13
- (3) 3000-dpm and 15,000 dpm beta-gamma particles on the air-handling unit in the men's change room.

All of these particles were removed.

19. DIRECT CAUSE:

6A Mgmt. Problem - Inadequate Administrative Control

20. CONTRIBUTING CAUSE(S):

21. ROOT CAUSE:

6A Mgmt. Problem - Inadequate Administrative Control

22. DESCRIPTION OF CAUSE:

Surveys of the overhead areas in Building 7910 have continued to reveal particles ranging from 1000 dpm to 150,000 dpm beta-gamma. This includes the areas above ceiling tiles and open areas in the utility room and shop. Further surveys of air-handling units revealed particles of up to 15,000 dpm beta-gamma.

To prevent contamination of the overhead and ventilation systems from spreading to occupied areas, the overhead areas have been posted by Health Physics as contamination areas for entry. Discharge registers from contaminated ventilation systems and gaps in ceiling tiles have been covered. Residents of the building have been instructed to take care when closing doors, which could shift ceiling tiles.

Isotopic analysis of the removed particles by the Radiochemical Engineering Development Center Analytical Chemistry Group revealed that the contamination was strontium-90.

Strontium-90 has been routinely identified in legacy contamination events. Strontium-90 is not characteristic of operational events that result in contaminations at the HFIR. There has been no movement of radioactive material at the HFIR that would account for the presence of strontium-90.

Past practices in controlling and identifying radioactive contamination were not adequate to prevent the spread of materials such as strontium-90. Therefore, the direct and root cause of this event is Management Problem, Inadequate Administrative Control. Because current practices are

OCCURRENCE REPORT

effective in controlling the spread of radioactive material, the only appropriate corrective action is to decontaminate the overhead areas in Building 7910.

23. EVALUATION: (by Facility Manager/Designee) COST EVALUATION: F8

The increased attention placed on surveying for contamination has resulted in new discoveries of legacy contamination, such as this incident.

Through removal of contamination from occupied spaces and isolation of the contaminated overhead and ventilation systems, it will be possible to use Building 7910 as decontamination activities proceed. Completion of decontamination in the utility room has demonstrated this as feasible.

24. IS FURTHER EVALUATION REQUIRED: Yes [] No [X]
IF YES, BEFORE FURTHER OPERATION: Yes [] No [X]
IF YES, BY WHOM? BY WHEN?

25. CORRECTIVE ACTIONS:

SEQUENCE NUMBER: 001 ACTION ID: A0056988

Perform a room-by-room decontamination of the overhead area of Building 7910.

TARGET COMPLETION DATE: 09/30/1995 COMPLETION DATE:

26. IMPACT ON ENVIRONMENT, SAFETY, AND HEALTH:

None

27. PROGRAMMATIC IMPACT:

None

28. IMPACT UPON CODES AND STANDARDS:

None

OCCURRENCE REPORT

29. FINAL EVALUATION AND LESSONS LEARNED:

Poor management practices in the past were the root cause of this incident. These practices have been the root cause of many legacy contamination events at the HFIR site, several involving strontium-90. Because strontium-90 does not originate at the HFIR site, it is likely that as these areas are discovered and decontaminated, the number and frequency of legacy contamination events will decrease.

Routine and prejob radiological surveys continue to be effective in finding contamination. Subsequently, the timely application of radiological controls enabled continued use of the facility while preventing the spread of material or personnel exposure.

30. SIMILAR OCCURRENCE REPORT NUMBERS:

ORO--MMES-X10HFIR-1990-0080
ORO--MMES-X10HFIR-1990-0173
ORO--MMES-X10HFIR-1992-0029
ORO--MMES-X10HFIR-1993-0022
ORO--MMES-X10HFIR-1994-0030

31. DOE FACILITY REPRESENTATIVE INPUT:

Entered by:

Date:

OCCURRENCE REPORT

32. SIGNATURES:

_____ Date: _____
Facility Manager (Name, Position)

_____ Date: _____
DOE Facility Representative (Name, Position)

_____ Date: _____
DOE Program Manager (Name, Position)

Appendix B

CALCULATION OF PARTICLE SIZE

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$^{90}\text{SrTiO}_3$

Molecular Weight = 186

Specific Activity for ^{90}Sr = 138 Ci/gr

Specific activity of pure $^{90}\text{SrTiO}_3$ = 66.8 Ci/g

$^{90}\text{SrTiO}_3$ is prepared by mixing $^{90}\text{SrCO}_3$ with TiO_2 and calcining at 1100°C

The specific activity of the final product is about 35 Ci/g or $8 \cdot 10^{13}$ dpm/g

A typical particle at SWSA 7 is 1500 dpm or 20 picograms

The reported product density is 3.5 g/cm^3 , therefore the typical particle size would be $5.5 \cdot 10^{-12} \text{ cm}^3$. Diameter would be about .02 microns.

Solubility test using seawater showed that the solubility rate is quite low.

ISOTOPIC POWER DATA SHEET

 ^{90}Sr

Source Material	SrTiO_3
Half-Life	$^{90}\text{Sr} - 27.7$ years ($^{90}\text{Y} - 64.2$ hr)
Decay and Radiation Properties	$^{90}\text{Sr} \rightarrow ^{90}\text{Y}$ 100% beta - 0.54 Mev $^{90}\text{Y} \rightarrow ^{90}\text{Zr}$ (stable) ~100% beta - 2.26 Mev
Isotopic Composition	55% ^{90}Sr , 43.9% ^{88}Sr , and 1.1% ^{86}Sr .
Activity Concentration	33 curies of ^{90}Sr per gram of fission product SrTiO_3 .
Radiochemical Purity	>99.9% $^{90}\text{Sr} + ^{88}\text{Sr}$. ^{90}Sr is present in concentrations dependent on length of time since discharge from the reactor and is usually <5% of the ^{90}Sr activity at time of fabrication of source pellets. Other radiochemical impurities such as ^{144}Ce can be neglected.
Chemical Purity	>95% strontium. Major impurities are Ca and Ba.
Specific Power	0.223 watts per gram of SrTiO_3 , or 6.772 watts per kilocurie of ^{90}Sr .
Thermal Energy	148 curies ^{90}Sr per thermal watt.
Density	~3.7 g/cm ³ . The theoretical density is 5.0 g/cm ³ . Production values vary from 3.2 to 4.2 g/cm ³ , averaging about 3.7 g/cm ³ .
Power Density	0.825 watts/cm ³ from ^{90}Sr at a density of 3.7 g/cm ³ . ^{88}Sr will contribute in proportion to its concentration at a rate of 3.4 watts/1000 curies of ^{90}Sr .
Thermal Conductivity	Values reported for inactive SrTiO_3 vary from 0.0132 to 0.0173 cal/sec·cm·°C at room temperature, depending on the density.
Coefficient of Expansion	$1.12 \times 10^{-6} \text{ } ^\circ\text{C}^{-1}$
Melting Point	~1900°C
Mechanical Strength	Fair
Thermal and Radiation Stability	The thermal stability is good. The radiation stability is good as exhibited in two-year old samples.

Radiation Attenuation

Dose Rate, rads/hr at 100 cm	Shielding in Centimeters of Uranium for a ^{90}Sr Source Strength of		
	100 w	1000 w	10,000 w
100	0.07	0.7	2.0
10	1.0	2.3	3.8
1	2.6	4.3	5.8
0.1	4.4	6.2	8.0

61

NRDL-TR-88-135

23 August 1968

**RADIOACTIVITY RELEASE FROM RADIONUCLIDE POWER
SOURCES. VIII. RELEASE FROM FULLY-FUELED
STRONTIUM TITANATE AND STRONTIUM OXIDE TO SEAWATER**

**U.S. NAVAL RADIOLOGICAL
DEFENSE LABORATORY**

SAN FRANCISCO • CALIFORNIA • 94135

IV. CONCLUSIONS

From the results of this study it would be predicted that if ^{90}SrO pellets were exposed to the marine environment, a rapid reaction between the ^{90}SrO and seawater would occur. The entire pellet would be dissolved in a relatively short period of time. The concentration of ^{90}Sr in the vicinity of the immersion would vary depending on mixing conditions and dilution factors but should not exceed 220 mg Sr/l (6.7 Ci $^{90}\text{Sr}/\text{l}$). A fraction of the dissolved activity would be adsorbed by the ocean-bottom material if the pellets were in contact with it.

For exposure of SrTiO_3 pellets the data indicated that the amount of SrTiO_3 released in seawater was relatively low. Application of the results to an actual SNAP 21 unit* is illustrated by Table 5 in which the total release as a function of post-immersion time has been tabulated. Although long-term release data cannot be accurately extrapolated, this can serve as a guide for those who wish to use these results for hazards-analysis calculations.

*The unit contains one right circular cylinder of SrTiO_3 with dimension of 2.63 inches (diameter) by 2.63 inches (height), weight of 816 g, and a loading of 30.3 curies ^{90}Sr per gram.

TABLE 5

Predicted Release of Strontium-90 to Seawater From a SNAP-21 Unit

Time (days)	⁹⁰ SrTiO ₃ Dissolved (g)	⁹⁰ SrTiO ₃ Dissolved (%)	Strontium-90 Release in Seawater (Ci)
20	2.14	0.26	65
40	3.86	0.47	117
60	5.04	0.62	153
80	5.78	0.71	175
100	6.38	0.78	193
140	7.56	0.92	229
180	8.67	1.06	263
365 (1y)	13.7*	1.68*	416*
3650 (10y)	103*	12.7*	3130*

*Extrapolated values for stoichiometric ⁹⁰SrTiO₃, assuming the dissolution rate to be constant (0.13 mg/cm²/day) throughout this period.

...the ...

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