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ARCL CALCULATIONS FOR DECOMMISSIONING THE
117-D FILTER BUILDING

Author

J. F. Beckstrom, R. B. Loveland

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ARCL CALCULATIONS FOR DECOMMISSIONING

THE 117-D FILTER BUILDING

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SUMMARY

This document describes how the Allowable Residual Contamination Level (ARCL) method was used in conjunction with the in situ decommissioning alternative to permanently dispose of the 117-D Filter Building. Using this strategy, the decommissioned 117-D Filter Building site represents a theoretical maximum dose of 1.7 mrem/year to the maximally exposed individual.

The 105-D Reactor Building ventilation system exhaust air entered the 117-D building via the underground concrete inlet duct. Under normal operating conditions, the air flow was diverted into the two filter cells by turning vanes. The exhaust air then passed through three sets of filter banks. The filtered air was then diverted by turning vanes to the 116-D stack via the underground exhaust duct. As was expected, the majority of contamination was found upstream of the filter cells.

Application of the ARCL methodology to the 117-D Filter Building is very straightforward. Instead of calculating eight separate ARCL values for each section of the building, one ARCL value was determined for the whole structure. The highest concentration of radionuclides for each section was weighted against the sectional surface area to establish the average concentration for the building. The weighted average was used to determine the ARCL value and the total isotopic inventory for the 117-D building.

The ARCL value, as calculated in this report, is based on radionuclide concentration. This means that the ARCL value is the maximum concentration of radionuclides that can be allowed to remain in the 117-D building without exceeding a site dose limit of 25 mrem/year. After demolition and burial in situ the contamination is no longer associated with the structure's surfaces. It is integrated into the matrix of the buried rubble. The residual contamination calculation is intended to be a point estimate of the radionuclide concentration in the building rubble buried in situ. When compared to the ARCL value, the residual contamination can be used to estimate the dose to a maximally exposed individual residing at this decommissioned site. Based on the total isotopic inventory and the mass of the 117-D building, the residual concentration of radionuclides in the rubble was calculated to be 6.7% of the ARCL value. This represents a dose to a maximally exposed individual of 1.7 mrem/year.

The calculations in this document have been prepared in accordance with UNI-2522, Allowable Residual Contamination Levels for Decommissioning Facilities in the 100 Areas of the Hanford Site, and as authorized by DOE in a letter to Hanford contractors, July 3, 1984, from the Manager, DOE-RL.

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1.0 INTRODUCTION

The purpose of this document is to demonstrate the Allowable Residual Contamination Level (ARCL) methodology in releasing the 117-D Filter Building for demolition and burial in situ and to show that the remaining or residual contamination in the building is less than the allowable levels specified by the ARCL. The ARCL calculation establishes the amount of radioactive contamination that may remain in the structure when it is demolished and buried in situ to ensure that a maximally exposed individual residing on the site will receive no more than a specified dose to the whole body or any organ.

The ARCL methodology can be applied to an entire structure or to various parts of a structure. In the case of the 117-D Filter Building the methodology was applied to the entire structure, including the underground ducts. Radionuclide concentrations for the ARCL and total isotopic inventory calculations are based on a weighted average approach.

ARCL calculations utilize an unrestricted-use mode, a dose limit of no more than 25 mrem/year to the whole body or any organ of a maximally exposed individual, a contamination condition of confined soil from 1 to 4 m deep, and the residential/home garden scenario. Residual contamination levels in the building were based on the total mass of concrete, excluding the auxiliary spaces identified in Section 3.1 of this report. No credit for additional dilution was taken for the dirt fill over the site other than that allowed for by the ARCL methodology.

2.0 BUILDING DESCRIPTION

2.1 History

The original ventilation system for the 105-D Reactor Building routed conditioned atmospheric air to noncontaminated portions of the reactor building, through zones of increasing contamination, and finally out of the reactor building to the 116-D Ventilation Exhaust Stack.

The 117-D Filter Building was built in 1960, approximately 16 years after startup of the 105-D Reactor, to filter the exhaust air before it was routed to the stack. The exhaust air was routed to the filter building via an underground concrete inlet duct, filtered through particulate (HEPA), and halogen (activated charcoal) filters, and then routed to the stack via an underground, concrete exhaust duct. In 1967 the reactor and associated facilities were shut down.

2.0 BUILDING DESCRIPTION (Cont'd)

2.2 Location

The 100-D/DR Area is located within the Hanford Site (Figure 1) on the south bank of the Columbia River, approximately 34 river miles upstream and 30 road miles from the city of Richland, in the south central Washington State. The 117-D Filter Building was located approximately 100 feet south of the 105-D Reactor Building (Figure 2).

2.3 Physical Description

The 117-D Filter Building (Figure 3) was a reinforced concrete structure 59 ft long, 39 ft wide and 35 ft high, of which 95% was below grade. The concrete walls and floors were generally 8 in. thick, with a maximum thickness of 12 in.

The building was connected to the 105-D building exhaust air system by an underground concrete duct which ran from the 105-D building exhaust fan discharge to the 117-D building filter cells. A discharge duct conveyed the filtered air from the 117-D filter cells to the 116-D stack. The ducts were made of reinforced concrete no more than 18 in. thick. Both ducts had inside dimensions of 7 ft wide by 8 ft-7 in. high. The inlet duct was 115 ft long and the exhaust duct was 92 ft long. The duct roofs were typically 8 ft below grade. Turning vanes installed in the ducts reduced flow turbulence into and out of the filter cells.

The 117-D Filter Building contained two identical filter cells (A and B) separated by a two-story gallery area (Figure 4). The operating gallery contained a small amount of piping and electrical gear. The floor was metal grating. Eight doors on this level provided access to the A and B filter cells. Two doors, one on either end, provided access to the inlet and the exhaust ducts. Fresh air supply manifolds and air flow and radiation level instruments were located on this level.

The equipment gallery, located directly below the operating gallery, contained the majority of the piping and valves, including water lines, drain lines, air lines, sump pump, and the exhaust fan system lines.

Each filter cell had six berths, arranged in three banks with two berths per bank. Each filter berth contained one aluminum filter frame that held 24 HEPA or halogen filters, each of which was 24 x 24 x 12 in.

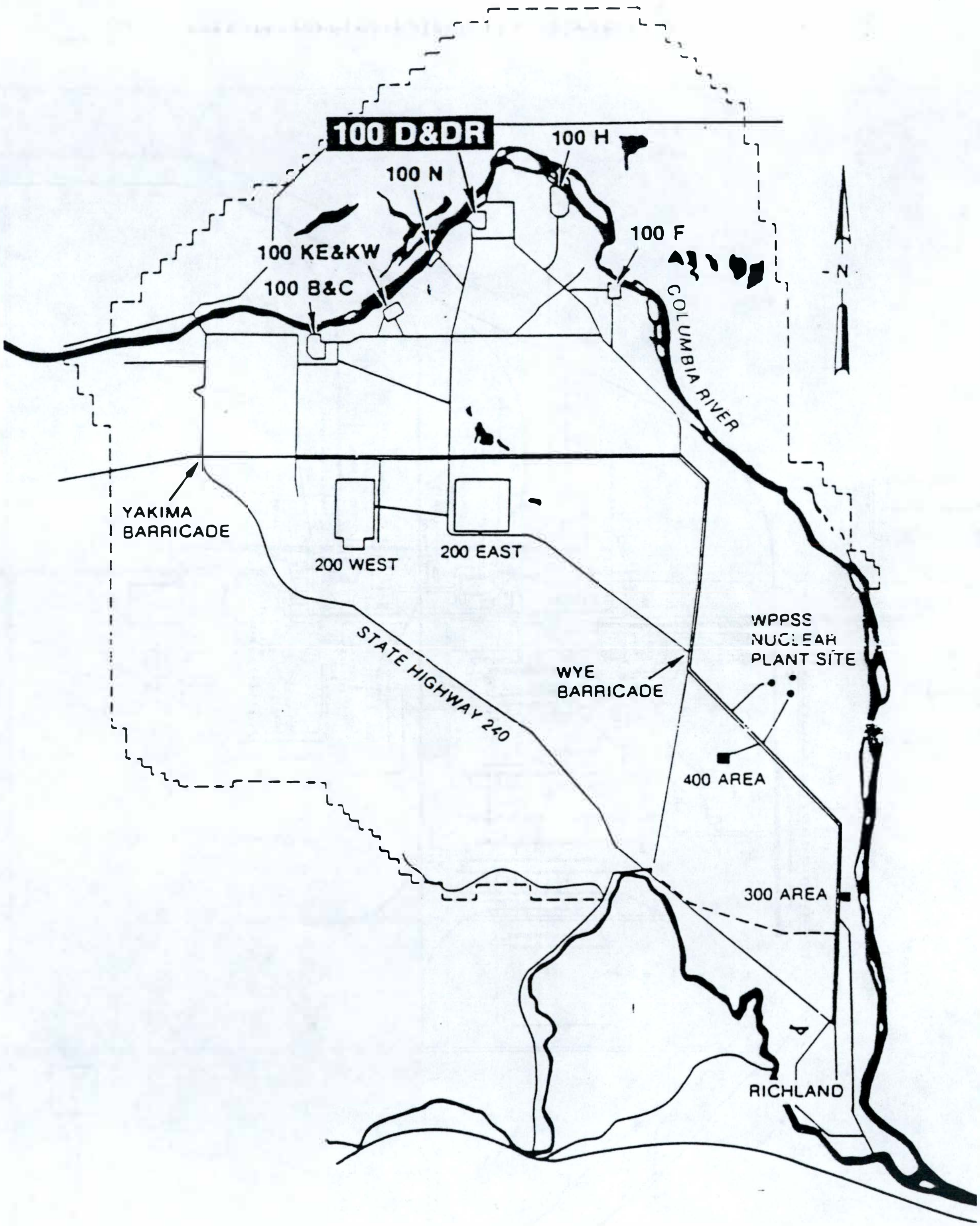


Figure 1. Hanford Site 2K8605-9.5

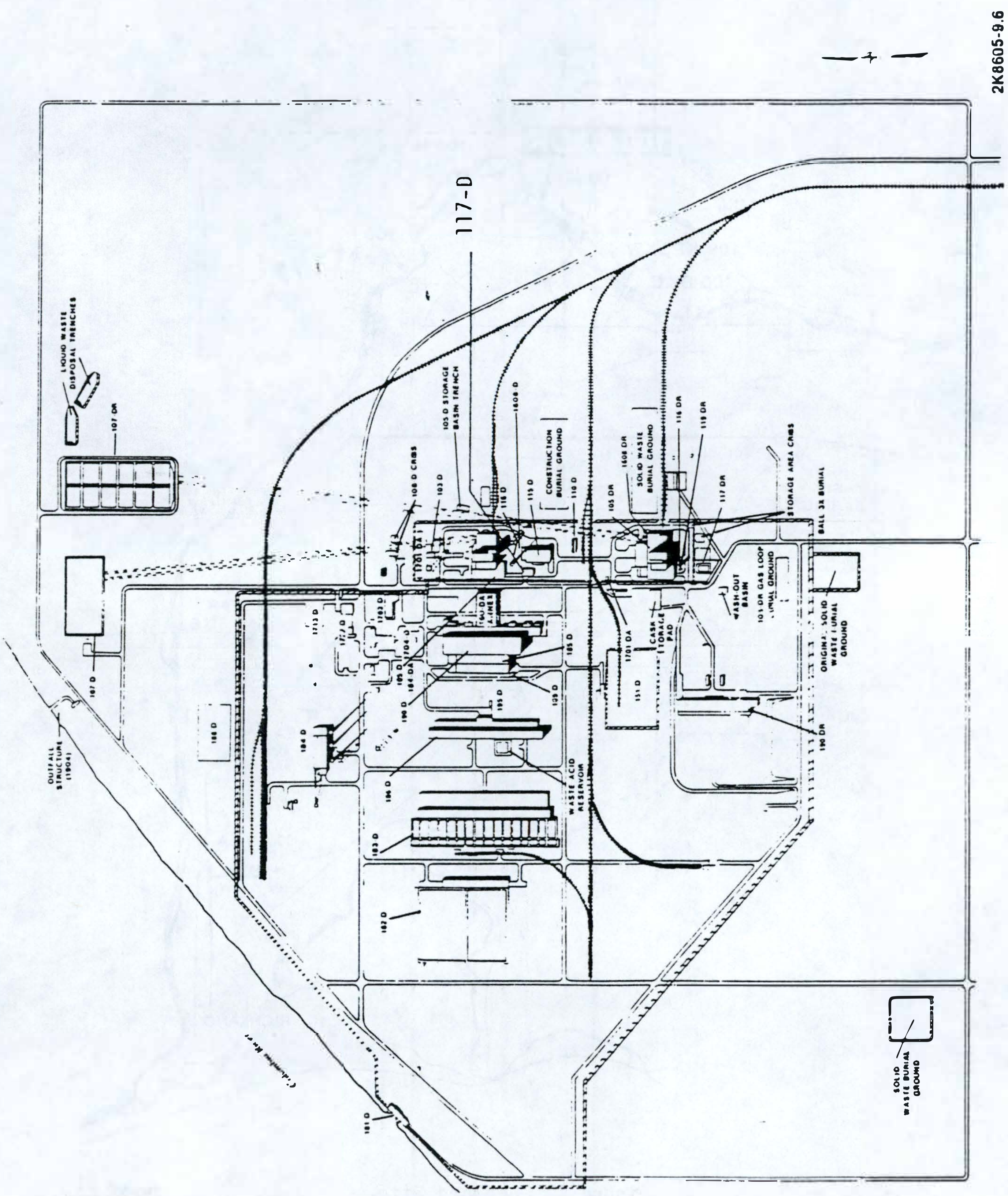
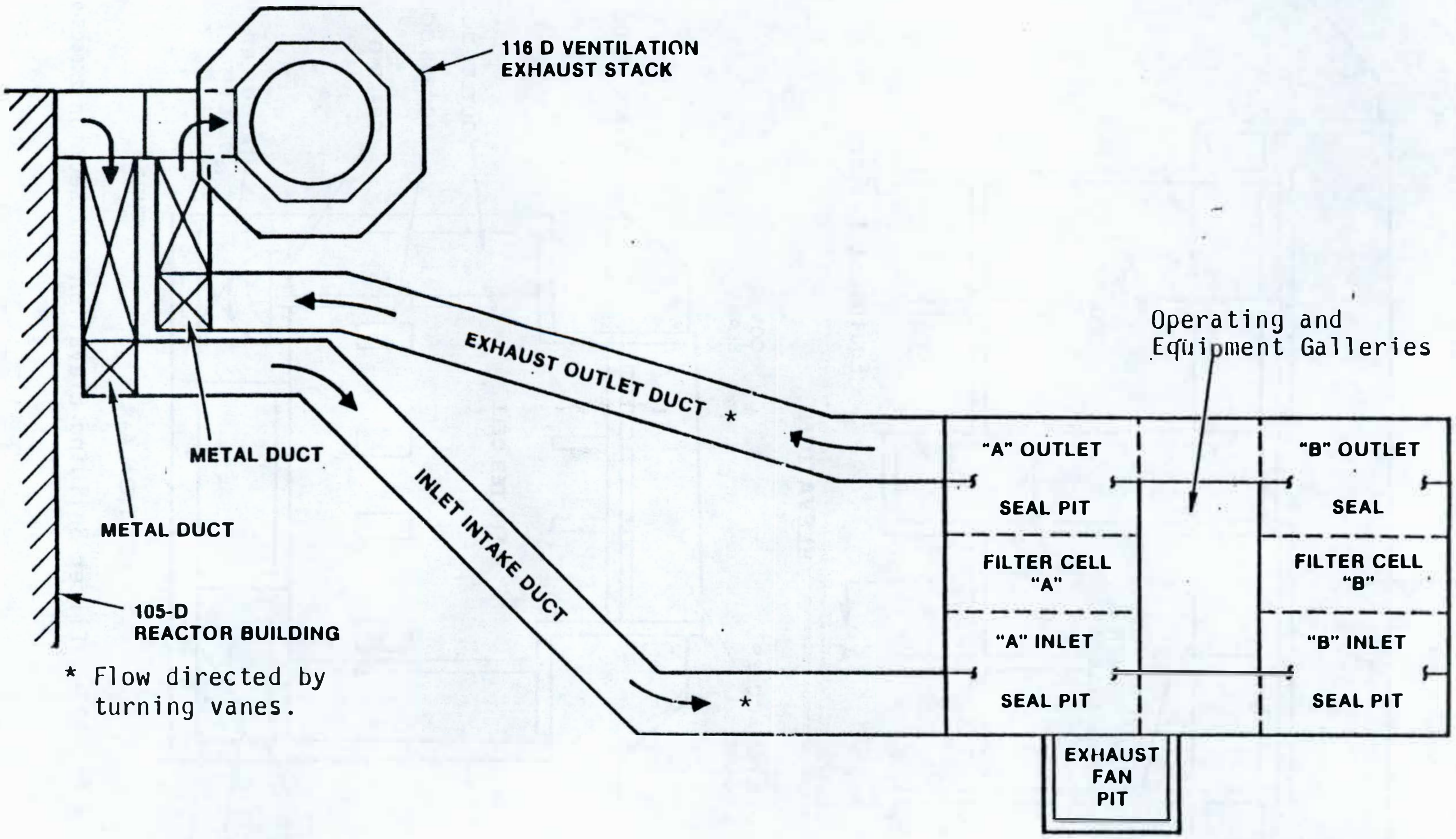


Figure 2. Location of 117-D Filter Building in the 100-D/DR Area



* Flow directed by turning vanes.

Figure 3. 117-D Filter Building and Underground Ducts - Plan View

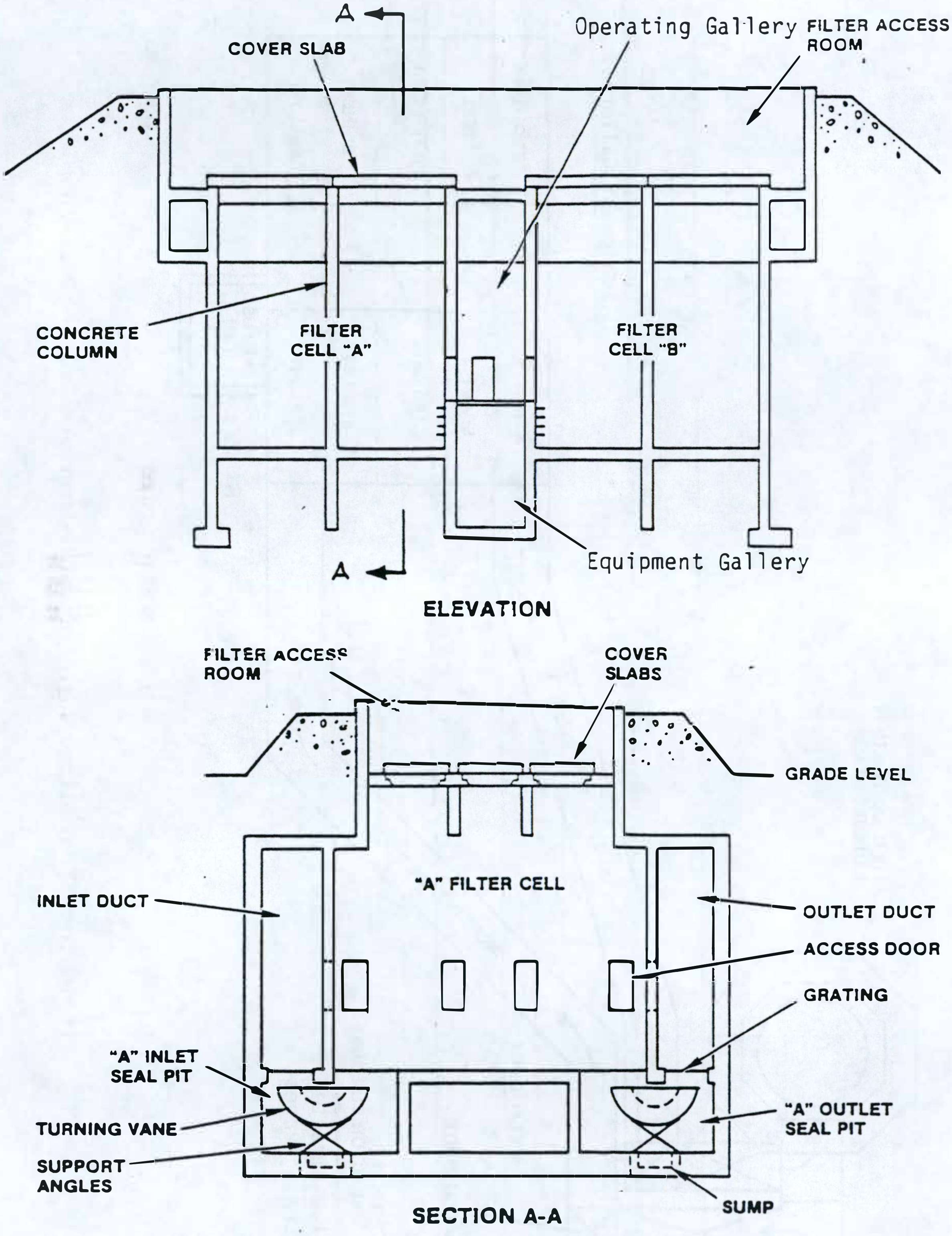


Figure 4. 117-D Filter Building Elevation and Section 2K8605-9.1

2.0 BUILDING DESCRIPTION (Cont'd)

2.3 Physical Description (Cont'd)

An electric-drive turbine exhaust fan was located in the fan pit to circulate the air and maintain a negative pressure during filter removal or maintenance. Removable roof panels functioned as upper weather seals, and rectangular concrete cover slabs functioned as upper radiation shields for the filter banks.

3.0 DECONTAMINATION ACTIVITIES

3.1 Preliminary Surveys

Based on the radiological data in UNI-946, Radiological Characterization of the Retired 100 Areas, the 117-D Filter Building was one of the most contaminated 117 buildings in the 100 Areas. This condition was verified by initial entry surveys conducted by Radiation and Water Quality Control (R&WQC) personnel. Because of this fact, decontamination activities were initiated prior to radiological characterization.

At the beginning of the 117-D Decommissioning Project, the Filter Access Room, Operating Gallery and Equipment Gallery were assumed to be noncontaminated. These spaces had no previous history of being contaminated and were isolated from the normal flow of the air filtering process. However, the potential for contamination did exist in these auxiliary spaces.

The contaminated and auxiliary sections of the 117-D Filter Building are listed below:

Contaminated	Auxiliary
- Inlet Duct and Fan Pit	- Filter Access Room
- Inlet Seal Pit A	- Operating Gallery
- Inlet Seal Pit B	- Equipment Gallery
- Filter Cell A	
- Filter Cell B	
- Outlet Seal Pit A	
- Outlet Seal Pit B	
- Exhaust Duct	

3.0 DECONTAMINATION ACTIVITIES (Cont'd)

3.2 Decontamination and Disposal (Cont'd)

3.2.1 Equipment/Component Removal

The 117-D Building inlet and exhaust ducts each had three sets of turning vanes to direct air flow and reduce turbulence (Figure 3). No time or effort was expended decontaminating these components. They were removed from the facility, wrapped and shipped to the 200 West Area burial site for disposal as radioactive waste.

The highest concentration of contamination within the 117-D Building was found in the inlet duct and the two inlet seal pits. To facilitate the decontamination of the seal pits, the turning vanes (Figure 4) in the pits were cut into sections and removed through the filter access hatch in the ceiling of the filter cells. These components were wrapped and shipped to the 200 West Area burial site for disposal as radioactive waste.

The underground concrete inlet and exhaust ducts of the 117-D Building were connected to the 105-D Reactor Building exhaust ventilation system and the 116-D Exhaust Stack by above-ground metal ducts. These metal ducts were removed, used as low-level waste containers for radioactive waste, and shipped to the 200 West Area burial site for disposal.

The metal gratings covering the inlet and outlet seal pits were left in place to be dispositioned with the 117-D Building. The gratings were contaminated. Their contribution to the total isotopic inventory was considered in the overall inventory calculations.

The sheet metal roof panels for the filter access were removed and stored for possible future salvage.

3.2.2 Decontamination of Surfaces

Further decontamination of surfaces was performed following the removal of the turning vanes and the air ducts. This decontamination was done to reduce the levels of contamination within the 117-D Building to ensure that the ARCL site dose criteria of 25 mrem/year would not be exceeded, and to ensure the site dose would be significantly reduced so the accumulated dose contributed from other decommissioned facilities within a 1-hectare area would also be less than the 25 mrem/year.

3.0 DECONTAMINATION ACTIVITIES (Cont'd)

3.2 Decontamination and Disposal (Cont'd)

3.2.2 Decontamination of Surfaces (Cont'd)

Decontamination consisted of sweeping the floors of the inlet and exhaust ducts and the two filter cells with a sawdust sweeping compound. Next, the floors were mopped with soap and water and left to dry. The floors of the inlet seal pits were vacuumed and wet mopped. The seal outlet pits were only vacuumed because the turning vanes restricted access to that area. Finally, the remaining surfaces exposed to the air flow (walls and ceiling) were wiped down with Masslinn cloth.

4.0 RADIOLOGICAL CHARACTERIZATION

4.1 Grid Scheme

Except for outlet seal pits, each section of the 117-D Building was divided into 2 m x 2 m grid. The exhaust seal pits were not divided into grids due to the difficulty in entering the exhaust seal pits and the hazard of surveying over the open turning vanes. The "seal pits" were essentially open pits and were not enclosed with a ceiling. The purpose of establishing grids was primarily for data accountability and control.

4.2 Radiological Surveys

Since the final disposition of the 117-D Filter Building is based on the ARCL Methodology, radiological surveys were conducted to ascertain the overall levels of contamination and to locate the highest concentrations of contamination within the facility.

Radiation surveys were performed on approximately 100% of the internal accessible surface areas of the facility. Since contamination was not found to be uniform over any given grid area, the entire grid surface was considered contaminated. Based on an evaluation of the survey data, the entire internal surface area associated with the flow path of exhaust air was considered to be contaminated.

4.3 Isotopic Analysis

4.3.1 Paint Samples

All interior surfaces of the inlet duct, filter cells, seal pits and exhaust duct had been painted with a thick coating of

4.0 RADIOLOGICAL CHARACTERIZATION (Cont'd)

4.3 Isotopic Analysis (Cont'd)

4.3.1 Paint Samples (Cont'd)

Amercoat 30, a vinyl base paint. The Amercoat 30 provided a very hard and smooth barrier that covered all concrete surfaces within the path of air flow. Based on the paint samples collected throughout the structure, the vinyl coating was determined to be of uniform thickness of about 1 mm. The density of the paint (1.15 g/cm^3) was determined by standard laboratory methods.

Paint samples were collected by removing approximately 30 g of paint from selected grids. The paint was placed into 250 ml plastic jars to maintain consistent geometry for gamma spectrum analysis.

Selected paint samples were sent to the U.S. Testing Company, Richland, Washington, for tritium, carbon-14, strontium-90, and gross alpha analyses. The results of these analyses are listed in Appendix A.

4.3.2 Concrete Samples

Concrete samples were collected from beneath the paint in the inlet and exhaust ducts, the filter cells and seal pits, to determine whether or not any of the contamination had penetrated the vinyl coating. In most cases the results of isotopic analysis showed little or no activity above background levels.

The activity in the concrete may be attributed to sample collection techniques. Since the contaminated paint had to be removed to get at the concrete, it is possible that several of the concrete samples could have been cross-contaminated. In any event, the contamination in the concrete is not considered significant and does not effect the total isotopic inventory calculation for the 117-D Building. (See Appendix A.)

Concrete samples were also collected from surfaces in the Filter Access, Operating Gallery, and Equipment Gallery. Isotopic analyses of these samples showed minimal concentrations of radioactive contamination.

5.0 RADIOLOGICAL INSTRUMENTS

5.1 Isotopic Analysis

Paint and concrete samples were analyzed on a multi-channel analyzer (TN-4000) with a germanium (lithium) detector for gamma energy identification. The isotopes cobalt-60, cesium-137, europium-152, and europium-154 were identified by this method. Selected paint samples were sent to United States Testing Company, Inc., Richland, Washington, for gross alpha, tritium, carbon-14, and strontium-90 analyses.

5.2 Counting Instruments

Portable survey instruments were maintained and calibrated by the Instrument Calibration and Evaluation Section, Pacific Northwest Laboratories, located in the Hanford 300 Area.

Alpha and beta counts for technical smears, paint and concrete were done with the following instruments:

Automatic System:	Canberra 2404 - Alpha/Beta, Gas Flow Proportional Counter
Manual System:	Tracor Northern - TN 4000 Multi-channel Nuclear Spectroscopy System (Multi-Channel Analyzer)
Portable Beta-Gamma Detector:	Eberline Instrument Corp., Model BNW-1, with P-11 "pancake" probe.
Portable Alpha Detector:	Eberline Instrument Corp. Model E-140B with alpha scintillation detector and MS-2 scaler with 6-in. dia. alpha scintillation probe.
Large Area Alpha Probe:	Ludlum, Model 12, with 125-cm^2 gas probe.
Micro-R-Meter:	Ludlum, Model 125

6.0 DETERMINATION OF THE ALLOWABLE RESIDUAL CONTAMINATION LEVELS (ARCL)

6.1 ARCL Methodology

The objective of the analysis of radionuclides in soil or facilities is the determination of whether radioactively contaminated sites require further decontamination or remedial action prior to demolition and burial in situ. The ARCL value for the 117-D Filter Building was calculated to be 8.2 pCi/g. Based on this value and the calculated residual radioactive concentration of the rubble, no additional decontamination was required prior to demolition and burial in situ. The ARCL methodology was based on the following criteria:

- Residential/Construction Exposure Scenario.
- Unrestricted use at time of release based on an annual dose rate of less than 25 mrem/year.
- Contamination condition of confined soil 1 to 4 meters deep.

6.2 Residential/Construction Exposure Scenario

The residential/construction scenario is based on the intruder/construction scenario developed by the United States Regulatory Commission in the Draft Environmental Impact Statement in support of 10 CFR Part 61 (U.S. NRC 1981). For this scenario, an individual is assumed to dig a basement for a home into a subsurface radioactive soil (or debris) zone. The radioactive soil is assumed to be 2.5 m from the surface. Typical surface areas for a house are assumed to be 20 m by 10 m, for an area of 200 m^2. This dimension is assumed for the base of the foundation hole. The foundation hole is assumed to be 3.5 m deep, with surface dimensions of 26 m by 16 m. The total excavation is assumed to involve about 200 m^3 of contaminated rubble mixed with 800 m^3 of clean overburden soil. The resulting 1000 m^3 has a radionuclide concentration that is 20% of the original concentration of contaminated soil. The contaminated soil mixture is assumed to be used as fill around the house and distributed uniformly within a 25 m radius around the house.

For the residential/construction scenario, dose estimates are made for the individual both during and after the construction activities. The most restrictive individual dose resulting from both scenarios for each radionuclide is then used in the ARCL calculation. During construction, the individual is assumed to spend 500 hours (over about a 3-month period) on the site. The individual is assumed to inhale air with a dust concentration of 0.1 E-4 g/m^3 and to be exposed to direct radiation for the 500-hour construction period. After the house is constructed, the individual is assumed to reside there and conduct activities similar to those identified by the NRC for the intruder/agriculture scenario.

6.3 Radiological Data Preparation

6.3.1 Analytical Results

The analytical results of the paint and concrete samples collected from the 117-D building are tabulated in Appendix A by building section. Gross alpha and beta analyses and analyses for gamma emitting nuclides were performed at the Health Physics Laboratory Facility, located in the 183-KE building, 100-K Area. Selected samples from each section of the building, except the auxiliary spaces, were sent to the U.S. Testing Company, Richland, Washington, for tritium, carbon-14, strontium-90, and gross alpha and beta analysis.

The ARCL and residual contamination calculations are based on the eight point samples analyzed by the U.S. Testing Company. The isotopic data were extracted from Appendix A and are presented in Table 1.

The calculations are intended to be a conservative estimate of the radiological status of the 117-D Filter Building, based on the following assumptions.

6.3.2 Assumptions for Calculations

For ARCL work sheet preparation and residual contamination calculations, the following assumptions were made in addition to those already present within the ARCL methodology.

1. Some grids within the 117-D building were not contaminated. However, it was assumed that the entire surface area of the room or section was contaminated and that the contamination within each room or section of the building was uniformly distributed over 100% of the surface area.

2. The U.S. Testing data, reported in Table 1, is assumed to be representative of the contamination in each section of the building.

3. Trace amounts of activity beneath the painted surfaces are present but do not impact the ARCL and total isotopic inventory calculations.

Table 1, Isotopic Concentrations - 117-D Filter Building.

BUILDING SECTION	H-3	C-14	Co-60	Sr-90	Cs-137 (pCi/g)	Eu-152	GROSS ALPHA	TOTAL
Inlet Duct	118	216	ND	212	682	31	ND	1259
A-Inlet Seal Pit	17	29	17	16	174	ND	5	258
B-Inlet Seal Pit	9	24	ND	2	100	ND	8	143
Filter Cell-A	688	573	180	561	1070	64	8	3144
Filter Cell-B	96	132	ND	3	1750	ND	15	1996
A-Outlet Seal Pit	8	20	ND	136	23	ND	4	191
B-Outlet Seal Pit	9	24	ND	10	100	ND	3	146
Exhaust Duct	23	25	ND	6	36	ND	38	128

COMMENTS: Isotopic concentrations are based on the samples analyzed by the U. S. Testing, extracted from Appendix A.
ND Indicates Not Detected.

6.3.2 Assumptions for Calculations (Cont'd)

4. The density of concrete was assumed to be 2.1 g/cm^3, based on standard industrial mixes for concrete. The rebar was not included in the total mass of the building.

5. The density of paint was determined to be 1.15 g/ml, based on standard density determination procedures.

6. The thickness of paint was determined to be uniform at 1 mm, based on measurements of paint samples collected.

7. The trace amounts of contamination on the Filter Access Room floor and in the sump in the Equipment Gallery have no significant impact on the ARCL residual contamination results.

6.4 Determination of the ARCL Value

The ARCL value is calculated by first establishing the post-decontamination activities of each isotope present in each section of the building. Isotopic concentrations are tabulated by section in Table 1.

The isotopic concentrations in each fractional section of the building are then weighted against the total area of the building (Table 2). The sum of the weighted concentrations for each isotope is used in the ARCL calculation (Table 3, ARCL work sheet). The isotope and weighted concentration are entered in columns 5 and 6 of the ARCL work sheet. The percentage contribution of each isotope to the total concentration is then calculated and entered in column 6a. Next, the scenario-specific dose factors are selected for each isotope. The selection of these factors is determined by the depth at which the structure is to be buried in situ (See Section 5.2.2, UNI-2522, Allowable Residual Contamination Levels for Decommissioning Facilities in the 100 Area of the Hanford Site, Reference 2). For the 117-D building a contamination condition of 1-4 m is used for all sections of the building (column 7).

The product of the items in columns 6a and 7 is entered in column 8. The units of the item in column 8 are rem/year per pCi/g. Column 8 is totaled and the sum of the values is entered onto the work sheet as item 8a. The annual dose limit of 0.025 rem/year is divided by the value in item 8a and the resulting quotient is the ARCL limiting value (item 8b, Table 3.)

Table 2, Isotopic and Weighted Average Concentrations - 117-D Filter Building.

BUILDING SECTION	H-3	C-14	Co-60	Sr-90 (pCi/g)	Cs-137	Eu-152	Pu-239 (a)	TOTAL
Inlet Duct	118	216	0	212	682	31	0	1259
% Area = 23.7								
Weighted Conc.	28	51	0	50	162	7	0	298
Inlet Seal Pit A	17	29	17	16	174	0	5	258
% Area = 4.1								
Weighted Conc.	0.7	1.2	0.7	0.7	7.1	0.0	0.2	10.6
Inlet Seal Pit B	9	24	0	2	100	0	8	143
% Area = 4.1								
Weighted Conc.	0	1	0	0	4	0	0	6
Filter Cell A	688	573	180	561	1070	64	8	3144
% Area = 20.4								
Weighted Conc.	140	117	37	114	218	13	2	641
Filter Cell B	96	132	0	3	1750	0	15	1996
% Area = 20.4								
Weighted Conc.	20	27	0	1	357	0	3	407
Outlet Seal Pit A	8	20	0	136	23	0	4	191
% Area = 4.1								
Weighted Conc.	0	1	0	6	1	0	0	8
Outlet Seal Pit B	9	24	0	10	100	0	3	146
% Area = 4.1								
Weighted Conc.	0.4	1.0	0.0	0.4	4.1	0.0	0.1	6.0
Exhaust Duct	23	25	0	6	36	0	38	128
% Area = 19.0								
Weighted Conc.	4	5	0	1	7	0	7	24
TOTAL (Sample)	968	1043	197	946	3935	95	81	7265
Weighted Avg. *	194	204	37	173	760	20	13	1401

COMMENTS: Isotopic concentrations are based on the sample from each section of the building analyzed by the U. S. Testing Co., Richland, Wa.

* These values represent the sum of the weighted concentrations in each section of the building. The concentrations are weighted with respect to room size and the totals are used in the ARCL calculation (Table 3).

(a) Based on gross alpha analyses.

9513360.0085

UNI-3870

Table 3, ARCL Worksheet

FACILTIY NAME: 117-D Filter Building

PREPARER'S NAME: J.F. Beckstrom

Checked by: E. V. dosRamos

DATE PREPARED: 8/12/86

Date: 10-21-86

Determination of ARCL Dose Factors to Enter From Table 5.2.2., UNI-2522. Check one Use Mode and one Contamination Condition.

Use/Contamination Condition		Contaminated Surfaces Ci/m2 or dpm/100cm2		Surface Soil (pCi/g)		Soil 1-4 m Deep	X	Soil >5 m Deep (pCi/g)
Restricted Use @ 0.5 rem/yr		Column 1		Column 4		Column 5		Column 6
Controlled Use @ 0.5 rem/yr		Column 2		Column 4		Column 5		Column 6
Unrestricted Use @ 0.025 rem/yr		Column 3		Column 4		Column 5	X	Column 6

5. Radionuclides concerned (list)	6. Radionuclide Concentrations (Available Units)	6a. Radionuclide* Concentrations (Ci/m2 or pCi/g)	7. Scenario-specific ARCL Dose Factors Step 4; (rem/yr)/[Ci/m2 or pCi/g])	8. Product of col. 6a. and 7. (rem/yr)/(pCi/g)	9. ARCL-product of Column 6a. & Item 8b. (pCi/g)
H-3	194.00	0.1385	3.40E-11	4.71E-12	1.13
C-14	204.00	0.1456	1.70E-08	2.48E-09	1.18
Co-60	37.00	0.0264	2.20E-03	5.81E-05	0.21
Sr-90	173.00	0.1235	2.20E-02	2.72E-03	1.00
Cs-137	760.00	0.5425	5.30E-04	2.88E-04	4.41
Eu-152	20.00	0.0143	1.00E-03	1.43E-05	0.12
Eu-154	0.00	0.0000	1.10E-03	0.00E+00	0.00
Pu-239	13.00	0.0093	1.80E-05	1.67E-07	0.08
		0.0000		0.00E+00	0.00
		0.0000		0.00E+00	0.00
TOTAL	1401.00				
		6b. Total: 1.00		8a. Total: 3.08E-03	9a. Total: 8.13
				8b. Annual Dose Limit Divided by 8a. (0.025 rem/yr Divided By 8a.) 8.13	ARCL VALUE

COMMENTS:
Concentrations in column 6. are values from bottom row of Table 2.

6.0 DETERMINATION OF THE ALLOWABLE RESIDUAL CONTAMINATION LEVELS (ARCL) (Cont'd)

6.4 Determination of ARCL Value (Cont'd)

The ARCL value is the controlling level of residual contamination that can be left in a facility or section of facility. In other words, the residual contamination in the structure's rubble, buried in situ at a specified depth, must be less than the ARCL value of 8.1 pCi/g. The ARCL value of 8.1 pCi/g corresponds to site dose of 25 mrem/year to a maximally exposed individual. Therefore, after demolition the residual concentration of contamination in the rubble must be less than 8.1 pCi/g.

7.0 DETERMINATION OF RESIDUAL CONTAMINATION LEVELS IN THE 117-D FILTER BUILDING

The entire 117-D Filter Building was assumed to be contaminated and both contaminated and auxiliary sections of the building are addressed in the ARCL and residual contamination calculations.

7.1 Disposition of Contaminated Spaces

Based on radiological surveys, the extent of contamination in the 117-D Building was determined and the dimensions of the contaminated areas were established. Paint samples were collected and analyzed to determine the radionuclide identity and concentrations. An estimated curie inventory was calculated by first determining the volume of paint covering the concrete surfaces. Gamma analyses of the concrete beneath the paint showed that the contamination did not penetrate the paint and absorb into the concrete. The concentration of residual contamination within the building was then determined by dividing the total mass of the building into the total estimated curie inventory.

The following sequence identifies the steps taken for the residual contamination calculations for each section of the 117-D building (Table 4).

Step 1 - Total internal surface area of the 117-D Filter Building (by section of building).

Total = 1.5 E + 7 cm^2

Table 4, Residual Activity Calculations.

	Step 1			Step 2		Step 3	Step 4
BUILDING SECTION	TOTAL SURFACE AREA cm^2	% AREA	THICKNESS OF SURFACE cm(4)	MASS OF SURFACE g	SAMPLE ACTIVITY pCi/g(5)	ISOTOPIC INVENTORY pCi	MASS OF CONCRETE g
Inlet Duct(1)	3.5E+06	23.7%	1.0E-01	4.0E+05	3.0E+02	1.2E+08	2.8E+08
Inlet Seal Pit A	6.1E+05	4.1%	1.0E-01	7.0E+04	1.1E+01	7.7E+05	5.6E+07
Inlet Seal Pit B	6.1E+05	4.1%	1.0E-01	7.0E+04	6.0E+00	4.2E+05	5.6E+07
Filter Cell A(2)	3.0E+06	20.4%	1.0E-01	3.5E+05	6.4E+02	2.2E+08	1.7E+08
Filter Cell B(2)	3.0E+06	20.4%	1.0E-01	3.5E+05	4.1E+02	1.4E+08	1.7E+08
Outlet Seal Pit B	6.1E+05	4.1%	1.0E-01	7.0E+04	8.0E+00	5.6E+05	5.6E+07
Outlet Seal Pit B	6.1E+05	4.1%	1.0E-01	7.0E+04	6.0E+00	4.2E+05	5.6E+07
Exhaust Duct	2.8E+06	19.0%	1.0E-01	3.2E+05	2.4E+01	7.7E+06	1.9E+08
TOTAL	1.5E+07	100.0%		1.7E+06	1.4E+03	4.9E+08	1.0E+09

Inventory Contribution from Turning Vanes and Grating:

A-Inlet Seal Pit(3) - Grating (pCi)	8.8E+06
B-Inlet Seal Pit(3) - Grating (pCi)	9.3E+06
A-Outlet Seal Pit Turning Vanes (pCi)	1.2E+07
A-Outlet Seal Pit Grating (pCi)	9.2E+06
B-Outlet Seal Pit Turning Vanes (pCi)	7.9E+06
B-Outlet Seal Pit Grating (pCi)	7.7E+06

TOTAL ISOTOPIC INVENTORY: 5.5E+08

RESIDUAL CONCENTRATION OF RADIONUCLIDES IN RUBBLE AFTER DEMOLITION AND BURIAL: Step 5

$$\text{Residual Activity (pCi/g)} = \frac{\text{Total Isotopic Inventory}}{\text{Total Mass of Concrete}} = \frac{5.5\text{E+08 pCi}}{1.0\text{E+09 g}} = 5.5\text{E-01 pCi/g}$$

(1) Includes data for Exhaust Fan Pit.
(2) Filter Frames removed and disposed of as rad. waste.
(3) Turning vanes removed and disposed of as rad. waste.
(4) Density of paint = 1.15 g/cm^3; density of concrete = 2.4 g/cm^3.
(5) Weighted concentration values from Total column, Table 2.

Checked by: E. V. doRosario
Date: 10-21-86

7.0 DETERMINATION OF RESIDUAL CONTAMINATION LEVELS IN THE 117-D FILTER BUILDING (Cont'd)

7.1 Disposition of Contaminated Spaces (Cont'd)

Step 2 - Total mass of contaminated paint, given surface area, thickness and density. The density of paint is 1.15 g/ml.

Thickness of paint - 0.1 cm

Total mass of surface = 1.7E+6 g

Step 3 - Total isotopic inventory based on mass of paint and weighted concentration per section of building.

Total = 4.9E+8 pCi

Step 4 - Total mass of concrete structure. Including exhaust fan pit and applicable surfaces in the Filter Access Room, Operating Gallery and Equipment Gallery.

Total mass = 1.0E+9 g

Step 5 - Residual concentration in concrete rubble (Total Step 3 divided by Total Step 4).

Residual Concentration = 0.55 pCi/g

Residual Contamination Level and ARCL Value

The residual level of contamination in the building rubble is compared to the ARCL value. If the residual concentration in the rubble is less than the ARCL value, the facility can be demolished and buried in situ. If the residual concentration in the rubble is greater than the ARCL value, additional remedial action efforts must be initiated. As demonstrated in Table 4, the residual concentration level of 0.55 pCi/g is significantly less than the ARCL value of 8.1 pCi/g.

It is important to emphasize at this point that the determination of the ARCL value and residual contamination level are calculated prior to demolition to ensure that appropriate remedial action steps have been taken.

7.0 DETERMINATION OF RESIDUAL CONTAMINATION LEVELS IN THE 117-D FILTER BUILDING (Cont'd)

7.2 Disposition of Auxiliary Spaces

The ARCL value and the residual contamination level for the 117-D building rubble were established without consideration of the Filter Access Room, Operating Gallery and the Equipment Gallery spaces. These spaces were omitted primarily to simplify the calculation process. It is recognized that the purpose of this report is to document the basis for arriving at the estimated site dose from the residual contamination in the buried rubble. Therefore, all contamination in all areas of the building must be accounted for. However, based on the following reasoning, the contamination in the auxiliary spaces has no impact on the potential dose to a maximally exposed individual.

First, only low levels of contamination were discovered in isolated spots of the auxiliary spaces, less than 1% of the respective areas. If the contamination in the auxiliary spaces were assumed to extend over 100% of the surface area, the impact on the total isotopic inventory would be overly conservative. Secondly, if the isotopic concentrations in these spaces were weighted in the same manner as the eight major sections of the 117-D building (Table 2), the resulting concentrations would be very small. Including these small concentrations in the weighted average concentration for the building would have negligible effect on the ARCL value. At most it would tend to increase the ARCL value slightly.

Using the same assumptions identified in Section 6.3.2 for calculating total isotopic inventory, the contribution from the auxiliary spaces to the total building inventory would not be significant. In addition, by including the isotopic inventory in the residual contamination calculations, the mass of concrete associated with the auxiliary spaces must also be included. When the total building mass is divided into the total isotopic inventory, as in Step 5 of Table 4, the resulting residual concentration in the building rubble also becomes slightly higher.

For example, the ARCL value for the 117-D building, including the auxiliary spaces, is 9.7 pCi/g and the residual contamination level is 0.64 pCi/g. Excluding the auxiliary spaces, the ARCL value is 8.2 pCi/g and the residual contamination level is 0.55 pCi/g. In both cases the residual contamination level is 7% of the ARCL

7.0 DETERMINATION OF RESIDUAL CONTAMINATION LEVELS IN THE 117-D FILTER BUILDING (Cont'd)

7.2 Disposition of Auxiliary Spaces (Cont'd)

value. Likewise, the dose to a maximally exposed individual from the buried rubble is identical in both cases. Therefore, the trace amounts of contamination in the auxiliary spaces were assumed to be insignificant in the estimated site dose derived in this report.

8.0 CONCLUSION

The calculations contained in this report were based on conservative assumptions and demonstrate that the 117-D Filter Building was decommissioned in situ resulting in a potential dose to a maximally exposed individual well below the ARCL limit of 25 mrem/year.

The ARCL value for the 117-D Filter Building was calculated to be 8.1 pCi/g. This value represents a concentration of radioactivity in the building materials that could cause a maximally exposed individual to receive a dose of 25 mrem/year. The calculated residual activity in the building rubble, buried 1-4 meters deep, was 0.55 pCi/g. The residual activity is approximately 6.8% of the ARCL value, which constitutes a potential dose to a maximally exposed individual of 1.7 mrem/year using the Residential/Construction Exposure Scenario.

Total radionuclide inventory in the 117-D building was estimated to be 0.55 millicuries. The radionuclides comprising this quantity of activity are tritium, carbon-14, cobalt-60, strontium-90, cesium-137, europium-152, europium-154, and plutonium-239. Of these radionuclides, strontium-90 is the most restrictive in the ARCL calculations.

Direct radiation readings taken in the various rooms of the 117-D building using a Micro-R-Meter showed no increase over the general background readings. Very minor amounts of alpha contamination were detected, but at concentrations that did not significantly impact the ARCL calculations.

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APPENDIX A

RESULTS OF ISOTOPIC ANALYSIS FOR PAINT AND CONCRETE SAMPLES

117-D FILTER BUILDING

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Appendix A

FACILITY/BLDG: 117-D Filter Building ROOM/AREA: Inlet Duct

SAMPLE #	GROSS BETA	GROSS ALPHA	H-3	C-14	Co-60	Sr-90	Cs-137	Eu-152
			<--------pCi/g--------->					
P-F-1(1)	2080	(a)	118	216	(a)	212	682	31
C-F-1	37	1	(b)	(b)	(a)	(b)	24	(a)
P-F-2	990	9	(b)	(b)	(a)	(b)	241	(a)
P-F-3	822	10	(b)	(b)	(a)	(b)	329	(a)
C-F-3	30	1	(b)	(b)	(a)	(b)	12	(a)
P-F-4	720	7	(b)	(b)	(a)	(b)	214	(a)
P-F-5	651	7	(b)	(b)	(a)	(b)	209	(a)
P-F-6	791	10	(b)	(b)	(a)	(b)	330	(a)
C-F-6	23	0.4	(b)	(b)	(a)	(b)	68	(a)
P-F-7	677	7	(b)	(b)	(a)	(b)	156	(a)
P-F-8	608	6	(b)	(b)	(a)	(b)	39	(a)
P-F-9	654	7	(b)	(b)	(a)	(b)	109	(a)
P-F-10	543	5	(b)	(b)	(a)	(b)	384	(a)
C-F-10	24	0.2	(b)	(b)	(a)	(b)	8	(a)

ROOM/AREA: Inlet Seal Pit A

SAMPLE #	GROSS BETA	GROSS ALPHA	H-3	C-14	Co-60	Sr-90	Cs-137	Eu-152
P-W-1	238	3	(b)	(b)	(a)	(b)	101	(a)
C-F-1	28	2	(b)	(b)	(a)	(b)	26	(a)
P-F-4(1)	457	5	17	29	17	16	174	(a)

ROOM/AREA: Inlet Seal Pit B

SAMPLE #	GROSS BETA	GROSS ALPHA	H-3	C-14	Co-60	Sr-90	Cs-137	Eu-152
P-F-1	379	5	(b)	(b)	(a)	(b)	409	(a)
C-F-1	61	1	(b)	(b)	(a)	(b)	37	(a)
P-F-2	72	1	(b)	(b)	1370	(b)	2080	(a)
P-F-3(1)	800	8	9	24	(a)	2	100	(a)

ROOM/AREA: Filter Cell A

SAMPLE #	GROSS BETA	GROSS ALPHA	H-3	C-14	Co-60	Sr-90	Cs-137	Eu-152
P-F-1	1228	12	(b)	(b)	44	(b)	761	(a)
C-F-1	40	0.5	(b)	(b)	(a)	(b)	10	(a)
P-F-2	1787	18	(b)	(b)	175	(b)	1410	(a)
P-F-3(1)	797	8	688	573	180	561	1070	64
c-F-3	43	1	(b)	(b)	(a)	(b)	20	(a)

ROOM/AREA: Filter Cell B

SAMPLE #	GROSS BETA	GROSS ALPHA	H-3	C-14	Co-60	Sr-90	Cs-137	Eu-152
P-F-1	867	10	(b)	(b)	(a)	(b)	442	(a)
C-F-1	29	0.9	(b)	(b)	(a)	(b)	10	(a)
P-F-2	1006	12	(b)	(b)	(a)	(b)	381	(a)
P-F-3(1)	1427	15	96	132	(a)	3	1750	(a)
C-F-3	89	0.5	(b)	(b)	(a)	(b)	42	(a)
P-F-4	3584	35	(b)	(b)	454	(b)	3230	(a)

P-Paint C-Concret F-Floor W-Wall O-Overhead (Ceiling)

NOTE: Unless otherwise specified, isotopic analysis of the paint and concrete samples were performed with the TN-4000 MCA, located at the 183-KE Lab. faciltiy.

(1) Analysis performed by US Testing Co.

(a) Not Detected.

(b) Analysis not performed.

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Appendix A

FACILITY/BLDG: 117-D Filter Building ROOM/AREA: Outlet Seal Pit A

SAMPLE #	GROSS BETA	GROSS ALPHA	H-3	C-14	Co-60	Sr-90	Cs-137	Eu-152
			<--------pCi/g--------->					
P-F-1(1)	238	3	8	20	(a)	136	23	(a)
C-F-1	46	0.7	(b)	(b)	(a)	(b)	(a)	(a)
P-F-2	41	4	(b)	(b)	(a)	(b)	(a)	(a)
ROOM/AREA: Outlet Seal Pit B								
P-F-1	68	1	(b)	(b)	(a)	(b)	(a)	(a)
P-F-2(1)	373	3	9	24	(a)	10	100	(a)
ROOM/AREA: Exhaust Duct								
P-F-1	402	38	(b)	(b)	(a)	(b)	(a)	(a)
C-F-1	18	1	(b)	(b)	(a)	(b)	(a)	(a)
P-F-2	513	32	(b)	(b)	(a)	(b)	(a)	(a)
P-F-3	414	39	(b)	(b)	(a)	(b)	29	(a)
C-F-3	20	0.7	(b)	(b)	(a)	(b)	(a)	(a)
P-F-4	374	36	(b)	(b)	(a)	(b)	(a)	(a)
P-F-5	277	19	(b)	(b)	(a)	(b)	(a)	(a)
P-F-6	430	49	(b)	(b)	(a)	(b)	34	(a)
P-F-7	445	47	(b)	(b)	(a)	(b)	(a)	(a)
C-F-7	52	0.6	(b)	(b)	(a)	(b)	(a)	(a)
P-F-8	146	15	(b)	(b)	(a)	(b)	(a)	(a)
P-F-9(1)	307	38	23	25	(a)	6	36	(a)
C-F-9	14	0.5	(b)	(b)	(a)	(b)	11	(a)
P-F-10	165	23	(b)	(b)	(a)	(b)	34	(a)
C-F-10	54	1	(b)	(b)	(a)	(b)	28	(a)
ROOM/AREA: Filter Access								
C-F-1	(b)	(b)	(b)	(b)	(a)	(b)	8	(a)
C-W-1	(b)	(b)	(b)	(b)	(a)	(b)	(a)	(a)
C-F-3	(b)	(b)	(b)	(b)	(a)	(b)	4	(a)
ROOM/AREA: Operating Gallery								
C-O-1	(b)	(b)	(b)	(b)	(a)	(b)	(a)	(a)
ROOM/AREA: Equipment Gallery								
C-F-1	(b)	(b)	(b)	(b)	(a)	(b)	10	(a)
C-S-1	25	0.2	(b)	(b)	(a)	(b)	28	(a)

P-Paint C-Concret F-Floor W-Wall O-Overhead (Ceili S-Sump concrete

NOTE: Unless otherwise specified, isotopic analysis of the paint and concrete sam were performed with the TN-4000 MCA, located at the 183-KE Lab. facility.

(1) Analysis performed by US Testing Co.

(a) Not Detected.

(b) Analysis not performed.

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Administrative Record/Environmental	67270		DOE
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