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Facility Effluent Monitoring Plan Determinations for the 600 Area Facilities

EDMC

Prepared for the U.S. Department of Energy
Assistant Secretary for Environment,
Safety and Health

Westinghouse
Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

Approved for Public Release

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600 AREA FACILITIES
FACILITY EFFLUENT MONITORING PLAN DETERMINATIONS

J. M. Nickels

ABSTRACT

This document determines the need for Facility Effluent Monitoring Plans for Westinghouse Hanford Company's 600 Area facilities on the Hanford Site. The Facility Effluent Monitoring Plan determinations were prepared in accordance with A Guide For Preparing Hanford Site Facility Effluent Monitoring Plans *(WHC 1991).*

Five major Westinghouse Hanford Company facilities in the 600 Area were evaluated: the Purge Water Storage Facility, 212-N, -P, and -R Facilities, the 616 Facility, and the 213-J&K Storage Vaults. Of the five major facilities evaluated in the 600 Area, none will require preparation of a Facility Effluent Monitoring Plan.

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FACILITY EFFLUENT MONITORING PLAN DETERMINATION

1.0 INTRODUCTION

A Facility Effluent Monitoring Plan (FEMP) determination has been conducted for the Purge Water Storage Facility (PWSF) located within the 600 Area of the Hanford Site. This evaluation was performed using *A Guide For Preparing Hanford Site Facility Effluent Monitoring Plans* (WHC 1991).

2.0 FACILITY DESCRIPTION

The PWSF consists of two large purge water modular storage tanks with secondary containment. The tanks contain purge water that originates from cleaning the water wells across the Hanford Site. The facility is located northeast of the 200 East Area high-level burial grounds (submarine trench) and adjacent to the 216-B-3 Pond. The facility is classified as a low hazard non-nuclear facility according to the classification requirements of the *Nonreactor Facility Safety Analysis Manual* (WHC 1990).

3.0 STATUS OF OPERATION

The facility currently is operating as interim storage for the purge water from cleaning water wells across the Hanford Site. Future treatment and replacement of the two purge water modular storage tanks will be the proposed purge water surface impoundment (Project W-097).

4.0 SOURCE TERM

The source term inventory is the same as the inventory identified in the hazard classification of Project W-097. The potential release mechanism for the facility is evaporation and subsequent aerosol generation. The chemically and radiologically contaminating constituents are identified in Tables 1 and 2. The facility is expected to store, before treatment, 29 Mgal of purge water through 1998.

The evaporation mechanism will account for the release of the tritium, all of which is assumed to be present as tritiated water, as well as volatile organic liquid contaminants. The aerosol generation will be the cause of the release of the dissolved nonvolatile radioactive and nonradioactive components.

Table 1. Miscellaneous Chemical Constituents in Purge Water. (2 sheets)

Constituent	(parts/billion)	
	Maximum	Average
Acetone	110	5
Aluminum, filtered	570	180
Aluminum	1,100	60
Ammonium	250	370**
Arsenic	51	---
Barium	255	53
Barium, filtered	20	45**
Benzene	49	---
Beryllium	8	---
Bis(2-ethylhexyl)phthalate	29	2
Cadmium	20	1
Calcium	64,000	57,400
Carbon tetrachloride	8,100	20
Chloride	34,000	23,000
Chloroform	1,650	<1
Chromium	1,690	31
Copper	274	4
Cyanide	1,690	10
1,2 Dichloroethane	6	5
Fluoride	12,800	730
Iron, filtered	600	67
Iron	1,600*	120
Lead, filtered	11	5
Lead	132	2
Magnesium	21,000	13,000
Manganese, filtered	30	7
Manganese	49	4
Mercury	0.54	---
Methylene chloride	1,800	120
N-nitrosodimethylamine	40	3
Nickel, filtered	20	11
Nickel	518	4
Nitrate	2,810,000	93,200

Table 1. Miscellaneous Chemical Constituents in Purge Water.
(2 sheets)

Constituent	(parts/billion)	
	Maximum	Average
PC3	23.8	---
Perchloroethylene	52	8
Phenol	8	1
Phosphate	11,000	1,150
Potassium	7,300	7,600**
Selenium	54	1
Silver	25	---
Sodium, filtered	94,000	19,500
Sodium	93,000	27,500
Strontium, filtered	470	311
Strontium	340	249
Sulfate	72,000	90,000**
Sulfide	1,350	---
Total organic halogen	1,600	70
Total alkalinity	593,000	89,000
Total organic carbon	1,800	830
Trans-1,2-dichloroethene	70	9
1,1,1-trichloroethane	120	8
Trichloroethene	38	8
Natural uranium	16,600	67
Vanadium	40	18
Zinc	240	87

*A spurious analysis of 222,000 ppb iron was not included.
**The average value is shown as higher than the maximum value in the data source.

Table 2. Miscellaneous Radionuclides in Purge Water.

Constituent	(pCi/L)	
	Maximum	Average
^{3}H	14,000,000	85,000
^{14}C	<700	---
^{60}Co	550	4
^{63}Ni	<3,000	---
^{90}Sr	23,000	24
^{99}Tc	37,000	239
^{103}Ru	<500	---
^{106}Ru	900	3
^{125}Sb	<500	4
^{129}I	90	3
^{131}I	29,000	202
^{137}Cs	2,500	1
^{226}Ra	4	---
^{235}U	12,000	40
^{238}Pu	0.4	---
$^{239/240}Pu$	72	---
^{241}Am	<0.3	---

4.1 POTENTIAL UPSET-OPERATING CONDITIONS

No potential upset-operating conditions have been identified or deemed credible.

4.2 RELEASE PARAMETERS

The release of material by evaporation is based on evaporation pan data from the Prosser Agriculture Experiment Station. Evaporation rates for the Hanford Site can be expected to be 40 in. annually with a peak of 12 in./mo in summer.

Conservative aerosol generation rates have been experimentally determined by Pacific Northwest Laboratory. The amount recommended for aerosol generated by gas bubbling through solution is 1 volume of liquid for every 10^7 volumes of vapor/gas.

4.3 SOURCE TERM

The toxicological source term is estimated assuming the release of volatile organic components occurs as the water is evaporated. Ideal solution behavior is assumed so the organic components will escape in the same relative proportion as they exist in the liquid phase.

The aerosol mechanism and subsequent release have not been calculated because using the conservative partition factor (ratio of liquid volume in the vapor/gas to the vapor/gas volume) of 10^{-7} gives a 7 order of magnitude reduction in the concentration found in the basin and is too low to be considered further.

For the toxicological dose estimate, the source term release rate for any volatile organic component is derived by multiplying the evaporation rate by the fraction in the liquid phase. The result is a release rate (Q) for the component.

The concentration at the receptor can be estimated using the atmospheric dispersion factor of the form

$$E/Q = LSDF$$

where

E = The concentration at the point of interest

Q = The emission rate

LSDF = The location-specific dispersion factor.

Rearrangement then permits solution for E if the LSDF and Q are known. Table 2 shows the organic concentrations for the substances considered. For the purposes of this analysis, carbon tetrachloride was the only constituent examined because its concentration in the liquid was closest to its protective action guideline (PAG) value.

The radiological source term is generated from both the evaporation and aerosol mechanism. The evaporation is considered because the tritium concentration in the purge water is assumed to exist as tritiated water. The tritium concentration is estimated using the maximum tritium concentration shown in Table 3 and multiplying by the total volume of purge water expected to be evaporated. The other radionuclides expected to be released by aerosol mechanism are estimated by multiplying the aerosol release volume by the concentrations of nuclides in the last evaporation volume (a conservative estimate would be the total nuclide quantity in the 1998 volume of 3,408,000 gal).

Table 3. Toxicological Constituents for Project W-097 Compared to IDLH[1] and PAG[2] Values.

Component	Concentration (ppm[3])	IDLH (ppm)	PAG (ppm)
Acetone	0.11	20,000	10,000
Ammonia	0.25	500	250
Benzene	0.049	2,000	1,000
Bis(2-ethylhexyl)phthalate	0.029	*	**
Carbon tetrachloride	8.1	300	150
Chloroform	1.65	1,000	500
Methylene chloride	1.8	5,000	2,500
N-Nitrosodimethylamine	0.04	*	**
Perchloroethylene	0.052	*	**
Phenol	0.008	100	50
Trichloroethene	0.038	*	50
1,1,1 Trichloroethane	0.12	1,000	500
1,2 Dichloroethane	0.006	*	2,000
1,2 Trans-Dichloroethene	0.07	*	2,000

[1]Immediately dangerous to life or health.
[2]Protective action guideline.
[3]Parts per million.
*IDLH values not listed. National Institute of Safety and Health recommends that the substance be treated as a potential human carcinogen.
**PAG values not listed for these compounds.

The nuclides and quantities estimated to be released over a 1-yr period are shown in Table 4.

Table 5 shows the calculated results of the radiological consequences compared with the safety analysis limits. These calculations are available on file with the cognizant engineer.

Concentrations of chemical constituents at the maximally exposed individual onsite and offsite shows Project W-097 to be a low hazard with regard to toxicological exposure.

The radiological and toxicological doses to offsite and onsite maximally exposed individuals are below limits for a low hazard facility.

The annual effective dose equivalent (EDE) for onsite individuals for tritium, the only credible source term inventory, is equal to 3.2×10^{-4} rem. For the maximally exposed offsite individual, the annual inhalation EDE is 1.5×10^{-5} rem. The annual ingestion EDE is 3.9×10^{-6} rem.

5.0 SUMMARY

Because of the standby maintenance condition and limited source term inventory for radioactive (tritium) and hazardous materials (carbon tetrachloride) with minimal offsite dose consequences, a FEMP is not required.

6.0 REFERENCES

Napier, B. A., R. A. Peloquin, D. L. Strenge, and J. V. Ramsdell, 1988, *GENII - The Hanford Environmental Radiation Dosimetry Software System*, PNL-6584, Vols. 1-3, Pacific Northwest Laboratory, Richland, Washington.

WHC, 1990, *Nonreactor Facility Safety Analysis Manual*, WHC-CM-4-46-Rel 15, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991, *A Guide for Preparing Hanford Site Facility Effluent Monitoring Plans*, WHC-EP-0438, Westinghouse Hanford Company, Richland, Washington.

Table 4. Radiological Source Term for Project W-097 (1-Yr Release).

Radionuclide	Ci
^{3}H	1.5 E+02
^{14}C	3.3 E-04
^{60}Co	2.6 E-04
^{63}Ni	1.4 E-03
^{90}Sr	1.1 E-02
^{99}Tc	2.0 E-02
^{103}Ru	2.4 E-04
^{106}Ru	4.3 E-04
^{125}Sb	2.4 E-04
^{129}I	4.3 E-05
^{131}I	1.4 E-02
^{137}Cs	1.2 E-03
^{234}U	5.0 E-03
^{238}Pu	1.9 E-07
^{239}Pu	3.5 E-05
^{241}Am	1.4 E-07
^{226}Ra	1.9 E-06

NOTE: Radon-226 was not included in the GENII (Napier et al. 1988) input decks because previous runs showed the nuclide to be an insignificant contributor to the receptor's dose.

Table 5. Radiological Consequences Compared with Westinghouse Hanford Company WHC-CM-4-46 (WHC 1990) Limits for a Low Hazard Facility.

ONSITE	
Radiological limit:	5 rem EDE, 50 rem to the max. organ
X/Q	= 1.76 E-06 sec/m^3
Distance	= 1,267.1 m
Direction	= South-southeast
EDE	= 3.2 E-04 rem inhalation and submersion
Max. organ (lung)	= 2.6 E-03 rem committed dose equivalent
OFFSITE	
Radiological limit:	0.5 rem EDE, 5 rem to the max. organ
X/Q	= 8.16 E-08 sec/m^3
Distance	= 15,557 m
Direction	= East
INHALATION AND SUBMERSION	
EDE	= 1.5 E-05 rem inhalation and submersion
Max. organ (lung)	= 1.2 E-04 rem committed dose equivalent
INGESTION AND GROUND SHINE	
EDE	= 6.5 E-06 rem cumulative dose
Max. organ (thyroid)	= 3.4 E-05 rem cumulative dose

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ATTACHMENT 1

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

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ATTACHMENT 1

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY Purge Water Storage Facility **DISCHARGE POINT** Storage Tanks

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

	Radionuclide	Physical/Chemical Form	Quantity (Curies)	Quantity Released	Projected Dose (mrem)
1.	^{3}H	gaseous/tritiated	1.5 E+02	1.5 E+02	EDE(lung) 1.5 E-05(rem)
2.		water			EDE(thyroid) 6.5 E-06(rem)
3.					
4.					
Total					

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

	Regulated Material	Quantity (lbs)	Quantity Released	Reportable Quantity (lbs)	% of Reportable Quantity/Year
1.	carbon tetrachloride	8.1 ppm		5,000	<RQ
2.					
3.					
4.					

Identification of Reference Material

The hazard classification of the purge water surface impoundment (Project W-097)

If the total projected dose from radionuclide exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ______ FEMP is not required X

EVALUATOR Thomas H. Sunday Jr. DATE 1-2-91

MANAGER, ENVIRONMENTAL [signature] DATE 1-9-91

FACILITY MANAGER [signature] DATE 1/9/91

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PART 2

212-N, -P, AND -R FACILITIES

FACILITY EFFLUENT MONITORING PLAN DETERMINATION

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212-N, -P, AND -R FACILITIES

FACILITY EFFLUENT MONITORING PLAN DETERMINATIONS

1.0 INTRODUCTION

The Westinghouse Hanford Company's (Westinghouse Hanford) Electrical Utilities function is responsible for determining Facility Effluent Monitoring Plan (FEMP) applicability to the 212-P Facility. Pacific Northwest Laboratory (PNL) is responsible for determining FEMP applicability to the 212-N and -R Facilities. Determining the need for a FEMP was conducted in accordance with *A Guide For Preparing Hanford Site Facility Effluent Monitoring Plans* (WHC 1991).

2.0 FACILITY DESCRIPTION/STATUS OF OPERATION

There are three identical buildings (212-N, -P, and -R) located north of the electrical substation in the Separations Area north of Route 2, halfway between the 200 East and 200 West Areas, called the Metal and Fuel Storage Basin Facilities. These were designed for underwater storage of irradiated reactor fuel elements (slugs). Each building is comprised of two main sections and a heater room. Each section has a concrete foundation and roof and walls constructed of concrete and concrete block. Exterior dimensions of the high roof section are 27 ft by 74 ft by 30 ft high. The low roof section is 49 ft by 72 ft by 12 ft high. The heater room is 14 ft by 26 ft by 12 ft high. The total area of each building is 5,970 ft^2; the storage basin is 3,300 ft^2 and the transfer basin is 400 ft^2.

These facilities were used from 1944 through 1952 for fuel storage. In 1970 PNL and Westinghouse Hanford moved 24 crates of various contaminated equipment to the 212-N and -R Buildings. Sometime during 1971 and 1972 nine of the crates were moved to a 200 West industrial burial ground, the 231-Z Building, and the 308 Building. All remaining crates in the 212-R Building were transferred to the 212-N Building. The remaining 15 crates have been stored in 212-N since 1972. The crates or boxes are stacked inside the building and covered with a mound of commercial insulating material. See Table 1 for current inventory.

The 212-P Building has been used only as a storage facility for approximately 5.03 m^3 of liquid and solid hazardous waste. This site is not included in the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990) action plan. See Table 2 for current inventory.

Table 1. Radionuclide Inventory for 218-N-1 (in Curies).

^{3}H	0.00000	^{134}Cs	0.00000
^{14}C	0.00000	^{137}Cs	0.00000
^{54}Mn	0.00000	^{141}Ce	0.00000
^{60}Co	0.00000	^{144}Ce	0.00000
^{63}Ni	0.00000	^{144}Pr	0.00000
^{85}Kr	0.00000	^{147}Pm	0.00000
^{90}Sr	0.00000	^{152}Eu	0.00000
^{91}Y	0.00000	^{154}Eu	0.00000
^{95}Nb	0.00000	^{155}Eu	0.00000
^{95}Zr	0.00000	^{237}Np	0.00000
^{99}Tc	0.00000	^{238}Pu	0.00000
^{103}Ru	0.00000	^{239}Pu	0.00000
^{106}Ru	0.00000	^{240}Pu	0.00000
^{113}Sn	0.00000	^{241}Pu	0.00000
^{125}Sb	0.00000	^{241}Am	0.00000
^{129}I	0.00000		
^{233}U (g)		0.00000	
^{232}Th (g)		0.00000	
Total U (kgs)		0.00000	
Total Pu (g)		40.00000	
Total beta activity		0.00000	
Total estimated TRU activity		0.00000	
Total volume stored (m^3)			

These values are decayed through December 31, 1988.
TRU = transuranic.

Table 2. Waste Information Data System Radionuclide Inventory (in Curies).

Site Name: 212-P Storage Facility					
Operable Unit: 200-NO-1					
Bibliography for the following individual isotopes: [404]					
^{3}H		^{113}Sn		^{234}U	
^{14}C		^{125}Sb		^{235}U	
^{22}Na		^{129}I		^{237}Np	
^{54}Mn		^{134}Cs		^{238}U	
^{58}Co		^{137}Cs	0.24450	^{238}Pu	0.05984
^{59}Fe		^{141}Ce		^{239}Pu	1.25180
^{60}Co		^{144}Ce		^{240}Pu	0.31020
^{63}Ni		^{147}Pm		^{241}Pu	0.86680
^{85}Kr		^{152}Eu		^{241}Am	0.45540
^{90}Sr	0.22290	^{154}Eu		^{242}Pu	0.00002
^{95}Zr		^{155}Eu		^{243}Am	
^{99}Tc		^{232}Th		^{245}Cm	
^{106}Ru	0.00001	^{233}U			
Inventory Total Pu:		2.48866	(summation of Pu isotopes listed above)		
Inventory Total U:		0.00000	(summation of U isotopes listed above)		
Reported Total Pu:			grams		
Reported Total U:		0.00000	kilograms		

The above values are decayed through December 31, 1988.

3.0 SOURCE TERM

The 212-N and -R Storage Buildings have been active since 1970. The 212-N Building stores approximately 15 large wooden boxes containing hoods and equipment formerly used for fabrication of fuels for the Plutonium Recycle Test Reactor. The boxes are still stacked inside the building. The waste is contaminated with an estimated 40 g of plutonium. No other inventory of radioactive material exists in this facility. The waste is owned by PNL.

Since 1982 the 212-P Building has held polychlorinated biphenyls (PCB), and PCB-contaminated waste (nonradioactive) in temporary (up to 9 mo) storage, according to the *Toxic Substances Control Act* (TSCA). Radioactively contaminated PCBs are stored in another area of this unit. Waste types include 854 kg of oil less than 50 ppm PCBs; 1,348 kg of oil greater than 50 ppm PCBs; 703 light ballasts containing PCBs stored in overpacks; 1,159 kg of oil greater than 500 ppm; 7 sealed transformers with less than 30 ppm PCBs oil; 1 capacitor with 1% PCB oil; 11 low-voltage capacitors with greater than 50 ppm PCB oil; and 42 kg regulated solvents with greater than 500 ppm PCB. Drained items as allowed under the TSCA occasionally are stored on an asphalt pad at the southeast corner of the building.

At any one time no more than 41,000 lb of liquid and solid PCB waste will be stored at the 212-P Building. As required by TSCA regulations, no drains are present and total containment is provided in the event of a container failure.

Shipments are made from the facility quarterly or as necessary to comply with the TSCA 9-mo storage limitation. Monthly documented inspections are performed by utilities personnel. This facility meets TSCA requirements for temporary storage of PCBs.

There are no radioactive materials stored at the 212-P Building. The 212-P Building has no water supply and no sewer drains as potential release points.

4.0 POTENTIAL UPSET-OPERATING CONDITIONS

No potential upset conditions have been identified or deemed credible.

5.0 SUMMARY

There are no processes at the 212-P, -N, and -R Buildings that could release any reportable quantities of hazardous or radioactive materials. These buildings are used as temporary storage where waste is staged before offsite disposal. A FEMP is not required.

6.0 REFERENCES

Ecology, EPA, and DOE, 1990, *Hanford Federal Facility Agreement and Consent Order*, Vol. 1 and 2, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Toxic Substances Control Act of 1976, 15 USC 2601 et seq.

WHC, 1991, *A Guide for Preparing Hanford Site Facility Effluent Monitoring Plans*, WHC-EP-0438, Westinghouse Hanford Company, Richland, Washington.

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ATTACHMENT 1

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

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Electrical Utilities is not in any way involved in operation of 212-N & 212-R

ATTACHMENT 1

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY 212 P/N/R   DISCHARGE POINT no pathways to env.

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

	Radionuclide	Physical/Chemical Form	Quantity (Curies)	Quantity Released	Projected Dose (mrem)
1.					
2.		No Radionuclides			
3.					
4.					
Total					

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

	Regulated Material	Quantity (lbs)	Quantity Released	Reportable Quantity (lbs)	% of Reportable Quantity/Year
1.	PCB		(regulated by TSCA)		
2.					
3.					
4.					

Identification of Reference Material

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ____   FEMP is not required X

EVALUATOR R L Granberg   DATE 01/10/91

MANAGER, ENVIRONMENTAL [signature]   DATE 4/1/91

FACILITY MANAGER [signature]   DATE 4/1/91

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PART 3

616 FACILITY

FACILITY EFFLUENT MONITORING PLAN

DETERMINATION

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CONTENTS

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616 FACILITY

FACILITY EFFLUENT MONITORING PLAN DETERMINATION

1.0 INTRODUCTION

A Facility Effluent Monitoring Plan (FEMP) is required for facilities that (1) contain quantities of radioactive materials that could cause radiation doses in excess of the required monitoring level specified in 40 Code of Federal Regulations (CFR) 61.93 (EPA 1989a) or (2) contain quantities of hazardous materials that exceed the reportable quantities listed in 40 CFR 302.4 (EPA 1989b). The criteria for hazardous materials can be relaxed if the facility can show that the maximum amount of hazardous materials released in any 12-mo period does not exceed a reportable quantity at the point of discharge.

2.0 FACILITY DESCRIPTION/STATUS OF OPERATION

The 616 Facility is located between the 200 East and 200 West Areas on the Hanford Site. The facility provides container storage for nonradioactive dangerous wastes generated in the research and development laboratories, process operations, and maintenance and transportation functions throughout the Hanford Site. Wastes are only stored at the facility until arrangements can be made to ship the waste to a permitted offsite treatment, storage, or disposal (TSD) facility. The unit was constructed to store up to 28,635 gal of nonradioactive dangerous waste in compliance with the Washington State *Dangerous Waste Regulations* (WAC 1989); however, administrative controls restrict this much waste from being stored at the facility at any given time. Storage of this waste is regulated under Washington Administrative Code (WAC) 173-303 (WAC 1989).

3.0 SOURCE TERM

3.1 RADIOACTIVE MATERIALS

There are no radioactive materials stored at the 616 Facility.

3.2 HAZARDOUS MATERIALS

Nonradioactive dangerous waste is stored by type of waste (oxidizer, caustic, combustible, acidic, Class A flammable, or Class 1B flammable) in one of six storage cells within the unit. Each cell has a secondary containment system that includes curbing, fireproof walls, and a sloped concrete pad that drains to an 18-in. deep by 12-in. wide blind trench (there are no interior drains in any of the cells). To meet spill requirements, each secondary containment system is capable of holding at least 10% of the total volume of waste being stored within the cell.

All waste is containerized and packaged in accordance with U.S. Department of Transportation regulations. Daily inspections of the waste packages are performed by Operations personnel at the facility, while weekly inspections are performed by Engineering personnel. The building emergency plan details the procedures that need to be followed to ensure immediate response to a nonpermitted spill. However, the majority of spill response activities are performed by Hanford Fire Department personnel, who are located across the street from the 616 Facility.

Solid Waste Operations maintains an inventory at the 616 Facility which reflects the total waste on hand at a given time. The annual inventory is also contained in DOE/RL-90-10 (DOE-RL 1990). This inventory currently is updated when waste is received (which is about two times a week) or when waste is shipped offsite (which is about twice a month). Information included in the inventory includes the hazardous material identification number, manifest number, drum number, shipping name, date received, and drum location. The inventory also indicates which wastes are identified as a reportable quantity item in accordance with 40 CFR 302.4 (EPA 1989b) regulations. The Hanford Fire Department is provided with updated inventories by close of business on days when the inventory changes.

Facility engineered controls (berms, trenches, etc.) limit the potential for a waste release to the environment since a spilled material would collect in the trench until removed. However, should a nonpermitted spill occur at the facility, the building emergency director, with support from other Hanford Site organizations, arranges for the TSD of the recovered waste. All soil, water, or other materials contaminated by a spill or discharge are treated, stored, or disposed of in accordance with WAC 173-303 (WAC 1989). The building emergency director activates any equipment necessary to perform this task and to protect public health and the environment.

As soon as possible after a spill situation, all cleanup debris and materials resulting from the incident are identified. If the spilled material is unknown, it is the responsibility of the building emergency director to coordinate the identification of the material. The building emergency director will, if necessary, collect and provide samples of the materials for onsite laboratory analyses to determine the hazards associated with handling them. The collected material also is designated in accordance with applicable standards of 40 CFR 261 (EPA 1989c) and WAC 173-303-070 (WAC 1989). After the released waste has been identified, cleanup of the affected area is initiated.

4.0 POTENTIAL UPSET-OPERATING CONDITIONS

Upset conditions were reviewed and considered for the hazardous materials stored at the facility. From these conditions it was determined that the worst-case scenario would result if a fire existed within one of the cells. However, due to total containment of the waste within each cell, fireproof walls, sloped curbing, negative pressure ventilation systems, a spill response team location, and administrative controls in place for flammable and/or reactive wastes, it is believed that a hazardous material release to the environment that exceeds a reportable quantity level would be very unlikely.

5.0 SUMMARY

Since there are no radioactive materials stored at the 616 Facility or processes that could release an excess of a reportable quantity of hazardous material to the environment, it was determined that a FEMP will not be required for the facility.

6.0 REFERENCES

DOE-RL, 1990, *Hanford Site Annual Dangerous Waste Report - Volumes 1-5*, DOE/RL-90-10, U.S. Department of Energy Field Office, Richland, Washington.

EPA, 1989a, "National Emission Standards for Hazardous Air Pollutants," Title 40, Code of Federal Regulations, Part 61, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989b, "Designation, Reportable Quantities, and Notification," Title 40, Code of Federal Regulations, Part 302, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989c, "Identification and Listing of Hazardous Waste," Title 40, Code of Federal Regulations, Part 261, U.S. Environmental Protection Agency, Washington, D.C.

WAC, 1989, *Dangerous Waste Regulations*, Washington Administrative Code 173-303, Washington State Department of Ecology, Olympia, Washington.

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ATTACHMENT 1

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

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ATTACHMENT 1

DETERMINATION OF FACILITY EFFLUENT
MONITORING PLAN REQUIREMENT

FACILITY 616 Unit **DISCHARGE POINT** None

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS:

There are no radioactive materials present at the 616 Unit.

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS:

The inventory of nonradioactive hazardous materials is contained in the *Hanford Site Annual Dangerous Waste Report - Volumes 1-5* (DOE-RL 1990). Information from this report identifies all nonradioactive waste which was processed through the unit, along with the weights of each item. Since all nonradioactive hazardous materials are contained at the unit and not released to the environment, the quantity released to the environment for each item is 0.

Identification of Reference Material

DOE/RL-90-10 (DOE-RL 1990)

If the total projected dose from radionuclides exceeds 0.1 mrem ede from any one discharge point or if any one regulated material discharged from a facility exceeds 10% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required _____ FEMP is not required __X__

EVALUATOR Robert E. Bolls DATE 2-11-91

MANAGER, ENVIRONMENTAL [signature] DATE 2-26/91

FACILITY MANAGER [signature] DATE 2/26/91

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PART 4

213-J&K STORAGE VAULTS

FACILITY EFFLUENT MONITORING PLAN DETERMINATION

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CONTENTS

LIST OF FIGURES

213-J&K STORAGE VAULTS

FACILITY EFFLUENT MONITORING PLAN DETERMINATION

1.0 INTRODUCTION

This report determines if a Facility Effluent Monitoring Plan (FEMP) is required for the 213-J&K Storage Vaults located in the 600 Area of the Hanford Site. This facility is divided into two sections and is used only for material storage. One side of the facility (vault K) currently is being used to store nuclear-grade metallic sodium contained in 55-gal drums for Westinghouse Hanford Company. Each drum is stored in a nitrogen atmosphere. The drums were placed in storage on June 7, 1983. Pacific Northwest Laboratory uses the other half of the facility (vault J) to store soil samples that have been obtained from outside the Hanford Site.

2.0 FACILITY DESCRIPTION/STATUS OF OPERATION

The 213-J&K Storage Vaults are located at the base of Gable Mountain in the 600 Area. Their primary function is for storage only; the vaults neither have the potential to generate radioactive airborne effluents nor generate hazardous airborne, radioactive liquids, or hazardous liquid effluents.

The 213-J&K Storage Vaults are 40 ft long by 18 ft wide, as shown in Figure 1. Construction was completed in 1945. Ventilation for the facility is passive for both sides of the vault. Although the facility does have a powered ventilation system with high-efficiency particulate air filters, this unit has been taken out of service.

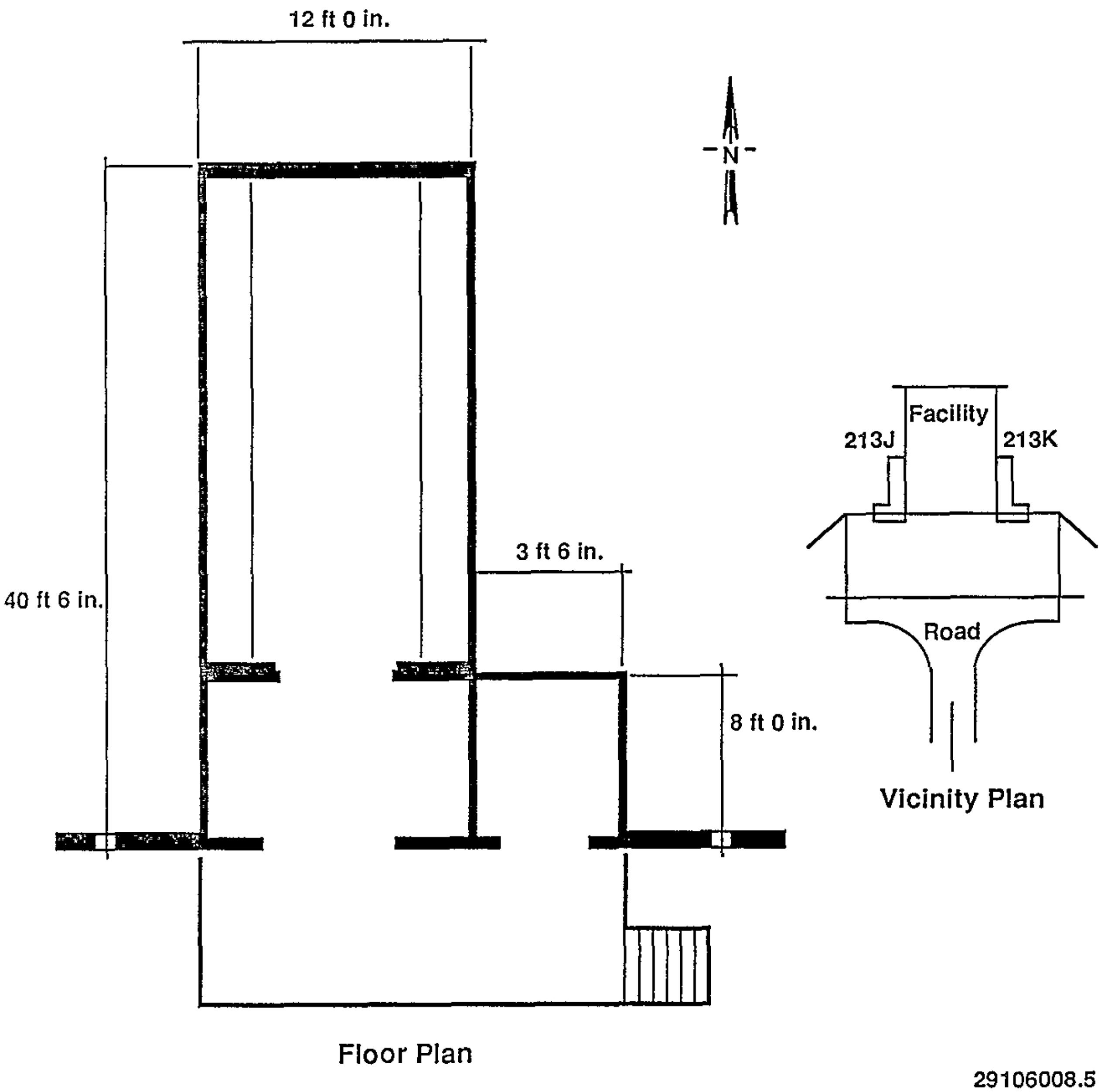
3.0 SOURCE TERM

Based on a review of the materials present in the 213-J&K facility, the inventory-at-risk for routine and upset conditions is the 55-gal drums of nuclear-grade metallic sodium (99.99% sodium purity) located in the K vault. In the event an accident should occur and containment is breached from the 55-gal drums, the metallic sodium would be contained by the secondary containment within the facility. However, when metallic sodium is exposed to moisture it becomes extremely reactive, resulting in detonation of the material. Metallic sodium is classified as a reactive metal.

4.0 POTENTIAL UPSET-OPERATING CONDITIONS

No potential upset conditions have been identified or deemed credible.

Figure 1. 213-J&K Storage Facility.



5.0 SUMMARY

Based on the information collected and data reviewed, a FEMP will not be required for the 213-J&K Facility. This determination considered hazardous materials present during routine and upset-operating conditions and the potential release for airborne and liquid effluent pathways.

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ATTACHMENT 1

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

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ATTACHMENT 1

DETERMINATION OF FACILITY EFFLUENT MONITORING PLAN REQUIREMENT

FACILITY 213-J&K/600 Area **DISCHARGE POINT** N/A

FACILITY INVENTORY AT RISK OF RADIOACTIVE MATERIALS

	Radionuclide Dose	Physical/Chemical Form	Quantity (Curies)	Quantity Released	Projected (mrem)
1.	None	N/A	N/A	N/A	N/A
2.					
3.					
4.					
Total					

FACILITY INVENTORY AT RISK OF NONRADIOACTIVE HAZARDOUS MATERIALS

	Regulated Material	Quantity (lbs)	Quantity Released	Reportable Quantity (lbs)	% of Reportable Quantity/Year
1.	Sodium-23	31,000	(None)	10 pounds	100% (If total quantity spilled)
2.					
3.					
4.					

Identification of Reference Material

Material Safety Data Sheet (MSDS) No. 2059
SARA III Inventory

If the total projected dose from radionuclide exceeds 0.1 mrem EDE from any one discharge point or if any one regulated material discharged from a facility exceeds 100% of a reportable quantity or a permitted quantity, a FEMP is required for that facility. Check the appropriate space below.

FEMP is required ____ FEMP is not required X

EVALUATOR D. W. Fritz Environmental Protection DATE 01/04/91

MANAGER, ENVIRONMENTAL L. P. Diediker DATE 01/04/91

FACILITY MANAGER H. C. Humphrey DATE 01/04/91

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APPENDIX A

UNIT DOSE CONVERSION FACTORS PREPARED BY PACIFIC NORTHWEST LABORATORY TO BE USED IN OFFSITE DOSE CALCULATIONS

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UNIT DOSE CALCULATIONS FOR WHC FACILITY EFFLUENT MONITORING PLANS

K. Rhoads January 3, 1991

INTRODUCTION

Dose calculations for unit (1 Ci) radionuclide releases were performed in support of efforts by Westinghouse Hanford Company (WHC) to develop Effluent Monitoring Plans for all WHC facilities on the Hanford site. Atmospheric releases from generic locations in the 100, 200 E, 200 W, and 300 areas were modeled for both elevated and ground-level releases; 400 area releases were modeled for ground level only. Impacts of liquid releases were evaluated for individuals at Ringold (100 and 200 area effluents) and Riverview (300 Area effluents). Both the CAP-88 (Beres 1990) and GENII (Napier et al 1988) code packages were used to model atmospheric releases in order to satisfy requirements of the U. S. Environmental Protection Agency (USEPA 1989) and the U. S. Department of Energy. The GENII code was used to model liquid releases.

METHODS

Standard parameters for Hanford dose calculations were included in the calculations where possible (McCormack, et al 1984). Meteorology data were collected at weather stations in each of the Hanford operating areas and represent the five-year average of data taken between 1983 and 1987. The location of the maximally exposed individual for each area is included in the attached tables with results of the dose calculations. Individual locations were based on the site boundary location having the greatest radionuclide air concentration under average atmospheric conditions. Doses were calculated as 50-year committed effective dose equivalents for all internal deposition pathways using the EPA model specified in 40 CFR 61. Default solubility classes were used for all radionuclides in these preliminary calculations. These should be appropriate for most facilities evaluated, except where plutonium or uranium are released in soluble form and contribute substantially to the overall dose from a given facility. Default classes for uranium and plutonium assume these radionuclides are released as insoluble compounds; this will result in a lower overall dose than would be the case if they were released in more soluble form.

RESULTS

Results of the evaluation are presented in Tables 1 - 11, and represent the 50-year committed dose equivalent following a chronic annual release of 1 Ci of each radionuclide. The CAP-88 and GENII codes handle ingrowth of long-lived radioactive daughter products differently, as noted in the tables. GENII calculates doses for all radionuclides in each decay chain, therefore the doses reported in Tables 1 -6 include contributions from both parent and ingrown daughters. CAP-88 does not calculate activities for ingrowth of daughter radionuclides following release of the parent, but will estimate the dose from very short-lived daughters where the parent-to-daughter activity ratio is effectively 1:1. CAP-88 doses reported in Tables 7 - 11 are for the parent nuclide only, except in the case where very short-lived daughters have been included in the parent dose as noted. CAP-88 doses including contributions from daughter ingrowth should be estimated using the fractional contribution from the parent nuclide reported in the GENII results.

The total dose expected from emissions at a given facility can be obtained by multiplying the release quantity in Ci for each radionuclide by the corresponding unit dose factor in the tables, and summing the contributions for all nuclides in the effluent stream. Please note that doses calculated using the GENII code are reported as rem to the maximum individual from an annual release; those from CAP-88 are reported in mrem. Values in the tables were taken directly from code outputs, and have been left in the units reported by each code to avoid transcription errors.

REFERENCES

Beres, D. A., 1990. The Clean Air Act Assessment Package -1988 (CAP-88). A Dose and Risk Assessment Methodology for Radionuclide Emissions to Air. Vols. 1-3, U. S. Environmental Protection Agency, Washington, D. C.

McCormack, W. D., J. V. Ramsdell, and B. A. Napier. 1984. Hanford Dose Overview Program: Standardized Methods and Data for Hanford Environmental Dose Calculations. PNL-3777, Rev. 1, Pacific Northwest Laboratory, Richland, Washington.

Napier, B. A., R. A. Peloquin, D. L. Strenge, and J. V. Ramsdell. 1988. GENII - The Hanford Environmental Radiation Dosimetry Software System. PNL-6584, Vols. 1-3. Pacific Northwest Laboratory, Richland, Washington.

U. S. Environmental Protection Agency. 1989. National Emission Standards for Hazardous Air Pollutants; Radionuclides; Final Rule and Notice of Reconsideration. 40 CFR Part 61, Federal Register 54 (240):51654-51715.

TABLE 2. GENII DOSE ESTIMATES FOR 1 Ci RADIONUCLIDE RELEASES - 200 E AREA
Location to the individual: 16000 METERS EAST

NUCLIDE	GROUND LEVEL DOSE EQUIVALENT (REM)*	89 m STACK DOSE EQUIVALENT (REM)*
H 3	2.0E-08	7.0E-09
C 14	4.2E-06	1.5E-06
MN 54	1.1E-06	3.7E-07
CO 60	9.0E-06	3.2E-06
SE 79	6.6E-05	2.2E-05
KR 85	1.6E-11	9.1E-12
SR 90	3.4E-05 (94)*	1.2E-05 (94)
Y 90	2.6E-07	9.0E-08
NB 94	1.0E-05	3.6E-06
ZR 95	1.1E-06 (75)	3.8E-07 (76)
NB 95	4.1E-07	1.5E-07
TC 99	3.4E-06	1.2E-06
RU 103	5.0E-07 (100)	1.7E-07 (100)
RU 106	1.4E-05	4.7E-06
RH 106	**	**
SN 113	7.9E-07	2.7E-07
SB 125	1.2E-06	4.2E-07
SN 126	8.4E-06 (74)	2.9E-06 (73)
I 129	8.4E-04	2.9E-04
I 131	5.1E-05 (100)	1.8E-05 (100)
CS 134	3.0E-05	1.0E-05
CS 135	3.2E-06	1.1E-06
CS 137**	2.2E-05	7.7E-06
CE 144	1.0E-05 (100)	3.6E-06 (100)
PM 147	9.8E-07	3.4E-07
RN 220	***	***
PO 216	***	***
PB 212	3.6E-06 (93)	1.3E-06 (95)
BI 212	1.7E-07	8.4E-08
PO 212	**	**
TL 208	**	**
RA 226	3.1E-04 (98)	1.0E-04 (98)
TH 230	5.5E-03 (100)	1.9E-03 (100)
U 233	2.8E-03 (100)	9.9E-04 (100)
U 234	2.8E-03	9.7E-04
U 235	2.6E-03 (100)	9.0E-04 (100)
U 236	2.7E-03	9.2E-04
U 238	2.5E-03 (100)	8.6E-04 (100)

* Doses calculated with GENII include contributions from the parent nuclide, long-lived daughter chains, and short-lived daughters. Numbers in parenthesis indicate percent of the total dose attributable to the parent nuclide in chains with long-lived daughters.

** Short-lived daughters are included in dose from parent nuclide.

*** Very short-lived; model as PB212.

TABLE 2. GENII DOSE ESTIMATES FOR 1 Ci RADIONUCLIDE RELEASES - 200 E AREA
(Cont.) Location to the individual: 16000 METERS EAST

NUCLIDE	GROUND LEVEL DOSE EQUIVALENT (REM)*	89 m STACK DOSE EQUIVALENT (REM)*
NP 237	1.4E-02 (100)	5.0E-03 (100)
PU 238	6.0E-03	2.1E-03
PU 239	6.4E-03	2.2E-03
PU 240	6.4E-03	2.2E-03
PU 241	1.0E-04 (100)	3.6E-05 (100)
AM 241	9.7E-03	3.4E-03
AM 243	9.7E-03 (100)	3.4E-03 (100)
CM 244	5.5E-03 (100)	1.9E-03 (100)

* Doses calculated with GENII include contributions from the parent nuclide, long-lived daughter chains, and short-lived daughters. Numbers in parenthesis indicate percent of the total dose attributable to the parent nuclide in chains with long-lived daughters.

TABLE 3. GENII DOSE ESTIMATES FOR 1 Ci RADIONUCLIDE RELEASES - 200 W AREA
Location to the individual: 24000 METERS EAST

NUCLIDE	GROUND LEVEL DOSE EQUIVALENT (REM)*		89 m STACK DOSE EQUIVALENT (REM)*	
H 3	1.2E-08		4.7E-09	
C 14	2.4E-06		1.0E-06	
MN 54	6.0E-07		2.4E-07	
CO 60	5.2E-06		2.1E-06	
SE 79	3.8E-05		1.5E-05	
KR 85	1.0E-11		5.8E-12	
SR 90	2.0E-05	(94)*	8.0E-06	(94)
Y 90	1.5E-07		6.0E-08	
NB 94	5.8E-06		2.4E-06	
ZR 95	6.3E-07	(76)	2.6E-07	(75)
NB 95	2.4E-07		9.8E-08	
TC 99	2.0E-06		7.8E-07	
RU 103	2.9E-07	(100)	1.2E-07	(100)
RU 106	7.7E-06		3.2E-06	
RH 106	**		**	
SN 113	4.5E-07		1.8E-07	
SB 125	6.8E-07		2.8E-07	
SN 126	4.7E-06	(74)	1.9E-06	(74)
I 129	4.9E-04		2.0E-04	
I 131	2.9E-05	(100)	1.2E-05	(100)
CS 134	1.7E-05		7.1E-06	
CS 135	1.8E-06		7.3E-07	
CS 137**	1.3E-05		5.2E-06	
CE 144	5.9E-06	(100)	2.4E-06	(100)
PM 147	5.6E-07		2.3E-07	
RN 220	***		***	
PO 216	***		***	
PB 212	2.1E-06	(92)	8.6E-07	(93)
BI 212	6.1E-08		4.3E-08	
PO 212	**		**	
TL 208	**		**	
RA 226	1.7E-04	(98)	7.1E-05	(98)
TH 230	3.2E-03	(100)	1.3E-03	(100)
U 233	1.6E-03	(100)	6.6E-04	(100)
U 234	1.6E-03		6.5E-04	
U 235	1.5E-03	(100)	6.1E-04	(100)
U 236	1.5E-03		6.2E-04	
U 238	1.4E-03	(100)	5.8E-04	(100)

* Doses calculated with GENII include contributions from the parent nuclide, long-lived daughter chains, and short-lived daughters. Numbers in parenthesis indicate percent of the total dose attributable to the parent nuclide in chains with long-lived daughters.

** Short-lived daughters are included in dose from parent nuclide.

*** Very short-lived; model as PB212.

TABLE 3. GENII DOSE ESTIMATES FOR 1 Ci RADIONUCLIDE RELEASES - 200 W AREA
(Cont.) Location to the individual: 24000 METERS EAST

NUCLIDE	GROUND LEVEL DOSE EQUIVALENT (REM)*	89 m STACK DOSE EQUIVALENT (REM)*
NP 237	8.1E-03 (100)	3.3E-03 (100)
PU 238	3.4E-03	1.4E-03
PU 239	3.6E-03	1.5E-03
PU 240	3.6E-03	1.5E-03
PU 241	5.9E-05 (100)	2.4E-05 (100)
AM 241	5.6E-03	2.3E-03
AM 243	5.6E-03 (100)	2.3E-03 (100)
CM 244	3.2E-03 (100)	1.3E-03 (100)

* Doses calculated with GENII include contributions from the parent nuclide, long-lived daughter chains, and short-lived daughters. Numbers in parenthesis indicate percent of the total dose attributable to the parent nuclide in chains with long-lived daughters.

TABLE 8. CAP-88 DOSE ESTIMATES FOR 1 Ci RADIONUCLIDE RELEASES - 200 E AREA
Location to the individual: 16000 METERS EAST

NUCLIDE	10 m STACK DOSE EQUIVALENT (MREM)*	89 m STACK DOSE EQUIVALENT (MREM)*
H-3	2.19E-05	5.42E-06
C-14	2.62E-03	6.48E-04
MN-54	5.51E-03	1.51E-03
CO-60	2.90E-02	7.94E-03
SE-79	**	**
KR-85	4.88E-08	1.21E-08
SR-90	4.38E-02	1.20E-02
Y-90	3.77E-04	1.04E-04
NB-94	2.58E-02	7.05E-03
ZR-95	2.65E-03	7.24E-04
NB-95	1.76E-03	4.82E-04
TC-99	1.09E-03	2.97E-04
RU-103	1.42E-03	3.89E-04
RU-106	2.09E-02	5.71E-03
RH-106	***	***
SN-113	1.18E-03	3.23E-04
SB-125	4.15E-03	1.14E-03
SN-126	8.63E-03	2.36E-03
I-129	2.91E-01	1.84E-01
I-131	1.68E-02	1.06E-02
CS-134	3.13E-02	8.56E-03
CS-135	2.15E-03	5.87E-04
CS-137***	2.39E-02	6.54E-03
CE-144	1.37E-02	3.75E-03
PM-147	1.14E-03	3.11E-04
RN-220	****	****
PO-216	****	****
PB-212	3.32E-03	9.42E-04
BI-212	2.66E-04	1.14E-04
PO-212	***	***
TL-208	***	***
RA-226	5.45E-01	1.49E-01
TH-230	5.69E+00	1.55E+00
U-233	3.23E+00	8.83E-01
U-234	3.19E+00	8.72E-01
U-235	2.96E+00	8.10E-01
U-236	3.02E+00	8.26E-01
U-238	2.84E+00	7.77E-01

* Doses calculated with CAP88 are for the parent nuclide only, and do not include contributions from long-lived daughter chains.

** Dose factors not included in code radionuclide library.

*** Short-lived daughters are included in dose from parent nuclide.

**** Very short-lived; model as PB212.

TABLE 8. CAP-88 DOSE ESTIMATES FOR 1 Ci RADIONUCLIDE RELEASES - 200 E AREA
(Cont.) Location to the individual: 16000 METERS EAST

NUCLIDE	10 m STACK DOSE EQUIVALENT (MREM)*	89 m STACK DOSE EQUIVALENT (MREM)*
NP-237	1.19E+01	3.25E+00
PU-238	8.02E+00	2.19E+00
PU-239	8.67E+00	2.37E+00
PU-240	8.66E+00	2.37E+00
PU-241	1.38E-01	3.76E-02
AM-241	1.31E+01	3.59E+00
AM-243	1.31E+01	3.59E+00
CM-244	6.94E+00	1.90E+00

* Doses calculated with CAP88 are for the parent nuclide only, and do not include contributions from long-lived daughter chains.

TABLE 9. CAP-88 DOSE ESTIMATES FOR 1 Ci RADIONUCLIDE RELEASES - 200 W AREA
Location to the individual: 24000 METERS EAST

NUCLIDE	10 m STACK DOSE EQUIVALENT (MREM)*	89 m STACK DOSE EQUIVALENT (MREM)*
H-3	1.38E-05	3.58E-06
C-14	1.65E-03	4.28E-04
MN-54	3.27E-03	9.84E-04
CO-60	1.72E-02	5.19E-03
SE-79	**	**
KR-85	3.07E-08	7.98E-09
SR-90	2.60E-02	7.82E-03
Y-90	2.22E-04	6.73E-05
NB-94	1.53E-02	4.61E-03
ZR-95	1.57E-03	4.73E-04
NB-95	1.05E-03	3.15E-04
TC-99	6.45E-04	1.94E-04
RU-103	8.45E-04	2.54E-04
RU-106	1.24E-02	3.73E-03
RH-106	***	***
SN-113	7.02E-04	2.11E-04
SB-125	2.47E-03	7.42E-04
SN-126	5.12E-03	1.54E-03
I-129	1.14E-01	1.09E-01
I-131	6.53E-03	6.29E-03
CS-134	1.86E-02	5.60E-03
CS-135	1.28E-03	3.84E-04
CS-137***	1.42E-02	4.28E-03
CE-144	8.14E-03	2.45E-03
PM-147	6.75E-04	2.03E-04
RN-220	****	****
PO-216	****	****
PB-212	1.85E-03	5.91E-04
BI-212	9.88E-05	5.81E-05
PO-212	***	***
TL-208	***	***
RA-226	3.23E-01	9.73E-02
TH-230	3.38E+00	1.02E+00
U-233	1.92E+00	5.77E-01
U-234	1.89E+00	5.70E-01
U-235	1.76E+00	5.30E-01
U-236	1.79E+00	5.40E-01
U-238	1.69E+00	5.08E-01

* Doses calculated with CAP88 are for the parent nuclide only, and do not include contributions from long-lived daughter chains.

** Dose factors not included in code radionuclide library.

*** Short-lived daughters are included in dose from parent nuclide.

**** Very short-lived; model as PB212.

TABLE 9. CAP-88 DOSE ESTIMATES FOR 1 Ci RADIONUCLIDE RELEASES - 200 W AREA
(Cont.) Location to the individual: 24000 METERS EAST

NUCLIDE	10 m STACK DOSE EQUIVALENT (MREM)*	89 m STACK DOSE EQUIVALENT (MREM)*
NP-237	7.05E+00	2.12E+00
PU-238	4.76E+00	1.43E+00
PU-239	5.15E+00	1.55E+00
PU-240	5.14E+00	1.55E+00
PU-241	8.17E-02	2.46E-02
AM-241	7.79E+00	2.35E+00
AM-243	7.79E+00	2.34E+00
CM-244	4.12E+00	1.24E+00

* Doses calculated with CAP88 are for the parent nuclide only, and do not include contributions from long-lived daughter chains.

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