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CHAPTER 11.0

RADIOACTIVE WASTE MANAGEMENT

11.1 SOURCE TERMS

This section presents the design bases for determining the source terms for radioactive releases from the plant, for shielding within the plant, and for accident analysis performed in Chapter 15.0. The source terms used for releases, shielding, and accident analyses are based on 0.12, 0.25, and 1.0 percent fuel defects, respectively.

Actual release data is contained in Annual Radioactive Effluent Release Reports filed with the NRC in accordance with Offsite Dose Calculation Manual (ODCM) requirements. Data supporting Chapter 15 accident analyses is not considered historical and is maintained current.

11.1.1 RADIOACTIVE CONCENTRATIONS AND RELEASES

Reactor coolant and secondary coolant specific activities for an assumed 0.12-percent fuel defects and an assumed 100 pounds per day primary-to-secondary leakage are listed in Table 11.1-1. The basis for calculating these sources is Regulatory Guide 1.112. Compliance with Regulatory Guide 1.112 is discussed in Table 11.1-3. Appendix 11.1A provides a description of the input used.

The decontamination factors applied are based on Regulatory Guide 1.112. A description of liquid leakage rates, process paths, and associated component activity levels is contained in Section 11.2 and Appendix 11.1A. A description of gaseous leakage rates, process paths, and associated activity levels is contained in Appendix 11.1A and Sections 11.3 and 9.4. In-plant airborne activity concentrations and other data regarding the ventilation systems are provided in Sections 12.3 and 12.4.

11.1.2 SHIELDING

Reactor coolant and secondary coolant source terms used for shielding are based on 0.25-percent fuel defects. The source terms and the parameters used to calculate the source terms are given in Table 11.1-4 and Appendix 11.1A, respectively. Table 11.1-6 provides the isotopic composition of the contained sources for radioactive waste management systems and for large, potentially radioactive outside storage tanks.

11.1.3 ACCIDENT ANALYSIS SOURCE TERMS

Except for a LOCA and a fuel handling accident, the specific activity used for accident analysis releases is based on operating with 1-percent fuel defects which results in a RCS activity limit more limiting than the Technical Specification 3.4.16 limit of 500 uci/gm DOSE EQUIVALENT XE-133. Table 11.1-5 provides the isotopic

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composition of the reactor coolant based on 1 percent fuel defects. Table 11.1-5 also identifies those isotopes excluded from the Technical Specification definition of DOSE EQUIVALENT XE-133 based on low concentration, short half life, or small dose conversion factors. Table 11.1-6 provides the inventory of the contained sources for radioactive waste management systems and for large, potentially radioactive outside storage tanks.

Sources for the LOCA are based on TID 14844.

Sources for the fuel handling accident are based on Regulatory Guide 1.25.

Chapter 15.0 provides a complete discussion and a listing of the source terms for each accident analyzed.

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TABLE 11.1-1

Reactor Coolant and Secondary Coolant
Specific Activities - 0.125% Fuel Defects⁽¹⁾

<u>Class 1</u>	Reactor Coolant <u>μCi/gm</u>	Secondary Coolant <u>μCi/gm</u>
Kr-83m	6.93E-02	2.40E-06
Kr-85m	2.83E-01	8.88E-06
Kr-85	1.18E+00	3.70E-05
Kr-87	1.84E-01	5.77E-06
Kr-88	5.33E-01	1.67E-05
Kr-89	1.51E-02	4.64E-07
Xe-131m	4.26E-01	1.34E-05
Xe-133	3.63E+01	1.14E-03
Xe-133m	6.71E-01	2.17E-05
Xe-135m	7.55E-02	1.08E-05
Xe-135	1.23E+00	4.00E-05
Xe-137	2.80E-02	8.62E-07
Xe-138	1.02E-01	3.19E-06
Total noble gas	4.11E+01	1.30E-03
<u>Class 2</u>		
Br-83	1.36E-02	2.48E-05
Br-84	7.28E-03	5.48E-06
Br-85	8.57E-04	7.50E-08
I-130	4.47E-03	1.20E-05
I-131	3.50E-01	1.06E-03
I-132	3.93E-01	7.47E-04
I-133	6.16E-01	1.74E-03
I-134	9.40E-02	1.03E-04
I-135	3.60E-01	8.81E-04
Total halogens	1.84E+00	4.75E-03

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TABLE 11.1-1 (Sheet 2)

Reactor Coolant and Secondary Coolant
Specific Activities - 0.125% Fuel Defects⁽¹⁾

<u>Class 3</u>	Reactor Coolant <u>μCi/gm</u>	Secondary Coolant <u>μCi/gm</u>
Rb-86	3.56E-03	1.96E-05
Rb-88	6.70E-01	3.40E-04
Rb-89	3.07E-02	1.35E-05
Cs-134	2.93E-01	1.62E-03
Cs-136	3.52E-01	1.93E-03
Cs-137	2.42E-01	1.34E-03
Cs-138	1.57E-01	1.34E-04
Total Cs, Rb	1.75E+00	5.40E-03
<u>Class 4</u>		
N-16	1.31E+02	3.12E-10
Water activation product		
<u>Class 5</u>		
H-3	3.50E+00	2.19E+00
Tritium		
<u>Class 6</u>		
Cr-51	1.90E-03	5.83E-06
Mn-54	3.10E-04	9.53E-07
Fe-55	1.60E-03	4.92E-06
Fe-59	1.00E-03	3.07E-06
Co-58	1.60E-02	4.92E-05
Co-60	2.00E-03	6.15E-06
Sr-89	6.39E-04	3.55E-06
Sr-90	2.38E-05	1.31E-07
Sr-91	8.42E-04	3.55E-06
Y-90	1.85E-04	4.92E-07
Sr-92	6.48E-06	2.27E-08
Y-91m	4.94E-04	1.87E-06
Y-91	7.14E-05	2.23E-07

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TABLE 11.1-1 (Sheet 3)

Reactor Coolant and Secondary Coolant
Specific Activities - 0.125% Fuel Defects⁽¹⁾

<u>Class 6</u>	Reactor Coolant <u>μCi/gm</u>	Secondary Coolant <u>μCi/gm</u>
Y-93	5.46E-05	1.45E-07
Zr-95	8.15E-05	2.50E-07
Nb-95	8.17E-05	2.51E-07
Mo-99	1.02E-01	3.07E-04
Tc-99m	9.43E-02	2.85E-04
Ru-103	6.69E-05	2.05E-07
Ru-106	2.06E-05	6.34E-08
Rh-103m	6.64E-05	2.05E-07
Rh-106	2.06E-05	3.21E-10
Ag-110m	1.64E-04	5.03E-07
Te-125m	7.40E-05	2.27E-07
Te-127m	3.69E-04	1.13E-06
Te-127	1.63E-03	4.42E-06
Te-129m	1.29E-03	3.95E-06
Te-129	1.70E-03	3.64E-06
Te-131m	3.19E-03	9.30E-06
Te-131	1.79E-03	2.45E-06
Te-132	3.74E-02	1.13E-04
Te-134	4.62E-03	4.27E-06
Ba-137m	2.29E-01	1.25E-03
Ba-140	5.17E-04	1.58E-06
La-140	1.69E-04	5.60E-07
Ce-141	7.92E-05	2.43E-07
Ce-143	6.91E-05	2.03E-07
Ce-144	5.87E-05	1.80E-07
Pr-143	7.67E-05	2.36E-07
Pr-144	5.87E-05	1.80E-07
Total other isotopes	<u>5.05E-01</u>	<u>2.07E-03</u> Note (3)

- (1) Refer to Table 11.1A-1 for assumptions.
- (2) For the secondary side, the noble gas activities are for the steam phase; all other activities are for the steam generator water activities.
- (3) Lower blowdown rates result in higher secondary system activities. A 60-gpm blowdown will result in a total of 5.85E-2 μCi/gm (excluding noble gases, N-16, and tritium) in the steam generator. A maximum blowdown rate was used in this table.

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TABLE 11.1-2

Table Deleted

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TABLE 11.1-3

COMPARISON OF THE DESIGN TO REGULATORY POSITIONS OF
REGULATORY GUIDE 1.112, REVISION 0, DATED APRIL, 1976,
TITLED "CALCULATION OF RELEASES OF RADIOACTIVE MATERIALS
IN GASEOUS AND LIQUID EFFLUENTS FROM LIGHT-WATER-COOLED
POWER REACTORS"

Regulatory Guide
1.112 Position

WCGS

1. Each application for a permit to construct a nuclear power reactor should include in-plant control measures to maintain releases of radioactive materials in liquid and gaseous effluents to the environment as low as is reasonably achievable in accordance with the requirements of Paragraph 20.1(c) of 10 CFR Part 20 and of Paragraph 50.34a, Paragraph 50.36a, and Appendix I of 10 CFR Part 50. For gaseous effluents, such measures could include storage for decay of noble gases removed from the primary coolant and charcoal adsorbers or HEPA filters to remove radioiodine and radioactive particulates released from building ventilation exhaust systems. For liquid effluents, such measures could include storage for decay, demineralization, reverse osmosis, and evaporation.

2. The method of calculation described in NUREG-0016 and NUREG-0017 and the parameters presented in Chapter 2 of each report should be used to calculate the quantities of radioactive materials in gaseous and liquid effluents from light-water-cooled nuclear power reactors.

3. If methods and parameters used in calculating source terms are different from those given in NUREG-0016 and NUREG-0017, they should be described in detail and in the Environmental Report the basis for the methods and parameters used should be provided.

1. Inplant control measures to maintain radioactive releases as low as is reasonably achievable have been incorporated in the design.

2. Parameters of NUREG-0017 are used as discussed in Appendix 11.1A. The method of calculation described in NUREG-0017 has been generally followed.

3. Justification for use of assumptions other than those used in NUREG-0017 are provided in Appendix 11.1A.

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TABLE 11.1-4

REACTOR COOLANT AND SECONDARY COOLANT
SHIELDING SOURCE TERMS - 0.25 PERCENT FUEL DEFECTS (1)

<u>Class 1</u>	Reactor Coolant <u>μCi/gm</u>	Secondary Coolant <u>μCi/gm</u>
Kr-83m	1.39E-01	4.80E-06
Kr-85m	5.66E-01	1.78E-05
Kr-85	2.35E+00	7.40E-05
Kr-87	3.68E-01	1.15E-05
Kr-88	1.07E+00	3.35E-05
Kr-89	3.03E-02	9.28E-07
Xe-131m	8.53E-01	2.68E-05
Xe-133	7.26E+01	2.28E-03
Xe-133m	1.34E+00	4.33E-05
Xe-135m	1.51E-01	2.16E-05
Xe-135	2.45E+00	7.99E-05
Xe-137	5.59E-02	1.72E-06
Xe-138	2.04E-01	6.37E-06
Total noble gas	8.21E+01	2.60E-03
<u>Class 2</u>		
Br-83	2.73E-02	4.96E-05
Br-84	1.46E-02	1.10E-05
Br-85	1.71E-03	1.50E-07
I-130	8.93E-03	2.41E-05
I-131	6.99E-01	2.11E-03
I-132	7.85E-01	1.49E-03
I-133	1.23E+00	3.48E-03
I-134	1.88E-01	2.07E-04
I-135	7.19E-01	1.76E-03
Total halogens	3.68E+00	9.14E-03

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TABLE 11.1-4 (Sheet 2)

Reactor Coolant and Secondary Coolant
Specific Activities - 0.25% Fuel Defects⁽¹⁾

<u>Class 3</u>	Reactor Coolant <u>μCi/gm</u>	Secondary Coolant <u>μCi/gm</u>
Rb-86	7.13E-03	3.91E-05
Rb-88	1.34E+00	6.80E-04
Rb-89	6.15E-02	2.71E-05
Cs-134	5.87E-01	3.25E-03
Cs-136	7.05E-01	3.86E-03
Cs-137	4.85E-01	2.68E-03
Cs-138	3.14E-01	2.68E-04
Total Cs, Rb	3.50E+00	1.08E-02
<u>Class 4</u>		
N-16	1.31E+02	3.12E-10
Water activation product		
<u>Class 5</u>		
H-3	3.50E+00	2.19E+00
Tritium		
<u>Class 6</u>		
Cr-51	1.90E-03	5.83E-06
Mn-54	3.10E-04	9.53E-07
Fe-55	1.60E-03	4.92E-06
Fe-59	1.00E-03	3.07E-06
Co-58	1.60E-02	4.92E-05
Co-60	2.00E-03	6.15E-06
Sr-89	1.28E-03	7.10E-06
Sr-90	4.76E-05	2.63E-07
Sr-91	1.68E-03	7.10E-06
Y-90	3.70E-04	9.83E-07
Sr-92	1.30E-05	4.54E-08
Y-91m	9.88E-04	3.74E-06
Y-91	1.43E-04	4.47E-07

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TABLE 11.1-4 (Sheet 3)

Reactor Coolant and Secondary Coolant
Specific Activities - 0.25% Fuel Defects ⁽¹⁾

<u>Class 6</u>	Reactor Coolant <u>μCi/gm</u>	Secondary Coolant <u>μCi/gm</u>
Y-93	1.09E-04	2.89E-07
Zr-95	1.63E-04	5.01E-07
Nb-95	1.63E-04	5.02E-07
Mo-99	2.05E-01	6.15E-04
Tc-99m	1.89E-01	5.69E-04
Ru-103	1.34E-04	4.11E-07
Ru-106	4.13E-05	1.27E-07
Rh-103m	1.33E-04	4.10E-07
Rh-106	4.13E-05	6.43E-10
Ag-110m	3.28E-04	1.01E-06
Te-125m	1.48E-04	4.55E-07
Te-127m	7.38E-04	2.27E-06
Te-127	3.25E-03	8.85E-06
Te-129m	2.58E-03	7.90E-06
Te-129	3.40E-03	7.28E-06
Te-131m	6.37E-03	1.86E-05
Te-131	3.58E-03	4.91E-06
Te-132	7.48E-02	2.25E-04
Te-134	9.24E-03	8.55E-06
Ba-137m	4.58E-01	2.51E-03
Ba-140	1.03E-03	3.17E-06
La-140	3.38E-04	1.12E-06
Ce-141	1.58E-04	4.86E-07
Ce-143	1.38E-04	4.05E-07
Ce-144	1.17E-04	3.61E-07
Pr-143	1.53E-04	4.71E-07
Pr-144	1.17E-04	3.61E-07
Total other isotopes	<hr/> 9.86E-01	<hr/> 4.07E-03 Note (3)

- (1) Refer to Table 11.1A-1 for assumptions.
- (2) For the secondary side, the noble gas activities are for the steam phase; all other activities are for the steam generator water activities.
- (3) Lower blowdown rates result in higher secondary system activities. A 60-gpm blowdown will result in a total of 1.17E-1 μCi/gm (excluding noble gases, N-16, and tritium) in the steam generator. A maximum blowdown rate was used in this table.

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TABLE 11.1-5

Reactor Coolant and Secondary Coolant
Specific Activities - 1% Fuel Defects⁽¹⁾

<u>Class 1</u>	Reactor Coolant <u>μCi/gm</u>	Secondary Coolant <u>μCi/gm</u>
Kr-83m*	5.54E-01	1.92E-05
Kr-85m	2.26E+00	7.10E-05
Kr-85*	9.41E+00	2.96E-04
Kr-87	1.47E+00	4.62E-05
Kr-88	4.26E+00	1.34E-04
Kr-89*	1.21E-01	3.71E-06
Xe-131m*	3.41E+00	1.07E-04
Xe-133	2.90E+02	9.12E-03
Xe-133m	5.37E+00	1.73E-04
Xe-135m	6.04E-01	8.62E-05
Xe-135	9.82E+00	3.20E-04
Xe-137*	2.24E-01	6.90E-06
Xe-138	8.15E-01	2.55E-05
Total noble gas	3.29E+02	1.04E-02
<u>Class 2</u>		
Br-83	1.09E-01	1.98E-04
Br-84	5.82E-02	4.38E-05
Br-85	6.86E-03	6.00E-07
I-130	3.57E-02	9.62E-05
I-131	2.80E+00	8.46E-03
I-132	3.14E+00	5.97E-03
I-133	4.93E+00	1.39E-02
I-134	7.52E-01	8.27E-04
I-135	2.88E+00	7.05E-03
Total halogens	1.47E+01	3.66E-02

*Excluded from Technical Specification definition of DOSE EQUIVALENT XE-133.

WOLF CREEK

TABLE 11.1-5 (Sheet 2)

Reactor Coolant and Secondary Coolant
Specific Activities - 1% Fuel Defects⁽¹⁾

<u>Class 3</u>	Reactor Coolant <u>μCi/gm</u>	Secondary Coolant <u>μCi/gm</u>
Rb-86	2.85E-02	1.56E-04
Rb-88	5.36E+00	2.72E-03
Rb-89	2.46E-01	1.08E-04
Cs-134	2.35E+00	1.30E-02
Cs-136	2.82E+00	1.54E-02
Cs-137	1.94E+00	1.07E-02
Cs-138	1.25E+00	1.07E-03
Total Cs, Rb	1.40E+01	4.32E-02
<u>Class 4</u>		
N-16	1.31E+02	3.12E-10
Water activation product		
<u>Class 5</u>		
H-3	3.50E+00	2.19E+00
Tritium		
<u>Class 6</u>		
Cr-51	1.90E-03	5.83E-06
Mn-54	3.10E-04	9.53E-07
Fe-55	1.60E-03	4.92E-06
Fe-59	1.00E-03	3.07E-06
Co-58	1.60E-02	4.92E-05
Co-60	2.00E-03	6.15E-06
Sr-89	5.11E-03	2.84E-05
Sr-90	1.90E-04	1.05E-06
Sr-91	6.73E-03	2.84E-05
Sr-92	1.48E-03	3.93E-06
Y-90	5.19E-05	1.82E-07
Y-91m	3.95E-03	1.49E-05
Y-91	5.71E-04	1.79E-06

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TABLE 11.1-5 (Sheet 3)

Reactor Coolant and Secondary Coolant
Specific Activities - 1% Fuel Defects⁽¹⁾

<u>Class 6</u>	Reactor Coolant <u>μCi/gm</u>	Secondary Coolant <u>μCi/gm</u>
Y-93	4.37E-04	1.16E-06
Zr-95	6.52E-04	2.00E-06
Nb-95	6.53E-04	2.01E-06
Mo-99	8.19E-01	2.46E-03
Tc-99m	7.54E-01	2.28E-03
Ru-103	5.35E-04	1.64E-06
Ru-106	1.65E-04	5.07E-07
Rh-103m	5.31E-04	1.64E-06
Rh-106	1.65E-04	2.57E-09
Ag-110m	1.31E-03	4.03E-06
Te-125m	5.92E-04	1.82E-06
Te-127m	2.95E-03	9.07E-06
Te-127	1.30E-02	3.54E-05
Te-129m	1.03E-02	3.16E-05
Te-129	1.36E-02	2.91E-05
Te-131m	2.55E-02	7.44E-05
Te-131	1.43E-02	1.96E-05
Te-132	2.99E-01	9.01E-04
Te-134	3.70E-02	3.42E-05
Ba-137m	1.83E+00	1.00E-02
Ba-140	4.14E-03	1.27E-05
La-140	1.35E-03	4.48E-06
Ce-141	6.34E-04	1.95E-06
Ce-143	5.53E-04	1.62E-06
Ce-144	4.69E-04	1.44E-06
Pr-143	6.13E-04	1.88E-06
Pr-144	4.69E-04	1.44E-06
Total other isotopes	<u>3.88E+00</u>	<u>1.61E-02</u> Note (3)

- (1) Refer to Table 11.1A-1 for assumptions.
- (2) For the secondary side, the noble gas activities are for the steam phase; all other activities are for the steam generator water activities.
- (3) Lower blowdown rates result in higher secondary system activities. A 60-gpm blowdown will result in a total of 4.65E-1 μCi/gm (excluding noble gases, N-16, and tritium) in the steam generator. A maximum blowdown rate was used in this table.

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TABLE 11.1-6

CONTAINED SOURCES OF THE RADIOACTIVE WASTE MANAGEMENT SYSTEMS
AND LARGE POTENTIALLY RADIOACTIVE OUTSIDE STORAGE TANKS

Component: Refueling Water Storage Tank Diameter, ft: 40.0
Location: Outside Height, ft: 34.5 Source volume, gal (1): 133,600

Class 1	Inventory (2) Ci	Concentration (3) Ci/gm	Class 5	Inventory (2) Ci	Concentration(3) μ Ci /gm
Kr-83m	NEG	NEG	H-3	3.79E+03	2.5E+0
Kr-85m	NEG	NEG			
Kr-85	NEG	NEG			
Kr-87	NEG	NEG	<u>Class 6</u>		
Kr-88	NEG	NEG			
Kr-89	NEG	NEG	Cr-51	3.47E-05	2.29E-08
Xe-131m	NEG	NEG	Mn-54	6.99E-06	4.62E-09
Xe-133m	NEG	NEG	Fe-55	3.66E-05	2.42E-08
Xe-133	NEG	NEG	Fe-59	1.99E-05	1.32E-08
Xe-135m	NEG	NEG	Co-58	3.36E-04	2.22E-07
Xe-135	NEG	NEG	Co-60	4.58E-05	3.03E-08
Xe-137	NEG	NEG	Sr-89	5.92E-05	9.78E-09
Xe-138	NEG	NEG	Sr-90	1.92E-06	3.17E-10
			Sr-91	NEG	NEG
Total noble gas	NEG	NEG	Y-89m	5.33E-09	NEG
			Y-90	1.76E-05	2.90E-10
<u>Class 2</u>			Y-91m	NEG	NEG
			Y-91	1.17E-05	1.93E-09
Br-83	NGE	NGE	Y-93	NEG	NEG
Br-84	NGE	NGE	Zr-95	1.25E-06	8.27E-10
Br-85	NGE	NGE	Nb-95m	1.06E-06	7.01E-10
I-130	NGE	NGE	Nb-95	1.31E-06	8.65E-10
I-131	2.34E-02	3.87E-06	Mo-99	1.59E-03	2.62E-07
I-132	3.57E-04	5.89E-08	Tc-99m	NEG	NEG
I-133	4.55E-05	7.52E-09	Ru-103	8.81E-07	5.82E-10
I-134	NEG	NEG	Ru-106	2.26E-07	1.49E-10
I-135	NEG	NEG	Rh-103m	NEG	NEG
			Rh-106	NEG	NEG
Total halogens	2.38E-02	3.94E-06	Te-125m	5.97E-07	3.95E-10
			Te-127m	6.07E-06	4.01E-09
<u>Class 3</u>			Te-127	6.09E-06	4.03E-09
			Te-129m	2.67E-05	1.76E-08
Rb-86	3.38E-05	5.59E-09	Te-129	1.71E-05	1.13E-08
Rb-88	NEG	NEG	Te-131m	3.41E-08	2.25E-10
Cs-134	1.39E-02	2.30E-06	Te-131	6.22E-08	4.11E-11
Cs-136	4.45E-03	7.35E-07	Te-132	8.65E-05	5.72E-08
Cs-137	1.01E-02	1.67E-06	Ba-137m	9.55E-03	1.58E-06
Total Cs, Rb	2.85E-02	4.71E-07	Ba-140	2.56E-05	4.22E-09
			La-140	2.90E-05	4.78E-09
<u>Class 4</u>			Ce-141	1.10E-05	1.82E-09
			Ce-143	7.26E-08	1.20E-11
N-16	NEG	NEG	Ce-144	6.19E-06	1.02E-09
			Pr-143	6.52E-07	1.08E-09
			Pr-144	6.20E-06	1.02E-09
			Total other isotopes	1.19E-02	2.29E-06

Notes:

- | | |
|--|---|
| <p>(1) For liquid vessels, this is based on at least 80 percent of vessel usable volume</p> <p>(2) Source is based on 1.0 percent fuel defects</p> | <p>(3) Source is based on 0.25 percent fuel defects</p> <p>NEG - negligible</p> |
|--|---|

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TABLE 11.1-6 (Sheet 2)

Component: Boron Recycle Holdup
Tank A or B
Location: Radwaste Building

Diameter, ft: 21

Height, ft: 31

Source Volume, gal (1): 44,800

Class 1	Inventory (2) Ci	Concentration (3) $\mu\text{Ci} / \text{gm}$	Class 5	Inventory (2) Ci	Concentration (3) $\mu\text{Ci} / \text{gm}$
Kr-83m	5.02E-01	7.40E-04	H-3	5.92E+02	3.50E+00
Kr-85m	4.93E+00	7.27E-03			
Kr-85	1.59E+03	2.35E+00	Tritium		
Kr-87	9.06E-01	1.34E-03			
Kr-88	5.80E+00	8.56E-03	<u>Class 6</u>		
Kr-89	3.10E-03	4.57E-06			
Xe-131m	3.35E+02	4.94E-01	Cr-51	5.48E-03	3.23E-05
Xe-133m	1.40E+02	2.06E-01	Mn-54	1.12E-03	6.62E-06
Xe-133	1.68E+04	2.47E+01	Fe-55	5.88E-03	3.47E-05
Xe-135m	1.06E-01	1.56E-04	Fe-59	3.16E-03	1.86E-05
Xe-135	4.40E+01	6.49E-02	Co-58	5.36E-02	3.16E-04
Xe-137	6.97E-03	1.03E-05	Co-60	7.38E-03	4.35E-05
Xe-138	9.38E-02	1.38E-04	Sr-89	1.65E-02	2.44E-05
Total noble gas	1.89E+04	2.78E+01	Sr-90	7.04E-04	1.04E-06
			Y-90	5.15E-03	7.59E-06
<u>Class 2</u>			Sr-91	5.23E-06	7.71E-09
Br-83	2.88E-03	4.25E-06	Y-91M	3.79E-05	5.59E-08
Br-84	3.40E-04	5.01E-07	Y-91	1.87E-03	2.76E-06
Br-85	3.61E-06	5.32E-09	Sr-92	1.26E-05	1.86E-08
I-129	2.18E-07	3.22E-10	Y-92	4.76E-05	7.02E-08
I-130	4.89E-03	7.20E-06	Y-93	4.73E-05	6.97E-08
I-131	4.96E+00	7.32E-03	Zr-95	2.17E-03	3.20E-06
I-132	7.90E-02	1.16E-04	Nb-95	2.39E-03	3.52E-06
I-133	1.13E+00	1.66E-03	Mo-99	5.72E-01	8.43E-04
I-134	7.25E-03	1.07E-05	Tc-99M	5.26E-01	7.75E-04
I-135	2.09E-01	3.08E-04	Ru-103	1.66E-03	2.45E-06
Total halogens	6.39E+00	9.43E-03	Rh-103M	5.28E-06	7.78E-09
			Ru-106	6.00E-04	8.84E-07
<u>Class 3</u>			Rh-106	1.46E-08	2.15E-11
Rb-86	8.92E-01	1.32E-03	Ag-110M	4.72E-03	6.96E-06
Rb-88	6.01E+00	8.86E-03	Te-125M	1.94E-03	2.86E-06
Rb-89	1.12E-02	1.64E-05	Te-127M	1.02E-02	1.51E-05
Cs-134	1.05E+02	1.54E-01	Te-127	1.10E-02	1.63E-05
Cs-136	7.65E+01	1.13E-01	Te-129M	3.10E-02	4.57E-05
Cs-137	8.72E+01	1.29E-01	Te-129	1.98E-02	2.91E-05
Cs-138	8.64E-02	1.27E-04	Te-131M	8.13E-03	1.20E-05
Total Cs, Rb	2.75E+02	4.06E-01	Te-131	6.35E-05	9.36E-08
			Te-132	2.45E-01	3.61E-04
<u>Class 4</u>			Te-134	2.75E-04	4.06E-07
N-16	NEG	NEG	Ba-137M	8.25E+01	1.22E-01
			Ba-140	9.16E-03	1.35E-05
			La-140	9.09E-03	1.34E-05
			Ce-141	1.89E-03	2.79E-06
			Ce-143	1.94E-04	2.86E-07
			Pr-143	1.52E-03	2.23E-06
			Ce-144	1.69E-03	2.50E-06
			Pr-144	1.69E-03	2.50E-06
			Total other isotopes	8.41E+01	1.24E-01

Notes:

- (1) Tank liquid usable volume is 44800 gal.
- (2) Based on 1.00% fuel defects.
- (3) Based on 0.25% fuel defects.

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TABLE 11.1-6 (Sheet 3)

Component: Spent Resin Storage Tank (Primary) Diameter, ft: 7
 Location: Radwaste Building Height, ft: 10.7 Source volume, ft3 (1): 280

Class 1	Inventory (2) Ci	Concentration (3) Ci /gm	Class 5	Inventory (2) Ci	Concentration(3) µCi /gm
Kr-83m	NEG	NEG	H-3	NEG	NEG
Kr-85m	NEG	NEG			
Kr-85	NEG	NEG			
Kr-87	NEG	NEG	<u>Class 6</u>		
Kr-88	NEG	NEG			
Kr-89	NEG	NEG	Cr-51	2.99E+01	3.90E+00
Xe-131m	NEG	NEG	Mn-54	2.91E+01	3.80E+00
Xe-133m	NEG	NEG	Fe-55	1.93E+02	2.52E+01
Xe-133	NEG	NEG	Fe-59	2.49E+01	3.26E+00
Xe-135m	NEG	NEG	Co-58	6.10E+02	7.98E+01
Xe-135	NEG	NEG	Co-60	2.56E+02	3.34E+01
Xe-137	NEG	NEG	Sr-89	9.80E+00	2.67E+00
Xe-138	NEG	NEG	Sr-90	1.35E+00	3.67E-01
			Sr-91	NEG	NEG
Total noble gas	NEG	NEG	Y-90	1.33E+00	3.62E-01
			Y-91m	NEG	NEG
<u>Class 2</u>			Y-91	2.18E+00	5.93E-01
			Y-93	NEG	NEG
Br-83	NEG	NEG	Zr-95	2.12E+00	2.77E-01
Br-84	NEG	NEG	Nb-95m	2.11E+00	2.76E-01
Br-85	NEG	NEG	Nb-95	3.00E+00	3.92E-01
I-130	5.80E-01	1.57E-01	Mo-99	1.36E+02	3.71E+01
I-131	1.17E+03	3.16E+02	Tc-99m	NEG	NEG
I-132	5.20E+01	7.51E+00	Ru-103	9.98E-01	1.31E-01
I-133	1.76E+02	4.80E+01	Ru-106	9.89E-01	1.29E-01
I-134	9.08E-01	2.47E-01	Rh-103m	NEG	NEG
I-135	2.83E+01	7.73E+00	Rh-106	NEG	NEG
Total halogens	1.43E+03	3.80E+02	Te-125m	9.18E-01	1.20E-01
			Te-127m	1.50E+01	1.96E+00
<u>Class 3</u>			Te-127	1.52E+01	1.99E+00
			Te-129m	2.69E+01	3.51E+00
Rb-86	7.91E-01	2.15E-01	Te-129	1.72E+01	2.25E+00
Rb-88	1.39E+00	3.80E-01	Te-131m	1.83E+00	2.39E-01
Cs-134	1.78E+03	4.85E+02	Te-131	NEG	NEG
Cs-136	8.91E+01	2.43E+01	Te-132	5.15E+01	6.74E+00
Cs-137	1.48E+03	4.03E+02	Ba-137m	1.40E+03	3.81E+02
Total Cs, Rb	3.35E+03	9.13E+02	Ba-140	1.63E+00	4.44E-01
			La-140	1.77E+00	4.82E-01
<u>Class 4</u>			Ce-141	1.28E+00	3.48E-01
			Ce-143	NEG	NEG
N-16	NEG	NEG	Ce-144	3.00E+00	8.15E-01
			Pr-143	4.25E-01	1.16E-01
			Pr-144	3.00E+00	8.15E-01
			Total other isotopes	2.89E+03	5.93E+02

Notes:

- | | |
|--|--|
| <p>(1) For liquid vessels, this is based on 80 percent of vessel usable volume.</p> <p>(2) Source is based on 0.12 percent fuel defects and 1 year accumulated activity.</p> | <p>(3) Source is based on 0.25 percent fuel defects.</p> <p>(4) Liquid activities are obtained by multiplying inventory and concentration by .001.</p> |
|--|--|

WOLF CREEK

TABLE 11.1-6 (Sheet 4)

Component: Secondary Liquid Waste System Diameter, ft: 12
 Drain Collector Tank A or B
 Location: Turbine Building Height, ft: 22.75 Source volume, gal (1): 12,600

Class 1	Inventory (2) Ci	Concentration (3) Ci /gm	Class 5	Inventory (2) Ci	Concentration (3) µCi /gm
Kr-83m	NEG	NEG	H-3	1.66E-01	3.49E-03
Kr-85m	NEG	NEG			
Kr-85	NEG	NEG			
Kr-87	NEG	NEG	<u>Class 6</u>		
Kr-88	NEG	NEG			
Kr-89	NEG	NEG	Cr-51	1.89E-09	3.98E-11
Xe-131m	NEG	NEG	Mn-54	4.28E-10	8.99E-12
Xe-133m	NEG	NEG	Fe-55	1.72E-09	3.60E-11
Xe-133	NEG	NEG	Fe-59	1.27E-09	2.67E-11
Xe-135m	NEG	NEG	Co-58	1.70E-08	3.57E-10
Xe-135	NEG	NEG	Co-60	1.93E-09	4.05E-11
Xe-137	NEG	NEG	Sr-89	3.54E-09	1.86E-11
Xe-138	NEG	NEG	Sr-90	7.13E-11	3.75E-13
			Sr-91	1.36E-09	7.13E-12
Total noble gas	NEG	NEG	Y-90	2.58E-11	1.36E-13
			Y-91m	9.21E-10	4.84E-12
<u>Class 2</u>			Y-91	5.51E-10	2.90E-12
			Y-93	7.00E-11	3.68E-13
Br-83	1.68E-08	8.83E-11	Zr-95	8.53E-11	1.79E-12
Br-84	9.95E-10	5.23E-12	Nb-95m	1.24E-11	2.61E-13
Br-85	NEG	NEG	Nb-95	8.47E-11	1.78E-12
I-130	4.44E-08	2.34E-10	Mo-99	5.97E-07	3.14E-09
I-131	1.49E-05	7.85E-08	Tc-99m	NEG	NEG
I-132	4.58E-07	2.68E-09	Ru-103	4.23E-11	8.89E-13
I-133	1.17E-05	6.17E-08	Ru-106	8.54E-12	1.79E-13
I-134	3.87E-08	2.03E-10	Rh-103m	NEG	NEG
I-135	2.26E-06	1.19E-08	Rh-106	NEG	NEG
Total halogens	2.94E-05	1.55E-07	Te-125m	2.13E-11	4.47E-13
			Te-127m	2.13E-10	4.48E-12
<u>Class 3</u>			Te-127	3.84E-10	8.06E-12
			Te-129m	1.27E-09	2.66E-11
Rb-86	7.52E-10	3.95E-12	Te-129	8.71E-10	1.83E-11
Rb-88	2.91E-09	1.53E-11	Te-131m	1.47E-09	3.08E-11
Cs-134	2.28E-07	1.20E-09	Te-131	2.75E-10	5.77E-12
Cs-136	1.13E-07	5.94E-10	Te-132	1.84E-08	3.86E-10
Cs-137	1.65E-07	8.66E-10	Ba-137m	1.56E-07	8.21E-10
Total Cs, Rb	5.10E-07	2.68E-09	Ba-140	1.72E-09	9.02E-12
			La-140	1.44E-09	7.56E-12
<u>Class 4</u>			Ce-141	7.04E-10	3.70E-12
			Ce-143	1.26E-10	6.63E-13
N-16	NEG	NEG	Ce-144	3.57E-10	1.88E-12
			Pr-143	3.50E-10	1.84E-12
			Pr-144	3.61E-10	1.90E-12
			Total other isotopes	8.12E-07	5.01E-09

Notes:

- (1) For liquid vessels, this is based on 84 percent of vessel usable Volume.
 - (2) Source is based on 1.0 percent fuel defects.
 - (3) Source is based on 0.25 percent fuel defects.
- NEG - negligible

WOLF CREEK

APPENDIX 11.1A

PARAMETERS FOR CALCULATION OF SOURCE TERMS FOR EXPECTED RADIOACTIVE CONCENTRATIONS AND RELEASES

11.1A.1 Regulatory Guide 1.112 provides guidelines for developing radioactive source terms. The following parameters and models are used to calculate radioactive source terms for the evaluation of radioactive waste treatment systems in determining the impact of radioactive effluents on the environment.

Figure 11.1A-1 shows a block diagram of liquid releases, and Table 11.1A-2 and Figure 11.1A-2 provide the volume, radioactivity level, and decontamination factors (DF) for each liquid path.

Figure 11.1A-3 shows a block diagram of gaseous releases, and Tables 11.1A-3 and 11.1A-4 provide the volume, radioactivity level, and DF for each gaseous path.

11.1A.2 The basic plant data for the source term calculations are provided in Table 11.1A-1.

Table 11.1A-5 provides summary GALE Code input data.

The following sections discuss the detailed design of waste systems:

a. Chemical and volume control	9.3.4
b. Gaseous radwaste	11.3
c. Liquid radwaste	11.2
d. Boron recycle	9.3.6
e. Secondary liquid waste	10.4.10
f. Steam generator blowdown	10.4.8

The plant ventilation systems are discussed in Section 9.4.

WOLF CREEK

TABLE 11.1A-1

PLANT DATA FOR SOURCE TERM CALCULATIONS

I.	Reactor Power, MWt	3565 x 1.02 = 3636
II.	Fuel Data	
	a. Number of fuel assemblies	193
	b. Uranium mass, MTU	87.8
	c. Enrichment, w/o	5.0
	d. Operation time, days	510
	e. Fuel with defects, %	1.0, 0.25, 0.125
III.	Plant Parameters	
	a. Reactor coolant average temperature, °F	593.2
	b. System pressure, psia	2250
	c. Letdown rate, gpm	75
	d. Mixed bed demineralizer volume, ft ³	30
	e. Cation demineralizer volume, ft ³	30
	f. Cation demineralizer effective flow, gpm	7.5
	g. Volume control tank	
	Liquid volume, ft ³	200
	Vapor volume, ft ³	200
	Pressure, nominal, psig	0-30
	Temperature, °F	115-125
	h. Chemical and volume control system parameter	See Figure 11.1A-2 (Sheet 1) and Table 11.1A-2
	i. Boron recycle system parameters	See Figure 11.1A-2 (Sheet 2) and Table 11.1A-2
IV.	Secondary System Parameters	
	a. Steam flow rate, 10 ⁷ lbs/hr	1.592
	b. Secondary side water, 10 ⁵ lbs	3.82
	c. Steam fraction in the secondary	0.08
	d. Moisture carryover fraction from the steam generator	0.25
	e. Primary to secondary leak rte, gpm	1
	f. Steam generator blowdown rate, gpm	360

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TABLE 11.1A-1 (Sheet 2)

V.	Liquid Waste Processing Systems	
	1. Liquid radwaste system design parameters	See Figure 11.1A-2 (Sheets 3,4,5) and Table 11.1A-2
	2. Secondary liquid waste system design parameters	See Figure 11.1A-2 (Sheet 7) and Table 11.1A-2
VI.	Gaseous Waste Processing System	
	Gaseous radwaste system design parameters	See Figure 11.3-2 and Tables 11.1A-3 & 4
VII.	Ventilation and Exhaust Systems	
	HVAC system design parameters	See Figure 11.3-2 and Tables 11.1A-3 & 4

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TABLE 11. 1A-2
PARAMETERS USED IN THE CALCULATION OF ESTIMATED ACTIVITY IN LIQUID WASTES

<u>Collector Tank With Sources</u>	<u>Volume of Liquid Wastes</u>	<u>Specific Activity</u>	<u>Basis</u>	<u>Collection Period Assumed Before Processing</u>	<u>Comments</u>
A. Reactor coolant drain tank	300 gal/day	1.0 PCA(1)	0.05 gpm/R.C. pump #2 seal leak and other	Feed and bleed	
B. Letdown shim-bleed	1,840 gal/day	1.0 PCA(1)	CVCS inventory control	Feed and bleed	
C. Waste holdup tank	400 gal/day	0.5 PCA(1)		10 days	
1. Equipment drains			Tank drains, filter drains, heat exchanger drains, demineralizer drains		
2. Excess samples			Miscellaneous pre-purges sample		
D. Floor drain tank	1,140 gal/day	0.06 PCA(1)		7 days	
1. Decontamination water			Fuel cask, vessel head system component flushing, floor washdown, etc.		Nominal discharge is 5,000 gallons at 35 gpm, approximately twice a week.
2. Laboratory equipment			Washing and rinsing of laboratory equipment. Reactor grade drains which are aerated. Maintenance drains for filters, H. Ex., demineralizers, etc.		
E. Chemical drain tanks	7,000 gal/yr	0.15 PCA(1)	Samples plus sample rinse water	90 days	Drummed

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TABLE 11.1A-2 (Sheet 2)

<u>Collector Tank With Sources</u>	<u>Volume of Liquid Wastes</u>	<u>Specific Activity</u>	<u>Basis</u>	<u>Collection Period Assumed Before Processing</u>	<u>Comments</u>
F. Laundry and hot shower tank	450 gal/day	N/A	Decon. tank waste 300 gal/day with remainder for abnormal and refueling operation	7 days	This item is historical. Laundry is processed off-site.
G. Steam generator	86,400-518,400 gal/day	1.0 SCA (2)	Continuous blowdown of 60-360 gpm	None	Normally recycled to condensate/feedwater water system
H. Secondary liquid waste drain collector tank	7,200 gal/day	(3)	Floor drains and equipment drains	None	Discharged or recycled to condensate storage tank.
I. Condensate demineralizer regeneration waste	4,286 gal/day	(3)	15,000 gal/high TDS regeneration waste - per regeneration	None	Processing options are: 1. Neutralize and discharge 2. Process and recycle to condenser 3. Evaporate and discharge
	12,857 gal/day	(3)	45,000 gal/low TDS regeneration waste - per regeneration		Recycle to secondary cycle or discharge

- (1) PCA - Primary coolant specific activity
- (2) SCA - Secondary coolant specific activity
- (3) Fraction of SCA internally calculated by GALE Code.

WOLF CREEK

TABLE 11.1A-3
DESCRIPTION OF MAJOR SOURCES OF GASEOUS RELEASES

Source	Basis (per unit), 0.12% Failed Fuel, 80% Plant Factor	Noble Gas	Factors Which Mitigate Radioactive Releases		Internal: P-H-C-H (2) Exhaust: P-H-C-H
			Partition Factors (5)	Holdup Filters (1)	
Containment building	1%/day, 0.001%/day of noble gas and iodine inventory in the reactor coolant, respectively	1	1	24 purges year	Internal: P-H-C-H (2) Exhaust: P-H-C-H
Auxiliary/fuel/radwaste buildings	Noble gas and volatile iodine in 160 lbs/day of reactor coolant (4)	1	0.15	No	Exhaust: P-H-C-H
Turbine building	1700 lbs/hr of secondary steam (3)	1	1	No	No
Condenser air removal system	Noble gas and volatile iodine in 100 lbs of primary coolant/day (4)	1	0.15	No	Exhaust: P-H-C-H
Gaseous radwaste system	Stripping of gases during power operation and degassing of reactor coolant during 2 cold shutdowns/year is directed by Chemistry.	-	-	90 days	Exhaust: P-H-C-H

Notes:

- (1) P - prefilter or roughing filter; H - HEPA filter; C - charcoal adsorber efficiencies of 99 percent for particulates and 70 percent for radioiodines.
- (2) No credit has been taken for the internal recirculation clean-up.
- (3) Secondary steam activities are based on 100 lbs./day primary-secondary leakage and a partition factor of 0.01 between liquid and vapor phases in the steam generator for iodines.
- (4) 5 percent of the iodine in the primary coolant is assumed to be in the volatile form.
- (5) Partition factors here mean either the partition on a mass basis between the liquid and vapor phases or the fraction of the leak that is airborne.

WOLF CREEK

TABLE 11.1A-4
CHARACTERISTICS OF RELEASE POINTS AND RELEASES

Source	Building Free Volume (cu. ft.)	Point of Release (1)	Filters (2)	Shape of Exhaust Vent	Type	Physical Characteristics of Effluent Streams		
						Flow rate (cfm)	Temperature (F)	Velocity (fpm)
A. Reactor building	2,500,000	Unit vent	Internal: P-H-C-H Exhaust: P-H-C-H	-	Intermittent 4 shutdown purges/yr 20 purges/yr at power	20,000	120 max.	-
B. Auxiliary building/fueling building	1,210,000/ 824,000	Unit vent	Exhaust: P-H-C-H	-	Continuous	32,000	104 max.	-
C. Unit vent point of release for sources A, B, G, H, and I	-	Top of containment (Base El. 2208', Release El. 2218')	-	Rectangular 7.6" x 5'0"	Continuous	66,000/ 82,000	110 max.	1,800/2,200
D. Vent collection header	-	Radwaste bldg. vent	Exhaust: P-H-C-H	-	Continuous	250	Ambient	-
E. Radwaste building for sources D, E gaseous radwaste system releases	477,400	Roof of radwaste building (Base El. 2055'-6" Release El. 2065'-6")	Exhaust: P-H-C-H	Square 34" x 34"	Continuous	12,000	104 max.	1,600
F. Turbine building	4,400,000	Roof of turbine building (Base El. 2137', Release El. 2147')	None	Roof exhaust fans	Continuous	800,000 (summer) 80,000 (winter)	100 max.	-
G. Condenser air removal filtration system	-	Unit vent	Exhaust: P-H-C-H	-	Continuous	1,000	120 max.	-

(1) Grade elevation is 2000'-0". Elevations shown are standard plant elevation - El. 2000'-0" is Wolf Creek El._MSL/
(2) P = prefilter or roughing filter, H = HEPA filter, C = charcoal adsorber

WOLF CREEK

TABLE 11.1A-4 (Sheet 2)

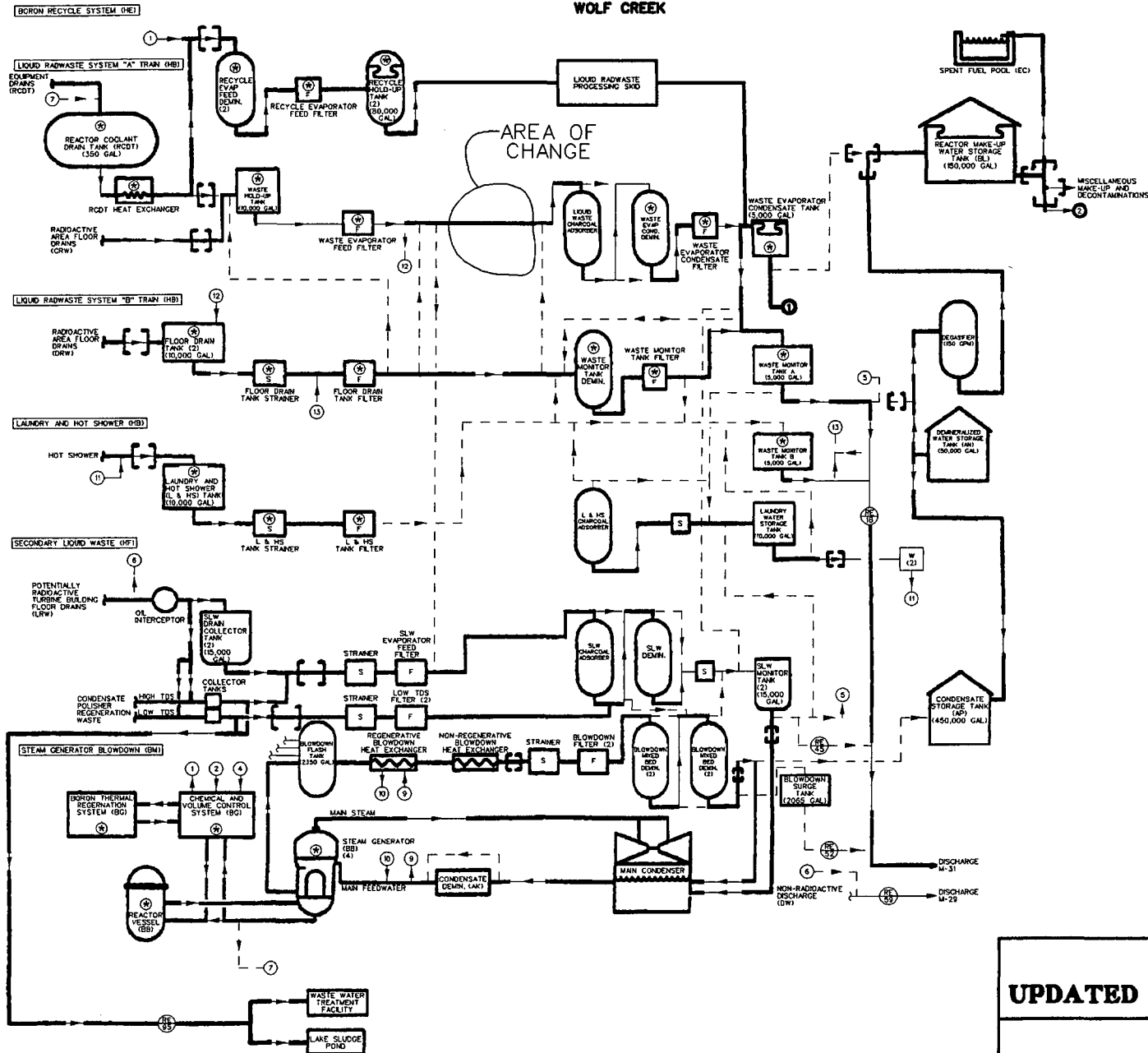
Source	Building Free Volume (cu. ft.)	Point of Release (1)	Filters (2)	Shape of Exhaust Vent	Type	Physical Characteristics of Effluent Streams
						Flow rate (cfm) Temperature (F) Velocity (fpm)
H. Access control area	208,000	Unit vent	Exhaust: P-H-C-H	-	Continuous	6,000 104 max. -
I. Main steam enclosure	166,000	Unit vent	None	-	Continuous	23,000 120 max. -

(1) Grade elevation is 2000'-0"
 (2) P = prefilter or roughing filter, H = HEPA filter, C = charcoal adsorber

TABLE 11.1A-5

Deleted Table

WOLF CREEK



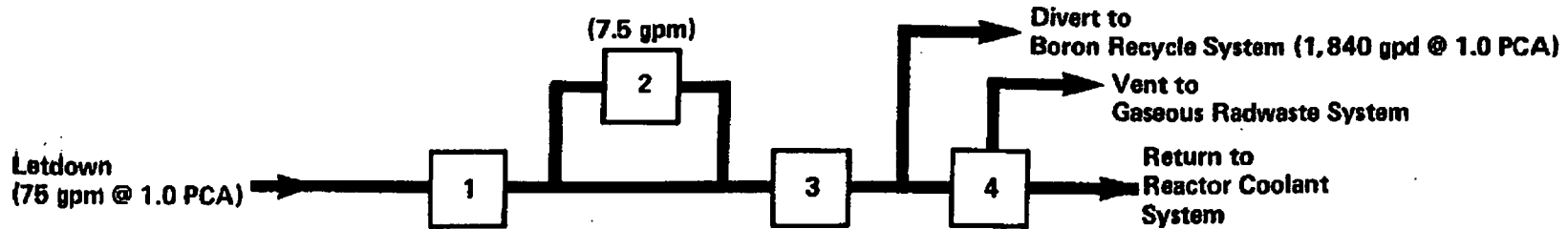
- NOTES:
1. SOLID LINE REPRESENT PRIMARY PROCESS PATHS.
 2. DASHED LINES REPRESENT ALTERNATE PROCESS PATHS.

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**WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT**

**FIGURE 11.1A-1
LIQUID WASTE TREATMENT SYSTEMS
BLOCK DIAGRAM**

WOLF CREEK



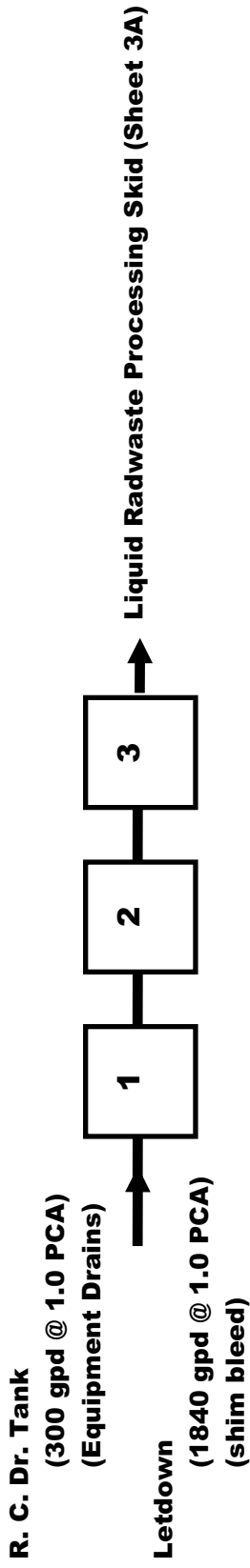
DECONTAMINATION FACTORS

	<u>Iodine</u>	<u>Cesium & Rubidium</u>	<u>Other Nuclides</u>
1. Mixed Bed Demineralizers	10	2	10
2. Cation Bed Demineralizer	1	10	10
3. Reactor Coolant Filter	1	1	1
4. Volume Control Tank (a)	—	—	—
System DF	10	20	10 ²

(a) For noble gases, a value of 0.25 is built into the GALE code for the y parameter for the case of continuous VCT purging.

Rev. 0

<p>WOLF CREEK UPDATED SAFETY ANALYSIS REPORT</p>
<p>FIGURE 11.1A-2 SYSTEM DECONTAMINATION FACTORS (SHEET 1)</p>



DECONTAMINATION FACTORS

	<u>Iodine</u>	<u>Cesium & Rubidium</u>	<u>Other Nuclides</u>
1. Recycle Evaporator Mixed Bed Demineralizer	10	2	10
2. Recycle Evaporator Feed Filter	1	1	1
3. Recycle Holdup Tanks	—	—	—
System DF	10	2	10

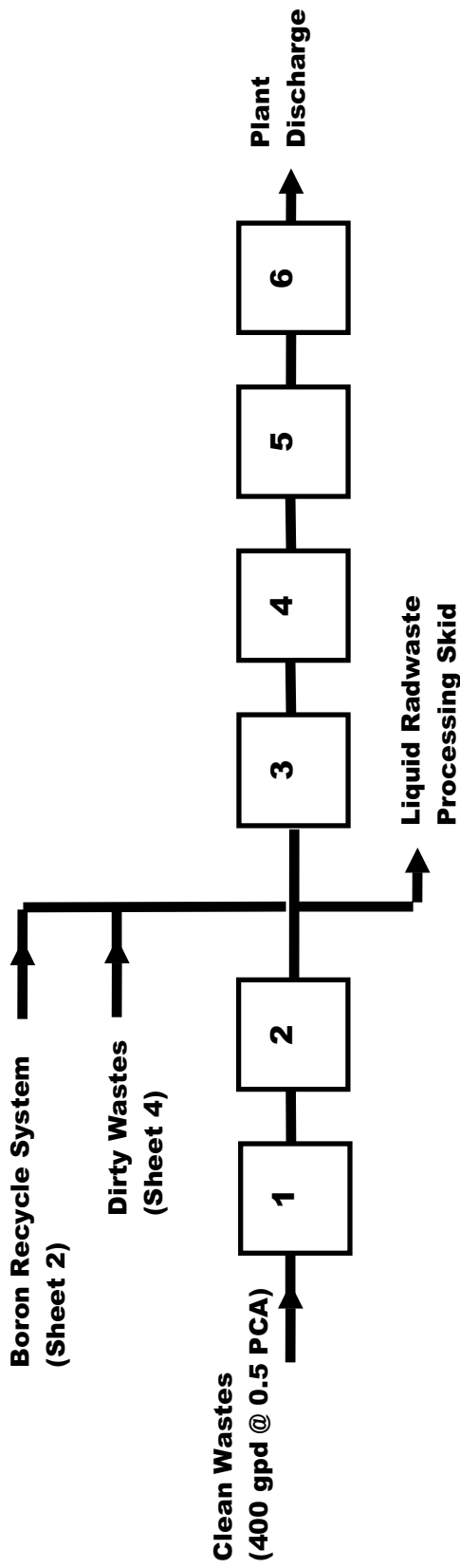
Decay Time

Boron Recycle Holdup Tank Collection Time

$$T_c = \frac{0.8 \times 56,000}{2,140} = 20.9 \text{ days}$$

Boron Recycle System Rev. 23

WOLF CREEK UPDATED SAFETY ANALYSIS REPORT
FIGURE 11.1A-2 (Sheet 2)
SYSTEM DECONTAMINATION FACTORS



DECONTAMINATION FACTORS

	Iodine		Cesium & Rubidium		Other Nuclides	
	1	10 ³	1	10 ⁴	1	10 ⁴
1. Waste Holdup Tank	1	1	1	1	1	1
2. Waste Evaporator Feed Filter	1	10 ³	1	10 ⁴	1	10 ⁴
3. Waste Evaporator Note 1, 2	1	1	1	1	1	1
4. Liquid Waste Charcoal Adsorber Note 1, 2	1	1	1	1	1	1
5. Waste Evaporator Condensate Demineralizer Note 1, 2	1	10	1	10	1	10
6. Waste Evaporator Condensate Filter Note 1, 2	1	1	1	1	1	1
System DF Note 1		10 ⁴		10 ⁵		10 ⁵

Note 1: Liquid Radwaste is processed as shown on sheet 3A.
This sheet retained for historical purposes only.

Note 2: Equipment permanently out of service.

Liquid Radwaste Train "A" — Clear Waste

Rev. 23

Decay Time

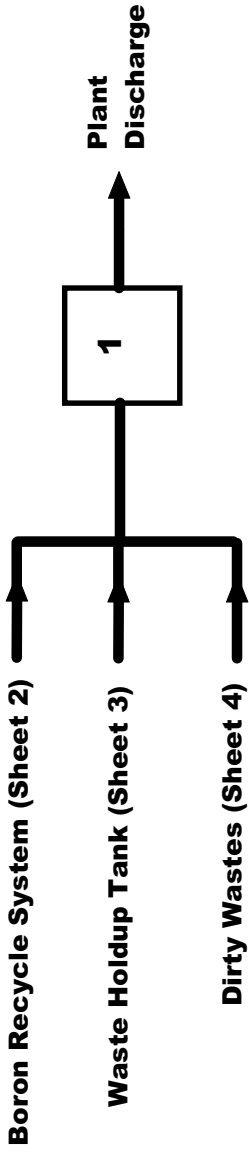
Waste Holdup Tank Collection Time

Waste Process Time

$$T_c = \frac{0.4 \times 10,000}{400} = 10 \text{ days}$$

$$T_p = \frac{0.4 \times 10,000}{21,600} = 0.185 \text{ day}$$

WOLF CREEK UPDATED SAFETY ANALYSIS REPORT
FIGURE 11.1A-2 (SHEET 3)
SYSTEM DECONTAMINATION FACTORS



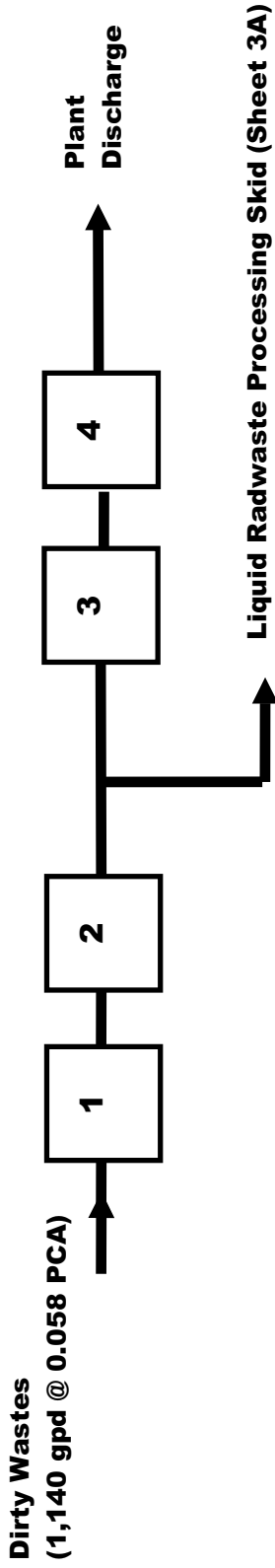
1. Liquid Radwaste Processing Skid

DECONTAMINATION FACTORS

	Cesium & Rubidium	Other Nuclides
<u>Iodine</u>	$>10^6$	$>10^5$

Liquid Radwaste Processing Skid
Rev. 14

WOLF CREEK UPDATED SAFETY ANALYSIS REPORT
FIGURE 11.1A-2 (SHEET 3A)
SYSTEM DECONTAMINATION FACTORS



DECONTAMINATION FACTORS

	<u>Iodine</u>	<u>Cesium & Rubidium</u>	<u>Other Nuclides</u>
1. Floor Drain Tank	—	—	—
2. Floor Drain Tank Filter	1	1	1
3. Waste Monitor Tank Demineralizer	—	—	—
4. Waste Monitor Tank Filter	1	1	1
System DF	1	1	1

Liquid Radwaste Train “B” — Dirty Wastes

Rev. 23

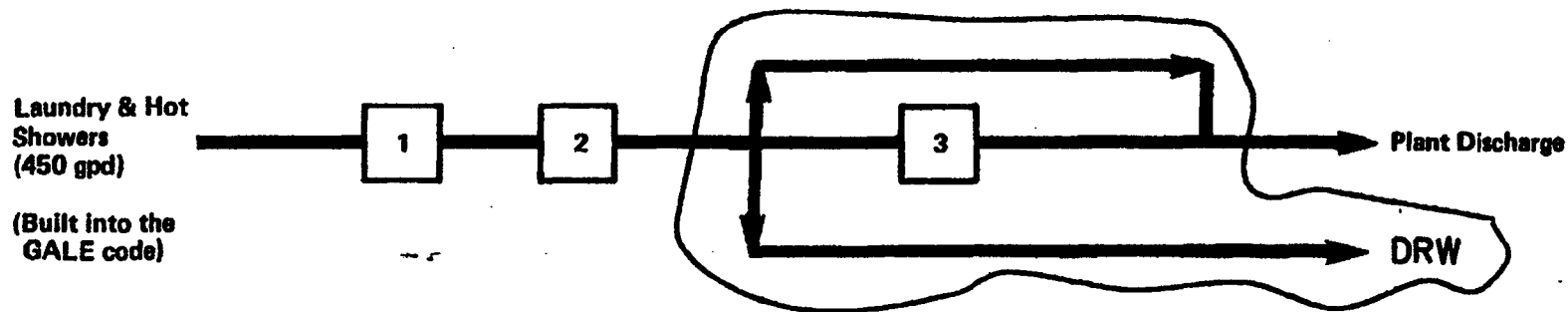
Decay Time

Floor Drain Tank
Collection Time

$$T_c = \frac{0.8 \times 10,000}{1,140} = 7 \text{ days}$$

WOLF CREEK UPDATED SAFETY ANALYSIS REPORT
FIGURE 11.1A-2 (SHEET 4)
SYSTEM DECONTAMINATION FACTORS

WOLF CREEK



DECONTAMINATION FACTORS

	<u>Iodine</u>	<u>Cesium & Rubidium</u>	<u>Other Nuclides</u>
1. Laundry and Hot Shower Tank			
2. Laundry and Hot Shower Filter	1	1	1
3. Laundry and Hot Shower Charcoal Adsorber	1	1	1
System DF (NOTE 1)	1	1	1

Decay Times*

L + H.S. Tank
Collection Time

$$T_c = \frac{0.4 \times 10,000}{450} = 8.9 \text{ days}$$

$$T_p = \frac{0.4 \times 10,000}{5,760} = 0.7 \text{ day}$$

*The GALE code does not use these decay credit factors.

NOTES:

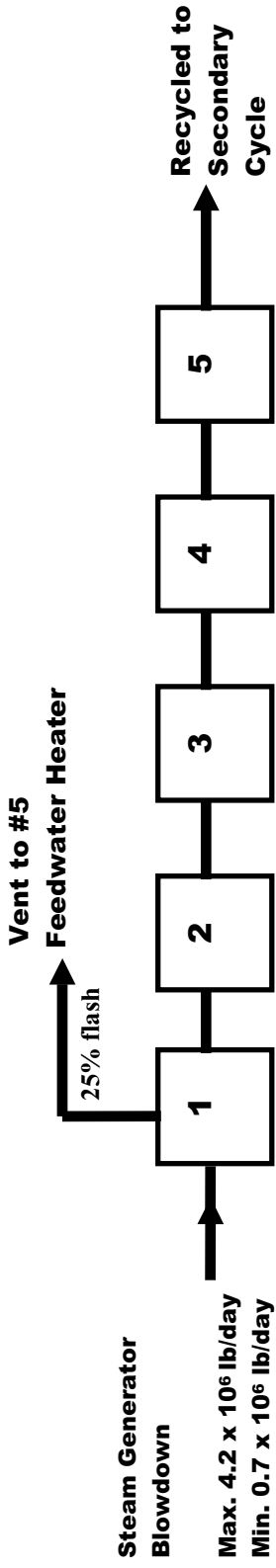
1.) VOLUMES ARE EXTREMELY CONSERVATIVE. LAUNDRY IS PROCESSED OFFSITE. NO CONTAMINATED INFLUENTS ARE NORMALLY RECEIVED BY THE L & HST.

Liquid Radwaste -
Laundry Train

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WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

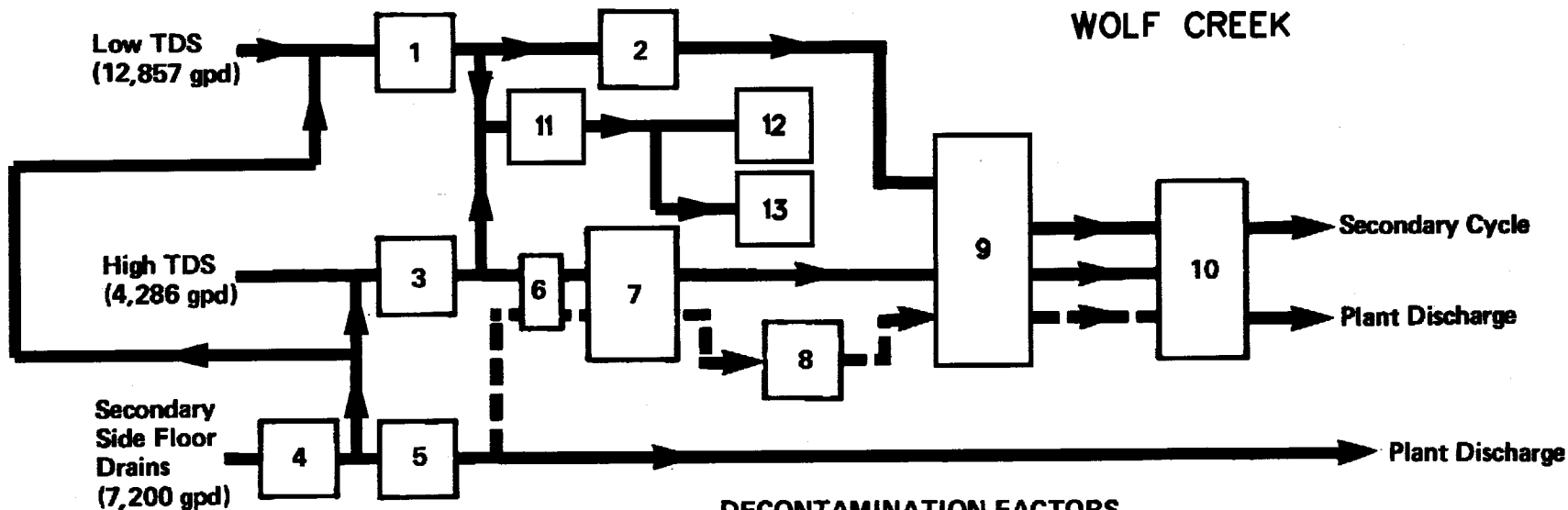
FIGURE 11.1A-2
SYSTEM DECONTAMINATION FACTORS
(SHEET 5)



DECONTAMINATION FACTORS

	<u>Iodine</u>	<u>Cesium & Rubidium</u>	<u>Other Nuclides</u>
1. Steam Generator Blowdown Flasketank	—	—	—
2. Steam Generator Blowdown Regenerative Heat Exchanger	—	—	—
3. S.G. Blowdown Nonregenerative Heat Exchanger	—	—	—
4. S.G. Blowdown Filters	1	1	1
5. S.G. Blowdown Demineralizer (each)	10^2	2	10^2
System DF	10^4	4	10^4

WOLF CREEK UPDATED SAFETY ANALYSIS REPORT
FIGURE 11.1A-2 (SHEET 6)
SYSTEM DECONTAMINATION FACTORS



DECONTAMINATION FACTORS

	<u>Iodine</u>	<u>Cesium & Rubidium</u>	<u>Other Nuclides</u>
1. Low TDS Collector Tank	—	—	—
2. Low TDS Filter	1	1	1
3. High TDS Collector Tank	—	—	—
4. Oil Interceptor	—	—	—
5. SLW Drain Collector Tank	—	—	—
6. SLW Filter	1	1	1
7. SLW Evaporator (available only for high TDS)	10 ³	10 ⁴	10 ⁴
8. SLW Charcoal Adsorber	—	—	—
9. SLW Demineralizer (C)	10(10 ²)	10(2)	10(10 ²)
10. SLW Monitor Tank (Low TDS)	—	—	—
System DF - High TDS	10 ⁴	10 ⁵	10 ⁵
Low TDS	10 ²	2	10 ²
11. SLW Radiation Monitor RE-95			
12. Wastewater Treatment Facility			
13. Lime Sludge Pond			

Secondary Liquid Waste System

Rev. 5

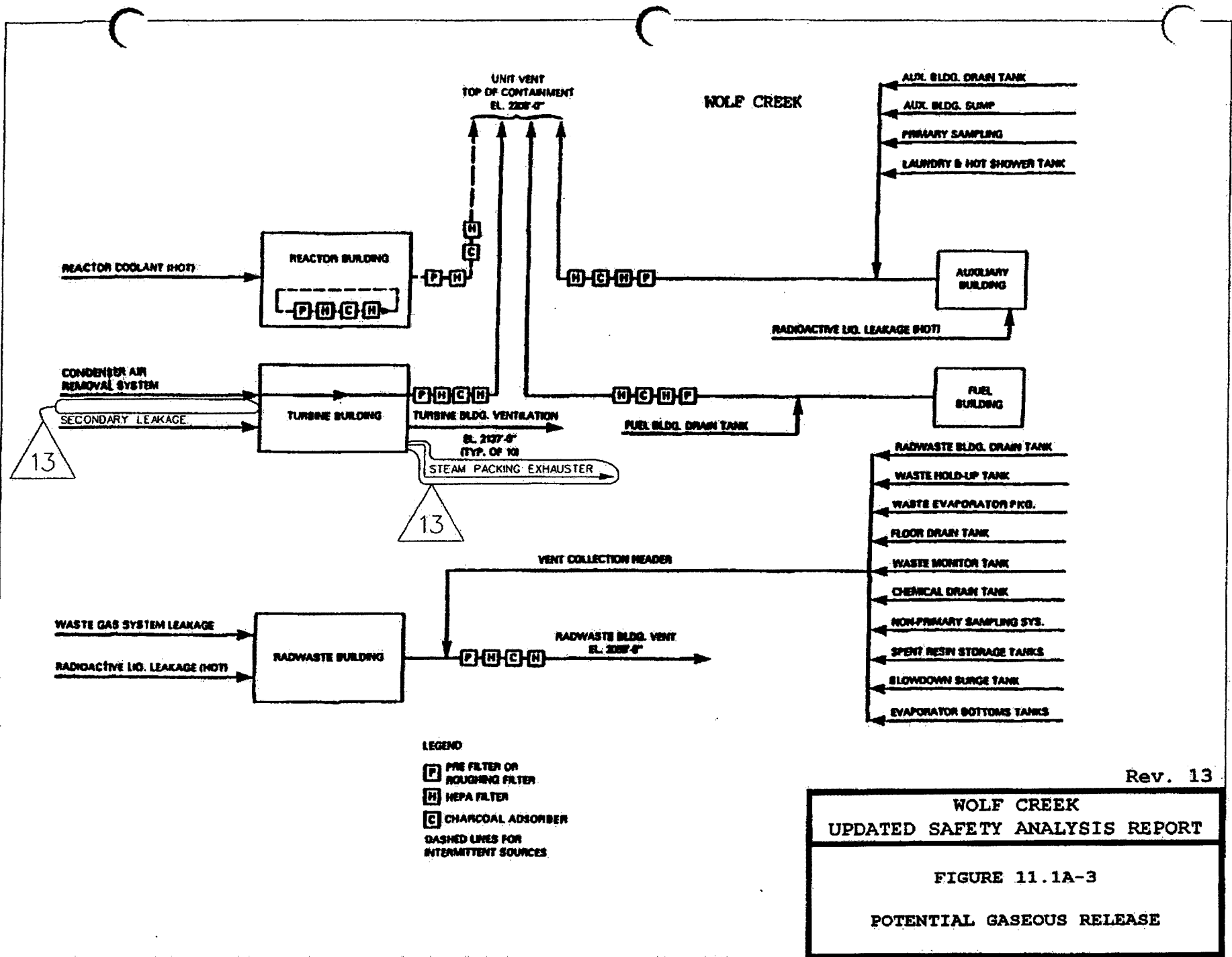
WOLF CREEK
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FIGURE 11.1A-2

SYSTEM DECONTAMINATION FACTORS

SHEET 7

- (a) Processing will be subject to chemistry requirements.
- (b) No credit is taken for collection and processing times.
- (c) Second number indicates Low TDS DF.



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11.2 LIQUID WASTE MANAGEMENT SYSTEMS

Several systems within the plant serve to control, collect, process, handle, store, recycle, and dispose of liquid radioactive waste generated as a result of normal plant operation, including anticipated operational occurrences. This section discusses the design and operating features and performance of the liquid radwaste system and the performance of other liquid waste management systems which are discussed in other sections.

11.2.1 DESIGN BASES

11.2.1.1 Safety Design Basis

Except for two containment penetrations and the component cooling water side of the reactor coolant drain tank heat exchanger, the liquid radwaste system (LRWS) is not a safety-related system.

SAFETY DESIGN BASIS ONE - The containment isolation valves in the LRWS are selected, tested, and located in accordance with the requirements of 10 CFR 50, Appendix A, GDC-56, and 10 CFR 50, Appendix J, Type C testing.

11.2.1.2 Power Generation Design Bases

POWER GENERATION DESIGN BASIS ONE - The LRWS, in conjunction with other liquid waste management systems, is designed to meet the requirements of the discharge concentration limits of 10 CFR 20 and the ALARA dose objective of 10 CFR 50, Appendix I.

POWER GENERATION DESIGN BASIS TWO - The LRWS uses design and fabrication codes consistent with quality group D (augmented), as assigned by Regulatory Guide 1.143, for radioactive waste management systems.

POWER GENERATION DESIGN BASIS THREE - Liquid effluent discharge paths are monitored for radioactivity and isolated upon detection of unacceptable radioactivity.

11.2.2 SYSTEM DESCRIPTION

11.2.2.1 General Description

This section describes the design and operating features of the LRWS. The performance of the LRWS, in conjunction with other liquid waste management systems, is discussed in Section 11.2.3. Detailed descriptions of other liquid waste management systems are provided in the following sections:

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- a. Boron recycle 9.3.6
- b. Steam generator blowdown 10.4.8
- c. CVCS boron thermal regeneration and purification 9.3.4
- d. Secondary liquid waste 10.4.10

The piping and instrumentation diagram for the LRWS is shown in Figure 11.2-1.

The LRWS collects and processes radioactive or potentially radioactive waste water. The LRWS consists of two subsystems designated as drain channel A and drain channel B. Drain channel A is for processing water which could be recycled and drain channel B is for processing water which would normally be discharged. Equipment drains and waste streams are segregated to prevent the intermixing of the liquid wastes. Tritiated waters (CRW), potentially radioactive nontritiated waste (DRW), and detergent waste (SRW) are discussed in Section 9.3.3. A drain system is also provided inside the containment to collect drainage and leakage and transfer it to an appropriate tank.

Operating experience has shown that operating dose rates and overall release of radioactivity to the environment are minimized by not recycling tritiated water to the Reactor Makeup Water Storage Tank (RMWST). This method of operation eliminates the potential for contamination of secondary systems while degassing the Reactor Makeup Water System (BL) water in the Demineralized Water Makeup Storage and Transfer System (AN).

The various waste streams are processed as follows:

BORON RECYCLE SYSTEM - The bulk of the radioactive liquid discharged from the reactor coolant system is processed by the Boron Recycle System as described in Section 9.3.6. This water is transferred from a Recycle Holdup Tank to the LRWS for processing by the Liquid Radwaste Processing Skid as indicated in Figure 11.1A-2.

TRITIATED WASTES - These consist of reactor coolant which has been exposed to the atmosphere and has become aerated. This waste consists of equipment drains, leakoffs, and overflows from tritiated systems (e.g., CVCS and reactor coolant samples which have not been chemically contaminated). This waste is typically collected in the floor and equipment drain system, transferred to the waste holdup tank and processed in the Liquid Radwaste Processing skid prior to entering the waste evaporator condensate tank, waste monitor tanks or secondary liquid waste monitor tanks. The processed wastes are analyzed for chemical and radioactive content in the waste evaporator condensate tank, waste monitor tanks (WMTs) or secondary liquid waste monitor tanks prior to being discharged.

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HIGH LEVEL CHEMICAL WASTE - High level chemical waste consists of plant samples which have been chemically contaminated and decontamination solutions used in the decontamination tanks located in the hot machine shop. These wastes are collected in the chemical drain tank. The contents are received and sampled by chemistry to ensure that no highly contaminated chemical solutions are allowed to enter the floor drain system. This is done by analyzing for conductivity and PH. (If an abnormal parameter exists the contents are drained in small quantities to the floor drain system to allow for dilution).

The chemical drain tank contents are processed by draining its contents to the Floor Drain Tanks for dilution then processed by the LRPS.

CONTROLLED ACCESS AREA FLOOR DRAINAGE - Controlled access area floor drain wastes are miscellaneous liquid wastes collected by the floor drain system within the radiologically controlled areas of the plant. The controlled access areas are radiation zones B through E and include the containment, auxiliary building, fuel building, radwaste building, hot machine shop, and the access control areas of the control building.

Floor drainage consists of miscellaneous leakage from systems within the above areas. Generally, the amount of highly radioactive reactor coolant leakage into the drain system is very small. The bulk of the water originates as leakage from nonradioactive or slightly radioactive systems, such as the service water and component cooling water systems. In addition to system leakage, the floor drain systems collect decontamination water used for area washdowns, spent fuel cask decontamination, and laboratory equipment decontamination and rinses. Highly contaminated chemical solutions are not allowed to enter the floor drain system in large volumes, and, therefore, are directed to the chemical drain tank for processing. During maintenance, equipment drains from nontritiated systems are directed to the floor drain system. Large volumes of component cooling water are not drained to the floor drain system to prevent contamination of the LRWS by corrosion inhibitors.

The floor drain tanks are processed through the liquid radwaste demineralizer skid. The FDT may contain chemical contaminants, mild decontamination solutions, organics, etc. Filtration and ion exchange are capable of providing the required purity for environmental discharge. Relatively small volumes of exchange media are consumed in comparison to the volumes of solidified concentrates generated by evaporator bottoms processing. Since the processed water is not recycled, it is not necessary to deaerate for discharge to the environment.

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The liquid waste charcoal adsorber (LWCA) should be used only if the presence of organics is detected. If the waste in the FDT has a low level of dissolved solids, an activity of less than 10^{-5} mCi/cc, and the operator intends to discharge, the floor drain tank filter, liquid waste charcoal adsorber, waste evaporator condensate filter, and waste monitor tank demineralizer in series may be used to process the waste effectively. This method of processing can also be employed when abnormally large volumes of floor drain wastes are to be processed. When the effluent has not been processed, it should be directed to an aerated waste monitor tank.

A second floor drain tank is available to allow one tank to be isolated and sampled prior to feeding the processing system while the other tank is available to receive wastes. The second floor drain tank also provides greater system storage volumes which will minimize inventory problems by providing greater surge capacity during periods of abnormal waste generation or equipment outages.

When processing floor drain waste it is highly desirable to operate with a known influent quality to ensure optimum system performance. This is normally accomplished by isolating the floor drain tank to be processed and withdrawing a sample to determine its chemical properties. The operator selects the appropriate process equipment.

If the sample indicates relatively clean waste (less than 25 ppm TDS without organic or boric acid contamination), it can be effectively processed through the demineralizer train. Waste is processed with the Liquid Radwaste Processing Skid. With known influent chemistry, the optimum process can be selected.

LAUNDRY AND PERSONNEL DECONTAMINATION WASTE - Laundry waste is generated by the radioactive contamination of protective clothing and gear. The use of vendor provided laundry services is employed to process laundry waste. The hot shower in the access control area is used only for personnel decontamination; consequently, its use should be infrequent.

The washing machine water supplies have been disconnected and the washing machine hot water heater tank has been removed. Therefore, no laundry can be performed on site and no laundry water will be generated for processing through Radwaste Systems.

Wolf Creek

The waste from personnel decontamination is collected in the chemical and detergent waste system's detergent drain tank and then transferred to the laundry and hot shower tank. Also, they may be transferred to the monitor tanks for discharge. Suspended solids are removed by strainers and filters located at the beginning of the processing train. The Laundry and Hot Shower Tank (LHST) contents are normally not reprocessed due to the small amount of water that would be recycled. The system generates low volumes due to contaminated laundry being processed offsite through vender services.

All tanks which contain or may contain concentrations of radioactivity have provisions to prevent the uncontrolled release of the fluid. Table 11.2-2 indicates the provisions made for each tank.

The system is designed to handle the occurrence of equipment faults of moderate frequency such as:

a. Malfunction in the LWPS

Malfunction in this system could include such things as pump or valve failures or evaporator failure. Because of pump standardization throughout the system, a spare pump can be used to replace most pumps in the system. There is sufficient surge capacity in the system to accommodate waste until the failures can be fixed and normal plant operation resumed.

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b. Excessive leakage in reactor coolant system equipment

The system is designed to handle a 1-gpm reactor coolant leak in addition to the expected leakage of 50 lb/day (Ref. 1) during normal operation, which is discussed in Section 5.2.5. Operation of the system is almost the same for normal operation, except that the load on the system is increased. A 1-gpm leak into the reactor coolant drain tank is handled automatically. If the 1-gpm leak enters the waste holdup tank, operation is the same as normal, except for the increased load on the system. Abnormal liquid volumes of reactor coolant resulting from excessive reactor coolant or auxiliary building equipment leakage (in excess of 1 gpm) can also be accommodated by the floor drain tank and processed by the LWPS.

c. Excessive leakage in the auxiliary system equipment

Leakage of this type could include water from steam side leaks and fan cooler leaks inside the containment which are collected in the containment sump and sent to the floor drain tank. Other sources could be component cooling water leaks, service water leaks, and secondary side leaks. This water enters the floor drain tank and is processed and discharged as during normal operation.

11.2.2.2 Component Description

Codes and standards applicable to the LRWS are listed in Tables 3.2-1 and 11.2-1. The LRWS is designed and constructed in accordance with quality group D (augmented). The LRWS is housed within a seismically designed building. Regulatory Guide 1.143 is complied with to the extent specified in Table 3.2-5.

REACTOR COOLANT DRAIN TANK PUMPS - Due to the relative inaccessability of the containment and the loop drain requirements, two pumps are provided. One pump provides sufficient flow for normal tank operation with one pump for standby.

WASTE EVAPORATOR FEED PUMP - One standard pump is used. The waste evaporator feed pump supplies feed to the evaporator and the liquid radwaste demineralizer skid (LRDS). The pump is shut off when low level is reached in the waste holdup tank.

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WASTE EVAPORATOR CONDENSATE TANK PUMP - The waste evaporator condensate tank pump is a transfer pump. One standard pump is used to transfer the contents of the waste condensate tank to the reactor makeup water storage tank or the boron recycle system holdup tanks.

CHEMICAL DRAIN TANK PUMP - One standard pump is used to recirculate the liquid back to the chemical drain tank for mixing prior to sampling.

LAUNDRY AND HOT SHOWER TANK PUMP - One standard pump is used to transfer the water to the waste monitor tank.

FLOOR DRAIN TANK PUMPS - Two standard pumps are available to transfer the contents of the floor drain tanks to the waste monitor tank. The pumps are cross-connected to the pump from either floor drain tank. The pumps can also be used to supply the LRDS.

WASTE MONITOR TANK PUMPS - One standard pump is to be used for each tank to discharge water from the plant site or for recycle if further processing is required. The pump may also be used for circulating the water in the waste monitor tank in order to obtain uniform tank contents and hence a representative sample before discharge. The pump can be throttled to achieve the desired discharge rate.

REACTOR COOLANT DRAIN TANK HEAT EXCHANGER - The reactor coolant drain tank heat exchanger is a U-tube type with one shell pass and four tube passes. Although the heat exchanger is normally used in conjunction with the reactor coolant drain tank, it can also cool the pressurizer relief tank from 200 to 120°F in less than 8 hours.

REACTOR COOLANT DRAIN TANK - One tank is provided to collect leakoff type drains inside the containment at a central collection point for further disposition through a single penetration via the reactor coolant drain tank pumps.

Only water which can be directed to the recycle holdup tanks enters the reactor coolant drain tank. The tank is provided with a hydrogen or nitrogen cover gas. The water must be compatible with reactor coolant.

Sources of water entering the reactor coolant drain tank include the reactor vessel flange leakoff, reactor coolant pump number two seal leakoffs, and the excess letdown heat exchanger flow. No continuous leakage is expected from the reactor vessel flange during operation.

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The tank maintains a constant level to minimize the amount of gas sent to the gaseous waste processing system and also to minimize the amount of hydrogen or nitrogen required. The level is maintained by using a proportional control valve in the discharge line. This valve operates, on a signal from a level controller, to maintain a constant level by discharging normally to the recycle system. The remainder of the flow is recirculated to the tank.

WASTE HOLDUP TANK - One atmospheric pressure tank is provided outside the containment to collect equipment drainage, pump seal leakoffs, recycle holdup tank overflows, and other water from tritiated, aerated sources.

WASTE EVAPORATOR CONDENSATE TANK - One tank with a diaphragm to exclude air is provided to collect condensate from the waste evaporator or demineralized water from the LRDS.

CHEMICAL DRAIN TANK - One tank is provided to collect chemically contaminated tritiated water from the laboratories.

LAUNDRY AND HOT SHOWER TANK - One atmospheric pressure tank is used to collect laundry and hot shower drainage.

FLOOR DRAIN TANKS - Two atmospheric pressure tanks are used to collect floor drainage from the reactor plant operations.

WASTE MONITOR TANKS - The two atmospheric waste monitor tanks are provided for monitoring liquid discharges from the plant site. Each tank is sized to hold a volume large enough such that sampling requirements are minimized, thus minimizing laboratory effluent.

WASTE EVAPORATOR REAGENT TANK - One tank is used for adding chemicals to the plant for such things as cleaning of the waste evaporator tubes.

WASTE EVAPORATOR CONDENSATE DEMINERALIZER - One mixed bed demineralizer with nonregenerative hydrogen-hydroxide resin is provided to remove ionic contaminants from the waste condensate.

WASTE MONITOR TANK DEMINERALIZER - One mixed bed demineralizer with nonregenerative hydrogen-hydroxide resin is provided to remove trace contaminants from the water in the floor drain tank.

FILTERS - The filters provided are of a disposable-type cartridge.

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The methods employed to change filters and screens are dependent on activity levels. Filters are valved out of service, drained to the appropriate tank, and vented locally. If the radiation level of the filter is low enough, it is changed manually. Filter handling is discussed in Section 11.4.

STRAINERS - Strainers are provided in the discharge of the laundry and hot shower pump and the floor drain tank pumps to remove large particulate matter and thus prevent clogging of the downstream lines and filters.

WASTE EVAPORATOR - The waste evaporator is abandoned in place.

LIQUID RADWASTE PROCESSING SKID (LRPS)- The LRPS consists of a vendor supplied skid containing a chemical injection system, filtration unit and a series of demineralizer vessels. Based on the chemical and/or isotopic analysis of the waste stream, the processing skid may use every component available, or bypass those components not needed. The processes include filtration, reverse osmosis, and/or demineralization. Filtration removes large complex radioactive isotopes not easily removed by ion exchange from plant radioactive wastewater. Reverse osmosis only allows water and selected ions to pass through a membrane. Demineralization provides filtration and selective ion exchange. Following filtration, the radioactive contaminants or other solids left in solution are removed by reverse osmosis or demineralization.

11.2.2.3 System Operation

The LRWS operation is manually initiated, except for some functions of the reactor coolant drain subsystem. The system includes adequate control equipment to protect the system components and instrumentation and alarm functions to provide operator information to ensure proper system operation. All pumps in the system have low level shutoffs, and all filters, strainers, and demineralizers have differential pressure indication to indicate fouling.

Operation of the LRWS is essentially the same during all phases of normal reactor plant operation; the only differences are in the load on the system. The following sections discuss the operation of the system in performing its various functions. In this discussion, the term "normal operation" should be taken to mean all phases of operation, except operation under emergency or accident conditions. The LRWS is not regarded as a safety-related system.

REACTOR COOLANT DRAIN TANK SUBSYSTEM OPERATION - Normal operation of the reactor coolant drain subsystem is automatic and requires no operator action. The system can be put in the manual mode, if desired. The leakage rate of reactor coolant pump No. 2 seal leakoffs, reactor vessel flange leakoffs, and discharges from the excess letdown heat exchanger into the reactor coolant drain tank (RCDT) can be estimated by putting the system

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in the manual mode, stopping operation of the reactor coolant drain tank pump, and watching the rate of level change. The reactor coolant drain tank pump normally discharges to the boron recycle system. These drains can also be processed in the waste holdup tank. The level in the RCDT is maintained by running one RCDT pump continuously and using a proportional control valve (LCV-1003) in the discharge line. This valve operates on a signal from the RCDT level controller to limit the flow out of the subsystem. The remainder of the flow is recirculated to the RCDT. The RCDT heat exchanger is sized to maintain the RCDT contents at or below 170°F, assuming an in-leakage of 10 gpm at 600°F.

A venting system is provided to prevent wide pressure variations in the RCDT. Hydrogen or nitrogen cover gas is supplied from the service gas system and is automatically maintained between 2 and 6 psig by pressure-regulating valves. PCV-7155 maintains a minimum tank pressure by admitting hydrogen or nitrogen, while PCV-7152 maintains maximum tank pressure by venting the RCDT to the gaseous radwaste system. The hydrogen is supplied from no more than two 194 SCF bottles, to limit the amount of hydrogen gas which might be accidentally released to the containment atmosphere. The RCDT vents to the gaseous radwaste system to limit any releases of radioactive gases.

The reactor coolant drain subsystem may also be used in the pressurizer relief tank (PRT) cooling mode of operation. In this mode, the level control valve in the discharge line to the recycle evaporator feed demineralizers (LCV-1003), the isolation valve at the discharge of the reactor coolant drain tank (HV-7127) and the isolation valve in the reactor coolant drain tank recirculation line (HV-7144) are all closed. The PRT contents are circulated through the reactor coolant drain tank heat exchanger, via valve BB-HV-8031 and the reactor coolant drain tank pumps, prior to returning to the PRT via valve BB-HV-7141. In this mode of operation, the RCDT heat exchanger is capable of cooling the PRT contents from 200°F to 120°F in less than 8 hours. As an alternative to returning the cooled fluid to the PRT, the fluid may be directly transferred to the recycle holdup tanks in the boron recycle system. In any and all cases of PRT cooling, the PRT is vented to less than 50 psig to prevent overpressurization of the RCDT subsystem.

The reactor coolant drain subsystem may be used to drain the reactor coolant loops by first venting the reactor coolant system, then connecting the spool piece in the RCDT pump suction piping. The design objective of this mode of operation is to drain the RCS to the midpoint of the reactor vessel nozzles in less than 8 hours with both RCDT pumps running. In this mode, valve HV-7144 is

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closed and, in order to maximize flow capability, the RCDT discharge level control valve (LCV-1003) may be bypassed during RCS draining operations. If automatic RCDT level control is desired, then the flow path through LCV-1003 may be used.

The reactor coolant drain subsystem may be used to drain down portions of the refueling pool which cannot be drained by the residual heat removal pumps. In this mode of operation, the RCDT heat exchanger may be bypassed and the RCDT level control valve (LCV-1003) may be bypassed to maximize flow through the fuel pool cooling and cleanup system to the refueling water storage tank. An alternate drain line is provided from the refueling pool to the containment sump to route decontamination chemicals away from the RCDT subsystem and minimize the possibility of contaminating any systems downstream of the RCDT pumps.

DRAIN CHANNEL "A" SUBSYSTEM OPERATION - Waste is accumulated in the waste holdup tank until a sufficient quantity exists to warrant processing. The Waste Holdup Tank contents are normally processed for discharge by the Liquid Radwaste Processing Skid. Processed effluent is not returned to the RMWS. Demineralized LRWS effluent is discharged.

WASTE EVAPORATOR OPERATION - The waste evaporator is abandoned in place.

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DRAIN CHANNEL "B" SUBSYSTEM OPERATION - Normally, one floor drain tank is aligned to receive the discharge from the floor and equipment drain system, while the other tank is being used to supply waste to the processing system. This procedure allows the waste to be sampled and pH adjusted prior to processing to ensure optimum system performance.

If the waste in the floor drain tank has a low total dissolved solids content (<25 ppm), an activity of less than 10^{-5} mCi/cc, and does not contain significant organics, it may be processed using the liquid waste charcoal adsorber and waste monitor tank demineralizer in series, and directed to waste monitor tanks.

Any planned releases from the system must be weighted with all other unit radioactive liquid releases to ensure that the local releases do not exceed the ODCM limits at the boundary of the restricted area.

LAUNDRY SUBSYSTEM OPERATION - Laundry waste from the washing machines and waste from the personnel decontamination shower is directed by gravity drain to the detergent drain tank located in the basement of the control building. This waste is pumped to the LHST where it is sampled, prior to being processed. If discharge of the LHST contents is desired and the tank contents are found to be of acceptable quality for discharge, the fluid may be transferred to the Secondary Liquid Waste Monitor Tanks or Waste Monitor Tank "B" by way of the Laundry and Hot Shower Tank Basket Strainer and Filter.

The processed laundry water is stored in the laundry water storage tank. The laundry water is then pumped, on demand to the washing machines through the washing machine hot water heater to the laundry equipment in operation. Note that the hot water heater is provided with a bypass to allow a feed of relatively cold water to the laundry equipment. Laundry operation additives such as detergents and soaps are used sparingly to ensure laundry waste water is compatible with process paths. The use of vendor provided laundry services for contaminated laundry may also be employed. This helps prevent the spread of highly contaminated particles throughout the laundry water system.

The laundry water stored in the laundry water storage tank may also be directed to the LHST for reprocessing or to the waste monitor tank "B" or one of the secondary liquid waste monitor tanks. Any planned releases from this system must be weighed with all other radioactive liquid releases to ensure total releases do not exceed the ODCM limits at the boundary of the restricted area.

The LRWS is operated so that the waste discharges are segregated. Waste monitor tank "B" is normally aligned for laundry water while waste monitor tank "A" is normally aligned for demineralized floor drains. Laundry water is normally low radioactivity waste, and does not require treatment other than the removal of organics. Provision is made to demineralize the laundry water, via the waste monitor tank demineralizer, prior to discharge, if necessary.

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Floor drain wastes are relatively dirty and may contain moderately high radioactivity. Treatment of floor drain wastes prior to discharge consists of options for Ozone Injection, Ultra Filtration, Reverse Osmosis and demineralization. These options are provided using the (ZERO) liquid waste processing components.

The chemical drain tank (CDT) receives chemically contaminated tritiated water from the plant sample stations, and chemically contaminated decontamination wastes. Contents of the tank are sampled as process initiation levels are reached then drained to the FDT subsystem to dilute any high conductivity prior to being processed by the liquid waste process system. A high level alarm is provided from the CDT for operator information.

11.2.3 RADIOACTIVE RELEASES

This section describes the estimated liquid release from the plant for normal operation and anticipated operational occurrences.

11.2.3.1 Sources

Section 11.1 and Appendix 11.1A provide the bases for determining the contained sources inventory and the normal releases.

A survey has been performed of liquid discharges from different Westinghouse pressurized water reactor plants. The results are presented in Table 11.2-17 of Reference 2. The data includes radionuclides released on an unidentified basis, and are all within the permissible concentration for the release of liquid containing all unidentified radionuclide mixtures.

11.2.3.2 Release points

Radioactive plant wastes are treated inside the power block, where the majority of radioactive material is concentrated for offsite disposal. Water containing small concentrations of radioactivity is discharged from the power block to the environment as plant effluent. The effluent normally discharges from the plant into the circulating water discharge piping, which dilutes the power block effluent and conveys it to the cooling lake. The point of discharge into the cooling lake for these effluents is at the circulating water discharge structure (See Figure 11.2-1). Three other potential discharge points to the cooling lake are directly from the lime sludge pond, the oily waste separator, and the Technical Support Center. The Technical Support Center decontamination shower would only be used by E-Plan personnel if access control and rad waste showers were unavailable. These three pathways have no dilution. Further discussion of concentrations of radioactivity in the cooling lake from normal operational releases is provided in Section 11.2.3.3. A discussion of concentrations of radioactivity in the cooling lake from accidental release of liquid effluents is discussed in Section 2.4.12.

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This low level radioactive liquid effluent is stored in the power block in the primary and secondary waste monitor tanks (two each, four total) and the steam generator blowdown surge tank. Each of these tanks feeds into the liquid radwaste discharge line, which is connected to the circulating water discharge piping (See Figure 11.2-2). Tank discharge is initiated manually in all cases.

The minimum flow of dilution water which conveys the power block radioactive effluent to the cooling lake is 5,000 gpm. In the event that the dilution flow is less than 5,000 gpm, release of radioactive power block effluent is prohibited and is terminated through automatic controls at a point inside the power block.

Circulating water pumps and service water pumps provide dilution to discharge from the power block. The release of radioactive effluent from the power block is automatically terminated when no Circulating Water Pumps are in service. Minimum dilution flow necessary for the discharge of radioactive effluents is established through administrative controls to ensure compliance with Federal discharge limits.

11.2.3.3 Dilution Factors

Liquid radioactive releases are normally diluted by cooling water with a flow rate of 1114 cfs and service water with a flow rate of 90 cfs for a total discharge of 1204 cfs. This is the normal dilution assumed for dose calculations to the maximum individual interacting with the cooling lake environment.

11.2.3.4 Estimated Doses

Preoperational estimates of doses from liquid effluents were shown to be in conformance with 10CFR50, Appendix I requirements. Actual dose from liquid effluents during plant operation are calculated using the approved methodology presented in the Offsite Dose Calculation Manual (ODCM). The ODCM describes the methods used for calculating concentration of radioactive material in the environment and the estimated potential offsite doses associated with liquid and gaseous effluents. The ODCM also specifies controls for release of liquid and gaseous effluents to ensure compliance with NRC regulations.

11.2.4 CALCULATIONAL BASIS FOR LIQUID SOURCE TERMS

The Wolf Creek Generating Station, Unit No. 1 uses the mixed bed demineralizer option shown in Item 5 of Figure 11.1A-2 (Sheet 2). The original GALE code input and annual liquid effluent releases are shown in Tables 11.2-10 and 11.2-11 respectively.

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11.2.5 SAFETY EVALUATION

Except for two associated containment penetrations and the CCW pressure boundary integrity at the reactor coolant drain tank, the LRWS is not a safety-related system.

SAFETY EVALUATION ONE - Sections 6.2.4 and 6.2.6 provide the safety evaluation for the system containment isolation arrangement and testability.

11.2.6 TESTS AND INSPECTION

Preoperational testing is discussed in Chapter 14.0.

The operability, performance, and structural and leaktight integrity of all system components are demonstrated by continuous operation.

11.2.7 INSTRUMENTATION DESIGN

The system instrumentation is described in Table 11.2-12 and shown on Figure 11.2-1.

The instrumentation readout is located mainly on the waste processing system panel in the radwaste building. Some instruments are read locally.

All alarms are shown separately on the waste processing system panel and further relayed to one common waste processing system annunciator on the main control board.

The waste processing system pumps are protected against loss of suction pressure by a control setpoint on the level instrumentation for the respective vessels feeding the pumps. The reactor coolant drain tank pumps and the spent resin sluice pump are, in addition, interlocked with flow rate instrumentation and stop operating when the delivery flows reach minimum setpoints.

Differential pressure indicators with local readout are provided for filters, strainers, and demineralizers.

11.2.8 REFERENCES

1. NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors" (PWR-GALE Code), NRC, April 1976, pg. 6-1.
2. "Appendix D to RESAR-3S, Liquid Waste Management System," WCAP 8665, March 1976.

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3. Attachment to Concluding Statement of Position of the Regulatory Staff. Public Rule-making Hearing on: Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Stations, USAEC, Docket No. RM-50-2, February 20, 1974.
4. Fletcher, J. F., and W. L. Dotson (compilers). HERMES-A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry, USAEC. Report HEDL-TME-71-168, Hanford Engineering Development Laboratory, 1971.
5. Final Environmental Statement Concerning Proposed Rule Making Action: Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as Practicable:" for Radioactive Material in Light-Water-Cooled, Nuclear Power Reactor Effluents, USAEC Report WASH-1258, Washington, D.C., July 1973.
6. Lyon, R. J., Shearin, R. L., 1976, EPA-520 Radionuclide Accumulation in a Reactor Cooling Lake: USEPA, Office of Radiation Programs.
7. Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I, Office of Standards Development.
8. Regulatory Guide 1.113, Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I, Office of Standards Development.
9. Simpson, D. B., McGill, B. L., 1980, NUREG/CR-1276 User's Manual for LADTAP II Computer Program: U.S.N.R.C. and Oak Ridge National Laboratory.

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TABLE 11.2-1

LIQUID WASTE PROCESSING SYSTEM EQUIPMENT
PRINCIPAL DESIGN PARAMETERS

Reactor Coolant Drain Tank Pumps

Number	2
Type	Horizontal centrifugal
Design pressure, psig	150
Design temperature, F	200
Design flow, gpm	
Point 1	100
Point 2	150
Design head, ft	
Point 1	260
Point 2	250
Material	Stainless steel
Design code	MS

Waste Evaporator Feed Pump

Number	1
Type	Canned centrifugal
Design pressure, psig	150
Design temperature, F	200
Design flow, gpm	
Point 1	35
Point 2	100
Design head, ft	
Point 1	250
Point 2	200

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TABLE 11.2-1 (Sheet 2)

Material	Stainless steel
Design code (1)	MS
<u>Waste Evaporator Condensate Pump</u>	
Number	1
Type	Canned centrifugal
Design pressure, psig	150
Design temperature, F	200
Design flow, gpm	
Point 1	35
Point 2	100
Design head, ft	
Point 1	250
Point 2	230
Material	Stainless steel
Design code	MS
<u>Chemical Drain Tank Pump</u>	
Number	1
Type	Canned centrifugal
Design pressure, psig	150
Design temperature, F	200
Design flow, gpm	
Point 1	35
Point 2	100
Design head, ft	
Point 1	250
Point 2	230

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TABLE 11.2-1 (Sheet 3)

Material	Stainless steel
Design code	MS
<u>Laundry and Hot Shower Tank Pump</u>	
Number	1
Type	Horizontal centrifugal
Design pressure, psig	150
Design temperature, F	200
Design flow, gpm	
Point 1	35
Point 2	100
Design head, ft	
Point 1	250
Point 2	230
Material	Stainless steel
Design code	MS
<u>Floor Drain Tank Pumps</u>	
Number	2
Type	Horizontal centrifugal
Design pressure, psig	150
Design temperature, F	200
Design flow, gpm	
Point 1	35
Point 2	100
Design head, ft	
Point 1	250
Point 2	230

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TABLE 11.2-1 (Sheet 4)

Material	Stainless steel
Design code	MS
<u>Waste Monitor Tank Pumps</u>	
Number	2
Type	Canned centrifugal
Design pressure, psig	150
Design temperature, F	200
Design flow, gpm	
Point 1	35
Point 2	100
Design head, ft	
Point 1	250
Point 2	230
Material	Stainless steel
Design code	MS
<u>Laundry Water Storage Tank Pump</u>	
Number	1
Type	Inline centrifugal
Design pressure, psig	150
Design temperature, F	200
Design flow, gpm	35
Design head, ft	81
Material	Stainless steel
Design code	MS

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TABLE 11.2-1 (Sheet 5)

Reactor Coolant Drain Tank Heat Exchanger

Number	1
Type	U-tube
Estimated UA, Btu/hr-F	70,000
Design flow, lb/hr	
Shell	112,000
Tube	44,600 (See *)
Temperature in, F	
Shell	105
Tube	180 (See *)
Temperature out, F	
Shell	125
Tube	130
Material	
Shell	Carbon steel
Tube	Stainless steel
Design code	
Shell side	ASME Section III
Tube side	ASME Section VIII

* At Operating temp. 170° F, Flow is 55,581 #/hr

Reactor Coolant Drain Tank

Number	1
Type	Horizontal
Usable volume, gal	350
Design pressure, psig*	100
Design temperature, F	250

*External design pressure is 60 psig.

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TABLE 11.2-1 (Sheet 6)

Material	Stainless steel
Design code (1)	ASME Section VIII
<u>Waste Holdup Tank</u>	
Number	1
Type	Vertical
Usable volume, gal	10,000
Design pressure	Atmospheric
Design temperature, F	200
Material	Stainless steel
Design code (1)	ASME Section VIII (no code stamp)
<u>Waste Evaporator Condensate Tank</u>	
Number	1
Type	Vertical
Usable volume, gal	5,000
Design pressure, psig	+0.433
Design temperature, F	200
Material	Stainless steel
Design code	ASME Section VIII (no code stamp)
<u>Chemical Drain Tank</u>	
Number	1
Type	Vertical
Usable volume, gal	600
Design pressure, psig	+0.5
Design temperature, F	200
Material	Stainless steel

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TABLE 11.2-1 (Sheet 7)

Design code	ASME Section VIII (no code stamp)
<u>Laundry and Hot Shower Tank</u>	
Number	1
Type	Vertical
Usable volume, gal	10,000
Design pressure, psig	+0.5
Design temperature, F	200
Material	Stainless steel
Design code	ASME Section VIII (no code stamp)
<u>Floor Drain Tanks</u>	
Number	2
Type	Vertical
Usable volume, gal	10,000
Design pressure, psig	+0.5
Design temperature, F	200
Material	Stainless steel
Design code	ASME Section VIII (no code stamp)
<u>Laundry Water Storage Tank</u>	
Number	1
Type	Vertical
Usable volume, gal	10,000
Design pressure	Atmospheric
Design temperature, F	200
Material	Stainless steel
Design code	ASME Section VIII (no code stamp)

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TABLE 11.2-1 (Sheet 8)

Waste Monitor Tanks

Number	2
Type	Vertical
Usable volume, gal	5,000
Design pressure, psig	+0.5
Design temperature, F	200
Material	Stainless steel
Design code	ASME Section VIII (no code stamp)

Waste Evaporator Reagent Tank

Number	1
Type	Vertical
Usable volume, gal	5
Design pressure, psig	150
Design temperature, F	200
Material	Stainless steel
Design code	ASME Section VIII

Waste Evaporator Condensate Demineralizer

Number	1
Type	Flushable
Design pressure, psig	300
Design temperature, F	250
Design flow, gpm	120
Resin volume, ft ³ max.	39
Material	Stainless steel
Design code (1)	ASME Section VIII

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TABLE 11.2-1 (Sheet 9)

Waste Monitor Tank Demineralizer

Number	1
Type	Flushable
Design pressure, psig	300
Design temperature, F	250
Design flow, gpm	120
Resin volume, ft ³ max.	39
Material	Stainless steel
Design code (1)	ASME Section VIII

Liquid Waste Charcoal Adsorber

Number	1
Type	Flushable
Design pressure, psig	150
Design temperature, F	200
Design flow rate, gpm	35
Charcoal volume, ft ³	42
Material	Stainless steel
Design code	ASME Section VIII

Laundry and Hot Shower Charcoal Adsorber

Number	1
Type	Flushable
Design pressure, psig	150
Design temperature, F	200
Design flow rate, (gpm) avg./max.	4/10
Charcoal volume, ft ³	10
Material	Stainless steel
Design code	ASME Section VIII

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TABLE 11.2-1 (Sheet 10)

Waste Evaporator Feed Filter

Number	1
Design pressure, psig	300
Design temperature, F	250
Design flow, gpm	250
P at design flow, unfouled, psi	5
Particle Retention	(see note 2 of Table 9.3-13)
Material	Stainless steel
Design code (1)	ASME Section VIII

Waste Evaporator Condensate Filter (FHB10) *

Number	1
Design pressure, psig	300
Design temperature, F	250
Design flow, gpm	250
P at design flow, unfouled, psi	5
Particle retention	(See Note 2 of Table 9.3-13)
Material	Stainless steel
Design code (1)	ASME Section VIII

Laundry and Hot Shower Tank Filter (FHB07) *

Number	1
Design pressure, psig	300
Design temperature, F	250
Design flow, gpm	250
P at design flow, unfouled, psi	5
Particle retention	(See Note 2 of Table 9.3-13)

*See comments on Sheet 2 of Table 9.3-13.

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TABLE 11.2-1 (Sheet 11)

Material	Stainless steel
Design code (1)	ASME Section VIII
<u>Waste Monitor Tank Filter</u> (FHB08) *	
Number	1
Design pressure, psig	300
Design temperature, F	250
Design flow, gpm	250
ΔP at design flow, unfouled, psi	5
Particle retention	(See Note 2 of Table 9.3-13)
Material	Stainless steel
Design code (1)	ASME Section VIII
<u>Floor Drain Tank Filter</u> (FHB06) *	
Number	1
Design pressure, psig	300
Design temperature, F	250
Design flow, gpm	250
ΔP at design flow, unfouled, psi	5
Particle retention	(See Note 2 of Table 9.3-13)
Material	Stainless steel
Design code (1)	ASME Section VIII

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TABLE 11.2-1 (Sheet 12)

Liquid Radwaste Demineralizer Skid

Number	1
Design flow rate, gpm Nominal	50
Design pressure, PSIG Maximum	150
Design temperature, F Maximum	150
Material	MS
Design code	ASME Section VIII

Laundry and Hot Shower Tank Strainer

Number	1
Design pressure, psig	150
Design temperature, F	200
Design flow, gpm	35
ΔP at design flow, unfouled, psi	0.2
Basket perforation size, inch	1/16
Material	Stainless steel
Design code	ASME Section VIII

Floor Drain Tank Strainer

Number	1
Design pressure, psig	150
Design temperature, F	200
Design flow, gpm	35
ΔP at design flow, unfouled, psi	0.2
Basket perforation size, inch	1/16
Material	Stainless steel
Design code	ASME Section VIII

WOLF CREEK

TABLE 11.2-1 (Sheet 13)

Waste Evaporator (2)

Number	1
Steam design pressure, psig	50
Design feed flow, gpm	15
Feed concentration, boron, ppm	10-2,500
Bottoms concentration, boron, ppm	7,200-21,000
Material (for concentrates)	Incoloy 825 (or equivalent)
Design code	ASME Section VIII/TEMA C

- (1) Table indicates that the required code is based on its safety-related importance as dictated by service and functional requirements and by the consequences of their failure. Note that the equipment may be supplied to a higher principal construction code than required.
- (2) Equipment is abandoned in place.

WOLF CREEK

TABLE 11.2-2

TANK UNCONTROLLED RELEASE PROTECTION PROVISIONS

I. Tanks Outside Plant Buildings	REF: Figure 1.2-1	Grade Elevation: 2000'-0"			
<u>Tanks</u>	<u>Elevation</u>	<u>Overflow Control</u>	<u>Level Indicator, High Alarms, Low Alarms, Etc.</u>	<u>Remarks</u>	
1. Condensate storage tank	2000'-0"	Overflows to waste holdup tank	Level indicator and high level alarm are provided in control room. Level is indicated in auxiliary shutdown panel. Refer to Figure 9.2-12.		
2. Refueling water storage tank	2000'-0"	Overflows to waste holdup tank	Low and high level alarms provided. Refer to Figure 6.3-1. Level indicator also provided.		
3. Reactor makeup water storage tank	2000'-0"	Overflows to waste holdup tank	Low and high level alarms provided in control room. Refer to Figure 9.2-13. Level indicator also provided.		
II. Tanks Inside the Radwaste Building					
REF: Figures 1.2-2 through 1.2-8					
1. Recycle holdup tanks (2)	1976'-0"	Overflows to rad. bldg. drain sump, from there pumped to the floor drain sump	Low and high level alarms on radwaste panel located in radwaste building. Refer to Figure 9.3-11. Level indicator also provided.	Located in watertight compartment below grade	
2. Waste gas decay tanks (8)	1976'-0"	None	None.		
3. Evaporator bottoms tanks (2)	1976'-0" 2000'-0"	Overflows to chemical drain tank	Low and high level alarms provided in control room. Refer to Figure 11.4-1. Level indicator also provided.	Curb provided	
4. Spent resin storage tanks (2)	2000'-0"	None	Low and high level alarms provided on radwaste panel in the radwaste building. Refer to Figure 11.4-1. Level indicator also provided.	Curb provided	
5. Chemical drain tank	1976'-0"	Overflows to rad. bldg. drain sump; from there to floor drain tank	Low and high level alarms provided on radwaste panel. Refer to Figure 11.2-1. Level indicator also provided.		
6. Waste evaporator cond. tank	1976'-0"	Overflows to rad. bldg. equipment drain tank	Low and high level alarms provided on radwaste panel. Refer to Figure 11.2-1. Level indicator also provided.		

WOLF CREEK

TABLE 11.2-2 (Sheet 2)

<u>Tanks</u>	<u>Elevation</u>	<u>Overflow Control</u>	<u>Level Indicator, High Alarms, Low Alarms, Etc.</u>
7. Waste holdup tank	1976'-0"	Overflows to rad. bldg drain sump.. then pumped to floor drain tank	Low and high level alarms provided on rad waste panel Refer to Figure 11.2-1. Level indicator also provided.
8. Floor drain tank (2)	1976'-0"	Overflows to rad. bldg. drain sump; from there to the tank itself	Low and high level alarms provided on rad-waste panel. Refer to Figure 11.2-1. Level indicator also provided.
9. S.G. blowdown surge tank	1976'-0"	Overflows to rad. bldg. drain sump; from there to floor drain tank	Low level pump shut-off and high level blow-down isolation provided. Refer to Figure 10.4-8. Level indicator also provided.
10. Solid radwaste disposal station (HIC)	2000'-0"	Overflows to drain trench	Level indication provided.
11. Waste monitor tanks (2)	2000'-0"	Overflows to rad. bldg. drain sump; from there to floor drain tank	Low and high level alarms provided on radwaste panel. Refer to Figure 11.2-1. Level indicator also provided.
12. Recycle evaporator	2000'-0"	None	Evaporator package shown in Figure 9.3-11 has been permanently removed from service. (Abandoned in place)
13. Waste evaporator	2000'-0"	None	Evaporator package shown in Figure 11.2-1. (Abandoned in place)
14. Laundry and hot shower tank	2031'-6"	Overflows to floor and equip. drain sump; then to floor drain tank	Low and high level alarms provided. Level indicator also provided. Refer to Figure 11.2-1.

WOLF CREEK

TABLE 11.2-2 (Sheet 3)

<u>Tanks</u>	<u>Elevation</u>	<u>Overflow Control</u>	<u>Level Indicator, High Alarms, Low Alarms, Etc.</u>	<u>Remarks</u>
III. Tanks Inside the Auxiliary Building				
REF: Figures 1.2-9 through 1.2-18				
1. Boric acid tanks (2)	1974'-0"	Overflows to aux. bldg. equip. drain tank	Low and high level alarms provided. Refer to Figure 9.3-8. Level indicator also provided.	
2. Boron injection tank	1974'-0"	None	No level alarms or level indicator provided. Refer to Figure 6.3-1.	
3. Deleted				
4. Equipment drain sumps (2)	1974'-0"	None	Low and high level alarms provided in control room. Refer to Figure 9.3-5. No level indicator provided.	
5. Volume control tank	2000'-0"	Relief valve discharge to recycle hold-up tank	Low and high level alarms provided. Refer to Figure 9.3-8. Level indicator also provided.	
6. Boric acid batching tank	2026'-0"	Overflows to aux. bldg. equip. drain tank	Low level alarm provided locally. Refer to Figure 9.3-8. Level indicator also provided.	
7. Chemical addition tank (chemical mixing tank)	2026'-0"	None	No alarms or level indicator provided. Refer to Figure 9.3-8. Tank filled locally by operating personnel.	
IV. Tanks Inside Reactor Building				
REF: Figure 1.2-11				
1. Reactor coolant drain tank	2000'-0"	None	Low and high level alarms provided. Refer to Figure 11.2-1. Level indicator also provided.	
2. Pressurizer relief tank	2000'-0"	None	Low and high level alarms provided in control room. Refer to Figure 11.2-1. Level indicator also provided.	

WOLF CREEK

TABLE 11.2-3
(Historical Information)

CALCULATED LIQUID EFFLUENT
DISCHARGE CONCENTRATIONS
FROM ROUTINE OPERATION

Isotope ^a	Release Ci/yr	pCi/l			
		Circulating Water ^b	Cooling Lake ^c	LeRoy ^d	
1H	3	4.10+002	2.38+004	2.34+004	7.38E+002
24CR	51	9.00-005	1.62-004	7.83-005	2.47E-006
25MN	54	1.20-004	1.22-003	1.11-003	3.50E-005
26FE	55	9.00-005	2.39-003	2.30-003	7.26E-005
26FE	59	5.00-005	1.17-004	7.02-005	2.22E-006
27CO	58	1.30-003	4.09-003	2.88-003	9.09E-005
27CO	60	9.80-004	4.07-002	3.98-002	1.26E-003
35BR	83	3.00-005	2.79-005	9.40-008	2.97E-009
42MO	99	1.80-003	1.84-003	1.67-004	5.27E-006
43TC	99M	1.70-003	1.60-003	1.33-005	4.20E-007
52TE	129M	7.00-005	1.39-004	7.42-005	2.34E-006
53I	131	9.50-002	1.12-001	2.40-002	7.57E-004
52TE	132	6.10-004	6.30-004	6.19-005	1.95E-006
53I	132	1.70-003	1.58-003	5.11-006	1.61E-007
53I	133	3.00-002	2.87-002	8.23-004	2.60E-005
55CS	134	8.10-003	1.79-001	1.71-001	5.40E-003
53I	135	5.20-003	4.89-003	4.55-005	1.44E-006
55CS	136	2.10-003	2.81-003	8.54-004	2.70E-005
55CS	137	7.30-003	5.03-001	4.96-001	1.57E-002
40ZR	95	1.40-004	4.14-004	2.84-004	8.96E-006
41NB	95	2.00-004	4.06-004	2.20-004	6.94E-006
37RB	86	2.00-005	3.03-005	1.17-005	3.69E-007
44RU	103	2.00-005	4.35-005	2.49-005	7.86E-007
44RU	106	2.40-004	2.90-003	2.68-003	8.46E-005
47AG	110M	4.00-005	3.46-004	3.09-004	9.75E-006
58CE	144	5.20-004	4.98-003	4.50-003	1.42E-004
38SR	89	2.00-005	5.12-005	3.26-005	1.03E-006
52TE	127M	1.00-005	4.32-005	3.39-005	1.07E-006
52TE	127	2.00-005	1.88-005	2.46-007	7.76E-009
52TE	129	5.00-005	4.65-005	7.49-008	2.36E-009
53I	130	1.00-004	9.49-005	1.63-006	5.14E-008
52TE	131M	3.00-005	2.90-005	1.18-006	3.72E-008
93NP	239	2.00-005	2.01-005	1.47-006	4.64E-008

^aM = Metastable

^bBased solely on dilution by the circulating water discharge and buildup of radionuclides over 40 year plant life.

^cBased on dilution by the circulating water discharge and buildup of radionuclides in the cooling lake over 40 year plant life.

^dConcentration of radionuclides at the LeRoy water works intake. Based on dilution by circulating water discharge and build-up of radionuclides in the cooling lake over 40 year plant life and additional dilution in the Neosho River.

WOLF CREEK

TABLE 11.2-4
(Historical Information)

BIOACCUMULATION FACTORS
(pCi/kg per pCi/liter)

<u>ELEMENT</u>	<u>FRESHWATER</u>		<u>SALTWATER</u>	
	<u>FISH</u>	<u>INVERTEBRATE</u>	<u>FISH</u>	<u>INVERTEBRATE</u>
H	9.0E-01	9.0E-01	9.0E-01	9.3E-01
C	4.6E 03	9.1E 03	1.8E 03	1.4E 03
NA	1.0E 02	2.0E 02	6.7E-02	1.9E-01
P	1.0E 05	2.0E 04	2.9E 04	3.0E 04
CR	2.0E 02	2.0E 03	4.0E 02	2.0E 03
MN	4.0E 02	9.0E 04	5.5E 02	4.0E 02
FE	1.0E 02	3.2E 03	3.0E 03	2.0E 04
CO	5.0E 01	2.0E 02	1.0E 02	1.0E 03
NI	1.0E 02	1.0E 02	1.0E 02	2.5E 02
CU	5.0E 01	4.0E 02	6.7E 02	1.7E 03
ZN	2.0E 03	1.0E 04	2.0E 03	5.0E 04
BR	4.2E 02	3.3E 02	1.5E-02	3.1E 00
RB	2.0E 03	1.0E 03	8.3E 00	1.7E 01
SR	3.0E 01	1.0E 02	2.0E 00	2.0E 01
Y	2.5E 01	1.0E 03	2.5E 01	1.0E 03
ZR	3.3E 00	6.7E 00	2.0E 02	8.0E 01
NB	3.0E 04	1.0E 02	3.0E 04	1.0E 02
MO	1.0E 01	1.0E 01	1.0E 01	1.0E 01
TC	1.5E 01	5.0E 00	1.0E 01	5.0E 01
RU	1.0E 01	3.0E 02	3.0E 00	1.0E 03
RH	1.0E 01	3.0E 02	1.0E 01	2.0E 03
TE	4.0E 02	6.1E 03	1.0E 01	1.0E 02
I	1.5E 01	5.0E 00	1.0E 01	5.0E 01
CS	2.0E 03	1.0E 03	4.0E 01	2.5E 01
BA	4.0E 00	2.0E 02	1.0E 01	1.0E 02
LA	2.5E 01	1.0E 03	2.5E 01	1.0E 03
CE	1.0E 00	1.0E 03	1.0E 01	6.0E 02
PR	2.5E 01	1.0E 03	2.5E 01	1.0E 03
ND	2.5E 01	1.0E 03	2.5E 01	1.0E 03
W	1.2E 03	1.0E 01	3.0E 01	3.0E 01
NP	1.0E 01	4.0E 02	1.0E 01	1.0E 01

*Regulatory Guide 1.109

WOLF CREEK

TABLE 11.2-5 (Sheet 1 of 4)
(Historical Information)

ASSUMPTIONS USED FOR ESTIMATING DOSES FROM LIQUID EFFLUENTS
AT THE WOLF CREEK GENERATING STATION SITE

The following assumptions and parameters were used in LADTAP II for estimating doses at the Wolf Creek Generating Station site from liquid effluents:

<u>PARAMETER</u>	<u>INDIVIDUAL</u>	<u>POPULATION</u>	<u>REFERENCE</u>
Cooling Lake volume,			
Normal	4.847E+009 ft ³	4.847E+009 ft ³	Sections 2.4.8.2 and
Pre-drought	4.649E+009 ft ³	4.649E+009 ft ³	2.4.11.3
Low-drought	4.451E+009 ft ³	4.451E+009 ft ³	
Seepage	3.5 ft ³ /sec	3.5 ft ³ /sec	Page 2.4-43
Blowdown Discharge			Sargent & Lundy
Normal-post drought	40.0 ft ³ /sec	40.0 ft ³ /sec	Report SL-3204 Revised
Pre-drought	3.5 ft ³ /sec	3.5 ft ³ /sec	March 26, 1976, on
Drought	0.0 ft ³ /sec	0.0 ft ³ /sec	Cooling Lake Operation pgs. 10, 11, 13, 14 & 15
Avg. Neosho River flow rate	1335 ft ³ /sec	1335 ft ³ /sec	WCGS-ER (OLS) 5.1.2.2 page 5.1-3
Dilution at Le Roy	31.69	31.69	
Population at Le Roy	--	624	1980 Census from Coffey County Clerk Telephone Call Record 4/17/81
Population - 50 mile 2000	--	1980 168,130 184,470	Table 2.1-3

WOLF CREEK

TABLE 11.2-5 (Sheet 2 of 4)
(Historical Information)

<u>PARAMETER</u>	<u>INDIVIDUAL</u>	<u>POPULATION</u>	<u>REFERENCE</u>
Circulating water discharge flow rate	1204 cfs	1204 cfs	WCGS-ER (OLS) Section 3.3 page 3.3-1
Circulating Water and Service Water			
Shore width factor, Cooling Lake	.3	.3	Reg. Guide 1.109 p. 15 Table A-2
Shore width factor, Neosho River	.2	.2	Reg. Guide 1.109 p. 15 Table A-2
Drinking Water			Reg. Guide 1.109 pgs. 39 & 40, Tables E-4, E-5
Adult	730 1/yr	370 1/yr	
Teen	510 1/yr	370 1/yr	
Child	510 1/yr	370 1/yr	
Infant	330 1/yr	370 1/yr	
Fish Consumption			Reg. Guide 1.109 Pgs. 39 & 40, Tables E-4 & E-5
Adult	21 Kg/yr	6.9 Kg/yr	
Teen	16 Kg/yr	5.2 Kg/yr	
Child	6.9 Kg/yr	2.2 Kg/yr	
Infant	0.0 Kg/yr	0.0 Kg/yr	
Invertebrate Consumption	Reg. Guide 1.109		
Adult	5 Kg/yr	1.0 Kg/yr	
Teen	3.8 Kg/yr	.75 Kg/yr	
Child	1.7 Kg/yr	.33 Kg/yr	
Infant	0.0 Kg/yr	0.0 Kg/yr	
Shoreline Exposure	Reg. Guide 1.109		
Adult	12 hr/yr	8.3 hr/yr	
Teen	67 hr/yr	47 hr/yr	
Child	14 hr/yr	9.5 hr/yr	

WOLF CREEK

TABLE 11.2-5 (Sheet 3 of 4)
(Historical Information)

<u>PARAMETER</u>	<u>INDIVIDUAL</u>	<u>POPULATION</u>	<u>REFERENCE</u>
Swimming	hrs per person		
Adult	7.8 hr/yr	3.42 hr/yr	HERMES Pgs. 144 & 145, Tables III-31 & 32
Teen	45.0 hr/yr	19.2 hr/yr	
Child	28.2 hr/y	12.0 hr/yr	
Boating	hrs per person		
Adult	52.2 hr/yr	29 hr/yr	HERMES Pgs. 144 & 145, Tables III-31 & 32
Teen	52.2 hr/yr	29 hr/yr	
Child	29.0 hr/yr	16.53 hr/yr	
Hold up time	hrs	hrs	Inherent to program
Water	12	24	Reg. Guide 1.109 P. 69
Fish	24	168	Pgs. 12 & 69
Invertebrate	24	168	Pgs. 12 & 69
Shoreline exposure	0	0	P. 69
Swimming	0	0	P. 69
Boating	0	0	P. 69
<u>POPULATION</u>			
Fraction of Population Inherent to program			
Adult	71%		
Teen	11%		
Child	18%		
Le Roy Population - 1980	50 Mile Population - 1980		Reference calculated from Le Roy - 1980
Adult	443	Adult 119,372	
Teen	69	18,494	Census from Coffey
Child	112	Child 30,263	County Clerk. 50 Mile -
Total	624	68,130	Table 2.1-3

Sport Fish Harvest - Hazleton Lake Use Feasibility Study WCGS-ER(OLS) Appendix 2A
Page 2A-8 Lake Capability 54,000 fishing trips annually 2 lbs per trip from lake.
Page 2A-4 18.4% of Kansas population are fishermen.

WOLF CREEK

TABLE 11.2-5 (Sheet 4 of 4)
(Historical Information)

Sport Fish Harvest 675 Kg/yr	48,990 Kg/yr	Fish Harvest	Site Specific
Sport Invertebrate Harvest 97.9 Kg/yr	26,350 Kg/yr	Invertebrate Harvest	Site Specific
<u>POPULATION</u>			
Le Roy Population - 1980	50 Mile Population - 1980		
Shoreline Recreation 7,984 hrs/yr	Shoreline Recreation 2,147,000 hrs/yr		Site Specific
4,184 hrs/yr	Swimming 1,126,500 hrs/yr		site Specific
Boating 16,700 hrs/yr	Boating 4,498,000 hrs/yr		site Specific
Nearest Downstream Water Intake Location - Le Roy			
Individual Intake .2678 gal/day	Population Intake 167 gal/day		Reg. Guide 1.109 Site Specific
Annual Liquid Release Source Terms			Table 11.1-2

WOLF CREEK

TABLE 11.2-6

(Historical Information)

ESTIMATED DOSE RATES TO MAXIMUM INDIVIDUALS RESIDING
IN THE TOWN OF LE ROY, FROM LIQUID EFFLUENTS

ADULT

MREM PER YEAR

<u>PATHWAY</u>	<u>SKIN</u>	<u>BONE</u>	<u>LIVER</u>	<u>TOTAL BODY</u>	<u>THYROID</u>	<u>KIDNEY</u>	<u>LUNG</u>	<u>GI-LLI</u>
Fish		6.64-002	1.07-001	7.57-002	1.89-003	3.66-002	1.31-002	3.59-003
Invertebrate		8.13-004	1.68-003	1.26-003	3.89-004	8.71-004	4.89-004	9.27-004
Drinking		1.16-003	5.83-002	5.78-002	5.75-002	5.71-002	5.67-002	5.66-002
Shoreline	8.11-005	6.95-005	6.95-005	6.95-005	6.95-005	6.95-005	6.95-005	6.95-005
Swimming	.00	2.97-007	2.97-007	2.97-007	2.97-007	2.97-007	2.97-007	2.97-007
Boating	.00	9.90-007	9.90-007	9.90-007	9.90-007	9.90-007	9.90-007	9.90-007
Total	8.11-005	6.84-002	1.67-001	1.35-001	5.99-002	9.47-002	7.04-002	6.12-002

TEENAGER

<u>PATHWAY</u>	<u>SKIN</u>	<u>BONE</u>	<u>LIVER</u>	<u>TOTAL BODY</u>	<u>THYROID</u>	<u>KIDNEY</u>	<u>LUNG</u>	<u>GI-LLI</u>
Fish		7.04-002	1.10-001	4.29-002	1.53-003	3.73-002	1.51-002	2.72-003
Invertebrate		8.61-004	1.64-003	7.88-004	3.06-004	8.07-004	4.35-004	6.86-004
Drinking		1.13-003	4.16-002	4.05-002	4.07-002	4.04-002	4.01-002	3.99-002
Shoreline	4.53-004	3.88-004	3.88-004	3.88-004	3.88-004	3.88-004	3.88-004	3.88-004
Swimming	.00	1.71-006	1.71-006	1.71-006	1.71-006	1.71-006	1.71-006	1.71-006
Boating	.00	9.90-007	9.90-007	9.90-007	9.90-007	9.90-007	9.90-007	9.90-007
Total	4.53-004	7.28-002	1.53-001	8.46-002	4.30-002	7.89-002	5.60-002	4.37-002

CHILD

<u>PATHWAY</u>	<u>SKIN</u>	<u>BONE</u>	<u>LIVER</u>	<u>TOTAL BODY</u>	<u>THYROID</u>	<u>KIDNEY</u>	<u>LUNG</u>	<u>GI-LLI</u>
Fish		8.79-002	9.70-002	1.69-002	1.34-003	3.18-002	1.20-002	1.55-003
Invertebrate		1.12-003	1.48-003	4.54-004	2.72-004	7.08-004	3.67-004	3.87-004
Drinking		3.26-003	7.99-002	7.69-002	7.84-002	7.75-002	7.67-002	7.64-002
Shoreline	9.46-005	8.10-005	8.10-005	8.10-005	8.10-005	8.10-005	8.10-005	8.10-005
Swimming	.00	1.07-006	1.07-006	1.07-006	1.07-006	1.07-006	1.07-006	1.07-006
Boating	.00	5.52-007	5.52-007	5.52-007	5.52-007	5.52-007	5.52-007	5.52-007
Total	9.46-005	9.24-002	1.78-001	9.44-002	8.01-002	1.10-001	8.92-002	7.84-002

INFANT¹

<u>PATHWAY</u>	<u>SKIN</u>	<u>BONE</u>	<u>LIVER</u>	<u>TOTAL BODY</u>	<u>THYROID</u>	<u>KIDNEY</u>	<u>LUNG</u>	<u>GI-LLI</u>
Fish		.00	.00	.00	.00	.00	.00	.00
Drinking	.00	3.37-003	7.93-002	7.53-002	7.83-002	7.61-002	7.54-002	7.50-002
Shoreline	.00	.00	.00	.00	.00	.00	.00	.00
Total	.00	3.37-003	7.93-002	7.53-002	7.83-002	7.61-002	7.54-002	7.50-002

(1) Assumes drinking water is the only liquid pathway an infant would receive exposure from.

WOLF CREEK

TABLE 11.2-7
(Historical Information)

ESTIMATED DOSE RATES TO MAXIMUM INDIVIDUALS FROM LIQUID EFFLUENT
CONCENTRATIONS AT THE CIRCULATING WATER DISCHARGE POINT²

		MREM PER YEAR							
ADULT	PATHWAY	SKIN	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
	Fish		2.15+000	3.46+000	2.46+000	1.12-001	1.19+000	4.26-001	1.19-001
	Invertebrate		2.73-002	5.53-002	4.12-002	1.71-002	3.35-002	1.58-002	5.11-002
	Drinking ¹		.00	.00	.00	.00	.00	.00	.00
	Shoreline	3.93-003	3.37-003	3.37-003	3.37-003	3.37-003	3.37-003	3.37-003	3.37-003
	Swimming	.00	1.05-005	1.05-005	1.05-005	1.05-005	1.05-005	1.05-005	1.05-005
	Boating	.00	3.50-005	3.50-005	3.50-005	3.50-005	3.50-005	3.50-005	3.50-005
	Total	3.93-003	2.18+000	3.52+000	2.51+000	1.32-001	1.22+000	4.45-001	1.74-001
TEENAGER									
ADULT	PATHWAY	SKIN	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
	Fish		2.28+000	3.56+000	1.39+000	9.67-002	1.21+000	4.89-001	9.00-002
	Invertebrate		2.89-002	5.39-002	2.60-002	1.42-002	3.17-002	1.40-002	3.71-002
	Drinking		.00	.00	.00	.00	.00	.00	.00
	Shoreline	2.20-002	1.88-002	1.88-002	1.88-002	1.88-002	1.88-002	1.88-002	1.88-002
	Swimming	.00	6.06-005	6.06-005	6.06-005	6.06-005	6.06-005	6.06-005	6.06-005
	Boating	.00	3.50-005	3.50-005	3.50-005	3.50-005	3.50-005	3.50-005	3.50-005
	Total	2.20-002	2.33+000	3.63+000	1.44+000	1.30-001	1.26+000	5.22-001	1.46-001
CHILD									
ADULT	PATHWAY	SKIN	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
	Fish		2.84+000	3.15+000	5.51-001	9.27-002	1.03+000	3.89-001	5.06-002
	Invertebrate		3.75-002	4.87-002	1.53-002	1.35-002	2.79-002	1.19-002	1.72-002
	Drinking		.00	.00	.00	.00	.00	.00	.00
	Shoreline	4.59-003	3.93-003	3.93-003	3.93-003	3.93-003	3.93-003	3.93-003	3.93-003
	Swimming	.00	3.77-005	3.77-005	3.77-005	3.77-005	3.77-005	3.77-005	3.77-005
	Boating	.00	1.95-005	1.95-005	1.95-005	1.95-005	1.95-005	1.95-005	1.95-005
	Total	4.59-003	2.88+000	3.20+000	5.70-001	1.10-001	1.06+000	4.05-001	7.18-002

1 Assumes the lake is not a source of drinking water.

2 Assumes an infant would not be exposed to the existing pathways.

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TABLE 11.2-8
(Historical Information)

ESTIMATED DOSE FROM LIQUID EFFLUENTS
TO POPULATION OF LEROY

	POPULATION DOSE (person-rem/yr)							
	<u>SKIN</u>	<u>BONE</u>	<u>LIVER</u>	<u>TOTAL BODY</u>	<u>THYROID</u>	<u>KIDNEY</u>	<u>LUNG</u>	<u>GI-LLI</u>
<u>INGESTION</u>								
Fish		2.60E-003	3.88E-003	2.28E-003	5.84E-005	1.32E-003	4.85E-004	1.15E-004
Invertebrate		1.95E-005	3.68E-005	2.38E-005	7.71E-006	1.84E-005	1.03E-005	1.70E-005
Drinking Water		4.85E-004	1.91E-002	1.88E-002	1.88E-002	1.87E-002	1.85E-002	1.85E-002
<u>EXTERNAL EXPOSURE</u>								
Shoreline	5.40E-005	4.62E-005	4.62E-005	4.62E-005	4.62E-005	4.62E-005	4.62E-005	4.62E-005
Swimming		1.59E-007	1.59E-007	1.59E-007	1.59E-007	1.59E-007	1.59E-007	1.59E-007
Boating		3.18E-007	3.18E-007	3.18E-007	3.18E-007	3.18E-007	3.18E-007	3.18E-007
Totals	5.40E-005	3.15E-003	2.31E-002	2.12E-002	1.89E-002	2.01E-002	1.90E-002	1.87E-002

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TABLE 11.2-9
(Historical Information)

APPENDIX I CONFORMANCE SUMMARY TABLE FOR LIQUID EFFLUENTS

<u>Type of Dose</u>	Design	Calculated	Point of Dose
Liquid Effluents	Objective ^a	Dose ^b	Evaluation
Dose to total body from all pathways	3 mrem/yr per site	2.51 mrem/yr ^b	Point of Discharge, Cooling Lake
Dose to any organ from all pathways	10 mrem/yr per site	3.63 mrem/yr ^c	Same as above

^aAppendix I design objectives from Sections II.A, II.B, II.C, and II. D (by Annex, RM50-2) of Appendix I, 10CFR Part 50; considers doses to maximum individual.

^bMaximum dose to an individual from all liquid pathways.

^cMaximum dose to a teen liver from all liquid pathways.

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TABLE 11.2-10
(Original Historical Information)

GALE CODE INPUT DATA

Parameters	PWR Value
Thermal power level (megawatts)	3565.000
Plant capacity factor	0.800
Mass of primary coolant (thousands lbs)	530.000
Percent fuel with cladding defects	0.120
Primary system letdown rate (gpm)	75.000
Letdown cation demineralizer flow (gpm)	7.500
Number of steam generators	4.000
Total steam flow (millions lbs/hr)	15.850
Mass of steam in each steam generator (thousands lbs)	8.000
Mass of liquid in each steam generator (thousands lbs)	104.000
Mass of water in steam generators (thousands lbs)	416.000
Total mass of secondary coolant (thousands lbs)	3570.000
Steam generator blowdown rate (thousands lbs/hr)	176.000
Primary to secondary leak rate (lbs/day)	100.000
Condensate demineralizer regeneration time (days)	17.500
Fission product carry-over fraction	0.001
Halogen carry-over fraction	0.010
Condensate demineralizer flow fraction	0.684
Radwaste dilution flow (thousands gpm)	5.000

Liquid Waste Inputs

Steam	Flow Rate (gal/day)	Fraction of PCA	Fraction Discharged	Collection Time (days)	Decay Time (days)	Decontamination Factors		
						I	CS	Others
Shim bleed rate	1.84E+03	1.000	.1	20.9	2.0	1.00E+04	2.00E+04	1.00E+05
Equipment drains	3.00E+02	1.000	.1	20.9	2.0	1.00E+04	2.00E+04	1.00E+05
Clean waste input	4.00E+02	.500	.1	10.0	.185	1.00E+04	1.00E+05	1.00E+05
Dirty waste input	1.14E+03	.058	1.0	7.0	.370	1.00E+04	1.00E+05	1.00E+05
S.G. blowdown	3.80E+05	(1)	.0	.0	.000	1.00E+03	1.00E+02	1.00E+03
Untreated blowdown	1.27E+05	(1)	1.0	.0	.000	1.00E+00	1.00E+00	1.00E+00
Regenerant solutions	1.71E+04	(1)	.0	.0	.350	1.33E+02	2.67E+02	1.33E+02

(1) Fraction of SCA internally calculated by GALE Code

Gaseous Waste Inputs

There is continuous low vol. purge of vol. control tk
 Holdup time for xenon (days) 9.0E+1
 Holdup time for krypton (days) 9.0E+1
 Fill time of decay tanks for the gas stripper (days) 0.0E+0

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TABLE 11.2-10 (Sheet 2)
(Original Historical Information)

Gas waste system: particulate release fraction	1.0E-2
Primary leakage to buildings outside containment (lb/day)	1.6E+2
Noncontainment: iodine release fraction	1.0E-1
Particulate release fraction	1.0E-2
Containment volume (million cu ft)	2.5E+0
Containment atmosphere cleanup rate (thousand cfm)	0.0E+0
Frequency of containment bldg. high vol. purge (times/yr.)	2.4E+1
Containment-shutdown purge iodine release fraction	1.0E-1
particulate release fraction	1.0E-2
Containment-normal purge rate (cfm)	4.0E+3
Containment-normal purge iodine release fraction	1.0E-1
particulate release fraction	1.0E-2
Steam leak to turbine bldg. (lbs/hr)	1.7E+3
Fraction iodine released from blowdown tank vent	0.0E+0
air ejector	3.0E-1
There is no cryogenic offgas system	3.0E-1

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TABLE 11.2-11
(Historical Information)
ANNUAL EFFLUENT RELEASES
LIQUID

Nuclide	Half-life (Days)	Coolant Concentrations		Boron RS (Curies)	Misc Wastes (Curies)	Secondary (Curies)	Turb Bldg (Curies)	Total LWS (Curies)	Adjusted Total (Ci/yr)	Detergent Wastes (Ci/yr)	Total (Ci/yr)	
		Primary (Micro Ci/ml)	Secondary (Micro Ci/ml)									
Corrosion and Activation Products												
Cr-51	2.78+001	1.90-003	4.07-008	.00000	.00000	.00000	.00000	.00000	.00009	.00000	.00009	
Mn-54	3.03+002	3.10-004	9.02-009	.00000	.00000	.00000	.00000	.00000	.00002	.00010	.00012	
Fe-55	9.50+002	1.60-003	3.61-008	.00000	.00000	.00000	.00000	.00000	.00009	.00000	.00009	
Fe-59	4.50+001	1.00-003	2.71-008	.00000	.00000	.00000	.00000	.00000	.00005	.00000	.00005	
Co-58	7.13+001	1.60-002	3.61-007	.00001	.00002	.00000	.00000	.00003	.00088	.00040	.00130	
Co-60	1.92+003	2.00-003	4.06-008	.00000	.00000	.00000	.00000	.00000	.00011	.00087	.00098	
Zr-95	6.50+001	.00	.00	.00000	.00000	.00000	.00000	.00000	.00000	.00014	.00014	
Nb-95	3.50+001	.00	.00	.00000	.00000	.00000	.00000	.00000	.00000	.00020	.00020	
Np-239	2.35+000	1.20-003	2.81-008	.00000	.00000	.00000	.00000	.00000	.00002	.00000	.00002	
Fission Products												
Br-83	1.00-001	4.80-003	5.13-008	.00000	.00000	.00000	.00000	.00000	.00003	.00000	.00003	
Rb-86	1.87+001	8.50-005	1.96-009	.00000	.00000	.00000	.00000	.00000	.00002	.00000	.00002	
Sr-89	5.20+001	3.50-004	9.04-009	.00000	.00000	.00000	.00000	.00000	.00002	.00000	.00002	
Mo-99	2.79+000	8.40-002	1.86-006	.00001	.00004	.00000	.00002	.00007	.00182	.00000	.00180	
Tc-99m	2.50-001	4.80-002	1.74-006	.00001	.00004	.00000	.00002	.00006	.00173	.00000	.00170	
Ru-103	3.96+001	4.50-005	9.04-010	.00000	.00000	.00000	.00000	.00000	.00000	.00001	.00002	
Ru-106	3.67+002	1.00-005	1.80-010	.00000	.00000	.00000	.00000	.00000	.00000	.00024	.00024	
Ag-110m	2.53+002	.00	.00	.00000	.00000	.00000	.00000	.00000	.00000	.00004	.00004	
Te-127m	1.09+002	2.80-004	4.51-009	.00000	.00000	.00000	.00000	.00000	.00002	.00000	.00001	
Te-127	3.92-001	8.50-004	1.62-008	.00000	.00000	.00000	.00000	.00000	.00002	.00000	.00002	
Te-129m	3.40+001	1.40-003	2.71-008	.00000	.00000	.00000	.00000	.00000	.00007	.00000	.00007	
Te-129	4.79-002	1.60-003	4.88-008	.00000	.00000	.00000	.00000	.00000	.00005	.00000	.00005	
I-130	5.17-001	2.10-003	2.91-008	.00000	.00000	.00000	.00000	.00000	.00010	.00000	.00010	
Te-131m	1.25+000	2.50-003	4.82-008	.00000	.00000	.00000	.00000	.00000	.00003	.00000	.00003	
I-131	8.05+000	2.70-001	4.06-006	.00071	.00229	.00000	.00040	.00339	.09468	.00006	.09500	
Te-132	3.25+000	2.70-002	4.63-007	.00000	.00001	.00000	.00000	.00002	.00061	.00000	.00061	
I-132	9.58-002	1.00-001	1.42-006	.00000	.00003	.00000	.00003	.00006	.00174	.00000	.00170	
I-133	8.75-001	3.80-001	5.50-006	.00003	.00058	.00000	.00045	.00106	.02961	.00000	.03000	
Cs-134	7.49+002	2.50-002	5.75-007	.00021	.00003	.00000	.00001	.00024	.00680	.00130	.00810	
I-135	2.79-001	1.90-001	2.51-006	.00000	.00005	.00000	.00013	.00019	.00524	.00000	.00520	
Cs-136	1.30+001	1.30-002	2.99-007	.00006	.00001	.00000	.00000	.00007	.00209	.00000	.00210	
Cs-137	1.10+004	1.80-002	4.16-007	.00015	.00002	.00000	.00000	.00018	.00495	.00240	.00730	
Ba-137m	1.77-003	1.60-002	9.58-007	.00014	.00002	.00000	.00000	.00017	.00462	.00000	.00460	
Ce-144	2.84+002	3.30-005	9.03-010	.00000	.00000	.00000	.00000	.00000	.00000	.00052	.00052	
All Others		2.53-001	1.13-006	.00000	.00000	.00000	.00000	.00000	.00006	.00000	.00006	
Total (Except Tritium)		1.46+000	2.17-005	.00133	.00317	.00000	.00107	.00557	.15557	.00629	.16000	
Tritium Release		410 Curies Per Year										

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TABLE 11.2-12

LIQUID WASTE MANAGEMENT SYSTEM
INSTRUMENTATION PRINCIPAL DESIGN PARAMETERS

Channel Number	Location of Primary Sensor	Design Pressure (psig)	Design Temperature (°F)	Range	Location of Readout
LICA-1001	Waste holdup tank	150	200	0 to 100 pct	Local and WPS panel
LICA-1002	Chemical drain tank	150	200	0 to 100 pct	Local and WPS panel
LICA-1003	Reactor coolant drain tank	150	250	0 to 100 pct	WPS panel
LICA-1004	Reactor coolant drain tank	150	250	0 to 100 pct	WPS panel
LICA-1005	Primary spent resin storage tank	150	200	0 to 100 pct	WPS panel
PIA-1006	Primary spent resin storage tank	150	200	0 to 100 psig	WPS panel
FI-1007	Waste evaporator feed pump discharge	150	200	0 to 30 gpm	Local
FIC-1008	Reactor coolant drain tank pump discharge	150	250	0 to 250 gpm	WPS panel
FIA-1009	Reactor coolant drain tank recirculation	150	250	0 to 250 gpm	WPS panel
LICA-1010	Laundry and hot shower tank	150	200	0 to 100 pct	WPS panel and local
FICA-1011	Primary spent resin sluice pump	150	200	0 to 150 gpm	WPS panel
LICA-1012	Waste evaporator condensate tank	150	200	0 to 100 pct	WPS panel and local
FQI-1014	Reactor coolant drain tank discharge to recycle holdup tank	150	250	0 to 10 gpm	Local
PI-1017	Waste evaporator feed filter ΔP	150	200	0 to 25 psid	Local
PI-1018A	Reactor coolant drain tank pump No. 1 discharge	150	250	0 to 150 psig	Local
PI-1018B	Reactor coolant drain tank pump No. 2 discharge	150	250	0 to 150 psig	Local

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TABLE 11.2-12 (Sheet 2)

Channel Number	Location of Primary Sensor	Design Pressure (psig)	Design Temperature (°F)	Range	Location of Readout
PI-1018C	Laundry and hot shower tank pump discharge	150	200	0 to 150 psig	Local
PI-1018D	Chemical drain tank pump discharge	150	200	0 to 150 psig	Local
PI-1018G	Waste evaporator condensate pump	150	200	0 to 150 psig	Local
TIA-1058	Reactor coolant drain tank	150	250	50 to 250 F	WPS panel
PI-1074	Waste evaporator condensate demineralizer ΔP	150	200	0 to 25 psid	Local
PI-1075	Waste evaporator condensate filter ΔP	150	200	0 to 25 psid	Local
LICA-1077A	Floor drain tank	150	200	0 to 100 pct	WPS panel and local
LICA-1077B	Floor drain tank	150	200	0 to 100 pct	WPS panel and local
PI-1078	Floor drain tank filter ΔP	150	200	0 to 25 psid	Local
PI-1079	Floor drain tank strainer ΔP	150	200	0 to 25 psid	Local
PI-1080	Laundry and hot shower tank filter ΔP	150	200	0 to 25 psid	Local
PI-1081	Laundry and hot shower tanks strainer ΔP	150	200	0 to 25 psid	Local
LICA-1082	Waste monitor tank No. 1	150	200	0 to 100 pct	WPS panel and local
LICA-1083	Waste monitor tank No. 2	150	200	0 to 100 pct	WPS panel and local
PI-1084A	Waste monitor tank pump No. 1 discharge	150	200	0 to 150 psig	Local
PI-1084B	Waste monitor tank pump No. 2	150	200	0 to 150 psig	Local
FI-1085A	Waste monitor tank pump No. 1 discharge	150	200	0 to 100 gpm	WPS panel and local
FI-1085B	Waste monitor tank pump No. 2 discharge	150	200	0 to 100 gpm	WPS panel and local
PI-1086	Resin sluice filter P	150	200	0 to 25 psid	Local

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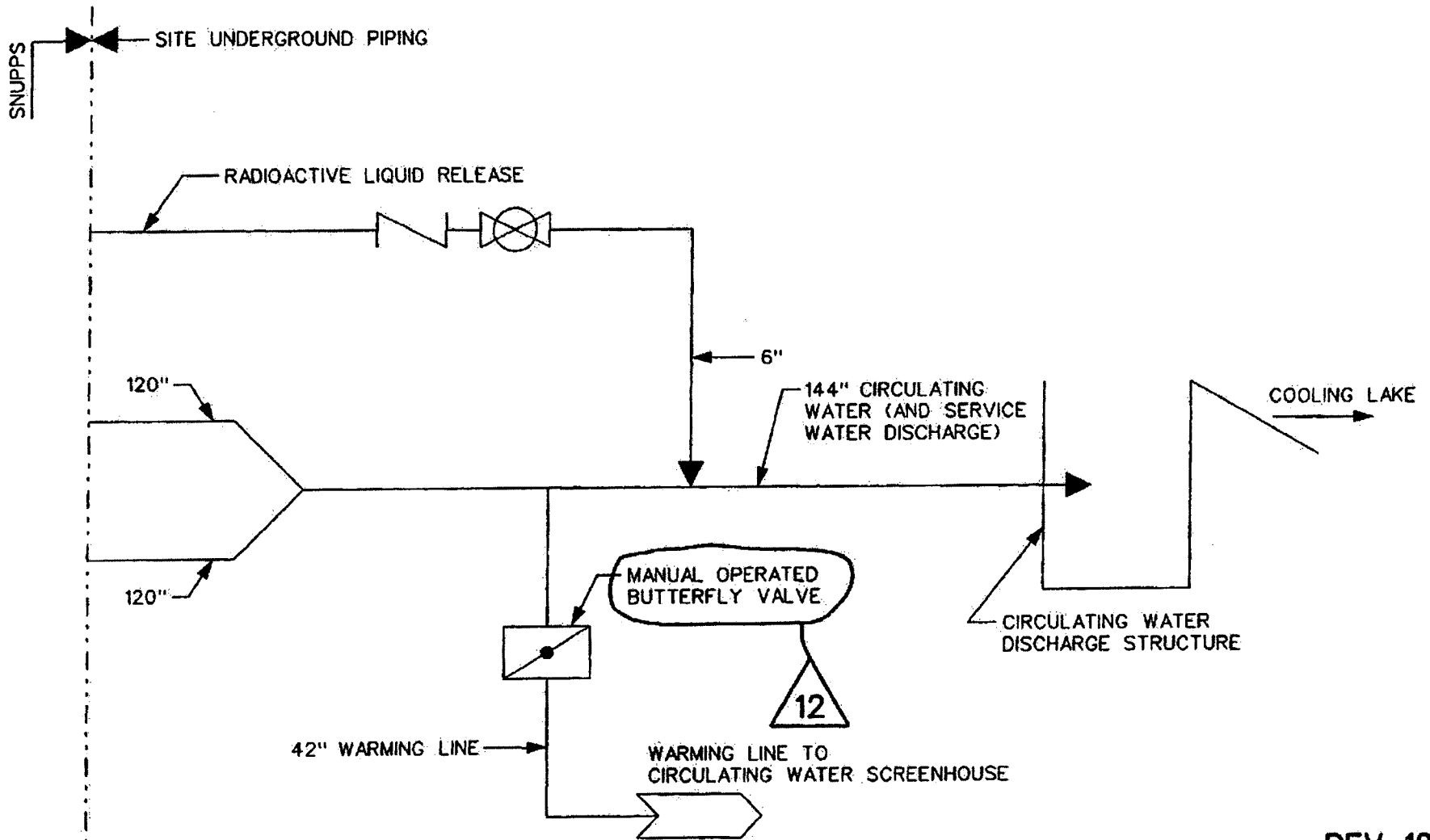
TABLE 11.2-12 (Sheet 3)

<u>Channel Number</u>	<u>Location of Primary Sensor</u>	<u>Design Pressure (psig)</u>	<u>Design Temperature (°F)</u>	<u>Range</u>	<u>Location of Readout</u>
PI-1088	Waste monitor tank filter ΔP	150	200	0 to 25 psid	Local
PI-1089	Waste monitor tank demineralizer ΔP	150	200	0 to 25 psid	Local
PI-1090A	Floor drain tank pump discharge	150	200	0 to 150 psig	Local
PI-1090B	Floor drain tank pump discharge	150	200	0 to 150 psig	Local

NOTES:

- F - Flow
- Q - Flow integrator
- P - Pressure
- L - Level
- T - Temperature
- R - Radiation
- I - Indication
- C - Control
- A - Alarm
- S - Switch

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UPDATED SAFETY ANALYSIS REPORT
FIGURE 11.2-1
RADIOACTIVE LIQUID RELEASE FLOW DIAGRAM
(SHEET 5)

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11.3 GASEOUS WASTE MANAGEMENT SYSTEMS

The gaseous radwaste system (GRWS) and the plant ventilation exhaust systems control, collect, process, store, and dispose of gaseous radioactive wastes generated as a result of normal operation, including anticipated operational occurrences. This section discusses the design, operating features, and performance of the GRWS and the performance of the ventilation systems. The plant ventilation exhaust systems accommodate other potential release paths for gaseous radioactivity due to miscellaneous leakages, aerated vents from systems containing radioactive fluids, and the removal of noncondensables from the secondary system. Systems which handle these gases are not normally considered gaseous waste systems and are discussed in detail in other sections. These systems are included here to the extent that they represent potential release paths for gaseous radioactivity.

11.3.1 DESIGN BASES

11.3.1.1 Safety Design Basis

The GRWS and other gaseous waste management systems serve no safety-related function.

11.3.1.2 Power Generation Design Bases

POWER GENERATION DESIGN BASIS ONE - The GRWS and the ventilation exhaust systems are designed to meet the requirements of the discharge concentration limits of 10 CFR 20 and the as low as reasonably achievable dose objective of 10 CFR 50, Appendix I.

POWER GENERATION DESIGN BASIS TWO - The GRWS includes design features to preclude the possibility of an explosion where a potential for an explosive mixture exists.

POWER GENERATION DESIGN BASIS THREE - The GRWS uses design and fabrication codes consistent with quality group D (augmented), as assigned by Regulatory Guide 1.143 for radioactive waste management systems.

POWER GENERATION DESIGN BASIS FOUR - The ventilation exhaust system complies with Regulatory Guide 1.140 to the extent specified in Table 9.4-3.

POWER GENERATION DESIGN BASIS FIVE - Gaseous effluent discharge paths are monitored for radioactivity.

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POWER GENERATION DESIGN BASIS SIX - The Radwaste Building (including the Waste Bale Drumming Area) is equipped with a monitored ventilation system which ensures that the potential release pathways are controlled and monitored as per 10 CFR 50, Appendix A, in case of a breach of container.

11.3.2 SYSTEM DESCRIPTIONS

11.3.2.1 General Description

This section describes the design and operating features of the GRWS. The performance of the GRWS and other plant gaseous waste management systems with respect to the release of radioactive gases is discussed in Section 11.3.3. Detailed descriptions of the plant ventilation systems and main condenser evacuation system are presented in Sections 9.4 and 10.4.2, respectively.

The piping and instrumentation diagram for the GRWS is shown in Figure 11.3-1.

The main flow path in the GRWS is a closed loop comprised of two waste gas compressors, two catalytic hydrogen recombiners, six gas decay tanks for normal power service, and two gas decay tanks for service at shutdown and startup. The system also includes a gas decay tank drain collection tank, drain pump, four gas traps to handle normal operating drains from the system, and a waste gas drain filter to permit maintenance and handle normal operating drains from the system. All of the equipment is located in the radwaste building.

The closed loop has nitrogen for a carrier gas. The primary influents to the GRWS are combined with hydrogen as the stripping or carrier gas. The hydrogen that is introduced to the system is recombined with oxygen, and the resulting water is removed from the system. As a result, the bulk of all influent gases is removed, leaving trace amounts of inert gases, such as helium and radioactive noble gases to build up.

The primary source of the radioactive gas is via the purge of the volume control tank with hydrogen, as described in Section 9.3.4. The operation of the GRWS serves to reduce the fission gas concentration in the reactor coolant system which, in turn, reduces the escape of fission gases from the reactor coolant system during maintenance operations or through equipment leakage. Smaller quantities are received, via the vent

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connections, from the reactor coolant drain tank, the pressurizer relief tank, and the recycle holdup tanks.

Since hydrogen is continuously removed in the recombiner, this gas does not build up within the system. The largest contributor to the nonradioactive gas accumulation is helium generated by a $B_{10}(n,\alpha)Li_7$ reaction in the reactor core. The second largest contributors are impurities in the bulk hydrogen and oxygen supplies. Stable and long-lived isotopes of fission gases also contribute small quantities to the system gas volume accumulation.

Operation of the system is such that fission gases are distributed throughout the six normal operation gas decay tanks. Separation of the GRWS gaseous inventory in several tanks assures that the allowable site boundary dose will not be exceeded in the event of a gas decay tank rupture. Radiological consequences of such a postulated rupture are discussed in Section 15.7.1.

The GRWS also provides the capacity for indefinite holdup of gases generated during reactor shutdown. Nitrogen gas from previous shutdowns is contained in the shutdown gas decay tank for use in stripping hydrogen from the reactor coolant system. The shutdown tank is normally at low pressure and is used to accept relief valve discharges from the normal operation gas decay tanks.

For all buildings where there is potential airborne radioactivity, the ventilation systems are designed to control the release. Where applicable, each building has a vent collection system for tanks and other equipment which contain air or aerated liquids. The condenser evacuation system discharge is filtered and discharged to the unit vent in addition to the discharges from the reactor building, auxiliary building, and fuel building. The radwaste building, which houses the GRWS, has its own release vent. The turbine building has an open ventilation system, and the steam packing exhaust discharges outside the turbine building.

The vent collection systems receive the discharge of vents from tanks and other equipment in the radwaste and auxiliary buildings which contain air or aerated liquids. These components contain only a very small amount of fission product gases. Prior to release via the radwaste or auxiliary building ventilation system, the gases are monitored, as described in Section 11.5, and passed through a prefilter, HEPA filter, charcoal filter, and another

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HEPA filter in series which reduce any airborne particulate radioactivity to negligible levels and provide a decontamination factor of at least 10 for radioactive iodines and 100 for particulates. Expected efficiencies for iodine removal are better than 99 percent for elemental iodine and 95 percent for organic iodine at 70-percent relative humidity. However, for gaseous effluent release calculations, 70-percent efficiency is conservatively used for radioiodine isotopes.

Although plant operating procedures, equipment inspection, and preventive maintenance are performed during plant operations to minimize equipment malfunction, overall radioactive release limits have been established as a basis for controlling plant discharges during operation with the occurrence of a combination of equipment faults of moderate frequency. These faults include operation with fuel defects in combination with steam generator tube leaks and malfunction of liquid or gaseous waste processing systems or excessive leakage in reactor coolant system equipment or auxiliary system equipment. Operational occurrences such as these can result in the discharge of radioactive gases from various plant systems. These unscheduled discharges may be from plant systems which are not normally considered gas processing systems or from a gas decay tank after a 90-day holdup period. These potential sources are tabulated in Table 11.1-2. The bases for assumed releases, the factors which tend to mitigate the release of radioactivity, and the release paths are given in Appendix 11.1A.

A further discussion of the gaseous releases from the plant is provided in Section 11.3.3.

11.3.2.2 Component Description

Codes and standards applicable to the GRWS are listed in Tables 3.2-1 and 11.3-1. The GRWS is designed and constructed in accordance with quality group D (augmented). The GRWS is seismically designed to the requirements of Reg. Guide 1.143, as discussed in Table 3.2-5. The GRWS is housed within a building also seismically designed to the requirements of Reg. Guide 1.143. The GRWS design complies with Regulatory Guide 1.143, as specified in Table 3.2-5.

WASTE GAS COMPRESSOR - The waste gas compressor is a water-sealed centrifugal displacement unit which maintains continuous circulation of nitrogen around the waste gas loop. The compressor is provided with a mechanical shaft seal to minimize water leakage. The compressor moisture separator normal water level is maintained to keep the shaft immersed at all times.

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Two waste gas compressor packages are provided. One compressor is normally used, and the other compressor is on standby. The packages are self-contained and skid-mounted. Construction is primarily of carbon steel.

CATALYTIC HYDROGEN RECOMBINER - The catalytic recombiner disposes of hydrogen brought into the GRWS. This is accomplished by adding a controlled amount of oxygen to the recombiner which reacts with the hydrogen as the gas flows through a catalyst bed. The control system for the recombiner is designed to preclude the possibility of a hydrogen explosion. This is further discussed in Section 11.3.6.

Two hydrogen recombiner packages are provided. One recombiner is normally used, and the other is on standby. The packages are self-contained and skid-mounted. The recombiner is located in the system where the hydrogen concentration and pressure are optimum with respect to hydrogen removal.

DECAY TANK - Eight gas decay tanks are provided, six for normal power operation and two for service at shutdown and startup. The tanks are of the vertical-cylindrical type and are constructed of carbon steel.

MISCELLANEOUS COMPONENTS - The gas decay drain collection tank provides a collection point for condensation drained from the gas decay tanks, recombiners, and gas compressors.

All control valves, with the exception of those on the recombiner, are provided with bellow seals to minimize the leakage of radioactive gases through the valve bonnet and stem. Valves on the recombiner package are provided with leakoffs. The leakoff port was removed and capped on the Feed Gas Pressure Control Valve for SHA01A "A" Hydrogen recombiner skid. This leak off line remains intact for the "B" Hydrogen Gas Recombiner skid.

Relief valves have soft seats and are exposed to pressures which are normally less than two-thirds of the relief valve set pressure. The relief valves of the major components discharge to the shutdown tanks. This permits decay and controlled disposal of all discharges less than about 3,000 scf. The relief valves are designed to relieve full flow from both waste gas compressors.

To maintain leakage from the system at the lowest practicable level, diaphragm-type manual valves are used throughout the waste gas system. For low temperature, low pressure service valves with a synthetic rubber-type diaphragm are used. This application includes all parts of the system, except the recombiners. Because of the high temperature that may exist in the recombiner, globe type valves with a metal diaphragm seal in the stem are used. There should be no measurable stem leakage from either type of valve.

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The gas decay tank drain pump directs water from the gas decay drain collection tank (due to condensation or maintenance) to the waste holdup tank or recycle holdup tanks. It is used when there is insufficient pressure in the gas system to drive the fluid. All parts of the pump in contact with the drain water are of austenitic stainless steel. The pump is a canned-motor type.

The waste gas drain filter is a disposable cartridge filter provided to prevent particulate matter, including rust, from entering the LRWS and BRS. Parts of the filter in contact with the drain water are of austenitic stainless steel.

The waste gas traps are designed to prevent gases from leaving the GRWS. There are four gas traps - two in the gas decay tank drain line and one each in the recombiner drain lines and compressor drain lines.

The component description for the ventilation systems is provided in Section 9.4.

11.3.2.3 System Operation

Operation of the ventilation systems is described in Section 9.4. The following is a description of the GRWS.

NORMAL OPERATION - During normal power operation, nitrogen gas, with contained fission gases, is circulated around the GRWS loop by one of the two compressors. Fresh hydrogen gas is introduced into the volume control tank where it is mixed with fission gases stripped from the reactor coolant by the action of the volume control tank letdown line spray nozzle. The gas is vented from the volume control tank into the circulating nitrogen in the waste gas system, at the compressor suction. Normal operational mode of the system is dependent on the reactor coolant system (RCS) gas concentration and the RCS status. A purge of the Volume Control Tank is performed as directed by Chemistry. During a VCT purge using the same Gas Decay Tank is advantageous. However, switching GDTs may be required, depending on the high operating pressure parameters of the system.

The resulting mixture of nitrogen, hydrogen, and fission gases is pumped by one of the compressors to one of the two catalytic hydrogen recombiners where enough oxygen is added to react with and reduce the hydrogen to a low residual level. Water vapor formed in the recombiner by the hydrogen and oxygen reaction is condensed and removed, and the cooled gas stream (now composed primarily of nitrogen, helium, and fission gases) is discharged from the recombiner, routed through a gas decay tank, and sent back to the compressor suction to complete the loop circuit.

Only one gas decay tank is valved into the waste gas loop at any time. By switching tanks when tank pressure nears the upper operating parameters, this will allow for more decay time for the gases stored in the tanks. This practice will result in fewer radioactive curies released.

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If it has been determined that excessive nitrogen buildup is occurring within the system or when other occurrences require it, one tank can be valved out of service and allowed to decay for a period of 90 days, and then discharged.

STARTUP - At plant startup, the system is first flushed free of air and filled with nitrogen at atmospheric pressure. One compressor, one recombiner, and one shutdown decay tank are in service. The reactor is at the cold shutdown condition. Fresh hydrogen is charged into the volume control tank, and the volume control tank vent gas mixes with the circulating nitrogen in the GRWS. This circulating mixture enters the compressor suction, passes through the recombiner and shutdown gas decay tank, and returns to the compressor suction. When the reactor coolant system hydrogen concentration is within operating specifications, the shutdown gas decay tank is isolated and the gas flow directed to one of the gas decay tanks provided for normal power operation. Gases accumulated in the shutdown tank will be retained for reuse during hydrogen stripping from the reactor coolant system during subsequent shutdown operations.

SHUTDOWN AND DEGASSING OF THE REACTOR COOLANT SYSTEM - Plant shutdown operations are essentially startup operations in reverse sequence. The volume control tank hydrogen purge is maintained until after the reactor is shut down and coolant fission gas concentrations have been reduced to specified level. During this operation, hydrogen purge flow may be increased to speed up coolant degassing. The gas decay tank in service for normal power operation is valved out, and a nitrogen purge from the shutdown tank to the volume control tank is begun. The shutdown tank is placed in the process loop at the compressor discharge so that the gas mixture from the volume control tank vents to the compressor suction and passes through the shutdown tank and to the recombiner where hydrogen is removed and returned to the compressor suction. The nitrogen purge continues until the reactor coolant hydrogen concentration reaches the required level. Degassing is then complete, and the reactor coolant system may be opened for maintenance or refueling.

11.3.3 RADIOACTIVE RELEASES

This section describes the estimated gaseous release from the plant for normal operation and anticipated operational occurrences.

11.3.3.1 Sources

Section 11.1 and Appendix 11.1A provide the bases for determining the contained source inventory and the normal releases.

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11.3.3.2 Release Points

Potential release paths for gaseous radioactivity are illustrated schematically in Appendix 11.1A. The general location of potential gaseous radioactivity release points is depicted in Figure 1.2-1. A description of potential release points for radioactive gaseous effluents is given in Appendix 11.1A, along with the physical characteristics of the gaseous effluent streams. Release points from the gaseous waste processing systems are shown on Figure 11.3-2.

11.3.3.3 Dilution Factors

The annual average dilution factors used in evaluating the release of gaseous radioactive effluents are derived and justified in Section 2.3.

11.3.3.4 Estimated Doses

The GASPARG computer code, which calculates doses due to normal gaseous effluents in accordance with Regulatory Guide 1.109, was used to determine the doses listed herein. This code was validated and verification is maintained on file.

The doses due to normal gaseous effluents from WCGS are listed in Tables 11.3-2, 3 and 4. Doses attributable to radioactive iodines and particulates at the controlling sector Exclusion-Restricted Area boundary are contained within Table 11.3-3 (Hypothetical Worst Case). Doses from iodines and particulates at the controlling residence are contained within Table 11.3-4 (Controlling Existing Resident). Table 11.3-2 contains doses from noble gases at the Exclusion-Restricted Area boundary.

The doses in these tables were calculated assuming intermittent purge operation. Intermittent purge mode release rates were taken from Section 11.1. The values of the dispersion and deposition coefficients, X/Q (non-decayed), X/Q (depleted and non-decayed) and D/Q used in the calculations were taken from Section 2.3 and Table 2.3-75. A comparison of the half lives of the radionuclides released to the time needed for released nuclides to disperse to any point within the 5-mile radius of interest shows that the effect of decay during this dispersion period is negligible. Thus, the values for X/Q (decayed) and X/Q (decayed and depleted) were taken to be equivalent to the corresponding X/Q (non-decayed) and X/Q (depleted and non-decayed) values.

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A survey of the area within a five-mile radius of the site was conducted during June 1980 and was used to determine the pathways present at the controlling locations. A 1986 survey of the same area indicates the pathways present at the controlling locations are still the same. X/Qs for the controlling locations were used in calculating doses from iodines and particulates as well as noble gases.

The total doses for Table 11.3-3 and 11.3-4 were calculated by summing the doses from each pathway present. It was conservatively assumed that all age groups were present at each controlling location.

Doses due to noble gases and radioactive iodines and particulates in no case exceed 10 CFR 50 Appendix I limits.

Actual doses from gaseous effluent during plant operation will be calculated using the approved methodology presented in the Offsite Dose Calculation Manual.

11.3.4 SAFETY EVALUATION

The GRWS serves no safety-related function.

11.3.5 TESTS AND INSPECTIONS

Preoperational testing is described in Chapter 14.0.

The operability, performance, and structural and leaktight integrity of all system components are demonstrated by continuous operation.

11.3.6 INSTRUMENTATION APPLICATION

The GRWS instrumentation, as described in Table 11.3-5, is designed to facilitate automatic operation and remote control of the system and to provide continuous indication of system parameters.

The instrumentation readout is located mainly on the waste processing system panel in the radwaste building. Some instruments are read where the equipment is located. Alarms are shown separately on the waste processing system panel and further relayed to one common waste processing system annunciator on the main control board of the plant. Where suitable, instrument lines are provided with diaphragm seals to prevent fission gas outleakage through the instrument. Figure 11.3-3 shows the location of the instruments on the compressor package.

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The compressors are interlocked with the seal water inventory in the moisture separators and trip off on either high or low moisture separator level. During normal operation, the proper seal water inventory is maintained automatically.

Figure 11.3-4 indicates the location of the instruments on the recombiner installation.

The catalytic recombiner system is designed for automatic operation with a minimum of operation attention. Each package includes two online gas analyzers, one to measure hydrogen and oxygen in and one to measure hydrogen and oxygen out. The analyzers are the primary means of recombiner control. Each of these online gas analyzers is independently controlled. In the event that these analyzers are declared inoperable, operation of the system may continue provided grab samples are taken and analyzed at least once per 24 hours. With both oxygen channels or both the inlet oxygen and inlet hydrogen channels inoperable, oxygen supply is suspended to the recombiner. Addition of waste gas to the system may continue provided grab samples are taken and analyzed at least once per 4 hours during degassing operations and at least once per 24 hours during other operations.

The GRWS is designed to operate with hydrogen concentrations above 4 percent by volume. Flammable mixtures of gases in the system are prevented by monitoring and controlling the oxygen concentration to appropriate levels. The setpoints for oxygen concentration in the catalyst bed inlet stream are 3 percent for the hi-alarm and 3.5 percent for the hi-hi alarm and isolation of the oxygen supply. The setpoint for oxygen concentration downstream of the catalyst bed is 60 ppm oxygen for the hi-hi alarm and isolation of inlet oxygen supply. Thus the oxygen supply to the recombiner would be terminated before the concentration in the GRWS would reach levels favorable for hydrogen flammability.

Since the GRWS is designed to operate with hydrogen concentrations up to 6 percent by volume, up to 3 percent oxygen is necessary for operation of the catalytic recombiner. Termination of oxygen feed at 2 percent as suggested by regulatory guidance is inappropriate. Further, since the minimum oxygen concentration necessary to support combustion at 4 percent by volume hydrogen concentrations is 5 percent, the hi-alarm setpoint of 3 percent provides sufficient margin (i.e., 60 percent of the limit) to flammability.

A multipoint temperature recorder monitors temperatures at several locations in the recombiner packages.

The process gas flow rate is measured by an orifice located upstream of the recombiner preheater. Local pressure gauges indicate pressure at the recombiner inlet and oxygen supply pressure.

The following controls and alarms are incorporated to maintain the gas composition outside the range of flammable and explosive mixtures:

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- a. If the recombiner feed concentration exceeds 6 percent by volume, a high-hydrogen alarm sounds to warn that all hydrogen entering the recombiner is not reacted. This alarm is followed by a second alarm indicating high hydrogen in the recombiner discharge. These alarms warn of a possible hydrogen accumulation in the system.
- b. If the hydrogen concentration in the recombiner feed reaches 9 percent by volume, a high-high hydrogen alarm sounds, the oxygen feed is terminated, and the volume control tank hydrogen purge flow is terminated. These controls limit the possible accumulation of hydrogen in the GRWS to 3 percent by volume.
- c. If the oxygen concentration in the recombiner feed reaches 3 percent by volume, an alarm sounds and oxygen feed flow is limited so that no further increase in flow is possible. This control maintains the system oxygen concentration at 3 percent or less, which is below the flammable limit for hydrogen-oxygen mixtures.
- d. If the oxygen concentration in the recombiner feed reaches 3.5 percent by volume, an alarm sounds and the oxygen feed flow is terminated.
- e. If hydrogen in the recombiner discharge exceeds 0.25 percent by volume, an alarm sounds. This alarm warns of high hydrogen feed, possible catalyst failure, or loss of oxygen feed.
- f. If oxygen in the recombiner discharge exceeds 60 ppm, an alarm sounds and oxygen feed is terminated. This control prevents any accumulation of oxygen in the system in case of hydrogen recombiner malfunction.
- g. On low flow through the recombiner, oxygen feed is terminated. This control prevents an accumulation of oxygen following system malfunction.
- h. High discharge temperature from the cooler-condenser (downstream from the reactor) terminates oxygen feed. This protects against loss of cooling water flow in the cooler-condenser.

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- i. High temperature indication by any one of six thermocouples in the catalyst bed limits oxygen feed so that no further increase is possible.
- j. High temperature indication at the recombiner reactor discharge terminates oxygen feed to the recombiner.

11.3.7 REFERENCES

Published References

- 1. Eckerman, K.F. and Lash, D G, 1978, GASPAR version marked "revised 8/19/77": U S Nuclear Regulatory Commission, Radiological Assessment Branch.
- 2. Eckerman, K.F., Congel, F.J., Roecklein, A.K. and Pasciak, W.J., 1980, NUREG-0597 Users Guide to GASPAR Code: U.S. Nuclear Regulatory Commission, Radiological Assessment Branch.

Personal References

- 1 Warminski, N C, 1979, Horticulture agent for the Sedgwick County Extension Office of the Kansas State University Cooperative Extension Service, Wichita, Kansas, telephone conversation (25, 26 January), written communication (29 January).

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TABLE 11.3-1

GASEOUS WASTE PROCESSING SYSTEM
MAJOR COMPONENT DESCRIPTION

Water Gas Compressors

Type	Centrifugal
Quantity	2
Design pressure, psig	150
Design temperature, F	180
Operating temperature, F	70 to 130
Design suction pressure, N ₂ at 130 F, psig	0.5
Design discharge pressure, psig	110
Design flow, N ₂ at 130 F, scfm	40
Material	Carbon steel
Design code (1)	ASME VIII/D (augmented)
Seismic design	In accordance with Table 3.2-1

Gas Decay Tanks

Type	Vertical
Quantity	8
Design pressure, psig	150
Design temperature, F	180
Volume, each, ft ³	600
Material of construction	Carbon steel
Design code (1)	ASME VIII/D (augmented)
Seismic design	In accordance with Table 3.2-1

Recombiners

Type	Catalytic
Quantity	2
Design pressure, psig	150
Design temperature, F	(2)
Design flow rate, scfm	50
Operating discharge pressure, psig	20
Operating discharge temperature, F	70 to 140
Material of construction	Stainless steel
Design code (1)	ASME VIII/D (augmented)
Seismic design	In accordance with Table 3.2-1

(1) Table indicates the required code based on its safety-related importance as dictated by service and functional requirements and by the consequences of their failure. Note that the equipment may be supplied to a higher principal construction code than required.

(2) Varies by component in the recombiner package, but exceeds operating temperatures by 100 F.

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TABLE 11.3-2

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TABLE 11.3-3

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TABLE 11.3-4

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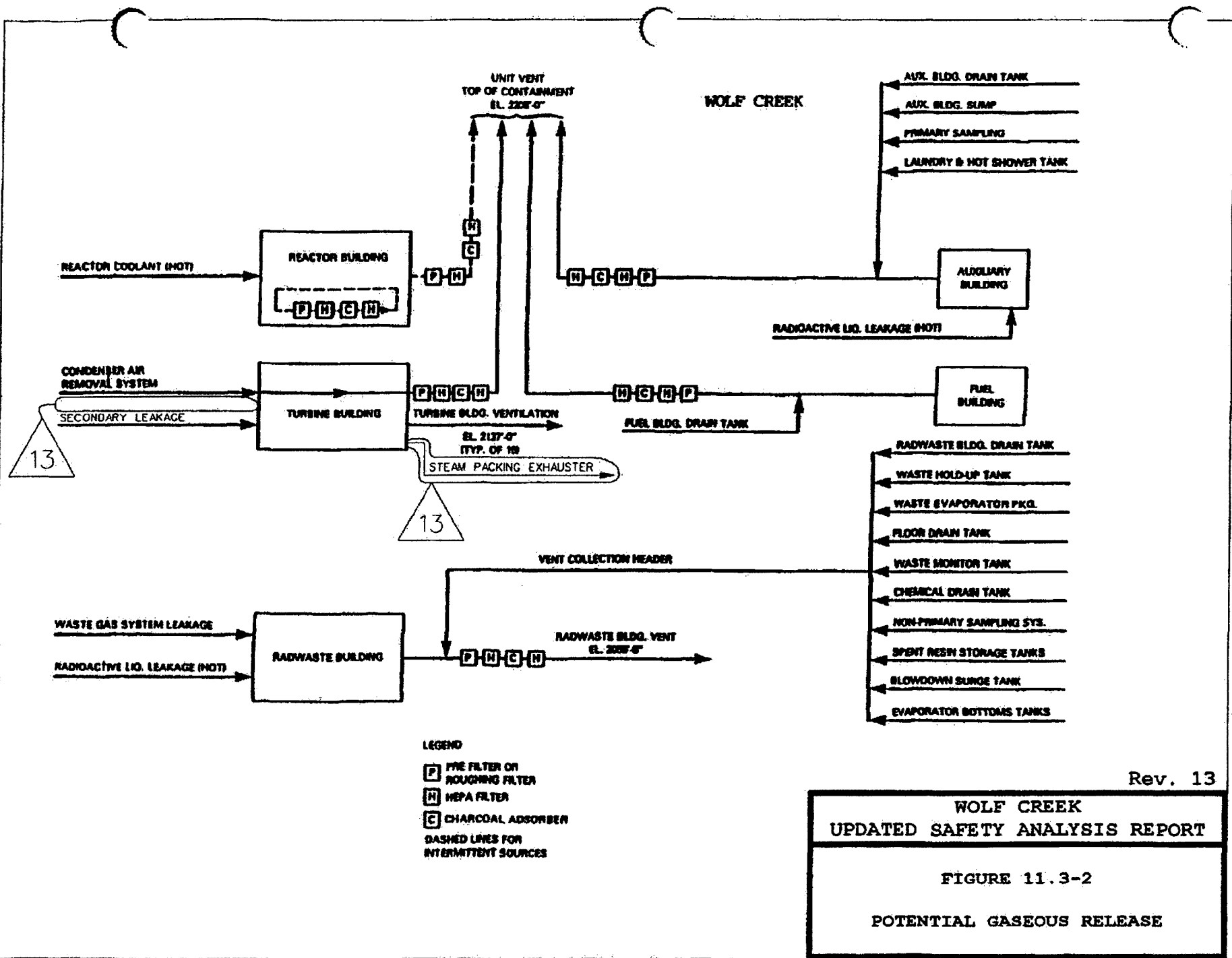
TABLE 11.3-5
GASEOUS WASTE PROCESSING SYSTEM INSTRUMENTATION DESIGN PARAMETERS

<u>Channel Number</u>	<u>Location of Primary Sensor</u>	<u>Design Pressure (psig)</u>	<u>Design Temperature (°F)</u>	<u>Range</u>	<u>Alarm Setpoint</u>	<u>Control Setpoint</u>	<u>Location of Readout</u>
Flow Instrumentation							
QIA-1091	Gas decay tank water flush	150	180	0 to 6,000 gal	3,000 to 6,000 gal (adjustable)	-	Local
HIC-1094	Volume control tank purge control	150	250	0 to 100 pct	None	Manual control (normal flow 0.7 scfm)	WPS panel
Pressure Instrumentation							
PI-1031	Moisture separator	150	180	0 to 100 psig	-	-	Local
PI-1033	Moisture separator	150	180	0 to 100 psig	-	-	Local
PIA-1036	Gas decay tank number 1	150	180	0 to 150 psig 0 to 30 psig	100 psig 20 psig	-	WPS panel
PIA-1037	Gas decay tank number 2	150	180	0 to 150 psig 0 to 30 psig	100 psig 20 psig	-	WPS panel
PIA-1038	Gas decay tank number 3	150	180	0 to 150 psig 0 to 30 psig	100 psig 20 psig	-	WPS panel
PIA-1039	Gas decay tank number 4	150	180	0 to 150 psig 0 to 30 psig	100 psig 20 psig	-	WPS panel
PIA-1052	Gas decay tank number 5	150	180	0 to 150 psig 0 to 30 psig	100 psig 20 psig	-	WPS panel

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TABLE 11.3-5 (Sheet 2)

Channel Number	Location of Primary Sensor	Design Pressure (psig)	Design Temperature (°F)	Range	Alarm Setpoint	Control Setpoint	Location of Readout
Pressure Instrumentation (Cont'd)							
PIA-1053	Gas decay tank number 6	150	180	0 to 150 psig 0 to 30 psig	100 psig 20 psig	-	WPS panel
PIA-1054	Gas decay tank number 7	150	180	0 to 150 psig 0 to 30 psig	90 psig 18 psig	-	WPS panel
PIA-1055	Gas decay tank number 8	150	180	0 to 150 psig 0 to 30 psig	90 psig 18 psig	-	WPS panel
PIA-1065	Hydrogen supply header	150	180	0 to 150 psig	90 psig	-	WPS panel
PIA-1066	Nitrogen supply header	150	180	0 to 150 psig	90 psig	-	WPS panel
PICA-1092	Compressor suction header	150	180	2 psi vac 2 psig	0.5 psi vac	0.5 psi vac	WPS panel
PI-1093	Gas decay tank makeup water	150	180	0 to 150 psig	N.A.	N.A.	Local
PI-1094	Volume control tank discharge pressure	150	250	0 to 20 psig	N.A.	N.A.	Local
Level Instrumentation							
LICA-1030	Compressor Moisture Separator	150	180	0 to 30 inches H ₂ O	15 inches H ₂ O 1 inch H ₂ O	10 inches H ₂ O 8 inches H ₂ O 5 inches H ₂ O	WPS panel and Local
LICA-1032	Compressor Moisture Separator	150	180	0 to 30 inches H ₂ O	15 inches H ₂ O 1 inch H ₂ O	10 inches H ₂ O 8 inches H ₂ O 5 inches H ₂ O	WPS panel and Local

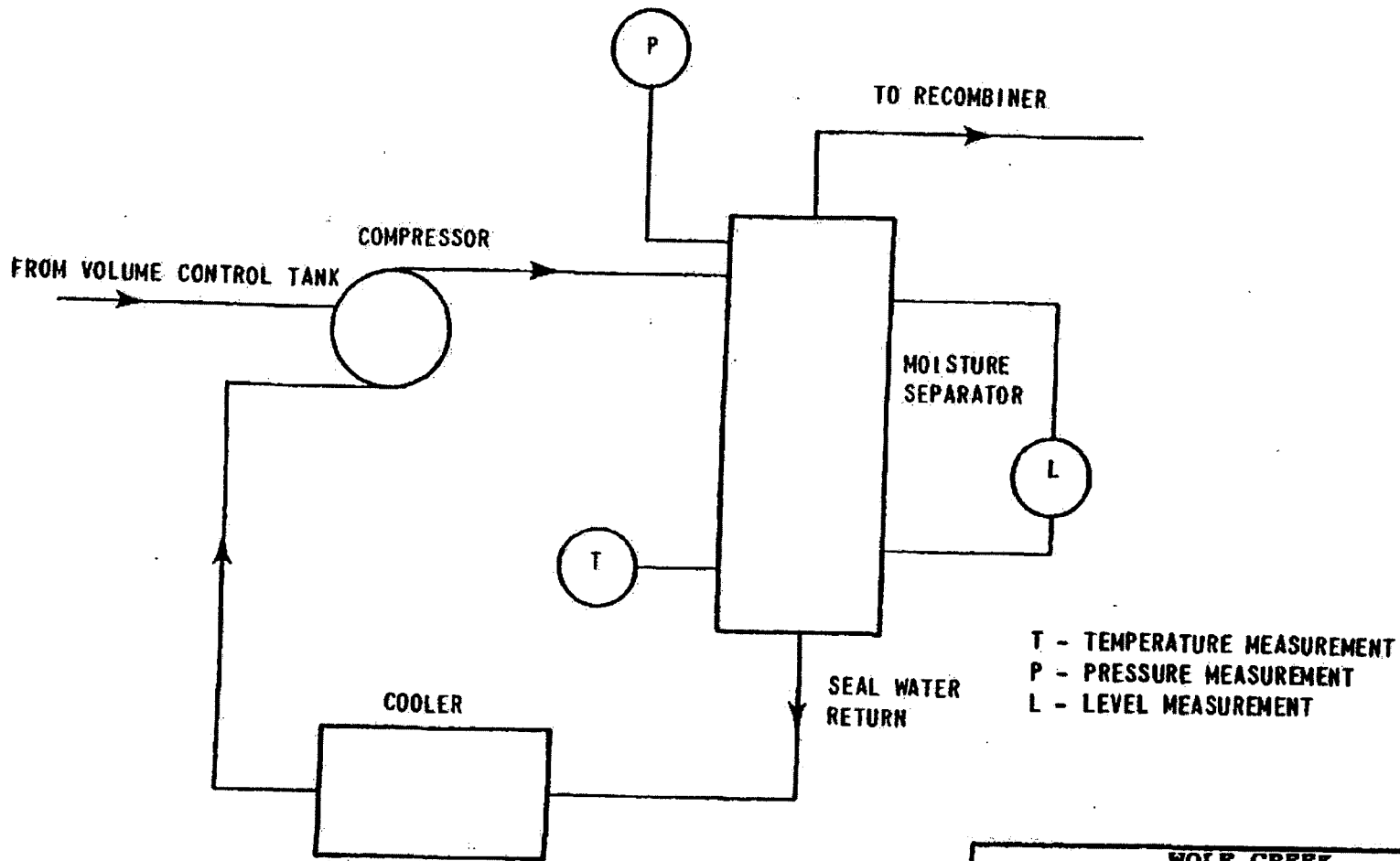


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FIGURE 11.3-2
POTENTIAL GASEOUS RELEASE

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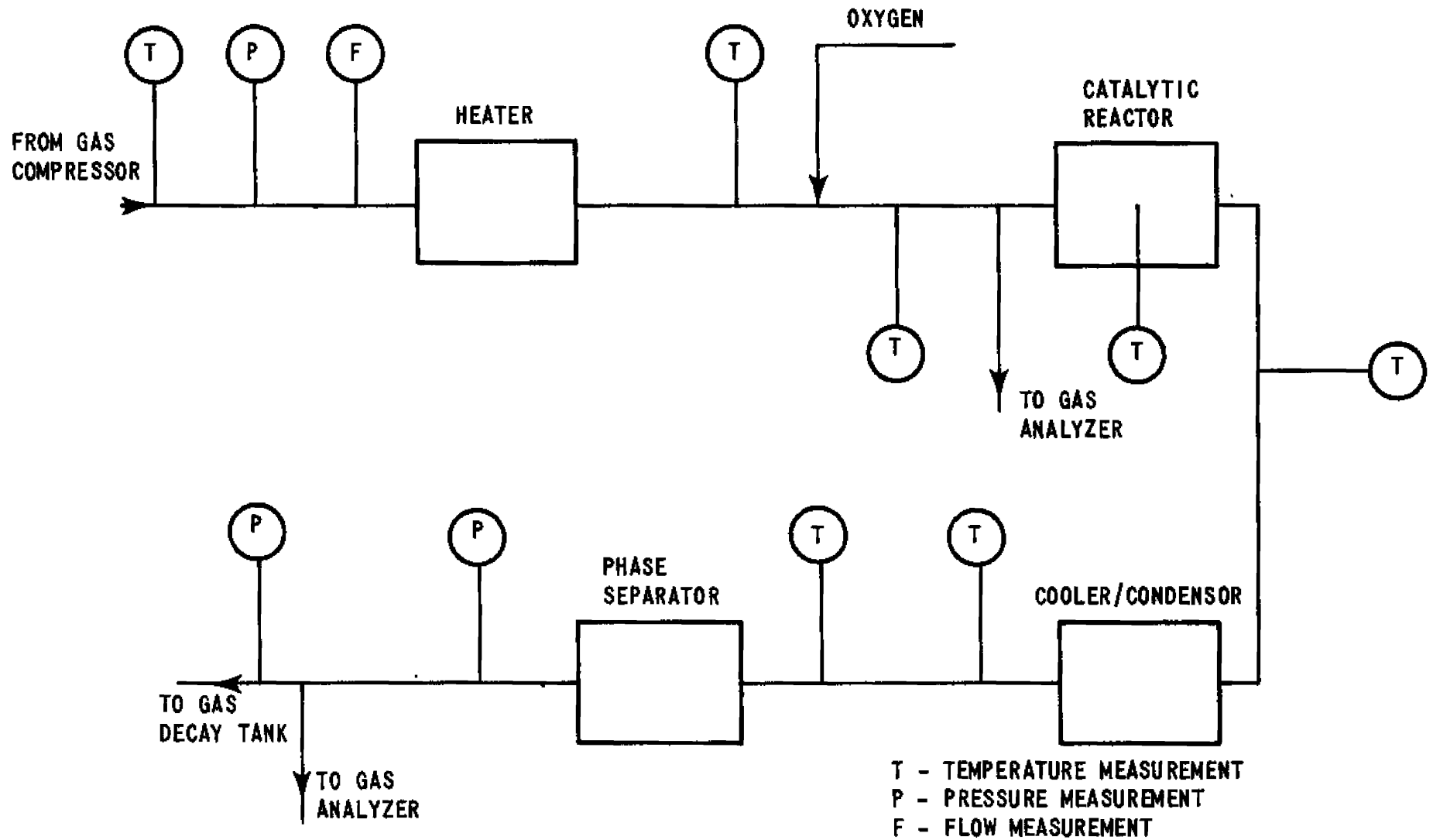


T - TEMPERATURE MEASUREMENT
P - PRESSURE MEASUREMENT
L - LEVEL MEASUREMENT

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FIGURE 11.3-3 COMPRESSOR PACKAGE INSTRUMENTS

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T - TEMPERATURE MEASUREMENT
P - PRESSURE MEASUREMENT
F - FLOW MEASUREMENT

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FIGURE 11.3-4
HYDROGEN RECOMBINER INSTRUMENTS

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11.4 SOLID WASTE MANAGEMENT SYSTEM

The solid radwaste system (SRS) is designed to meet the functional requirements of the solid waste management system. The SRS is designed to collect, process, and package low-level radioactive wastes (LLW) generated as a result of normal plant operation, including anticipated operational occurrences, and to store this packaged waste until it is shipped offsite to a waste processor for treatment and/or disposal or to a licensed burial site. The process and effluent radiological and sampling systems are described in Section 11.5.

11.4.1 DESIGN BASES

11.4.1.1 Safety Design Bases

The SRS performs no function related to the safe shutdown of the plant, and its failure does not adversely affect any safety-related system or component; therefore, the SRS has no safety design bases.

11.4.1.2 Power Design Bases

POWER GENERATION DESIGN BASIS ONE - The SRS is designed to meet the following objectives:

- a. Provide remote transfer and hold-up capability for spent radioactive resins from the chemical and volume control system, fuel pool cooling and cleanup system, boron recycle system, liquid radwaste system, steam generator blowdown system, and secondary liquid waste system and for spent radioactive activated charcoal from the liquid radwaste system and the secondary liquid waste system.
- b. Provide a means to semiremotely remove and transfer the spent filter cartridges from the filter vessels to the solid radwaste processing system in a manner which minimizes radiation exposure to operating personnel and the spread of contamination.
- c. Provide a means for compacting and packaging miscellaneous dry radioactive materials, such as paper, rags, and contaminated clothing.
- d. Provide a means for dewatering primary and secondary resin storage and shipment offsite.

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POWER GENERATION DESIGN BASIS TWO - The SRS is designed and constructed in accordance with Regulatory Guide 1.143, as described in Table 3.2-5, and Branch Technical Position ETSB 11-3, as described in Table 11.4-1. The seismic design classification of the radwaste building, which houses the solid waste management system, and the seismic design and quality group classification for the system components and piping are provided in Section 3.2.

POWER GENERATION DESIGN BASIS THREE - The SRS design parameters are based on the radionuclide concentrations and volumes consistent with reactor operating experience for similar designs and with the source terms of Section 11.1.

POWER GENERATION DESIGN BASIS FOUR - Collection, packaging, and storage of radioactive wastes are to be performed so as to maintain any potential radiation exposure to plant personnel during system operation or during maintenance to "as low as is reasonably achievable" (ALARA) levels, in accordance with the intent of Regulatory Guide 8.8 in order to maintain personnel exposures well below 10 CFR 20 requirements. Design features incorporated to maintain ALARA criteria include remote system operation, remotely actuated flushing, and equipment layout permitting the shielding of components containing radioactive materials. Additionally, access to the solid waste processing and storage areas is controlled to minimize personnel exposure.

POWER GENERATION DESIGN BASIS FIVE - The onsite storage facilities for solid wastes have a capacity for temporary storage of solid wastes resulting from approximately 5 years of plant operation. Temporary onsite storage and shipping offsite of solid radwaste do not present a radiation hazard to persons onsite or offsite, for either normal conditions or extreme environmental conditions, such as tornados, floods, or seismic events. Greater detail on interim on-site storage is provided in section 11.4.A.

POWER GENERATION DESIGN BASIS SIX - The SRS is designed to meet the requirements of General Design Criterion 60 of 10 CFR 50, Appendix A. Packaging and shipment of radioactive wastes is performed in accordance with the requirements of 10 CFR 61, 10 CFR 71, 49 CFR 173, and applicable state regulations.

POWER GENERATION DESIGN BASIS SEVEN - Temporary storage, on a concrete slab or within a building addition located West of the IOS facility and South of the Radwaste Building provides temporary indoor/outdoor storage of large waste material which becomes activated during reactor operation. Each stored item will be unique, therefore procedures for storing items outdoors will be determined on a case by case basis.

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11.4.2 SYSTEM DESCRIPTION

11.4.2.1 General Description

The SRS consists of the following subsystems which are illustrated in the piping and instrumentation diagrams provided in Figure 11.4-1:

- a. Dry waste system
- b. Resin handling system
- c. Filter handling system
- d. Waste disposal system

The activity of the influents to the SRS is dependent on the activities of the various fluid systems, such as the boron recycle system, secondary liquid waste system, liquid waste management system, chemical and volume control system, fuel pool cooling and cleanup system, floor and equipment drain system, and the steam generator blowdown system. Reactor coolant system activities and the decontamination factors for the systems given above also determine the influent activities to the solid radwaste system.

Table 11.4-2 lists the estimated expected and maximum activities of waste to be processed on an annual basis and their physical form and source. The isotopic makeup and curie content of the expected influents to the SRS are given in Table 11.4-2. The estimated maximum annual quantities of solid radwaste generation are presented in Table 11.4-3. The estimated annual expected and maximum curie and isotopic content is presented in Table 11.4-4, for each waste category. Packaged waste volumes are based on the following:

- a. Waste content volume in Table 11.4-3, when based on packaging in 55-gallon and solidified with concrete, are:
 - (1) 3.5 ft³ primary spent resin, primary charcoal, and primary evaporator bottoms per drum
 - (2) 4.8 ft³ secondary spent resin and charcoal per drum
 - (3) 5.3 ft³ secondary evaporator bottoms
 - (4) 4.0 ft³ chemical waste per drum
 - (5) 1 filter cartridge per drum
 - (6) 7.5 ft³ shipped volume per drum (including cement)
- b. Disposal volumes are based on packaging in the following typical containers:

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<u>Waste Stream</u>	<u>Container Type</u>	<u>Container Volume</u>
Primary Resin	PL8-120	120.3 cuft
Secondary Resin	PL14-215	205.8 cuft
Filters	PL6-80	83.4 cuft
DAW	85 Gallon Drum	11.6 cuft
	79 Gallon Drum	10.8 cuft
	55 Gallon Drum	7.5 cuft
	B-25 Box	96 cuft

Section 11.1 and Appendix 11.1A provided the bases for determination of liquid source terms which are used to calculate the solid waste source terms. The sources presented in Tables 11.4-2 and 11.4-4 are conservatively based on Section 11.1, Appendix 11.1A and the following additional information:

- a. As a basis for the activities given in Table 11.4-4, 30 days decay is assumed.
- b. The miscellaneous dry and compacted waste volume will reflect the historical increases since the issuance of Case 6 in Table 2-49 of WASH-1258, July 1973.

11.4.2.2 Component Description

Codes and standards applicable to the SRS are listed in Tables 3.2-1 and 11.4-5. The SRS is housed within a seismically designed building. Regulatory Guide 1.143 is complied with to the extent specified in Table 3.2-5.

SRS component parameters are presented in Table 11.4-5. The following is a functional description of the major system components:

SPENT RESIN STORAGE TANK (PRIMARY) - Provides for storage and decay of the spent resins from the demineralizers in the chemical and volume control system, fuel pool cooling and cleanup system, boron recycle system, and liquid radwaste system.

SPENT RESIN STORAGE TANK (SECONDARY) - Provides for storage and decay of the spent resins and spent activated charcoal from the demineralizers and charcoal adsorbers in the steam generator blowdown system, secondary liquid waste system, and charcoal adsorbers in the liquid radwaste system.

EVAPORATOR BOTTOMS TANK (PRIMARY) - Provides for storage, decay, sampling, and chemistry control of the concentrated wastes from the liquid radwaste system.

EVAPORATOR BOTTOMS TANK (SECONDARY) - Provides for storage, decay, sampling, and chemistry control of the concentrated wastes from the secondary liquid waste system.

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SPENT RESIN SLUICE PUMPS (PRIMARY AND SECONDARY) - Provides the motive flow to transfer spent resin or spent activated charcoal from the various demineralizers or adsorbers to the appropriate spent resin storage tank.

EVAPORATOR BOTTOMS TANK PUMPS (PRIMARY AND SECONDARY) - Are available to transfer the concentrated liquid wastes from the evaporator bottoms tanks to the solid radwaste disposal station.

ACID ADDITION TANK AND METERING PUMP - Provides chemistry control to the chemical drain tank, and floor drain tank.

CAUSTIC ADDITION TANK AND METERING PUMP - Provides chemistry control to the chemical drain tank, floor drain tank, waste holdup tank, evaporator bottoms tank (primary), and evaporator bottoms tank (secondary).

RESIN CHARGING TANKS - Provides remote means of gravity sluicing clean resin and activated charcoal into the demineralizer and adsorber units.

WASTE DISPOSAL STATION - The waste disposal station provides the capability to transfer primary/secondary spent resins and evaporator bottoms, and liquid radwaste demineralizer skid spent resins, to a HIC for storage/shipping. A return header provides a path for decanted water to be returned to the liquid radwaste system or the Secondary Spent Resin Storage Tank or the Primary Spent Resin Storage Tank. The waste disposal station also provides necessary interface support requirements for mobile vendor processing systems.

RADWASTE BRIDGE CRANE - A crane, remotely operated from the solid radwaste control console, which provides the means of moving containers to the processing area, from the processing area to the solid waste storage area, and from the solid waste storage area to the shipping area. The crane is equipped with a television camera system to facilitate the remote handling operation.

DRY WASTE COMPACTORS - Hydraulic power mechanical ram devices that are used to reduce the volume of compressible dry wastes by a factor of approximately five. They are designed with exhaust fan and filter to control the airborne dust during dry waste compaction operations.

11.4.2.3 System Operation

11.4.2.3.1 Waste Disposal System

The waste disposal station provides the capability to transfer primary/secondary spent resins and evaporator bottoms, and liquid radwaste demineralizer skid spent resins, to a HIC for storage/shipping. A return header provides a path for decanted water to be returned to the liquid radwaste system or the Secondary Spent Resin Storage Tank or the Primary Spent Resin Storage Tank. The waste disposal station also provides necessary interface support requirements for mobile vendor processing systems.

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Evaporator concentrates are stored in either the evaporator bottoms tank (primary) or the evaporator bottoms tank (secondary). Each tank is provided with a mixer, and the piping system contains a relatively high flow pump for recirculation of the tank's contents to maintain the concentrates in the homogeneous

state. Each tank is supplied with external strip heaters, and all piping that can contain the concentrated waste is heat traced to preclude crystallization and eventual plugging within the piping system.

Spent resins are stored in either the primary or secondary resin storage tank. Each tank is supplied with nitrogen gas for sluicing the spent resin to the waste disposal station. Spent resin from the liquid radwaste demineralizer skid is also sluiced to the waste disposal station using Reactor make-up water or the associated system pump. Spent resins are normally sluiced into a High Integrity Container (HIC) for disposal. Resins are dewatered in accordance with the Process Control Program using approved procedures.

The waste disposal station area consists of a segmented concrete shield with nine inch walls, capable of containing the largest anticipated HIC, 60 inch diameter and 73 inch height, with 630 curies of activity without disturbing normal operations.

The waste disposal station utilizes the necessary system controls to prevent improper system operation to preclude the spillage of waste. Because of these system design features, waste spillage is not anticipated although provisions are made for processing waste spillage. A drain system is provided in the waste disposal station for handling waste spillage. Provisions are also contained in the drain system to feed waste to a mobile vendor solidification system/mobile vendor resin dewatering system.

11.4.2.3.2 Dry Waste System

Low-level dry wastes are collected in drums at appropriate locations throughout the plant, as dictated by the volume of these wastes generated during operation or maintenance. Dry wastes, which can be compressed by a factor of five to minimize the volume, may be compacted in 55-gallon drums with a dry waste compactor. Compactors are located in the radwaste building and the auxiliary building. The dry waste compactors have an integral shroud which directs any airborne dusts created by the compaction operation through an exhaust fan and filter, and then to the respective building's ventilation system.

The filled drums are sealed and moved to the storage area in the radwaste building, or other designated areas, where they are stored until shipment offsite.

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Dry wastes can also be processed/compacted offsite by contractor as part of the shipment and waste disposal contract. The low level dry waste collected can be placed in a NRC/DOT approved waste container (e.g., sea van) which is shipped offsite when filled. The container is placed outside the radwaste building within the radiological controlled area.

Large components and equipment which have been activated during reactor operation and which are not amenable to solidification or compaction are handled either by qualified plant personnel or by outside contractors specializing in radioactive materials handling, and are packaged in shipping casks or appropriate shipping packages of an appropriate size.

Dry noncompressible radwaste (such as hoses, buckets, etc.) will be packaged in approved containers and shipped as Low Specific Activity (LSA) or Type A waste.

11.4.2.3.3 Resin Handling System

The resin handling system provides the capability for remote removal of spent radioactive resin and activated charcoal from the demineralizer and charcoal adsorber vessels in the chemical and volume control system, fuel pool cooling and cleanup system, boron recycle system, liquid radwaste system, steam generator blowdown system, and secondary liquid waste system and to transfer them to the associated spent resin storage tank.

In the resin transfer mode, the spent resin sluice pumps take suction from the storage tank via a screened connection on the tank and pump water through the respective vessel to first backflush the resin and then sluice the resin to the spent resin storage tank. Positive indication that the resin has been sluiced to the spent resin storage tank is provided by an ultrasonic density element located in the spent resin sluice header. Alternate Sluice water may be provided by the Reactor Makeup Water system, if the sluice pumps are inoperable.

The spent resin storage tank (primary), which accepts resins from the reactor purification systems, is capable of accommodating at least 60 days' waste generation at normal generation rates. The spent resin storage tank (secondary), which accepts spent resin and spent activated charcoal from the remaining vessels, is capable of accommodating at least 30-days' waste generation at normal generation rates.

Spent resin and spent activated charcoal are transferred from the spent resin storage tanks to the waste disposal station by pressurizing the storage tank with nitrogen and supplying sluice water at the outlet nozzle on the tank. Positive indication that resin has been transferred is provided by a local camera, monitoring at the container entry at the solid radwaste disposal station. Upon completion of the resin transfer, the tank is vented to the radwaste building ventilation system.

The empty demineralizer or charcoal adsorber vessels are filled with clean resin or activated charcoal by gravity sluicing from the resin charging tank into the associated vessels. The filling operations are performed remotely from the vessels being filled.

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11.4.2.3.4 Filter Handling System

The filter handling system is a semiremote system which provides the capability to remove spent radioactive cartridge filters from their filter housings and to transport them to the solid radwaste processing area in the radwaste building.

The system, requires the operator to be in the proximity of the filters; however, they are protected by distance which minimizes operator exposure.

The filter handling system consists of long handled tools for removal of the filter housing top and assemblies. As necessary, shielded transport casks are used for transport and storage of the filter assembly.

The steps required by the operator for the removal of the filters are as follows:

- a. Using a monorail hoist, the shield plug above the filter housing is removed and set aside. Any time the plug hole is uncovered, the operators must take care to stay well away from the proximity of the hole, to avoid exposure. This necessitates that the monorail hoist be operated with a remote pendant controller.
- b. Using long-handled tools the operator loosens the housing head bolts and flips them back out of the way.
- c. With another tool, he engages the housing head and flips it back out of the way.
- d. The filter is lifted part way out of the housing and allowed to drip for a while. It is placed into a shielded cask or shielded storage location.
- e. A new cartridge is installed in the filter housing, either by reversing the previous sequence or, if filter housing radiation levels permit, by manually loading and securing the head.

11.4.2.3.5 Mixed Waste Handling System

Mixed waste (MW) is defined as radioactive waste that has hazardous characteristics or components as defined by 40 CFR 260/261. MW (liquid and solid) is collected in the plant and placed in the appropriate containers. The containers are then stored in the Mixed Waste Storage Facility (MWSF) in the Owens Corning Building (Figure 1.2-44). The MWSF meets the EPA requirements for storage of hazardous wastes, and the NRC requirements for storage of radioactive wastes.

The MW will be processed (if required) and shipped for disposal. Radioactive content of the MWSF will be limited to prevent exceeding the limits in 10 CFR 20 and 10 CFR 50 Appendix I during normal operation, including anticipated operational occurrences.

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11.4.2.4 Packaging, Storage, and Shipment

Solidified radwaste, or waste meeting the no free standing water criteria of Branch Technical Position ETSB 11-3 (i.e., dewatered), shall be stored in the Waste Bale Drumming Area. These wastes satisfy all applicable transportation and disposal requirements.

Wet radioactive waste, defined as any waste which does not meet receiving burial site free liquid requirements may be temporarily stored in the Waste Bale Drumming Area. Wet waste storage containers are designed to withstand the corrosive nature of the wet waste for the expected duration of the storage. Temporarily stored wet waste will be processed (i.e., dewatered) or shipped to a waste processor for treatment prior to disposal.

DRY ACTIVE WASTE (DAW) - includes contaminated trash (paper, cloth, plastic, etc.)

SOLIDIFIED/DEWATERED WASTES - includes resin, filter cartridges and filter sludges transferred into HICs, and dewatered to less than 1% free standing water.

UNCOMPACTIBLE CONTAMINATED WASTE - other wastes not suitable for packaging in drums or HICs may be packaged in LSA boxes (B-25 or equivalent) or packaged into modular storage containers and stored on the temporary outdoor storage slab.

Spent resins, evaporator bottoms, spent charcoal, spent filter cartridges, and solid compactable waste such as contaminated paper, rags, and clothing are packaged in approved containers in accordance with 10CFR61 and shipped in accordance with applicable NRC (10CFR71) and DOT (49CFR173) regulations.

The 55-gallon drums used in the solid radwaste system meet the requirements of DOT approved containers.

Packaged solid radwaste is stored in the Waste Bale Drumming Area of the existing radwaste building prior to shipment offsite. The NRC/DOT approved waste container (e.g., sea van) is placed outside the radwaste building within the radiological controlled area prior to shipment offsite for processing.

The radwaste building storage areas have the ability to store 1,450 fifty-five gallon drums. However, other container sizes and storage configuration may be used.

Containers with radwaste are inventoried and their location recorded prior to being placed in storage.

Primary radwaste normally consists of:

- Spent resins, primary
- Filter cartridges, primary

Secondary waste normally consists of:

- Spent resins, secondary
- Filter cartridges, secondary
- Dry and compacted wastes
- Chemical wastes

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Of the secondary waste, it is possible that Most or all of it will be surveyed and released, rather than stored as radioactive waste.

Refer to Table 11.4-3 for Estimated Maximum Annual Quantities of Solid Radwaste.

11.4.3 SAFETY EVALUATION

Packaged solid radwastes containing, or potentially containing, significant quantities of radioactivity (i.e., spent resins, evaporator bottoms, are in a form that is highly resistant to release and spread of radioactivity during an extreme environmental event, such as a tornado or earthquake. This configuration provides, in effect, a double barrier against the release of radioactivity.

The containers that require radiation shielding are stored in the waste bale drum area which is resistant to tornados as described in Section 11.4-A. The containers with significant quantities of radioactivity remain in place during any extreme environmental event. The drums or other approved containers for the storage of dry active waste (DAW) have a low specific activity. See Section 11.4A for further details.

The packaged radwaste storage areas protect the containers from rainfall and corrosion. As described in Chapter 2.0, flooding is not a potential concern in grade-level buildings at the Wolf Creek site.

Although compacted and solidified wastes are expected to be stored onsite for some period of time prior to shipment, normally no credit other than 30-day decay is taken for radioactive decay realized by such storage when filling containers for shipping in accordance with 49 CFR 173 dose limitations. That is, once filled, containers can normally be shipped immediately, with the proper shielding, without exceeding Department of Transportation radiation limits. If 49 CFR 173 dose limitations cannot be met with the available shielding, however, the applicable containers are stored in the shielded storage area until the doses are acceptable for shipping in accordance with Department of Transportation requirements.

The normal onsite residence time for low level solid radwaste prior to shipping, such as dry compacted waste, steam generator blowdown spent resins, evaporator bottoms, spent charcoal, and ranges from several days to a few months. The normal onsite residence time for primary solid radwaste prior to shipping, such as primary spent resins and spent filter cartridges from the primary system, ranges from a few months to a few years. Onsite residence time is based on the initial activity of the container, the time required to have sufficient containers to completely load a transporting vehicle, the thickness of the shields available, the number of containers which can be stored in the available shipping casks, the availability of a transporting vehicle, and the availability of ultimate disposal facilities.

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Solid radwaste is shipped from the site in Department of Transportation-approved containers by Department of Transportation-approved carriers. Containers with any significant surface dose rate are moved remotely from the shielded storage areas to the transporting vehicle.

Radiation measurements made at the time of shipment of any radioactive waste material ensure that all shipments leave the site well within prescribed limits. Similarly, external contamination measurements are made to detect any potential release of radioactive material from the container prior to shipment.

Mixed waste will be stored in liquid and solid form in the MWSF. The total Curie content of the MWSF will be restricted accordingly to maintain doses to the maximally exposed individual during an extreme environmental event (e.g. fire, tornado, etc.) below the applicable limits in 10 CFR 20 and 10 CFR 100.

11.4.4 TESTS AND INSPECTIONS

The SRS is in intermittent use throughout normal reactor operation. Periodic visual inspection and preventive maintenance are conducted using normal industry practice. Refer to Chapter 14.0 for information on preoperational and startup testing.

11.4.5 INSTRUMENTATION APPLICATION

Two control panels are provided for the equipment in the SRS which contains or processes potentially radioactive fluids or slurries. One control panel is located in the radwaste building control room and contains the instrumentation for the equipment which interfaces the influent systems (i.e., evaporator bottoms tank - primary, evaporator bottoms tank - secondary, spent resin storage tank - primary, and spent resin storage tank - secondary) and for the equipment used for process control (i.e., acid addition tank, acid addition metering pump, caustic addition tank, and caustic addition metering pump).

The second control panel (radwaste crane control panel) is located in a separate room in close proximity to the solid radwaste processing area. The control panel contains all instrumentation, including television monitors, required for remote operations. Pertinent instruments and controls for the transferring of the wastes from the tanks containing the wastes are duplicated on this panel so that the solid radwaste system operator can transfer the waste from these tanks to the waste disposal station.

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TABLE 11.4-1 (Sheet 2)

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concentrates should be rendered immobile by combining with a suitable binding agency (cement, urea formaldehyde, asphalt, etc.) to form a homogeneous solid matrix (absent of free water) prior to off-site shipment. Adsorbents such as vermiculite are not acceptable substitutes for binding agents.

b. Spent resins and filter sludges may, if acceptable to the receiving burial site, be shipped dewatered. These dewatered wastes are subject to (1) items B.II.1.b, and B.II.2 below, (2) to the receiving burial site maximum free liquid criteria (upon receipt at the burial site), and (3) applicable DOT regulations. Furthermore, the activity level of the dewatered wastes may, subject to receiving burial site requirements, dictate the type of container used. Solidification of spent resins and filter sludges in a suitable binder is also an acceptable alternative

c. Spent cartridge filter elements may be packaged in a shielded container with a suitable adsorber such as vermiculite, although it would be desirable to solidify the elements in a suitable binder.

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and other liquid wastes demineralized/dewatered to form a homogeneous solid matrix prior to offsite shipment. No adsorbent such as vermiculite is used for liquid wastes.

I.2.b Complies. Vendor portable dewatering systems are utilized which meet or exceed the maximum free liquid acceptance criteria of the receiving burial site.

I.2.c Complies. Spent cartridge filter elements are dewatered and packaged in HICs

TABLE 11.4-1 (Sheet 3)

ETSB 11-3 POSITION

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II. ASSURANCE OF COMPLETE SOLIDIFICATION

Complete solidification or dewatering of wet wastes should be assured by the implementation of a process control program or by methods to detect free liquids within container contents prior to shipment.

1. Process Control Program

a. Solidification (binding) agents and potential waste constituents should be tested and a set of process parameters (pH, ratio of waste to agent, etc.) established which provide boundary conditions within which reasonable assurance can be given that solidification will be complete.

II.1.a

Complies. Solidification formula demonstrating complete solidification for the expected wastes is determined by shop tests. These tests provide the boundary condition within which reasonable assurance is given that complete solidification, i.e., lack of free water, has occurred.

b. Dewatering procedures, equipment and potential waste constituents should be tested and a set of processing parameters (settling time, drain time, drying time, etc.) be established which provide boundary conditions within which reasonable assurance can be given that dewatering will be complete, with essentially zero free liquid.

II.1.b

Complies. Vendor portable dewatering procedures have been tested for compliance to the receiving burial site free liquid acceptance criteria. Results of these tests have confirmed that dewatering is complete with essentially zero free liquid.

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TABLE 11.4-1 (Sheet 4)

ETSB 11-3 POSITION

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<p>c. The solid waste processing system (or liquid waste processing system, as appropriate) should include appropriate instrumentation and wet waste sampling capability necessary to successfully implement and/or verify the process control program described in II.1.a and/or II.1.b above.</p>	<p>II.1.c</p>	<p>Complies. Sample provisions exist for the determination of chemical constituents to be solidified. In addition, pH adjustments can be made to optimize solidification operations.</p>
<p>d. The plant operator should provide assurance that the process is run within the parameters established under I.1.a and II.1.b above. Appropriate records should be maintained for individual batches showing conformance with the established parameters.</p>	<p>II.1.d</p>	<p>Complies. Administrative controls are used and records are maintained to ensure that the process is operated within the established boundaries.</p>
<p>2. Free Liquid Detection Each container filled with solidified or dewatered wet wastes should be checked by suitable methods to verify the absence of free liquids if a process control program is not followed or an off-normal condition exists during processing. Visual inspection of the upper surface of the waste in the container is not alone sufficient to ensure that</p>	<p>II.2</p>	<p>The shop-tested solidification formula and dewatering procedures coupled with the administrative controls assure the absence of free liquids.</p>

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TABLE 11.4-1 (Sheet 5)

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free water is not present in the container. Provisions to be used to verify the absence of free liquids should consider actual solidification procedures which may create a thin layer of solidification agent on top without affecting the lower portion of the container.

III. WASTE STORAGE

- | | | |
|---|-------|-----------|
| 1. Tanks accumulating spent resins from reactor water purification systems should be capable of accomodating at least 60 days waste generation at normal generation rates. Tanks accumulating spent resins from other sources and tanks accumulating filter sludges should be capable of accomodating at least 30 days waste generation at normal generation rates. | III.1 | Complies. |
| 2. Storage areas for solidified wastes should be capable of accomodating at least 30 days waste generation at normal generation rates. These storage areas should be located indoors. | III.2 | Complies. |
| 3. Storage areas for dry wastes and packaged contaminated equipment should be capable of accomodating at least one full offsite waste shipment. | III.3 | Complies. |

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TABLE 11.4-1 (Sheet 6)

ETSB 11-3 POSITION

WCGS POSITION

IV. PORTABLE SOLID WASTE SYSTEMS

The following supplementary guidance should be incorporated into the design and use of portable (mobile) solidification and/or dewatering systems:

- | | | |
|--|-------------|---|
| <p>1. Tanks containing wet wastes are limited to inplant installation, they should not be part of the portable system.</p> | <p>IV.1</p> | <p>Complies.</p> |
| <p>2. The use of flexible piping should be limited to necessary interfaces with plant systems. Such piping is also subject to the hydrostatic test requirements delineated in Regulatory Guide 1.143.</p> | <p>IV.2</p> | <p>Complies.</p> |
| <p>3. Portable water systems should be located, as a minimum, on concrete pads with curbs and drainage provisions for containing radioactive spills. Provisions should be available for interfacing with drains with the plant's liquid radwaste system. Portable systems should have integral ventilation systems with either self-contained filters, or interface with the plant's ventilation exhaust system.</p> | <p>IV.3</p> | <p>Complies. Dewatering procedures coupled with administrative controls which require continuous monitoring of spent resin transfer to the shipping container and a spill containment barrier of absorbent material when processing in the truck bay provide for containing radioactive spills.</p> |
| <p>4. Regulatory Guide 1.143 seismic criteria for structures housing solid waste systems are not applicable.</p> | <p>IV.4</p> | <p>Complies.</p> |

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TABLE 11.4-1 (Sheet 7)

WCGS POSITION

ETSB 11-3 POSITION

V. ADDITIONAL DESIGN FEATURES

The following additional design features should be incorporated into the design of the solid waste system.

- | | | |
|--|------|-----------|
| 1. Evaporator concentrate piping and tanks should have heat tracing if the concentrates are likely to solidify at ambient temperatures. | IV.1 | Complies. |
| 2. Components and piping which contain radioactive slurries should have flushing connections. | IV.2 | Complies. |
| 3. Solidification agents should be stored in low radiation areas, generally less than 2.5 mr/hr, with provisions for sampling. | IV.3 | Complies. |
| 4. Tanks or equipment which use compressed gases for transport or drying of resins or filter sludges should be vented directly to the plant ventilation exhaust system which includes HEPA filters as a minimum. The vent design should prevent liquids and solids from entering the plant ventilation system. | IV.4 | Complies. |

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TABLE 11.4-2

Deleted Table

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TABLE 11.4-3

Deleted Table

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TABLE 11.4-4

Deleted Table

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TABLE 11.4-5

SOLID RADWASTE SYSTEM - COMPONENT DESCRIPTION

Evaporator Bottoms Tank (Primary)	
Quantity	1
Capacity (usable), gal	1,000
Design pressure, psig	15
Design temperature, °F	250
Material	SB-424, Incoloy 825
Design Code	ASME Sec. VIII
Evaporator Bottoms Tank (Secondary)	
Quantity	1
Capacity (usable), gal	2,500
Design pressure, psig	15
Design temperature, °F	250
Material	SB-424, Incoloy 825
Design code	ASME Sec. VIII
Spent Resin Storage Tank (Primary)	
Quantity	1
Capacity (usable), ft ³	350
Design pressure, psig	150
Design temperature, °F	200
Material	Austenitic stainless steel
Design code(1)	ASME Sec. VIII
Spent Resin Storage Tank (Secondary)	
Quantity	1
Capacity (usable), gal	4,200
Design pressure, psig	150
Design temperature, °F	200
Material	Austenitic stainless steel
Design code	ASME Sec. VIII
Spent Resin Sluice Pump (Primary)	
Quantity	1
Type	Canned centrifugal
Design pressure psig	150
Design temperature, °F	200
Design flow, gpm	
Rated	140
Runout	250

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TABLE 11.4-5 (Sheet 2)

Design head, ft	
Rated	250
Runout	210
Material	Austenitic stainless steel
Design code(1)	Manufacturer's standard (MS)
Spent Resin Sluice Pump (Secondary)	
Quantity	1
Type	Vertical inline centrifugal
Design pressure, psig	300
Design temperature, °F	140
Design flow, gpm	225
Design head, ft	250
Material	Austenitic stainless steel
Design code	MS
Evaporator Bottoms Tank Pump (Primary)	
Quantity	1
Type	Vertical inline centrifugal
Design pressure, psig	300
Design temperature, °F	220
Design flow, gpm	225
Design head, ft	50
Material	Alloy 20
Design code	MS
Evaporator Bottoms Tank Pump (Secondary)	
Quantity	1
Type	Vertical inline centrifugal
Design pressure, psig	300
Design temperature, °F	220
Design flow, gpm	225
Design head, ft	50
Material	Alloy 20
Design code	MS
Acid Addition Tank	
Quantity	1
Capacity (usable), gal	250
Design pressure, psig	10
Design temperature, °F	150
Material	Carbon steel
Design code	ASME Sec. VIII

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TABLE 11.4-5 (Sheet 3)

Caustic Addition Tank

Quantity	1
Capacity (usable), gal	550
Design pressure, psig	10
Design temperature, °F	150
Material	Austenitic stainless steel
Design code	ASME Sec. VIII

Acid Addition Metering Pump

Quantity	1
Type	Positive displacement diaphragm
Design pressure, psig	220
Design temperature, °F	104
Design flow, gph	25
Design head, psi	45
Material	Alloy 20 S.S.
Design code	MS
Contained solution	3% H2SO4

Caustic Addition Metering Pump

Quantity	1
Type	Positive displacement diaphragm
Design pressure, psig	110
Design temperature, °F	104
Design flow, gph	60
Design head, psi	45
Material	Alloy 20 S.S.
Design code	MS
Contained solution	50% NaOH

Resin Charging Tank (CVCS)

Quantity	1
Type	Vertical, conical bottom, on wheels
Capacity (usable), gal	325
Design pressure, psig	ATM
Design temperature, °F	120
Material	Austenitic stainless steel
Design code	ASME Sec. VIII

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TABLE 11.4-5 (Sheet 4)

Resin Charging Tank (Radwaste)

Quantity	1
Type	Vertical, conical bottom, on wheels
Capacity (usable), gal	325
Design pressure, psig	Atmospheric
Design temperature, °F	120
Material	Austenitic stainless steel
Design code	ASME Sec. VIII

Spent Resin Sluice Filter (Primary) (FHC01) *

Quantity	1
Design pressure, psig	300
Design temperature, °F	250
Design flow, gpm	250
P @ design flow, psi	5
Particle Retention	(See Note 2 of Table 9.3-13)
Material	Austenitic stainless steel
Design code(1)	ASME Sec. VIII

Spent Resin Sluice Filter (Secondary) (FHC02) *

Quantity	1
Design pressure, psig	150
Design temperature, °F	250
Design flow, gpm	225
P @ design flow, psi	5
Particle Retention	(See Note 2 of Table 9.3-13)
Material	Austenitic stainless steel
Design code	ASME Section VIII

*See comments on Sheet 2 of Table 9.3-13.

Dry Waste Compactors

Quantity	2
Type	Hydraulic press
Design code	MS

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TABLE 11.4-5 (Sheet 5)

Solid Radwaste Bridge Crane	
Quantity	1
Capacity, tons	9.3
TV cameras, quantity	4

- (1) Table indicates the required code based on its safety-related importance as dictated by service and functional requirements and by the consequences of their failure. Note that the actual equipment may be supplied to a higher principal construction code than required.

This figure has been deleted

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FIGURE 11.4-2 DRUMMING PROCESS OPERATION SCHEMATIC

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APPENDIX 11.4A

INTERIM ON-SITE STORAGE FACILITY

11.4A.1 Introduction

In order to permit plant operation in the event that a permanent disposal site is unavailable, it is necessary to store waste temporarily on-site. This temporary storage is provided by the Interim On-Site Storage (IOS) Facility. The existing waste bale drum structure, which is South of the Radwaste Building, will be used as the IOS facility.

Temporary storage, on a concrete slab or within a building addition located West of the IOS facility and South of the Radwaste Building, provides temporary indoor/outdoor storage of large waste material which becomes activated during reactor operation. Each stored item will be unique, therefore procedures for storing items outdoors will be determined on a case by case basis.

11.4A.2 Design Objectives

The design of the IOS facility provides storage for solid waste produced at WCGS based on five years of processed waste (i.e. resins and sludges, including filter cartridges) and, due to storage capacity limitations, three and one half years of Dry Active Waste (DAW) generated as a result of normal operation of WCGS. The values contained in Table 11.4A-4, "Estimated Capacity and Radwaste Container Distribution for the IOS Facility", serve as the basis for the design storage capacity.

11.4A.3 Description of Containers

Containers used for packaging of radioactive material, and stored in the IOS, shall meet the applicable DOT requirements for quantity and form or the current burial site regulations for disposal (HIC) when placed in storage. Typical containers expected to be stored in the IOS facility are detailed in Table 11.4A-4. All containers are designed to reduce the occurrence of uncontrolled releases of radioactive materials due to handling, transportation, and storage. All containers are designed with materials compatible with the stored waste to prevent significant container corrosion.

11.4A.4 Description of Stored Wastes

Solidified radwaste, or waste meeting the no free standing water criteria of Branch Technical Position ETSS 11-3 (i.e. dewatered), shall be stored in the IOS facility. These wastes satisfy all applicable transportation and disposal requirements.

Wet radioactive waste, defined as any waste which does not meet receiving burial site free liquid requirements may be temporarily stored in the IOS facility.

11.4A.4.1 Dry Active Waste (DAW)

This includes contaminated trash (paper, cloth, plastic, etc.) super compacted into drums, typically by an off-site vendor. The exposure rate from these containers is low (2 mrem/hr to about 100 mrem/hr with a majority less than 10 mrem/hr).

11.4A.4.2 Solidified/Dewatered Wastes

Resin, filter cartridges and filter sludges will be transferred into HICs, and dewatered to less than 1% free standing water. Tables 11.1-6 (Sheet 1) to 11.1-6 (Sheet 24) and 11.4-4 provide normal activity concentrations in the input streams.

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11.4A.4.3 Uncompactible Contaminated Waste

Other wastes not suitable for packaging in drums or HICs may be packaged in LSA boxes (B-25 or equivalent) and stored in the IOS facility, or packaged in modular storage containers and stored on the temporary outdoor storage slab.

11.4A.5 Design Concepts

11.4A.5.1 Storage areas

The wastes will be stored in four separate storage areas as identified in Table 11.4A-4 and Figures 11.4A-1 and 2.

- a. High and Low Level Storage Areas
Two separate areas containing all three forms of waste (i.e. super compacted DAW in drums, solidified/dewatered waste in HICs, and uncompactible waste in LSA boxes).
- b. DAW Storage Areas
Two separate areas, adjacent to the high and low level storage areas, containing super compacted DAW in drums.

The storage areas act as a protective barrier to:

- a. Protect the waste containers from weather effects.
- b. Prevent an uncontrolled release of radioactive material to the environment.
- c. Provide shielding for radiation emitted by the waste.

11.4A.5.2 Handling and Storage Operations

Inventory data including batch number, container number, date of storage, and other necessary data shall be maintained. The design includes an index system that allows specific identification of container locations so that administrative controls may be used to effectively inventory stored wastes.

Containers to be stored in the IOS facility are first visually inspected and checked for surface contamination. No damaged containers will be sent to the IOS facility. Details of the IOS facility layout are shown in Figures 11.4A-1 and 2. The actual waste container configuration may deviate from the above description based on changing waste processing/storage needs. Upon retrieval of containers from storage for transport and permanent disposal, each container is swipe tested.

11.4A.5.3 Personnel Exposure

As required by 10CFR20, occupational exposures shall be kept as low as reasonably achievable (ALARA). During waste handling operations, only employees required to handle the shipment, perform maintenance activities, or perform inspections are allowed in the areas of the IOS facility for the time needed to perform their task.

All operations in the IOS facility are controlled by plant radiation protection personnel to assure that all employees are monitored, confirm that dose limits are not exceeded, and ensure that good working practices are being followed. All operations are conducted in accordance with written procedures.

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To reduce the possible exposure of personnel during inspection and maintenance, the following concepts have been incorporated in the design of the IOS facility:

- a. The IOS facility and equipment are designed to require minimum maintenance activities in high radiation storage areas.
- b. Containers are handled by a remote-controlled crane carrying CCTV cameras and lights.
- c. Inspection of the storage areas in the IOS facility is to be accomplished using CCTV from the solidification control panel room.
- d. Access to the bridge crane and its cables is provided over the truck bay area to reduce exposure to maintenance personnel. Additional portable shielding may be used as necessary.
- e. Additional portable shields may be used as necessary.

11.4A.5.4 Provision for Liquid Drainage

The IOS facility is provided with an internal drainage system consisting of trenches and stainless steel piping which route potentially contaminated water to a radwaste sump. The drainage is then pumped to the liquid radwaste system, and processed prior to discharging. Walls and curbs are utilized to confine any potentially contaminated water inside the building. The IOS facility is also provided with exterior storm drains to prevent water from entering the storage areas. (see Section 9.3)

11.4A.5.5 Structural and Architectural

The IOS facility is a non-nuclear safety non-seismic Category I structure. The finished floors in the storage areas are constructed with minimal slope in order to accommodate drum stacking, and covered with an easily decontaminable material. The roof of the storage building consists of built up roofing and rigid insulation on a metal deck.

11.4A.5.6 Shielding

Shielding evaluations were performed utilizing the waste stream distribution, historical generation, isotopic activities, and storage configurations as described in Tables 11.4A-1, 2, 3A - 3D, and 4, and Figures 11.4A-1 and 2. The storage configuration provides adequate shielding for five years of radioactive waste. The concrete walls provide shielding primarily for the outer layers of containers. Consideration was given for a self-shielding effect due to the large number of containers in the storage areas (i.e. containers with high exposure rates will, to the extent possible, be placed in the center of the storage areas using containers with lower exposure rates for shielding). The roof, made of built up roofing and rigid insulation on a metal deck, provides shielding equivalent to approximately 0.25 inches of steel. Additional portable container shields may be used as necessary.

Maximum anticipated dose rates outside of the IOS are shown in Tables 11.4A-5A and 5B. Maximum anticipated dose rates along the south RCA boundary are shown in Table 11.4A-6. The dose rates are also shown in Figures 11.4A-3, 11.4A-3A and 11.4A-3B.

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11.4A.5.7 Design Basis Events

11.4A.5.7.1 Fire Protection

Fire protection is accomplished through the use of non-combustible construction materials, local fire extinguishers, and local hose stations. Fire/smoke detection devices, which alarm locally, and in the main control room, are provided throughout the IOS facility. The only combustibile material in the IOS facility is DAW and HIC liner material (high density, cross linked polyethylene).

11.4A.5.7.2 Flood Protection

The topography of the site is such that flooding from natural causes is not a design basis event for above grade buildings. (see Section 2.0)

11.4A.5.7.3 Wind Protection

The IOS is a reinforced structure designed for a wind velocity of 100 miles/hr. This velocity corresponds to a recurrence time of 100 years.

11.4A.5.7.4 Tornado Protection

The storage areas and stored waste have been evaluated with respect to a tornado, and it has been determined that the design is such that there will be no adverse affects from a tornado for the following reasons.

- a) All waste is stored in a form that is resistant to the release and spread of radioactivity.
- b) Waste with high activity levels will be stored in tornado resistant rooms (i.e. rooms that have three foot thick reinforced walls which are 16'-9" high) in containers that, due to their weight, will remain in place during a tornado.
- c) Waste with low activity levels will be stored in non-tornado resistant rooms (i.e. rooms that have only one foot thick reinforced masonry block walls which are 14' high). However, the waste that will be stored in the non-tornado resistant rooms will have low activity levels (i.e., 2 mrem/hr to 100 mrem/hr, with the majority less than 10 mrem/hr).
- d) The non-tornado resistant rooms, although they themselves do not provide resistance to a tornado, are protected from a tornado by surrounding structures. The rooms are located in the Waste Bale Drumming Area which is designed to withstand 100 mph winds. Also, most tornadoes come from the southwest, and the rooms will be shielded by three foot thick 16'-9" high walls on the west, a concrete segmented shield on the south, and the Radwaste Building on the north.
- e) If, in the unlikely event that most of the waste stored in the non-tornado resistant rooms were dispersed during a tornado, the released activity levels would remain below the 2.5 rem whole body or 30 rem thyroid dose limit allowed by GL 81-38.
- f) In the unlikely event a tornado missile were to enter one of these rooms, and penetrate a container, the missile would tend to plug its own hole, minimizing any potential for release of radioactivity. Liquid waste will be contained by the curbs and floor drain system.

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Based on these reasons, the storage of radwaste as allowed per this modification does not present a radiation hazard with respect to a tornado. In the unlikely event of waste container failure or dispersal due to a tornado, plant procedures will provide instructions on handling and repackaging/reprocessing of the waste on a case by case basis. In case of a unique failure not anticipated in plant procedures, WCGS Engineering and Technical personnel would evaluate the situation and determine the best course of action based on the specific conditions.

11.4A.5.7.5 Seismic Event

In the unlikely event of waste container failure due to a seismic event, plant procedures will provide instructions on handling and repackaging/reprocessing of the waste on a case by case basis. A failure due to a seismic event would in all likelihood result in the failed container remaining within the IOS facility. In case of a unique failure not anticipated in plant procedures, WCGS Engineering and Technical personnel would evaluate the situation and determine the best course of action based on the specific conditions. In no case would the method of resolution fail to meet shipping and burial criteria, or result in any radioactive release to the environment.

11.4A.5.7.6 Waste Container Failure

In the unlikely event of waste container failure after final packaging, during storage, or prior to shipment, plant procedures will provide instructions on handling and repackaging/ reprocessing of the waste on a case by case basis. A failure within the IOS facility would in all likelihood result in the failed container remaining within the IOS facility. In case of a unique failure not anticipated in plant procedures, WCGS Engineering and Technical personnel would evaluate the situation and determine the best course of action based on the specific conditions. In no case would the method of resolution fail to meet shipping and burial criteria, or result in any radioactive release to the environment.

11.4A.5.8 HVAC Systems

The IOS facility is maintained at a negative pressure by the Radwaste Building ventilation system. This is accomplished by an interlock that requires an exhaust fan in operation, prior to starting a supply fan. Also, two exhaust fans are provided with interlocks to ensure that upon the loss of one fan, the other will automatically start. All exhaust air is monitored and filtered prior to release. (see Section 9.4.5)

11.4A.5.9 Bridge Crane

11.4A.5.9.1 Crane Description

The bridge crane has a rated capacity of 9-1/3 tons. The crane has the capability to handle all containers (i.e. HICs, LSA boxes, and drums). The drum grab has the capability to recover fallen drums. The crane carries TV cameras and lighting for storage, handling and inspection of containers, and may perform other tasks in the storage and truck bay areas as required.

There are two motors on the crane, one high speed and one low speed for bridge, trolley and hoist movement. The redundant motors can be used to move the crane in the event one motor fails. In the event of other problems, a cable can be manually attached for crane retrieval.

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11.4A.5.9.2 Crane Control

The solid radwaste control console is equipped so that radwaste movements may be accomplished by remotely controlling the bridge crane. The crane system is designed for precise placement of drums, HICs or LSA boxes, and for lifting and placement of the cask transportation lid. The bridge and trolley are accurately positioned by the use of a CCTV monitoring system and an overhead index system. It will have sufficient range to move HICs from the solid radwaste disposal station to the storage areas, and unload drums and boxes from the trucks and move them to their storage areas.

11.4A.5.9.3 CCTV System

The CCTV includes cameras mounted on the bridge crane. Monitors are installed in the solidification control panel room. They are equipped with manual control capabilities to adjust the pan and tilt for the cameras. The cameras on the crane are fixed focus and adjusted locally to get a close view of any container for inspection purposes, the two surveillance cameras have pan and tilt capabilities.

11.4A.5.10 Lighting

Fixed lights are provided throughout the IOS facility. These lights provide illumination for all IOS activities, including inspections.

11.4A.5.11 Security

The IOS facility is surrounded by a chain link fence bounding the RCA. Access to the IOS facility is controlled to minimize personnel exposure.

11.4A.6 Monitoring Operations

11.4A.6.1 Containers

Before the radioactive waste containers are placed in storage, the activity level of each container is determined. Radiological monitoring of the storage containers is performed using portable equipment. Swipe testing and analysis capability is provided in the truck bay area.

11.4A.6.2 Storage Areas

The IOS facility includes provision for remote monitoring of the storage areas through closed circuit television (CCTV) so that the condition of any stored container can be observed. In order to maximize visual inspection in the storage areas for the longest period of time, drums will initially be stacked in every other row, to the extent practicable.

Area radiation monitors are installed, one in the corridor across from the radwaste control room and another in a truck bay area near the personnel entrance. If predetermined radiation setpoints are exceeded, alarms sound both locally and in the main control room. Additional radiation monitoring is performed by the plant radiation protection group using portable equipment as necessary.

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11.4A.6.3 Offsite

The IOS facility is designed to ensure that the annual dose to the public is a small fraction of the 25 mrem/yr allowed from all sources of the Uranium cycle, as per 40CFR190. Exposure levels are monitored at the RCA boundary fence using RDD dosimeters. Table 11.4A-7 details anticipated dose rates at the restricted area boundary.

All potential pathways for the release of radioactivity to the environment are controlled and monitored. In particular, water from potentially contaminated drains is processed in the liquid radwaste system, and air from the IOS facility is processed in the Radwaste Building exhaust system. Both systems sample and analyze for radioactivity prior to release to the environment. (see Section 11.5)

Since the normal operation of the IOS facility is not expected to produce any radioactive discharge or otherwise hazardous effluents, no significant effects on environmental air or water quality are expected. Offsite environmental surveillance is implemented through the environmental monitoring program.

TABLE 11.4A-1

ISOTOPIC DISTRIBUTION OF RADWASTE
(PERCENT ABUNDANCE)

NUCLIDE	HALF-LIFE (DAYS)	*** RESINS, CLASS A	FILTERS & CLASS B	EVAP *** CLASS C	DAW -----
Mn-54	312.7	1.43	3.94	1.80	1.45
Fe-55	2.7*	57.35	21.70	41.00	59.70
Co-57	270.9	0.00	0.43	0.00	0.11
Co-58	70.8	2.28	22.70	25.60	1.69
Co-60	5.27*	12.67	11.70	6.60	24.90
Ni-59	75000*	0.00	0.17	0.00	0.00
Ni-63	100.1*	15.07	16.20	12.60	7.37
Ag-110m	249.85	0.00	0.00	1.90	0.24
H-3	12.28*	0.88	0.00	3.40	0.02
C-14	5730*	0.17	0.54	0.50	0.00
Nb-95	35.06	0.00	0.10	1.60	1.73
Cs-134	2.062*	4.02	9.07	0.30	1.02
Cs-137	30.17*	6.07	12.50	0.50	1.46
Ce-144	284.3	0.00	0.00	0.10	0.34
Sb-125	2.77*	0.00	0.76	0.00	0.00
Cm243/44	28.5*	0.002	0.00	0.00	0.00
Sr-95	24.4**	0.00	0.00	0.00	0.00
Zr-95	64.02	0.00	0.15	2.40	0.00
SR-90	28.6*	0.00	0.01	0.00	0.00
Cr-51	27.7	0.00	0.00	1.70	0.00

BASED ON CHARACTERIZATION OF WASTE SAMPLES FROM PLANT OPERATIONS DURING 1988 TO 1991 AND RADMAN COMPUTER CODE.

DAW ISOTOPIC DISTRIBUTION IS BASED ON RADMAN COMPUTER CODE.

* HALF-LIFE IN YEARS
** HALF-LIFE IN SECONDS

TABLE 11.4A-2

AVERAGE ANNUAL ACTIVITY OF RADWASTE (RESINS/FILTERS)
(1988 TO 1991)

***** WASTE CLASS *****

TYPE/ PERIOD	***** CLASS A *****		***** CLASS B *****		***** CLASS C *****	
	VOLUME (ft ³)	ACTIVITY (mCi)	VOLUME (ft ³)	ACTIVITY (mCi)	VOLUME (ft ³)	ACTIVITY (mCi)
=====	=====	=====	=====	=====	=====	=====
	120.3	5.31E+05	120.3	5.05E+05	84.3	1.72E+04
	120.3	6.29E+05	120.3	2.56E+05		
	120.3	1.11E+05	205.8	2.31E+05		
1988 TO	411.6	3.46E+01	120.3	1.94E+05		
1991	411.6	1.06E+02	120.3	2.07E+05		
	205.8	2.64E+05				
	205.8	8.00E+03				
	388.2	1.30E+00				
	83.4	8.91E+02				
	83.4	8.53E+02				
	83.4	7.80E+03				
	83.4	2.12E+03				
	205.8	4.65E-02				
TOTAL	2523.3	1.55E+06	687	1.39E+06	84.3	1.72E+04
ANNUAL AVE	630.8	3.89E+05	171.8	3.48E+05	21.1	4.30E+03
mCi/Cuft		6.16E+02		2.03E+03		2.04E+02
PROJECTED VOL. CUFT.		710		200		80
EST'D Ci/Yr		4.37E+02		4.06E+02		1.63E+01

TABLE 11.4A-3A
ONE YEAR ISOTOPIC ACTIVITY OF RADWASTE
STORED AT WCGS (CURIE)

NUCLIDE	***** RESIN/EVA/FIL*****		***** DAW *****		***** YEAR TOTAL *****		
	710 CUFT CLASS A	200 CUFT CLASS B	80 CUFT CLASS C	2610 CUFT OUTAGE	1610 CUFT NON OUTAGE	3600 CUFT OUTAGE YR	2600 CUFT NON OUTAGE YR
Mn-54	6.25E+00	1.60E+01	2.94E-01	3.61E-02	2.22E-02	2.26E+01	2.26E+01
Fe-55	2.51E+02	8.81E+01	6.69E+00	1.48E+00	9.16E-01	3.47E+02	3.46E+02
Co-57	0.00E+00	1.75E+00	0.00E+00	2.74E-03	1.69E-03	1.75E+00	1.75E+00
Co-58	9.96E+00	9.22E+01	4.18E+00	4.20E-02	2.59E-02	1.06E+02	1.06E+02
Co-60	5.54E+01	4.75E+01	1.08E+00	6.19E-01	3.82E-01	1.05E+02	1.04E+02
Ni-59	0.00E+00	6.90E-01	0.00E+00	0.00E+00	0.00E+00	6.90E-01	6.90E-01
Ni-63	6.59E+01	6.58E+01	2.06E+00	1.83E-01	1.13E-01	1.34E+02	1.34E+02
Ag-110m	0.00E+00	0.00E+00	3.10E-01	5.97E-03	3.68E-03	3.16E-01	3.14E-01
H-3	3.85E+00	0.00E+00	5.55E-01	4.97E-04	3.07E-04	4.40E+00	4.40E+00
C-14	7.47E-01	2.19E+00	8.16E-02	0.00E+00	0.00E+00	3.02E+00	3.02E+00
Nb-95	0.00E+00	4.06E-01	2.61E-01	4.30E-02	2.65E-02	7.10E-01	6.94E-01
CS-134	1.76E+01	3.68E+01	4.90E-02	2.54E-02	1.56E-02	5.45E+01	5.45E+01
CS-137	2.65E+01	5.08E+01	8.16E-02	3.63E-02	2.24E-02	7.74E+01	7.74E+01
Ce-144	0.00E+00	0.00E+00	1.63E-02	8.46E-03	5.22E-03	2.48E-02	2.15E-02
Sb-125	4.37E-03	3.09E+00	0.00E+00	0.00E+00	0.00E+00	3.09E+00	3.09E+00
Cm243/44	8.74E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.74E-03	8.74E-03
Sr-95	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zr-95	0.00E+00	6.09E-01	3.92E-01	0.00E+00	0.00E+00	1.00E+00	1.00E+00
Sr-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	0.00E+00	4.06E-02	0.00E+00	0.00E+00	0.00E+00	4.06E-02	4.06E-02
Cr-51	0.00E+00	0.00E+00	2.77E-01	0.00E+00	0.00E+00	2.77E-01	2.77E-01
Fe-59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTALS	4.37E+02	4.05E+02	1.57E+01	2.49E+00	1.53E+00	8.60E+02	8.59E+02

NOTES: ISOTOPIC DISTRIBUTION IS BASED ON CHARACTERIZATION OF WASTE SAMPLE (CLASS B) AND RADMAN COMPUTER PROGRAM (CLASS A/B):

- CLASS A - FEBRUARY 1991 SHIPMENT PL6-80
- CLASS B - CVCS WASTE IN PL8-120 POLY HIC, MAY 1991 SHIPMENT
- CLASS C - FILTER SHIPMENT IN PL6-80. SEPTEMBER 1990.

THE ONE YEAR TOTAL ACTIVITY IS BASED ON:
1993 OUTAGE YEAR. RADWASTE ACTIVITY WITH NO DECAY.

TABLE 11.4A-3B
TWO YEAR PROJECTED ISOTOPIC ACTIVITY OF RADWASTE
STORED WITHIN THE IOS (CURIE)

NUCLIDE	HIGH LEVEL STORAGE	***** LOW LEVEL STORAGE AREA *****			
		SEC 5 8 PL-120 C & 12%A	SEC 6 3 PL-215 C & 12%A	SEC 7 16 B25 DAW	SEC 8 70 DRUMS DAW
=====	=====	=====	=====	=====	=====
Mn-54	3.00E+01	1.51E+00	1.08E+00	4.35E-02	2.90E-02
Fe-55	4.94E+02	6.61E+01	5.34E+01	1.79E+00	1.19E+00
Co-57	2.43E+00	0.00E+00	0.00E+00	3.30E-03	2.20E-03
Co-58	1.03E+02	5.52E+00	1.23E+00	5.07E-02	3.38E-02
Co-60	1.68E+02	1.45E+01	1.25E+01	7.47E-01	4.98E-01
Ni-59	1.33E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	2.31E+02	1.98E+01	1.58E+01	2.21E-01	1.47E-01
Ag-110m	0.00E+00	4.23E-01	0.00E+00	7.20E-03	4.80E-03
H-3	5.68E+00	1.98E+00	8.98E-01	6.00E-04	4.00E-04
C-14	5.52E+00	3.43E-01	1.79E-01	0.00E+00	0.00E+00
Nb-95	4.06E-01	2.61E-01	0.00E+00	5.19E-02	3.46E-02
Cs-134	8.60E+01	3.70E+00	3.61E+00	3.06E-02	2.04E-02
Cs-137	1.40E+02	6.46E+00	6.29E+00	4.38E-02	2.92E-02
Ce-144	0.00E+00	2.30E-02	0.00E+00	1.02E-02	6.80E-03
Sb-125	5.49E+00	9.33E-04	9.33E-04	0.00E+00	0.00E+00
Cm243/44	1.31E-02	2.07E-03	2.07E-03	0.00E+00	0.00E+00
Zr-95	6.21E-01	3.00E-01	0.00E+00	0.00E+00	0.00E+00
SR-90	8.02E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cr-51	0.00E+00	2.77E-01	0.00E+00	0.00E+00	0.00E+00
=====	=====	=====	=====	=====	=====
TOTAL	1.27E+03	1.21E+02	9.50E+01	3.00E+00	2.00E+00

NOTE: The activities of the DAW stored at the Drum Areas A and B are estimated at 2 and 1 curies, respectively. They will have negligible contributions to the dose rates.

The two year activity is based on the sum of the first year activity decayed for one year and the second year activity with no decay.

TABLE 11.4A-3C
THREE YEAR PROJECTED ISOTOPIC ACTIVITY OF RADWASTE
STORED WITHIN THE IOS (CURIE)

NUCLIDE	HIGH LEVEL STORAGE				***** LOW LEVEL STORAGE AREA *****				*** DRUM STORAGE ***	
	SEC 1+2 12 PL120 CL76%A&B	SEC 5 3 (PL80) CL C+12%A	SEC 6 4 PL215 CL 12%A	SEC 7 26 B25 DAW	SEC 8 100 DRUM DAW	AREA A DAW	AREA B DAW	***	***	***
Mn-54	3.41E+01	1.71E+00	1.23E+00	5.80E-02	4.36E-02	2.30E-02	1.15E-02			
Fe-55	6.61E+02	8.72E+01	7.13E+01	2.39E+00	1.79E+00	1.50E+00	7.48E-01			
Co-57	2.70E+00	0.00E+00	0.00E+00	4.40E-03	3.31E-03	1.61E-03	8.04E-04			
Co-58	1.03E+02	5.53E+00	1.23E+00	6.76E-02	5.08E-02	1.36E-02	6.79E-03			
Co-60	2.37E+02	2.04E+01	1.76E+01	9.96E-01	7.49E-01	7.11E-01	3.55E-01			
Ni-59	2.07E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
Ni-63	3.45E+02	2.97E+01	2.35E+01	2.95E-01	2.22E-01	2.42E-01	1.21E-01			
Ag-110m	0.00E+00	4.64E-01	0.00E+00	9.60E-03	7.22E-03	3.35E-03	1.67E-03			
H-3	8.30E+00	2.88E+00	1.31E+00	8.00E-04	6.01E-04	6.20E-04	3.10E-04			
C-14	8.28E+00	5.14E-01	2.69E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
Nb-95	4.06E-01	2.61E-01	0.00E+00	6.92E-02	5.20E-02	1.33E-02	6.64E-03			
CS-134	1.12E+02	4.80E+00	4.69E+00	4.08E-02	3.07E-02	2.37E-02	1.18E-02			
CS-137	2.08E+02	9.57E+00	9.33E+00	5.84E-02	4.39E-02	4.70E-02	2.35E-02			
Ce-144	0.00E+00	2.58E-02	0.00E+00	1.36E-02	1.02E-02	5.10E-03	2.55E-03			
Sb-125	7.37E+00	1.25E-03	1.25E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
Ce243/44	1.95E-02	3.07E-03	3.07E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
Zr-95	6.21E-01	3.99E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
Sr-90	1.19E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
Cr-51	0.00E+00	2.77E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
TOTALS	1.73E+03	1.64E+02	1.31E+02	4.00E+00	3.00E+00	2.58E+00	1.29E+00			

THE THREE YEAR TOTAL ACTIVITY IS BASED ON THE SUM OF:
 1993 OUTAGE YEAR. RADWASTE ACTIVITY DECAYED FOR 2 YEARS.
 1994 OUTAGE YEAR. RADWASTE ACTIVITY DECAYED FOR 1 YEAR.
 1995 NON-OUTAGE YEAR. RADWASTE ACTIVITY WITH NO DECAY.

TABLE 11.4A-3D
 FIVE YEAR PROJECTED ISOTOPIC ACTIVITY OF RADWASTE
 STORED WITHIN THE IOS (CURIE)

NUCLIDE	HIGH LEVEL STORAGE		** LOW LEVEL STORAGE AREA **				** DRUM STORAGE AREAS **					
	5 (PL80) CLC+12%A	6 PL215 CL 12%A	36 B25 6 Ci DAW	162 DRUM 5 Ci DAW	147 DRUMS 4 Ci DAW	72 DRUMS 2 Ci DAW	SEC 5	SEC 6	SEC 7	SEC 8	AREA A	AREA B
Mn-54	3.67E+01	1.81E+00	8.70E-02	7.25E-02	5.80E-02	2.90E-02						
Fe-55	8.90E+02	1.15E+02	3.58E+00	2.99E+00	2.40E+00	1.20E+00						
Co-57	2.85E+00	0.00E+00	6.60E-03	5.50E-03	4.40E-03	2.20E-03						
Co-58	1.03E+02	5.49E+00	1.01E-01	8.45E-02	6.76E-02	3.38E-02						
Co-60	3.50E+02	2.95E+01	1.49E+00	1.25E+00	9.96E-01	4.98E-01						
Ni-59	3.45E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00						
Ni-63	5.71E+02	4.80E+01	3.79E+01	4.42E-01	3.69E-01	1.47E-01						
Ag-110m	0.00E+00	4.84E-01	0.00E+00	1.44E-02	1.20E-02	4.80E-03						
H-3	1.31E+01	4.50E+00	2.01E+00	1.20E-03	1.04E-04	4.00E-04						
C-14	1.38E+01	8.43E-01	4.36E-01	0.00E+00	0.00E+00	0.00E+00						
Nb-95	4.06E-01	2.61E-01	0.00E+00	1.04E-01	8.65E-02	3.46E-02						
Cs-134	1.43E+02	5.98E+00	5.84E+00	6.12E-02	5.10E-02	2.04E-02						
Cs-137	3.39E+02	1.52E+01	1.48E+01	8.76E-02	7.90E-02	2.92E-02						
Ce-144	0.00E+00	2.74E-02	0.00E+00	2.04E-02	1.70E-02	6.80E-03						
Sb-125	9.96E+00	1.64E-03	1.64E-03	0.00E+00	0.00E+00	0.00E+00						
Cm243/44	3.17E-02	4.86E-02	4.86E-03	0.00E+00	0.00E+00	0.00E+00						
Zr-95	6.21E-01	3.99E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00						
SR-90	1.94E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00						
Cr-51	0.00E+00	2.77E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00						
TOTAL	2.48E+03	2.28E+02	1.82E+02	6.00E+00	5.00E+00	4.00E+00						

GRAND TOTAL - 2.91E+03

THE FIVE YEAR TOTAL ACTIVITY IS BASED ON THE SUM OF:

- 1993 OUTAGE YEAR. RADWASTE ACTIVITY DECAYED FOR 4 YEARS.
- 1994 OUTAGE YEAR. RADWASTE ACTIVITY DECAYED FOR 3 YEARS.
- 1995 NON-OUTAGE YEAR. RADWASTE ACTIVITY DECAYED FOR 2 YEARS
- 1996 OUTAGE YEAR. RADWASTE ACTIVITY DECAYED FOR 1 YEAR.
- 1997 OUTAGE YEAR. RADWASTE ACTIVITY WITH NO DECAY.

TABLE 11.4A-4

Estimated Capacity and Radwaste Container
Distribution for the IOS Facility

AREA ACTIVITY (CURIE)	DIMENSIONS (Inside)	WASTE TYPE	CONTAINERS	5 Yr CAPACITY* (cuft)
HLSA 2,480	30' x 20'9"	Primary Resin	20 PL8-120	2,406
LLSA	30' x 46'			
SECTION 5 228		Resin/ Filter	5 PL6-80	417
SECTION 6 182		Sec Resin	6 PL14-215	1,235
SECTION 7 6		DAW	36 B25-boxes	3,456
SECTION 8 5		DAW	162 Drums	1,782
DRUM AREA 'A' 4	5'5" x 32'11"	DAW	147 Drums	1,617
DRUM AREA 'B' 2	15'5" x 17'10"	DAW	72 Drums	792
TOTAL 2,907	60' x 100'		31 HICS	11,705

including Truck Bay: 36 boxes and 381 drums

* Volume is based on the Following anticipated usage and waste configuration as shown in Figure 11.4A-1.

WASTE STREAM	CONTAINER TYPE	CONTAINER VOLUME
PRIMARY RESIN	PL8-120	120.3 cuft
SECONDARY RESIN	PL14-215	205.8 cuft
FILTERS	PL6-80	83.4 cuft
DAW	85 Gal.Drum	11 cuft
	79 Gal.Drum	11 cuft
	55 Gal.Drum	7.5 cuft
	B-25 Box	96 cuft

TABLE 11.4A-5A

Total Offsite Dose Rates (mrem/hr)
from 3-Year Storage (2,036 Ci)

Distance From Outside Wall

	Surface	1 M	15 M	29 M	43 M	57 M
<u>WEST SIDE</u>						
Skyshine Dose Rate	3.2298	2.8393	1.2070	0.7552	0.5252	0.3842
Direct Exposure Dose Rate	<u>0.0734</u>	<u>0.0636</u>	<u>0.0056</u>	<u>0.0016</u>	<u>0.0007</u>	<u>0.0004</u>
TOTAL	3.3032	2.9029	1.2126	0.7568	0.5259	0.3846

SOUTH SIDE

Skyshine Dose Rate	1.0911	1.0462	0.6956	0.4989		
Direct Exposure Dose Rate	<u>0.0029</u>	<u>0.0025</u>	<u>0.0006</u>	<u>0.0001</u>		
TOTAL	1.0940	1.0487	0.6962	0.4990		

EAST SIDE

Skyshine Dose Rate	1.6607	1.6027	0.9932	0.6874	0.5042	0.3814
Direct Exposure Dose Rate	<u>0.1427</u>	<u>0.1119</u>	<u>0.0108</u>	<u>0.0033</u>	<u>0.0015</u>	<u>0.0008</u>
TOTAL	1.8034	1.7146	1.004	0.6907	0.5057	0.3822

TABLE 11.4A-5B

Total Offsite Dose Rates (mrem/hr)
from 5-Year Storage (2907 Ci)

Distance From Outside Wall

Surface 1 M 15 M 29 M 43 M 57 M

WEST SIDE

Skyshine Dose Rate 4.3900 3.9586 1.8515 1.1887 0.8382 0.6192

Direct Exposure Dose Rate 0.0812 0.0698 0.0060 0.0017 0.0007 0.0004

TOTAL 4.4712 4.0284 1.8575 1.1904 0.8389 0.6196

SOUTH SIDE

Skyshine Dose Rate 1.5180 1.4572 0.9716 0.6975

Direct Exposure Dose Rate 0.0038 0.0032 0.0008 0.0003

TOTAL 1.5218 1.4604 0.9724 0.6978

EAST SIDE

Skyshine Dose Rate 2.6574 2.5690 1.5443 1.0742 0.7904 0.5993

Direct Exposure Dose Rate 0.2281 0.1791 0.0173 0.0053 0.0024 0.0013

TOTAL 2.8855 2.7481 1.5616 1.0795 0.7928 0.6006

TABLE 11.4A-6

TOTAL DOSE RATES (mrem/hr)
ALONG THE SOUTH RCA BOUNDARY
West Side of the IOS

Source	Surface	Distance From the West Wall (METERS)				
		1 M	15 M	29 M	43 M	57 M
1. HLSA	2.0385	1.9962	1.3601	0.9027	0.6527	0.4913
2. LLSA Section 5*	0.1856	0.1811	0.1182	0.0755	0.0543	0.0409
LLSA Section 6*	<u>0.1593</u>	<u>0.1500</u>	<u>0.0743</u>	<u>0.0484</u>	<u>0.0343</u>	<u>0.0254</u>
Total 5 Yr Dose Rate	2.3834	2.3273	1.5526	1.0266	0.7413	0.5576

* - Low Level Storage Sections are described by Figure 11.4A-1.

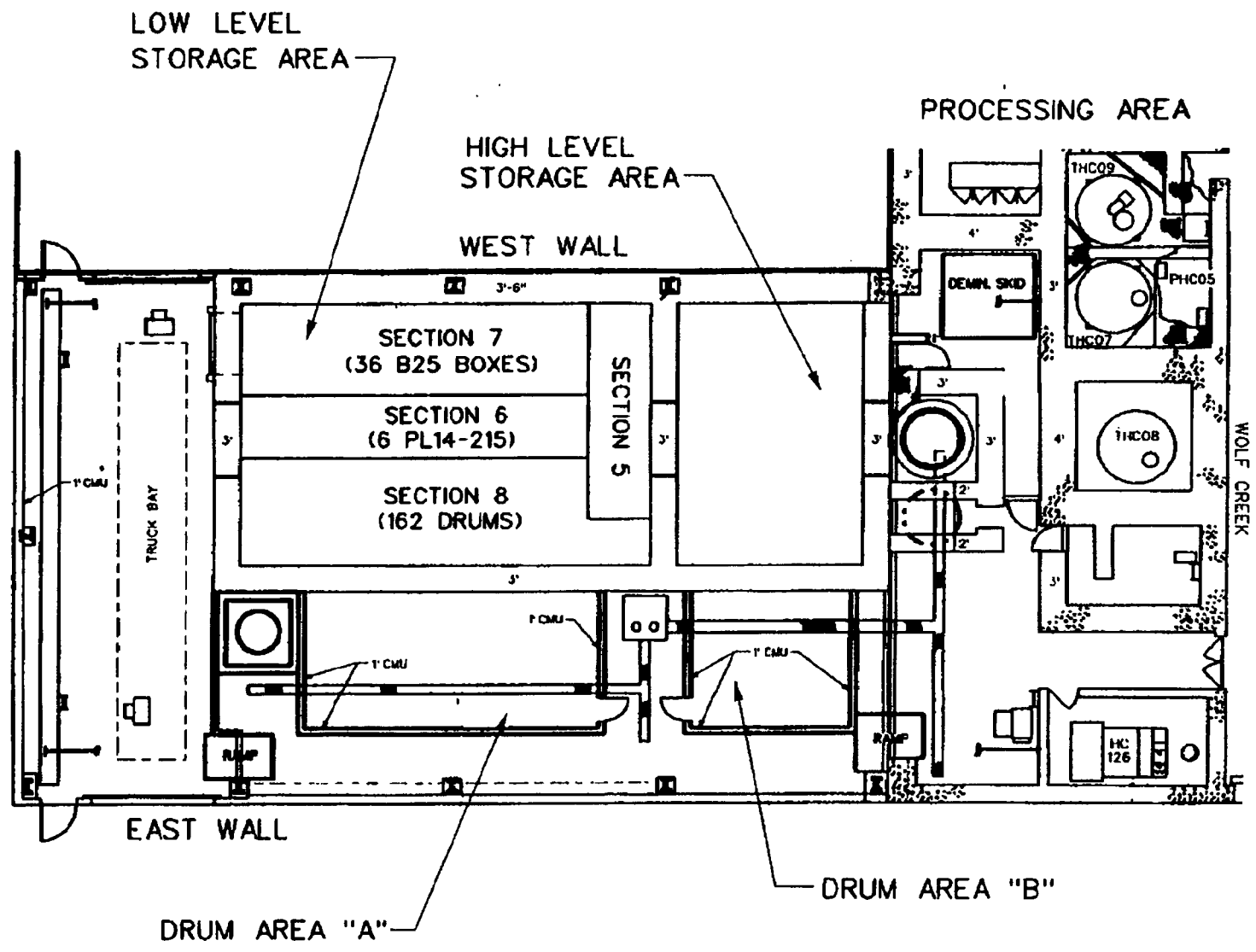
TABLE 11.4A-7
TOTAL OFFSITE DOSE AT THE UNRESTRICTED AREA
(Exclusion Area Boundary, EAB, is 1200 meters
from Center of Containment)

Source/EAB direction	Dose at the EAB	
	Hourly Dose (mrem/hr)	Annual Dose (mrem/yr)
5 Year Storage		
<u>West Side</u>		
High Level Storage	1.5160E-06	
Low Level Storage 5	1.1515E-07	
Low Level Storage 6	<u>5.4731E-08</u>	
5 yr Storage Dose At West EAB	1.6859E-06	0.0148
<u>South Side</u>		
High Level Storage	7.7607E-07	
Low Level Storage 5	8.0440E-07	
Low Level Storage 6	<u>1.7227E-07</u>	
5 yr Storage Dose At South EAB	1.7527E-06	0.0154
<u>East Side</u>		
High Level Storage	1.7690E-06	
Low Level Storage 5	1.1512E-07	
Low Level Storage 6	<u>6.1442E-08</u>	
5 yr Storage Dose At East EAB	1.9456E-06	0.0171
3 Year Storage		
<u>West Side</u>		
High Level Storage	4.9940E-07	
Low Level Storage 5	4.2856E-08	
Low Level Storage 6	<u>3.8725E-08</u>	
3 yr Storage Dose At West EAB	5.8097E-07	0.0051
<u>South Side</u>		
High Level Storage	5.4989E-07	
Low Level Storage 5	5.3937E-07	
Low Level Storage 6	<u>5.9423E-08</u>	
3 yr Storage Dose At South EAB	1.1486E-06	0.0101

TABLE 11.4A-7 (Sheet 2)
TOTAL OFFSITE DOSE AT THE UNRESTRICTED AREA
 (Exclusion Area Boundary, EAB, is 1200 meters
 from Center of Containment - Continued)

Source/EAB direction	Dose at the EAB	
	Hourly Dose (mrem/hr)	Annual Dose (mrem/yr)
<u>East Side</u>		
High Level Storage	8.9247E-07	
Low Level Storage 5	9.6958E-08	
Low Level Storage 6	<u>4.3531E-08</u>	
3 yr Storage Dose At East EAB	1.0330E-06	0.0091
2 Year Storage		
High Level Storage	8.3118E-07	
Low Level Storage 5	2.3780E-08	
Low Level Storage 6	<u>2.7916E-08</u>	
2 yr Storage Dose At West EAB	8.8288E-07	.0077
<u>South Side</u>		
High Level Storage	4.0898E-07	
Low Level Storage 5	4.1932E-07	
Low Level Storage 6	<u>2.7141E-08</u>	
3 yr Storage Dose At South EAB	8.5544E-07	.0075
<u>East Side</u>		
High Level Storage	4.5226E-07	
Low Level Storage 5	8.8748E-08	
Low Level Storage 6	<u>3.1376E-08</u>	
2 yr Storage Dose At East EAB	5.7238E-07	0.0050

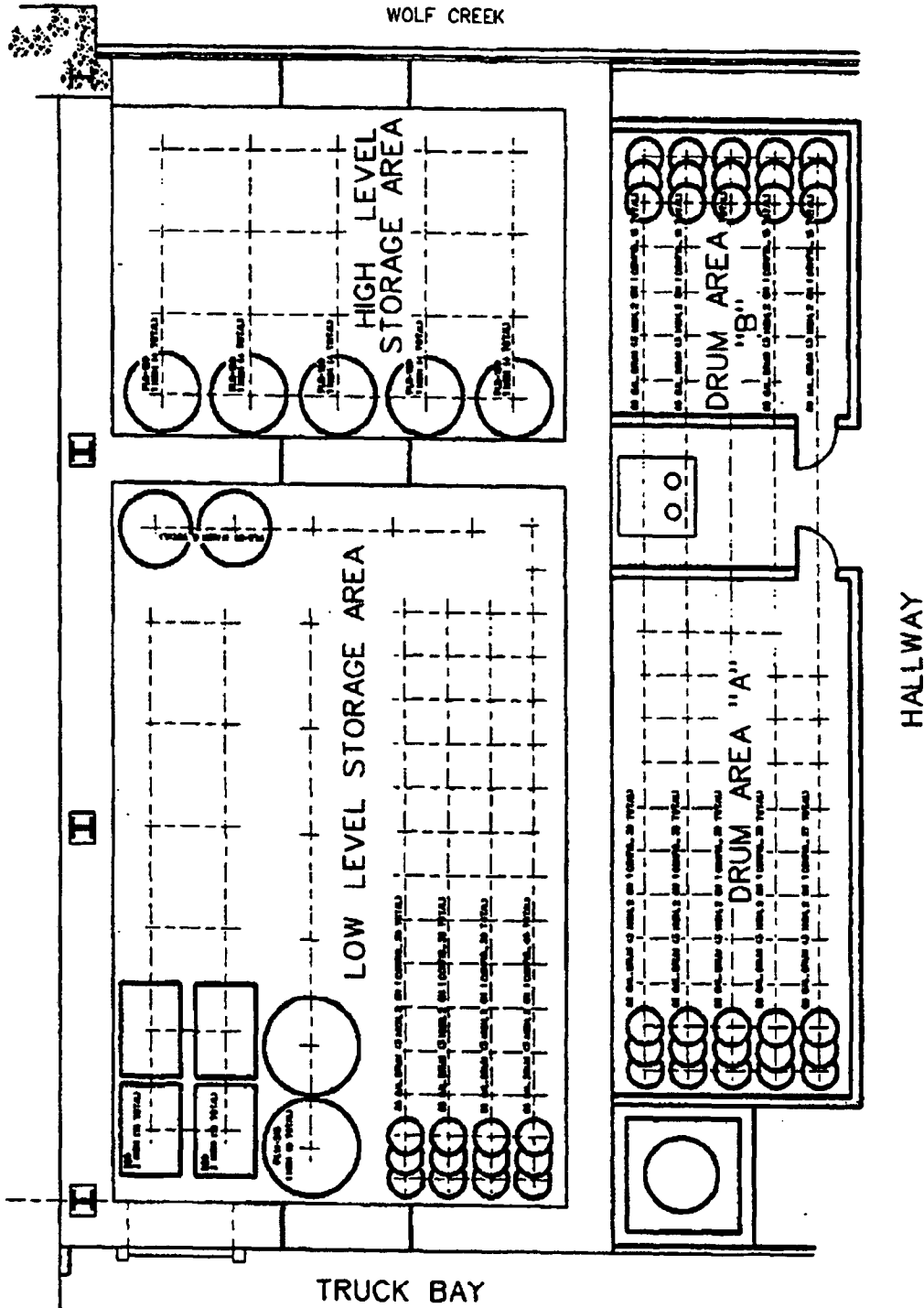
NOTE: Low Level Storage Sections are described by Figure 11.4A-1.



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FIGURE 11.4A-1
 LAYOUT OF THE INTERIM
 ONSITE STORAGE FACILITY

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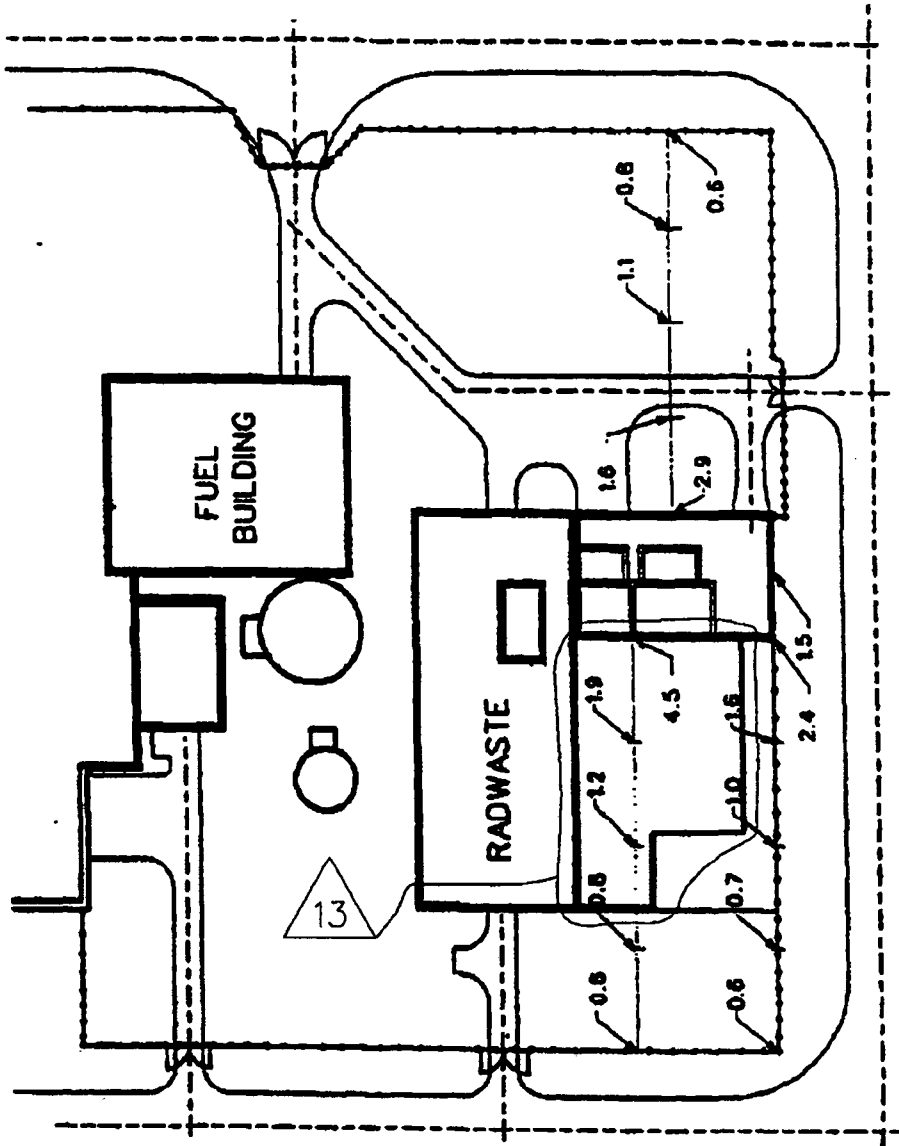


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FIGURE 11.4A-2
STORAGE CONFIGURATION OF THE
INTERIM ONSITE STORAGE FACILITY

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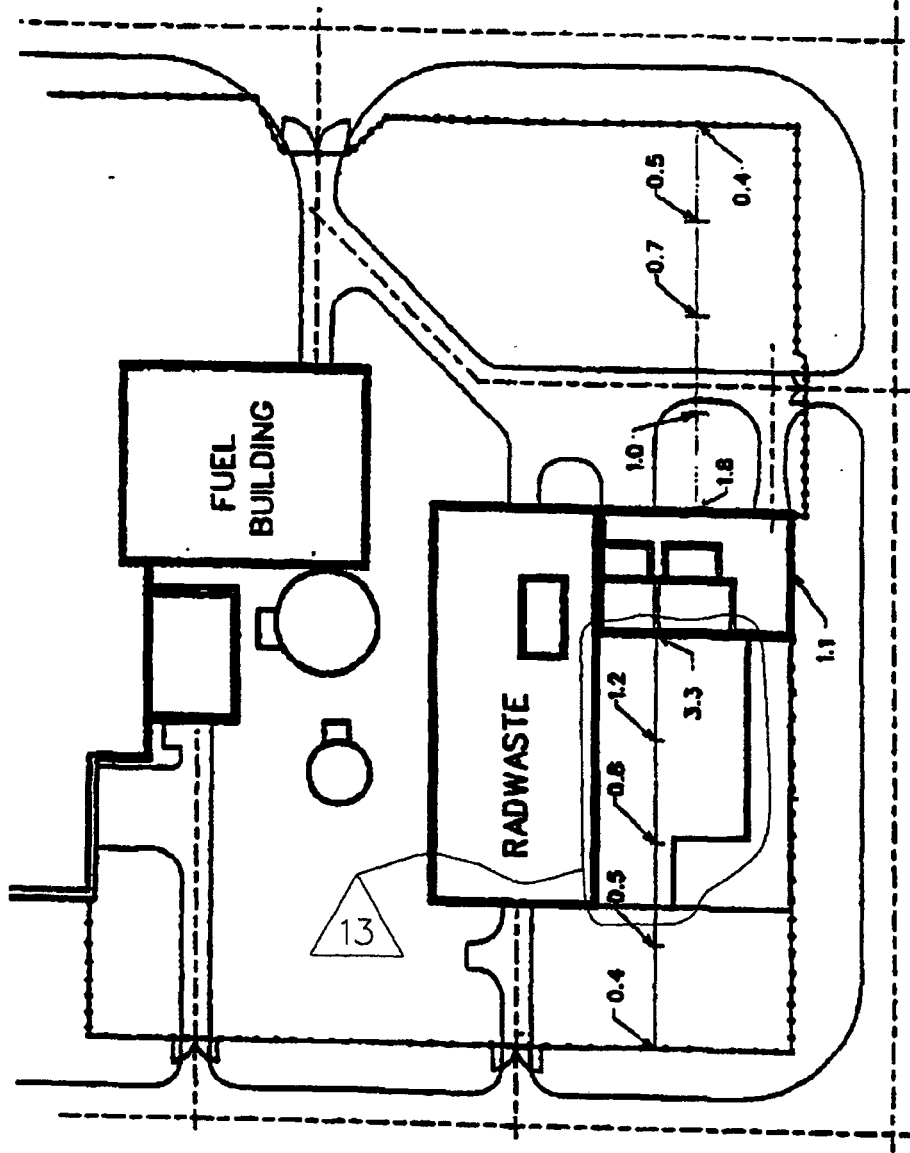
NOTE:
THESE NUMBERS ARE DOSE RATES (mrem/hr) FROM 5 YEAR STORAGE

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Figure 11.4A-3
TOTAL DOSE RATES OUTSIDE THE IOS
UP TO THE RCA BOUNDARY

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NOTE:
THESE NUMBERS ARE DOSE RATES (mrem/hr) FROM 3 YEAR STORAGE

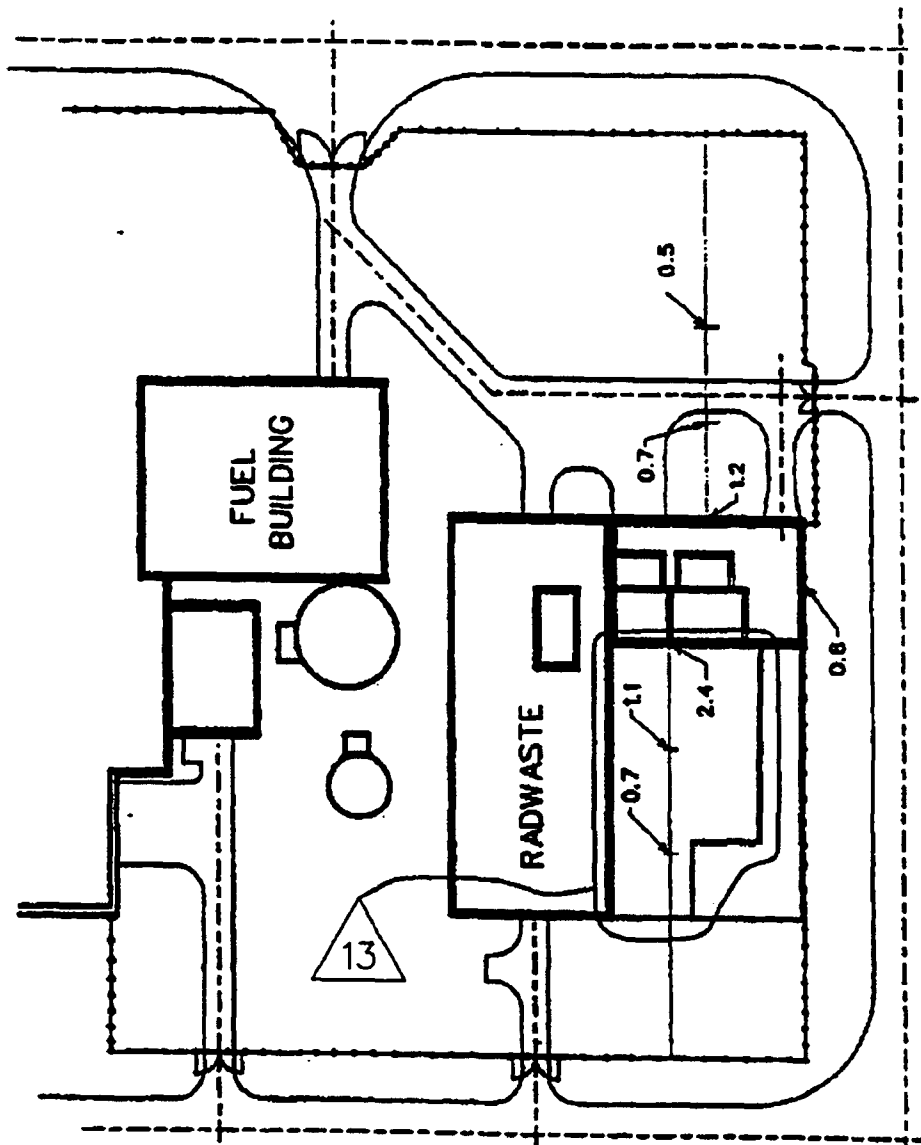
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Figure 11.4A-3A

TOTAL DOSE RATES OUTSIDE THE 105
UP TO THE RCA BOUNDARY

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NOTE:
THESE NUMBERS ARE DOSE RATES (mrem/hr) FROM 2 YEAR STORAGE

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Figure 11.4A-3B
TOTAL DOSE RATES OUTSIDE THE IOS
UP TO THE RCA BOUNDARY

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11.5 PROCESS AND EFFLUENT RADIOLOGICAL MONITORING AND SAMPLING SYSTEMS

The function of the process and effluent radiological monitoring systems is to monitor, record, and control the release of radioactive materials that may be generated during normal operation, anticipated operational occurrences, and postulated accidents.

The process and effluent radioactivity monitoring systems furnish information to operations personnel concerning radioactivity levels in principal plant process streams and atmospheres. The monitoring systems indicate and alarm excessive radioactivity levels (GDC-63). They initiate operation of standby systems, provide inputs to the ventilation and liquid discharge isolation systems, and record the rate of release of radioactive materials to the environs, as outlined in Regulatory Guide 1.21 and GDCs 60 and 64. The systems consist of permanently installed, continuous-monitoring devices together with a program and provisions for specific sample collections and laboratory analyses.

11.5.1 DESIGN BASES

The principal objectives and criteria of the process and effluent radiological monitoring systems are provided below.

11.5.1.1 Safety Design Bases

SAFETY DESIGN BASES - The control room ventilation monitors, the containment atmosphere monitors, the containment purge monitors, and the fuel building exhaust monitors are designed to activate engineered safety features systems in the event that airborne radioactivity in excess of allowable limits exists. Additional design bases are stated in the following sections:

- a. Containment purge isolation system, Sections 6.2.4, 7.3.2, 9.4.6, and 12.3.4.
- b. Fuel building ventilation isolation, Sections 7.3.3, 9.4.2, and 12.3.4.
- c. Control room intake isolation, Sections 6.4.1, 7.3.4, 9.4.1, and 12.3.4.

These radioactivity monitors are protection system elements and are designed in accordance with IEEE Standard 279.

The safety evaluation of these systems is discussed in Section 7.3.

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These monitors also serve for in-plant worker protection, and this function is discussed in Section 12.3.4. Compliance with Regulatory Guide 1.97 is discussed in Appendix 7A.

11.5.1.2 Power Generation Design Bases

POWER GENERATION DESIGN BASIS ONE - The process and effluent radioactivity monitors operate continuously during both intermittent and continuous discharges of potentially radioactive plant effluents, in compliance with Regulatory Guide 1.21. The monitors verify that the most restrictive anticipated nuclides are at concentrations within the limits specified in 10 CFR 20 and that the concentrations are low enough that 10 CFR 50, Appendix I, dose guidelines are met for unrestricted areas.

POWER GENERATION DESIGN BASIS TWO - The process and effluent radioactivity monitors alarm and automatically terminate the release of effluents when radionuclide concentrations exceed the limits specified (GDC-60). Where termination of releases is not feasible, the monitors provide continuous indication of the magnitude of the activity released.

POWER GENERATION DESIGN BASIS THREE - The radwaste process system monitors measure radioactivity in process streams to aid personnel in the treatment of radioactive fluids prior to recycle or discharge (GDC-63).

POWER GENERATION DESIGN BASIS FOUR - The process and effluent radioactivity monitors monitor the containment atmosphere, spaces containing components for recirculation of LOCA fluids, and effluent discharge paths for radioactivity that may be released from postulated accidents, as required by GDC-64.

POWER GENERATION DESIGN BASIS FIVE - The process and effluent monitors indicate the existence and, to the extent possible, the magnitude of reactor coolant and reactor auxiliary system leakage to the containment atmosphere, cooling water systems, or the secondary side of the steam generators.

POWER GENERATION DESIGN BASIS SIX - The process and effluent radioactivity monitors provide alarm and automatic termination of the transfer of radioactivity fluids to storage facilities in zone A areas, defined in Section 12.4.1.1.

POWER GENERATION DESIGN BASIS SEVEN - Process radioactivity monitors provide alarm and gross indication of the extent of any failed fuel within the primary system.

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POWER GENERATION DESIGN BASIS EIGHT - The effluent radioactivity monitors provide sufficient radioactivity release data to prepare the reports required by Regulatory Guide 1.21.

11.5.1.3 Codes and Standards

Codes and standards applicable to the process and effluent radioactivity monitors are indicated in Table 3.2-1. The monitors listed in Section 11.5.1.1 are designed as protection system elements.

11.5.2 SYSTEM DESCRIPTION

11.5.2.1 General Description

11.5.2.1.1 Data Collection

The process and effluent radiological monitoring systems consist of liquid and airborne radioactivity monitors with the attendant controls, alarms, pumps, valves, and indicators required to meet the design bases. Each monitor consists of the detector assembly and a local microprocessor. The local microprocessor processes the detector assembly signal in digital form, computes average radioactivity levels, stores data, performs alarm or control functions, and transmits the digital signal to the control room microprocessor. Signal transmission is accomplished via redundant data highways. A single fault in either data highway would not prevent the control room microprocessor from receiving the data.

The local microprocessors for monitors which perform safety functions (control room ventilation, fuel building ventilation, containment atmosphere, and containment purge monitors, refer to Section 12.3.4) are wired directly to individual indicators located on the seismic Category I radioactivity monitoring system cabinets in the control room. The input from the safety-related channels to the daisy-chain loop is an isolated signal to ensure that the safety-related signals are not affected by signals or conditions existing in the nonsafety portion of the system.

The control room microprocessor provides controls and indication for the radioactivity monitoring system. Indication is via a CRT located in the control room. The signals from each monitor may also be recorded on a system printer.

11.5.2.1.2 Alarms

Each monitor channel is provided with a three-level alarm system. One alarm setpoint is below the background counting rate and serves as a circuit failure alarm. The other two-alarm setpoints provide sequential alarms on increasing radioactivity levels. Loss

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of power causes an alarm on all three-alarm circuits. The alarms must be manually reset and can be reset only after the alarm condition is corrected.

11.5.2.1.3 Check Sources

Each monitor is provided with a check source, operated from the control room, which simulates a radioactive sample in the detector assembly for operational and gross calibration checks.

11.5.2.1.4 Power Supplies

All Class IE radioactivity monitoring systems are powered from Class IE motor control centers. The power supplies for all of the monitors are given in Table 11.5-5.

11.5.2.1.5 Calibration and Maintenance

The radioactivity monitors are calibrated by the manufacturer for at least the principal radionuclides listed in Tables 11.5-1 through 11.5-4. The manufacturer's calibration standards are traceable to National Institute of Standards and Technology primary calibration standard sources and are accurate to at least 5 percent. The source detector geometry during this primary calibration is identical to the sample detector geometry. Secondary standards counted in reproducible geometry during the primary calibration are supplied with each continuous monitor. Each continuous monitor is calibrated at a frequency established by station procedures.

The count rate response of each continuous monitor to remotely positionable check sources is recorded by the manufacturer after the primary calibration. This count rate response and background count rate is checked at intervals specified by plant procedures during reactor operation.

Surveillance is performed in accordance with Technical Specifications or the ODCM.

Any fluid released to the environment is analyzed for radioactivity prior to release. If, at any time, a monitor requires maintenance or decontamination, the process flow is terminated or periodic grab sampling with laboratory analysis is implemented.

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This does not impair system integrity since the detector is off-line and not installed in the stream.

11.5.2.1.6 Sensitivities

Each effluent monitoring system is able to detect a minimum concentration within the release limits established in the Technical Specifications.

Due to sensitivity considerations, monitors are located at the effluent release points. Dilution factors between the release point and the site boundary are considered in complying with the limitations of 10 CFR 50, Appendix I. Tables 11.5-1 through 11.5-4 provide the detailed sensitivity selection criteria for the process and effluent monitors.

11.5.2.1.7 Monitor Locations

The location of each process and effluent radioactivity monitor is shown on the radiation zone drawings, Figure 12.3-2. The monitors are located in low background areas, near the systems being monitored, to minimize background and sampling interferences.

11.5.2.1.8 Ranges and Setpoints

The ranges of the various process monitors are based on the expected activity levels in the system being monitored. The bases for their setpoints are determined by the need for process control and to alert the operators of leakage of radioactivity into normally nonradioactive systems.

The ranges of the various effluent monitors are based on the ability to detect radioactivity concentrations at the effluent release point which might result in site boundary doses in excess of 10 CFR 50 Appendix I levels to those from postulated accidents. The Hi alarm is administratively established at a point sufficiently below the Hi-Hi alarm so as to provide additional assurance that Technical Specification limits are not exceeded. The Hi-Hi alarm is established to ensure that Technical Specification limits are not exceeded. (See Offsite Dose Calculation Manual.)

The ranges and setpoints for the process and effluent monitors are provided in Tables 11.5-1 through 11.5-4.

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11.5.2.1.9 Expected System Parameters

The expected ranges of system parameters, such as flow, composition, and concentrations, are summarized in Tables 11.5-1 through 11.5-4. Detailed information on the individual systems can be found in other sections of the USAR, principally Chapters 9.0 and 11.0.

11.5.2.2 Liquid Monitoring Systems

11.5.2.2.1 Selection Criteria for Liquid Monitors

The liquid monitors consist of fixed-volume, off-line, leadshielded sample chambers through which the liquid samples flow. A NaI(Tl) gamma scintillation detector is located within each sample chamber to detect the activity level. The detector assemblies monitor gross gamma activity in the range of 10^{-7} to 10^{-2} mCi/ml. These range apply to all liquid monitors except O-SJ-RE-01. The controlling isotope for the liquid monitors is Cs-137. Minimum detectable concentrations are listed in Tables 11.5-1 and 11.5-2.

A manually operated isolation valve at the sample chamber inlet is provided to permit purging of the sample chamber to facilitate background activity checks. A source of noncontaminated water is provided for decontamination purposes.

Sample chambers in which permanent contamination interferes with measurement can readily be replaced. Liquid monitor alarms are annunciated in the control room on the plant annunciator, the NPIS computer, and the radiation monitoring system CRT (RM-11). The NPIS computer located in the TSC provides a visual display of alarm status. The RM-11 in the control room provides audible and visual alarm indication.

The liquid radioactivity monitors are located to comply with the design bases. The specific sample points are selected to provide representative samples of the systems monitored, to reduce sample transport times, and to limit the amount of radioactivity released in the event of a high radioactivity signal.

The continuous liquid radioactivity monitoring systems are discussed in the following sections. A summary of the functions and characteristics of each monitor is presented in Tables 11.5-1 and 11.5-2.

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11.5.2.2.2 Liquid Process Radioactivity Monitors

A detailed listing of liquid process monitor parameters is given in Table 11.5-1.

11.5.2.2.2.1 Component Cooling Water Monitors

The component cooling water system (CCWS) is discussed in Section 9.2.2.

The CCWS radioactivity monitors, 0-EG-RE-9 and 0-EG-RE-10, detect, indicate, and alarm elevated radiation levels in the CCWS. The elevated radiation levels would be indicative of radioactive leakage into the CCWS from systems and components served by the CCWS. Each detector assembly receives a continuous sample flow when an associated CCWS pump is operating. The CCWS pumps provide the motive force for the sample flow. Each detector sample is taken from the CCWS upstream of the CCW heat exchanger and the sample is returned to the CCWS downstream of the heat exchanger. The alert alarm provides indication of radioactive inleakage to the system. A high alarm is provided to indicate increasing radioactivity levels and to close the component cooling water surge tank air vent and makeup water valves.

11.5.2.2.2.2 Steam Generator Liquid Radioactivity Monitor

The steam generator liquid sample system is discussed in Section 9.3.2.

The steam generator liquid radioactivity monitor, 0-SJ-RE-2, continuously monitors the blowdown from the steam generators, either individually or collectively, to detect, indicate, and alarm primary-to-secondary system leaks in the steam generators. This monitor closes the steam generator blowdown isolation valves on high radiation to prevent the discharge of radioactive fluid and to limit radioactive contamination of the blowdown demineralizers. The monitor also provides backup information and verification of the condenser air removal system gaseous radioactivity monitor (Section 11.5.2.3.2.1). The fixed-volume detector assembly receives a continuous flow from the steam generator liquid sample header which samples the tube sheet area near the minimum water level of the steam generators. The sample point is located downstream of the sample system heat exchanger to provide conditioning and pressure reduction of the radioactivity monitor sample. The radioactivity alarms provide indication of primary-to-secondary leakage in the steam generator.

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11.5.2.2.2.3 Steam Generator Blowdown Processing System Radio-activity Monitor

The steam generator blowdown processing system is discussed in Section 10.4.8.

The steam generator blowdown process radioactivity monitor, 0-BM-RE-25, continuously monitors the fluid entering the steam generator blowdown filters to detect, alarm, and indicate excessive radioactivity levels in the blowdown system. The steam generator blowdown process radioactivity monitor acts to terminate blowdown from the steam generators to prevent discharge of radioactive fluid and to limit radioactive contamination of the blowdown demineralizers. The monitor provides backup information for the steam generator liquid radioactivity monitor (Section 11.5.2.2.2.2) and the condenser air removal gaseous radioactivity monitor (Section 11.5.2.3.2.1) for the detection of a primary-to-secondary leakage in the steam generator. The fixed-volume detector assembly receives a continuous flow from the discharge of the blowdown system heat exchangers and returns the sample to the system. The sample location provides an unfiltered sample at temperatures within the limits of the detector. The high radioactivity alarm closes the steam generator blowdown isolation valves and the blowdown system discharge valve to terminate blowdown and prevent discharge of radioactivity from the steam generators.

11.5.2.2.2.4 Boron Recycle System Distillate Radioactivity Monitor

The boron recycle system is discussed in Section 9.3.6.

The boron recycle radioactivity monitor, 0-HE-RE-16, is permanently out of service and no longer used

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11.5.2.2.2.5 Chemical and Volume Control System Letdown Monitor

The chemical and volume control system (CVCS) is discussed in Section 9.3.4.

The CVCS letdown radioactivity monitor, 0-SJ-RE-01, acts as a gross failed fuel detector. The fixed-volume detector assembly continuously monitors the CVCS letdown sample line which extracts a sample upstream of the CVCS letdown demineralizers. The radiation alarms alert the operator to an abnormal increase in gross gamma activity in the CVCS letdown system. Determination of the cause can be made by laboratory analysis. The sample location provides an unfiltered sample prior to demineralization. The arrangement and location of the sample line provide sufficient delay in transport to allow decay of nitrogen-16, which could cause erroneously high readings.

11.5.2.2.2.6 Auxiliary Steam System Condensate Recovery Monitor

The auxiliary steam system is discussed in Section 9.5.9.

The auxiliary steam condensate recovery radioactivity monitor, 0-FB-RE-50, detects radioactive contamination from the potentially radioactive systems which discharge to the auxiliary steam condensate recovery tank. The fixed-volume detector assembly continuously monitors the discharge of the auxiliary steam condensate transfer pumps. The radioactivity alarms alert the operator to possible contamination, isolates auxiliary steam supply to the radwaste building and trips the auxiliary steam condensate transfer pumps. The source of the contamination can be determined by selective isolation of the potentially radioactive systems. The sample location ensures that all potentially radioactive sources are monitored.

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11.5.2.2.3 Liquid Effluent Radioactivity Monitors

A detailed listing of the liquid effluent monitor parameters is given in Table 11.5-2.

11.5.2.2.3.1 Steam Generator Blowdown Discharge Radioactivity Monitor

The steam generator blowdown system is discussed in Section 10.4.8.

The steam generator blowdown discharge radioactivity monitor, 0-BM-RE-52, continuously monitors the blowdown discharge pump outlet to detect radioactivity due to system demineralizer break-through and to provide backup to the steam generator blowdown process radioactivity monitor (Section 11.5.2.1.2.3) to prevent discharge of radioactive fluid. The sample point is located on the discharge of the pump in order to monitor discharge or recycled blowdown fluid and upstream of the discharge isolation valve to limit the radioactivity released.

The high radioactivity alarm acts to close the blowdown isolation valves and the blowdown discharge valve.

A weekly laboratory isotopic analysis is made for any liquid discharged, in conformance with Regulatory Guide 1.21.

11.5.2.2.3.2 Liquid Radwaste Discharge Monitor

The liquid radwaste system is discussed in Section 11.2. The liquid radwaste radiation monitor, 0-HB-RE-18, continuously monitors the discharge of the liquid radwaste processing system to prevent the discharge of radioactive fluid to the environs. The fixed-volume detector assembly continuously monitors the system discharge line upstream of the discharge valve. The high radioactivity alarm closes the liquid radwaste system discharge valve to terminate discharge. The sample point is located to ensure that all potentially radioactive fluids from the liquid radwaste processing system are monitored prior to discharge. Laboratory isotopic analyses are made of each batch prior to discharge, as required by Regulatory Guide 1.21 and the plant Technical Specifications.

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11.5.2.2.3.3 Secondary Liquid Waste System Monitor

The secondary liquid waste system is discussed in Section 10.4.10. The secondary liquid waste system discharge radioactivity monitor, 0-HF-RE-45, monitors secondary liquid waste system effluents prior to discharge to the environs. The fixed-volume detector assembly continuously monitors the discharge line upstream of the discharge isolation valve. The high radioactivity alarm closes the secondary liquid waste system discharge valve to prevent the discharge of radioactive fluid. The sample location ensures that all potentially radioactive sources from the system are monitored prior to discharge. Laboratory isotopic analyses are made of each batch prior to discharge, in accordance with Regulatory Guide 1.21.

11.5.2.2.3.4 Turbine Building Drain Monitor

The turbine building drain effluent radioactivity monitor, 0-LE-RE-59, is provided to monitor turbine building liquid effluents prior to release to the environs. The fixed-volume detector assembly continuously monitors the drain effluent line upstream of the drain line isolation valve. The high radioactivity alarm closes the drain line isolation valve to prevent the release of radioactive fluids. The sample location ensures that all potentially radioactive turbine building liquid effluents are monitored prior to discharge. A weekly isotopic analysis is made in the laboratory, in conformance with Regulatory Guide 1.21.

11.5.2.2.3.5 Wastewater Treatment System Monitor

Radioactivity monitor HF-RE-95 monitors the discharge from the high and low TDS collection drain tanks to the Wastewater Treatment System. The fixed volume detector assembly continuously monitors the discharge line upstream of the discharge isolation valve. The high radioactivity setpoint will close the discharge isolation valve automatically to terminate the release of radioactive fluid. This discharge is normally not radioactive and would remain so unless a primary to secondary steam generator tube leak would occur. Such a tube leak and resultant radioactivity release from the primary system would first be detected in the steam generator liquid radiation monitor (SJ-RE-02) steam generator blowdown process radiation monitor (BM-RE-25) steam generator discharge radiation monitor (BM-RE-52) and/or condenser air discharge monitor (GE-RE-92).

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11.5.2.3 Airborne Monitoring Systems

11.5.2.3.1 Selection Criteria for Airborne Monitors

11.5.2.3.1.1 Introduction

The type of fixed instrumentation used for monitoring airborne radioactivity is offline. The offline system extracts a sample from the process stream and transports that sample to the radioactivity monitoring system, which contains the specified equipment to detect particulates, halogens, and/or noble gases.

11.5.2.3.1.2 Sampling Criteria

The sampling system for the particulate/halogen/noble gas monitors is designed and installed to meet the intent of ANSI N13.1-1969. Systems whose sensitivity is dependent upon sample flow employ isokinetic nozzles and suitable control of flow rate.

11.5.2.3.1.3 Detection Criteria

Since both radioactive particulates and radioactive noble gases are beta emitters, beta sensitive scintillation detectors are used to sense radioactivity in order to minimize the effects due to background radiation and, consequently, obtain a lower minimum detectable concentration.

Where spectrometric analysis is required (such as in iodine monitoring) an NaI(Tl), gamma scintillation detector assembly is employed.

11.5.2.3.1.4 Instrumentation Criteria

Instrumentation necessary to indicate, alarm, and perform control functions is provided to complete the monitoring system.

Since radioactive concentrations may vary substantially, wide range instruments are utilized. All airborne radiation monitors include provisions for obtaining a grab sample for laboratory isotopic analysis. The particulate and charcoal filters can readily be removed for periodic isotopic laboratory analyses, as required by the Technical Specifications.

The airborne particulate monitors each consist of a fixed filter upon which radioactive particulate matter is deposited. The fixed filter is located in front of a beta scintillation detector coupled to a photomultiplier tube.

Each airborne iodine monitor consists of a charcoal cartridge upon which iodine is adsorbed. The air sample is prefiltered to remove particulates. The charcoal cartridge is located in front of a gamma scintillation detector coupled to a photomultiplier tube.

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Each airborne noble gas monitor consists of a fixed-volume sample chamber through which prefiltered sample air is passed. A beta scintillation detector is located within the sample chamber to detect the activity level of the air sample.

All of the detectors and sample chambers are enclosed in heavily shielded lead pigs. Two motor-operated valves operated locally are provided to permit air-purging of the sample chamber to facilitate background activity checks.

The sensitivities and alarm setpoints are given in Tables 11.5-3 and 11.5-4. The alert-alarm points are based on the methodologies presented in the ODCM.

11.5.2.3.2 Airborne Process Radioactivity Monitors

A detailed listing of airborne process monitor parameters is given in Table 11.5-3.

11.5.2.3.2.1 Condenser Air Discharge Monitor

The condenser air discharge monitor, 0-GE-RE-92, is provided to detect, indicate, and alarm gaseous activity in the condenser air removal system exhaust. The condenser air discharge monitor closes the steam generator blowdown isolation valves on high radiation to prevent discharge of radioactive fluid and to limit radioactive contamination of the blowdown demineralizers. The monitor is also equipped with particulate and iodine filters which are removed and analyzed in the laboratory. This monitor provides backup to the steam generator liquid and the steam generator blowdown processing radiation monitors for detection of primary-to-secondary leaks in the steam generator. The condenser air removal system removes noncondensable gases which would be present if a primary-to-secondary leak occurred. Particulate and iodines would also be removed by entrainment in the air discharged.

The monitor is provided with a nozzle to extract a representative sample from the exhaust duct. A sample cooler is provided to dry the sample prior to entering the sample filters or the fixed-volume gaseous detector assembly to preclude damage to the filters or to the detector. The sample point is located upstream of the condenser air removal system filters.

The radiation alarms alert the operator to the presence of gaseous activity and the possibility of steam generator tube leakage.

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11.5.2.3.2.2 Containment Atmosphere Radioactivity Monitors

The containment atmosphere radioactivity monitors, 0-GT-RE-31 and 0-GT-RE-32, continuously monitor the containment atmosphere for particulate, iodine, and gaseous radioactivity. They isolate the containment purge system on high gaseous activity via the ESFAS. See Sections 7.3.2 and 9.4.6 for further discussion of this function. These monitors also serve for reactor coolant pressure boundary leakage detection (See Section 5.2.5 for a detailed description of this function) and for personnel protection (see Section 12.3.4 for a detailed description of this function). The containment atmosphere radioactivity monitors provide backup indication for the containment purge monitors. These seismic Category I monitors are completely redundant.

Samples are extracted from the operating deck level (El. 2047'-6") through sample lines which penetrate the containment. The monitors are located as close as possible to the containment penetrations to minimize the length of the sample tubing and the effects of sample plate out. The sample points are located in areas which ensure that representative samples are obtained. Each sample passes through the penetration, then through the fixed filter (particulate), charcoal filter (iodine), and fixed-volume gaseous detector assemblies. After passing through the pumping system, the sample is discharged back to the containment through a separate penetration.

Indication is provided for each monitor on individual indicators on the radioactivity monitoring system control panel and, through isolated signals, on the radioactivity monitoring system CRT in the control room.

11.5.2.3.2.3 Containment Purge System Radioactivity Monitors

The containment purge system radioactivity monitors, 0-GT-RE-22 and 0-GT-RE-33, continuously monitor the containment purge exhaust duct during purge operations for particulate, iodine, and gaseous radioactivity. The purpose of these monitors is to isolate the containment purge system on high gaseous activity via the ESFAS. See Sections 7.3.2 and 9.4.6 for additional information concerning this function. These monitors also serve as backup indication for personnel protection (see Section 12.3.4) and reactor coolant pressure boundary leakage detection (see Section 5.2.5) for the containment atmosphere radioactivity monitors.

These seismic Category I monitors are completely redundant.

The sample points are located outside the containment between the containment isolation dampers and the containment purge filter adsorber unit.

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Each monitor is provided with two isokinetic nozzles to ensure that representative samples are obtained for both normal purge and minipurge flow rates. Isokinetic nozzle selection is accomplished by sample selector valves which automatically align the correct nozzle to the monitor based on operation of the minipurge and normal purge exhaust systems. The sample is extracted through the selected nozzle and then passed through the selector valve, the fixed filter (particulate), charcoal filter (iodine), and fixed-volume gaseous detectors. The sample then passes through the pumping system and is discharged back to the duct.

Indication is provided for each monitor on individual indicators on the radioactivity monitoring system control panel and, through isolated signals, on the radioactivity monitoring system CRT in the control room.

11.5.2.3.2.4 Containment High Range Radiation Monitors

The containment digital high range radiation monitor (DHRRM) system includes two redundant monitors, 0-GT-RT-59 and 0-GT-RT-60, to detect and indicate gamma radiation levels in the containment over a range from 1 rad/hr to 10^8 rads/hr. The DHRRM also provides an alarm function.

Each DHRRM subsystem consists of a gamma radiation detector, a microprocessor, junction box, and control/display module. The subsystems are safety related and designed and qualified to IEEE 323-1974 for the normal and accident environments for their installed locations. The subsystems are also designed and qualified to be seismic Category I. The detector locations are indicated on Figure 12.3-2, Sheet 4. Detectors are mounted on the inside surface of the containment wall at El. 2052'-0" for GT-RE-60 and at El. 2073'-0" for GT-RE-59. The DHRRM subsystems are also connected to the process and effluent radiation monitoring system (optically isolated) for readout on the CRT (SPO-56A) in the control room.

11.5.2.3.2.5 Auxiliary/Fuel Building Ventilation Exhaust Radioactivity Monitor

The Auxiliary/Fuel building ventilation exhaust radiation monitors 0-GG-RE-27 and 0-GG-RE-28, continuously monitor for particulate, iodine, and gaseous radioactivity in the Auxiliary/Fuel building ventilation exhaust system. In the event of a fuel handling accident, these monitors function to isolate the normal ventilation and start up the emergency ventilation system on high gaseous activity via the ESFAS. Sections 7.3.3 and 9.4.2 have additional information about this function. These monitors have an additional function to alert workers to high airborne radioactivity in the fuel building. This latter function is discussed in Section 12.3.4.

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These seismic Category I monitors are completely redundant.

During normal operation, each monitor extracts a sample from the normal exhaust duct through individual isokinetic nozzles and sample selector valves. This normal sample point is upstream of the fuel building normal exhaust filter adsorber unit.

When the emergency ventilation system is in use, the capability is provided from the control room to transfer the sample points via sample selector valves to isokinetic nozzles located in the fuel building emergency exhaust system upstream of the emergency exhaust filter adsorber units, with one monitor aligned to each emergency exhaust duct.

Indication is provided by individual indicators on the radioactivity monitoring system control panel and, through isolated signals, by the radioactivity monitoring system CRT in the control room.

11.5.2.3.2.6 Control Room Ventilation Radioactivity Monitor

The control room ventilation radioactivity monitors, 0-GK-RE-04 and 0-GK-RE-05, continuously monitor the supply air of the normal heating, ventilation, and air-conditioning system for particulate, iodine, and gaseous radioactivity to provide protection for the control room operators. These monitors function automatically to switch the control room from the normal to the emergency ventilation system on high gaseous activity via the ESFAS. See Sections 6.4, 7.3.4, and 9.4.1 for more details. These monitors also function to alert the operators to high airborne radioactivity in the control room ventilation supply. This function is described in Section 12.3.4.

These seismic Category I monitors are completely redundant.

Samples are extracted through individual isokinetic nozzles, and flow through the fixed filter (particulate), charcoal filter (iodine), and fixed-volume gaseous detector assemblies prior to passing through the pumping system for discharge.

Indication for these monitors is provided on individual indicators on the radioactivity monitoring system control panel and, through isolated signals, on the radioactivity monitoring system CRT in the control room.

11.5.2.3.3 Airborne Effluent Radioactivity Monitors

A detailed listing of airborne effluent monitor parameters is given in Table 11.5-4.

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11.5.2.3.3.1 Unit Vent Radioactivity Monitor

The unit vent radioactivity monitor, 0-GT-RE-21, continuously monitors the effluent from the unit vent for particulate, iodine (halogen), and gaseous radioactivity. The unit vent, via ventilation exhaust systems, continuously purges various tanks and sumps normally containing low-level radioactive aerated liquids that can potentially generate airborne activity.

The exhaust systems which supply air to the unit vent are from the fuel building, auxiliary building, the access control area, the containment purge, and the condenser air discharge.

All of these systems are filtered before they exhaust to the unit vent. The unit vent monitor measures actual plant effluents and not inplant concentrations. Thus, the system continuously monitors downstream of the last point of potential radioactivity entry. The monitoring system consists of an off-line, three-way airborne radioactivity monitor. An isokinetic sampling probe is located downstream of the last point of potential radioactivity entry for sample collection.

The Alert alarms are set below the High alarms to act as precautionary warnings. The High alarm is set to ensure that Technical Specification limits are not exceeded. (See Offsite Dose Calculation Manual.) Refer to Table 11.5-4 for the alert and high alarm setpoints, the range, and the sensitivity.

Portions of the sample tubing located outside the building are adequately protected and routed to prevent the accumulation and freezing of condensate. The sample extracted by the isokinetic nozzle is passed through the fixed filter (particulate), charcoal filter (iodine), and fixed-volume (gaseous) detector assemblies and then through the pumping system for discharge back to the unit vent.

Indication is provided on the radioactivity monitoring system CRT in the control room. This monitor provides a signal to the radioactive release report generation system described in Section 11.5.2.1.1.

11.5.2.3.3.2 Radwaste Building Ventilation Effluent Radioactivity Monitor

The radwaste building ventilation effluent radiation monitor, 0-GH-RE-10, continuously monitors for particulate, halogen, and gaseous radioactivity in the effluent duct downstream of the exhaust filter and fans. The sample point is located downstream of the last possible point of radioactive influent, including the

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waste gas decay tank discharge line. The flow path provides ventilation exhaust for all parts of the building structure and components within the building and provides a discharge path for the waste gas decay tank release line. These components represent potential sources for the release of gaseous and air particulate and iodine activities in addition to the drainage sumps, tanks, and equipment purged by the waste processing system.

The monitoring system consists of a fixed filter particulate monitor, an iodine monitor, and gaseous activity monitor.

The sample is extracted through an isokinetic nozzle to ensure that a representative sample of the air is obtained prior to release to the environment. After passing through the fixed filter (particulate), charcoal filter (halogen), and fixed-volume (noble gas) detector assemblies and the pumping system, the sample is discharged back to the exhaust duct.

The sensitivities and alarm setpoints are given in Table 11.5-4. The Alert alarm is set below the High alarm to act as a precautionary warning. The High alarm is set to ensure that Technical Specification limits are not exceeded. (See Offsite Dose Calculation Manual.)

Indication of this monitor is provided on the radiation monitoring system CRT in the control room. This monitor provides a signal to the NPIS computer in the TSC computer room, (see Section 11.5.2.1.1).

This monitor isolates the waste gas decay tank discharge line if the radioactivity release rate is above the preset limit when the waste gas discharge valve has been deliberately or inadvertently opened.

11.5.2.4 Safety Evaluation

The control room ventilation monitors, the containment atmosphere monitors, the containment purge monitors, the containment LOCA atmosphere monitors, and the fuel building exhaust monitors are redundant, independent, seismic Category I, with Class IE power supplies. The control room and fuel building monitors will automatically switch from the normal to the emergency ventilation systems on high gaseous activity via the ESFAS. The containment atmosphere and containment purge monitors will automatically isolate the containment purge and stop the fans on high gaseous activity via the ESFAS.

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11.5.3 EFFLUENT MONITORING AND SAMPLING

All potentially radioactive effluent discharge paths are continuously monitored for gross radiation level. Liquid releases are monitored for gross gamma. Airborne releases are monitored for gross beta activity (particulates and noble gases) and gross gamma (iodines).

An isotopic analysis is performed on samples obtained from each continuous effluent release path and per batch for each batch type effluent release path in order to verify the adequacy of effluent processing to meet the discharge limits to unrestricted areas. This effluent sampling program is of such a comprehensive nature as to provide the information for the effluent measuring and reporting programs required by 10 CFR 50 Part 36A and Appendix I and Regulatory Guide 1.21 in annual reports to the NRC. The effluent release data is compiled and the annual effluent report is generated.

By a combination of the installed equipment described previously in Section 11.5 and the installed equipment described in Section 12.3.4, along with portable equipment described in Section 12.5, and the Emergency Plan, the requirements of General Design Criterion 64 to monitor normal operations, anticipated operational occurrences, and postulated accidents are met.

11.5.4 PROCESS MONITORING AND SAMPLING

All potentially significant radioactive systems which lead to effluent discharge paths are equipped with a control system to automatically isolate the discharge on indication of a high radioactivity level. These include the containment purge system, the fuel building ventilation system, and the gaseous and liquid radwaste systems. Batch releases are sampled and analyzed prior to discharge, in addition to the continuous effluent monitoring.

By means of the continuous radioactivity monitors mentioned above and their associated control valves, and due to the extensive sampling program described in the Environmental Report, General Design Criterion 60 and the Radiological Effluent Technical Specifications are met with regard to the control of releases of radioactivity to the environment.

Process monitoring is accomplished by continuous radioactivity monitors discussed in Sections 11.5.2.2.2 and 11.5.2.3.2. By means of the continuous radioactivity monitors, GDC-63 is met with regard to monitoring radioactivity levels in the radioactive waste process systems.

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TABLE 11.5-1

LIQUID PROCESS RADIOACTIVITY MONITORS

Monitor Number	Description	Type (continuous)	Detection	Range ($\mu\text{Ci/cc}$)	MDC (1) ($\mu\text{Ci/cc}$)	Control-ling Isotope	Hi Alarm ($\mu\text{Ci/cc}$)	Hi-Hi Alarm ($\mu\text{Ci/cc}$)	Sample Flow Rate (gpm)	Monitor Control Function
O-EG-RE-9 O-EG-RE-10	Component cooling water monitor	Liquid	NaI (Tl) gamma scintillation	10^{-7} to 10^{-2}	1×10^{-6}	Cs-137	1×10^{-5} (3)	1×10^{-4} (4)	1-5 (9)	Isolates air vents and makeup water valves on component cooling water surge tanks on Hi-Hi alarms
O-SJ-RE-2	Steam generator liquid radioactivity monitor	Liquid (2)	NaI (Tl) gamma scintillation	10^{-7} to 10^{-2}	1×10^{-6}	Cs-137	1×10^{-5} (3)	1×10^{-4} (4)	1-5	Closes blowdown isolation valves on Hi-Hi alarm
O-BM-RE-25	Steam generator blowdown processing system monitor	Liquid (2)	NaI (Tl) gamma scintillation	10^{-7} to 10^{-2}	1×10^{-6}	Cs-137	1×10^{-5} (3)	1×10^{-4} (4)	1-5	Closes blowdown isolation valves on Hi-Hi alarms
O-SJ-RE-01	Chemical and volume control system letdown monitor	Liquid	NaI (Tl) gamma scintillation	$1.7\text{E}-3$ to $1.7\text{E}+3$	NA	---	(7)	(8)	.2-1	Alarms
O-FB-RE-50	Auxiliary steam system condensate recovery monitor	Liquid	NaI (Tl) gamma scintillation	10^{-7} to 10^{-2}	1×10^{-6}	Cs-137	1×10^{-5} (3)	1×10^{-4} (4)	1-5	Hi-Hi alarm isolates auxiliary steam supply to radwaste building a trips auxiliary steam condensate transfer pumps

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TABLE 11.5-1 (Sheet 2)

LIQUID PROCESS RADIOACTIVITY MONITORS

Monitor Number	Description	Type (continuous)	Detection	Range (wCi/cc)	MDC (1) (wCi/cc)	Control-ling Isotope	Hi Alarm (wCi/cc)	Hi-Hi Alarm (wCi/cc)	Sample Flow Rate (gpm)	Monitor Control Function
O-FB-RE-50	Auxiliary steam system condensate recovery monitor	Liquid (2) scintillation	NaI (Tl) gamma	10 ⁻⁷ to 10 ⁻²	1 X 10 ⁻⁶	Cs-137	1 X 10 ⁻⁵ (3)	1 X 10 ⁻⁴ (4)	1-5	Hi-Hi alarm isolates steam supply to radwaste building and trips auxiliary steam condensate transfer pumps

- (1) MDC - minimum detectable concentration.
- (2) When in operation.
- (3) One order of magnitude above MDC to avoid spurious alarms and to indicate the leakage of radioactivity into an otherwise nonradioactive system. Setpoint may be changed based on plant conditions to provide prompt indication of increased leakage.
- (4) Two orders of magnitude above MDC to indicate significant leakage of radioactivity. Setpoint may be changed based on plant conditions to provide prompt indication of increased leakage.
- (5) Only water cleaner than this is sent to the reactor makeup water storage tank.
- (6) High activity may indicate a crud burst or iodine spiking. Alarm is varied based on normal to ensure the operators are alerted to changes in activity levels from normal.
- (7) High activity may indicate a crud burst, iodine spiking, or failed fuel. Laboratory analyses are performed to determine cause. Alarm is varied based on normal to ensure the operators know that significant changes in activity have occurred.
- (8) 1 - 5 gpm is a nominal or expected range when the CCW system is flowing at approximately 10,000 gpm or greater regardless of the temperature control valve (TCV 29 or 30) position. Sample flow rates are proportionately reduced for system flow rates less than 10,000 gpm and with the TCV open. The sample flow rate will range from about 0.3 gpm with the system flow rate at 3,000 gpm and the TCV open, to about 1 gpm with the system flow rate at 10,000 gpm and the TCV open. The sample flow rate will be 0 gpm when the CCW system flow rate is 0 gpm.
- (9)

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TABLE 11.5-2
LIQUID EFFLUENT RADIOACTIVITY MONITORS

Monitor Number	Description	Type (continuous)	Detection	Range (Ci/cc)	MDC (1) (Ci/cc)	Control-ling Isotope	Hi Alarm (Ci/cc)	Hi-Hi Alarm (Ci/cc)	Sample Flow Rate (gpm)	Monitor Control Function
O-HF-RE-45	Secondary liquid waste system monitor	Liquid (4)	NaI (Tl) gamma scintillation	10^{-7} to 10^{-2}	1×10^{-6}	Cs-137	(7)	(2)	1-5	Closes discharge valves on Hi-Hi alarm
1-HF-RE-95	Wastewater treatment system influent monitor	Liquid (6)	NaI (Tl) gamma scintillation	10^{-7} to 10^{-2}	1×10^{-6}	Cs-137	(3)	(2)	1-5	Closes discharge valve on Hi-Hi alarm
O-HB-RE-18	Liquid rad-waste discharge monitor	Liquid (4)	NaI (Tl) gamma scintillation	10^{-7} to 10^{-2}	1×10^{-6}	Cs-137	(7)	(2)	1-5	Closes discharge valve on Hi-Hi alarm
O-LB-RE-59	Turbine building drain monitor	Liquid (5)	NaI (Tl) gamma scintillation	10^{-7} to 10^{-2}	1×10^{-6}	Cs-137	(3)	(2)	1-5	Closes discharge valve on Hi-Hi alarm
O-BM-RE-52	Steam generator blow-down discharge monitor	Liquid (4)	NaI (Tl) gamma scintillation	10^{-7} to 10^{-2}	1×10^{-6}	Cs-137	(3)	(2)	1-5	Closes discharge and blowdown isolation valves on Hi-Hi alarm

- (1) MDC = minimum detectable concentration.
- (2) Hi-Hi alarm is set to ensure that the ODCM limit is not exceeded and to initiate isolation before the limit can be exceeded.
- (3) The Hi alarm is set one order of magnitude below the Hi-Hi Alarm/Trip Setpoint for release points that have dilution and up to the Hi-Hi Alarm value for those without dilution.
- (4) The monitor is to prevent inadvertent discharge valve opening and to ensure that any releases that might become necessary are within limits. In accordance with the ODCM, batch analyses are performed before any releases are made.
- (5) Normally, not radioactive since potentially radioactive drains are segregated from this waste stream.
- (6) The monitor is to terminate inadvertent radioactive discharges to the wastewater treatment facility.
- (7) The alert alarm is set to 80% of the Hi-Hi Alarm/Trip Setpoint.

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TABLE 11.5-3
AIRBORNE PROCESS RADIOACTIVITY MONITORS

Monitor	Type	Range ($\mu\text{Ci}/\text{cc}$)	MDC (1) ($\mu\text{Ci}/\text{cc}$)	Control- ling Isotope	Hi Alarm ($\mu\text{Ci}/\text{cc}$)	Hi-Hi Alarm ($\mu\text{Ci}/\text{cc}$)	Total Ventila- tion Flow (cfm)	Minimum Required Sensitivity ($\mu\text{Ci}/\text{cc}$)	Monitor Control Function
O-GT-RE-31 Containment atmosphere monitors	Particulate (3)	10^{-12} to 10^{-7}	1×10^{-11}	Cs-137	1×10^{-8} (8)	1×10^{-7} (7)	420,000	1×10^{-7} (7)	Isolates con- tainment purge, de-energizes purge fans on Hi-Hi gaseous activity via the ESPAS (see Section 7.3)
O-GT-RE-32	Iodine (4)	10^{-11} to 10^{-6}	1×10^{-10}	I-131	2×10^{-8} (8)	2×10^{-7} (7)	420,000	2×10^{-7} (7)	
O-GT-RE-33	Gaseous (3)	10^{-7} to 10^{-2}	2×10^{-7}	Xe-133	2.06×10^{-4} (13)	2.06×10^{-3} (14)	420,000	1×10^{-4} (7)	
O-GT-RE-22	Particulate (3)	10^{-12} to 10^{-7}	1×10^{-11}	Cs-137	1×10^{-8} (8)	1×10^{-7} (7)	20,000/4000	1×10^{-7} (7)	Isolates con- tainment purge, de-energizes purge fans on Hi-Hi gaseous activity via the ESPAS (see Section 7.3)
O-GT-RE-23	Iodine (4)	10^{-11} to 10^{-6}	1×10^{-10}	I-131	2×10^{-8} (8)	2×10^{-7} (7)	20,000/4000	2×10^{-7} (7)	
O-GT-RE-24	Gaseous (3)	10^{-7} to 10^{-2}	2×10^{-7}	Xe-133	(12)	(11)	20,000/4000	1×10^{-4} (7)	
O-GT-RE-25	Gamma (5)	1 to 10^4 rads hr	1 rad hr	NA	NA	NA	NA	NA	NA
O-GT-RE-26	Containment high activity monitors								
O-GE-RE-92	Gaseous (continuous) air dis- charge monitor	10^{-7} to 10^{-2}	2×10^{-7}	Xe-133	2×10^{-6} (9)	2×10^{-5} (10)	1000	NA	Closes blow- down isolation valve on Hi-Hi alarms
O-GG-RE-27	Particulate (3)	10^{-12} to 10^{-7}	1×10^{-11}	Cs-137	1×10^{-8} (8)	1×10^{-7} (7)	20,000	1×10^{-7} (7)	Initiates switch to fuel building emergency ven- tilation on Hi-Hi gaseous activity via the ESPAS (see Section 7.3)
O-GG-RE-28	Iodine (4)	10^{-11} to 10^{-6}	1×10^{-10}	I-131	2×10^{-8} (8)	2×10^{-7} (7)	20,000	2×10^{-7} (7)	
O-GK-RE-04	Gaseous (3)	10^{-7} to 10^{-2}	2×10^{-7}	Xe-133	1.62×10^{-4} (15)	1.62×10^{-3} (16)	20,000	1×10^{-3} (7)	
O-GK-RE-05	Particulate (3)	10^{-12} to 10^{-7}	1×10^{-11}	Cs-137	1×10^{-8} (8)	1×10^{-7} (7)	1950	1×10^{-7} (7)	Initiates switch to con- trol room emergency ven- tilation on Hi-Hi gaseous activity via the ESPAS (see Section 7.3)
O-GK-RE-06	Iodine (4)	10^{-11} to 10^{-6}	1×10^{-10}	I-131	2×10^{-8} (8)	2×10^{-7} (7)	1950	2×10^{-7} (7)	
O-GK-RE-07	Gaseous (3)	10^{-7} to 10^{-2}	2×10^{-7}	Xe-133	1.35×10^{-4} (17)	1.35×10^{-3} (18)	1950	1×10^{-3} (7)	

Sample flow for each channel is 3 cfm

(1) MDC = minimum detectable concentration.

(2) When fuel is in the building.

(3) Beta scintillation detector.

(4) Gamma scintillation detector.

(5) Gamma sensitive ion chamber.

(6) DAC (DAQ) on monitor maximum, which ever is less.

(7) One order of magnitude above MDC to avoid spurious alarms and to indicate primary to secondary leakage. Setpoint may be changed based on plant conditions to provide prompt indication of increased leakage.

(8) One order of magnitude above MDC to indicate significant leakage of radioactivity. Setpoint may be changed based on plant conditions to provide prompt indication of increased leakage.

(9) Two orders of magnitude above MDC to indicate significant leakage of radioactivity. Setpoint may be changed based on plant conditions to provide prompt indication of increased leakage.

(10) Hi-Hi alarm is set to ensure that Technical Specification limits (10 CFR 20 general population Dose Rate for the controlling isotopes at the boundary of the restricted area) are not exceeded. See ODCM.

(11) See ODCM

(12) Equivalent to 0.9 mR/hr submersion dose rate (may increase per Tech Spec Table 3.3-6)

(13) Equivalent to 9 mR/hr submersion dose rate (may increase per Tech Spec Table 3.3-6)

(14) Equivalent to 0.2 mR/hr submersion dose rate

(15) Equivalent to 2 mR/hr submersion dose rate

(16) Equivalent to 0.2 mR/hr submersion dose rate

(17) Equivalent to 2 mR/hr submersion dose rate

(18) Equivalent to 0.2 mR/hr submersion dose rate

(19) GER0092 is approved for a vacuum flow rate of 2.6 to 3.0 SCFM

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TABLE 11.5-4

AIRBORNE EFFLUENT RADIOACTIVITY MONITORS

Monitor	Type (continuous)	Range ($\mu\text{Ci}/\text{cc}$)	MDC (1) ($\mu\text{Ci}/\text{cc}$)	Control- ling Isotope	Hi Alarm ($\mu\text{Ci}/\text{cc}$)	Hi-Hi Alarm ($\mu\text{Ci}/\text{cc}$)	Total Ventila- tion Flow (cfm)	Dilu- tion Factor	Minimum Required Sensitivity ($\mu\text{Ci}/\text{cc}$)	Monitor Control Function
O-GT-RE-21A Plant unit vent monitor	Particulate (2) (11)	10^{-12} to 10^{-7}	1×10^{-11}	Cs-137	1×10^{-8} (9)	1×10^{-7} (10)	66,000	(4)	(5)	Alarms
O-GT-RE-21B Plant unit vent monitor	Iodine (3) (11)	10^{-11} to 10^{-6}	1×10^{-10}	I-131	6×10^{-9} (9)	6×10^{-8} (10)	66,000	(4)	(5) (6)	
O-GH-RE-10A Radwaste Building exhaust monitor	Gaseous (2)	10^{-7} to 10^5	2×10^{-7}	Xe-133	(8)	(7)	66,000	(4)	(5)	
O-GH-RE-10B Radwaste Building Exhaust Monitor	Particulate (2) (12)	10^{-12} to 10^{-7}	1×10^{-11}	Cs-137	1×10^{-8} (9)	1×10^{-7} (10)	12,000	(4)	(5)	Hi-Hi alarm isolates the waste gas decay tank discharge line
	Iodine (3) (12)	10^{-11} to 10^{-6}	1×10^{-10}	I-131	6×10^{-9} (9)	6×10^{-8} (10)	12,000	(4)	(5)	
	Gaseous (2)	10^{-7} to 10^5	2×10^{-7}	Xe-133	(8)	(7)	12,000	(4)	(5)	Hi-Hi alarm isolates the waste gas decay tank discharge line

Sample flow for each channel is 3 cfm

- (1) MDC = minimum detectable concentration.
- (2) Beta scintillation detector.
- (3) Gamma scintillation detector.
- (4) Dilution factor = vent flow rate in m^3/sec X Q (annual average).
- (5) Minimum required sensitivity of monitor in Ci/cc at maximum allowable annual average concentration of controlling isotope at monitor which will result in annual average Appendix I dose at the site boundary = population MPC for controlling isotope X 1 X 1 X 1 where the bioaccumulation factor is 1 for 100 bioaccumulation factor dilution factor
- (6) noble gases and 1,000 for iodines and particulates. See Offsite Dose Calculation Manual. using previously established ratios.
- (7) Hi-Hi alarm is set to ensure that ODCM limits (the 10 CFR 20 general population MPCs for the controlling isotopes at the boundary of the restricted area) are not exceeded.
- (8) Hi alarm is set to alert operators to that average concentration which, if maintained for a full year, would result in the 10 CFR 50 Appendix I annual dose guidelines being reached. See Offsite Dose Calculation Manual.
- (9) 10% of Hi-Hi Alarm
- (10) ODCM calculated setpoint or monitor maximum ($\mu\text{Ci}/\text{cc}$) whichever is less.
- (11) O-GT-RE-21B may be used as an alternate sampler.
- (12) O-GH-RE-10B may be used as an alternate sampler.

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TABLE 11.5-5

POWER SUPPLIES FOR PROCESS AND EFFLUENT MONITORS

Liquid Process Radioactivity Monitors (non-IE)

<u>Monitor Name and Number</u>	<u>Normal Power Supply</u>	<u>Restored After Loss of Offsite Power</u>
Component cooling water 0-EG-RE-9 0-EG-RE-10	Non-IE MCCs	No
Steam generator liquid radioactivity 0-SJ-RE-2	Non-IE MCCS	No
Steam generator blowdown processing system 0-BM-RE-25	Non-IE MCCs	No
Boron recycle system distillate 0-HE-RE-16	Non-IE MCCs	No
CVCS letdown 0-SJ-RE-01	Non-IE MCCs	No
Auxiliary steam system liquid condensate recovery 0-FB-RE-50	Non-IE MCCs	No

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TABLE 11.5-5 (Sheet 2)

Liquid Effluent Radioactivity Monitors (Non-IE)		
<u>Monitor Name and Number</u>	<u>Normal Power Supply</u>	<u>Restored After Loss of Offsite Power</u>
Secondary liquid waste system 0-HF-RE-45	Non-IE MCCS	No
Wastewater treatment system influent 1-HF-RE-95	Non-IE MCCS	No
Liquid radwaste discharge 0-HB-RE-18	Non-IE MCCs	No
Turbine building drain 0-LE-RE-59	Non-IE MCCs	No
Steam generator blowdown discharge 0-BM-RE-52	Non-IE MCCs	No
Airborne Process Radioactivity Monitors (Class IE)		
Containment atmosphere 0-GT-RE-31 0-GT-RE-32	Class IE MCCs	Yes
Containment purge system 0-GT-RE-22 0-GT-RE-33	Class IE MCCs	Yes
Containment high activity monitors 0-GT-RE-59 0-GT-RE-60	Class IE MCCs	Yes
Fuel building exhaust 0-GG-RE-27 0-GG-RE-28	Class IE MCCs	Yes
Control room air supply 0-GK-RE-04 0-GK-RE-05	Class IE MCCs	Yes

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TABLE 11.5-5 (Sheet 3)

Airborne Process Radioactivity Monitor (Non-IE)

<u>Monitor Name and Number</u>	<u>Normal Power Supply</u>	<u>Restored After Loss of Offsite Power</u>
Condenser air discharge 0-GE-RE-92	Non-IE MCC	No

Airborne Effluent Radioactivity Monitors (Non-IE)

Plant unit vent 0-GT-RE-21	Non-IE MCCs	No
Radwaste building exhaust 0-GH-RE-10	Non-IE MCCs	No