H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
OFF-SITE DOSE CALCULATIONAL MANUAL
(ODCM)

Revision 7

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CAROLINA POWER & LIGHT COMPANY

HBRODCO

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2.0 LIQUID EFFLUENTS

2.1 MONITOR ALARM SETPOINT DETERMINATION

This methodology determines the monitor alarm setpoint that indicates if the concentration of radionuclides in the liquid effluent released from the site to unrestricted areas exceeds the concentrations specified in 10CFR20, Appendix B, Table II, Column 2, for radionuclides other than dissolved or entrained noble gases or exceeds a concentration 2×10^{-4} μCi/ml for dissolved or entrained noble gases. Two methodologies may be utilized to calculate monitor alarm setpoints. Section 2.1.1 determines a fixed setpoint based on the worst case assumptions that I-131 is the only nuclide being discharged. This is consistent with the limit of 10CFR20, Appendix B, Footnote 3.a. Section 2.1.2 methodology determines the setpoint based on the radionuclide mix via analysis prior to release to demonstrate compliance with 10CFR20, Appendix B, limits and may also be used as an alternative method for calculating setpoints.

2.1.1 Setpoint Based on Iodine-131

The following method applies to liquid releases via the discharge canal when determining the alarm/trip setpoint for the Condensate Polisher Liquid Waste Monitor (R-37) and the Steam Generator Blowdown Monitor (R-19A, R-19B, and R-19C) during operational conditions when there is no primary to secondary leaks. This methodology complies with Specification 3.9.1.1 of the RETS by satisfying the following equation:

$$\frac{cf}{f + F} \le C$$

where:

C = The effluent concentration limit (Specification 3.9.1.1) implementing 10CFR20 for the site in μCi/ml.

= 160 gpm for each Steam Generator Blowdown Monitor.

= 130 gpm for each Steam Generator Blowdown Monitor while draining a steam generator.

= 300 gpm for the Condensate Polisher Liquid Waste Monitor.

S = 0.5, safety factor used as a conservatism to assure that the radionuclide concentrations are less than the limits specified in 10CFR20, Appendix B, at the point of discharge.

2.1.1.2 Determine CR (calculated monitor count rate in corrected counts per minute [ccpm]) attributed to the radionuclides for each of the dilution water flow rates.

CR = (c) (E)

E = The applicable effluent monitor efficiency located in the Plant Operating Manual, Volume 15, Curve Book. Use the radioactivity concentration "c" to find CR.

2.1.1.3 Determine SP (the monitor alarm/trip setpoint including background [cpm] for each of the dilution water flow rates.

$$SP = (T_m)(CR) + Bkg + 3.3\sqrt{\frac{Bkg}{2\tau}}$$

where: T_m = Fraction of the radioactivity from the site that may be released via the monitored pathway to ensure that the site boundary limit is not exceeded due to simultaneous releases from several pathways.

= .16 for each Steam Generator Blowdown Monitor (R-19A, R-19B, and R-19C).

= .25 for the Condensate Polisher Liquid Waste (R-37).

Bkg = the monitor background.

3.3 $\sqrt{\frac{Bkg}{2\tau}}$ = statistical variance on the background (Bkg) count rate (CPM) at a 99.95% confidence level at a RC time constant τ (minutes). This is included to prevent inadvertent high/trip alarms due to random counts on the monitor.

2.1.2 Setpoint Based on an Analysis of Liquid Prior to Discharge

The following method applies to liquid releases via the discharge canal when determining the alarm setpoint for the Waste Disposal System Liquid Effluent Monitor (R-18), the Steam Generator Blowdown Monitors (R-19A, R-19B, and R-19C), and the Condensate Polisher Liquid Waste Monitor (R-37) when an analysis of the activity of the principal gamma emitters has been made prior to or during the release.

2.1.2.1 Determine D (the minimum acceptable dilution factor):

$$D = S\Sigma_i \frac{Ci}{MPC_i} \text{ or}$$

$$D = S[\Sigma_g \frac{C_g}{MPC_g} + \frac{C_a}{MPC_a} + \frac{C_s}{MPC_s} + \frac{C_t}{MPC_t} + \frac{C_{Fe-55}}{MPC_{Fe-55}}]$$

C_i = Radioactivity concentration of radionuclide "i" in the liquid effluent prior to dilution (μCi/ml) from analysis of the liquid effluent to be released.

C_g = The concentration of each measured gamma-emitting radionuclide observed by gamma spectroscopy including noble gases.

C_a = The measured concentration of alpha-emitting radionuclides observed by gross alpha analysis of the monthly composite sample.

C_s = The measured concentration of Sr-89 and Sr-90 in liquid waste as determined by analysis of the quarterly composite sample.

C_t = The measured concentrations of H-3 in liquid waste as determined by analysis of the monthly composite sample.

C_{Fe-55} = The measured concentration of Fe-55 in liquid waste as determined by analysis of the quarterly composite sample.

MPC_i = MPC_g, MPC_a, MPC_s, MPC_t, and MPC_{Fe-55} are limiting concentrations of the appropriate gamma-emitting radionuclides, alpha-emitting radionuclides, strontium radionuclides, tritium, and iron-55 from 10CFR20, Appendix B, repsectively.

S = 2, A safety factor used as a conservatism to assure that the radionuclide concentrations are less than the limits specified in 10CFR20, Appendix B, at the point of discharge.

2.1.2.3 Determine c the monitor setpoint concentration [μCi/ml] attributed to the radionuclides for the dilution water flow rate available during the release.

$$c = (\Sigma_g C_g) \left(\frac{F + f}{D f}\right) (Tm)$$

where:

C_g = The total radioactivity concentration of gamma-emitting radionuclides in liquid effluent prior to dilution (μCi/ml).

f = The maximum approved discharged flow rate prior to dilution (gpm).

= 60 gpm for the Waste Disposal System Liquid Effluent Monitor[3].

= 160 gpm for each Steam Generator Blowdown Monitor.

= 130 gpm for each Steam Generator Blowdown Monitor while draining a steam generator.

= 300 gpm for the Condensate Polisher Liquid Waste Monitor.

F = Dilution water flow rate (gpm).

= 160,000 gpm from one circulating water pump[1], Unit 2.

= 250,000 gpm from two circulating water pumps[1], Unit 2.

= 400,000 gpm from three circulating water pumps[1], Unit 2.

or

= 50,000 gpm from one circulating water pump[2], Unit 1.

= 80,000 gpm from two circulating water pumps[2], Unit 1.

T_m = Fraction of the radioactivity from the site that may be released via the monitored pathway to ensure that the site boundary limit is not exceeded due to simultaneous releases from more than one pathway.

= .25 for the Waste Disposal System Liquid Effluent Monitor (R-18).

= .16 for each of the Steam Generator Blowdown Monitor (R-19A, R-19B or R-19C).

= .25 for the Condensate Polisher Liquid Waste (R-37).

If it is determined that $\frac{F+f}{D\ f} < 1$, the release cannot be made. Reevaluate the discharge flow rate prior to dilution and/or the dilution flow rates.

If $\frac{F+f}{D\ f} > 1$, the release may be made.

The mixture of radionuclides released must be of such concentrations that Equation 2.2-3 must be met.

For HBR, the liquid radwaste effluent line discharges to the circulating water system. Therefore, the dilution flow rate (D_{fr}) is a function of the number of circulating water pumps operating. Unit 2 of the H.B. Robinson Steam Electric Plant has three circulating water pumps. Pump curves show that with three pumps operating, the circulating water flow is 400,000 gpm, with two pumps--250,000 gpm, and with one pump--160,000 gpm. Unit 1 of the H.B. Robinson Steam Electric Plant has two circulating water pumps. The circulating water flow is 50,000 gpm with one pump and 80,000 gpm with two pumps. At least one circulating water pump must be operating during any liquid waste discharge.

Batch releases from the HBR liquid radwaste system may occur from the waste condensate tanks, the monitor tanks, and the steam generators (during drainage). Continuous release may occur from Steam Generator Blowdown and the Condensate Polisher Liquid Waste. The maximum administrative release rate (R_b) is 160 gpm for each of the steam generators, 60 gpm from the monitor and waste condensate tanks, and 300 gpm for the Condensate Polisher Liquid Wastes, and 130 for each of the steam generators during drainage.

2.2.2.2 Postrelease

The Steam Generation Blowdown Monitor (R-19A, R-19B, and R-19C), the Waste Disposal System Liquid Monitor (R-18), and the Condensate Polisher Liquid Waste Monitor (R-37) setpoint will each be limited to 50 percent of the 10CFR20 limits. These setpoints will ensure that 10CFR20 limits are met. However, because they are based upon a given mix, the possibility exists that the alarm trip setpoints may be exceeded, while 10CFR20 limits are not exceeded. The following methodology is provided to determine whether actual releases exceeded 10CFR20 limits.

TABLE 2.3-1
Air VALUES FOR THE ADULT FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT
(MREM/HR PER MICRO-Ci/ML)

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
H-3	0.00E-01	2.26E 01	2.26E-01	2.26E-01	2.26E-01	2.26E-01	2.26E-01
C-14	3.13E+04	6.26E 03	6.26E+03	6.26E+03	6.26E+03	6.26E+03	6.26E+03
Na-24	4.07E+02	4.07E 02	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02
P-32	4.62E+07	2.87E 06	1.79E 06	0.00E-01	0.00E-01	0.00E-01	5.19E 06
Cr-51	0.00E-01	0.00E+01	1.27E 00	7.61E-01	2.81E-01	1.69E 00	3.20E 02
Mn-54	0.00E-01	4.38E 03	8.35E 02	0.00E-01	1.30E 03	0.00E-01	1.34E 04
Mn-56	0.00E-01	1.10E 02	1.95E 01	0.00E-01	1.40E 02	0.00E-01	3.51E 03
Fe-55	6.58E 02	4.55E 02	1.06E 02	0.00E-01	0.00E-01	2.54E 02	2.61E 02
Fe-59	1.04E 03	2.44E 03	9.36E 02	0.00E-01	0.00E-01	6.82E 02	8.14E 03
Co-57	0.00E+00	2.09E+01	3.48E+01	0.00E+00	0.00E+00	0.00E+00	5.31E+02
Co-58	0.00E-01	8.92E 01	2.00E 02	0.00E-01	0.00E-01	0.00E-01	1.81E 03
Co-60	0.00E-01	2.56E 02	5.65E 02	0.00E-01	0.00E-01	0.00E-01	4.81E 03
Ni-63	3.11E 04	2.16E 03	1.04E 03	0.00E-01	0.00E-01	0.00E-01	4.50E 02
Ni-65	1.26E 02	1.64E 01	7.49E 00	0.00E-01	0.00E-01	0.00E-01	4.17E 02
Cu-64	0.00E-01	9.97E 00	4.68E 00	0.00E-01	2.51E 01	0.00E-01	8.50E 02
Zn-65	2.32E 04	7.37E 04	3.33E 04	0.00E-01	4.93E 04	0.00E-01	4.64E 04
Zn-69	4.93E 01	9.43E 01	6.56E 00	0.00E-01	6.13E 01	0.00E-01	1.42E 01
Br-83	0.00E-01	0.00E-01	4.04E 01	0.00E-01	0.00E-01	0.00E-01	5.82E 01
Br-84	0.00E-01	0.00E-01	5.24E 01	0.00E-01	0.00E-01	0.00E-01	4.11E-04
Br-85	0.00E-01	0.00E-01	2.15E 00	0.00E-01	0.00E-01	0.00E-01	1.01E-15
Rb-86	0.00E-01	1.01E 05	4.71E 04	0.00E-01	0.00E-01	0.00E-01	1.99E 04
Rb-88	0.00E-01	2.90E 02	1.54E 02	0.00E-01	0.00E-01	0.00E-01	4.00E-09
Rb-89	0.00E-01	1.92E 02	1.35E 02	0.00E-01	0.00E-01	0.00E-01	1.12E-11
Sr-89	2.21E 04	0.00E-01	6.35E 02	0.00E-01	0.00E-01	0.00E-01	3.55E 03
Sr-90	5.44E 05	0.00E-01	1.34E 05	0.00E-01	0.00E-01	0.00E-01	1.57E 04
Sr-91	4.07E 02	0.00E-01	1.64E 01	0.00E-01	0.00E-01	0.00E-01	1.94E 03
Sr-92	1.54E 02	0.00E-01	6.68E 00	0.00E-01	0.00E-01	0.00E-01	3.06E 03
Y-90	5.76E-01	0.00E-01	1.54E-02	0.00E-01	0.00E-01	0.00E-01	6.10E 03
Y-91M	5.44E-03	0.00E-01	2.11E-04	0.00E-01	0.00E-01	0.00E-01	1.60E-02
Y-91	8.44E 00	0.00E-01	2.26E-01	0.00E-01	0.00E-01	0.00E-01	4.64E 03
Y-92	5.06E-02	0.00E-01	1.48E-03	0.00E-01	0.00E-01	0.00E-01	8.86E 02
Y-93	1.60E-01	0.00E-01	4.43E-03	0.00E-01	0.00E-01	0.00E-01	5.09E 03
Zr-95	2.40E-01	7.70E-02	5.21E-02	0.00E-01	1.21E-01	0.00E-01	2.44E 02
Zr-97	1.33E-02	2.68E-03	1.22E-03	0.00E-01	4.04E-03	0.00E-01	8.30E 02
Nb-95	4.47E 02	2.48E 02	1.34E 02	0.00E-01	2.46E 02	0.00E-01	1.51E 06
Mo-99	0.00E-01	1.03E 02	1.96E 01	0.00E-01	2.34E 02	0.00E-01	2.39E 02
Tc-99M	8.87E-03	2.51E-02	3.19E-01	0.00E-01	3.81E-01	1.23E-02	1.48E+01

3.0 GASEOUS EFFLUENTS

3.1 MONITOR ALARM SETPOINT DETERMINATION

This methodology determines the monitor alarm setpoint if the dose rate in the unrestricted areas due to radionoble gases in the gaseous effluent released from the site to areas at and beyond the site boundary exceeds 500 mrem/year to the whole body or exceeds 3000 mrem/year to the skin using a conservative mix (GALE Code).

The methodology described in Section 3.1.2 provides an alternative means to determine monitor alarm setpoints when an analysis is performed prior to release.

3.1.1 Setpoint Based on Conservative Radionuclide Mix (Ground and Mixed Mode Releases

Releases through the steam generator flash tank vent can only occur through this vent when significant primary-to-secondary leakage exists within the steam generators and the blowdown is not going through heat recovery. Detection of primary-to-secondary leakage is accomplished most effectively by continuously monitoring the condenser vacuum pump vent (R-15). Steam generator blowdown is continuously monitored by R-19A, R-19B, and R-19C as a liquid pathway. The condenser vacuum pump vent discharges via plant vent which is monitored by R-14.

The following method applies to gaseous releases via the plant vent when determining the high-alarm setpoint for the plant vent gas monitor (R-14C) and the Fuel Handling Basement Exhaust Monitor (R-20), using the GALE code during the following operational conditions:

- Continuous release via the plant vent (R-14C).
- Continuous release via the Fuel Handling Basement Exhaust (R-20).

3.1.1.1 Determine the "mix" (noble gas radionuclides and composition) of the gaseous effluent.

Determine S_i, the fraction of the total noble gas radioactivity in the gaseous effluent comprised by noble gas radionuclide "i," for each individual noble gas radionuclide in the gaseous effluent or use the Si from Table 3.1-1 when using GALE Code.

$$S_i = \frac{A}{\Sigma_i A_i} \qquad (3.1\text{-}1)$$

A_i = The radioactivity of noble gas radionuclide "i" in the gaseous effluent from Table 3.1-1.

3.1.1.2 Determine the Q_m, the maximum acceptable total release rate [μCi/sec] of all noble gas radionuclides in the gaseous effluent based upon the whole body exposure limit of 500 mrem/year by:

$$Q_m = \frac{500}{(\overline{X/Q})\ \Sigma_i\ K_i S_i} \qquad (3.1\text{-}2)$$

$(\overline{X/Q})$ = The highest calculated annual average relative dispersion factor for any area at or beyond the unrestricted area boundary for all sectors (sec/m^3).

= 8.1 E-5 sec/m^3 (Continuous Ground Release) from Table A-1, Appendix A.

= 9.9 E-7 sec/m^3 (Mixed Mode Release) from Table A-10, Appendix A.

K_i = The total whole body dose factor due to gamma emissions from noble gas radionuclide "i" (mrem/yr/ μCi/m^3) from Table 3.1-2.

3.1.1.3 Determine Q_m, the maximum acceptable release rate [μCi/sec] of all gas radionuclides in the gaseous effluent based upon the skin exposure limit of 3000 mrem/yr by:

$$Q_m = \frac{3000}{(\overline{X/Q})\ \Sigma_i\ [(L_i + 1.1\ M_i)\ S_i]} \qquad (3.1\text{-}3)$$

$L_i + 1.1M_i$ = The total skin dose factor due to emissions from noble gas radionuclide "i" (mrem/yr/μCi/m^3) from Table 3.1-2.

3.1.1.4 Determine C_m, the maximum acceptable total radioactivity concentration [μCi/cc] of all noble gas radionuclides in the gaseous effluent.

$$C_m = \frac{2.12\ E\text{-}3\ Q_m}{F}\ (T_m)\ (SF) \qquad (3.1\text{-}4)$$

NOTE: Use the <u>lower</u> of the Q_m values obtained in Sections 3.1.1.2 and 3.1.1.3. This will protect both the skin and total body from being exposed to the limit.

where:

T_m = Fraction of the radioactivity from the site that may be released via the monitored pathway to ensure that the site boundary limit is not exceeded due to simultaneous releases from several pathways.

= 0.92 for Plant Vent Gas Monitor (R-14C).

= 0.05 for the Fuel Handling Basement Exhaust Monitor (R-20).

F = The maximum acceptable effluent flow rate at the point of release (cfm).

= 60,600 cfm for plant vent.

= 10,200 cfm for the fuel-handling building.

2.12 E-3 = Unit conversion constant to convert μCi/sec/cfm to μCi/cc. $[\frac{sec - ft^3}{min - cc}]$

SF = An engineering factor used to provide a margin of safety for cumulated measurement uncertainties. = 0.5

3.1.1.5 Determine CR, the calculated monitor count rate above background attributed to the noble gas radionuclides [cpm], by:

$$CR = (C_m)(E_m) \qquad (3.1\text{-}5)$$

where:

E_m = Obtained from the applicable effluent monitor efficiency curve located in the Plant Operating Manual, Volume 15, Curve Book. Use the radioactivity concentration "C_m" to find CR.

3.1.1.6 Determine the HSP, the monitor high-alarm setpoint including background [cpm], by:

$$HSP = CR + background + 3.3\sqrt{\frac{Bkg}{2\tau}} \qquad (3.1\text{-}6)$$

where:

$3.3\sqrt{\frac{Bkg}{2\tau}}$ = Statistical variance on the background (Bkg) counting rate quoted at the 99.95% confidence level at a RC time constant t (minutes). This term is included to prevent inadvertent high alarm trips due to random fluctuations in the monitor background.

3.1.2 Setpoint Based on Sample Analysis Prior to Release

The following method applies to gaseous releases when determining the high-alarm setpoint with prior sample analysis and using the maximum acceptable effluent flow rate at the point of release. The method applies to the following conditions.

Batch Releases

- Containment purge.*
- Containment pressure relief.
- Waste gas decay tanks.

Continuous Releases

- Plant vent.
- Fuel handling basement exhaust.
- Environmental and Radiation Control Building Hood Exhaust.
- Containment purge.
- Radwaste Building exhaust vent.

* Batch containment purge is considered as 1 volume of containment air removed.

3.1.2.1 Determine R_i, the noble gas release rate [μCi/sec] for radionuclide "i":

$$R_i = 472\ (C_i)\ (F). \qquad (3.1\text{-}7)$$

where:

472 = A conversion factor to convert cfm to cc/sec.

C_i = The radioactivity concentration of noble gas radionuclide "i" from analysis of gaseous effluent (μCi/cc) from the Plant Vent (stack), Fuel Handling Basement Exhaust, Environmental & Radiation Control (E&RC) Building Hood Exhaust, Radwaste Building Exhaust Vent and the Containment Vessel when R-12 is sampling from the Containment. If there are no isotopes identified in the sample, the LLD's for Xe-133 and Kr-85 may be used as actual values for the purpose of the setpoint calculation.

Containment Purge--

($\mu Ci/cc_i$ from analysis of Containment Vent) (0.366) +
($\mu Ci/cc_i$ from analysis of Plant Vent) (0.634)

Containment Pressure Relief--

($\mu Ci/cc_i$ from analysis of Containment Vent) (0.040) +
($\mu Ci/cc_i$ from analysis of Plant Vent) (0.960)

Waste Gas Decay Tanks--

($\mu Ci/cc_i$ from analysis of WGDT) (0.0016) +
($\mu Ci/cc_i$ from analysis of Plant Vent) (0.9984)

Waste Gas Decay Tanks during Containment Purge--

($\mu Ci/cc_i$ from analysis of WGDT) (0.0010) +

($\mu Ci/cc_i$ from analysis of Plant Vent) (0.633) +

($\mu Ci/cc_i$ from analysis of C.V.) (0.366)

0.366 =	Dilution correction factor for C.V. Purge	$= \frac{35{,}000\ CFM}{(60{,}600 + 35{,}000)\ CFM}$
0.634 =	Dilution correction factor for Plant Vent during C.V. Purge	$= \frac{60{,}600\ CFM}{(60{,}600 + 35{,}000)\ CFM}$
0.040 =	Dilution correction factor for C.V. Pressure Relief	$= \frac{2500^{*}\ CFM}{(60{,}600 + 2500^{*})\ CFM}$
0.960 =	Dilution correction factor for Plant Vent during C.V. Pressure Relief	$= \frac{60{,}600\ CFM}{(60{,}600 + 2500^{*})\ CFM}$
0.0016 =	Dilution correction factor for Waste Gas Decay Tank	$= \frac{100\ CFM}{(60{,}600 + 100)\ CFM}$
0.9984 =	Dilution correction factor for Plant Vent during WGDT Release	$= \frac{60{,}600\ CFM}{(60{,}600 + 100)\ CFM}$
0.0010 =	Dilution correction factor for Waste Gas Decay Tank during a Continuous C.V. Purge and Plant Vent Release	$= \frac{100\ CFM}{(60{,}600 + 35{,}000 + 100)\ CFM}$
0.633 =	Dilution correction factor for Plant Vent during a Continuous C.V. Purge and Plant Vent Release	$= \frac{60{,}600\ CFM}{(60{,}600 + 35{,}000 + 100)\ CFM}$
0.366 =	Dilution correction factor for Continuous C.V. Purge during WGDT Release	$= \frac{35{,}000\ CFM}{(60{,}600 + 35{,}000 + 100)\ CFM}$

F - The maximum acceptable effluent flow rate at the point of release (CFM)

- 60,600 CFM for the plant vent
- 10,200 CFM for the fuel handling basement exhaust
- 11,500 CFM for the E&RC building hood exhaust
- 15,000 CFM for the Radwaste Building exhaust vent
- 95,600 CFM for the containment vessel purge plus plant vent
- 63,100 CFM for the containment vessel pressure relief
- 60,700 CFM for the waste gas decay tank
- 95,700 CFM for the waste gas decay tank during a continuous containment vessel purge
- 35,000 CFM for containment vessel purge or continuous release
- 2500 CFM for containment vessel pressure relief releases

*2500 CFM--Refer to Appendix B.4 for additional information

3.1.2.2 Determine the monitor alarm setpoint based on total body and skin dose rate:

a. Determine dose rate for total body (mrem/yr).

$$DR_{TB} = (\overline{X/Q})\ \Sigma_i\ K_i\ R_i \qquad (3.1\text{-}8)$$

where:

$\overline{X/Q}$ = The highest calculated annual average relative dispersion factor for any area at or beyond the unrestricted area boundary for all sectors (sec/m^3) from Appendix A.

= 8.1 E-5 sec/m^3 (continuous ground release) from Table A-1, Appendix A. To be conservative this can be used for all releases.

= 9.9 E-7 sec/m^3 (continuous mixed mode release) from Table A-10, Appendix A, only with upper wind speeds of ≤ 9 mph.

= 5.1 E-5 sec/m^3 (batch ground release) from Table A-7, Appendix A.

= 2.9 E-6 sec/m^3 (batch mixed mode release) from Table A-16, Appendix A.

K_i = The total whole body dose factor due to gamma emissions from noble gas radionuclide "i" ($mrem/yr/\mu Ci/m^3$) from Table 3.1-2.

b. Determine dose rate for skin (mrem/yr).

$$DR_{SK} = \overline{X/Q}\ \Sigma_i\ (L_i + 1.1\ M_i)\ R_i \qquad (3.1\text{-}9)$$

where:

SF = An engineering factor used to provide a margin of safety for cumulative uncertainties of measurements.

= .5

T_m = Fraction of the radioactivity from the site that may be released via the monitored pathway to ensure that the site boundary limit is not exceeded due to simultaneous releases from several pathways.

= [illegible] .r the Plant Vent Gas Monitor (R-14C).

= 0.05 for the Fuel Handling Basement Exhaust Monitor (R-20).

= 0.01 for other potential release points.

= 0.01 for the E&RC Building Hood Exhaust Monitor (R-22).

= 0.01 for the Radwaste Building exhaust vent Monitor (R-23).

= 0.81 for C.V. releases via R-11 and R-12
[This indicates 0.81 of 10CFR20 limits for Containment releases and is also monitored by R-14C. 0.92 = 0.81 + 0.11 (Normal Plant Releases)]

e. Determine the maximum monitor setpoint (CPM) for total body (S_t) and skin (S_s).

(Maximum total body setpoint in μCi/cc) (monitor efficiency) +

$$Bkg + 3.3\sqrt{\frac{Bkg}{2t}} \qquad (3.1\text{-}14)$$

TABLE 3.1-1

GASEOUS SOURCE TERMS*

Radionuclide	Plant Vent Release[1]		Condenser Vacuum Pump Vent[2]		Containment Purge or Pressure Relief		Gas Decay Tanks[3]	
	A. (Ci/yr)	S.	A. (Ci/yr)	S.	A. (Ci/yr)	S.	A. (Ci/yr)	S.
Kr-85m	2.0E0	5.26E-2	1.0E0	4.35E-2	0.00	0.00	0.00	0.00
Kr-85	0.00	0.00	0.00	0.00	0.00	0.00	1.6E2	8.00E-1
Kr-87	1.0E0	2.63E-2	0.00	0.00	0.00	0.00	0.00	0.00
Kr-88	3.0E0	7.89E-2	2.0E0	8.70E-2	1.0E0	2.90E-3	0.00	0.00
Xe-131m	0.00	0.00	0.00	0.00	1.0E0	2.90E-3	9.0E0	4.50E-2
Xe-133m	0.00	0.00	0.00	0.00	4.0E0	1.16E-2	0.00	0.00
Xe-133	2.8E1	7.37E-1	1.8E+1	7.83E-1	3.1E2	8.99E-1	3.1E1	1.55E-1
Xe-135	4.0E0	1.05E-1	2.0E0	8.70E-2	4.0E0	1.16E-2	0.00	0.00
Ar-41	0.00	0.00	0.00	0.00	2.5E1	7.25E-2	0.00	0.00
TOTAL	3.8E1		2.3E1		3.45E2		2.0E2	

*Source terms are based upon GALE Code (not actual releases) from the evaluation of H.B. Robinson Unit 2 to demonstrate conformance to the design objectives of 10CFR50, Appendix I, Table 2-4. These values are only for routine releases and not for a complete inventory of gases in an emergency.

[1]These values are used to determine the monitor alarm setpoints for the Plant Vent Gas Monitor (R-14C).

[2]These values are used to determine the monitor alarm setpoint for the Condenser Vacuum Pump Vent Monitor (R-15). R-15 is a process monitor and its effluents are monitored by R-14A, R-14B and R-14C. This column is intentionally left for reference.

[3]These values are used to determine the monitor alarm setpoint for the Fuel Handling Basement Exhaust Monitor (R-20).

3.2 COMPLIANCE WITH 10CFR20 (GASEOUS)

3.2.1 Noble Gases

The gaseous effluent monitors setpoints are utilized to show compliance with 10CFR20 for noble gases. However, because they are based upon a conservative mix of radionuclides, the possibility exists that the setpoints could be exceeded and yet 10CFR20 limits may actually be met. Therefore, the following methodology has been provided in the event that if the alarm trip setpoints are exceeded, a determination may be made as to whether the actual releases have exceeded 10CFR20.

The dose rate in unrestricted areas resulting from noble gas effluents is limited to 500 mrem/year to the total body and 3000 mrem/year to the skin. Based upon NUREG 0133, the following are used to show compliance with 10CFR20.

$$\Sigma_i K_i [(\overline{X/Q})_v \dot{Q}_{iv} + (\overline{X/Q})_e \dot{Q}_{ie}] \le 500 \ mrem/yr \quad (3.2\text{-}1)$$

$$\Sigma_i (L_i + 1.1 M_i) [(\overline{X/Q})_v \dot{Q}_{iv} + (\overline{X/Q})_e \dot{Q}_{ie}] \le 3000 \ mrem/yr \quad (3.2\text{-}2)$$

where:

$(\overline{X/Q})_v$ = Annual average relative dilution for plant vent releases at the site boundary, sec/m^3.

= From Table A-1 for ground level releases used for additional conservatism.

= From Table A-10 for mixed mode releases.

$(\overline{X/Q})_e$ = Annual average relative dilution for the Fuel Handling Basement Exhaust, the Environmental and Radiation Control Building Exhaust, and Radwaste Building Exhaust releases at the site boundary, sec/m^3.

= From Table A-1 for ground level releases.

K_i = The total body dose factor due to gamma emissions for noble gas radionuclide "i," mrem/year per $\mu Ci/m^3$.

L_i = The skin dose factor due to beta emissions for noble gas radionuclide "i," mrem/year per $\mu Ci/m^3$.

M_i = The air dose factor due to gamma emissions for noble gas radionuclide "i," mrad/year per $\mu Ci/m^3$.

1.1 = The ratio of the tissue to air absorption coefficients over the energy range of the photon of interest, mrem/mrad (reference NUREG 0133, October 1978).

$\dot{Q}_{ie}$ = The release rate of noble gas radionuclide "i" in gaseous effluents from the radwaste building exhaust vent, fuel handling basement exhaust, and the environmental and radiation control building hood exhaust, $\mu Ci/sec$.

$\dot{Q}_{iv}$ = The release rate of noble gas radionuclide "i" in gaseous effluents from the plant vent $\mu Ci/sec$.

The determination of limiting location for implementation of 10CFR20 for noble gases is a function of the radionuclide mix, release rate, and the meteorology. For the most limiting location, the radionuclide mix will be based on sample analysis of the effluent gases.

The X/Q value utilized in the equations for implementation of 10CFR20 is based upon the maximum long-term annual average ($\overline{X/Q}$) in the unrestricted area. Table 3.2-2 presents the distances from HBR to the nearest area for each of the 16 sectors as well as to the nearest residence, vegetable garden, cow, goat, and beef animal. Long-term annual average ($\overline{X/Q}$) values for the HBR release points to the special locations in Table 3.2-2 are presented in Appendix A. A description of their derivation is also provided in this appendix.

$\dot{Q}_{iv}$ = Release rate of radionuclide "i" from the plant vent, µCi/sec.

$\dot{Q}_{ie}$ = Release rate of radionuclide "i" from the radwaste building exhaust vent, fuel handling building basement exhaust, and environmental and radiation control building exhaust µCi/sec.

$(\overline{X/Q})_v$ = Annual average relative dilution for plant vent releases at the site boundary, sec/m^3.

$(\overline{X/Q})_e$ = Annual average relative dilution for fuel handling building basement exhaust, environmental and radiation control building exhaust, and radwaste building exhaust vent releases at the site boundary, sec/m^3.

P_{i_I} = The dose parameter for Iodine-131, Iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days for the inhalation pathway only in the most restrictive sector in mrem/yr per µCi/m^3. The dose factor is based on the most restrictive group (child) and most restrictive organ at the SITE BOUNDARY (see Table 3.2-4).

where:

In the calculation to show compliance with 10CFR20, only the inhalation is considered. A description of the methodology used in calculating the P_i values is presented in Appendix B. Compliance with 10CFR20 is achieved if the dose rate via inhalation pathway to a child is ≤ 1500 mrem/year.

TABLE 3.2-1

RELEASES FROM H.B. ROBINSON UNIT NO. 2*

(Ci/yr)

Isotope	Plant Vent (Q_v)	Condenser Vacuum Pump Vent (Q_e)	Total
Kr-85m	2.0E0	1.0E0	3.0E0
Kr-85	1.6E2	0.00	1.6E2
Kr-87	1.0E0	0.00	1.0E0
Kr-88	4.0E0	2.0E0	6.0E0
Xe-131m	1.0E1	0.00	1.0E1
Xe-133m	4.0E0	0.00	4.0E0
Xe-133	3.7E2	1.8E1	3.9E2
Xe-135	8.0E0	2.0E0	1.0E1
I-131	3.6E-2	2.3E-2	5.9E-2
I-133	5.4E-2	3.4E-2	9.8E-2
Mn-54	4.7E-3	0.00	4.7E-3
Fe-59	1.6E-3	0.00	1.6E-3
Co-58	1.6E-2	0.00	1.6E-2
Co-60	7.3E-3	0.00	7.3E-3
Sr-89	3.4E-4	0.00	3.4E-4
Sr-90	6.3E-5	0.00	6.3E-5
Cs-134	4.7E-3	0.00	4.7E-3
Cs-137	7.8E-3	0.00	7.8E-3

*Calculations based upon GALE Code and do not reflect actual release data from the Evaluation Conformance to the Design Objectives of 10CFR50, Appendix I. These values are only for routine releases and not for a complete inventory of gases in an emergency. Condenser vacuum pump vent is intentionally left in for reference.

3.3 COMPLIANCE WITH 10CFR50 (GASEOUS)

3.3.1 Noble Gases

3.3.1.1 Cumulation of Doses

Based upon NUREG 0133, the air dose in the unrestricted area due to noble gases released in gaseous effluents can be determined by the following equations:

$$D_\gamma = 3.17 \times 10^{-8} \Sigma_i M_i \left[(\overline{X/Q})_v \overline{Q}_{iv} + (\overline{X/q})_v \overline{q}_{iv} + (\overline{X/Q})_e \overline{Q}_{ie} \right] \qquad (3.3\text{-}1)$$

$$D_\beta = 3.17 \times 10^{-8} \Sigma_i N_i \left[(\overline{X/Q})_v \overline{Q}_{iv} + (\overline{X/q})_v \overline{q}_{iv} + (\overline{X/Q})_e \overline{Q}_{ie} \right] \qquad (3.3\text{-}2)$$

where:

D_γ = The air dose from gamma radiation, mrad.

D_β = The air dose from beta radiation, mrad.

M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide "i," mrad/ year per $\mu Ci/m^3$.

N_i = The air dose factor due to beta emissions for each identified noble gas radionuclide "i," mrad/year per $\mu Ci/m^3$.

$(\overline{X/Q})_v$ = The annual average dilution for areas at or beyond the unrestricted area boundary for long-term plant vent releases (> 500 hrs/year), sec/m^3.

= From Table A-1 for ground level releases used for conservatism.

- From Table A-10 for mixed mode releases.

$(\overline{X/q})_v$ = The dilution for areas at or beyond the unrestricted area boundary for short-term plant vent releases (≤ 500 hours/year), sec/m^3.

- From Table A-1 for ground level continuous release for conservatism.

- From Table A-7 for ground level releases.

- From Table A-16 for mixed mode releases.

$(\overline{X/Q})_e$ = Annual average relative dilution for fuel handling basement exhaust, the environmental and radiation control building exhaust, and radwaste building exhaust vent releases at the site boundary, (> 500 hours/year), sec/m^3.

- From Table A-1 for ground level releases;

q_{iv} = The average release of noble gas radionuclide "i" in gaseous releases for short-term plant releases (≤ 500 hours/year), μCi;

$\bar{Q}_{ie}$ = The average release of noble gas radionuclide "i" in gaseous releases for long-term fuel handling basement exhaust, the environmental and radiation control building exhaust, and radwaste building exhaust (> 500 hours/year), μCi;

$\bar{Q}_{iv}$ = The average release of noble gas radionuclide "i" in gaseous effluents for long-term vent releases (> 500 hours/year), μCi;

3.17×10^{-8} = The inverse of the number of seconds in a year (sec/year)$^{-1}$.

At HBR the limiting location is 0.26 miles SSE. Based upon the tables presented in Appendix A, substitution of the short-term X/Q value into Equation 3.3-1 yields lower dose value than the long-term X/Q values been used. In order to be conservative, for purposes of this document only, long-term annual

If the projected doses exceed 0.6 mrad for gamma radiation or 1.3 mrad for beta radiation when averaged over a calendar quarter, the ventilation exhaust treatment system will be operated to reduce releases of radioactive materials.

3.3.2 Radioiodine, Particulates and Tritium

3.3.2.1 Cumulation of Doses

Section II.C of Appendix I of 10CFR50 limits the release of radioiodines and radioactive material in particulate form from each reactor such that estimated annual dose or dose commitment to an individual in an unrestricted area from all pathways of exposure is not in excess of 15 mrem to any organ. Based upon NUREG 0133, the dose to an organ of an individual from radioiodines, tritium, and particulates with half-lives ≥ 8 days in gaseous effluents released to unrestricted areas can be determined by the following equation:

$$D_\tau = 3.17 \times 10^{-8} \Sigma_i R_{i_I} [(\overline{X/Q})_v Q_{iv} + (\overline{X/Q})_e Q_{ie} + (\overline{X/q})_v q_{iv}] +$$

$$(R_{i_g} + R_{i_M} + R_{i_V} + R_{i_G}) [(\overline{D/Q})_v Q_{iv} + (\overline{D/q})_v q_{iv} + (\overline{D/Q})_e Q_{ie}] +$$

$$(R_{T_M} + R_{T_g} + R_{T_I} R_{T_V}) [(\overline{X/Q})_v Q_{TV} + (\overline{X/q})_v q_{TV} + (\overline{X/Q})_e Q_{TE}] \quad (3.3\text{-}8)$$

where:

D_τ = Dose to any organ τ from I-131, I-133, particulates with ≥ 8 day half-lives, and Tritium in mrem.

3.17×10^{-8} = The inverse of the number of seconds in a year, $(sec/year)^{-1}$.

$(\overline{X/Q})_v$ = Annual average relative concentration for plant vent releases (> 500 hrs/yr) sec/m^3.

= From Table A-1 for ground level releases for conservatism.

= From Table A-10 for mixed mode releases.

$(\overline{X/Q})_e$ = Annual average dilution for radwaste building vent, fuel handling basement exhaust, and the environmental and radiation control building hood exhaust releases (> 500 hours/yr) sec/m^3.

= From Table A-1 for ground level releases.

$(\overline{X/q})_v$ = Annual average relative concentration for plant vent releases (≤ 500 hrs/yr) sec/m^3.

= From Table A-7 for ground release.

= From Table A-16 for mixed mode releases.

$(\overline{D/Q})_v$ = Annual average deposition factor for plant vent releases (>500 hrs/yr) m^{-2}.

= From Table A-3 for ground level releases for conservatism.

= From Table A-12 for mixed mode releases.

$(\overline{D/q})_v$ = Relative deposition factor for short-term plant vent releases (≤ 500 hrs/yr), m^{-2}.

= From Table A-3 for ground level continuous releases for conservatism.

= From Table A-9 for ground level releases.

= From Table A-18 for mixed mode releases

$(\overline{D/Q})_e$ = Annual average relative deposition factor for radwaste building vent, fuel handling basement exhaust, and the environmental and radiation control building hood exhaust releases (> 500 hrs/ yr), m^{-2}.

= From Table A-3 for ground level releases.

Q_{i*} = Release of radionuclide "i" in gaseous effluents for long-term radwaste building vent, fuel handling basement exhaust, and the environmental and radiation control building hood exhaust releases (> 500 hrs/yr), µCi.

Q_{iv} = Release of radionuclide "i" in gaseous effluents for long-term plant vent releases (> 500 hrs/yr), µCi.

q_{iv} = Release of radionuclide "i" in gaseous effluents for short-term plant vent releases (≤ 500 hrs/yr), µCi.

R_{i_G} = Dose factor for an organ for radionuclide "i" for the ground plane exposure pathway, mrem/yr per µCi/sec per m^{-2}.

R_{i_I} = Dose factor for an organ for radionuclide "i" for the inhalation pathway, mrem/yr per $\mu Ci/m^3$.

R_{i_V} = Dose factor for an organ for radionuclide "i" for the vegetable pathway, mrem/yr per $\mu Ci/m^{-2}$.

R_{T_V} = Dose factor for an organ for tritium for the vegetable pathway, mrem/yr per $\mu Ci/m^3$.

R_{T_I} = Dose factor for an organ for tritium for the inhalation pathway, mrem/yr per $\mu Ci/m^3$.

Q_{TV} = Release of tritium in gaseous effluents for long-term plant vent releases (> 500 hrs/yr), µCi.

R_{i_M} = Dose factor for an organ for radionuclide "i" for the milk exposure pathway, mrem/yr per µCi/sec per m^2.

R_{T_M} = Dose factor for an organ for tritium for the milk pathway, mrem/yr per $\mu Ci/m^3$.

R_{T_B} = Dose factor for an organ for tritium for the meat pathway, mrem/yr per $\mu Ci/m^3$.

R_{i_B} = Dose factor for an organ for radionuclide "i" for the meat exposure pathway, mrem/yr per $\mu Ci/sec/m^{-2}$.

Q_{T*} = Release of tritium in gaseous effluents for long-term radwaste building vent, fuel handling basement exhaust, and the environmental and radiation control building hood exhaust (>500 hrs/ yr), μCi.

q_{TV} = Release of tritium in gaseous effluents for short-term plant vent releases ($\leq$ 500 hrs/yr), μCi.

To show compliance with 10CFR50, Equation 3.3-8 is evaluated at the limiting pathway location. At HBR this location is the vegetable garden 0.3 miles in the SSE sector. The critical receptor is a child. Substitution of the appropriate X/Q and D/Q values from tables in Appendix A into Equation 3.3-8 would yield an equation with the short-term X/Q and D/Q values being less than the long-term values. Therefore, for this document, only long-term annual X/Q and D/Q values (i.e., more conservative values) are used.

The determination of a limiting location for implementation of 10CFR50 for radioiodines and particulates is a function of:

1. Radionuclide mix and isotopic release
2. Meteorology
3. Exposure pathway
4. Receptor's age

In the determination of the limiting location, the radionuclide mix of radioiodines and particulates was based upon the source terms calculated using the GALE Code. This mix is presented in Table 3.2-1 as a function of release point. The only source of short-term releases from the plant vent is containment purges. In the determination of the limiting location, all of the exposure pathways, as presented in Table 3.2-2, were evaluated. These include cow milk, goat

3.4 METHODOLOGY FOR R-11 SETPOINT (Air Particulate)

Determine the Monitor Alarm Setpoint based on the inhalation pathway to the child. The most restrictive organ "j" will be determined from the following methodology.

3.4.1 Determine dose rate for organ "j" (mrem/yr).

$$DR_j = \overline{X/Q}\ \Sigma_i\ R_{i_j}\ Q_i \qquad (3.4\text{-}1)$$

where:

$\overline{X/Q}$ = the highest calculated annual average relative dispersion factor for any area at or beyond the unrestricted area boundary for all sectors (sec/m^3) from Appendix A.

= 8.1E-5 sec/m^3 (continuous ground release) from Table A-1, Appendix A.

R_{i_j} = the organ "j" dose factor due to gamma emissions from particulates greater than or equal to 8 day half-life, I-133, I-131, and H-3.

Q_i = the particulate release rate (μCi/sec) for radionuclide "i".

= 472 (C_i)(F)

where:

472 = conversion factor to convert CFM to cc/sec.

C_i = (μCi/cc$_i$ from analysis of containment vessel) (0.366) + (DF) + μCi/cc$_i$ from analysis of Plant Vent) (0.634) when R-11 is sampling the Plant Vent for CV purges.

= (μCi/cc$_i$ from analysis of CV) (0.04) + (DF) + (μCi/cc$_i$ from analysis of Plant Vent) (0.960) when RMS-11 sampling from Plant Vent for CV pressure relief.

= (μCi/cc$_i$ from analysis of CV) + (DF) when RMS-11 is sampling CV.

F = 95,600 cfm for CV purge when R-11 is sampling from Plant Vent.

= 35,000 cfm for CV purge when R-11 is sampling from CV.

= 2,500 cfm for CV pressure relief when R-11 is sampling from CV.

= 63,100 cfm for CV pressure relief when R-11 is sampling Plant Vent.

DF = 1.0 for Tritium

= 10 for Iodines when using characoal filters

= 100 for Particulates ≥ 8 day half-lives when using HEPA Filters.

3.4.2 Determine the particulate emission Projected Dose Rate Ratio (PDRR) for the most critical organ "j".

$$PDRR_j = DR_j/1500 \quad (3.4\text{-}2)$$

1500 = the allowable organ dose rate due to particulates with > 8 day half-life, I-131, I-133, H-3 (mrem/year).

3.4.3 Determine the maximum monitor setpoint concentration (μCi/cc) for most critical organ "j".

Maximum Monitor Setpoint for Organ "j" =

$$[(\Sigma_i\ C_i) / (PDRR_j)]\ (SF)\ (T_m)\ (TL)$$

where:

SF = an engineering factor used to provide a margin of safety for cumulative measurement uncertainties = 0.50.

T_m = fraction of the radioactivity from the site that may be released via the monitored pathway to ensure that the site boundary limit is not exceeded due to simultaneous releases from several pathways.

= 0.81 for R-11 particulate monitor.

TL = total activity / $\Sigma_i\ C_i$ where the total activity is the sum of all detectable particulates from analysis of particulate filter divided by the detectable particulates of ≥ 8 day half-lives. If their ratio is not known, use 1.0.

= 1.0 when R-11 sampling from Plant Vent.

3.5 Methodology for R-14A Setpoint (Particulate Monitor)

This section describes the methodology in determining high alarm setpoint for the plant vent monitor (R-14A) based on the inhalation pathway to the child. The most restrictive organ "j" will be determined from a conservative mix (GALE Code).

3.5.1 Determine Si, the fraction of the total radioactivity in particulate form in the gaseous effluents comprised by radionuclide "i" for each radionuclide in the gaseous effluent from Table 3.2-1.

$$Si = \frac{Ai}{\Sigma i\ Ai} \qquad (3.5\text{-}1)$$

where:

Ai = The radioactivity of radioparticulate radionuclide "i" in the gaseous effluent from Table 3.2-1.

3.5.2 Determine Qm, the maximum acceptable total release rate [uCi/sec] of all the radioparticulate radionuclides in the gaseous effluent based upon the most restrictive organ "j" exposure limit of 1500 mrem/year by:

$$Qm_I = \frac{1500}{(\overline{X/Q})\ \Sigma i\ Si\ Pi_I} \qquad (3.5\text{-}2)$$

where:

1500 = the maximum allowable dose rate in an unrestricted area in gaseous effluents due to radioparticulates with half lives greater than 8 days, radioiodines and tritium via the inhalation pathway to the child.

$(\overline{X/Q})$ = The highest calculated annual average relative dispersion factor for any area at or beyond the unrestricted area boundary for all sectors (sec/m^3).

= 8.1E-05 Sec/m^3 (continuous ground release) from Table A-1, Appendix A.

Pi_I = The dose parameter for I-131, I-133, H-3, and all particulates in particulate form with half lives greater than 8 days for the inhalation pathway only in the most restrictive sector in mrem/year per uCi/m^3. The dose factor is based on the most restrictive group (child) and most restrictive organ at the S'"T BOUNDARY (see Table 3.2-4).

3.5.3 Determine Qiv_I, fraction of plant stack release rate acquired on filter, by:

$$Qiv_I = Qm_I \, [3.33E\text{-}05] \qquad (3.5\text{-}3)$$

where:

3.33E-05 = fraction of monitor sample rate to plant vent flow rate (2.02 CFM/60,600 CFM)

3.5.4 Determine HCI, maximum acceptable concentration [uCi] accumulated on the filter due to all radioparticulate radionuclides in the gaseous effluents based on the most restrictive organ "j", by:

$$HCI = Qiv_I \, (T) \qquad (3.5\text{-}4)$$

where:

T = time in seconds
= 8.64E04 for one day
= 6.05E05 for one week

3.5.5 Determine HAC, high alarm concentration [uCi] from radioparticulate radionuclides in gaseous effluents, by:

$$HAC = (HCI)\,(SF)\,(Tm) \qquad (3.5\text{-}5)$$

where:

SF = An engineering factor used to provide a margin of safety for cumulative uncertainties of measurements
= 0.5

Tm = Fraction of the radioactivity from the site that may be released to ensure the site boundary limit is not exceeded due to simultaneous releases from pathways
= .92 for the Plant Vent Monitor (R-14A).

3.5.6 Determine the HSP, High Alarm Setpoint including background [cpm], by:

$$HSP = (HAC/Em) + BKG + 3.3\sqrt{\frac{BKG}{2\tau}} \qquad (3.5\text{-}6)$$

where:

Em = from monitor efficiency curve located in the Plant Operating Manual Curve Book.

3.6 <u>Methodology for R-14B Setpoint (Iodine Monitor)</u>

This section describes the methodology in determining high alarm setpoint for the plant vent monitor (R-14B) based on the inhalation pathway to the child. The most restrictive organ "j" will be determined from a conservative mix (GALE Code).

3.6.1 Determine Qm_I, the maximum acceptable release rate [uCi/sec] of I-131 in gaseous effluents based upon the most restrictive organ "j" exposure limit of 1500 mrem/year, by:

$$Qm_I = \frac{1500}{(X/Q)\ Pi_I} \qquad (3.6\text{-}1)$$

where:

Pi_I = The dose parameter for I-131 for the inhalation pathway only in the most restrictive sector in mrem/year per uCi/m^3. The dose factor is based on the most restrictive group (child) and most restrictive organ at the Site Boundary (see Table 3.2-4).

3.6.2 Determine Qiv_I, fraction of plant stack release rate acquired on the cartridge, by:

$$Qiv_I = Qm_I(3.33E\text{-}05) \qquad (3.6\text{-}2)$$

3.6.3 Determine HCI, maximum acceptable concentration [uCi] accumulated on the cartridge due to I-131 in gaseous effluents based on the most restrictive organ "j".

$$HCI = (Qiv_I)\ (T) \qquad (3.6\text{-}3)$$

where:

T = time is seconds
= 8.64E04 for one day
= 6.05E05 for one week

3.6.4 Determine HAC, high alarm concentration [uCi] from I-131 in gaseous effluents, by:

$$HAC = (HCI)\ (SF)\ (Tm) \qquad (3.6\text{-}4)$$

3.6.5 Determine HSP, High Alarm Setpoint including background [cpm], by:

$$HSP = (HAC/Em) + BKG + 3.3\sqrt{\frac{BKG}{2\tau}} \qquad (3.6\text{-}5)$$

3.7 <u>Methodology for R-22 and R-23 Setpoint Determination for the Iodine and Particulate Monitors</u>

This section describes the methodology in determining high alarm setpoint for the particulate and iodine channels for the Environmental and Radiation Control Building and Radwaste Building exhaust vent (R-22 and R-23, respectively) based on the inhalation pathway to the most restrictive organ and age group (child).

3.7.1 The dose rate in an unrestricted area resulting from the release of radioiodines, tritium, and particulates with half-lives ≥ 8 days is limited to 1500 mrem/yr to any organ via inhalation (10CFR20). The iodine and particulate monitor setpoints for R-22 and R-23 are limited to 1.0% of 10CFR20 over one hour period. Therefore, the iodine and particulate channels high alarm shall be set to 1.0% of 10CFR20 for any given hour.

3.7.2 Determine Q_i, the maximum release rate (μCi/sec) for Iodine-131 and Cobalt-60 (the most restrictive particulate ≥ 8 day half-life) base on the most restrictive organ "j" via inhalation to a child.

$$Q_i = \frac{15}{(R_i)\ (\overline{X/Q})} \qquad (3.7\text{-}1)$$

where:

15 = 1.0% of the maximum allowable dose rate in an unrestricted area in gaseous effluents due to radioparticulates with half-lives greater than or equal to 8 days, radioiodine, and tritium via the inhalation pathway to the child.

R_i = The dose factor based on the most restrictive age group (child) and the most restrictive organ (thyroid) for Iodine-131 (1.62E7 mrem/yr/μCi/m^3) and lung for Co-60 (7.06E6 mrem/yr/μCi/m^3) at the most restrictive location (SITE BOUNDARY).

$\overline{X/Q}$ = Annual average relative dilution for continuous ground level releases for the most restrictive section at the SITE BOUNDARY (8.08E-5 sec/m^3 for the SSE sector from Table A-1).

Therefore:

$Q_{i\,Iodine\text{-}131}$ = 1.15E-2 μCi/sec

$Q_{i\,Cobalt\text{-}60}$ = 2.63E-2 μCi/sec

3.7.3 Determine S_{c_i}, the air particulate filter and charcoal cartridge sample collection rate (µCi/sec) by:

$$S_{c_i} = Q_i \frac{f}{F} \qquad (3.7\text{-}2)$$

where:

f = sampler flow rate (typically 2.5 CFM for R-22 and 2 CFM for R-23)

F = Radwaste Building exhaust vent flow rate (15,000 typically)

= Environmental and Radiation Control Building exhaust vent flow rate (11,500 typically)

Therefore:

The typical Co-60 sample collection rate is 5.72E-6 µCi/sec and 4.39E-6 µCi/sec, for R-22 and R-23, respectively.

The typical I-131 sample collection rate is 2.5E-6 µCi/sec and 1.91E-6 µCi/sec for R-22 and R-23, respectively.

3.7.4 Determine Q_{m_i}, the setpoint activity (µCi) accumulated on the air particulate filter and charcoal filter for any given hour by:

$$Q_{m_i} = (S_{c_i})\,(T) \qquad (3.7\text{-}3)$$

where:

T = 3600 sec in an hour.

Therefore:

The typical setpoint activity for the air particulate filter and the charcoal cartridge is:

Monitor	Particulate	Iodine
R-22	2.06E-02	9.00E-03
R-23	1.58E-02	6.88E-03

3.7.5 Determine the HSP, High Alarm Setpoint including background (cpm) by:

$$HSP = (Q_{m_i}) (Em) + BKG \qquad (3.7\text{-}4)$$

where:

Em = efficiency of the detector
BKG = the background of the detector

The above methodology shall be used for the iodine cartridge and air particulate filter setpoint determinations for the Environmental and Radiation Control Building and Radwaste Building exhaust vent. The sampling and building vent flow rates used in the above equations are subject to change and shall be controlled by plant procedures. If or when this occurrs, the recalculations of setpoints shall be performed by approved procedures using the above methodology.

TABLE D-1

Liquid Process Monitors

Name	R #	ID #	Drawing #
Containment Vessel Fan Cooling Water	16	R-16	C997261
Component Cooling Water	17	R-17	C997246
Liquid Waste Disposal	18	PI 871109	NRC Industries 4PI Liquid Sample Manual
Condensate Polisher Liquid Waste	37	R-37	Plant Mod.-723 H.B.R.-2-9065
Steam Generator Blowdown	19A 19B 19C	R-19A R-19B R-19C	Mod 898

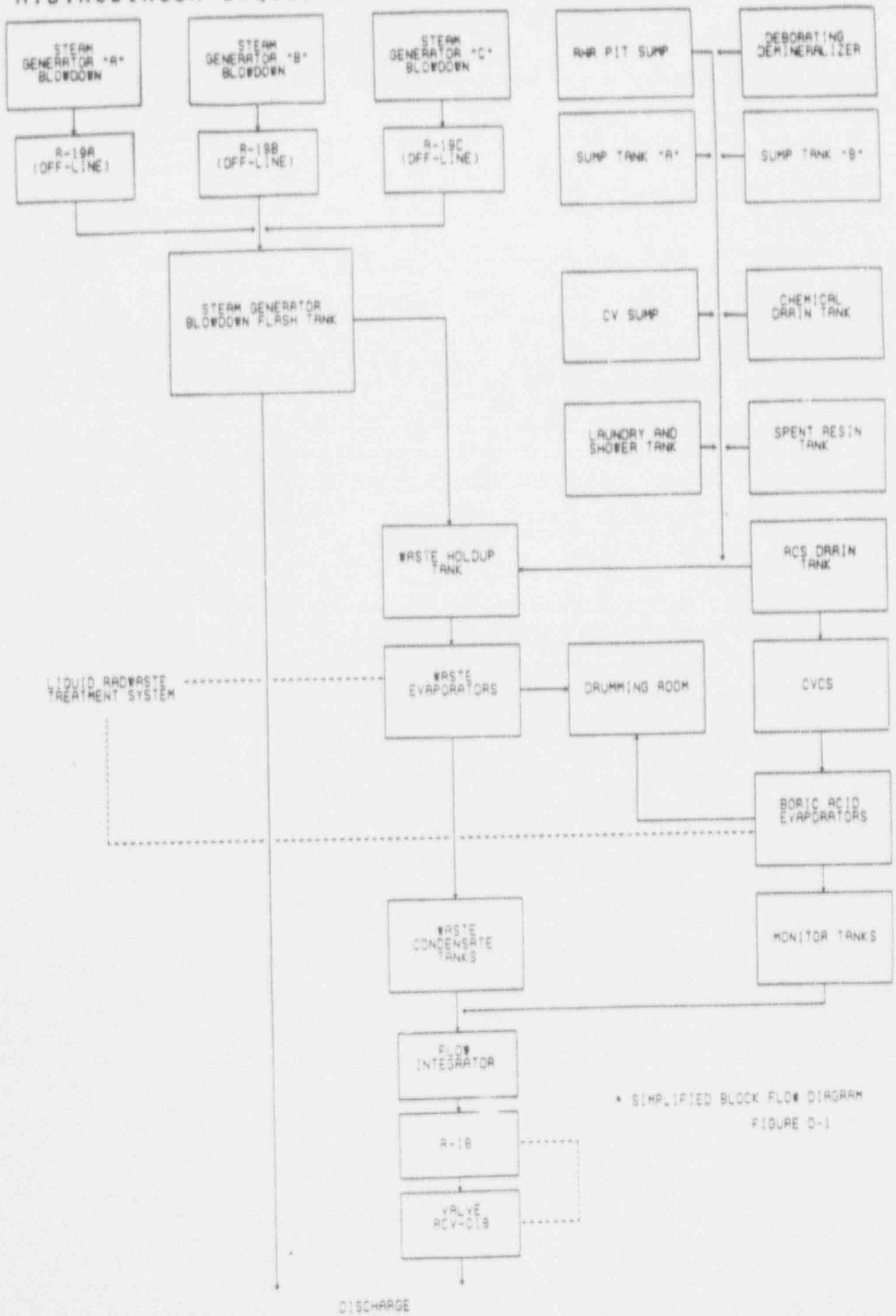
Liquid Radwaste Flow Measurement Devices

Liquid Radwaste Flow (ITT Barton Flow Integrator)	N/A	FT 1064	

TABLE D-2
Gaseous Process Monitors

Name	R #	ID #	Drawing #	Sample Flow Rate Measurement Device	System Flow Rate Measurement Device
Containment Vessel Particulate	11	11	D997556	F&P Co. Flow Tube FP-3/4-27-G 10/80	UGC Microflow 3000 (if sampling stack)
Containment Vessel Gaseous	12	12	D997556	F&P Co. Flow Tube FP-3/4-27-G 10/80	UGC Microflow 3000 (if sampling stack)
Plant Vent Low Range	14C	R-14	Mod 1005	Kurz 4200 Isokinetic Sample System	F-14 Plant Vent Stack Flow Monitor (Kurz)
Fuel Handling Building Basement Exhaust	20	R-20	C998233	Fisher Porter Flowmeter Mod. 10A35755Z Serial 6908A0837A1	None (Use fan ratings)
Fuel Handling Building Upper Level Exhaust	21	R-21	C9988233	Fisher Porter Flowmeter Mod. 1043565 Mod. 6908A0837A1	None (Use fan ratings)

H.B.ROBINSON LIQUID RADWASTE PROCESS/EFFLUENT SYSTEM*



* SIMPLIFIED BLOCK FLOW DIAGRAM

FIGURE D-1

H.B.ROBINSON GASEOUS RADWASTE EFFLUENT SYSTEM*

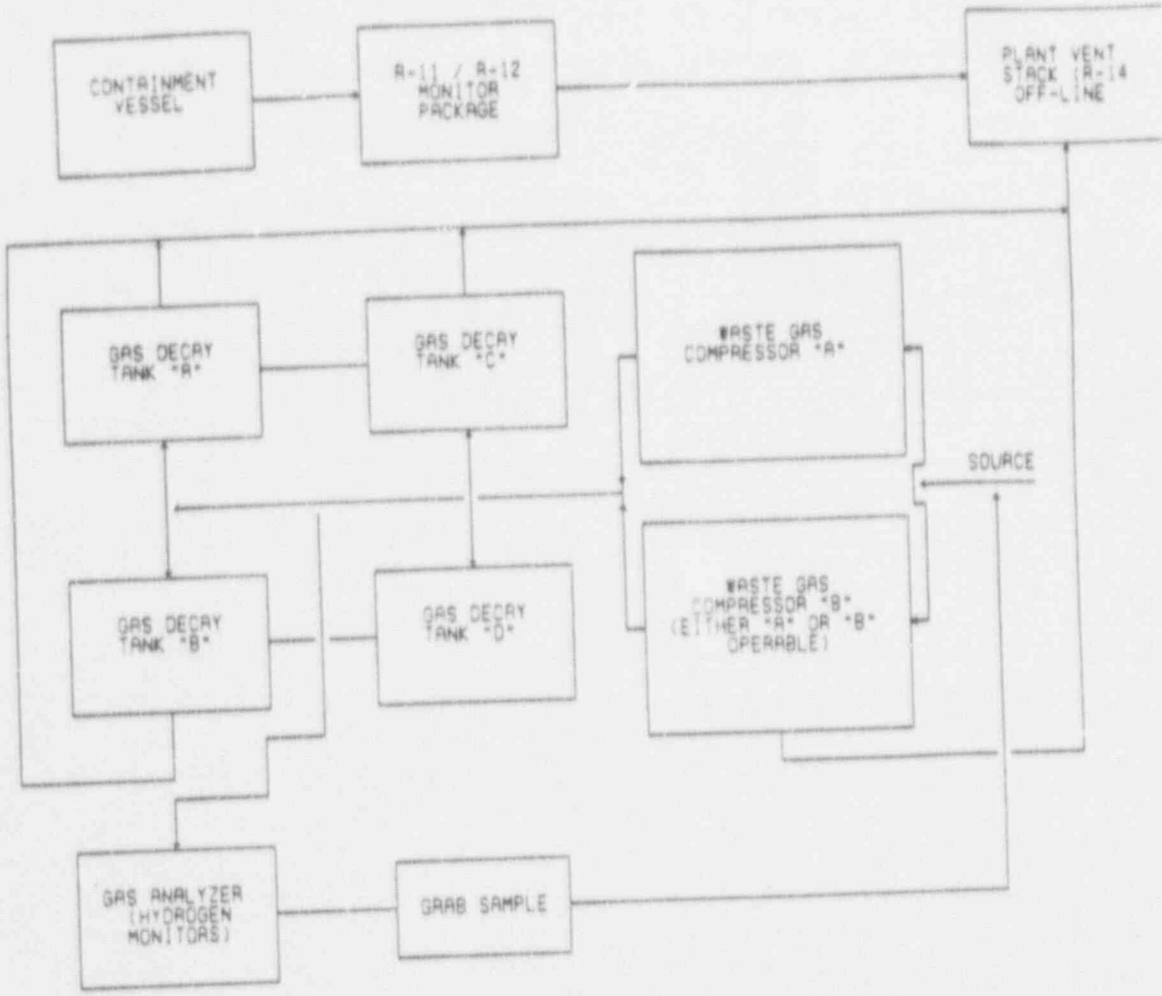


FIGURE D-2

* SIMPLIFIED BLOCK FLOW DIAGRAM

THE GASEOUS RADWASTE SYSTEM MAY BE COMPRISED OF ONE WASTE GAS COMPRESSOR AND ONE WASTE GAS DECAY TANK.

II. CHANGES TO THE RADIOACTIVE WASTE SYSTEMS

There were no changes to the Radioactive Waste System during this reporting period.

III. CHANGES TO THE PROCESS CONTROL PROGRAM

There were no changes to the Process Control Program (PCP) during this reporting period.

IV. CHANGES TO THE LAND USE CENSUS

There were no changes to the environmental sampling program as a result of the Land Use Census performed in the first six months of 1991.

V INSTRUMENT INOPERABILITY

FI-1064, which is the liquid effluent flowrate measuring device, was declared inoperable in July of 1990 due to erratic readings. It was discovered that this monitor is obsolete and repair parts are not available. Therefore, an engineering evaluation has been initiated to determine and procure a suitable replacement for this monitor.

For the equipment inoperability shown, supplemental surveillances were initiated as required by Technical Specification Table 3.5-6.

VI. LIQUID HOLDUP TANK CURIE LIMIT

There were no outside liquid holdup tanks that exceeded the ten curie limit during this reporting period.

VII. WASTE GAS DECAY TANK CURIE LIMIT

There were no waste gas decay tanks with a curie content that exceeded the 1.90E+04 curie limit during this reporting period.

VIII. INDEPENDENT SPENT FUEL STORAGE INSTALLATION

The onsite independent spent fuel storage installation, license #SNM-2502/docket #72-3, became operational during the first six months of 1989. See Addendum I for reporting requirements concerning this facility.

IX. DISPOSAL OF BOILER CHEMICAL CLEANING WASTE

Pursuant to 10CFR20.302(a) and USNRC IE Information Notice No. 86-90, slightly contaminated waste from the acid cleaning of the Unit #1 boiler was released to the onsite Ash Ponds under the approval of the South Carolina Department of Health and Environmental Control. The approval was requested in a letter of August 20, 1991 (Serial: RNPD/91-1281) and received in a SCDHEC letter of September 16, 1991. The transfer consisted of approximately 30,200 gallons of waste containing a total of 63 μCi.

The above Curies released to the Ash Ponds onsite are not included in Section IV, Liquid Effluents, of Enclosure 1 of this report.

SUPPLEMENTS TO PREVIOUS
SEMIANNUAL REPORTS

TABLE OF CONTENTS
Enclosure 3

I. DISCUSSION

There were two changes to a previous report during this reporting period. The volume of solid waste shipped as Waste Class "A", Type "b" in the first half of 1991 was reported as 3.59E+01 cubic meters. The actual volume shipped was 3.62E+01 cubic meters. This was an addition error made while tabulating data for the first semiannual period of 1991. The table on page 3 of Enclosure 3 reflects this correction.

Also, 6.35E-06 curies of F-18 was reported in liquid effluents for the second quarter of 1991. Upon further investigation, it was determined that the reported F-18 was actually caused by Co-58 interference on the gamma spectroscopic analysis of an effluent sample. The table on page 4 of Enclosure 3 reflects this correction.

II. DATA TABLES

The following tables provide correction to data reported in the first semiannual period of 1991.

SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
LIQUID EFFLUENTS - CONTINUOUS MODE AND BATCH MODE RELEASES

V. SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
REPORT TIME PERIOD JANUARY 1 THROUGH JUNE 30, 1991

A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (not irradiated fuel)

WASTE CLASS A

Type of Waste	Unit	6-Month Period	Est. Total Error (%)	Solid. Agent	Cont. Type	Form	No. Ship.
a. Spent resins, filter sludges, evaporator bottoms, etc	m^3 Ci	4.94E+00 6.23E-02	2.00E+01 2.00E+01	NA	STP	Dewatered Resin	17
b. Dry compressible waste, contaminated equip, etc	m^3 Ci	3.62E+01 4.32E+00	2.00E+01 2.00E+01	NA	STP	Compacted / Uncompacted	53
c. Irradiated components, control rods, etc	m^3 Ci	NA	NA	NA	NA	NA	NA
d. other (describe)	m^3 Ci	NA	NA	NA	NA	NA	NA

STP = Strong Tight Package

TABLE IV-B
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT - 1991
LIQUID EFFLUENTS - CONTINUOUS MODE AND BATCH MODE RELEASES

		CONTINUOUS MODE		BATCH MODE	
	UNITS	1ST QUARTER	2ND QUARTER	1ST QUARTER	2ND QUARTER
1. PARTICULATES					
Na-24	Ci	<LLD	<LLD	7.64E-06	1.24E-05
Cr-51	Ci	<LLD	<LLD	2.56E-03	2.18E-04
Mn-54	Ci	<LLD	<LLD	3.85E-04	1.80E-05
Fe-55	Ci	<LLD	<LLD	1.61E-02	2.62E-03
Co-57	Ci	<LLD	<LLD	7.03E-05	4.52E-06
Co-58	Ci	<LLD	<LLD	3.70E-02	2.12E-03
Co-60	Ci	<LLD	<LLD	1.81E-02	1.32E-03
Nb-95	Ci	<LLD	<LLD	3.84E-04	<LLD
Zr-95	Ci	<LLD	<LLD	5.87E-05	<LLD
Tc-99m	Ci	<LLD	<LLD	2.98E-06	<LLD
Ag-110m	Ci	<LLD	<LLD	1.42E-03	3.50E-05
Sn-113	Ci	<LLD	<LLD	2.59E-05	<LLD
Sb-124	Ci	<LLD	<LLD	4.11E-03	3.93E-04
Sb-125	Ci	<LLD	<LLD	2.73E-02	7.41E-03
Cs-134	Ci	<LLD	<LLD	4.60E-06	1.22E-04
Cs-137	Ci	<LLD	<LLD	9.70E-04	1.03E-03
Total for Period	Ci	<LLD	<LLD	1.08E-01	1.53E-02
2. GASES					
Xe-133	Ci	<LLD	<LLD	1.57E-04	1.82E-03
Total for Period	Ci	<LLD	<LLD	1.57E-04	1.82E-03

INDEPENDENT SPENT FUEL STORAGE INSTALLATION

H. B. ROBINSON STEAM ELECTRIC PLANT UNIT 2

SEMIANNUAL ENVIRONMENTAL REPORT

July 1, 1991 - December 31, 1991

FACILITY OPERATING LICENSE NO. SNM-2502
DOCKET NO. 72-3

I. HISTORY OF THE FACILITY

The Independent Spent Fuel Storage Installation (ISFSI) is located within the Protected Area of HBR2. Currently, the installation contains eight (8) Dry Storage Canisters. The initial canister was loaded on 3/16/89 and other canisters were loaded on 4/11/89, 4/18/89, 4/24/89, 5/2/89, 5/8/89, 6/28/89, and 7/3/89 .

II. EFFLUENT LIMITS AND CONTROLS

This installation operates under effluent control limits as required by 10CFR72.44. However, there are, by design of the sealed storage canisters at the ISFSI, no effluent releases, and all H. B. Robinson site cask loading and unloading operations and waste treatment therefrom will occur at the H. B. Robinson Steam Electric Plant Unit 2 under the specifications of its operating license (DPR-23).

III. RADIOLOGICAL EFFLUENT RELEASES

A review of the quarterly surveillance tests performed during this reporting period indicates that NO RADIOACTIVE LIQUID OR GASEOUS RELEASES OCCURRED DURING THIS REPORT PERIOD.

IV. THE ISFSI ENVIRONMENTAL PROGRAM

The ISFSI Environmental Program consists of two air samplers and three TLD's about the installation plus an unaffected air sampler and TLD site 26 miles ESE of the facility. Two of the environmental TLD's are maintained at the air sampling sites adjacent to the plant boundary. These are located south at 0.2 miles and southwest at 0.3 miles from the ISFSI. A third TLD site is located 0.1 miles north of the installation. The nearest residence is located south to south-southeast approximately 0.25 miles from the facility. Air samplers operate continuously and samples are changed weekly. TLD's are changed quarterly.

V. OTHER ENVIRONMENTAL PROGRAMS

In addition to the ISFSI Environmental Program, the HBR2 Environmental Program is described in Technical Specification 3.17 (see Carolina Power and Light Company, "Technical Specifications and Bases for H. B. Robinson Unit No. 2," Appendix A to Facility Operating License DPR-23, Docket No. 50-261, Darlington County, S.C.). For a comprehensive summary of this program and its results, see also "Environmental Surveillance Report," H. B. Robinson Steam Electric Plant, Unit 2 issued in compliance with the above referenced Technical Specification for this report period.

VI. ISFSI ENVIRONMENTAL MEASUREMENTS

A. Environmental TLD's

TLD (Location)	3rd Qtr. (mrem/wk.)	4th Qtr. (mrem/wk.)
1 (26 miles ESE) (Control)	1.20	1.00
2 (0.2 miles S)	1.00	1.00
6 (0.3 miles SW)	1.10	1.00
56 (0.1 miles N)	1.00	1.00

B. Air Sampling

Gross Beta Measurements - 3rd Qtr.
(picocuries per cubic meter)

Air Sampler (Location)	Average	Maximum
1 (26 miles ESE) (Control)	1.55E-02	2.74E-02
2 (0.2 miles S)	1.63E-02	2.70E-02
6 (0.3 miles SW)	1.70E-02	2.70E-02

Gross Beta Measurements - 4th Qtr.
(picocuries per cubic meter)

Air Sampler (Location)	Average	Maximum
1 (26 miles ESE) (Control)	1.91E-02	2.67E-02
2 (0.2 miles S)	2.26E-02	3.00E-02
6 (0.3 miles SW)	2.12E-02	2.76E-02

A composite analysis of air samples detected no radionuclides from man-made sources for either quarter.

VII. CONCLUSIONS

Based on the above measurements performed during this reporting period, it is our conclusion that the dose issuing from the ISFSI to the most exposed MEMBER OF THE PUBLIC did not exceed 1 mrem. This is best estimated as presented in the ISFSI FSAR and compensated for eight canisters and a partial year of operation as 0.4 mrem per year.

VIII. SUMMARY

This report is submitted in compliance with ISFSI Specification 1.4.1 as required pursuant to 10CFR72.44(d)(3). Paragraph III specifies liquid and gaseous releases to the environment. Paragraphs VI and VII are provided for estimation of potential radiation dose commitment to the public resulting from effluent release.