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Dr. J. N. Grace
Regional Administrator
U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, Suite 3100
Atlanta, Georgia 30323

SUBJECT: Effluent and Waste Disposal Semiannual Report

Dear Dr. Grace:

Enclosed is Enclosure 1, the Effluent and Waste Disposal Semiannual Report for January through June, 1986, as required by 10CFR50.36a (a) (2); Enclosure 2, the revised pages to Revision 1 of ODCM; and Enclosure 3, the entire ODCM Revision 2.

Please contact me if you need additional information.

Very truly yours,

R. E. Morgan
General Manager
H. B. Robinson S. E. Plant

ALT:ac

Enclosures

cc: R. A. Hartfield (2)
M. D. Hill (1)
A. L. Taylor (2)
J. M. Taylor (25)
B. H. Webster (4)

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1/1

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cc: R. A. Hartfield (2)
M. D. Hill (1)
A. L. Taylor (2)
J. M. Taylor (25)
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EFFLUENT AND WASTE DISPOSAL

SEMIANNUAL REPORT

1/1/86 - 6/30/86

CAROLINA POWER AND LIGHT COMPANY

H. B. ROBINSON SEG PLANT - UNIT 2

FACILITY OPERATING LICENSE NO. DPR-23

DOCKET NO. 50-261

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I. INTRODUCTION

This Effluent and Waste Disposal Report is submitted per Technical Specification 6.9.1.d to the H. B. Robinson Steam Electric Plant - Unit 2 Facility Operating License No. DPR-23. The data in this report covers the period from January 1 to June 30, 1986, and is the first semiannual report under the full implementation of the Radiological Effluent Technical Specifications (RETS).

The summations of gaseous and liquid effluents are in accordance with the tables in Regulatory Guide 1.21 (Rev. 1, 6/74) Appendix B. The summations of the solid waste shipments are slightly different but similar to Regulatory Guide 1.21 due to additional reporting requirements by the operating license and 10CFR Part 61.

The values reported for the activity of nuclides released are the actual measured activities. If no activity for a nuclide was detected for a quarter, the reader is referred to the respective Lower Limit of Detection (LLD) Table for that radionuclide. The total of activity released is a total of only the nuclides that had measured activity.

Compliance with 10CFR50, Appendix I for maximum individual doses is demonstrated by using average meteorology and the methods in the Offsite Dose Calculation Manual.

The meteorological data for this report period is on file in the format of Regulatory Guide 1.21 and is available to the NRC upon request. This data will be sent 60 days after January 1, 1987, with the second semiannual Effluent and Waste Disposal Report for 1986.

There have been no changes to the NRC (May 16, 1986) approved Process Control Program (PCP) and no changes to the radioactive waste systems (liquid, gaseous, or solid) during this report period.

The land use census, conducted May 6, 1986, revealed no new or additional locations that require sampling.

The Radioactive Liquid and Gaseous Effluent Monitoring Instrumentation listed in Tables 3.5-6 and 3.5-7 of the Technical Specifications Amendment No. 85 have not exceeded any of their continuous inoperability requirements.

Revision 1 and Revision 2 of the Offsite Dose Calculation Manual (ODCM) were reviewed and approved by the Plant Nuclear Safety Committee (PNSC) on November 20, 1985 and March 6, 1986, respectively. These changes do not reduce the accuracy or reliability of the dose calculations or setpoint determinations.

II. SUPPLEMENTAL INFORMATION

A. Regulatory Limits

1. Fission and Activation Gases:

10CFR20 Limits (Instantaneous Release Rate)
- Total Body ≤500 mrem/yr
- Skin ≤3000 mrem/yr

10CFR50 Appendix I
- For Calendar Quarter
  - Gamma Dose ≤5 mrad
  - Beta Dose ≤10 mrad
- For Calendar Year
  - Gamma Dose ≤10 mrad
  - Beta Dose ≤20 mrad

2. Iodine - 131, 133, Tritium, and Particulates ≥8 day half-lives:

10CFR50 Limits (Instantaneous Release Rate)
- Inhalation (only) to a child to any organ ≤1500 mrem/yr

10CRF50 Appendix I
- For Calendar Quarter ≤7.5 mrem
- For Calendar Year ≤15 mrem

3. Liquids:

Concentrations are specified in 10CFR20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2E-4 μCi/ml total activity.

10CFR50 Appendix I
- For Calendar Quarter
  - Total Body ≤1.5 mrem
  - Any Organ ≤5 mrem
- For Calendar Year
  - Total Body ≤3 mrem
  - Any Organ ≤10 mrem

B. Measurements and Approximations of Total Radioactivity

1. Continuous Gaseous Releases

a. Fission and Activation Gases - The total activity released is determined from the net count rate of the gaseous monitor, its calibration factor, and the total exhaust flow. The activity of radiogas is determined by the fraction of that radiogas in the isotopic analysis for that period.

b. Iodines - The activity released as iodine-131, 133, and 135 is based on the charcoal cartridge and particulate filter activities and the total vent flow.

c. Particulates - The activity released via particulates with half-lives greater than eight days is determined by isotopic analysis of particulate filters and the total vent flow.

d. Tritium - The activity released as tritium is based on weekly grab sample analysis and total vent flow.

2. Batch Gaseous Releases

a. Fission and Activation Gases - The activity released is based on the volume released and the activity of the individual nuclides obtained from an isotopic analysis of the grab sample taken prior to the release.

b. Iodines - The iodines from batch releases are included in the iodine determination from the continuous Auxiliary Building release.

c. Particulates - The particulates from batch releases are included in the particulate determination from the continuous Auxiliary Building release.

d. Tritium - The activity released as tritium is based on the grab sample analysis of each batch and the batch volume.

3. Liquid Releases

a. Fission and Activation Products - The total release values (not including tritium, strontium, Iron-55, and alpha) are comprised of the sum of the individual radionuclide activities in each batch released to the discharge canal for the respective quarter. These values represent the activity known to be present in the liquid radwaste effluent.

b. Tritium & Alpha - The measured tritium and alpha concentrations in a composite sample are used to calculate the total release and average diluted concentration during each period.

c. Strontium-89, 90, and Iron-55 - The total release values are measured quarterly from composite samples.

C. Estimated Total Errors

1. Estimated total errors for gaseous effluents are based on uncertainties in counting equipment calibration, counting statistics, vent flow rates, vent sample flow rates, non-steady release rates, chemical yield factors, and sample losses for such items as charcoal cartridges.

2. Estimated total errors for liquid effluents are based on uncertainties in counting equipment calibration, counting statistics, non-steady release flow rate, chemical yield factors, sampling and mixing losses, and volume determinations.

3. Estimated total errors for solid waste are based on uncertainties in equipment calibration, dose rate measurements, geometry, and volume determinations.

III. GASEOUS EFFLUENTS

1. Batch Releases

A.	Number of Batch Releases	1.10E+02
B.	Total Time Period for Batch Releases	7.40E+04Min
C.	Maximum Time Period for a Batch Release	4.32E+03Min
D.	Average Time Period for Batch Releases	6.73E+02Min
E.	Minimum Time Period for a Batch Release	2.00E+01Min

2. Abnormal Releases

1.	Number of Releases	0
2.	Total Activity Released	0 Ci

TABLE 1A
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT - 1986
GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

		UNITS	1ST QUARTER	2ND QUARTER
A.	Fission and Activation Gases:			
1.	Total Release	Ci	3.03E+02	7.21E+01
2.	Estimated Total Error	%	1.10E+02	1.10E+02
3.	Average Release Rate for Period	µCi/sec	1.93E+01	4.61E00
4.	Percent of 10CFR50 Appendix I			
	Quarterly Limit			
	Gamma Air	%	5.86E00	1.07E-01
	Beta Air	%	8.34E00	3.59E00
	Yearly Limit			
	Gamma Air	%	2.93E00	2.99E00
	Beta Air	%	4.17E00	5.96E00
B.	Iodines, Particulates, and Tritium:			
	Iodines			
1.	Total Iodine - 131	Ci	4.19E-03	7.22E-05
2.	Estimated Total Error	%	1.10E+02	1.10E+02
3.	Average Release Rate	µCi/sec	2.68E-04	4.62E-06
	Particulates			
1.	Particulates with Half-Lives >8 days	Ci	1.76E-04	3.21E-06
2.	Estimated Total Error	%	1.00E+02	1.00E+02
3.	Average Release Rate for Period	µCi/sec	1.12E-05	2.05E-07
4.	Gross Alpha Radioactivity	Ci	<LLD	<LLD
	Tritium			
1.	Total Release	Ci	2.15E00	6.81E-01
2.	Estimated Total Error	%	9.00E+01	9.00E+01
3.	Average Release Rate for Period	µCi/sec	1.37E-01	4.36E-02
	Percent of 10CFR50 Appendix I			
	Quarterly Limit			
	Organ Thyroid	%	5.16E+01	3.11E-01
	Yearly Limit			
	Organ Thyroid	%	2.58E+01	2.60E+01 *

*Cumulative total for the year-to-date.

TABLE 1B

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT - 1986

GASEOUS EFFLUENTS - ELEVATED RELEASES

All releases at H. B. Robinson are made as ground releases.

TABLE 1C
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT - 1986
GASEOUS EFFLUENTS GROUND LEVEL RELEASES

			CONTINUOUS MODE		BATCH MODE	
		UNITS	1st QUARTER	2nd QUARTER	1st QUARTER	2nd QUARTE
1.	FISSION GASES					
	Ar-41	Ci	<LLD	<LLD	2.27E-02	7.34E-02
	Kr-85	Ci	<LLD	7.15E+01	3.12E-01	6.57E-03
	Kr-85m	Ci	<LLD	<LLD	3.72E-02	6.64E-05
	Kr-87	Ci	<LLD	<LLD	4.41E-03	<LLD
	Kr-88	Ci	<LLD	<LLD	2.45E-02	<LLD
	Xe-131m	Ci	<LLD	<LLD	1.84E00	1.75E-03
	Xe-133	Ci	1.36E+02	3.16E-01	1.58E+02	1.67E-01
	Xe-133m	Ci	<LLD	<LLD	9.08E-01	1.92E-03
	Xe-135	Ci	3.69E00	<LLD	1.12E00	5.36E-03
	Xe-135m	Ci	<LLD	<LLD	<LLD	<LLD
	Total for Period	Ci	1.40E+02	7.19E+01	1.63E+02	2.57E-01
2.	IODINES[1]					
	I-131	Ci	4.19E-03	7.22E-05		
	I-133	Ci	5.81E-05	8.55E-05		
	I-135	Ci	<LLD	<LLD		
	Total for Period	Ci	4.25E-03	1.58E-04		
3.	PARTICULATES[1]					
	H-3	Ci	6.22E-02	4.35E-01	2.08E00	2.46E-01
	Cr-51	Ci	1.58E-05	<LLD		
	Mn-54	Ci	<LLD	1.31E-07		
	Co-58	Ci	3.15E-05	1.61E-06		
	Fe-59	Ci	<LLD	<LLD		
	Co-60	Ci	4.93E-05	1.04E-06		
	Zn-65	Ci	<LLD	<LLD		
	Sr-89	Ci	<LLD	2.59E-08		
	Sr-90	Ci	<LLD	9.29E-09		
	Nb-95	Ci	1.70E-06	<LLD		
	Mo-99	Ci	<LLD	<LLD		
	Ru-103	Ci	<LLD	2.04E-07		
	Cs-134	Ci	2.64E-05	<LLD		
	Cs-137	Ci	5.05E-05	1.86E-07		
	Ba/La-140	Ci	<LLD	<LLD		
	Ce-141	Ci	<LLD	<LLD		
	Ce-144	Ci	<LLD	<LLD		
	Gross Alpha	Ci	<LLD	<LLD		
Total for Period		Ci	6.24E-02	4.35E-01	2.08E00	2.46E-0

[1]Continuous Accountability includes Batch Accountability (excludes H-3).

TYPICAL LOWER LIMIT OF DETECTION TABLE FOR GASEOUS EFFLUENTS

Nuclide	LLD (μCi/cc)
H-3	1.00E-06
Ar-41	2.00E-06
Cr-51	1.40E-13
Mr-54	1.00E-11
Co-58	1.00E-11
Fe-59	1.00E-11
Co-60	1.00E-11
Zn-65	1.00E-11
Kr-85	8.90E-05
Kr-87	1.00E-04
Kr-88	1.00E-04
Sr-89	1.00E-11
Sr-90	1.00E-11
Nb-95	3.70E-14
Mo-99	1.00E-11
Ru-103	3.00E-13
I-131	1.00E-12
I-133	1.00E-10
Xe-133	1.00E-04
Xe-133m	1.00E-04
Cs-134	1.00E-11
Xe-135	1.00E-04
Xe-135m	9.30E-05
Cs-137	1.00E-11
Xe-138	1.00E-04
Ba/La-140	1.00E-13
Ce-141	1.00E-11
Ce-144	1.00E-11
Gross Alpha	1.00E-11

IV. LIQUID EFFLUENTS

1. Batch Releases

A.	Number of Batch Releases	1.38E+02
B.	Total Time Period for Batch Releases	3.05E+04 Min
C.	Maximum Time Period for a Batch Release	9.00E+02 Min
D.	Average Time Period for Batch Releases	2.21E+02 Min
E.	Minimum Time Period for a Batch Release	3.00E+01 Min
F.	Average Stream Flow During Release Periods	2.09E+05 GPM

2. Abnormal Releases

A.	Number of Releases	0
B.	Total Activity Released	0 Ci

TABLE 2A
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT - 1986
LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

		UNITS	1st QUARTER	2nd QUARTER
A.	FISSION AND ACTIVATION PRODUCTS			
	1. Total Releases	Ci	1.36E-01	2.08E-02
	2. Total Estimated Error	%	1.00E+02	1.00E+02
	3. Average Diluted Concentration	µCi/ml	6.57E-09	2.50E-09
B.	TRITIUM			
	1. Total Release	Ci	4.04E+01	1.71E+01
	2. Estimated Total Error	%	4.00E+01	4.00E+01
	3. Average Diluted Concentration	µCi/ml	1.95E-06	2.06E-06
C.	DISSOLVED AND ENTRAINED GASES			
	1. Total Release	Ci	9.75E-03	<LLD
	2. Estimated Total Error	%	1.00E+02	1.00E+02
	3. Average Diluted Concentration	µCi/ml	4.70E-10	<LLD
D.	GROSS ALPHA RADIOACTIVITY			
	1. Total Release	Ci	<LLD	<LLD
	2. Estimated Total Error	%	1.00E+02	1.00E+02
E.	VOLUME OF WASTE RELEASED	Liters	1.84E+07	8.97E+05
F.	VOLUME OF DILUTION WATER	Liters	2.07E+10	8.33E+09
G.	PERCENT OF 10CFR50 APPENDIX I			
	Quarterly Limit			
	Organ Liver	%	5.59E00	7.37E-01
	Total Body	%	1.33E+01	1.79E00
	Yearly Limit			
	Organ Liver	%	2.80E00	3.17E00 *
	Total Body	%	6.66E00	7.55E00 *

*Cumulative total for the year-to-date.

TABLE 2B
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT - 1986
LIQUID EFFLUENTS

NUCLIDES RELEASED	UNITS	CONTINUOUS MODE 1st QUARTER	CONTINUOUS MODE 2nd QUARTER	BATCH MODE 1st QUARTER	BATCH MODE 2nd QUARTER
H-3	Ci	<LLD	<LLD	4.04E+01	1.71E+01
Na-24	Ci	<LLD	<LLD	1.15E-04	<LLD
Cr-51	Ci	<LLD	<LLD	3.97E-03	5.02E-04
Mn-54	Ci	<LLD	<LLD	6.54E-04	2.33E-04
Fe-55	Ci	<LLD	<LLD	3.34E-03	<LLD
Fe-59	Ci	<LLD	<LLD	1.96E-05	1.20E-05
Co-57	Ci			1.32E-04	1.59E-05
Co-58	Ci	2.67E-03	<LLD	5.99E-02	9.82E-03
Co-60	Ci	<LLD	<LLD	3.63E-02	4.03E-03
Zn-65	Ci	<LLD	<LLD	2.70E-05	1.74E-05
Sr-89	Ci	<LLD	<LLD	2.60E-05	3.74E-06
Sr-90	Ci	<LLD	<LLD	<LLD	<LLD
Sr-92	Ci			3.00E-04	1.57E-04
Zr-95	Ci	<LLD	<LLD	1.41E-04	4.32E-05
Nb-95	Ci	<LLD	<LLD	6.23E-04	1.89E-04
Nb-97	Ci	<LLD	<LLD	3.36E-04	<LLD
Tc-99m	Ci	<LLD	<LLD	<LLD	<LLD
Mo-99	Ci	<LLD	<LLD	<LLD	<LLD
Ag-110m	Ci			7.09E-04	1.48E-04
Sb-124	Ci			1.26E-02	2.23E-04
I-131	Ci	6.71E-06	<LLD	5.90E-04	2.30E-05
Cs-134	Ci	<LLD	<LLD	3.79E-03	2.00E-03
Cs-137	Ci	<LLD	<LLD	9.62E-03	3.38E-03
Ba/La-140	Ci	<LLD	<LLD	<LLD	<LLD
Ce-141	Ci	<LLD	<LLD	<LLD	<LLD
Ce-144	Ci	<LLD	<LLD	<LLD	<LLD
Total	Ci	2.68E-03	<LLD	4.05E+01	1.71E+01
Xe-133	Ci	1.40E-05	<LLD	9.68E-03	<LLD
Xe-133m	Ci	<LLD	<LLD	7.56E-06	<LLD
Xe-135	Ci	<LLD	<LLD	5.75E-05	<LLD
Total	Ci	1.40E-05	<LLD	9.75E-03	<LLD

TYPICAL LOWER LIMIT OF DETECTION TABLE FOR LIQUID EFFLUENTS

NUCLIDE	LLD (μCi/ml)
H-3	1.00E-05
Na-24	2.10E-07
Cr-51	7.10E-06
Mn-54	5.00E-07
Fe-55	1.00E-06
Co-58	5.00E-07
Fe-59	5.00E-07
Co-60	5.00E-07
Zn-65	5.00E-07
Sr-89	5.00E-08
Sr-90	5.00E-08
Nb-95	1.10E-07
Zr-95	2.00E-07
Nb-97	3.00E-07
Mo-99	5.00E-07
Tc-99m	6.60E-08
I-131	1.00E-06
Xe-133	1.00E-05
Xe-133m	1.00E-05
Cs-134	5.00E-07
Xe-135	1.00E-05
Cs-137	5.00E-07
Ba/La-140	2.40E-07
Ce-141	5.00E-07
Ce-144	5.00E-07
Gross Alpha	1.00E-07

V. SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
REPORT TIME PERIOD JANUARY 1 TO JUNE 30 YEAR 1986

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

WASTE CLASS A

1. 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	1.78E+02 7.33E+01	6.50E+01	cement	HIC,STP	Dewatered Solidified	19
b. Dry compressible waste, contaminated equip, etc.	m^3 Ci	1.28E+02 2.20E+01	6.50E+01	NA	STP	Compacted Uncompacted	7
c. Irradiated components, control rods, etc.	m^3 Ci	0.00E00 0.00E00	NA	NA	NA	NA	NA
d. Other (describe)	m^3 Ci	0.00E00 0.00E00	NA	NA	NA	NA	NA

2. Estimate of major nuclide composition (by type of waste)

	Nuclide		Ci
a.	Co-58	13.35%	9.78E00
	Co-60	32.33%	2.37E+01
	Cr-51	1.58%	1.17E00
	Cs-134	2.37%	1.74E00
	Cs-137	3.99%	2.92E00
	Sb-124	1.45%	1.06E00
	Fe-55	22.31%	1.63E+01
	Ni-63	8.04%	5.89E00
	H-3	11.81%	8.65E00
	Others*	2.77%	2.03E00
b.	Co-58	4.78%	1.05E00
	Co-60	4.26%	9.39E-01
	Cs-134	6.18%	1.36E00
	Cs-137	7.59%	1.68E00
	Fe-55	68.21%	1.50E+01
	Ni-63	3.57%	7.87E-01
	H-3	4.06%	8.95E-01
	Others **	1.35%	2.98E-01

3. Solid Waste Disposition

Number of Shipments ***	24
Mode of Transportation	Sole Use Vehicle
Destination	Barnwell, S.C.

B. IRRADIATED FUEL SHIPMENTS (Disposition)

Number of Shipments	0
Mode of Transportation	NA
Destination	NA

* Others include: Ag-110m, Co-57, Mn-54, I-131, Nb-95, Sb-125, Sr-89, Pu-241, C-14, Te-125m, Xe-131m, Fe-59, Cs-136, Sr-90, Cm-242, Xe-133, Zr-95, Zn-65, Sn-113, Tc-99, Ce-141, Ce-144, Pu-238, Pu-239, Am-241, Cm-244, I-129.

** Others include: Ag-110m, Co-57, Cr-51, Mn-54, I-131, Nb-95, Sb-124, Sb-125, Sr-89, C-14, Te-125m, Xe-131m, Fe-59, Sn-113, Zr-95.

*** The sum of the number of shipments in Section 1 does not equal the number of shipments in Section 3, due to two mixed waste shipments.

VI. CHANGES TO ODCM

PAGE NO.	COMMENTS FOR CHANGES IN ODCM REV. 1
Page i	Repagination of Section 3.3 and added the existing Section 6.5 to the Table of Contents.
Page ii	Repagination of Tables 3.2-1, 3.2-2, 3.2-3, and 3.2-4.
Page iv	Repagination of Figures 4-1 and 4-2.
Page 1-1	The ODCM based on NUREG-0472, Revision 3, Draft 6, has been changed to NUREG-0472, Revision 3, Draft 7, as per guidance received from the NRC October 4, 1984. Monitor setpoints have been changed from standing orders (Standing Order Number 4) to the Plant Operating Procedures (OMM-014). Subsequently, the ODCM reflects this change in Section 1.0.
Page 2-1 and Page 3-1	Editorial change, "procedure" to "methodology" in first sentence.
Page 2-2	In response to EG&G/NRC comment dated October, 1983, the value of 1.0E-7 μCi/ml for an unknown mix has been changed to the most conservative MPC of the radionuclides to this path and "visible" to RMS-18, RM-19, and RMS-37. The worst case assumption is that I-131 is the only nuclide being discharged. This is appropriate according to Footnote 3a of 10CFR20, Appendix B.
Page 2-3	Steam generator blowdown flow rates have increased, and an additional potential release pathway has been added (Condensate Polisher Liquid Waste) as a result of the Steam Generator Replacement outage. This also changed the liquid discharge allocation fractions.
Page 2-4	Additional clarification has been added to define the term Ci (added non-gamma emitters) in Section 2.1.2.1. This compliments the Nuclear Data Effluent Management software programs and 10CFR20. Added Condensate Polisher Liquid Waste Monitor (RMS-37) to Section 2.1.2.
Page 2-5 and Page 2-14	Flow rates of Steam Generator Blowdown and Condensate Polisher Liquid Waste have been added to Section 2.1.2.3 and 2.2.1, respectively. See page 2-3 for justification.
Page 2-6	Corrected minor typographical error. Allocation has been changed for Steam Generator Blowdown and new fraction added for Condensate Polisher Liquid Waste. See Page 2-3 for justification.
Page 2-11	Methodology to base monitor setpoint on I-131 was included in Section 2.2.1. See page 2-2 for justification.

Page 2-16- Page 2-18

(1) Page 2-12 requires no change in response to EG&G's/NRC comments. Concentrations are to be compared to 10CFR20. In Section 2.2, it is both implied and understood that pre and post-release concentrations must be compared to 10CFR20, Appendix B, Table II, and Column 2 in order to determine whether HBR is in compliance. Furthermore, this is stated on page 3-13 in the pre-release section. For the sake of clarity, it is also added in the post-release section (page 2-16).

(2) Equation (2.3-1) the correction factor for the transit time for radionuclide decay ($e^{-\lambda_i t_p}$) has been removed to be compatible with the Nuclear Data software. This is more conservative, simpler, and follows the guidance of NUREG-0133 instead of Reg. Guide 1.109.

Page 2-20

In response to EG&G comments, the 31 day dose projection methodology was clarified.

Page 2-24

Table 2.3-2 "Values of $e^{-\lambda_i t_p}$ for liquid dose calculations" has been deleted. See page 2-16 for justification.

Page 3-3 and Page 3-4

The typo has been deleted in paragraph 3.1.1.5 as per EG&G/NRC comments. The fuel handling building flow rate has been added in Section 3.1.1.4, since it is a potential release pathway.

Page 3-6

ΔP has been changed to ΔP_c. T^C has been changed to T_t. 0°C = 273°K has been added as per EG&G/NRC comments.

Correction for K° has been provided in the respective procedures used for calculation of the flow rates from containment and from the gas decay tanks.

Page 3-7

Formula for "C" has been changed for clarity as per EG&G/NRC comments to:
$C = C_i$ (μCi/cc) x monitor efficiency (cpm/μCi/cc) = cpm

Page 3-10

Table 3.1-1, "Gaseous Source Terms," Condenser Vacuum Pump Vent had two typographical errors: Xe - 133 = 1.8E + 1 Ci/yr, not 1.8E-1 Ci/yr and Xe-135 = 2.0E + 1 Ci/yr, not 2.0E-1 Ci/yr

Page 3-2 and 3-13

Sample analysis has been added in Section 3.1.1.1 (page 3-2) and page 3-13 to be used as source terms in monitor setpoint calculations and dose rate calculations. Typo "n" has been corrected to "in". These changes were in response to EG&G/NRC comments.

Page 3-14 and 3-15

Section 3.2.2 has been revised to cover the inhalation pathway only. This is in response to EG&G/NRC comments and is consistent with Technical Specifications.

Page 3-16	The response to EG&G/NRC relative to Table 3.2-1 is that, as indicated by the footnote, the source was determined by the GALE code.
Page 3-19	The P_i values listed in Table 3.2-4 are not necessarily meant to be exhaustive but representative of the radionuclides usually observed in releases and usually expected based on Source Terms. Should other radionuclides be observed, the data from Reg. Guide 1.109 will be used to establish dose factors for these radionuclides.
Page 3-21	In response to EG&G/NRC editorial changes have been made as follows "for purposes of this document, only long-term $\bar{X}/Q$ values will be used since this is a more conservative approach than using short-term $\bar{X}/Q$ values for dose estimation. Should the calculated dose exceed 10CFR50 limits, recalculation of dose may be performed using short-term $\bar{X}/Q$ values for batch releases."
Page 3-22	D_α has been revised to D_β as per EG&G/NRC comments.
Page 3-23	In response to EG&G/NRC, statement has been included which describes how dose projections will be performed and when the gaseous radwaste treatment system will be operated.
Page 3-24, 3-25, 3-26, & 3-27	In response to EG&G/NRC, a plus ("+") has been inserted in Equation 3.3-8 and has been expanded to include milk and meat pathways, and the new terms have been defined.
Page 3-28	In response to EG&G/NRC, it is preferred to leave the grazing period as based on NUREG-0133 in the text of the ODCM.
Page 3-29 & 3-30	In response to EG&G/NRC, statement has been rewritten to include how dose projections will be performed and when the gaseous radwaste treatment system will be operated.
Page 4-2, 4-3, & 4-9	Editorial added the compass degrees to the first seven sample stations and relocated sample Station 7 one mile further out because the existing location is no longer available for our use. Station 7 also relocated on map on page 4-9. Station 11 was corrected to third power pole from the Old Camden Road instead of fourth pole. Distance and sector are still the same.
Page 4-4	Station 15. Typo 1.0 mile, not 10 miles.

Page 4-6 — In response to EG&G/NRC, H-3 analysis is performed monthly rather than quarterly since H-3 levels are usually much higher than the LLD, and the Plant wishes to monitor H-3 more closely in both surface and ground water. In addition, an editorial change was made in Section b, groundwater. Each unit has more than one well, and only one well is generally used at a time. Sampling will be performed only on the operating well.

Page 4-7 — In response to EG&G/NRC, the frequency for sampling fish has been changed to semiannually. Also, the control location for fish has two ponds to choose from due to drainage of May Lake for dam repairs which resulted in a major fish kill. Food products (leafy vegetables) location numbers were changed. Auburndale Plantation's Milk and a milk control station were added.

Page 4-8 — Changed Footnote 8 due to Land-Use census.

Page 6-1, 6-2, & 6-3 — In response to EG&G/NRC comments, the following changes were made: 6.2.(1) Actual doses will be utilized rather than assuming the dose to be $\leq$ 1 mrem/yr since the actual dose data will be readily available; 6.2.(4) The intent in this section is not to be conservative but to make an approximation of the real dose to a MEMBER OF THE PUBLIC as realistically as possible.

Also added headers to 6.1 and 6.2 for consistency.

Some of the verbiage from 6-1 carried over to 6-2 as a result of adding headers to page 6-1 and, likewise, with page 6-2 to page 6-3.

Page A-4 — Title had typo (sec/cm^3); changed to (sec/m^3).

Page A-5 — Title had typo (sec/cm^3); changed to (sec/m^3).

Page A-7 — Title had typo (sec/cm^3); changed to (sec/m^3).

Page A-8 — Title had typo (sec/cm^3); changed to (sec/m^3).

Page A-21 — Title had typo (m^{2-}); changed to (m^{-2}).

Page B-11 — R_{i_m} has been changed to R_{i_B}, and F_m has been changed to F_f as per EG&G/NRC comments.

Page B-12 — F_m has been changed to F_f as per EG&G/NRC comments.

Page B-13	A plus ("+") has been inserted in Equation B.2-7 as per EG&G/NRC comments.
Page D-1	Added Condensate Polisher Liquid Waste Monitor. See page 2-3 for additional justification.

JUSTIFICATION FOR CHANGE IN ODCM REVISION 2

Prior to implementing the Gaseous portion of the Radiological Effluent Technical Specification, the setpoint Section (3.1) of the ODCM was upgraded and additional clarification made as follows:

A. All batch releases are to be sampled and analyzed for setpoint source term calculations.

B. All continuous releases have the following source term setpoint options:

1. Using a conservative Gale Code distribution.
2. Using detectable nuclide distribution from the sample analysis.
3. Using the calculated LLD values for Xe-133 and Kr-85.

C. The R-14 setpoint calculations (monitors Plant vent and isolates releases from Waste Gas Decay Tanks) in Revision 1 of the ODCM did not take into account dilution (60,000 cfm) from the Plant vent. Therefore, a revision was made to calculate R-14 setpoint using the weighted average concentration based on maximum flow rates.

D. The monitors RMS-11 and RMS-12 (particulate and noble gas monitors) provide isolation for CV Pressure Reliefs and Purges. These monitors can sample from the Containment Vessel or the Plant Vent. The ODCM was revised to calculate weighted average concentrations for RMS-11, RMS-12, and RMS-14 setpoint determinations based on their respective source terms and flow rate.

E. The concept of PDRR (Projected Dose Rate Ratio) was incorporated in the calculation of setpoints and release rates. This is consistent with algorithm used in vendor software.

F. The statistical variance in the background count rate on gaseous effluent monitors was included in the high/trip alarm setpoints to prevent inadvertent high/trip alarms due to the random counts on the monitors.

G. Ten R_i tables were added to the ODCM (all age groups) for grass-cow-milk, grass-cow-meat, and vegetation pathways consistent with the guidance in NUREG-0133 and vendor software.

H. The algorithm for converting the monitor setpoint from μCi/cc to cpm was revised to accept non-linear monitor efficiency relationships.

PAGE NO.	COMMENTS FOR CHANGES IN ODCM REVISION 2
Title Page	Changed Revision 1 to Revision 2 and changed date.
i	Added Section 3.4 to Table of Contents.
ii	Added ingestion dose R factors to List of Tables 3.4-1 through 3.4-10. (See justification G.)
3-1	Minor editorial changes; added RMS-20 in Section 3.1.1 as an additional potential release pathway, reference to use of Gale Code when determining high-alarm setpoint for gas monitors RMS-14, RMS-15, RMS-20; removed batch release of containment purge via the Plant Vent, batch release for containment pressure relief via the Plant Vent, and batch release of Waste Gas Decay Tanks via the Plant Vent. (See justifications A, B, C, & D.)
3-2	Removed 3.1.1.1a determination of source term since Gale Code is used for source term in calculating the rate in Section 3.1.1 for average X/Q values for batch ground releases and for batch mixed mode releases in Section 3.1.1.2. (See justifications A & B.)
3-3	Maximum concentration calculation modified to include Engineering safety factor 0.5.
3-4	Revised airflow in fuel handling building from 10,800 CFM to 10,200 CFM as referenced in the system description; added definition of SF in Equation 3.1-4. Modified Equation 3.1-6. (See justifications F.)
3-5	Added definition of statistical variance; modified Equations 3.1-4 and 3.1-6; minor editorial change; added four additional operational conditions when determining high alarm setpoint with prior sample analysis and maximum acceptable flow rate; and added Equation 3.1-7. (See justification parts A, E, & F.)
3-6 & 3-7	Revised Ci definition. (See justifications C & D.)
3-8	Maximum flow rates (f) for all pathways were re-evaluated and upgraded; revised Section 3.1.2.2 to include calculation of skin dose rate and monitor setpoints. (See justifications C & D.)

3-9	Defined ($\bar{X}/Q$) values in Equation 3.1-8 for continuous mixed mode release and continuous ground release. (See justifications A and B.)
3-10	Defined Equations 3.1-10 and 3.1-11 to determine projected dose rate ratio for total body and skin; defined Equation 3.1-12 and 3.1-13 to determine the maximum monitor setpoint concentration for total body and skin; replaced Section 3.1.2.3, "Determine the monitor alarm setpoint based on the skin dose rate," with Section 3.1.2.2.e, "Determine the maximum monitor setpoint for total body and skin." (See justification E.)
3-11	Provided Plant specific values for Tm as used in Equations 3.1-12 and 3.1-13; added Section 3.1.2.2.e, "Determine the maximum monitor setpoint for total body and skin" and included term for monitor statistical variance. (See justification F.)
Page 3-12	Defined terms in Equations 3.1-14 and 3.1-15. (See justification F and H.)
Page 3-13	Gaseous source terms, changed Xe-135 value from 2.0E+1 to 2.0E+0. . . Typo. Footnote 1 - deleted reference to RMS-20. . . Plant vent release. . . values are used to determine the monitor alarm setpoints for the Plant vent gas monitor. Footnote 3 - added to values for gas decay tanks - "these values are used to determine the monitor alarm setpoint for the fuel handling basement exhaust monitor (RMS-20)."
Page 3-17	Editorial change. Added "and tritium" to heading of section describing dose rate equation - consistent with Technical Specifications.
Page 3-26	Added projected dose from this release "DB" to 31 day dose projection in Equation 3.3-7.
Page 3-27	Corrected typo.
Page 3-32	Added projected dose from this release "DB" to 31 day dose projection in Equation 3.3-11.
Page 3-34- Page 3-52	Added reference to Reg. Guide 1.109 to tables. (See justification G.)
Page 3-53	Added ingestion dose R factors grass-cow-milk pathway (infant). (See justification G.)

Page 3-54	Added ingestion dose R factors grass-cow-milk pathway (child). (See justification G.)
Page 3-55	Added ingestion dose R factors grass-cow-milk pathway (teen). (See justification G.)
Page 3-56	Added ingestion dose R factors grass-cow-milk pathway (adult). (See justification G.)
Page 3-57	Added ingestion dose R factors grass-cow-meat pathway (child). (See justification G.)
Page 3-58	Added ingestion dose R factors grass-cow-meat pathway (teen). (See justification G.)
Page 3-59	Added ingestion dose R factors grass-cow-meat pathway (adult). (See justification G.)
Page 3-60	Added ingestion dose R factors vegetation pathway (child). (See justification G.)
Page 3-61	Added ingestion dose R factors vegetation pathway (teen). (See justification G.)
Page 3-62	Added ingestion dose R factors vegetation pathway (adult). (See justification G.)
Page 4-1	Editorial change.
Page 5-1	Added that results of environmental sample analyses comparison program would be included in the annual radiological environmental operating report. Deleted "the results will be provided to the NRC upon request."
Page B-6	Editorial change of Appendix B.2 Title by adding "Following Reg. Guide 1.109 Methodology" for calculation of R_i. (Justification: added reference.) Added (in description) to include reference to 1.109. (Justification: added reference.)
Page B-18	Added "calculation of R_i following NUREG-0133 methodology." (See justification G.)
Page B-19	Added grass-cow-milk pathway. (See justification G.)
Page B-20	Added grass-cow-meat pathway. (See justification G.)

Page B-21	Added vegetation pathway. (See justification G.)
Page B-22	Provided documentation of maximum flow rate of CV pressure relief as provided by CP&L Nuclear Fuels Section. (See justification D.)
Page 2-20	Equation 2.3-8, added "projected dose for the current release to the total projected dose for previous releases." Define term "DB". (Justification: DB definition was inadvertently omitted.)
Page 3-63- Page 3-65	Added section 3.4 describing the setpoint methodology for RMS-11. (See justification D.)

OLD

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

Revision 1

DOCKET NO. 50-261

PNSC Review _____ DATE 11/20/85
PNSC Chairman

CAROLINA POWER & LIGHT COMPANY
October 30, 1985

CONTROLLED COPY

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1.0 INTRODUCTION

The Off-Site Dose Calculation Manual (ODCM) provides the information and methodologies to be used by H. B. Robinson Steam Electric Plant Unit 2 (HBR) to assure compliance with Specifications 3.9.1, 3.9.2, 3.9.3, 3.9.4, 3.9.5, and 3.9.6 of the H. B. Robinson Technical Specification. These portions are those related to liquid and gaseous radiological effluents. They are intended to show compliance with 10CFR20, 10CFR50.36a, Appendix I of 10CFR50, and 40CFR190.

The ODCM is based on "Radiological Effluent Technical Specifications for PWRs (NUREG 0472, Rev. 3, Draft 7), "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants" (NUREG 0133), and guidance from the United States Nuclear Regulatory Commission (NRC). Specific plant procedures for implementation of this manual are presented in H. B. Robinson Unit 2 Plant Operating Manual. These procedures will be utilized by the operating staff of HBR to assure compliance with technical specifications.

The ODCM has been prepared as generically as possible in order to minimize the need for future revisions. However, some changes to the ODCM will be expected in the future. Any such changes will be properly reviewed and approved as indicated in the Administrative Control Section, Specification 6.16.2, of the HBR Technical Specifications.

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 Waste Disposal System Effluent Monitor (RMS-18) and the Steam Generator Blowdown Monitor (RMS-19) during all operational conditions when the radwaste discharge flow rate is maintained constant. This methodology complies with Specification 3.9.1.1 of the RETS by satisfying the following equation:

$$\frac{cf}{F} \leq C$$

where:

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

c = The setpoint, in μCi/ml, of the radioactivity monitor measuring the radioactivity concentration in the effluent line prior to dilution and subsequent release; the setpoint represents a value which, if exceeded, would result in concentrations exceeding the limits of 10CFR20 in the unrestricted area.

f = The waste effluent flow rate in gpm.

F = The dilution water flow rate in gpm.

2.1.1.1 Determine c (the effluent monitor setpoint) in μCi/ml for each of the dilution water flow rates.

where: $c = \frac{CF}{f}$

C = 3×10^{-7} μCi/ml, the effluent concentration limit based on 10CFR20, Appendix B, for I-131.

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.

f = The maximum acceptable discharge flow rate prior to dilution (gpm).

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

= 750 gpm for the Steam Generator Blowdown Monitor.

= 450 gpm for the Steam Generator Blowdown Monitor while draining a steam generator.

= 390 gpm for the Condensate Polisher Liquid Waste Monitor.

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.

$SP = (T_m CR + \text{Background})$

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.

= .05 for the Waste Disposal System Liquid Effluent Monitor (RMS-18).

= .70 for the Steam Generator Blowdown Monitor (RMS-19).

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

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 (RMS-18), the Steam Generator Blowdown Monitor (RMS-19), and the Condensate Polisher Liquid Waste Monitor (RMS-37) when an analysis of the activity of the principal gamma emitters has been made prior to each batch released.

2.1.2.1 Determine D (the minimum acceptable dilution factor):

$$D = S\sum_i \frac{Ci}{MPC_i}$$

$$C_i = \sum C_g + [C_a + C_s + C_t + C_{Fe\text{-}55}]$$

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

$\sum C_g$ = The sum of the concentrations of each measured gamma-emitting radionuclide observed by gamma spectroscopy.

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.

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

MPC_i = The liquid effluent radioactivity limit for radionuclide "i" (μCi/ml) from 10CFR20, Appendix B.

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.

$$c = (\sum_g C_g)\ (\frac{F}{D\ f})\ (Tm)$$

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].

= 750 gpm for the Steam Generator Blowdown Monitor.

= 450 gpm for the Steam Generator Blowdown Monitor while draining a steam generator.

= 390 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.

= .05 for the Waste Disposal System Liquid Effluent Monitor (RMS-18).

= .70 for the Steam Generator Blowdown Monitor (RMS-19).

= .25 for the Condensate Polisher Liquid Waste.

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

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

2.1.2.4 Determine SP (the monitor alarm setpoint [ccpm].

$SP = (c)\ (E_m) + \text{background}.$

where:

E_m = The applicable effluent monitor efficiency based on "c," from the efficiency curves located in the Plant Operating Manual, Volume 15, Curve Book.

2.2 COMPLIANCE WITH 10CFR20 (LIQUIDS)

Liquid effluents from H.B. Robinson Unit 2 (HBR) will occur both continuously and on a batch basis. The following sections discuss the methodology which will be utilized by the HBR to show compliance with 10CFR20.

2.2.1 Continuous Releases

Steam generator blowdown is continuously released from HBR. Each operational working day grab samples will be taken of steam generator blowdown. These samples are composited at the rate of 100 ml/sgr. An aliquot of the SG composite is analyzed each week for I-131 and various other fission, activation, and corrosion products, as outlined in Table 4.10-1 of the technical specification for HBR. Samples are to be maintained until the end of the quarter and analyzed for strontium. Steam generator volumes are based on blowdown rates. In addition, a monthly analysis will be performed to determine the activity levels of tritium and dissolved and entrained gases. Compliance with 10CFR20 during actual release is established through the steam generator blowdown effluent monitor alarm setpoint. This setpoint is based upon I-131 as noted in Section 2.1. However, if a continuous release should occur in which the effluent monitor alarm setpoint is exceeded, then actual compliance with 10CFR20 may be determined utilizing the actual radionuclide mix and the following equation:

$$Conc_i = \frac{C_{ic}\, V_c}{V_{dc}} \qquad (2.2\text{-}1)$$

where:

$Conc_i$ = Concentration of radionuclide "i" at the unrestricted area, $\mu Ci/ml$;

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, the steam generators, and the Condensate Polisher Liquid Waste. The maximum release rate (R_b) is 750 gpm for the steam generators, 60 gpm from the monitor and waste condensate tanks, and 390 gpm for the Condensate Polisher Liquid Wastes.

2.2.2.2 Postrelease

The Steam Generation Blowdown Monitor (RMS-19), the Waste Disposal System Liquid Monitor (RMS-18), and the Condensate Polisher Liquid Waste Monitor (RMS-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.

The concentration of each radionuclide in the unrestricted area following release from a batch tank will be calculated in the following manner:

D_{fr} = Dilution flow rate from circulating water pumps during release k, gpm.

The circulating water pump flow rates were given in Section 2.2.2.1 above.

For the case where a batch release is occurring at the same time that a continuous release is occurring, the compliance with 10CFR20 limits may be determined by the following equation:

$$Conc_{ik} = \frac{C_{ikb} V_{kb} + C_{ikc} V_{kc}}{V_{kd}} \quad (2.2\text{-}8)$$

where:

C_{ikc} = Concentration of radionuclide "i" in continuous releases during release period k, μCi/ml;

V_{kc} = Volume of continuous release during period k, gal.

Calculated concentrations are to be compared to the concentration in Appendix B, Table II, Column 2, of 10CFR20.

2.3 COMPLIANCE WITH 10CFR50

2.3.1 Cumulation of Doses

The dose contribution from the release of liquid effluents will be calculated once per month, and a cumulative summation of these total body and any organ doses should be maintained for each calendar quarter. The dose contribution for all batch releases will be calculated using the following equation:

$$D_{\tau b} = \sum_k \sum_i A_{i\tau} t_{kb} C_{ikb} F_{kb} \quad (2.3\text{-}1)$$

where:

$D_{\tau b}$ = The cumulative dose commitment to the total body or any organ τ, from batch liquid effluents, mrem;

t_{kb} = The length of time of batch release k over which C_{ikb} and F_{kb} are averaged for each batch liquid release, hours;

C_{ikb} = The average concentration of radionuclide "i" in undiluted batch liquid effluent during batch release k, μCi/ml;

$A_{i\tau}$ = The site-related ingestion dose commitment factor to the total body or any organ τ for each identified principal gamma and beta emitter, mrem-ml per hr-μCi;

F_{kb} = The near-field average dilution factor for C_{ikb} during any batch liquid effluent release k. Defined as the ratio of the volume of undiluted liquid waste released to the product of the dilution volume from the site discharge structure to unrestricted receiving waters times 1.0. (1.0 is the site-specific applicable factor for the mixing effect of the HBR discharge structure as defined in NUREG-0133, October 1978).

$$= \frac{V_{kb}}{V_{kd} \times 1.0}$$

Where V_{kb} and V_{kd} are as defined in Equation 2.2-5.

The dose factor $A_{i\tau}$ was calculated for an adult for each isotope using the following equation:

$$A_{i\tau} = 1.14 \times 10^5 \, (21BF_i) \, DF_{i\tau} \qquad (2.3\text{-}2)$$

where:

$$1.14 \times 10^5 = 10^6 \, \frac{pCi}{\mu Ci} \times 10^3 \, \frac{ml}{l} \times \frac{1 \text{ yr}}{8760 \text{ hr}}$$

21 = Adult fish consumption rate from Table E-5 of Regulatory Guide 1.109, Revision 1, kg/yr;

BF_i = Bioaccumulation factor for radionuclide "i" in fish from Table A-1 of Regulatory Guide 1.109, Revision 1, pCi/kg per pCi/l;

$DF_{i\tau}$ = Dose conversion factor for radionuclide "i" for adults for a particular organ τ from Table E-11 of Regulatory Guide 1.109, Revision 1, mrem/pCi.

The potable water pathway does not exist either within Lake Robinson or downstream of the Lake Robinson dam. Therefore, the potable water term was excluded from the calculation of $A_{i\tau}$ values. Table 2.3-1 presents $A_{i\tau}$ values for an adult at HBR.

As noted in Section 2.2.2, steam generator blowdown is continuously released from HBR. The dose from continuous releases will be calculated using the following equation:

$$D_{\tau C} = \sum_k \sum_i A_{i\tau}\, t_{kc}\, C_{ikc}\, F_{kc} \qquad (2.3\text{-}3)$$

where:

$D_{\tau C}$ = The cumulative dose commitment to the total body or any organ τ, from liquid effluents for continuous releases, mrem;

t_{kc} = The length of time of continuous release period k over which C_{ikc} and F_{kc} are averaged for all continuous liquid releases, hours;

C_{ikc} = The average concentration of radionuclide "i" in undiluted liquid effluent during continuous release period k from any continuous liquid release, μCi/ml;

F_{kc} = The near-field average dilution factor for C_{ikc} during continuous liquid effluent release k. Defined as the ratio of the volume of undiluted liquid waste released to the product of the dilution volume from the site discharge structure to unrestricted receiving water times 1.0. (1.0 is the site-specific applicable factor for the mixing effect of the HBR discharge structure as defined in NUREG-0133, October 1978).

$$F_{kc} = \frac{V_{kc}}{V_{kd} \times 1.0}$$

Where V_{kc} and V_{kd} are, as defined in Equation 2.2-5, only now distinguished for continuous releases.

The sum of the cumulative dose from all batch and continuous releases for a quarter are compared to one half the design objectives for total body and any organ. The sum of the cumulative doses from all batch and continuous releases for a calendar year are compared to the design objective doses. The following relationships should hold for HBR to show compliance with Technical Specification 3.9.2.1 of the technical specifications for H.B. Robinson Unit 2.

For the calendar quarter,

$D_\tau \leq 1.5$ mrem total body (2.3-4)

$D_\tau \leq 5$ mrem any organ (2.3-5)

For the calendar year,

$D_\tau \leq 3$ mrem total body (2.3-6)

$D_\tau \leq 10$ mrem any organ (2.3-7)

where:

D_τ = Cumulative total dose to any organ τ or the total body from continuous and batch releases, mrem;

$$= D_{\tau b} + D_{\tau c}$$

The quarterly limits given above represent one half the annual design objective of Section II.A of Appendix I of 10CFR50. If any of the limits in Expressions 2.3-4 through 2.3-7 are exceeded, a special report pursuant to Technical Specification 6.9.3.2 must be filed with the NRC. This report complies with Section IV.A, of Appendix I of 10CRF50.

2.3.2 Projection of Doses

Doses resulting from the release of liquid effluents will be projected once per 31 days. These projections will include a safety margin, based upon expected operational conditions, which will take into consideration both planned and unplanned releases.

Projected dose will be calculated as follows:

$$PD = \frac{(DA)(TA)}{(TE)} + M \qquad (2.3\text{-}8)$$

where:

PD = projected doses in mrem.
DA = dose accumulated during current quarter in mrem.
TE = time elapsed in quarter in days.
TA = time in quarter in days.
M = safety margin in mrem.

If the projected doses exceed 0.2 mrem to the whole body or 0.6 mrem to any organ when averaged over a calendar quarter, the liquid radwaste equipment will be operated to reduce the radioactive materials in the liquid effluent.

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3.0 GASEOUS EFFLUENTS

3.1 MONITOR ALARM SETPOINT DETERMINATION

This methodology determines the monitor alarm setpoint that indicates if the dose rate in the unrestricted areas due to noble gas radionuclides 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.

The methodology described in Section 3.1.2 provides an alternative means to determine monitor alarm setpoints that may be used when an analysis of batch releases 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 plant is operating below 30 percent power. Detection of primary-to-secondary leakage is accomplished most effectively by continuously monitoring the condenser vacuum pump vent (RMS-15). Steam generator blowdown is continuously monitored by RMS-19 as a liquid pathway.

The following method applies to gaseous releases via the plant vent and condenser vacuum pump vent when determining the high-alarm setpoint for the plant vent gas monitor (RMS-14) and condenser vacuum pump vent gas monitor (RMS-15) during the following operational conditions:

- Continuous release via the plant vent.
- Continuous release via the condenser vacuum pump vent.
- Batch release of containment purge via the plant vent.

- Batch release for containment pressure relief via the plant vent.

- Batch release of waste gas decay tanks via the plant vent.

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

a. Determine the concentration (μCi/cc) of radioactive isotopes to be released in the gaseous effluent. This source term will be used for calculating the release rate.

If the concentration of radioactive isotopes listed in Table 3.1-1 (calculated using the Gale code) results in a more conservative release rate this may be used as the source term for calculating the release rate.

b. 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.

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

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

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

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

$(\overline{X/Q})$ = 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 (Continuous Mixed Mode Release) from Table A-10, Appendix A, only with upper wind speed $\geq$ 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 only with upper wind speed $\geq$ 9 mph.

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 of all gas radionuclides in the gaseous effluent [μCi/sec]) based upon the skin exposure limit of 3000 mrem/yr by:

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

$L_i + 1.1M_i$ = 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 of all noble gas radionuclides in the gaseous effluent [μCi/cc]).

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

NOTE: Use the lower 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:

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

= 60,000 cfm for plant vent.

= 45 cfm for the condenser vacuum pump vent.

= 10,800 cfm for the fuel-handling building.

2.12 E-3 = Unit conversion constant to convert µCi/sec/cfm to µCi/cc.

3.1.1.5 Determine CR (the calculated monitor count rate above background attributed to the noble gas radionuclides [ccpm]) by:

$CR = (C_m)\ (E_m)$

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:

$$HSP = T_m CR + \text{background (cpm)} \qquad (3.1\text{-}5)$$

where:

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

C_i = The radioactivity concentration of noble gas radionuclide "i" in the gaseous effluent (μCi/cc) from the analysis of the gaseous effluent to be released.

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

= 45 for the condenser.

= 50,000 for the containment purge.

$$= \frac{2\ E6\ (\frac{\Delta P_c}{14.7})\ (\frac{273^o}{T_c})}{t}$$ for pressure relief.

$$= \frac{525\ (\frac{\Delta P_t}{14.7})\ (\frac{273^o}{T_t})}{t}$$ for a gas decay tank release.

where:

= 2 E6 and 525 are the volumes (ft^3) of the containment and decay tank respectively, and T_c, T_t, ΔP_c, and ΔP_t are the respective temperature and change in pressure (psig) following the release of the containment and decay tank.

t = Length of release (min).

0°C = 273°K.

T_c = 273°K + C°.

T_t = 273°K + C°

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

a. Determine CR_t (the monitor count rate per mrem/yr, total body).

$$CR_t = \frac{C}{(\overline{X/Q}) \sum_i K_i R_i}.$$

where:

C = The count rate of the monitor corresponding to the radioactivity concentration in the analyzed sample.

C = C_i (μCi/ml) x monitor efficiency (cpm/μCi/cc) = cpm.

$\overline{X/Q}$ = 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.

= 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, only with upper wind speeds of $\geq$ 9 mph.

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.

b. Determine S_t (the count rate of the gaseous effluent noble gas monitor at the alarm setpoint based on total body dose rate [ccpm]):

$$S_t = SF \times T_m \times D_t \times CR_t$$

TABLE 3.1-1

GASEOUS SOURCE TERMS*

Radionuclide	Plant Vent Release[1]		Condenser Vacuum Pump Vent[2]		Containment Purge or Presure Relief		Gas Decay Tanks	
	A_i (Ci/yr)	S_i	A_i (Ci/yr)	S_i	A_i (Ci/yr)	S_i	A_i (Ci/yr)	S_i
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	2.0E+1	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 and 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 (RMS-14) and Fuel-Handling Basement Exhaust Monitor (RMS-20).

[2]These values are used to determine the monitor alarm setpoint for the Condenser Vacuum Pump Vent Monitor (RMS-15).

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 condenser vacuum pump vent $\mu Ci/sec$.

$\dot{Q}_{iv}$ = 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 deriviation is also provided in this appendix.

To select the limiting location, the highest annual average $\overline{X/Q}$ value for the ground level releases and the mixed mode releases was used. Since mixed mode releases may not necessarily decrease with distance (i.e., the site boundary may not have the highest $\overline{X/Q}$ value), long-term annual average ($\overline{X/Q}$) values, calculated at the midpoint of 10 standard distances as given in Appendix A were also considered. For HBR, mixed mode release X/Q values decrease with distance for all directions except the WNW, NW, and NNW so that the maximum site boundary X/Q is usually greater at the site boundary than at distances greater than the site boundary. In addition, the maximum site boundary X/Q for both the ground level and mixed mode releases occurs at the SSE site boundary. Therefore, the limiting location for implementation of 10CFR20 for noble gases is the SSE site boundary.

Values for K_i, L_i, and M_i, which were used in the determination of the limiting location and which are to be used by HBR in Expressions 3.2-1 and 3.2-2 to show compliance with 10CFR20, are presented in Table 3.2-3. These values were taken from Table B-1 of NRC Regulatory Guide 1.109, Revision 1. The values have been multiplied by 1.0 E6 to convert microcuries to picocuries for use in Expressions 3.2-1 and 3.2-2.

3.2.2 Radioiodines and Particulates

The dose rate in an unrestricted area resulting from the release of radioiodines, tritium, and particulates with half-lives $\geq$ 8 days is limited to 1500 mrem/yr to any organ. Based upon NUREG 0133, the following is used to show compliance with 10CFR20.

$$\sum_i P_{i_I} \left[(\overline{X/Q})_v Q_{iv} + (\overline{X/Q})_e Q_{ie} \right] \leq 1500 \text{ mrem/yr} \qquad (3.2\text{-}3)$$

Q_{iv} = Release rate of radionuclide "i" from the plant vent, μCi/sec.

Q_{ic} = Release rate of radionuclide "i" from the condenser vacuum pump vent, 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 condenser vacuum pump 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 $\mu Ci/m^3$. The dose factor is based on the most restrictive group (child) and most restrictive organ (thyroid) at the SITE BOUNDARY (see Table 3.3-18).

where:

In the calculation to show compliance with 10CFR20, only the inhalation is considered. A description of the methodology used in calculating the Pi values is presented in Appendix B. Compliance with 10CFR20 is achieved if the dose rate via inhalation pathway to a child is $\leq$ 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 Comformance 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.

TABLE 3.2-2

DISTANCE TO SPECIAL LOCATIONS FOR THE H.B. ROBINSON PLANT (MILES)

Sector	Site Boundary	Milk Cow	Milk Goat	Meat Animal	Nearest Resident	Nearest Garden
NNE	1.26	-	-	1.65	1.3	1.4
NE	1.01	-	-	1.16	1.2	1.3
ENE	0.86	-	-	2.41	0.9	2.2
E	0.61	4.2	-	3.12	0.8	2.8
ESE	0.50	-	-	1.99	0.6	0.6
SE	0.29	-	-	-	0.3	0.3
SSE	0.26	-	-	-	0.3	0.3
S	0.28	-	-	2.32	0.3	0.4
SSW	0.29	-	-	2.08	0.3	0.5
SW	0.36	-	2.5*	2.27	0.4	0.5
WSW	0.36	-	-	2.69	0.4	0.6
W	0.50	-	-	3.97	0.6	0.6
WNW	0.55	-	-	4.07	0.7	0.9
NW	1.23	-	-	1.60	1.3	1.3
NNW	1.89	-	-	2.84	2.9	3.0
N	1.94	-	-	2.93	2.9	2.9

*Milk is not presently used for human consumption.

TABLE 3.2-3

DOSE FACTORS FOR NOBLE GASES AND DAUGHTERS*

Radionuclide	Total Body Dose Factor K_i (mrem/yr per $\mu Ci/m^3$)	Skin Dose Factor L_i (mrem/yr per $\mu Ci/m^3$)	Gamma Air Dose Factor M_i (mrad/yr per $\mu Ci/m^3$)	Beta Air Dose Factor N_i (mrad/yr per $\mu Ci/m^3$)
Kr-83m	7.56E-02	---	1.93E+01	2.88E+02
Kr-85m	1.17E+03	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03

*The listed dose factors are for radionuclides that may be detected in gaseous effluents.

TABLE 3.2-4

P_1 VALUES FOR AN INFANT FOR THE H.B. ROBINSON UNIT NO. 2*

Isotope	Inhalation	Ground Plane	Cow Milk	Goat Milk
H-3	6.47E2	0.00	2.38E3	4.86E3
P-32	2.03E6	0.00	1.60E11	1.93E11
Cr-51	1.28E4	6.67E6	4.79E6	5.65E5
Mn-54	1.00E6	1.09E9	3.89E7	4.68E6
Fe-59	1.02E6	3.92E8	3.93E8	5.11E6
Co-58	7.77E5	5.29E8	6.06E7	7.28E6
Co-60	4.51E6	4.40E9	2.10E8	2.52E7
Zn-65	6.47E5	6.89E8	1.90E10	2.29E9
Rb-86	1.90E5	1.28E7	2.22E10	2.67E9
Sr-89	2.03E6	3.16E4	1.27E10	2.66E10
Sr-90	4.09E7	0.00	1.21E11	2.55E11
Y-91	2.45E6	1.52E6	5.26E6	6.32E5
Zr-95	1.75E6	3.48E8	8.28E5	9.95E4
Nb-95	4.79E5	1.95E8	2.06E8	2.48E7
Ru-103	5.52E5	1.55E8	1.05E5	1.27E4
Ru-106	1.16E7	2.99E8	1.44E6	1.73E5
Ag-110m	3.67E6	3.14E9	1.46E10	1.75E9
Te-127m	1.31E6	1.18E5	1.04E9	1.24E8
Te-129m	1.68E6	2.86E7	1.40E9	1.68E8
Cs-134	7.03E5	2.81E9	6.79E10	2.04E11
Cs-136	1.35E5	2.13E8	5.76E9	1.73E10
Cs-137	6.12E5	1.15E9	6.02E10	1.81E11
Ba-140	1.60E6	2.94E7	2.41E8	2.89E7
Ce-141	5.17E5	1.98E7	1.37E7	1.65E6
Ce-144	9.84E6	5.84E7	1.33E8	1.60E7
I-131	1.48E7	2.46E7	1.06E12	1.27E12
I-132	1.69E5	1.78E6	1.39E2	1.64E2
I-133	3.56E6	3.54E6	9.80E9	1.18E10
I-135	6.96E5	3.67E6	2.27E7	2.68E7

*Units are mrem/yr per $\mu Ci/m^3$ for H-3 and the inhalation pathway and mrem/yr per $\mu Ci/sec$ per m^{-2} for the food and ground plane pathways.

3.3 COMPLIANCE WITH 10CRF50 (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:

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

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

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.

= From Table A-10 for mixed mode releases to be used only with upper wind speeds $\geq$ 9 mph.

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

= 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 condenser vacuum pump 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 ($\leq$ 500 hours/year), μCi;

$\bar{Q}_{ie}$ = The average release of noble gas radionuclide "i" in gaseous releases for long-term condenser vacuum pump vent releases (> 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

average ($\overline{X/Q}$) values will be used. Should the calculated doses exceed 10CFR50 limits, recalculation of doses may be performed using short-term X/Q values for batch releases.

To select the limiting location, the highest annual average $\overline{X/Q}$ value for ground level and mixed mode releases and the highest short-term X/Q value for ground level and mixed mode releases were considered. Since mixed mode releases may increase and then decrease with distance (i.e., the site boundary may not have the highest X/Q value), long-term X/Q values were calculated at the midpoint of 10 standard distances as given in Appendix A. The calculated values decreased with the distance for all but the WNW, NW, and NNW sectors. The values for these sectors were not found to be limiting such that the maximum site boundary X/Q for both long-term and short-term ground level and mixed mode releases occurred at the SSE site boundary. The limiting location for implementation of 10CFR20 for noble gases is the SSE site boundary.

Values for M_i and N_i which are utilized in the calculation of the gamma air and beta air doses in Equation 3.3-1 to show compliance with 10CFR50 were presented in Table 3.2-3. These values originate from NUREG 0472, Revision 0, and were taken from Table B-1 of the NRC Regulatory Guide 1.109, Revision 1. The values have been multiplied by 1.0 E6 to convert from picocuries to microcuries.

The following relationship should hold for HBR to show compliance with HBR's Technical Specification 3.9.4.1.

For the calendar quarter:

$$D_\gamma \leq 5 \text{ mrad} \qquad (3.3\text{-}3)$$

$$D_\beta \leq 10 \text{ mrad} \qquad (3.3\text{-}4)$$

For the calendar year:

$$D_\gamma \leq 10 \text{ mrad} \qquad (3.3\text{-}5)$$

$$D_\beta \leq 20 \text{ mrad} \qquad (3.3\text{-}6)$$

The quarterly limits given above represent one-half of the annual design objectives of Section II.B.1 of Appendix I of 10CFR50. If any of the limits of Equations 3.3-3 through 3.3-6 are exceeded, a special report pursuant to Technical Specification 6.9.4.a must be filed with the NRC. This report complies with Section IV.A of Appendix I of 10CFR50.

3.3.1.2 Projection of Doses

Doses resulting from the release of gaseous effluents will be projected once per 31 days. These projections will include a safety margin based upon expected operational conditions which will take into consideration both planned and unplanned releases.

Projected dose will be calculated as follows:

$$PD = \frac{(DA)\ (TA)}{(TE)} + M \qquad (3.3\text{-}7)$$

where:

PD = Projected doses in mrem.

DA = Dose accumulated during current quarter in mrem.

TE = Time elapsed in quarter in days.

TA = Time in quarter in days.

M = Safety margin in mrem.

If the projected doses exceed 0.6 mrad for gamma radiation 02 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 and Particulates

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 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:

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

$$(R_{i_B} + R_{i_M} + R_{i_V} + R_{i_G}) \left[(\overline{D/Q})_v Q_{iv} + (\overline{D/q})_v q_{iv} + (\overline{D/Q})_e Q_{ie} \right] + \qquad (3.3\text{-}8)$$

$$(R_{T_M} + R_{T_B} + R_{T_I} + R_{T_V}) \left[(\overline{X/Q})_v Q_{Tv} + (\overline{X/q})_v q_{Tv} + (\overline{X/Q})_e Q_{Te} \right] \Big]$$

where:

D_τ = Dose to any organ τ from radioiodines and particlates, mrem.

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

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

= From Table A-1 for ground level releases.

= From Table A-10 for mixed mode releases only to be used with wind speeds > 9 mph.

$(\overline{X/Q})_e$ = Annual average dilution for condenser vacuum pump vent releases (> 500 hours/yr) sec/m^3.

= From Table A-1 for ground level 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.

= From Table A-12 for mixed mode releases only to be used with upper wind speeds > 9 mph.

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

= From Table A-9 for ground level releases.

= From Table A-18 for mixed mode releases only to be used with upper wind speeds > 9 mph.

$(D/Q)_e$ = Annual average relative deposition factor for condenser vacuum pump vent releases (> 500 hrs/ yr), m^{-2}.

= From Table A-3 for ground level releases.

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

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

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

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

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

Q_{Te} = Release of tritium in gaseous effluents for long-term condenser vacuum pump releases (> 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 milk, beef and vegetable ingestion, and inhalation and ground plane exposure. An infant was assumed to be present at all milk pathway locations. A child was assumed to be present at all vegetable garden and beef animal

locations. The ground plane exposure pathway was not considered a viable pathway for an infant. Naturally, the inhalation pathway was present everywhere an individual was present.HBR Technical Specification 4.20.2.1 requires that a land-use census survey be conducted on an annual basis. The age groupings at the various receptor locations are also determined during this survey; a new limiting location and receptor age group can result.

For the determination of the limiting location, the highest D/Q values for the vegetable garden, cow milk, and goat milk pathways were selected. The thyroid dose was calculated at each of these locations using the radionuclide mix and releases of Table 3.2-1. Based upon these calculations, it was determined that the limiting receptor pathway is the vegetable/child pathway.

In the determination of the limiting location, annual average D/Q and X/Q values are used. A description of the derivation of the various X/Q and D/Q values is presented in Appendix A.

Short-term and long-term X/Q and D/Q values for ground level releases and for long-term mixed mode releases are provided in tables in Appendix A. They may be utilized if an additional special location arises different from those presented in the special locations of Table 3.2-2.

Tables 3.3-1 through 3.3-19 present R_i values for the total body, GI-tract, bone, liver , kidney, thyroid, and lung organs for the ground plane, inhalation, cow milk, goat milk, vegetable, and meat ingestion pathways for the infant, child, teen, and adult age groups as appropriate to the pathways. These values were calculated using the methodology described in NUREG 0133 using a grazing period of eight months. A description of the methodology is presented in Appendix B.

The following relationship should hold for HBR to show compliance with HBR Technical Specification 3.9.5.1.

For the calendar quarter:

$$D_\tau \leq 7.5 \text{ mrem} \qquad (3.3\text{-}9)$$

For the calendar year:

$$D_\tau \leq 15 \text{ mrem} \qquad (3.3\text{-}10)$$

The quarterly limits given above represent one-half the annual design objectives of Section II.C of Appendix I of 10CFR50. If any of the limits of Equations 3.3-9 or 3.3-10 are exceeded, a special report pursuant to Technical Specification 6.9.4.a must be filed with the NRC. This report complies with Section IV.A of Appendix I of 10CFR50.

3.3.2.2 Projection of Doses

Doses resulting from release of radioiodines and particulate effluents will be projected once per 31 days. These projections will include a safety margin based upon expected operational conditions which will take into consideration both planned and unplanned releases.

Projected dose will be calculated as follows:

$$PD = \frac{(DA)\ (TA)}{(TE)} + M \qquad (3.3\text{-}11)$$

where:

PD = Projected doses in mrem.

DA = Dose accumulated during current quarter in mrem.

TE = Time elapsed in quarter in days.

TA = Time in quarter in days.

M = Safety margin in mrem.

If the projected doses exceed 1.0 mrem to any organ when averaged over a calendar quarter, the ventilation exhaust treatment system will be operated to reduce releases of radioactive materials.

TABLE 4.0-1

H. B. ROBINSON RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
1. Airborne Particulates and Radioiodine	1.	Florence, S. C. (Control Station)[2] 26 miles ESE @ 119°	Continuous operating sampler with sample collection at least weekly	Weekly Weekly Quarterly	I-131 for Air Cartridges Gross Beta[3] Gamma Scan[4] of composite (by location)
	2.	Information Center 0.2 mile S @ 180°			
	3.	Microwave tower 0.7 mile N @ 5°			
	4.	Spillway 0.4 mile ESE @ 110°			
	5.	East Shore of lake across from plant intake Johnson's Landing 0.9 mile ENE @ 73°			
	6.	Information Center 0.3 mile SW @ 214°			
	7.	CP&L Hartsville substation, 6.3 miles ESE @ 109°			
2. Direct Radiation	1.	Florence, S.C. (Control Station)[2] 26 miles ESE @ 119°	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose[5]

Table 4.0-1 (continued)

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
2. Direct Radiation (continued)	2.	Information Center 0.2 mile S @ 180°	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose[5]
	3.	Microwave tower 0.7 mile N @ 5°			
	4.	Spillway 0.4 mile ESE @ 110°			
	5.	East shore of lake across from plant intake Johnson's landing 0.9 mile ENE @ 73°			
	6.	Information Center 0.3 mile SW @ 214°			
	7.	CP&L Hartsville substation 6.3 miles ESE @ 109°			
	8.	On transmission poles intersecting with different transmission lines directly from HBR, approximately two pole sections down from railroad tracks 0.8 mile SSE.			
	9.	Second transmission pole from 151 Highway 1.0 mile S.			
	10.	Power pole at corner of The Church of God cemetary 1.0 mile WSW.			
	11.	Third power pole from the Old Camden Road 1.0 mile SW.			
	12.	Pine tree located at the second intersection of dirt road. Yellow mark on tree 1.2 miles SSW.			

Table 4.0-1 (continued)

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
2. Direct Radiation (continued)	13.	Corner pine tree where dirt road splits 1.0 mile W.	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose[5]
	14.	Power pole by Highway 151 on front of Pine Ridge Church 0.9 mile WNW.			
	15.	Pine tree down dirt road off Highway 151 directly adjacent to ash pond on CP&L property 1.0 miles NW.			
	16.	Southeast fence at Darlington County I.C. Turbine Plant 1.0 mile NNW.			
	17.	Small pine tree, right side of road, 1.0 mile down Discharge Canal road at Old Unit One Weir 1.1 miles N.			
	18.	Left side of train trestle over Black Creek 0.7 mile SE.			
	19.	Third power pole on Road #S-16-23 from intersection with 1.0 mile E.			
	20.	Power Pole #47 at right side of Road #S-16-39 going north 1.3 miles ENE.			
	21.	Power pole in the yard of A. Atkinson at Atkinson's boat landing.			
	22.	Shady Rest at light pole near the dock 1.9 miles NNE.			
	23.	Power Pole #41E-5 on Road #41E-5 on Road #S-16-39 1.2 miles ESE.			
	24.	151 north past peach farm, first paved Road #S-13-711 left. Fifth pole left side of road. Yellow marking 5.0 miles NW.			

Table 4.0-1 (continued)

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
2. Direct Radiation (continued)	25.	Road #S-13-346 off 151 North. Cross railroad tracks and proceed 3/8 mile. Walk down right fence line into the woods towards pond. Badge on right pine tree f 18 yards directly in front of fence marked "No Trespassing" 4.6 miles NNW.	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose[5]
	26.	Power pole #32J-6 across old yellow house on Road #S-13-346 5.0 miles N.			
	27.	Road #S-13-763, f 1.3 miles from intersection 5.0 miles NNE.			
	28.	Power Pole #30-4-A near dumpster on road #S-13-39 4.8 miles NE.			
	29.	Transmission pole nearest Road #S-16-20 f 1/2 mile south of lookout tower.			
	30.	Located on Road #S-16-20, power pole in front yard of Johnson Fence and Awning 4.6 miles E.			
	31.	Lakeshore Drive, Pole #1122 right side of road. Yellow marking 4.6 miles ESE.			
	32.	Straight down the end of Kalber Drive, 12 feet up the transmission tower. Yellow marking 4.5 miles SE.			
	33.	Power Pole #25-4, left side of Road #S-16-493 near Harley Segar's driveway 4.6 miles SSE.			
	34.	Transmission pole nearest Road #S-16-772 4.6 miles S.			

Table 4.0-1 (continued)

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
2. Direct Radiation (continued)	35.	Power pole at corner of Road #S-31-51 off Road #S-16-12 4.4 miles SSW.	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose[5]
	36.	Power pole f 3/4 mile down paved road off Road #S-16-85. Pole is in front of old house 4.7 miles SW.			
	37.	Transmission tower closest to Clay Road 5.0 miles WSW.			
	38.	Transmission pole right side of Road S-16-231 next to Union Church 4.9 miles W.			
	39.	Power pole, right side of road in middle of field. Yellow paint 5.0 miles WNW.			
3. Waterborne a. Surface Water	40.	Black Creek at Road 1623 0.6 mile ESE (indicator).	Composite sample[6] over one-month period	Monthly	Gamma Scan[4] H-3
	41.	Black Creek (Control Station[2] 7.2 miles NNW.			
b. Groundwater	40.	Artesian well 0.6 mile ESE.	Grab Sample	Monthly	Gamma Scan[4] H-3
	42.	Unit 1 deep well			
	43.	Unit 2 deep well			
c. Drinking Water		Not required[7].			
d. Shoreline Sediment	44.	East Shore of Lake, Shady Rest Club 1.9 miles NNE.	Semiannually	Semiannually	Gamma Scan[4]

Table 4.0-1 (continued)

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
4. Ingestion a. Milk	53.	Lyndale Farm 9.0 miles SW (control station)	Semimonthly when animals are on pasture; monthly @ other times	Semimonthly when animals are on pasture; monthly @ other times	Gamma Scan[4] and I-131 analysis semi-monthly when animals are on pasture; monthly @ other times
	54.	Auburndale Plantation[8] 10.1 miles E.			
b. Fish	45.	Site varies within Lake Robinson.	Semiannually (collect comparable species at all three locations)	Each sample	Gamma Scan[4] Edible portion
	46.	Prestwood Lake 4.9 miles ESE.			
	47.	Bee Lake (Control Station)[2] 13 miles NNW or May Lake 12.5 miles NW.			
c. Food Products leafy vegetables	58.	One location within 3 miles of site in the sector with the highest deposition rate based on the latest information or historical data (location may vary).	Annual at Harvest	Each sample	Gamma Scan[4]
	49.	One location greater than 5 miles from plant site with the least deposition rate (Control Station)[2].			
	54.	Auburndale Plantation[8] 10.1 miles E.			
d. Broad-leaf vegetation	50.	0.25 mile SSE CP&L property[9].	Monthly when available (3 different kinds of broad-leaf vegetation)	Each sample	Gamma Scan[4] I-131
	51.	0.25 NNE CP&L property[9].			
	52.	10 miles W Bethune (Control Station)[2].			

FOOTNOTES:

1. The LLD for each analysis is specified in Table 3.17-3 of the HBR Technical Specifications.

2. Control stations are locations outside the influence of plant effluents.

3. Airborne particulate sample filter shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate is greater than ten times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

4. Gamma scan means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

5. Thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters.

6. Composite sample aliquots shall be collected at time intervals that are short (5 or 6 times daily) relative to the compositing period (monthly in order to assure obtaining a representative sample).

7. Collection of drinking water samples is not required since there are no known reservoirs on Black Creek used for drinking purposes.

8. Water from Black Creek is used to irrigate feed and fodder for Arburndale Plantation's Dairy operation. This dairy is located *f* 11 miles east @ 90° from plant.

9. Sample Points 50 and 51 are the highest and the second highest D/Q values, respectively. These locations are more restrictive than site boundary locations.

6.0 TOTAL DOSE (40CFR190 CONFORMANCE)

6.1 COMPLIANCE WITH 40CFR190

Compliance with 40CFR190 as prescribed by Specification 3.9.6 is to be demonstrated only when one or more of Specifications 3.9.2.1.a, 3.9.2.1.b, 3.9.4.1a, 3.9.4.1.b, 3.9.5.1.a, and 3.9.5.1.b is exceeded by a factor of 2. Once this occurs the Company has 30 days to submit this report in accordance with Specification 6.9.4(d).

6.2 CALCULATIONS EVALUATING CONFORMANCE WITH 40CFR190

To perform the calculations to evaluate conformance with 40CFR190, an effort is made to develop doses that are realistic by removing assumptions that lead to overestimates of dose to a MEMBER OF THE PUBLIC (i.e., calculations for compliance with 10CFR50, App. I). To accomplish this the following calculational rules are used:

(1) Doses to a MEMBER OF THE PUBLIC via the liquid release pathway will be calculated.

(2) Doses to a MEMBER OF THE PUBLIC due to a milk pathway will be evaluated only as can be shown to exist. Otherwise, doses via this pathway will be estimated as <1 mrem/yr.

(3) Environmental sampling data which demonstrate that no pathway exists may be used to delete a pathway to man from a calculation.

(4) To sum numbers represented as "less than" (<), use the value of the largest number in the group.

(i.e. <5 + <1 + <1 + <3 = 5)

(5) When doses via direct radiation are added to doses via inhalation pathway, they will be calculated for the same distance in the same sector.

(6) The calculational locations for a MEMBER OF THE PUBLIC will only be at residences or places of employment.

NOTE: Additional assumptions may be used to provide situation-specific parameters, provided they are documented along with their concomitant bases.

6.3 CALCULATIONS OF TOTAL BODY DOSE

Estimates will be made for each of the following exposure pathways to the same location by age class. Only those age classes known to exist at a location are considered.

6.3.1 Direct Radiation

The component of dose to a MEMBER OF THE PUBLIC due to direct radiation will be determined by:

(1) Determining the direct radiation dose at the plant boundary in each sector, $D_{B,\theta}$.

(2) Extrapolate that dose to the calculational location as follows:

$$D_{L,\theta} = \frac{D_{B,\theta}\ (1.49\ E{+}6)}{(X_{L,\theta})^2}$$

$D_{L,\theta}$ = dose at calculational location in sector θ.

1.49E+6 = square of mean distance to the site boundary (1220 m).

$X_{L,\theta}$ = Distance to calculational locations in sector θ in meters.

6.3.2 Inhalation Dose

The inhalation dose will be determined at the calculational locations for each age class at risk according to the methods outlined in Section 3.3 of this manual.

6.3.3 Ingestion Pathway

The dose via the ingestion pathway will be calculated at the consumer locations for the consumers at risk. If no milk pathway exists in a sector, the dose via this pathway will be treated as <1 mrem/yr.

6.3.4 Other Uranium Fuel Cycle Sources

The dose from other fuel cycle sources will be treated as <1 mrem/yr.

6.4 THYROID DOSE

The dose to the thyroid will be calculated for each sector as the sum of inhalation dose and milk ingestion dose (if existing). The calculational methods will be those identified in Section 3.3 of this manual.

6.5 DOSE PROJECTIONS

Dose projections are to incorporate planned plant operations such as power reduction or outages for the projected period.

TABLE A-1

X/Q Values for Long-Term Ground Level Releases at Special Locations (sec/m^3)*

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Straight Line (ANNX009)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	6.67E-06	4.13E-06	0.00	6.26E-06	5.56E-06
NE	3.02E-06	2.56E-06	2.13E-06	2.44E-06	2.13E-06
ENE	4.41E-06	4.93E-07	0.00	4.18E-06	7.36E-07
E	6.39E-06	3.02E-07	1.44E-07	3.51E-06	3.68E-07
ESE	1.12E-05	1.18E-06	0.00	7.90E-06	7.90E-06
SE	3.28E-05	0.00	0.00	3.27E-05	3.27E-05
SSE	8.08E-05	0.00	0.00	6.01E-05	6.01E-05
S	3.29E-05	4.22E-07	0.00	2.78E-05	1.65E-05
SSW	2.10E-05	5.61E-07	0.00	2.04E-05	8.07E-06
SW	8.91E-06	2.61E-07	2.14E-07**	6.90E-06	5.38E-06
WSW	3.97E-06	1.16E-07	0.00	3.22E-06	1.83E-06
W	2.11E-06	3.89E-08	0.00	1.38E-06	1.38E-06
WNW	1.62E-06	5.32E-08	0.00	1.03E-06	6.06E-07
NW	7.93E-07	5.06E-07	0.00	7.39E-07	7.39E-07
NNW	1.31E-06	4.78E-07	0.00	4.42E-07	3.82E-07
N	1.45E-06	6.44E-07	0.00	6.67E-07	6.67E-07

* Zeroes indicate that this point was not calculated

** A milk goat is located here

TABLE A-2

Depleted X/Q Values for Long-Term Ground Level Releases at Special Locations (sec/m^3)*

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Depleted Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Straight Line (ANNXOQ9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	5.84E-06	3.38E-06	0.00	5.25E-06	4.77E-06
NE	2.68E-06	2.21E-06	1.79E-06	2.09E-06	1.79E-06
ENE	3.95E-06	3.99E-07	0.00	3.72E-06	5.93E-07
E	5.79E-06	2.42E-07	1.08E-07	3.12E-06	2.86E-07
ESE	1.01E-05	9.72E-07	0.00	7.11E-06	7.11E-06
SE	3.08E-05	0.00	0.00	3.05E-05	3.05E-05
SSE	7.46E-05	0.00	0.00	5.61E-05	5.61E-05
S	3.11E-05	3.42E-07	0.00	2.61E-05	1.53E-05
SSW	1.91E-05	4.55E-07	0.00	1.96E-05	7.35E-06
SW	8.25E-06	2.14E-07	2.44E-07**	6.44E-06	4.88E-06
WSW	3.68E-06	8.92E-08	0.00	2.94E-06	1.68E-06
W	1.98E-06	2.96E-08	0.00	1.26E-06	1.26E-06
WNW	1.47E-06	4.07E-08	0.00	9.26E-07	5.42E-07
NW	6.71E-07	4.19E-07	0.00	6.31E-07	6.31E-07
NNW	1.09E-06	3.80E-07	0.00	3.48E-07	2.98E-07
N	1.24E-06	5.11E-07	0.00	5.24E-07	5.24E-07

* Zeroes indicate that this point was not calculated

** A milk goat is located here

TABLE A-4

X/Q Values for Long-Term Ground Level Releases at Standard Distances (sec/m^3)

Carolina Power & Light Company - Robinson

Release Type: Annual

Release Mode: Ground Level

Variable: Relative Concentration (Sec./Cubic Meter)

Calculation Points: Standard

Model: Straight Line (ANNX009)

Application of Terrain Correction Factors: Yes

Number of Observations: 8703

BASE DISTANCE IN MILES/KILOMETERS

Aftd Sect	Design Dist MI	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	8.8E-05	1.5E-05	6.4E-06	3.5E-06	2.3E-06	1.7E-06	1.1E-06	8.0E-07	5.5E-07	3.7E-07
NE	0.	3.9E-05	4.6E-06	2.0E-06	1.1E-06	6.9E-07	4.6E-07	3.5E-07	2.8E-07	2.2E-07	1.7E-07
ENE	0.	3.2E-05	5.2E-06	1.8E-06	9.7E-07	5.3E-07	3.8E-07	2.6E-07	2.1E-07	1.7E-07	1.5E-07
E	0.	2.9E-05	4.5E-06	1.6E-06	8.3E-07	6.2E-07	3.3E-07	2.7E-07	1.9E-07	1.3E-07	9.5E-08
ESE	0.	3.6E-05	5.4E-06	2.3E-06	1.3E-06	9.2E-07	6.2E-07	5.1E-07	3.6E-07	2.7E-07	1.9E-07
SE	0.	4.0E-05	5.4E-06	2.6E-06	1.3E-06	8.5E-07	4.8E-07	3.6E-07	2.1E-07	1.9E-07	1.6E-07
SSE	0.	8.2E-05	1.2E-05	5.0E-06	2.6E-06	1.5E-06	9.2E-07	6.5E-07	5.5E-07	4.5E-07	4.0E-07
S	0.	3.6E-05	4.4E-06	1.7E-06	9.1E-07	4.2E-07	3.3E-07	2.6E-07	2.1E-07	1.7E-07	1.4E-07
SSW	0.	2.5E-05	4.6E-06	1.9E-06	7.9E-07	4.5E-07	3.0E-07	2.1E-07	1.6E-07	1.2E-07	9.8E-08
SW	0.	1.5E-05	2.2E-06	8.3E-07	3.7E-07	2.3E-07	1.6E-07	1.2E-07	8.8E-08	7.1E-08	5.9E-08
WSW	0.	6.5E-06	1.0E-06	3.7E-07	2.0E-07	1.6E-07	1.0E-07	6.9E-08	5.8E-08	4.8E-08	3.7E-08
W	0.	6.5E-06	8.3E-07	3.2E-07	1.7E-07	1.3E-07	8.8E-08	6.7E-08	4.3E-08	3.0E-08	2.4E-08
WNW	0.	6.1E-06	7.8E-07	3.0E-07	1.8E-07	1.3E-07	9.6E-08	7.1E-08	5.4E-08	4.0E-08	3.0E-08
NW	0.	1.1E-05	1.6E-06	7.4E-07	4.2E-07	2.4E-07	1.3E-07	8.0E-08	6.7E-08	5.3E-08	4.4E-08
NNW	0.	2.0E-05	3.6E-06	1.9E-06	1.4E-06	9.4E-07	5.2E-07	2.7E-07	1.8E-07	1.2E-07	9.2E-08
N	0.	5.2E-05	8.0E-06	3.3E-06	1.6E-06	1.0E-06	7.1E-07	4.9E-07	3.7E-07	2.9E-07	2.4E-07

Number of Valid Observations	=	8703
Number of Invalid Observations	=	57
Number of Calms Lower Level	=	398
Number of Calms Upper Limit	=	0

TABLE A-5

Depleted X/Q Values for Long-Term Ground Level Releases at Standard Distances (sec/m^3)

Carolina Power & Light Company - Robinson

Release Type: Annual

Release Mode: Ground Level

Variable: Relative Concentration (Sec./Cubic Meter)

Calculation Points: Standard

Model: Straight Line (ANNX009)

Application of Terrain Correction Factors: Yes

Number of Observations: 8703

BASE DISTANCE IN MILES/KILOMETERS

Aftd Sect	Design Dist MI	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	8.3E-05	1.3E-05	5.4E-06	3.0E-06	2.0E-06	1.3E-07	8.3E-06	6.2E-07	4.1E-07	2.7E-07
NE	0.	3.6E-05	4.1E-06	1.7E-06	9.2E-07	5.6E-07	3.6E-07	2.7E-07	2.1E-07	1.6E-07	1.3E-07
ENE	0.	3.1E-05	4.6E-06	1.5E-06	8.3E-07	4.3E-07	3.0E-07	2.0E-07	1.6E-07	1.3E-07	1.1E-07
E	0.	2.7E-05	4.1E-06	1.3E-06	6.9E-07	5.0E-07	2.7E-07	2.1E-07	1.4E-07	9.4E-08	7.2E-08
ESE	0.	3.4E-05	4.9E-06	2.0E-06	1.1E-06	7.4E-07	5.0E-07	4.0E-07	2.9E-07	2.1E-07	1.5E-07
SE	0.	3.8E-05	4.9E-06	2.2E-06	1.1E-06	7.0E-07	3.8E-07	2.8E-07	1.7E-07	1.4E-07	1.2E-07
SSE	0.	7.8E-05	1.1E-05	4.4E-06	2.2E-06	1.3E-06	7.6E-07	5.1E-07	4.3E-07	3.3E-07	2.9E-07
S	0.	3.5E-05	3.9E-06	1.4E-06	7.6E-07	3.5E-07	2.6E-07	2.0E-07	1.6E-07	1.3E-07	1.1E-07
SSW	0.	2.3E-05	4.1E-06	1.6E-06	6.6E-07	3.7E-07	2.4E-07	1.7E-07	1.2E-07	8.9E-08	6.9E-08
SW	0.	1.4E-05	1.9E-06	7.1E-07	3.1E-07	1.9E-07	1.2E-07	9.8E-08	6.7E-08	5.0E-08	4.3E-08
WSW	0.	6.2E-06	9.2E-07	3.2E-07	1.7E-07	1.3E-07	8.0E-08	5.4E-08	4.4E-08	3.6E-08	2.7E-08
W	0.	6.1E-06	7.5E-07	2.8E-07	1.4E-07	1.1E-07	6.8E-08	5.2E-08	3.3E-08	2.3E-08	1.8E-08
WNW	0.	5.8E-06	7.0E-07	2.6E-07	1.5E-07	1.1E-07	7.6E-08	5.5E-08	4.2E-08	3.0E-08	2.2E-08
NW	0.	1.1E-05	1.4E-06	6.4E-07	1.4E-07	2.0E-07	1.0E-07	6.1E-08	5.0E-08	4.0E-08	3.3E-08
NNW	0.	1.9E-05	3.1E-06	1.6E-06	1.1E-06	7.6E-07	4.2E-07	2.0E-07	1.3E-07	8.8E-08	7.1E-08
N	0.	4.9E-05	7.2E-06	2.8E-06	1.4E-06	8.1E-07	5.6E-07	3.8E-07	2.9E-07	2.2E-07	1.8E-07

Number of Valid Observations	=	8703
Number of Invalid Observations	=	57
Number of Calms Lower Level	=	398
Number of Calms Upper Limit	=	0

TABLE A-18

D/Q Values for Short-Term Mixed Mode Releases at Special Locations (m^{-2})*

Carolina Power & Light Company - Robinson
Release Type: Purge
Release Mode: Mixed Mode
Variable: Relative Deposition Rate ($Meter^{-2}$)
Calculation Points: Special
Model: Purge (ACNPURG2)
Application of Terrain Correction Factors: No
Number of Observations: 8703
Purge Time: 100 Hours

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	5.77E-09	3.45E-09	0.00	5.70E-09	4.68E-09
NE	7.18E-09	5.72E-09	4.70E-09	5.20E-09	4.70E-09
ENE	1.04E-08	1.16E-09	0.00	9.77E-09	1.74E-09
E	2.08E-08	8.36E-10	5.32E-10	1.06E-08	9.36E-10
ESE	2.12E-08	2.22E-09	0.00	1.73E-08	1.73E-08
SE	2.99E-08	0.00	0.00	2.88E-08	2.88E-08
SSE	1.81E-08	0.00	0.00	1.64E-08	1.64E-08
S	3.04E-08	9.84E-10	0.00	2.80E-08	2.48E-08
SSW	3.66E-08	2.33E-09	0.00	3.72E-08	2.78E-08
SW	2.20E-08	1.48E-09	1.18E-09**	2.14E-08	1.97E-08
WSW	2.83E-08	1.23E-09	0.00	2.55E-08	2.07E-08
W	2.09E-08	4.69E-10	0.00	1.62E-08	1.62E-08
WNW	2.01E-08	6.45E-10	0.00	1.38E-08	8.18E-09
NW	4.98E-09	3.00E-09	0.00	4.53E-09	4.53E-09
NNW	2.32E-09	9.15E-10	0.00	8.99E-10	8.09E-10
N	1.36E-09	5.75E-10	0.00	6.24E-10	6.24E-10

* Zeroes indicate that this point was not calculated

** A milk goat is located here

The concentration of tritium in milk is based on the airborne concentration rather than the deposition. Therefore, the R_i is based on X/Q:

$$R_{T_M} = K'K'''F_m Q_F U_{ap} (DFL_i)_a \, 0.75(0.5/H) \qquad (B.2\text{-}4)$$

where:

R_{T_M} = Dose factor for the cow or goat milk pathway for tritium for the organ of interest, mrem/yr per $\mu Ci/m^3$;

K''' = A constant of unit conversion;
= 10^3 gm/kg;

H = Absolute humidity of the atmosphere, gm/m^3;

0.75 = The fraction of total feed that is water;

0.5 = The ratio of the specific activity of the feed grass water to the atmospheric water.

and other parameters and values are given above. A value of H = 8 grams/meter^3, was used in lieu of site-specific information.

B.2.4 Grass-Cow-Meat Pathway

The integrated concentration in meat follows in a similar manner to the development for the milk pathway, therefore:

$$R_{i_B} = I_i K' Q_F U_{ap} F_f (DFL_i)_a \, e^{-\lambda_i t_s} \left[f_p f_s \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_p \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] \right.$$

$$\left. (1-f_p f_s) \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_s \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] e^{-\lambda_i t_h} \right] \qquad (B.2\text{-}5)$$

where:

R_{i_B} = Dose factor for the meat ingestion pathway for radionuclide "i" for any organ of interest, mrem/yr per $\mu Ci/sec$ per m^{-2};

F_f = The stable element transfer coefficients, pCi/Kg per pCi/day;

U_{ap} = The receptor's meat consumption rate for age group a, kg/yr;

t_s = The transport time from slaughter to consumption, sec;

t_h = The transport time from harvest to animal consumption, sec;

t_e = Period of pasture grass and crop exposure during the growing season, sec;

I_i = Factor to account for fractional deposition of radionuclide "i."

For radionuclides other than iodine, I_i is equal to one. For radioiodines, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Tables 3.3-6 through 3.3-8.

All other terms remain the same as defined in Equation B.2-3. Table B-2 contains the values which were used in calculating R_i for the meat pathway.

The concentration of tritium in meat is based on its airborne concentration rather than the deposition. Therefore, the R_i is based on X/Q.

$$R_{T_B} = K'K'''F_f Q_F U_{ap} (DFL_i)_a \, 0.75(0.5/H) \qquad (B.2\text{-}6)$$

where:

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

All other terms are defined in Equations B.2-4 and B.2-5.

B.2.5 Vegetation Pathway

The integrated concentration in vegetation consumed by man follows the expression developed in the derivation of the milk factor. Man is considered to consume two types of vegetation (fresh and stored) that differ only in the time period between harvest and consumption, therefore:

$$R_{iv} = I_i K' (DFL_i)_a \left[U_a^L f_L e^{-\lambda_i t_L} \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_v \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] + U_a^S f_g e^{-\lambda_i t_h} \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_v \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] \right] \quad (B.2\text{-}7)$$

where:

R_{iv} = Dose factor for vegetable pathway for radionuclide "i" for the organ of interest, mrem/yr per μCi/sec per m^{-2};

K' = A constant of unit conversion;
= 10^6 pCi/μCi;

U_a^L = The consumption rate of fresh leafy vegetation by the receptor in age group a, kg/yr;

U_a^S = The consumption rate of stored vegetation by the receptor in age group a, kg/yr;

f_L = The fraction of the annual intake of fresh leafy vegetation grown locally;

f_g = The fraction of the annual intake of stored vegetation grown locally;

t_L = The average time between harvest of leafy vegetation and its consumption, sec;

TABLE D-1
Liquid Process Monitors

Name	RMS #	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	19	R-19	997261

Liquid Radwaste Flow Measurement Devices

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

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

Revision 2

DOCKET NO. 50-261

PNSC Review _____ DATE 3-6-86
PNSC Chairman

CAROLINA POWER & LIGHT COMPANY
March 5, 1986

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1.0 INTRODUCTION

The Off-Site Dose Calculation Manual (ODCM) provides the information and methodologies to be used by H. B. Robinson Steam Electric Plant Unit 2 (HBR) to assure compliance with Specifications 3.9.1, 3.9.2, 3.9.3, 3.9.4, 3.9.5, and 3.9.6 of the H. B. Robinson Technical Specification. These portions are those related to liquid and gaseous radiological effluents. They are intended to show compliance with 10CFR20, 10CFR50.36a, Appendix I of 10CFR50, and 40CFR190.

The ODCM is based on "Radiological Effluent Technical Specifications for PWRs (NUREG 0472, Rev. 3, Draft 7), "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants" (NUREG 0133), and guidance from the United States Nuclear Regulatory Commission (NRC). Specific plant procedures for implementation of this manual are presented in H. B. Robinson Unit 2 Plant Operating Manual. These procedures will be utilized by the operating staff of HBR to assure compliance with technical specifications.

The ODCM has been prepared as generically as possible in order to minimize the need for future revisions. However, some changes to the ODCM will be expected in the future. Any such changes will be properly reviewed and approved as indicated in the Administrative Control Section, Specification 6.16.2, of the HBR Technical Specifications.

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 Waste Disposal System Effluent Monitor (RMS-18) and the Steam Generator Blowdown Monitor (RMS-19) during all operational conditions when the radwaste discharge flow rate is maintained constant. This methodology complies with Specification 3.9.1.1 of the RETS by satisfying the following equation:

$$\frac{cf}{F} \leq C$$

where:

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

c = The setpoint, in uCi/ml, of the radioactivity monitor measuring the radioactivity concentration in the effluent line prior to dilution and subsequent release; the setpoint represents a value which, if exceeded, would result in concentrations exceeding the limits of 10CFR20 in the unrestricted area.

f = The waste effluent flow rate in gpm.

F = The dilution water flow rate in gpm.

2.1.1.1 Determine c (the effluent monitor setpoint) in uCi/ml for each of the dilution water flow rates.

where: $c = \frac{CF}{f}$

C = 3×10^{-7} uCi/ml, the effluent concentration limit based on 10CFR20, Appendix B, for I-131.

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.

f = The maximum acceptable discharge flow rate prior to dilution (gpm).

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

= 750 gpm for the Steam Generator Blowdown Monitor.

= 450 gpm for the Steam Generator Blowdown Monitor while draining a steam generator.

= 390 gpm for the Condensate Polisher Liquid Waste Monitor.

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.

$SP = (T_m CR + \text{Background})$

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.

= .05 for the Waste Disposal System Liquid Effluent Monitor (RMS-18).

= .70 for the Steam Generator Blowdown Monitor (RMS-19).

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

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 (RMS-18), the Steam Generator Blowdown Monitor (RMS-19), and the Condensate Polisher Liquid Waste Monitor (RMS-37) when an analysis of the activity of the principal gamma emitters has been made prior to each batch released.

2.1.2.1 Determine D (the minimum acceptable dilution factor):

$$D = S\sum_i \frac{Ci}{MPC_i}$$

$$C_i = \sum C_g + [C_a + C_s + C_t + C_{Fe-55}]$$

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

$\sum C_g$ = The sum of the concentrations of each measured gamma-emitting radionuclide observed by gamma spectroscopy.

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 = The liquid effluent radioactivity limit for radionuclide "i" (μCi/ml) from 10CFR20, Appendix B.

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.

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

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].

= 750 gpm for the Steam Generator Blowdown Monitor.

= 450 gpm for the Steam Generator Blowdown Monitor while draining a steam generator.

= 390 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.

= .05 for the Waste Disposal System Liquid Effluent Monitor (RMS-18).

= .70 for the Steam Generator Blowdown Monitor (RMS-19).

= .25 for the Condensate Polisher Liquid Waste.

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

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

2.1.2.4 Determine SP (the monitor alarm setpoint [ccpm].

$SP = (c)\ (E_m)$ + background.

where:

E_m = The applicable effluent monitor efficiency based on "c," from the efficiency curves located in the Plant Operating Manual, Volume 15, Curve Book.

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SECTION 2.1 REFERENCES

1. Carolina Power & Light Company Drawing Number G-190825. Using the System Q-H Curve for Emergency Low Water Level.

2. Carolina Power & Light Company, Darlington County S.E. Plant. 1960-182 MW Installation, Unit 1. SYSTEM HEAD CURVES Unit 1 Circulating Water System Draining Quosig.

3. H.B. Robinson Electric Plant Unit 2, Updated Final Safety Analysis Report.

2.2 COMPLIANCE WITH 10CFR20 (LIQUIDS)

Liquid effluents from H.B. Robinson Unit 2 (HBR) will occur both continuously and on a batch basis. The following sections discuss the methodology which will be utilized by the HBR to show compliance with 10CFR20.

2.2.1 Continuous Releases

Steam generator blowdown is continuously released from HBR. Each operational working day grab samples will be taken of steam generator blowdown. These samples are composited at the rate of 100 ml/sgr. An aliquot of the SG composite is analyzed each week for I-131 and various other fission, activation, and corrosion products, as outlined in Table 4.10-1 of the technical specification for HBR. Samples are to be maintained until the end of the quarter and analyzed for strontium. Steam generator volumes are based on blowdown rates. In addition, a monthly analysis will be performed to determine the activity levels of tritium and dissolved and entrained gases. Compliance with 10CFR20 during actual release is established through the steam generator blowdown effluent monitor alarm setpoint. This setpoint is based upon I-131 as noted in Section 2.1. However, if a continuous release should occur in which the effluent monitor alarm setpoint is exceeded, then actual compliance with 10CFR20 may be determined utilizing the actual radionuclide mix and the following equation:

$$Conc_i = \frac{C_{ic}\, V_c}{V_{dc}} \qquad (2.2\text{-}1)$$

where:

$Conc_i$ = Concentration of radionuclide "i" at the unrestricted area, μCi/ml;

C_{ic} = Concentration of radionuclide "i" in the continuous release, μCi/ml;

V_c = Volume of continuous effluent released, gal;

V_{dc} = Volume of dilution flow during release, gal.

2.2.2 Batch Releases

Batch releases will occur during normal operation. When this does occur at HBR, a continuous release will usually be occurring at the same time. However, during certain shutdown conditions, only batch releases may occur at HBR. Therefore, both situations are treated here to provide the methodology to show compliance with 10CFR20.

2.2.2.1 Prerelease

The radioactivity content of each batch release will be determined prior to release in accordance with Table 4.10-1 of the technical specifications for HBR. HBR will show compliance with 10CFR20 in the following manner:

For the case where only a batch release is to occur, the concentration of the various radionuclides in the batch release, determined in accordance with Table 4.10-1 of the technical specifications for HBR, is multiplied by the ratio of the maximum release rate of the potential batch release to the dilution flow rate to obtain the concentration at the unrestricted area. This calculation is shown in the following equation:

$$Conc_i = \frac{C_{ib} R_b}{D_{fr}} \qquad (2.2\text{-}2)$$

where:

$Conc_i$ = Concentration of radionuclide "i" at the unrestricted area, μCi/ml;

C_{ib} = Concentration of radionuclide "i" in the potential batch release, μCi/ml;

R_b = Release rate of the potential batch release, gpm;

D_{fr} = The dilution flow rate based upon the number of circulating water pumps in service during the release, gpm.

The concentration in the unrestricted area is compared to the concentrations in Appendix B, Table II, Column 2, of 10CFR20. Before release may occur, the mixture of radionuclides released must be of such concentration that Equation 2.2-3 is met.

$$\sum_i (Conc_i/MPC_i) \leq 1 \qquad (2.2\text{-}3)$$

where:

MPC_i = Maximum permissible concentration of radionuclide "i" from Appendix B, Table II, Column 2 of 10CFR20, μCi/ml.

For those cases where batch releases may be occurring at the same time that continuous releases are occurring, the concentration in the unrestricted area will be calculated by the following equation:

$$Conc_i = \frac{C_{ib} R_b + C_{ic} R_c}{D_{fr}} \qquad (2.2\text{-}4)$$

where:

R_c = Maximum continuous liquid effluent release rate, gpm.

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, the steam generators, and the Condensate Polisher Liquid Waste. The maximum release rate (R_b) is 750 gpm for the steam generators, 60 gpm from the monitor and waste condensate tanks, and 390 gpm for the Condensate Polisher Liquid Wastes.

2.2.2.2 Postrelease

The Steam Generation Blowdown Monitor (RMS-19), the Waste Disposal System Liquid Monitor (RMS-18), and the Condensate Polisher Liquid Waste Monitor (RMS-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.

The concentration of each radionuclide in the unrestricted area following release from a batch tank will be calculated in the following manner:

For the case where only batch releases are occurring, the total activity of radionuclide "i" released is divided by the actual dilution flow to obtain the concentration in the unrestricted area. This calculation is shown in the following equation:

$$Conc_{ik} = \frac{C_{ikb}\ V_{kb}}{V_{kd}} \qquad (2.2\text{-}5)$$

where:

$Conc_{ik}$ = The concentration of radionuclide "i" at the unrestricted area during release k, μCi/ml;

C_{ikb} = Concentration of radionuclide "i" in the batch release k, μCi/ml;

V_{kb} = Volume of batch release k, gal;

V_{kd} = Actual volume of dilution flow during release k, gal.

To show compliance with 10CFR20, the following relationship must hold:

$$\sum_i (Conc_{ik}/MPC_i) \leq 1 \qquad (2.2\text{-}6)$$

The actual dilution volume during release k (V_{kd}) is calculated by the following equation:

$$V_{kd} = 60 \sum_k (D_{fr})t_k \qquad (2.2\text{-}7)$$

where:

60 = Conversion factor, min/hr;

t_k = Duration of release k, hr;

D_{fr} = Dilution flow rate from circulating water pumps during release k, gpm.

The circulating water pump flow rates were given in Section 2.2.2.1 above.

For the case where a batch release is occurring at the same time that a continuous release is occurring, the compliance with 10CFR20 limits may be determined by the following equation:

$$Conc_{ik} = \frac{C_{ikb} V_{kb} + C_{ikc} V_{kc}}{V_{kd}} \qquad (2.2\text{-}8)$$

where:

C_{ikc} = Concentration of radionuclide "i" in continuous releases during release period k, μCi/ml;

V_{kc} = Volume of continuous release during period k, gal.

Calculated concentrations are to be compared to the concentration in Appendix B, Table II, Column 2, of 10CFR20.

2.3 COMPLIANCE WITH 10CFR50

2.3.1 Cumulation of Doses

The dose contribution from the release of liquid effluents will be calculated once per month, and a cumulative summation of these total body and any organ doses should be maintained for each calendar quarter. The dose contribution for all batch releases will be calculated using the following equation:

$$D_{\tau b} = \sum_k \sum_i A_{i\tau} t_{kb} C_{ikb} F_{kb} \qquad (2.3\text{-}1)$$

where:

$D_{\tau b}$ = The cumulative dose commitment to the total body or any organ τ, from batch liquid effluents, mrem;

t_{kb} = The length of time of batch release k over which C_{ikb} and F_{kb} are averaged for each batch liquid release, hours;

C_{ikb} = The average concentration of radionuclide "i" in undiluted batch liquid effluent during batch release k, μCi/ml;

$A_{i\tau}$ = The site-related ingestion dose commitment factor to the total body or any organ τ for each identified principal gamma and beta emitter, mrem-ml per hr-μCi;

F_{kb} = The near-field average dilution factor for C_{ikb} during any batch liquid effluent release k. Defined as the ratio of the volume of undiluted liquid waste released to the product of the dilution volume from the site discharge structure to unrestricted receiving waters times 1.0. (1.0 is the site-specific applicable factor for the mixing effect of the HBR discharge structure as defined in NUREG-0133, October 1978).

$$= \frac{V_{kb}}{V_{kd} \times 1.0}$$

Where V_{kb} and V_{kd} are as defined in Equation 2.2-5.

The dose factor $A_{i\tau}$ was calculated for an adult for each isotope using the following equation:

$$A_{i\tau} = 1.14 \times 10^5 \, (21BF_i) \, DF_{i\tau} \qquad (2.3\text{-}2)$$

where:

$$1.14 \times 10^5 = 10^6 \, \frac{pCi}{\mu Ci} \times 10^3 \, \frac{ml}{l} \times \frac{1 \text{ yr}}{8760 \text{ hr}}$$

21 = Adult fish consumption rate from Table E-5 of Regulatory Guide 1.109, Revision 1, kg/yr;

BF_i = Bioaccumulation factor for radionuclide "i" in fish from Table A-1 of Regulatory Guide 1.109, Revision 1, pCi/kg per pCi/l;

$DF_{i\tau}$ = Dose conversion factor for radionuclide "i" for adults for a particular organ τ from Table E-11 of Regulatory Guide 1.109, Revision 1, mrem/pCi.

The potable water pathway does not exist either within Lake Robinson or downstream of the Lake Robinson dam. Therefore, the potable water term was excluded from the calculation of $A_{i\tau}$ values. Table 2.3-1 presents $A_{i\tau}$ values for an adult at HBR.

As noted in Section 2.2.2, steam generator blowdown is continuously released from HBR. The dose from continuous releases will be calculated using the following equation:

$$D_{\tau c} = \sum_k \sum_i A_{i\tau}\, t_{kc}\, C_{ikc}\, F_{kc} \qquad (2.3\text{-}3)$$

where:

$D_{\tau c}$ = The cumulative dose commitment to the total body or any organ τ, from liquid effluents for continuous releases, mrem;

t_{kc} = The length of time of continuous release period k over which C_{ikc} and F_{kc} are averaged for all continuous liquid releases, hours;

C_{ikc} = The average concentration of radionuclide "i" in undiluted liquid effluent during continuous release period k from any continuous liquid release, μCi/ml;

F_{kc} = The near-field average dilution factor for C_{ikc} during continuous liquid effluent release k. Defined as the ratio of the volume of undiluted liquid waste released to the product of the dilution volume from the site discharge structure to unrestricted receiving water times 1.0. (1.0 is the site-specific applicable factor for the mixing effect of the HBR discharge structure as defined in NUREG-0133, October 1978).

$$F_{kc} = \frac{V_{kc}}{V_{kd} \times 1.0}$$

Where V_{kc} and V_{kd} are, as defined in Equation 2.2-5, only now distinguished for continuous releases.

The sum of the cumulative dose from all batch and continuous releases for a quarter are compared to one half the design objectives for total body and any organ. The sum of the cumulative doses from all batch and continuous releases for a calendar year are compared to the design objective doses. The following relationships should hold for HBR to show compliance with Technical Specification 3.9.2.1 of the technical specifications for H.B. Robinson Unit 2.

For the calendar quarter,

$D_\tau \leq 1.5$ mrem total body (2.3-4)

$D_\tau \leq 5$ mrem any organ (2.3-5)

For the calendar year,

$D_\tau \leq 3$ mrem total body (2.3-6)

$D_\tau \leq 10$ mrem any organ (2.3-7)

where:

D_τ = Cumulative total dose to any organ τ or the total body from continuous and batch releases, mrem;

$$= D_{\tau b} + D_{\tau c}$$

The quarterly limits given above represent one half the annual design objective of Section II.A of Appendix I of 10CFR50. If any of the limits in Expressions 2.3-4 through 2.3-7 are exceeded, a special report pursuant to Technical Specification 6.9.3.2 must be filed with the NRC. This report complies with Section IV.A, of Appendix I of 10CRF50.

2.3.2 Projection of Doses

Doses resulting from the release of liquid effluents will be projected once per 31 days. These projections will include a safety margin, based upon expected operational conditions, which will take into consideration both planned and unplanned releases.

Projected dose will be calculated as follows:

$$PD = \frac{31\ (DA) + (DB)}{(TE)} + M \qquad (2.3\text{-}8)$$

where:

PD = projected doses in mrem.
DA = dose accumulated during current quarter in mrem.
DB = projected dose from this release.
TE = time elapsed in quarter in days.
TA = time in quarter in days.
M = safety margin in mrem.

If the projected doses exceed 0.2 mrem to the whole body or 0.6 mrem to any organ when averaged over a calendar quarter, the liquid radwaste equipment will be operated to reduce the radioactive materials in the liquid effluent.

(Left blank intentionally).

TABLE 2.3-1

$A_{i\tau}$ 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-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

TABLE 2.3-1 (continued)

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
Tc-99M	8.87E-03	2.51E-02	3.19E-01	0.00E-01	3.81E-01	1.23E-02	1.48E+01
Tc-101	9.12E-03	1.31E-02	1.29E-01	0.00E-01	2.37E-01	6.72E-03	3.95E-14
Ru-103	4.43E+00	0.00E-01	1.91E+00	0.00E-01	1.69E+01	0.00E-01	5.17E+02
Ru-105	3.69E-01	0.00E-01	1.46E-01	0.00E-01	4.76E+00	0.00E-01	2.26E+02
Ru-106	6.58E+01	0.00E-01	3.33E+00	0.00E-01	1.27E+02	0.00E-01	4.26E+03
Ag-110M	8.81E-01	8.15E-01	4.84E-01	0.00E-01	1.60E 00	0.00E-01	3.33E 02
Te-125M	2.57E 03	9.30E 02	3.44E 02	7.72E 02	1.04E 04	0.00E-01	1.02E 04
Te-127M	6.48E 03	2.32E 03	7.90E 02	1.66E 03	2.63E 04	0.00E-01	2.17E 04
Te-127	1.05E 02	3.78E+01	2.28E 01	7.80E 01	4.29E 02	0.00E-01	8.31E 03
Te-129M	1.10E 04	4.11E 03	1.74E 03	3.78E 03	4.60E 04	0.00E-01	5.54E 04
Te-129	3.01E 01	1.13E 01	7.33E 00	2.31E 01	1.26E 02	0.00E-01	2.27E 01
Te-131M	1.66E 03	8.10E 02	6.75E 02	1.28E 03	8.21E 03	0.00E-01	8.04E 04
Te-131	1.89E 01	7.88E 00	5.96E 00	1.55E 01	8.26E 01	0.00E-01	2.67E 00
Te-132	2.41E 03	1.56E 03	1.47E 03	1.72E 03	1.50E 04	0.00E-01	7.38E 04
I-130	2.71E 01	8.01E 01	3.16E 01	6.79E 03	1.25E 02	0.00E-01	6.89E 01
I-131	1.49E 02	2.14E 02	1.22E 02	7.00E 04	3.66E 02	0.00E-01	5.64E 01
I-132	7.29E 00	1.95E 01	6.82E 00	6.82E 02	3.11E 01	0.00E-01	3.66E 00
I-133	5.10E 01	8.87E 01	2.70E 01	1.30E 04	1.55E 02	0.00E-01	7.97E 01
I-134	3.81E 00	1.03E 01	3.70E 00	1.79E 02	1.64E 01	0.00E-01	9.01E-03
I-135	1.59E 01	4.17E 01	1.54E 01	2.75E 03	6.68E 01	0.00E-01	4.70E 01
Cs-134	2.98E 05	7.09E 05	5.79E 05	0.00E-01	2.29E 05	7.61E 04	1.24E 04
Cs-136	3.12E 04	1.23E 05	8.86E 04	0.00E-01	6.85E 04	9.38E 03	1.40E 04
Cs-137	3.82E 05	5.22E 05	3.42E 05	0.00E-01	1.77E 05	5.89E 04	1.01E 04
Cs-138	2.64E 02	5.22E 02	2.59E 02	0.00E-01	3.84E 02	3.79E+01	2.23E-03
Ba-139	9.29E-01	6.62E-04	2.72E-02	0.00E-01	6.19E-04	3.75E-04	1.65E 00
Ba-140	1.94E 02	2.44E-01	1.27E 01	0.00E-01	8.30E-02	1.40E-01	4.00E 02
Ba-141	4.51E-01	3.41E-04	1.52E-02	0.00E-01	3.17E-04	1.93E-04	2.13E-10
Ba-142	2.04E-01	2.10E-04	1.28E-02	0.00E-01	1.77E-04	1.19E-04	2.87E-19
La-140	1.50E-01	7.54E-02	1.99E-02	0.00E-01	0.00E-01	0.00E-01	5.54E 03
La-142	7.66E-03	3.48E-03	8.68E-04	0.00E-01	0.00E-01	0.00E-01	2.54E 01
Ce-141	2.24E-02	1.52E-02	1.72E-03	0.00E-01	7.04E-03	0.00E-01	5.79E 01
Ce-143	3.95E-03	2.92E 00	3.23E-04	0.00E-01	1.29E-03	0.00E-01	1.09E 02
Ce-144	1.17E 00	4.88E-01	6.27E-02	0.00E-01	2.90E-01	0.00E-01	3.95E 02
Pr-143	5.51E-01	2.21E-01	2.73E-02	0.00E-01	1.27E-01	0.00E-01	2.41E 03
Pr-144	1.80E-03	7.48E-04	9.16E-05	0.00E-01	4.22E-04	0.00E-01	2.59E-10
Nd-147	3.76E-01	4.35E-01	2.60E-02	0.00E-01	2.54E-01	0.00E-01	2.09E 03
W-187	2.96E 02	2.47E 02	8.65E 01	0.00E-01	0.00E-01	0.00E-01	8.10E 04
Np-239	2.85E-02	2.80E-03	1.54E-03	0.00E-01	8.74E-03	0.00E-01	5.75E 02

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3.0 GASEOUS EFFLUENTS

3.1 MONITOR ALARM SETPOINT DETERMINATION

This methodology determines the monitor alarm setpoint that indicates if the dose rate in the unrestricted areas due to noble gas radionuclides 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.

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 plant is operating below 30 percent power 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 (RMS-15). Steam generator blowdown is continuously monitored by RMS-19 as a liquid pathway.

The following method applies to gaseous releases via the plant vent and condenser vacuum pump vent when determining the high-alarm setpoint for the plant vent gas monitor (RMS-14) and condenser vacuum pump vent gas monitor (RMS-15), and the Fuel Handling Basement Exhaust Monitor (RMS-20), using the GALE code during the following operational conditions:

- Continuous release via the plant vent.
- Continuous release via the condenser vacuum pump vent.

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.

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

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 of all noble gas radionuclides in the gaseous effluent [μCi/sec], based upon the whole body exposure limit of 500 mrem/year by:

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

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

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

= $9.9 \text{ E-}7$ sec/m^3 (Continuous Mixed Mode Release) from Table A-10, Appendix A, only with upper wind speed $\geq$ 9 mph.

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.

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

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

$L_i + 1.1M_i$ = 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 of all noble gas radionuclides in the gaseous effluent [μCi/cc].

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

NOTE: Use the lower 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.

= 0.91 for Plant Vent Gas Monitor (RMS-14).

= 0.01 for the Condenser Vacuum Pump Vent Monitor (RMS-15).

= 0.06 for the Fuel Handling Basement Exhaust Monitor (RMS-20).

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

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

= 60,000 cfm for plant vent.

= 45 cfm for the condenser vacuum pump 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:

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

where:

3.3 $\frac{\overline{Bkg}}{2\tau}$ = Statistical variance on the background (Bkg) counting rate quoted at the 99.95% confidence level at a RC time constant τ (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 release of containment purge.
- Batch release of containment pressure relief.
- Batch release of waste gas decay tanks.
- Plant vent release.
- Condenser vacuum pump vent.
- Fuel handling basement exhaust.
- Environmental and Radiation Control Building Hood Exhaust.

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 Condenser Vacuum Pump Vent, Plant Vent (stack), Fuel Handling Basement Exhaust, and the Environmental & Radiation Control (E&RC) Building Hood Exhaust.

Containment Purge--**

($\mu Ci/cc_i$ from analysis of Containment Vent) (0.0368) +
($\mu Ci/cc_i$ from analysis of Plant Vent) (0.632)

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) (0.0017) +
($\mu Ci/cc_i$ from analysis of Plant Vent) (0.9983)

Waste Gas Decay Tanks during Containment Purge--

($\mu Ci/cc_i$ from analysis of WGDT) (0.0011) +
($\mu Ci/cc_i$ from analysis of Plant Vent) (0.631) +
($\mu Ci/cc_i$ from analysis of C.V.) (0.368)

NOTES:

*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.

**$\mu Ci/cc_i$ from analysis for CV when RMS-12 is lined up on the CV.

0.368 = Dilution correction factor for C.V. Purge = $\frac{35{,}000 \text{ CFM}}{(60{,}000 + 35{,}000) \text{ CFM}}$

0.632 = Dilution correction factor for Plant Vent during C.V. Purge = $\frac{60{,}000 \text{ CFM}}{(60{,}000 + 35{,}000) \text{ CFM}}$

0.040 = Dilution correction factor for C.V. Pressure Relief = $\frac{2500^* \text{ CFM}}{(60{,}000 + 2500^*) \text{ CFM}}$

0.960 = Dilution correction factor for Plant Vent during C.V. Pressure Relief = $\frac{60{,}000 \text{ CFM}}{(60{,}000 + 2500^*) \text{ CFM}}$

0.0017 = Dilution correction factor for Waste Gas Decay Tank = $\frac{100 \text{ CFM}}{(60{,}000 + 100) \text{ CFM}}$

0.9983 = Dilution correction factor for Plant Vent during WGDT Release = $\frac{60{,}000 \text{ CFM}}{(60{,}000 + 100) \text{ CFM}}$

0.0011 = Dilution correction factor for Waste Gas Decay Tank during a Continuous C.V. Purge and Plant Vent Release = $\frac{100 \text{ CFM}}{(60{,}000 + 35{,}000 + 100) \text{ CFM}}$

0.631 = Dilution correction factor for Plant Vent during a Continuous C.V. Purge and Plant Vent Release = $\frac{60{,}000 \text{ CFM}}{(60{,}000 + 35{,}000 + 100) \text{ CFM}}$

0.368 = Dilution correction factor for Continuous C.V. Purge during WGDT Release = $\frac{35{,}000 \text{ CFM}}{(60{,}000 + 35{,}000 + 100) \text{ CFM}}$

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

= 45 CFM for the condenser

= 60,000 CFM for the plant vent

= 10,200 CFM for the fuel handling basement exhaust

= 11,500 CFM for the E&RC building hood exhaust

= 95,000 CFM for the containment vessel purge plus plant vent

= 62,500 CFM for the containment vessel pressure relief

= 60,100 CFM for the waste gas decay tank

= 95,100 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--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.

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

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:

$L_i + 1.1 M_i$ = The total skin dose factor for noble gas emission "i" radionuclide ($mrem/yr/\mu Ci/m^3$) from Table 3.1-2

c. Determine the noble gas emission Projected Dose Rate Ratio (PDRR) for Total Body and Skin.

$$PDRR_{TB} = \frac{DR_{TB}}{500} \quad (3.1\text{-}10)$$

$$PDRR_{SKIN} = \frac{DR_{SKIN}}{3000} \quad (3.1\text{-}11)$$

500 = The allowable total body dose rate due to noble gas gamma emissions in mrem/yr.

3000 = The allowable skin dose rate due to noble gas beta emissions in mrem/yr.

d. Determine the maximum monitor setpoint concentration (μCi/cc) for total body and skin.

$$\text{Maximum Monitor Total Body Setpoint} = \frac{(\Sigma_i Ci)}{(PDRR_{TB})} (SF) (T_m) \quad (3.1\text{-}12)$$

$$\text{Maximum Monitor Skin Setpoint} = \frac{(\Sigma_i Ci)}{(PDRR_{SKIN})} (SF) (T_m) \quad (3.1\text{-}13)$$

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.

= 0.91 for the Plant Vent Gas Monitor (RMS-14).

= 0.01 for the Condenser Vacuum Pump Vent Monitor (RMS-15).

= 0.06 for the Fuel Handling Basement Exhaust Monitor (RMS-20).

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

= 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-14. 0.91 = 0.81 + 0.10 (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) +

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

(Maximum skin setpoint in μCi/cc) (monitor efficiency) + Bkg +

$$3.3\sqrt{\frac{Bkg}{2\tau}} \qquad (3.1\text{-}15)$$

Monitor efficiency= Obtained from the applicable effluent monitor efficiency curve located in the Plant Operating Manual, Volume 15, Curve Book. Use the radioactivity concentration (μCi/cc) to find (CPM).

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 factor is included to prevent inadvertent high/trip alarms due to random counts on the monitor.

f. Determine the actual gaseous monitor setpoint:

The setpoints that were determined based on the dose rate limits to the total body (S_t) and to the skin (S_s) are compared and the lesser value is used as the actual setpoint.

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_i (Ci/yr)	S_i	A_i (Ci/yr)	S_i	A_i (Ci/yr)	S_i	A_i (Ci/yr)	S_i
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 and 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 (RMS-14).

[2]These values are used to determine the monitor alarm setpoint for the Condenser Vacuum Pump Vent Monitor (RMS-15).

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

TABLE 3.1-2

DOSE FACTORS AND CONSTANTS*

Radionuclide	Total Whole Body Dose Factor (K_i) (mrem/yr/μCi/m^3)	Total Skin Dose Factor ($L_i + 1.1\ M_i$) mrem/yr/μCi/m^3)
Kr-83m	7.56E-2	2.12E1
Kr-85m	1.17E3	2.81E3
Kr-85	1.61E1	1.36E3
Kr-87	5.92E3	1.65E4
Kr-88	1.47E4	1.91E4
Kr-89	1.66E4	2.91E4
Kr-90	1.56E4	2.52E4
Xe-131m	9.15E1	6.48E2
Xe-133m	2.51E2	1.35E3
Xe-133	2.94E2	6.94E2
Xe-135m	3.12E3	4.41E3
Xe-135	1.81E3	3.97E3
Xe-137	1.42E3	1.39E4
Xe-138	8.83E3	1.43E4
Xe-139	0.00	0.00
Ar-41	8.84E3	1.29E4

*Regulatory Guide 1.109, October 1977, Table B-1, times (1.0 E6 pCi/μCi).

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.

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

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

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.

= From Table A-10 for mixed mode releases only with upper wind speed of $\geq$ 9 mph.

$(\overline{X/Q})_e$ = Annual average relative dilution for condenser vacuum pump vent 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 condenser vacuum pump vent $\mu Ci/sec$.

$\dot{Q}_{iv}$ = 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.

To select the limiting location, the highest annual average $\overline{X/Q}$ value for the ground level releases and the mixed mode releases was used. Since mixed mode releases may not necessarily decrease with distance (i.e., the site boundary may not have the highest $\overline{X/Q}$ value), long-term annual average ($\overline{X/Q}$) values, calculated at the midpoint of 10 standard distances as given in Appendix A were also considered. For HBR, mixed mode release X/Q values decrease with distance for all directions except the WNW, NW, and NNW so that the maximum site boundary X/Q is usually greater at the site boundary than at distances greater than the site boundary. In addition, the maximum site boundary X/Q for both the ground level and mixed mode releases occurs at the SSE site boundary. Therefore, the limiting location for implementation of 10CFR20 for noble gases is the SSE site boundary.

Values for K_i, L_i, and M_i, which were used in the determination of the limiting location and which are to be used by HBR in Expressions 3.2-1 and 3.2-2 to show compliance with 10CFR20, are presented in Table 3.2-3. These values were taken from Table B-1 of NRC Regulatory Guide 1.109, Revision 1. The values have been multiplied by 1.0 E6 to convert picocuries to microcuries for use in Expressions 3.2-1 and 3.2-2.

3.2.2 Radioiodines, Particulates, and Tritium

The dose rate in an unrestricted area resulting from the release of radioiodines, tritium, and particulates with half-lives $\geq$ 8 days is limited to 1500 mrem/yr to any organ. Based upon NUREG 0133, the following is used to show compliance with 10CFR20.

$$\sum_i P_{i_I} \left[(\overline{X/Q})_v Q_{iv} + (\overline{X/Q})_e Q_{ie} \right] \leq 1500 \text{ mrem/yr} \qquad (3.2\text{-}3)$$

Q_{iv} = Release rate of radionuclide "i" from the plant vent, μCi/sec.

Q_{ic} = Release rate of radionuclide "i" from the condenser vacuum pump vent, 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 condenser vacuum pump 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 $\mu Ci/m^3$. The dose factor is based on the most restrictive group (child) and most restrictive organ (thyroid) at the SITE BOUNDARY (see Table 3.3-18).

where:

In the calculation to show compliance with 10CFR20, only the inhalation is considered. A description of the methodology used in calculating the Pi values is presented in Appendix B. Compliance with 10CFR20 is achieved if the dose rate via inhalation pathway to a child is $\leq$ 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 Comformance 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.

TABLE 3.2-2

DISTANCE TO SPECIAL LOCATIONS FOR THE H.B. ROBINSON PLANT (MILES)

Sector	Site Boundary	Milk Cow	Milk Goat	Meat Animal	Nearest Resident	Nearest Garden
NNE	1.26	-	-	1.65	1.3	1.4
NE	1.01	-	-	1.16	1.2	1.3
ENE	0.86	-	-	2.41	0.9	2.2
E	0.61	4.2	-	3.12	0.8	2.8
ESE	0.50	-	-	1.99	0.6	0.6
SE	0.29	-	-	-	0.3	0.3
SSE	0.26	-	-	-	0.3	0.3
S	0.28	-	-	2.32	0.3	0.4
SSW	0.29	-	-	2.08	0.3	0.5
SW	0.36	-	2.5*	2.27	0.4	0.5
WSW	0.36	-	-	2.69	0.4	0.6
W	0.50	-	-	3.97	0.6	0.6
WNW	0.55	-	-	4.07	0.7	0.9
NW	1.23	-	-	1.60	1.3	1.3
NNW	1.89	-	-	2.84	2.9	3.0
N	1.94	-	-	2.93	2.9	2.9

*Milk is not presently used for human consumption.

TABLE 3.2-3

DOSE FACTORS FOR NOBLE GASES AND DAUGHTERS*

Radionuclide	Total Body Dose Factor K_i (mrem/yr per $\mu Ci/m^3$)	Skin Dose Factor L_i (mrem/yr per $\mu Ci/m^3$)	Gamma Air Dose Factor M_i (mrad/yr per $\mu Ci/m^3$)	Beta Air Dose Factor N_i (mrad/yr per $\mu Ci/m^3$)
Kr-83m	7.56E-02	---	1.93E+01	2.88E+02
Kr-85m	1.17E+03	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03

*The listed dose factors are for radionuclides that may be detected in gaseous effluents.

TABLE 3.2-4

P_i VALUES FOR AN INFANT FOR THE H.B. ROBINSON UNIT NO. 2*

Isotope	Inhalation	Ground Plane	Cow Milk	Goat Milk
H-3	6.47E2	0.00	2.38E3	4.86E3
P-32	2.03E6	0.00	1.60E11	1.93E11
Cr-51	1.28E4	6.67E6	4.79E6	5.65E5
Mn-54	1.00E6	1.09E9	3.89E7	4.68E6
Fe-59	1.02E6	3.92E8	3.93E8	5.11E6
Co-58	7.77E5	5.29E8	6.06E7	7.28E6
Co-60	4.51E6	4.40E9	2.10E8	2.52E7
Zn-65	6.47E5	6.89E8	1.90E10	2.29E9
Rb-86	1.90E5	1.28E7	2.22E10	2.67E9
Sr-89	2.03E6	3.16E4	1.27E10	2.66E10
Sr-90	4.09E7	0.00	1.21E11	2.55E11
Y-91	2.45E6	1.52E6	5.26E6	6.32E5
Zr-95	1.75E6	3.48E8	8.28E5	9.95E4
Nb-95	4.79E5	1.95E8	2.06E8	2.48E7
Ru-103	5.52E5	1.55E8	1.05E5	1.27E4
Ru-106	1.16E7	2.99E8	1.44E6	1.73E5
Ag-110m	3.67E6	3.14E9	1.46E10	1.75E9
Te-127m	1.31E6	1.18E5	1.04E9	1.24E8
Te-129m	1.68E6	2.86E7	1.40E9	1.68E8
Cs-134	7.03E5	2.81E9	6.79E10	2.04E11
Cs-136	1.35E5	2.13E8	5.76E9	1.73E10
Cs-137	6.12E5	1.15E9	6.02E10	1.81E11
Ba-140	1.60E6	2.94E7	2.41E8	2.89E7
Ce-141	5.17E5	1.98E7	1.37E7	1.65E6
Ce-144	9.84E6	5.84E7	1.33E8	1.60E7
I-131	1.48E7	2.46E7	1.06E12	1.27E12
I-132	1.69E5	1.78E6	1.39E2	1.64E2
I-133	3.56E6	3.54E6	9.80E9	1.18E10
I-135	6.96E5	3.67E6	2.27E7	2.68E7

*Units are mrem/yr per $\mu Ci/m^3$ for H-3 and the inhalation pathway and mrem/yr per $\mu Ci/sec$ per m^{-2} for the food and ground plane pathways.

3.3 COMPLIANCE WITH 10CRF50 (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:

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

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

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.

= From Table A-10 for mixed mode releases to be used only with upper wind speeds $\geq$ 9 mph.

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

= 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 condenser vacuum pump 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 ($\leq$ 500 hours/year), μCi;

$\bar{Q}_{ie}$ = The average release of noble gas radionuclide "i" in gaseous releases for long-term condenser vacuum pump vent releases (> 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

average ($\overline{X/Q}$) values will be used. Should the calculated doses exceed 10CFR50 limits, recalculation of doses may be performed using short-term X/Q values for batch releases.

To select the limiting location, the highest annual average $\overline{X/Q}$ value for ground level and mixed mode releases and the highest short-term X/Q value for ground level and mixed mode releases were considered. Since mixed mode releases may increase and then decrease with distance (i.e., the site boundary may not have the highest X/Q value), long-term X/Q values were calculated at the midpoint of 10 standard distances as given in Appendix A. The calculated values decreased with the distance for all but the WNW, NW, and NNW sectors. The values for these sectors were not found to be limiting such that the maximum site boundary X/Q for both long-term and short-term ground level and mixed mode releases occurred at the SSE site boundary. The limiting location for implementation of 10CFR20 for noble gases is the SSE site boundary.

Values for M_i and N_i which are utilized in the calculation of the gamma air and beta air doses in Equation 3.3-1 to show compliance with 10CFR50 were presented in Table 3.2-3. These values originate from NUREG 0472, Revision 0, and were taken from Table B-1 of the NRC Regulatory Guide 1.109, Revision 1. The values have been multiplied by 1.0 E6 to convert from picocuries to microcuries.

The following relationship should hold for HBR to show compliance with HBR's Technical Specification 3.9.4.1.

For the calendar quarter:

$$D_\gamma \leq 5 \text{ mrad} \qquad (3.3\text{-}3)$$

$$D_\beta \leq 10 \text{ mrad} \qquad (3.3\text{-}4)$$

For the calendar year:

$$D_\gamma \leq 10 \text{ mrad} \qquad (3.3\text{-}5)$$

$$D_\beta \leq 20 \text{ mrad} \qquad (3.3\text{-}6)$$

The quarterly limits given above represent one-half of the annual design objectives of Section II.B.1 of Appendix I of 10CFR50. If any of the limits of Equations 3.3-3 through 3.3-6 are exceeded, a special report pursuant to Technical Specification 6.9.4.a must be filed with the NRC. This report complies with Section IV.A of Appendix I of 10CFR50.

3.3.1.2 Projection of Doses

Doses resulting from the release of gaseous effluents will be projected once per 31 days. These projections will include a safety margin based upon expected operational conditions which will take into consideration both planned and unplanned releases.

Projected dose will be calculated as follows:

$$PD = \frac{31\,(DA) + (DB)}{(TE)} + M \qquad (3.3\text{-}7)$$

where:

PD = Projected doses in mrem.

DA = Dose accumulated during current quarter in mrem.

DB = Projected dose from this release.

TE = Time elapsed in quarter in days.

TA = Time in quarter in days.

M = Safety margin in mrem.

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 and Particulates

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 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:

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

$$(R_{i_B} + R_{i_M} + R_{i_V} + R_{i_G}) \left[(\overline{D/Q})_v Q_{iv} + (\overline{D/q})_v q_{iv} + (\overline{D/Q})_e Q_{ie} \right] + \qquad (3.3\text{-}8)$$

$$\left. (R_{T_M} + R_{T_B} + R_{T_I} + R_{T_V}) \left[(\overline{X/Q})_v Q_{TV} + (\overline{X/q})_v q_{TV} + (\overline{X/Q})_e Q_{Te} \right] \right]$$

where:

D_τ = Dose to any organ τ from radioiodines and particulates, mrem.

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

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

= From Table A-1 for ground level releases.

= From Table A-10 for mixed mode releases only to be used with wind speeds > 9 mph.

$(\overline{X/Q})_e$ = Annual average dilution for condenser vacuum pump vent releases (> 500 hours/yr) sec/m^3.

= From Table A-1 for ground level 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.

= From Table A-12 for mixed mode releases only to be used with upper wind speeds > 9 mph.

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

= From Table A-9 for ground level releases.

= From Table A-18 for mixed mode releases only to be used with upper wind speeds > 9 mph.

$(D/Q)_e$ = Annual average relative deposition factor for condenser vacuum pump vent releases (> 500 hrs/ yr), m^{-2}.

= From Table A-3 for ground level releases.

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

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

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

R_{T_B} = Dose factor for an organ for tritium for the meat pathway, mrem/yr/μCi/m^3.

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

Q_{Te} = Release of tritium in gaseous effluents for long-term condenser vacuum pump releases (> 500 hrs/ yr), μCi.

q_{TV} = Release of tritium in gaseous effluents for short-term plant vent releases (≤ 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

milk, beef and vegetable ingestion, and inhalation and ground plane exposure. An infant was assumed to be present at all milk pathway locations. A child was assumed to be present at all vegetable garden and beef animal locations. The ground plane exposure pathway was not considered a viable pathway for an infant. Naturally, the inhalation pathway was present everywhere an individual was present. HBR Technical Specification 4.20.2.1 requires that a land-use census survey be conducted on an annual basis. The age groupings at the various receptor locations are also determined during this survey; a new limiting location and receptor age group can result.

For the determination of the limiting location, the highest D/Q values for the vegetable garden, cow milk, and goat milk pathways were selected. The thyroid dose was calculated at each of these locations using the radionuclide mix and releases of Table 3.2-1. Based upon these calculations, it was determined that the limiting receptor pathway is the vegetable/child pathway.

In the determination of the limiting location, annual average D/Q and X/Q values are used. A description of the derivation of the various X/Q and D/Q values is presented in Appendix A.

Short-term and long-term X/Q and D/Q values for ground level releases and for long-term mixed mode releases are provided in tables in Appendix A. They may be utilized if an additional special location arises different from those presented in the special locations of Table 3.2-2.

Tables 3.3-1 through 3.3-19 present R_i values for the total body, GI-tract, bone, liver , kidney, thyroid, and lung organs for the ground plane, inhalation, cow milk, goat milk, vegetable, and meat ingestion pathways for the infant, child, teen, and adult age groups as appropriate to the pathways. These values were calculated using the methodology described in NUREG 0133 using a grazing period of eight months. A description of the methodology is presented in Appendix B.

The following relationship should hold for HBR to show compliance with HBR Technical Specification 3.9.5.1.

For the calendar quarter:

$$D_\tau \leq 7.5 \text{ mrem} \qquad (3.3\text{-}9)$$

For the calendar year:

$$D_\tau \leq 15 \text{ mrem} \qquad (3.3\text{-}10)$$

The quarterly limits given above represent one-half the annual design objectives of Section II.C of Appendix I of 10CFR50. If any of the limits of Equations 3.3-9 or 3.3-10 are exceeded, a special report pursuant to Technical Specification 6.9.4.a must be filed with the NRC. This report complies with Section IV.A of Appendix I of 10CFR50.

3.3.2.2 Projection of Doses

Doses resulting from release of radioiodines and particulate effluents will be projected once per 31 days. These projections will include a safety margin based upon expected operational conditions which will take into consideration both planned and unplanned releases.

Projected dose will be calculated as follows:

$$PD = \frac{31\,(DA) + (DB)}{(TE)} + M \qquad (3.3\text{-}11)$$

where:

PD = Projected doses in mrem.

DA = Dose accumulated during current quarter in mrem.

DB = Projected dose from this release.

TE = Time elapsed in quarter in days.

TA = Time in quarter in days.

M = Safety margin in mrem.

If the projected doses exceed 1.0 mrem to any organ when averaged over a calendar quarter, the ventilation exhaust treatment system will be operated to reduce releases of radioactive materials.

TABLE 3.3-1

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Ground

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Cr-51	4.66E 06	4.66E 06	4.66E 06	4.66E 06	4.66E 06	4.66E 06	4.66E 06	5.51E 06
Mn-54	1.34E 09	1.34E 09	1.34E 09	1.34E 09	1.34E 09	1.34E 09	1.34E 09	1.57E 09
Fe-59	2.75E 08	2.75E 08	2.75E 08	2.75E 08	2.75E 08	2.75E 08	2.75E 08	3.23E 08
Co-58	3.79E 08	3.79E 08	3.79E 08	3.79E 08	3.79E 08	3.79E 08	3.79E 08	4.44E 09
Co-60	2.15E 10	2.15E 10	2.15E 10	2.15E 10	2.15E 10	2.15E 10	2.15E 10	2.52E 10
Zn-65	7.49E 08	7.49E 08	7.49E 08	7.49E 08	7.49E 08	7.49E 08	7.49E 08	8.61E 08
Rb-86	8.99E 06	8.99E 06	8.99E 06	8.99E 06	8.99E 06	8.99E 06	8.99E 06	1.03E 07
Sr-89	2.23E 04	2.23E 04	2.23E 04	2.23E 04	2.23E 04	2.23E 04	2.23E 04	2.58E 04
Y-91	1.08E 06	1.08E 06	1.08E 06	1.08E 06	1.08E 06	1.08E 06	1.08E 06	1.22E 06
Zr-95	2.49E 08	2.49E 08	2.49E 08	2.49E 08	2.49E 08	2.49E 08	2.49E 08	2.89E 08
Nb-95	1.36E 08	1.36E 08	1.36E 08	1.36E 08	1.36E 08	1.36E 08	1.36E 08	1.60E 08
Ru-103	1.09E 08	1.09E 08	1.09E 08	1.09E 08	1.09E 08	1.09E 08	1.09E 08	1.27E 08
Ru-106	4.19E 08	4.19E 08	4.19E 08	4.19E 08	4.19E 08	4.19E 08	4.19E 08	5.03E 08
Ag-110M	3.48E 09	3.48E 09	3.48E 09	3.48E 09	3.48E 09	3.48E 09	3.48E 09	4.06E 09
Te-127M	9.15E 04	9.15E 04	9.15E 04	9.15E 04	9.15E 04	9.15E 04	9.15E 04	1.08E 05
Te-129M	2.00E 07	2.00E 07	2.00E 07	2.00E 07	2.00E 07	2.00E 07	2.00E 07	2.34E 07
I-131	1.72E 07	1.72E 07	1.72E 07	1.72E 07	1.72E 07	1.72E 07	1.72E 07	2.09E 07
I-132	1.24E 06	1.24E 06	1.24E 06	1.24E 06	1.24E 06	1.24E 06	1.24E 06	1.46E 06
I-133	2.47E 06	2.47E 06	2.47E 06	2.47E 06	2.47E 06	2.47E 06	2.47E 06	3.00E 06
I-135	2.56E 06	2.56E 06	2.56E 06	2.56E 06	2.56E 06	2.56E 06	2.56E 06	2.99E 06
Cs-134	6.82E 09	6.82E 09	6.82E 09	6.82E 09	6.82E 09	6.82E 09	6.82E 09	7.96E 09
Cs-136	1.49E 08	1.49E 08	1.49E 08	1.49E 08	1.49E 08	1.49E 08	1.49E 08	1.69E 08
Cs-137	1.03E 10	1.03E 10	1.03E 10	1.03E 10	1.03E 10	1.03E 10	1.03E 10	1.20E 10
Ba-140	2.05E 07	2.05E 07	2.05E 07	2.05E 07	2.05E 07	2.05E 07	2.05E 07	2.34E 07
Ce-141	1.36E 07	1.36E 07	1.36E 07	1.36E 07	1.36E 07	1.36E 07	1.36E 07	1.53E 07
Ce-144	6.95E 07	6.95E 07	6.95E 07	6.95E 07	6.95E 07	6.95E 07	6.95E 07	8.03E 07

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-2

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Veget

AGE GROUP = Adult

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	2.28E 03	2.28E 03	0.00E 01	2.28E 03	2.28E 03	2.28E 03	2.28E 03	2.28E 03
P-32	5.91E 07	1.72E 08	1.53E 09	9.51E 07	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Cr-51	4.60E 04	1.16E 07	0.00E 01	0.00E 01	1.01E 04	2.75E 04	6.10E 04	0.00E 01
Mn-54	5.83E 07	9.36E 08	0.00E 01	3.05E 08	9.09E 07	0.00E 01	0.00E 01	0.00E 01
Fe-59	1.12E 08	9.75E 08	1.24E 08	2.93E 08	0.00E 01	0.00E 01	8.17E 07	0.00E 01
Co-58	6.71E 07	6.07E 08	0.00E 01	2.99E 07	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Co-60	3.67E 08	3.12E 09	0.00E 01	1.66E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Zn-65	5.77E 08	8.04E 08	4.01E 08	1.28E 09	8.54E 08	0.00E 01	0.00E 01	0.00E 01
Rb-86	1.03E 08	4.36E 07	0.00E 01	2.21E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Sr-89	2.87E 08	1.60E 09	1.00E 10	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Sr-90	1.64E 11	1.93E 10	6.70E 11	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Y-91	1.34E 05	2.76E 09	5.01E 06	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Zr-95	2.51E 05	1.17E 09	1.16E 06	3.71E 05	5.82E 05	0.00E 01	0.00E 01	0.00E 01
Nb-95	4.19E 04	4.73E 08	1.40E 05	7.79E 04	7.70E 04	0.00E 01	0.00E 01	0.00E 01
Ru-103	2.04E 06	5.53E 08	4.74E 06	0.00E 01	1.81E 07	0.00E 01	0.00E 01	0.00E 01
Ru-106	2.46E 07	1.26E 10	1.94E 08	0.00E 01	3.75E 08	0.00E 01	0.00E 01	0.00E 01
Ag-110M	6.23E 06	4.28E 09	1.13E 07	1.05E 07	2.06E 07	0.00E 01	0.00E 01	0.00E 01
Te-127M	6.12E 07	1.68E 09	5.02E 08	1.80E 08	2.04E 09	1.28E 08	0.00E 01	0.00E 01
Te-129M	4.71E 07	1.50E 09	2.98E 08	1.11E 08	1.24E 09	1.02E 08	0.00E 01	0.00E 01
I-131	6.61E 07	3.04E 07	8.07E 07	1.15E 08	1.98E 08	3.78E 10	0.00E 01	0.00E 01
I-132	5.21E 01	2.80E 01	5.57E 01	1.49E 02	2.37E 02	5.21E 03	0.00E 01	0.00E 01
I-133	1.12E 06	3.30E 06	2.11E 06	3.67E 06	6.40E 06	5.39E 08	0.00E 01	0.00E 01
I-135	3.91E 04	1.20E 05	4.05E 04	1.06E 05	1.70E 05	7.00E 06	0.00E 01	0.00E 01
Cs-134	8.83E 09	1.89E 08	4.54E 09	1.08E 10	3.49E 09	0.00E 01	1.16E 09	0.00E 01
Cs-136	1.19E 08	1.88E 07	4.19E 07	1.66E 08	9.21E 07	0.00E 01	1.26E 07	0.00E 01
Cs-137	5.94E 09	1.76E 08	6.63E 09	9.07E 09	3.08E 09	0.00E 01	1.02E 09	0.00E 01
Ba-140	8.40E 06	2.64E 08	1.28E 08	1.61E 05	5.47E 04	0.00E 01	9.22E 04	0.00E 01
Ce-141	1.48E 04	4.99E 08	1.93E 05	1.31E 05	6.07E 04	0.00E 01	0.00E 01	0.00E 01
Ce-144	1.69E 06	1.06E 10	3.15E 07	1.32E 07	7.80E 06	0.00E 01	0.00E 01	0.00E 01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-3

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Veget

AGE GROUP = Teen

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	2.61E 03	2.61E 03	0.00E 01	2.61E 03	2.61E 03	2.61E 03	2.61E 03	2.61E 03
P-32	6.80E 07	1.47E 08	1.75E 09	1.09E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Cr-51	6.11E 04	1.03E 07	0.00E 01	0.00E 01	1.34E 04	3.39E 04	8.72E 04	0.00E 01
Mn-54	8.79E 07	9.09E 08	0.00E 01	4.43E 08	1.32E 08	0.00E 01	0.00E 01	0.00E 01
Fe-59	1.60E 08	9.78E 08	1.77E 08	4.14E 08	0.00E 01	0.00E 01	1.30E 08	0.00E 01
Co-58	9.79E 07	5.85E 08	0.00E 01	4.25E 07	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Co-60	5.57E 08	3.22E 09	0.00E 01	2.47E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Zn-65	8.68E 08	7.88E 08	5.36E 08	1.86E 09	1.19E 09	0.00E 01	0.00E 01	0.00E 01
Rb-86	1.30E 08	4.09E 07	0.00E 01	2.76E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Sr-89	4.36E 08	1.81E 09	1.52E 10	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Sr-90	2.05E 11	2.33E 10	8.32E 11	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Y-91	2.06E 05	3.15E 09	7.68E 06	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Zr-95	3.68E 05	1.23E 09	1.69E 06	5.35E 05	7.86E 05	0.00E 01	0.00E 01	0.00E 01
Nb-95	5.77E 04	4.48E 08	1.89E 05	1.05E 05	1.02E 05	0.00E 01	0.00E 01	0.00E 01
Ru-103	2.90E 06	5.66E 08	6.78E 06	0.00E 01	2.39E 07	0.00E 01	0.00E 01	0.00E 01
Ru-106	3.93E 07	1.50E 10	3.12E 08	0.00E 01	6.02E 08	0.00E 01	0.00E 01	0.00E 01
Ag-110M	9.39E 06	4.34E 09	1.63E 07	1.54E 07	2.95E 07	0.00E 01	0.00E 01	0.00E 01
Te-127M	9.44E 07	1.98E 09	7.93E 08	2.81E 08	3.22E 09	1.89E 08	0.00E 01	0.00E 01
Te-129M	6.79E 07	1.61E 09	4.29E 08	1.59E 08	1.79E 08	1.38E 08	0.00E 01	0.00E 01
I-131	5.77E 07	2.13E 07	7.68E 07	1.07E 08	1.85E 08	3.14E 10	0.00E 01	0.00E 01
I-132	4.72E 01	5.72E 01	5.02E 01	1.31E 02	2.07E 02	4.43E 03	0.00E 01	0.00E 01
I-133	1.01E 06	2.51E 06	1.96E 06	3.32E 06	5.83E 06	4.64E 08	0.00E 01	0.00E 01
I-135	3.49E 04	1.04E 05	3.66E 04	9.42E 04	1.49E 05	6.06E 06	0.00E 01	0.00E 01
Cs-134	7.54E 09	2.02E 08	6.90E 09	1.62E 10	5.16E 09	0.00E 01	1.97E 09	0.00E 01
Cs-136	1.13E 08	1.35E 07	4.28E 07	1.68E 08	9.16E 07	0.00E 01	1.44E 07	0.00E 01
Cs-137	4.90E 09	2.00E 08	1.06E 10	1.41E 10	4.78E 09	0.00E 01	1.86E 09	0.00E 01
Ba-140	8.88E 06	2.12E 08	1.38E 08	1.69E 05	5.72E 04	0.00E 01	1.14E 05	0.00E 01
Ce-141	2.12E 04	5.29E 08	2.77E 05	1.85E 05	8.70E 04	0.00E 01	0.00E 01	0.00E 01
Ce-144	2.71E 06	1.27E 10	5.04E 07	2.09E 07	1.25E 07	0.00E 01	0.00E 01	0.00E 01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-4

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Veget

AGE GROUP = Child

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	4.04E 03	4.04E 03	0.00E 01	4.04E 03	4.04E 03	4.04E 03	4.04E 03	4.04E 03
P-32	1.42E 08	1.01E 08	3.67E 09	1.72E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Cr-51	1.16E 05	6.15E 06	0.00E 01	0.00E 01	1.76E 04	6.44E 04	1.18E 05	0.00E 01
Mn-54	1.73E 08	5.44E 08	0.00E 01	6.49E 08	1.82E 08	0.00E 01	0.00E 01	0.00E 01
Fe-59	3.17E 08	6.62E 08	3.93E 08	6.36E 08	0.00E 01	0.00E 01	1.84E 08	0.00E 01
Co-58	1.92E 08	3.66E 08	0.00E 01	6.27E 07	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Co-60	1.11E 09	2.08E 09	0.00E 01	3.76E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Zn-65	1.70E 09	4.81E 08	1.03E 09	2.74E 09	1.73E 09	0.00E 01	0.00E 01	0.00E 01
Rb-86	2.81E 08	2.94E 07	0.00E 01	4.56E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Sr-89	1.03E 09	1.40E 09	3.62E 10	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Sr-90	3.49E 11	1.86E 10	1.38E 12	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Y-91	4.89E 05	2.44E 09	1.83E 07	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Zr-95	7.44E 05	8.71E 08	3.80E 06	8.35E 05	1.20E 06	0.00E 01	0.00E 01	0.00E 01
Nb-95	1.12E 05	2.91E 08	4.04E 05	1.57E 05	1.48E 05	0.00E 01	0.00E 01	0.00E 01
Ru-103	5.86E 06	3.94E 08	1.52E 07	0.00E 01	3.84E 07	0.00E 01	0.00E 01	0.00E 01
Ru-106	9.38E 07	1.17E 10	7.52E 08	0.00E 01	1.02E 09	0.00E 01	0.00E 01	0.00E 01
Ag-110M	1.87E 07	2.78E 09	3.46E 07	2.34E 07	4.35E 07	0.00E 01	0.00E 01	0.00E 01
Te-127M	2.26E 08	1.54E 09	1.90E 09	5.12E 08	5.42E 09	4.55E 08	0.00E 01	0.00E 01
Te-129M	1.55E 08	1.22E 09	9.98E 08	2.79E 08	2.93E 09	3.22E 08	0.00E 01	0.00E 01
I-131	8.16E 07	1.23E 07	1.43E 08	1.44E 08	2.36E 08	4.75E 10	0.00E 01	0.00E 01
I-132	7.53E 01	1.93E 02	8.91E 01	1.64E 02	2.51E 02	7.60E 03	0.00E 01	0.00E 01
I-133	1.67E 06	1.78E 06	3.57E 06	4.42E 06	7.36E 06	8.21E 08	0.00E 01	0.00E 01
I-135	5.54E 04	8.92E 04	6.50E 04	1.17E 05	1.79E 05	1.04E 07	0.00E 01	0.00E 01
Cs-134	5.40E 09	1.38E 08	1.56E 10	2.56E 10	7.93E 09	0.00E 01	2.84E 09	0.00E 01
Cs-136	1.43E 08	7.77E 06	8.04E 07	2.21E 08	1.18E 08	0.00E 01	1.76E 07	0.00E 01
Cs-137	3.52E 09	1.50E 08	2.49E 10	2.39E 10	7.78E 09	0.00E 01	2.80E 09	0.00E 01
Ba-140	1.61E 07	1.40E 08	2.76E 08	2.42E 05	7.87E 04	0.00E 01	1.44E 05	0.00E 01
Ce-141	4.75E 04	3.99E 08	6.42E 05	3.20E 05	1.40E 05	0.00E 01	0.00E 01	0.00E 01
Ce-144	6.49E 06	9.94E 09	1.22E 08	3.81E 07	2.11E 07	0.00E 01	0.00E 01	0.00E 01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-5

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Meat

AGE GROUP = Adult

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	3.27E 02	3.27E 02	0.00E 01	3.27E 02	3.27E 02	3.27E 02	3.27E 02	3.27E 02
P-32	1.18E 08	3.43E 08	3.05E 09	1.89E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Cr-51	4.27E 03	1.08E 06	0.00E 01	0.00E 01	9.42E 02	2.56E 03	5.67E 03	0.00E 01
Mn-54	1.06E 06	1.71E 07	0.00E 01	5.57E 06	1.66E 06	0.00E 01	0.00E 01	0.00E 01
Fe-59	1.43E 08	1.25E 09	1.59E 08	3.74E 08	0.00E 01	0.00E 01	1.04E 08	0.00E 01
Co-58	2.43E 07	2.20E 08	0.00E 01	1.08E 07	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Co-60	1.03E 08	8.76E 08	0.00E 01	4.66E 07	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Zn-65	3.58E 08	4.98E 08	2.49E 08	7.91E 08	5.29E 08	0.00E 01	0.00E 01	0.00E 01
Rb-86	1.42E 08	6.00E 07	0.00E 01	3.04E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Sr-89	5.23E 06	2.92E 07	1.82E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Sr-90	2.02E 09	2.38E 08	8.22E 09	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Y-91	1.80E 04	3.71E 08	6.75E 05	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Zr-95	2.43E 05	1.14E 09	1.12E 06	3.59E 05	5.64E 05	0.00E 01	0.00E 01	0.00E 01
Nb-95	4.12E 05	4.65E 09	1.38E 06	7.66E 05	7.58E 05	0.00E 01	0.00E 01	0.00E 01
Rr-103	2.72E 07	7.38E 09	6.32E 07	0.00E 01	2.41E 08	0.00E 01	0.00E 01	0.00E 01
Ru-106	2.19E 08	1.12E 11	1.73E 09	0.00E 01	3.35E 09	0.00E 01	0.00E 01	0.00E 01
Ag-110M	2.34E 06	1.61E 09	4.27E 06	3.95E 06	7.76E 06	0.00E 01	0.00E 01	0.00E 01
Te-127M	1.00E 08	2.76E 09	8.22E 08	2.94E 08	3.34E 09	2.10E 08	0.00E 01	0.00E 01
Te-129M	1.17E 08	3.73E 09	7.40E 08	2.76E 08	3.09E 09	2.54E 08	0.00E 01	0.00E 01
I-131	5.77E 06	2.66E 06	7.04E 06	1.01E 07	1.73E 07	3.30E 09	0.00E 01	0.00E 01
I-133	1.51E-01	4.46E-01	2.85E-01	4.96E-01	8.66E-01	7.29E 01	0.00E 01	0.00E 01
I-135	6.07E-17	1.86E-16	6.28E-17	1.64E-16	2.64E-16	1.08E-14	0.00E 01	0.00E 01
Cs-134	7.81E 08	1.67E 07	4.01E 08	9.55E 08	3.09E 08	0.00E 01	1.03E 08	0.00E 01
Cs-136	2.14E 07	3.33E 06	7.53E 06	2.97E 07	1.65E 07	0.00E 01	2.27E 06	0.00E 01
Cs-137	4.99E 08	1.47E 07	5.57E 08	7.61E 08	2.58E 08	0.00E 01	8.59E 07	0.00E 01
Ba-140	1.20E 06	3.77E 07	1.83E 07	2.30E 04	7.82E 03	0.00E 01	1.32E 04	0.00E 01
Ce-141	6.46E 02	2.18E 07	8.42E 03	5.69E 03	2.65E 03	0.00E 01	0.00E 01	0.00E 01
Ce-144	4.70E 04	2.96E 08	8.75E 05	3.66E 05	2.17E 05	0.00E 01	0.00E 01	0.00E 01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-6

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Meat

AGE GROUP = Teen

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.95E 02	1.95E 02	0.00E 01	1.95E 02	1.95E 02	1.95E 02	1.95E 02	1.95E 02
P-32	9.98E 07	2.16E 08	2.58E 09	1.60E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Cr-51	3.42E 03	5.75E 05	0.00E 01	0.00E 01	7.49E 02	1.90E 03	4.88E 03	0.00E 01
Mn-54	8.43E 05	8.72E 06	0.00E 01	4.25E 06	1.27E 06	0.00E 01	0.00E 01	0.00E 01
Fe-59	1.15E 08	7.02E 08	1.27E 08	2.97E 08	0.00E 01	0.00E 01	9.36E 07	0.00E 01
Co-58	1.93E 07	1.15E 08	0.00E 01	8.36E 06	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Co-60	8.15E 07	4.71E 08	0.00E 01	3.62E 07	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Zn-65	2.83E 08	2.57E 08	1.75E 08	6.07E 08	3.89E 08	0.00E 01	0.00E 01	0.00E 01
Rb-86	1.19E 08	3.76E 07	0.00E 01	2.54E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Sr-89	4.40E 06	1.83E 07	1.54E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Sr-90	1.31E 09	1.49E 08	5.32E 09	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Y-91	1.52E 04	2.33E 08	5.68E 05	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Zr-95	1.95E 05	6.53E 08	8.97E 05	2.83E 05	4.16E 05	0.00E 01	0.00E 01	0.00E 01
Nb-95	3.29E 05	2.55E 09	1.08E 06	5.97E 05	5.79E 05	0.00E 01	0.00E 01	0.00E 01
Ru-103	2.20E 07	4.30E 09	5.15E 07	0.00E 01	1.82E 08	0.00E 01	0.00E 01	0.00E 01
Ru-106	1.84E 08	7.00E 10	1.46E 09	0.00E 01	2.81E 09	0.00E 01	0.00E 01	0.00E 01
Ag-110M	1.86E 06	8.59E 08	3.23E 06	3.06E 06	5.83E 06	0.00E 01	0.00E 01	0.00E 01
Te-127M	8.25E 07	1.73E 09	6.94E 08	2.46E 08	2.81E 09	1.65E 08	0.00E 01	0.00E 01
Te-129M	9.81E 07	2.33E 09	6.20E 08	2.30E 08	2.59E 09	2.00E 08	0.00E 01	0.00E 01
I-131	4.40E 06	1.62E 06	5.85E 06	8.20E 06	1.41E 07	2.39E 09	0.00E 01	0.00E 01
I-133	1.23E-01	3.06E-01	2.39E-01	4.05E-01	7.10E-01	5.65E 01	0.00E 01	0.00E 01
I-135	4.88E-17	1.46E-16	5.11E-17	1.32E-16	2.08E-16	8.46E-15	0.00E 01	0.00E 01
Cs-134	3.48E 08	9.34E 06	3.19E 08	7.51E 08	2.39E 08	0.00E 01	9.11E 07	0.00E 01
Cs-136	1.55E 07	1.86E 06	5.87E 06	2.31E 07	1.26E 07	0.00E 01	1.98E 06	0.00E 01
Cs-137	2.14E 08	8.75E 06	4.62E 08	6.15E 08	2.09E 08	0.00E 01	8.13E 07	0.00E 01
Ba-140	9.76E 05	2.34E 07	1.51E 07	1.86E 04	6.29E 03	0.00E 01	1.25E 04	0.00E 01
Ce-141	5.42E 02	1.35E 07	7.07E 03	4.72E 03	2.22E 03	0.00E 01	0.00E 01	0.00E 01
Ce-144	3.96E 04	1.85E 08	7.37E 05	3.05E 05	1.82E 05	0.00E 01	0.00E 01	0.00E 01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-7

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Meat

AGE GROUP = Child

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	2.36E 02	2.36E 02	0.00E 01	2.36E 02	2.36E 02	2.36E 02	2.36E 02	2.36E 02
P-32	1.87E 08	1.34E 08	4.86E 09	2.27E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Cr-51	5.33E 03	2.83E 05	0.00E 01	0.00E 01	8.09E 02	2.96E 03	5.40E 03	0.00E 01
Mn-54	1.30E 06	4.08E 06	0.00E 01	4.86E 06	1.36E 06	0.00E 01	0.00E 01	0.00E 01
Fe-59	1.82E 08	3.80E 08	2.25E 08	3.65E 08	0.00E 01	0.00E 01	1.06E 08	0.00E 01
Co-58	2.99E 07	5.70E 07	0.00E 01	9.76E 06	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Co-60	1.27E 08	2.38E 08	0.00E 01	4.30E 07	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Zn-65	4.35E 08	1.23E 08	2.62E 08	6.99E 08	4.40E 08	0.00E 01	0.00E 01	0.00E 01
Rb-86	2.21E 08	2.32E 07	0.00E 01	3.60E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Sr-89	8.31E 06	1.13E 07	2.91E 08	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Sr-90	1.74E 09	9.26E 07	6.87E 09	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Y-91	2.87E 04	1.43E 08	1.07E 06	0.00E 01	0.00E 01	0.00E 01	0.00E 01	0.00E 01
Zr-95	3.12E 05	3.65E 08	1.59E 06	3.50E 05	5.01E 05	0.00E 01	0.00E 01	0.00E 01
Nb-95	5.17E 05	1.34E 09	1.86E 06	7.23E 05	6.80E 05	0.00E 01	0.00E 01	0.00E 01
Ru-103	3.58E 07	2.41E 09	9.31E 07	0.00E 01	2.34E 08	0.00E 01	0.00E 01	0.00E 01
Ru-106	3.43E 08	4.27E 10	2.75E 09	0.00E 01	3.71E 09	0.00E 01	0.00E 01	0.00E 01
Ag-110M	2.89E 06	4.30E 08	5.36E 06	3.62E 06	6.74E 06	0.00E 01	0.00E 01	0.00E 01
Te-127M	1.55E 08	1.06E 09	1.31E 09	3.52E 08	3.73E 09	3.13E 08	0.00E 01	0.00E 01
Te-129M	1.81E 08	1.42E 09	1.17E 09	3.26E 08	3.43E 09	3.77E 08	0.00E 01	0.00E 01
I-131	6.20E 06	9.72E 05	1.09E 07	1.09E 07	1.79E 07	3.61E 09	0.00E 01	0.00E 01
I-133	2.07E-01	2.21E-01	4.43E-01	5.48E-01	9.13E-01	1.02E 02	0.00E 01	0.00E 01
I-135	7.87E-17	1.27E-16	9.25E-17	1.66E-16	2.55E-16	1.47E-14	0.00E 01	0.00E 01
Cs-134	1.95E 08	4.93E 06	5.63E 08	9.23E 08	2.86E 08	0.00E 01	1.03E 08	0.00E 01
Cs-136	1.80E 07	9.78E 05	1.01E 07	2.78E 07	1.48E 07	0.00E 01	2.21E 06	0.00E 01
Cs-137	1.20E 08	5.10E 06	8.51E 08	8.15E 08	2.65E 08	0.00E 01	9.55E 07	0.00E 01
Ba-140	1.63E 06	1.42E 07	2.80E 07	2.45E 04	7.97E 03	0.00E 01	1.46E 04	0.00E 01
Ce-141	9.86E 02	8.28E 06	1.33E 04	6.64E 03	2.91E 03	0.00E 01	0.00E 01	0.00E 01
Ce-144	7.42E 04	1.14E 08	1.39E 06	4.36E 05	2.41E 05	0.00E 01	0.00E 01	0.00E 01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-8

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Cow Milk

AGE GROUP = Adult

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	7.69E 02	7.69E 02	0.00E-01	7.69E 02	7.69E 02	7.69E 02	7.69E 02	7.69E 02
P-32	4.32E 08	1.26E 09	1.12E 10	6.95E 08	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Cr-51	1.73E 04	4.36E 06	0.00E-01	0.00E-01	3.82E 03	1.04E 04	2.30E 04	0.00E-01
Mn-54	9.76E 05	1.57E 07	0.00E-01	5.11E 06	1.52E 06	0.00E-01	0.00E-01	0.00E-01
Fe-59	1.60E 07	1.39E 08	1.77E 07	4.17E 07	0.00E-01	0.00E-01	1.17E 07	0.00E-01
Co-58	6.28E 06	5.68E 07	0.00E-01	2.80E 06	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Co-60	2.24E 07	1.91E 08	0.00E-01	1.02E 07	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zn-65	1.38E 09	1.92E 09	9.59E 08	3.05E 09	2.04E 09	0.00E-01	0.00E-01	0.00E-01
Rb-86	7.54E 08	3.19E 08	0.00E-01	1.62E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-89	2.50E 07	1.40E 08	8.70E 08	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-90	7.59E 09	8.94E 08	3.09E 10	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Y-91	1.37E 02	2.81E 06	5.11E 03	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zr-95	1.22E 02	5.71E 05	5.62E 02	1.80E 02	2.83E 02	0.00E-01	0.00E-01	0.00E-01
Nb-95	1.48E 04	1.67E 08	4.95E 04	2.75E 04	2.72E 04	0.00E-01	0.00E-01	0.00E-01
Ru-103	2.63E 02	7.14E 04	6.11E-02	0.00E-01	2.33E 03	0.00E-01	0.00E-01	0.00E-01
Ru-106	1.60E 03	8.17E 05	1.26E 04	0.00E-01	2.44E 04	0.00E-01	0.00E-01	0.00E-01
Ag-110M	2.04E 07	1.40E 10	3.71E 07	3.44E 07	6.76E 07	0.00E-01	0.00E-01	0.00E-01
Te-127M	4.11E 06	1.13E 08	3.37E 07	1.21E 07	1.37E 08	8.62E 06	0.00E-01	0.00E-01
Te-129M	6.19E 06	1.97E 08	3.91E 07	1.46E 07	1.63E 08	1.34E 07	0.00E-01	0.00E-01
I-131	1.59E 08	7.32E 07	1.94E 08	2.77E 08	4.76E 08	9.09E 10	0.00E-01	0.00E-01
I-132	1.03E-01	5.51E-02	1.10E-01	2.93E-01	4.67E-01	1.03E 01	0.00E-01	0.00E-01
I-133	1.40E 06	4.13E 06	2.64E 06	4.59E 06	8.01E 06	6.75E 08	0.00E-01	0.00E-01
I-135	9.03E 03	2.76E 04	9.34E 03	2.45E 04	3.92E 04	1.61E 06	0.00E-01	0.00E-01
Cs-134	6.71E 09	1.44E 08	3.45E 09	3.21E 09	2.66E 09	0.00E-01	8.82E 08	0.00E-01
Cs-136	4.73E 08	7.46E 07	1.66E 08	6.57E 08	3.65E 08	0.00E-01	5.01E 07	0.00E-01
Cs-137	4.22E 09	1.25E 08	4.71E 09	6.44E 09	2.19E 09	0.00E-01	7.27E 08	0.00E-01
Ba-140	1.12E 06	3.53E 07	1.71E 07	2.15E 04	7.32E 03	0.00E-01	1.23E 04	0.00E-01
Ce-141	2.23E 02	7.52E 06	2.91E 03	1.97E 03	9.14E 02	0.00E-01	0.00E-01	0.00E-01
Ce-144	1.15E 04	7.26E 07	2.15E 05	8.97E 04	5.32E 04	0.00E-01	0.00E-01	0.00E-01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-9

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Cow Milk

AGE GROUP = Teen

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.00E 03	1.00E 03	0.00E-01	1.00E 03	1.00E 03	1.00E 03	1.00E 03	1.00E 03
P-32	8.00E 08	1.73E 09	2.06E 10	1.28E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Cr-51	3.02E 04	5.08E 06	0.00E-01	0.00E-01	6.63E 03	1.68E 04	4.32E 04	0.00E-01
Mn-54	1.69E 06	1.75E 07	0.00E-01	8.52E 06	2.54E 06	0.00E-01	0.00E-01	0.00E-01
Fe-59	2.79E 07	1.71E 08	3.10E 07	7.23E 07	0.00E-01	0.00E-01	2.28E 07	0.00E-01
Co-58	1.09E 07	6.50E 07	0.00E-01	4.72E 06	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Co-60	3.88E 07	2.25E 08	0.00E-01	1.72E 07	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zn-65	2.38E 09	2.16E 09	1.47E 09	5.11E 09	3.27E 09	0.00E-01	0.00E-01	0.00E-01
Rb-86	1.39E 09	4.37E 08	0.00E-01	2.95E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-89	4.59E 07	1.91E 08	1.60E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-90	1.08E 10	1.23E 09	4.37E 10	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Y-91	2.52E 02	3.85E 06	9.40E 03	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zr-95	2.13E 02	7.16E 06	9.83E 02	3.10E 02	4.56E 02	0.00E-01	0.00E-01	0.00E-01
Nb-95	2.58E 04	2.00E 08	8.45E 04	4.68E 04	4.54E 04	0.00E-01	0.00E-01	0.00E-01
Ru-103	4.65E 02	9.08E 04	1.09E 03	0.00E-01	3.83E 03	0.00E-01	0.00E-01	0.00E-01
Ru-106	2.93E 03	1.11E 06	2.32E 04	0.00E-01	4.48E 04	0.00E-01	0.00E-01	0.00E-01
Ag-110M	3.53E 07	1.63E 10	6.14E 07	5.81E 07	1.11E 08	0.00E-01	0.00E-01	0.00E-01
Te-127M	7.39E 06	1.55E 08	6.22E 07	2.21E 07	2.52E 08	1.48E 07	0.00E-01	0.00E-01
Te-129M	1.13E 07	2.69E 08	7.15E 07	2.65E 07	2.99E 08	2.31E 07	0.00E-01	0.00E-01
I-131	2.65E 08	9.75E 07	3.52E 08	4.93E 08	8.48E 08	1.44E 11	0.00E-01	0.00E-01
I-132	1.83E-01	2.22E-01	1.94E-01	5.09E-01	8.02E-01	1.71E 01	0.00E-01	0.00E-01
I-133	2.49E 06	6.19E 06	4.82E 06	8.18E 06	1.43E 07	1.14E 09	0.00E-01	0.00E-01
I-135	1.58E 04	4.74E 04	1.66E 04	4.27E 04	6.75E 04	2.75E 06	0.00E-01	0.00E-01
Cs-134	6.54E 09	1.75E 08	5.99E 09	1.41E 10	4.48E 09	0.00E-01	1.71E 09	0.00E-01
Cs-136	7.48E 08	8.97E 07	2.83E 08	1.11E 09	6.07E 08	0.00E-01	9.56E 07	0.00E-01
Cs-137	3.96E 09	1.62E 08	8.54E 09	1.14E 10	3.87E 09	0.00E-01	1.50E 09	0.00E-01
Ba-140	1.99E 06	4.77E 07	3.09E 07	3.79E 04	1.28E 04	0.00E-01	2.55E 04	0.00E-01
Ce-141	4.09E 02	1.02E 07	6.33E 03	3.56E 03	1.68E 03	0.00E-01	0.00E-01	0.00E-01
Ce-144	2.12E 04	9.93E 07	3.95E 05	1.63E 05	9.76E 04	0.00E-01	0.00E-01	0.00E-01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-10

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Cow Milk

AGE GROUP = Child

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.58E 03	1.58E 03	0.00E-01	1.58E 03	1.58E 03	1.58E 03	1.58E 03	1.58E 03
P-32	1.96E 09	1.41E 09	5.09E 10	2.38E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Cr-51	6.17E 04	3.27E 06	0.00E-01	0.00E-01	9.36E 03	3.42E 04	6.25E 04	0.00E-01
Mn-54	3.39E 06	1.07E 07	0.00E-01	1.27E 07	3.57E 06	0.00E-01	0.00E-01	0.00E-01
Fe-59	5.79E 07	1.21E 08	7.18E 07	1.16E 08	0.00E-01	0.00E-01	3.37E 07	0.00E-01
Co-58	2.21E 07	4.20E 07	0.00E-01	7.21E 06	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Co-60	7.90E 07	1.48E 08	0.00E-01	2.68E 07	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zn-65	4.79E 09	1.35E 09	2.89E 09	7.70E 09	4.85E 09	0.00E-01	0.00E-01	0.00E-01
Rb-86	3.36E 09	3.52E 08	0.00E-01	5.47E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-89	1.13E 08	1.54E 08	3.97E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-90	1.87E 10	9.95E 08	7.38E 10	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Y-91	6.21E 02	3.09E 06	2.32E 04	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zr-95	4.47E 02	5.23E 05	2.28E 03	5.02E 02	7.18E 02	0.00E-01	0.00E-01	0.00E-01
Nb-95	5.31E 04	1.37E 08	1.91E 05	7.42E 04	6.98E 04	0.00E-01	0.00E-01	0.00E-01
Ru-103	9.88E 02	6.65E 04	2.57E 03	0.00E-01	6.47E 03	0.00E-01	0.00E-01	0.00E-01
Ru-106	7.14E 03	8.90E 05	5.72E 04	0.00E-01	7.72E 04	0.00E-01	0.00E-01	0.00E-01
Ag-110M	7.19E 07	1.07E 10	1.33E 08	9.00E 07	1.68E 08	0.00E-01	0.00E-01	0.00E-01
Te-127M	1.82E 07	1.24E 08	1.53E 08	4.13E 07	4.37E 08	3.66E 07	0.00E-01	0.00E-01
Te-129M	2.74E 07	2.15E 08	1.76E 08	4.92E 07	5.18E 08	5.68E 07	0.00E-01	0.00E-01
I-131	4.88E 08	7.64E 07	8.54E 08	8.59E 08	1.41E 09	2.84E 11	0.00E-01	0.00E-01
I-132	3.89E-01	9.95E-01	4.60E-01	8.45E-01	1.29E 00	3.92E 01	0.00E-01	0.00E-01
I-133	5.48E 06	5.84E 06	1.17E 07	1.45E 07	2.41E 07	2.69E 09	0.00E-01	0.00E-01
I-135	3.35E 04	5.39E 04	3.93E 04	7.07E 04	1.08E 05	6.26E 06	0.00E-01	0.00E-01
Cs-134	4.78E 09	1.22E 08	1.38E 10	2.27E 10	7.03E 09	0.00E-01	2.52E 09	0.00E-01
Cs-136	1.14E 09	6.17E 07	6.39E 08	1.76E 09	9.36E 08	0.00E-01	1.40E 08	0.00E-01
Cs-137	2.91E 09	1.23E 08	2.06E 10	1.97E 10	6.42E 09	0.00E-01	2.31E 09	0.00E-01
Ba-140	4.36E 06	3.78E 07	7.47E 07	6.54E 04	2.13E 04	0.00E-01	3.90E 04	0.00E-01
Ce-141	9.73E 02	8.17E 06	1.31E 04	6.55E 03	2.87E 03	0.00E-01	0.00E-01	0.00E-01
Ce-144	5.20E 04	7.96E 07	9.74E 05	3.05E 05	1.69E 05	0.00E-01	0.00E-01	0.00E-01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-11

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Cow Milk

AGE GROUP = Infant

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	2.40E 03	2.40E 03	0.00E-01	2.40E 03	2.40E 03	2.40E 03	2.40E 03	2.40E 03
P-32	4.06E 09	1.42E 09	1.05E 11	6.17E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Cr-51	9.77E 04	2.85E 06	0.00E-01	0.00E-01	1.39E 04	6.38E 04	1.24E 05	0.00E-01
Mn-54	5.37E 06	8.71E 06	0.00E-01	2.37E 07	5.25E 06	0.00E-01	0.00E-01	0.00E-01
Fe-59	9.23E 07	1.12E 08	1.34E 08	2.34E 08	0.00E-01	0.00E-01	6.92E 07	0.00E-01
Co-58	3.60E 07	3.59E 07	0.00E-01	1.44E 07	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Co-60	1.29E 08	1.30E 08	0.00E-01	5.47E 07	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zn-65	6.14E 09	1.12E 10	3.88E 09	1.33E 10	6.45E 09	0.00E-01	0.00E-01	0.00E-01
Rb-86	6.86E 09	3.55E 08	0.00E-01	1.39E 10	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-89	2.17E 08	1.55E 08	7.55E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-90	2.05E 10	1.00E 09	8.04E 10	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Y-91	1.16E 08	3.12E 06	4.36E 04	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zr-95	7.01E 02	4.92E 05	4.05E 03	9.88E 02	1.06E 03	0.00E-01	0.00E-01	0.00E-01
Nb-95	8.48E 04	1.24E 08	3.56E 05	1.47E 05	1.05E 05	0.00E-01	0.00E-01	0.00E-01
Ru-103	1.74E 03	6.33E 04	5.21E 03	0.00E-01	1.08E 04	0.00E-01	0.00E-01	0.00E-01
Ru-106	1.47E 04	8.95E 05	1.18E 05	0.00E-01	1.39E 05	0.00E-01	0.00E-01	0.00E-01
Ag-110M	1.19E 08	9.32E 09	2.46E 08	1.80E 08	2.57E 08	0.00E-01	0.00E-01	0.00E-01
Te-127M	3.75E 07	1.25E 08	3.10E 08	1.03E 08	7.64E 08	8.96E 07	0.00E-01	0.00E-01
Te-129M	5.57E 07	2.16E 08	3.62E 08	1.24E 08	9.05E 08	1.39E 08	0.00E-01	0.00E-01
I-131	9.23E 08	7.49E 07	1.78E 09	2.10E 09	2.45E 09	6.90E 11	0.00E-01	0.00E-01
I-132	6.90E-01	1.57E-00	9.55E-01	1.94E 00	2.16E 00	9.09E 01	0.00E-01	0.00E-01
I-133	1.05E 07	6.09E 06	2.47E 07	3.60E 07	4.23E 07	6.55E 09	0.00E-01	0.00E-01
I-135	5.93E 04	5.83E 04	8.17E 04	1.63E 05	1.81E 05	1.46E 07	0.00E-01	0.00E-01
Cs-134	4.19E 09	1.13E 08	2.23E 10	4.15E 10	1.07E 10	0.00E-01	4.38E 09	0.00E-01
Cs-136	1.37E 09	5.58E 07	1.25E 09	3.67E 09	1.46E 09	0.00E-01	2.99E 08	0.00E-01
Cs-137	2.72E 09	1.20E 08	3.28E 10	3.84E 10	1.03E 10	0.00E-01	4.18E 09	0.00E-01
Ba-140	7.91E 06	3.77E 07	1.54E 08	1.54E 05	3.65E 04	0.00E-01	9.43E 04	0.00E-01
Ce-141	1.87E 03	3.21E 06	2.60E 04	1.59E 04	4.90E 03	0.00E-01	0.00E-01	0.00E-01
Ce-144	7.82E 04	8.01E 07	1.40E 06	5.71E 05	2.31E 05	0.00E-01	0.00E-01	0.00E-01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-12

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Goat Milk

AGE GROUP = Adult

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.57E 03	1.57E 03	0.00E-01	1.57E 03	1.57E 03	1.57E 03	1.57E 03	1.57E 03
P-32	5.19E 08	1.51E 09	1.34E 10	8.34E 08	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Cr-51	2.08E 03	5.23E 05	0.00E-01	0.00E-01	4.58E 02	1.24E 03	2.76E 03	0.00E-01
Mn-54	1.17E 05	1.88E 06	0.00E-01	6.14E 05	1.83E 05	0.00E-01	0.00E-01	0.00E-01
Fe-59	2.08E 05	1.81E 06	2.31E 05	5.42E 05	0.00E-01	0.00E-01	1.51E 05	0.00E-01
Co-58	7.54E 05	6.82E 06	0.00E-01	3.36E 05	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Co-60	2.69E 06	2.29E 07	0.00E-01	1.22E 06	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zn-65	1.65E 08	2.31E 08	1.15E 08	3.66E 08	2.45E 08	0.00E-01	0.00E-01	0.00E-01
Rb-86	9.05E 07	3.83E 07	0.00E-01	1.94E 08	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-89	5.24E 07	2.93E 08	1.83E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-90	1.59E 10	1.88E 09	6.49E 10	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Y-91	1.64E 01	3.37E 05	6.13E 02	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zr-95	1.46E 01	6.85E 04	6.74E 01	2.16E 01	3.39E 01	0.00E-01	0.00E-01	0.00E-01
Nb-95	1.78E 03	2.01E 07	5.94E 03	3.31E 03	3.27E 03	0.00E-01	0.00E-01	0.00E-01
Ru-103	3.16E 01	8.56E 03	7.33E 01	0.00E-01	2.80E 02	0.00E-01	0.00E-01	0.00E-01
Ru-106	1.92E 02	9.81E 04	1.52E 03	0.00E-01	2.93E 03	0.00E-01	0.00E-01	0.00E-01
Ag-110M	2.45E 06	1.68E 09	4.46E 06	4.12E 06	8.11E 06	0.00E-01	0.00E-01	0.00E-01
Te-127M	4.93E 05	1.36E 07	4.05E 06	1.45E 06	1.64E 07	1.03E 06	0.00E-01	0.00E-01
Te-129M	7.43E 05	2.36E 07	4.69E 06	1.75E 06	1.96E 07	1.61E 06	0.00E-01	0.00E-01
I-131	1.91E 08	8.78E 07	2.33E 08	3.33E 08	5.71E 08	1.09E 11	0.00E-01	0.00E-01
I-132	1.23E-01	6.61E-02	1.32E-01	3.52E-01	5.61E-01	1.23E 01	0.00E-01	0.00E-01
I-133	1.68E 06	4.95E 06	3.17E 06	5.51E 06	9.61E 06	8.10E 08	0.00E-01	0.00E-01
I-135	1.08E 04	3.32E 04	1.12E 04	2.94E 04	4.71E 04	1.94E 06	0.00E-01	0.00E-01
Cs-134	2.01E 10	4.31E 08	1.03E 10	2.46E 10	7.97E 09	0.00E-01	2.65E 09	0.00E-01
Cs-136	1.42E 09	2.24E 08	4.99E 08	1.97E 09	1.10E 09	0.00E-01	1.50E 08	0.00E-01
Cs-137	1.27E 10	3.74E 08	1.41E 10	1.93E 10	6.56E 09	0.00E-01	2.18E 09	0.00E-01
Ba-140	1.35E 05	4.23E 06	2.06E 06	2.58E 03	8.78E 02	0.00E-01	1.48E 03	0.00E-01
Ce-141	2.68E 01	9.03E 05	3.49E 02	2.36E 02	1.10E 02	0.00E-01	0.00E-01	0.00E-01
Ce-144	1.38E 03	8.71E 06	2.58E 04	1.08E 04	6.39E 03	0.00E-01	0.00E-01	0.00E-01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-13

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Goat Milk

AGE GROUP = Teen

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	2.04E 03	2.04E 03	0.00E-01	2.04E 03	2.04E 03	2.04E 03	2.04E 03	2.04E 03
P-32	9.60E 08	2.08E 09	2.48E 10	1.53E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Cr-51	3.63E 03	6.10E 05	0.00E-01	0.00E-01	7.95E 02	2.02E 03	5.18E 03	0.00E-01
Mn-54	2.03E 05	2.10E 06	0.00E-01	1.02E 06	3.05E 05	0.00E-01	0.00E-01	0.00E-01
Fe-59	3.63E 05	2.22E 06	4.03E 05	9.40E 05	0.00E-01	0.00E-01	2.96E 05	0.00E-01
Co-58	1.30E 06	7.80E 06	0.00E-01	5.66E 05	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Co-60	4.66E 06	2.69E 07	0.00E-01	2.07E 06	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zn-65	2.86E 08	2.60E 08	1.77E 08	6.13E 08	3.93E 08	0.00E-01	0.00E-01	0.00E-01
Rb-86	1.66E 08	5.24E 07	0.00E-01	3.54E 08	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-89	9.65E 07	4.01E 08	3.37E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-90	2.27E 10	2.58E 09	9.18E 10	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Y-91	3.02E 01	4.62E 05	1.13E 03	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zr-95	2.56E 01	8.59E 04	1.18E 02	3.72E 01	5.47E 01	0.00E-01	0.00E-01	0.00E-01
Nb-95	3.09E 03	2.40E 07	1.01E 04	5.62E 03	5.45E 03	0.00E-01	0.00E-01	0.00E-01
Ru-103	5.58E 01	1.09E 04	1.30E 02	0.00E-01	4.60E 02	0.00E-01	0.00E-01	0.00E-01
Ru-106	3.51E 02	1.34E 05	2.79E 03	0.00E-01	5.38E 03	0.00E-01	0.00E-01	0.00E-01
Ag-110M	4.24E 06	1.96E 09	7.37E 06	6.97E 06	1.33E 07	0.00E-01	0.00E-01	0.00E-01
Te-127M	8.87E 05	1.86E 07	7.46E 06	2.65E 06	3.02E 07	1.77E 06	0.00E-01	0.00E-01
Te-129M	1.36E 06	3.22E 07	8.58E 06	3.19E 06	3.59E 07	2.77E 06	0.00E-01	0.00E-01
I-131	3.18E 08	1.17E 08	4.22E 08	5.91E 08	1.02E 09	1.73E 11	0.00E-01	0.00E-01
I-132	2.19E-01	2.66E-01	2.33E-01	6.11E-01	9.62E-01	2.06E 01	0.00E-01	0.00E-01
I-133	2.99E 06	7.43E 06	5.79E 06	9.81E 06	1.72E 07	1.37E 09	0.00E-01	0.00E-01
I-135	1.90E 04	5.63E 04	1.99E 04	5.13E 04	8.10E 04	3.30E 06	0.00E-01	0.00E-01
Cs-134	1.96E 10	5.26E 08	1.80E 10	4.23E 10	1.34E 10	0.00E-01	5.13E 09	0.00E-01
Cs-136	2.25E 09	2.69E 07	8.50E 08	3.34E 09	1.82E 09	0.00E-01	2.87E 08	0.00E-01
Cs-137	1.19E 10	4.85E 08	2.56E 10	3.41E 10	1.16E 10	0.00E-01	4.51E 09	0.00E-01
Ba-140	2.39E 05	5.72E 06	3.71E 06	4.55E 03	1.54E 03	0.00E-01	3.06E 03	0.00E-01
Ce-141	4.91E 01	1.22E 06	6.40E 02	4.27E 02	2.01E 02	0.00E-01	0.00E-01	0.00E-01
Ce-144	2.55E 03	1.19E 07	4.74E 04	1.96E 04	1.17E 04	0.00E-01	0.00E-01	0.00E-01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-14

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Goat Milk

AGE GROUP = Child

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	3.23E 03	3.23E 03	0.00E-01	3.23E 03	3.23E 03	3.23E 03	3.23E 03	3.23E 03
P-32	2.35E 09	1.69E 09	6.11E 10	2.86E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Cr-51	7.40E 03	3.93E 05	0.00E-01	0.00E-01	1.12E 03	4.11E 03	7.50E 03	0.00E-01
Mn-54	4.07E 05	1.28E 06	0.00E-01	1.53E 06	4.29E 05	0.00E-01	0.00E-01	0.00E-01
Fe-59	7.52E 05	1.57E 06	9.34E 05	1.51E 06	0.00E-01	0.00E-01	4.38E 05	0.00E-01
Co-58	2.65E 06	5.05E 06	0.00E-01	8.65E 05	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Co-60	9.48E 06	1.78E 07	0.00E-01	3.21E 06	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zn-65	5.74E 08	1.62E 08	3.47E 08	9.24E 08	5.82E 08	0.00E-01	0.00E-01	0.00E-01
Rb-86	4.04E 08	4.22E 07	0.00E-01	6.57E 08	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-89	2.38E 08	3.23E 08	8.34E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-90	3.93E 10	2.09E 09	1.55E 11	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Y-91	7.45E 01	3.71E 05	2.79E 03	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zr-95	5.36E 01	6.28E 04	2.74E 02	6.02E 01	8.62E 01	0.00E-01	0.00E-01	0.00E-01
Nb-95	6.37E 03	1.65E 07	2.29E 04	8.91E 03	8.37E 03	0.00E-01	0.00E-01	0.00E-01
Ru-103	1.19E 02	7.98E 03	3.09E 02	0.00E-01	7.77E 02	0.00E-01	0.00E-01	0.00E-01
Ru-106	8.56E 02	1.07E 05	6.86E 03	0.00E-01	9.27E 03	0.00E-01	0.00E-01	0.00E-01
Ag-110M	8.63E 06	1.28E 09	1.60E 07	1.08E 07	2.01E 07	0.00E-01	0.00E-01	0.00E-01
Te-127M	2.18E 06	1.49E 07	1.84E 07	4.95E 06	5.24E 07	4.40E 06	0.00E-01	0.00E-01
Te-129M	3.28E 06	2.58E 07	2.12E 07	5.91E 06	6.21E 07	6.82E 06	0.00E-01	0.00E-01
I-131	5.85E 08	9.17E 07	1.02E 09	1.03E 09	1.69E 09	3.41E 11	0.00E-01	0.00E-01
I-132	4.67E-01	1.19E 00	5.52E-01	1.01E 00	1.55E 00	4.71E 01	0.00E-01	0.00E-01
I-133	6.58E 06	7.00E 06	1.41E 07	1.74E 07	2.90E 07	3.23E 09	0.00E-01	0.00E-01
I-135	4.01E 04	6.47E 04	4.72E 04	8.49E 04	1.30E 05	7.52E 06	0.00E-01	0.00E-01
Cs-134	1.43E 10	3.67E 08	4.14E 10	6.80E 10	2.11E 10	0.00E-01	7.56E 09	0.00E-01
Cs-136	3.41E 09	1.85E 08	1.92E 09	5.27E 09	2.81E 09	0.00E-01	4.19E 08	0.00E-01
Cs-137	8.72E 09	3.70E 08	6.17E 10	5.91E 10	1.93E 10	0.00E-01	6.93E 09	0.00E-01
Ba-140	5.23E 05	4.54E 05	8.96E 06	7.85E 03	2.56E 03	0.00E-01	4.68E 03	0.00E-01
Ce-141	1.17E 02	9.81E 05	1.53E 03	7.36E 02	3.45E 02	0.00E-01	0.00E-01	0.00E-01
Ce-144	6.24E 03	9.55E 06	1.17E 05	3.66E 04	2.03E 04	0.00E-01	0.00E-01	0.00E-01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-15

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Goat Milk

AGE GROUP = Infant

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	4.90E 03	4.90E 03	0.00E-01	4.90E 03	4.90E 03	4.90E 03	4.90E 03	4.90E 03
P-32	4.88E 09	1.70E 09	1.26E 11	7.40E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Cr-51	1.17E 04	3.42E 05	0.00E-01	0.00E-01	1.67E 03	7.65E 03	1.49E 04	0.00E-01
Mn-54	6.45E 05	1.04E 06	0.00E-01	2.84E 06	6.30E 05	0.00E-01	0.00E-01	0.00E-01
Fe-59	1.20E 06	1.45E 06	1.74E 06	3.04E 06	0.00E-01	0.00E-01	9.00E 05	0.00E-01
Co-58	4.31E 06	4.31E 06	0.00E-01	1.73E 06	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Co-60	1.55E 07	1.56E 07	0.00E-01	6.56E 06	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zn-65	7.36E 08	1.35E 09	4.66E 08	1.60E 09	7.74E 08	0.00E-01	0.00E-01	0.00E-01
Rb-86	8.23E 08	4.26E 07	0.00E-01	1.67E 09	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-89	4.55E 08	3.26E 08	1.59E 10	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-90	4.30E 10	2.11E 09	1.69E 11	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Y-91	1.39E 02	3.75E 05	5.23E 03	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Zr-95	8.41E 01	5.90E 04	4.85E 02	1.19E 02	1.28E 02	0.00E-01	0.00E-01	0.00E-01
Nb-95	1.02E 04	1.48E 07	4.27E 04	1.76E 04	1.26E 04	0.00E-01	0.00E-01	0.00E-01
Ru-103	2.09E 02	7.60E 03	6.25E 02	0.00E-01	1.30E 03	0.00E-01	0.00E-01	0.00E-01
Ru-106	1.77E 03	1.07E 05	1.41E 04	0.00E-01	1.67E 04	0.00E-01	0.00E-01	0.00E-01
Ag-110M	1.43E 07	1.12E 09	2.95E 07	2.16E 07	3.08E 07	0.00E-01	0.00E-01	0.00E-01
Te-127M	4.51E 06	1.50E 07	3.72E 07	1.23E 07	9.16E 07	1.08E 07	0.00E-01	0.00E-01
Te-129M	6.69E 06	2.59E 07	4.34E 07	1.49E 07	1.09E 08	1.67E 07	0.00E-01	0.00E-01
I-131	1.11E 09	8.99E 07	2.14E 09	2.52E 09	2.94E 09	8.28E 11	0.00E-01	0.00E-01
I-132	8.28E-01	1.88E 00	1.15E 00	2.33E 00	2.59E 00	1.09E 02	0.00E-01	0.00E-01
I-133	1.27E 07	7.31E 06	2.97E 07	4.32E 07	5.08E 07	7.86E 09	0.00E-01	0.00E-01
I-135	7.11E 04	7.06E 04	9.81E 04	1.95E 05	2.17E 05	1.75E 07	0.00E-01	0.00E-01
Cs-134	1.26E 10	3.38E 08	6.68E 10	1.25E 11	3.21E 10	0.00E-01	1.31E 10	0.00E-01
Cs-136	4.11E 09	1.67E 08	3.75E 09	1.10E 10	4.39E 09	0.00E-01	8.98E 08	0.00E-01
Cs-137	8.17E 09	3.61E 08	9.85E 10	1.15E 11	3.10E 10	0.00E-01	1.25E 10	0.00E-01
Ba-140	9.50E 05	4.53E 06	1.84E 07	1.84E 04	4.38E 03	0.00E-01	1.13E 04	0.00E-01
Ce-141	2.24E 02	9.85E 05	3.13E 03	1.91E 03	5.88E 02	0.00E-01	0.00E-01	0.00E-01
Ce-144	9.39E 03	9.61E 06	1.67E 05	6.86E 04	2.77E 04	0.00E-01	0.00E-01	0.00E-01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-16

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Inhal

AGE GROUP = Adult

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.26E 03	1.26E 03	0.00E-01	1.26E 03	1.26E 03	1.26E 03	1.26E 03	1.26E 03
P-32	5.00E 04	8.63E 04	1.32E 06	7.70E 04	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Cr-51	9.99E 01	3.32E 03	0.00E-01	0.00E-01	2.28E 01	5.94E 01	1.44E 04	0.00E-01
Mn-54	6.29E 03	7.72E 04	0.00E-01	3.95E 04	9.83E 03	0.00E-01	1.40E 06	0.00E-01
Fe-59	1.05E 04	1.88E 05	1.17E 04	2.77E 04	0.00E-01	0.00E-01	1.01E 06	0.00E-01
Co-58	2.07E 03	1.06E 05	0.00E-01	1.58E 03	0.00E-01	0.00E-01	9.27E 05	0.00E-01
Co-60	1.48E 04	2.84E 05	0.00E-01	1.15E 04	0.00E-01	0.00E-01	5.96E 06	0.00E-01
Zn-65	4.65E 04	5.34E 04	3.24E 04	1.03E 05	6.89E 04	0.00E-01	8.63E 05	0.00E-01
Rb-86	5.89E 04	1.66E 04	0.00E-01	1.35E 05	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-89	8.71E 03	3.49E 05	3.04E 05	0.00E-01	0.00E-01	0.00E-01	1.40E 06	0.00E-01
Sr-90	6.09E 06	7.21E 05	9.91E 07	0.00E-01	0.00E-01	0.00E-01	9.59E 06	0.00E-01
Y-91	1.24E 04	3.84E 05	4.62E 05	0.00E-01	0.00E-01	0.00E-01	1.70E 06	0.00E-01
Zr-95	2.32E 04	1.50E 05	1.07E 05	3.44E 04	5.41E 04	0.00E-01	1.77E 06	0.00E-01
Nb-95	4.20E 03	1.04E 05	1.41E 04	7.80E 03	7.72E 03	0.00E-01	5.04E 05	0.00E-01
Ru-103	6.57E 02	1.10E 05	1.53E 03	0.00E-01	5.82E 03	0.00E-01	5.04E 05	0.00E-01
Ru-106	8.71E 03	9.11E 05	6.90E 04	0.00E-01	1.33E 05	0.00E-01	9.35E 06	0.00E-01
Ag-110M	5.94E 03	3.02E 05	1.08E 04	9.99E 03	1.97E 04	0.00E-01	4.63E 06	0.00E-01
Te-127M	1.57E 03	1.49E 05	1.26E 04	5.76E 03	4.57E 04	3.28E 03	9.59E 05	0.00E-01
Te-129M	1.58E 03	3.83E 05	9.75E 03	4.67E 03	3.65E 04	3.44E 03	1.16E 06	0.00E-01
I-131	2.05E 04	6.27E 03	2.52E 04	3.57E 04	6.12E 04	1.19E 07	0.00E-01	0.00E-01
I-132	1.16E 03	4.06E 02	1.16E 03	3.25E 03	5.18E 03	1.14E 05	0.00E-01	0.00E-01
I-133	4.51E 03	8.87E 03	8.63E 03	1.48E 04	2.58E 04	2.15E 06	0.00E-01	0.00E-01
I-135	2.56E 03	5.24E 03	2.68E 03	6.97E 03	1.11E 04	4.47E 05	0.00E-01	0.00E-01
Cs-134	7.27E 05	1.04E 04	3.72E 05	8.47E 05	2.87E 05	0.00E-01	9.75E 04	0.00E-01
Cs-136	1.10E 05	1.17E 04	3.90E 04	1.46E 05	8.55E 04	0.00E-01	1.20E 04	0.00E-01
Cs-137	4.27E 05	8.39E 03	4.78E 05	6.20E 05	2.22E 05	0.00E-01	7.51E 04	0.00E-01
Ba-140	2.56E 03	2.18E 05	3.90E 04	4.90E 01	1.67E 01	0.00E-01	1.27E 06	0.00E-01
Ce-141	1.53E 03	1.20E 05	1.99E 04	1.35E 04	6.25E 03	0.00E-01	3.61E 05	0.00E-01
Ce-144	1.84E 05	8.15E 05	3.43E 06	1.43E 06	8.47E 05	0.00E-01	7.76E 06	0.00E-01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-17

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Inhal

AGE GROUP = Teen

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.27E 03	1.27E 03	0.00E-01	1.27E 03	1.27E 03	1.27E 03	1.27E 03	1.27E 03
P-32	7.15E 04	9.27E 04	1.89E 06	1.09E 05	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Cr-51	1.35E 02	3.00E 03	0.00E-01	0.00E-01	3.07E 01	7.49E 01	2.09E 04	0.00E-01
Mn-54	8.39E 03	6.67E 04	0.00E-01	5.10E 04	1.27E 04	0.00E-01	1.98E 06	0.00E-01
Fe-59	1.43E 04	1.78E 05	1.59E 04	3.69E 04	0.00E-01	0.00E-01	1.53E 06	0.00E-01
Co-58	2.77E 03	9.51E 04	0.00E-01	2.07E 03	0.00E-01	0.00E-01	1.34E 06	0.00E-01
Co-60	1.98E 04	2.59E 05	0.00E-01	1.51E 04	0.00E-01	0.00E-01	8.71E 06	0.00E-01
Zn-65	6.23E 04	4.66E 04	3.85E 04	1.33E 05	8.63E 04	0.00E-01	1.24E 06	0.00E-01
Rb-86	8.39E 04	1.77E 04	0.00E-01	1.90E 05	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-89	1.25E 04	3.71E 05	4.34E 05	0.00E-01	0.00E-01	0.00E-01	2.41E 06	0.00E-01
Sr-90	6.67E 06	7.64E 05	1.08E 08	0.00E-01	0.00E-01	0.00E-01	1.65E 07	0.00E-01
Y-91	1.77E 04	4.08E 05	6.60E 05	0.00E-01	0.00E-01	0.00E-01	2.93E 06	0.00E-01
Zr-95	3.15E 04	1.49E 05	1.45E 05	4.58E 04	6.73E 04	0.00E-01	2.68E 06	0.00E-01
Nb-95	5.66E 03	9.67E 04	1.85E 04	1.03E 04	9.99E 03	0.00E-01	7.50E 05	0.00E-01
Ru-103	8.95E 02	1.09E 05	2.10E 03	0.00E-01	7.42E 03	0.00E-01	7.82E 05	0.00E-01
Ru-106	1.24E 04	9.59E 05	9.83E 04	0.00E-01	1.90E 05	0.00E-01	1.61E 07	0.00E-01
Ag-110M	7.98E 03	2.72E 05	1.38E 04	1.31E 04	2.50E 04	0.00E-01	6.74E 06	0.00E-01
Te-127M	2.18E 03	1.59E 05	1.80E 04	8.15E 03	6.53E 04	4.38E 03	1.65E 06	0.00E-01
Te-129M	2.24E 03	4.04E 05	1.39E 04	6.57E 03	5.18E 04	4.57E 03	1.97E 06	0.00E-01
I-131	2.64E 04	6.48E 03	3.54E 04	4.90E 04	8.39E 04	1.46E 07	0.00E-01	0.00E-01
I-132	1.57E 03	1.27E 03	1.59E 03	4.37E 03	6.91E 03	1.51E 05	0.00E-01	0.00E-01
I-133	6.21E 03	1.03E 04	1.21E 04	2.05E 04	3.59E 04	2.92E 06	0.00E-01	0.00E-01
I-135	3.48E 03	6.94E 03	3.69E 03	9.43E 03	1.49E 04	6.20E 05	0.00E-01	0.00E-01
Cs-134	5.48E 05	9.75E 03	5.02E 05	1.13E 06	3.75E 05	0.00E-01	1.46E 05	0.00E-01
Cs-136	1.37E 05	1.09E 04	5.14E 04	1.93E 05	1.10E 05	0.00E-01	1.77E 04	0.00E-01
Cs-137	3.11E 05	8.48E 03	6.69E 05	8.47E 05	3.04E 05	0.00E-01	1.21E 05	0.00E-01
Ba-140	3.51E 03	2.28E 05	5.46E 04	6.69E 01	2.28E 01	0.00E-01	2.03E 06	0.00E-01
Ce-141	2.16E 03	1.26E 05	2.84E 04	1.89E 04	8.87E 03	0.00E-01	6.13E 05	0.00E-01
Ce-144	2.62E 05	8.63E 05	4.88E 06	2.02E 06	1.21E 06	0.00E-01	1.33E 07	0.00E-01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-18

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Inhal

AGE GROUP = Child

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	1.12E 03	1.12E 03	0.00E-01	1.12E 03	1.12E 03	1.12E 03	1.12E 03	1.12E 03
P-32	9.86E 04	4.21E 04	2.60E 06	1.14E 05	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Cr-51	1.54E 02	1.08E 03	0.00E-01	0.00E-01	2.43E 01	8.53E 01	1.70E 04	0.00E-01
Mn-54	9.50E 03	2.29E 04	0.00E-01	4.29E 04	1.00E 04	0.00E-01	1.57E 06	0.00E-01
Fe-59	1.67E 04	7.06E 04	2.07E 04	3.34E 04	0.00E-01	0.00E-01	1.27E 06	0.00E-01
Co-58	3.16E 03	3.43E 04	0.00E-01	1.77E 03	0.00E-01	0.00E-01	1.10E 06	0.00E-01
Co-60	2.26E 04	9.61E 04	0.00E-01	1.31E 04	0.00E-01	0.00E-01	7.06E 06	0.00E-01
Zn-65	7.02E 04	1.63E 04	4.25E 04	1.13E 05	7.13E 04	0.00E-01	9.94E 05	0.00E-01
Rb-86	1.14E 05	7.98E 03	0.00E-01	1.98E 05	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-89	1.72E 04	1.67E 05	5.99E 05	0.00E-01	0.00E-01	0.00E-01	2.15E 06	0.00E-01
Sr-90	6.43E 06	3.43E 05	1.01E 08	0.00E-01	0.00E-01	0.00E-01	1.47E 07	0.00E-01
Y-91	2.43E 04	1.84E 05	9.13E 05	0.00E-01	0.00E-01	0.00E-01	2.62E 06	0.00E-01
Zr-95	3.69E 04	6.10E 04	1.90E 05	4.17E 04	5.95E 04	0.00E-01	2.23E 06	0.00E-01
Nb-95	6.54E 03	3.69E 04	2.35E 04	9.16E 03	8.61E 03	0.00E-01	6.13E 05	0.00E-01
Ru-103	1.07E 03	4.47E 04	2.79E 03	0.00E-01	7.02E 03	0.00E-01	6.61E 05	0.00E-01
Ru-106	1.69E 04	4.29E 05	1.36E 05	0.00E-01	1.84E 05	0.00E-01	1.43E 07	0.00E-01
Ag-110M	9.13E 03	1.00E 05	1.68E 04	1.14E 04	2.12E 04	0.00E-01	5.47E 06	0.00E-01
Te-127M	3.01E 03	7.13E 04	2.48E 04	8.53E 03	6.35E 04	6.06E 03	1.48E 06	0.00E-01
Te-129M	3.04E 03	1.81E 05	1.92E 04	6.84E 03	5.02E 04	6.32E 03	1.76E 06	0.00E-01
I-131	2.72E 04	2.84E 03	4.80E 04	4.80E 04	7.87E 04	1.62E 07	0.00E-01	0.00E-01
I-132	1.87E 03	3.20E 03	2.11E 03	4.06E 03	6.24E 03	1.93E 05	0.00E-01	0.00E-01
I-133	7.68E 03	5.47E 03	1.66E 04	2.03E 04	3.37E 04	3.84E 06	0.00E-01	0.00E-01
I-135	4.14E 03	4.43E 03	4.91E 03	8.72E 03	1.34E 04	7.91E 05	0.00E-01	0.00E-01
Cs-134	2.24E 05	3.84E 03	6.50E 05	1.01E 06	3.30E 05	0.00E-01	1.21E 05	0.00E-01
Cs-136	1.16E 05	4.17E 03	6.50E 04	1.71E 05	9.53E 04	0.00E-01	1.45E 04	0.00E-01
Cs-137	1.28E 05	3.61E 03	9.05E 05	8.24E 05	2.82E 05	0.00E-01	1.04E 05	0.00E-01
Ba-140	4.32E 03	1.02E 05	7.39E 04	6.47E 01	2.11E 01	0.00E-01	1.74E 06	0.00E-01
Ce-141	2.89E 03	5.65E 04	3.92E 04	1.95E 04	8.53E 03	0.00E-01	5.43E 05	0.00E-01
Ce-144	3.61E 05	3.88E 05	6.76E 06	2.11E 06	1.17E 06	0.00E-01	1.19E 07	0.00E-01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.3-19

R VALUES FOR THE H.B. ROBINSON STEAM ELECTRIC PLANT*

(Reference Regulatory Guide 1.109)

PATHWAY = Inhal

AGE GROUP = Infant

Nuclide	T.Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
H-3	6.46E 02	6.46E 02	0.00E-01	6.46E 02	6.46E 02	6.46E 02	6.46E 02	6.46E 02
P-32	7.73E 04	1.61E 04	2.03E 06	1.12E 05	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Cr-51	8.93E 01	3.56E 02	0.00E-01	0.00E-01	1.32E 01	5.75E 01	1.28E 04	0.00E-01
Mn-54	4.98E 03	7.05E 03	0.00E-01	2.53E 04	4.98E 03	0.00E-01	9.98E 05	0.00E-01
Fe-59	9.46E 03	2.47E 04	1.35E 04	2.35E 04	0.00E-01	0.00E-01	1.01E 06	0.00E-01
Co-58	1.82E 03	1.11E 04	0.00E-01	1.22E 03	0.00E-01	0.00E-01	7.76E 05	0.00E-01
Co-60	1.18E 04	3.19E 04	0.00E-01	8.01E 03	0.00E-01	0.00E-01	4.50E 06	0.00E-01
Zn-65	3.10E 04	5.13E 04	1.93E 04	6.25E 04	3.24E 04	0.00E-01	6.46E 05	0.00E-01
Rb-86	8.81E 04	3.03E 03	0.00E-01	1.90E 05	0.00E-01	0.00E-01	0.00E-01	0.00E-01
Sr-89	1.14E 04	6.39E 04	3.97E 05	0.00E-01	0.00E-01	0.00E-01	2.03E 06	0.00E-01
Sr-90	2.59E 06	1.31E 05	4.08E 07	0.00E-01	0.00E-01	0.00E-01	1.12E 07	0.00E-01
Y-91	1.57E 04	7.02E 04	5.87E 05	0.00E-01	0.00E-01	0.00E-01	2.45E 06	0.00E-01
Zr-95	2.03E 04	2.17E 04	1.15E 05	2.78E 04	3.10E 04	0.00E-01	1.75E 06	0.00E-01
Nb-95	3.77E 03	1.27E 04	1.57E 04	6.42E 03	4.71E 03	0.00E-01	4.78E 05	0.00E-01
Ru-103	6.78E 02	1.61E 04	2.01E 03	0.00E-01	4.24E 03	0.00E-01	5.51E 05	0.00E-01
Ru-106	1.09E 04	1.64E 05	8.67E 04	0.00E-01	1.06E 05	0.00E-01	1.15E 07	0.00E-01
Ag-110M	4.99E 03	3.30E 04	9.97E 03	7.21E 03	1.09E 04	0.00E-01	3.66E 06	0.00E-01
Te-127M	2.07E 03	2.73E 04	1.66E 04	6.89E 03	3.75E 04	4.86E 03	1.31E 06	0.00E-01
Te-129M	2.22E 03	6.89E 04	1.41E 04	6.08E 03	3.17E 04	5.47E 03	1.68E 06	0.00E-01
I-131	1.96E 04	1.06E 03	3.79E 04	4.43E 04	5.17E 04	1.48E 07	0.00E-01	0.00E-01
I-132	1.26E 03	1.90E 03	1.69E 03	3.54E 03	3.94E 03	1.69E 05	0.00E-01	0.00E-01
I-133	5.59E 03	2.15E 03	1.32E 04	1.92E 04	2.24E 04	3.55E 06	0.00E-01	0.00E-01
I-135	2.77E 03	1.83E 03	3.86E 03	7.59E 03	8.46E 03	6.95E 05	0.00E-01	0.00E-01
Cs-134	7.44E 04	1.33E 03	3.96E 05	7.02E 05	1.90E 05	0.00E-01	7.95E 04	0.00E-01
Cs-136	5.28E 04	1.43E 03	4.82E 04	1.34E 05	5.63E 04	0.00E-01	1.17E 04	0.00E-01
Cs-137	4.54E 04	1.33E 03	5.48E 05	6.11E 05	1.72E 05	0.00E-01	7.12E 04	0.00E-01
Ba-140	2.89E 03	3.83E 04	5.59E 04	5.59E 01	1.34E 01	0.00E-01	1.59E 06	0.00E-01
Ce-141	1.99E 03	2.15E 04	2.77E 04	1.66E 04	5.24E 03	0.00E-01	5.16E 05	0.00E-01
Ce-144	1.76E 05	1.48E 05	3.19E 06	1.21E 06	5.37E 05	0.00E-01	9.83E 06	0.00E-01

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference Regulatory Guide 1.109.

TABLE 3.4-1

INGESTION DOSE R FACTORS

GRASS-COW-MILK PATHWAY (INFANT)

(Reference NUREG 0133)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	2.38E3	2.38E3	2.38E3	2.38E3	2.38E3	2.38E3
Cr-51	ND	ND	1.61E5	1.05E5	2.30E4	2.05E5	4.71E6
Mn-54	ND	3.89E7	8.83E6	ND	8.63E6	ND	1.43E7
Fe-55	1.35E8	8.72E7	2.33E7	ND	ND	4.26E7	1.11E7
Fe-59	2.26E8	3.94E8	1.55E8	ND	ND	1.17E8	1.88E8
Co-58	ND	2.43E7	6.06E7	ND	ND	ND	6.05E7
Co-60	ND	8.81E7	2.08E8	ND	ND	ND	2.10E8
Ni-63	3.49E10	2.16E9	1.21E9	ND	ND	ND	1.07E8
Zn-65	5.55E9	1.90E10	8.78E9	ND	9.24E9	ND	1.61E10
Rb-86	ND	2.23E10	1.10E10	ND	ND	ND	5.70E8
Sr-89	ND	1.45E6	9.98E5	ND	ND	ND	4.93E5
Sr-90	1.22E11	ND	3.10E10	ND	ND	ND	1.52E9
Y-91	7.33E4	ND	1.95E3	ND	ND	ND	5.26E6
Zr-95	6.84E3	1.67E3	1.18E3	ND	1.80E3	ND	8.30E5
Nb-95	5.93E5	2.44E5	1.41E5	ND	1.75E5	ND	2.06E8
Ru-103	8.68E3	ND	2.90E3	ND	1.81E4	ND	1.06E5
Ru-106	1.90E5	ND	2.38E4	ND	2.25E5	ND	1.44E6
Ag-110M	3.86E8	2.82E8	1.87E8	ND	4.03E8	ND	1.46E10
Te-125M	1.51E8	5.04E7	2.04E7	5.07E7	ND	ND	7.18E7
Te-127M	4.21E8	1.40E8	5.10E7	1.22E8	1.04E9	ND	1.70E8
Te-129M	5.60E8	1.92E8	8.62E7	2.15E8	1.40E9	ND	3.34E8
I-131	2.72E9	3.21E9	1.41E9	1.05E12	3.75E9	ND	1.15E8
I-133	3.09E7	4.51E7	1.32E7	8.21E9	5.31E7	ND	7.64E6
Cs-134	3.65E10	6.80E10	6.87E9	ND	1.75E10	7.18E9	1.85E8
Cs-136	2.03E9	5.96E9	2.22E9	ND	2.37E9	4.85E8	9.05E7
Cs-137	5.15E10	6.02E10	4.27E9	ND	1.62E10	6.55E9	1.88E8
Ba-140	2.41E8	2.41E5	1.24E7	ND	5.73E4	1.48E5	5.92E7
Ce-141	4.34E4	2.64E4	3.11E3	ND	8.16E3	ND	1.37E7
Ce-144	2.33E6	9.52E5	1.30E5	ND	3.85E5	ND	1.33E8
Pr-143	1.49E3	5.56E2	7.37E1	ND	2.07E2	ND	7.85E5
Nd-147	8.86E2	9.10E2	5.57E1	ND	3.51E2	ND	5.77E5

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference NUREG 0133.

TABLE 3.4-2

INGESTION DOSE R FACTORS

GRASS-COW-MILK PATHWAY (CHILD)

(Reference NUREG 0133)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	1.57E3	1.57E3	1.57E3	1.57E3	1.57E3	1.57E3
Cr-51	ND	ND	1.02E5	5.66E4	1.55E4	1.03E5	5.41E6
Mn-54	ND	2.09E7	5.58E6	ND	5.87E6	ND	1.76E7
Fe-55	1.12E8	5.93E7	1.84E7	ND	ND	3.35E7	1.10E7
Fe-59	1.21E8	1.96E8	9.75E7	ND	ND	5.67E7	2.04E8
Co-58	ND	1.21E7	3.72E7	ND	ND	ND	7.08E7
Co-60	ND	4.32E7	1.27E8	ND	ND	ND	2.39E8
Ni-63	2.96E10	1.59E9	1.01E9	ND	ND	ND	1.07E8
Zn-65	4.13E9	1.10E10	6.85E9	ND	6.94E9	ND	1.93E9
Rb-86	ND	8.77E9	5.39E9	ND	ND	ND	5.64E8
Sr-89	6.69E9	ND	1.91E8	ND	ND	ND	2.59E8
Sr-90	1.12E11	ND	2.83E10	ND	ND	ND	1.50E9
Y-91	3.91E4	ND	1.04E3	ND	ND	ND	5.21E6
Zr-95	3.85E3	8.46E2	7.53E2	ND	1.21E3	ND	8.83E5
Nb-95	3.18E5	1.24E5	8.84E4	ND	1.16E5	ND	2.29E8
Ru-103	4.29E3	ND	1.65E3	ND	1.08E4	ND	1.11E5
Ru-106	9.24E4	ND	1.15E4	ND	1.25E5	ND	1.44E6
Pg-110M	2.09E8	1.41E8	1.13E8	ND	2.63E8	ND	1.68E10
Te-125M	7.38E7	2.00E7	9.84E6	2.07E7	ND	ND	7.12E7
Te-127M	2.08E8	5.60E7	2.47E7	4.97E7	5.93E8	ND	1.68E8
Te-129M	3.17E8	8.85E7	4.92E7	1.02E8	9.31E8	ND	3.87E8
I-131	1.30E9	1.31E9	7.46E8	4.34E11	2.15E9	ND	1.17E8
I-133	1.47E7	1.82E7	6.87E6	3.37E9	3.03E7	ND	7.32E6
Cs-134	2.26E10	3.71E10	7.84E9	ND	1.15E10	4.13E9	2.00E8
Cs-136	1.04E9	2.85E9	1.84E9	ND	1.52E9	2.26E8	1.00E8
Cs-137	3.22E10	3.09E10	4.55E9	ND	1.01E10	3.62E9	1.93E8
Ba-140	1.17E8	1.03E5	6.84E6	ND	3.34E4	6.12E4	5.94E7
Ce-141	2.19E4	1.09E4	1.62E3	ND	4.78E3	ND	1.36E7
Ce-144	1.62E6	5.09E5	8.66E4	ND	2.82E5	ND	1.33E8
Pr-143	7.19E2	2.16E2	3.57E1	ND	1.17E2	ND	7.76E5
Nd-147	4.47E2	3.62E2	2.80E1	ND	1.99E2	ND	5.73E5

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference NUREG 0133.

TABLE 3.4-3

INGESTION DOSE R FACTORS

GRASS-COW-MILK PATHWAY (TEEN)

(Reference NUREG 0133)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	9.94E2	9.94E2	9.94E2	9.94E2	9.94E2	9.94E2
Cr-51	ND	ND	5.00E4	2.78E4	1.09E4	7.13E4	8.40E6
Mn-54	ND	1.40E7	2.78E6	ND	4.18E6	ND	2.87E7
Fe-55	4.45E7	3.16E7	7.36E6	ND	ND	2.00E7	1.37E7
Fe-59	5.21E7	1.22E8	4.70E7	ND	ND	3.87E7	2.88E8
Co-58	ND	7.95E6	1.83E7	ND	ND	ND	1.10E8
Co-60	ND	1.64E6	3.70E6	ND	ND	ND	3.14E7
Ni-63	1.82E10	8.35E8	4.01E8	ND	ND	ND	1.33E8
Zn-65	2.11E9	7.32E9	3.41E9	ND	4.68E9	ND	3.10E9
Rb-86	ND	4.73E9	2.22E9	ND	ND	ND	6.99E8
Sr-89	2.70E9	ND	7.73E7	ND	ND	ND	3.22E8
Sr-90	6.61E10	ND	1.63E10	ND	ND	ND	1.86E9
Y-91	1.58E4	ND	4.24E2	ND	ND	ND	6.48E6
Zr-95	1.66E3	5.22E2	3.59E2	ND	7.68E2	ND	1.21E6
Nb-95	1.41E5	7.80E4	4.29E4	ND	7.56E4	ND	3.34E8
Ru-103	1.81E3	ND	7.74E2	ND	6.39E3	ND	1.51E5
Ru-106	3.75E4	ND	4.73E3	ND	7.24E4	ND	1.80E6
Ag-110M	9.64E7	9.12E7	5.55E7	ND	1.74E8	ND	2.56E10
Te-125M	3.00E7	1.08E7	4.02E6	8.39E6	ND	ND	8.86E7
Te-127M	8.44E7	2.99E7	1.00E7	2.01E7	3.42E8	ND	2.10E8
Te-129M	1.11E8	4.11E7	1.75E7	3.57E7	4.63E8	ND	4.16E8
I-131	5.38E8	7.53E8	4.05E8	2.20E11	1.30E9	ND	1.49E8
I-133	6.05E6	1.03E7	3.13E6	1.43E9	1.80E7	ND	7.77E6
Cs-134	9.81E9	2.31E10	1.07E10	ND	7.34E9	2.80E9	2.87E8
Cs-136	4.59E8	1.80E9	1.21E9	ND	9.82E8	1.55E8	1.45E8
Cs-137	1.34E10	1.78E10	6.20E9	ND	6.06E9	2.35E9	2.53E8
Ba-140	4.87E7	5.96E4	3.14E6	ND	2.02E4	4.01E4	7.51E7
Ce-141	8.89E3	5.93E3	6.81E2	ND	2.79E3	ND	1.70E7
Ce-144	6.58E5	2.72E5	3.54E4	ND	1.63E5	ND	1.65E8
Pr-143	2.89E2	1.15E2	1.44E1	ND	6.73E1	ND	9.53E5
Nd-147	1.82E2	1.98E2	1.19E1	ND	1.16E2	ND	7.15E5

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference NUREG 0133.

TABLE 3.4-4

INGESTION DOSE R FACTORS

GRASS-COW-MILK PATHWAY (ADULT)

(Reference NUREG 0133)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	7.63E2	7.63E2	7.63E2	7.63E2	7.63E2	7.63E2
Cr-51	ND	ND	2.86E4	1.71E4	6.27E3	3.80E4	7.20E6
Mn-54	ND	8.40E6	1.60E6	ND	2.50E6	ND	2.57E7
Fe-55	2.51E7	1.73E7	4.04E6	ND	ND	9.67E6	9.95E6
Fe-59	2.99E7	7.02E7	2.69E7	ND	ND	1.96E7	2.34E8
Co-58	ND	4.72E6	1.06E7	ND	ND	ND	9.51E7
Co-60	ND	1.64E7	3.62E7	ND	ND	ND	3.08E8
Ni-63	6.73E9	4.66E8	2.27E8	ND	ND	ND	9.73E7
Zn-65	1.37E9	4.37E9	1.97E9	ND	2.92E9	ND	2.75E9
Rb-86	ND	2.59E9	1.21E9	ND	ND	ND	5.11E8
Sr-89	1.47E9	ND	4.21E7	ND	ND	ND	2.35E8
Sr-90	4.69E10	ND	1.15E10	ND	ND	ND	1.35E9
Y-91	8.60E3	ND	2.29E2	ND	ND	ND	4.73E6
Zr-95	1.06E3	3.04E2	2.06E2	ND	4.77E2	ND	9.63E5
Nb-95	5.65E5	2.44E5	9.59E3	ND	2.43E5	ND	1.95E9
Ru-103	1.02E3	ND	4.39E2	ND	3.89E3	ND	1.19E5
Ru-106	2.04E4	ND	2.58E3	ND	3.94E4	ND	1.32E6
Ag-110M	5.83E7	5.39E7	3.20E7	ND	1.06E8	ND	2.20E10
Te-125M	1.63E7	5.90E6	2.18E6	4.90E6	6.63E7	ND	6.50E7
Te-127M	4.58E7	1.64E7	5.58E6	1.17E7	1.86E8	ND	1.54E8
Te-129M	6.05E7	2.26E7	9.58E6	2.08E7	2.53E8	ND	3.05E8
I-131	2.97E8	4.24E8	2.43E8	1.39E11	7.27E8	ND	1.12E8
I-133	3.31E6	5.76E7	1.75E6	8.46E8	1.00E7	ND	5.17E6
Cs-134	5.65E9	1.34E10	1.10E10	ND	4.33E9	1.44E9	2.35E8
Cs-136	2.69E8	1.06E9	7.65E8	ND	5.92E8	8.11E7	1.21E8
Cs-137	7.38E9	1.01E10	6.61E9	ND	3.43E9	1.14E9	1.95E8
Ba-140	2.70E7	3.39E4	1.77E6	ND	1.15E4	1.94E4	5.55E7
Ce-141	4.85E3	3.28E3	3.72E2	ND	1.52E3	ND	1.25E7
Ce-144	3.58E5	1.50E5	1.92E4	ND	8.87E4	ND	1.21E8
Pr-143	1.94E2	7.79E1	9.62E0	ND	4.49E1	ND	8.50E5
Nd-147	9.49E1	7.10E2	6.56E0	ND	6.41E1	ND	5.26E5

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference NUREG 0133.

TABLE 3.4-5

INGESTION DOSE R FACTORS

GRASS-COW-MEAT PATHWAY (CHILD)

(Reference NUREG 0133)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	2.34E2	2.34E2	2.34E2	2.34E2	2.34E2	2.34E2
Cr-51	ND	ND	8.82E3	4.89E3	1.34E3	8.93E3	4.68E5
Mn-54	ND	7.99E6	2.13E6	ND	2.24E6	ND	6.70E6
Fe-55	4.57E8	2.42E8	7.50E7	ND	ND	1.37E8	4.49E7
Fe-59	3.81E8	6.16E8	3.07E8	ND	ND	1.79E8	6.42E8
Co-58	ND	1.65E7	5.04E7	ND	ND	ND	9.60E7
Co-60	ND	6.93E7	2.04E8	ND	ND	ND	3.84E8
Ni-63	2.91E10	1.56E9	9.91E8	ND	ND	ND	1.05E8
Zn-65	3.76E8	1.00E9	6.22E8	ND	6.30E8	ND	1.76E8
Rb-86	ND	5.77E8	3.55E8	ND	ND	ND	3.71E7
Sr-89	4.92E8	ND	1.40E7	ND	ND	ND	1.90E7
Sr-90	1.04E10	ND	2.64E9	ND	ND	ND	1.40E8
Y-91	1.81E6	ND	4.83E4	ND	ND	ND	2.41E8
Zr-95	2.69E6	5.91E5	5.26E5	ND	8.46E5	ND	6.16E8
Nb-95	3.09E6	1.20E6	8.61E5	ND	1.13E6	ND	2.23E9
Ru-103	1.55E8	ND	5.97E7	ND	3.91E8	ND	4.02E9
Ru-106	4.44E9	ND	5.54E8	ND	5.99E9	ND	6.90E10
Ag-110M	8.41E6	5.68E6	4.54E6	ND	1.06E7	ND	6.76E8
Te-125M	5.69E8	1.54E8	7.59E7	1.60E8	ND	ND	5.49E8
Te-127M	1.77E9	4.78E8	2.11E8	4.24E8	5.06E9	ND	1.44E9
Te-129M	4.78E9	5.05E8	2.81E8	5.83E8	5.31E9	ND	2.21E9
I-131	1.66E7	1.67E7	9.49E6	5.52E9	2.74E7	ND	1.49E6
I-133	1.99E-1	2.46E-1	9.31E-2	4.57E1	4.10E-1	ND	9.91E-2
Cs-134	9.22D8	1.51E9	3.19E8	ND	4.69E8	1.68E8	8.16E6
Cs-136	1.73E7	4.74E7	3.07E7	ND	2.53E7	3.77E6	1.67E6
Cs-137	1.33E9	1.28E9	1.88E8	ND	4.16E8	1.50E8	7.99E6
Ba-140	4.39E7	3.85E4	2.56E6	ND	1.25E4	2.29E4	2.22E7
Ce-141	2.22E4	1.11E4	1.64E3	ND	4.86E3	ND	1.38E7
Ce-144	2.32E6	7.26E5	1.24E5	ND	4.02E5	ND	1.89E8
Pr-143	3.35E4	1.01E4	1.66E3	ND	5.45E3	ND	3.61E7
Nd-147	1.18E4	9.60E3	7.43E2	ND	5.27E3	ND	1.52E7

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference NUREG 0133.

TABLE 3.4-6

INGESTION DOSE R FACTORS

GRASS-COW-MEAT PATHWAY (TEEN)

(Reference NUREG 0133)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	1.94E2	1.94E2	1.94E2	1.94E2	1.94E2	1.94E2
Cr-51	ND	ND	5.65E3	3.14E3	1.24E3	8.07E3	9.49E5
Mn-54	ND	6.98E6	1.39E6	ND	2.08E6	ND	1.43E7
Fe-55	2.38E8	1.69E8	3.93E7	ND	ND	1.07E8	7.30E7
Fe-59	2.15E8	5.01E8	1.94E8	ND	ND	1.58E8	1.19E9
Co-58	ND	1.41E7	3.25E7	ND	ND	ND	1.94E8
Co-60	ND	5.83E7	1.31E8	ND	ND	ND	7.60E8
Ni-63	1.52E10	1.07E9	5.15E8	ND	ND	ND	1.71E8
Zn-65	2.50E8	8.69E8	4.06E8	ND	5.56E8	ND	3.68E8
Rb-86	ND	4.06E8	1.91E8	ND	ND	ND	6.01E7
Sr-89	2.60E8	ND	7.44E6	ND	ND	ND	3.09E7
Sr-90	8.05E9	ND	1.99E9	ND	ND	ND	2.26E8
Y-91	9.56E5	ND	2.56E4	ND	ND	ND	3.92E8
Zr-95	1.51E6	4.78E5	3.28E5	ND	7.02E5	ND	1.10E9
Nb-95	1.79E6	9.93E5	5.47E5	ND	9.63E5	ND	4.25E9
Ru-103	8.58E7	ND	3.67E7	ND	3.03E8	ND	7.17E9
Ru-106	2.36E9	ND	2.97E8	ND	4.55E9	ND	1.13E11
Ag-110M	5.07E6	4.80E6	2.92E6	ND	9.15E6	ND	1.35E9
Te-125M	3.03E8	1.09E8	4.05E7	8.47E7	ND	ND	8.94E8
Te-127M	9.42E8	3.34E8	1.12E8	2.24E8	3.82E9	ND	2.35E9
Te-129M	9.61E8	3.57E8	1.52E8	3.10E8	4.02E9	ND	3.61E9
I-131	8.97E6	1.26E7	6.75E6	3.66E9	2.16E7	ND	2.48E6
I-133	1.07E-1	1.82E-1	5.54E-2	2.54E1	3.19E-1	ND	1.38E-1
Cs-134	5.23E8	1.23E9	5.71E8	ND	3.91E8	1.49E8	1.53E7
Cs-136	9.96E6	3.92E7	2.63E7	ND	2.13E7	3.36E6	3.15E6
Cs-137	7.24E8	9.63E8	3.36E8	ND	3.28E8	1.27E8	1.37E7
Ba-140	2.39E7	2.93E4	1.54E6	ND	9.94E3	1.97E4	3.69E7
Ce-141	1.18E4	7.88E3	9.05E2	ND	3.71E3	ND	2.25E7
Ce-144	1.23E6	5.08E5	6.60E4	ND	3.04E5	ND	3.09E8
Pr-143	1.76E4	7.03E3	8.76E2	ND	4.09E3	ND	5.79E7
Nd-147	6.32E3	6.87E3	4.12E2	ND	4.04E3	ND	2.48E7

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference NUREG 0133.

TABLE 3.4-7

INGESTION DOSE R FACTORS

GRASS-COW-MEAT PATHWAY (ADULT)

(Reference NUREG 0133)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	3.25E2	3.25E2	3.25E2	3.25E2	3.25E2	3.25E2
Cr-51	ND	ND	7.06E3	4.22E3	1.56E3	9.37E3	1.78E6
Mn-54	ND	9.16E6	1.75E6	ND	2.72E6	ND	2.80E7
Fe-55	2.93E8	2.02E8	4.72E7	ND	ND	1.13E8	1.16E8
Fe-59	2.69E8	6.32E8	2.42E8	ND	ND	1.76E8	2.11E9
Co-58	ND	1.83E7	4.10E7	ND	ND	ND	3.70E8
Co-60	ND	7.52E7	1.66E8	ND	ND	ND	1.41E9
Ni-63	1.89E10	1.31E9	6.33E8	ND	ND	ND	2.73E8
Zn-65	3.56E8	1.13E9	5.12E8	ND	7.58E8	ND	7.13E8
Rb-86	ND	4.86E8	2.27E8	ND	ND	ND	9.59E7
Sr-89	3.08E8	ND	8.83E6	ND	ND	ND	4.93E7
Sr-90	1.24E10	ND	3.05E9	ND	ND	ND	3.59E8
Y-91	1.13E6	ND	3.03E4	ND	ND	ND	6.24E8
Zr-95	1.89E6	6.06E5	4.10E5	ND	9.51E5	ND	1.92E9
Nb-95	2.29E6	1.28E6	6.86E5	ND	1.26E6	ND	7.74E9
Ru-103	1.05E8	ND	4.54E7	ND	4.02E8	ND	1.23E10
Ru-106	2.80E9	ND	3.54E8	ND	5.40E9	ND	1.81E11
Ag-110M	6.70E6	6.19E6	3.69E6	ND	1.22E7	ND	2.53E9
Te-125M	3.59E8	1.30E8	4.81E7	1.08E8	1.46E9	ND	1.43E9
Te-127M	1.12E9	3.99E8	1.36E8	2.85E8	4.53E9	ND	3.74E9
Te-129M	1.15E9	4.28E8	1.82E8	3.94E8	4.79E9	ND	5.78E9
I-131	1.08E7	1.54E7	8.85E6	5.06E9	2.65E7	ND	4.07E6
I-133	1.28E-1	2.23E-1	6.78E-2	3.27E1	3.88E-1	ND	2.00E-1
Cs-134	6.57E8	1.56E9	1.29E9	ND	5.06E8	1.68E8	2.74E7
Cs-136	1.28E7	5.04E7	3.63E7	ND	2.80E7	3.84E6	5.73E6
Cs-137	8.72E8	1.19E9	7.81E8	ND	4.05E8	1.35E8	2.31E7
Ba-140	2.90E7	3.64E4	1.90E6	ND	1.24E4	2.08E4	5.96E7
Ce-141	1.41E4	9.51E3	1.08E3	ND	4.41E3	ND	3.63E7
Ce-144	1.46E6	6.09E5	7.82E4	ND	3.61E5	ND	4.93E8
Pr-143	2.09E4	8.39E3	1.04E3	ND	4.85E3	ND	9.17E7
Nd-147	7.17E3	8.29E3	4.96E2	ND	4.85E3	ND	3.99E7

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference NUREG 0133.

TABLE 3.4-8

INGESTION DOSE R FACTORS

VEGETATION PATHWAY (CHILD)

(Reference NUREG 0133)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	4.01E3	4.01E3	4.01E3	4.01E3	4.01E3	4.01E3
Cr-51	ND	ND	1.18E5	6.54E4	1.79E4	1.19E5	6.25E6
Mn-54	ND	6.61E8	1.76E8	ND	1.85E8	ND	5.55E8
Fe-55	8.00E8	4.24E8	1.31E8	ND	ND	2.40E8	7.86E7
Fe-59	4.07E8	6.58E8	3.28E8	ND	ND	1.91E8	6.85E8
Co-58	ND	6.47E7	1.98E8	ND	ND	ND	3.77E8
Co-60	ND	3.78E8	1.12E9	ND	ND	ND	2.10E9
Ni-63	3.95E10	2.11E9	1.34E9	ND	ND	ND	1.42E8
Zn-65	8.13E8	2.17E9	1.35E9	ND	1.36E9	ND	3.80E8
Rb-86	ND	4.52E8	2.78E8	ND	ND	ND	2.91E7
Sr-89	3.74E10	ND	1.07E9	ND	ND	ND	1.45E9
Sr-90	1.24E12	ND	3.15E11	ND	ND	ND	1.67E10
Y-91	1.87E7	ND	5.01E5	ND	ND	ND	2.49E9
Zr-95	3.92E6	8.63E5	7.68E5	ND	1.23E6	ND	9.00E8
Nb-95	4.10E5	1.60E5	1.14E5	ND	1.50E5	ND	2.95E8
Ru-103	1.54E7	ND	5.92E6	ND	3.88E7	ND	3.98E8
Ru-106	7.45E8	ND	9.30E7	ND	1.01E9	ND	1.16E10
Ag-110M	3.23E7	2.18E7	1.74E7	ND	4.06E7	ND	2.59E9
Te-125M	3.51E8	9.50E7	4.67E7	9.84E7	ND	ND	3.38E8
Te-127M	1.32E9	3.56E8	1.57E8	3.16E8	1.94E9	ND	1.07E9
Te-129M	8.58E8	2.40E8	1.33E8	2.77E8	2.52E9	ND	1.05E9
I-131	1.43E8	1.44E8	8.18E7	4.76E10	2.36E8	ND	1.28E7
I-133	3.19E6	3.95E6	1.49E6	7.33E8	6.58E6	ND	1.59E6
Cs-134	1.60E10	2.63E10	5.55E9	ND	8.15E9	2.92E9	1.42E8
Cs-136	4.44E8	1.22E9	7.90E8	ND	6.50E8	9.69E7	4.29E7
Cs-137	2.39E10	2.29E10	3.38E9	ND	7.46E9	2.68E9	1.43E8
Ba-140	2.77E8	2.43E5	1.62E7	ND	7.91E4	1.45E5	1.40E8
Ce-141	6.56E5	3.27E5	4.86E4	ND	1.43E5	ND	4.08E8
Ce-144	1.27E8	3.98E7	6.78E6	ND	2.21E7	ND	1.04E10
Pr-143	1.46E5	4.39E4	7.26E3	ND	2.38E4	ND	1.58E8
Nd-147	7.23E4	5.86E4	4.54E3	ND	5.47E1	ND	9.28E7

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference NUREG 0133.

TABLE 3.4-9

INGESTION DOSE R FACTORS

VEGETATION PATHWAY (TEEN)

(Reference NUREG 0133)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	4.10E3	4.10E3	4.10E3	4.10E3	4.10E3	4.10E3
P-32	1.60E9	9.91E7	6.20E7	ND	ND	ND	1.34E8
Cr-51	ND	ND	6.19E4	3.44E4	1.36E4	8.84E4	1.04E7
Mn-54	ND	4.52E8	8.97E7	ND	1.35E8	ND	9.27E8
Fe-55	3.25E8	2.31E8	5.38E7	ND	ND	1.46E8	9.98E7
Fe-59	1.83E8	4.28E8	1.65E8	ND	ND	1.35E8	1.01E9
Co-58	ND	4.38E7	1.01E8	ND	ND	ND	6.04E8
Co-60	ND	2.49E8	5.60E8	ND	ND	ND	3.24E9
Ni-63	1.61E10	1.13E9	5.44E8	ND	ND	ND	1.81E8
Zn-65	4.24E8	1.47E9	6.87E8	ND	9.43E8	ND	6.24E8
Rb-86	ND	2.73E8	1.28E8	ND	ND	ND	4.04E7
Sr-89	1.57E10	ND	4.50E8	ND	ND	ND	1.87E9
Sr-90	7.51E11	ND	1.85E11	ND	ND	ND	2.11E10
Y-91	7.87E6	ND	2.11E5	ND	ND	ND	3.23E9
Zr-95	1.75E6	5.52E5	3.80E5	ND	8.12E5	ND	1.27E9
Nb-95	1.92E5	1.06E5	5.85E4	ND	1.03E5	ND	4.54E8
Ru-103	6.85E6	ND	2.93E6	ND	2.41E7	ND	5.72E8
Ru-106	3.09E8	ND	3.90E7	ND	5.97E8	ND	1.48E10
Ag-110M	1.52E7	1.44E7	8.76E6	ND	2.75E7	ND	4.04E9
Te-125M	1.48E8	5.34E7	1.98E7	4.14E7	ND	ND	4.37E8
Te-127M	5.52E8	1.96E8	6.56E7	1.31E8	2.24E9	ND	1.37E9
Te-129M	3.69E8	1.37E8	5.84E7	1.19E8	1.54E9	ND	1.39E9
I-131	7.70E7	1.08E8	5.79E7	3.15E10	1.86E8	ND	2.13E7
I-133	1.75E6	2.97E6	9.06E5	4.15E8	5.21E6	ND	2.25E6
Cs-134	7.10E9	1.67E10	7.75E9	ND	5.31E9	2.03E9	2.08E8
Cs-136	4.65E7	1.83E8	1.23E8	ND	9.96E7	1.57E7	1.47E7
Cs-137	1.01E10	1.35E10	4.69E9	ND	4.59E9	1.78E9	1.92E8
Ba-140	1.39E8	1.71E5	8.97E6	ND	5.78E4	1.15E5	2.15E8
Ce-141	2.83E5	1.89E5	2.17E4	ND	8.90E4	ND	5.41E8
Ce-144	5.27E7	2.18E7	2.82E6	ND	1.30E7	ND	1.33E10
Pr-143	6.99E4	2.79E4	3.48E3	ND	1.62E4	ND	2.30E8
Nd-147	3.66E4	3.98E4	2.39E3	ND	2.34E4	ND	1.44E8

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference NUREG 0133.

TABLE 3.4-10

INGESTION DOSE R FACTORS

VEGETATION PATHWAY (ADULT)

(Reference NUREG 0133)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	5.11E3	5.11E3	5.11E3	5.11E3	5.11E3	5.11E3
Cr-51	ND	ND	4.66E4	2.79E4	1.03E4	6.18E4	1.17E7
Mn-54	ND	3.11E8	5.94E7	ND	9.27E7	ND	9.54E8
Fe-55	2.09E8	1.45E8	3.37E7	ND	ND	8.06E7	8.29E7
Fe-59	1.29E8	3.02E8	1.16E8	ND	ND	8.45E7	1.01E9
Co-58	ND	3.09E7	6.92E7	ND	ND	ND	6.26E8
Co-60	ND	1.67E8	3.69E8	ND	ND	ND	3.14E9
Ni-63	1.04E10	7.21E8	3.49E8	ND	ND	ND	1.50E8
Zn-65	3.18E8	1.01E9	4.57E8	ND	6.76E8	ND	6.37E8
Rb-86	ND	2.19E8	1.02E8	ND	ND	ND	4.32E7
Sr-89	1.03E10	ND	2.96E8	ND	ND	ND	1.65E9
Sr-90	6.05E11	ND	1.48E11	ND	ND	ND	1.75E10
Y-91	5.13E6	ND	1.37E5	ND	ND	ND	2.82E9
Zr-95	1.19E6	3.83E5	2.59E5	ND	6.00E5	ND	1.21E9
Nb-95	1.42E5	7.90E4	4.24E4	ND	7.81E4	ND	4.79E8
Ru-103	4.79E6	ND	2.06E6	ND	1.83E7	ND	5.59E8
Ru-106	1.93E8	ND	2.44E7	ND	3.72E8	ND	1.25E10
Ag-110M	1.06E7	9.78E6	5.81E6	ND	1.92E7	ND	3.99E9
Te-125M	9.66E7	3.50E7	1.29E7	2.90E7	3.93E8	ND	3.86E8
Te-127M	3.49E8	1.25E8	4.26E7	8.93E7	1.42E9	ND	1.17E9
Te-129M	2.56E8	9.55E7	4.05E7	8.79E7	1.07E9	ND	1.29E9
I-131	8.09E7	1.16E8	6.63E7	3.79E10	1.98E8	ND	3.05E7
I-133	1.89E6	3.29E6	1.00E6	4.83E8	5.73E6	ND	2.95E6
Cs-134	4.66E9	1.11E10	9.07E9	ND	3.59E9	1.19E9	1.94E8
Cs-136	4.47E7	1.77E8	1.27E8	ND	9.82E7	1.35E7	2.01E7
Cs-137	6.36E9	8.70E9	5.70E9	ND	2.95E9	9.81E8	1.68E8
Ba-140	1.29E8	1.62E5	8.47E6	ND	5.52E4	9.29E4	2.66E8
Ce-141	1.97E5	1.33E5	1.51E4	ND	6.20E4	ND	5.10E8
Ce-144	3.29E7	1.37E7	1.77E6	ND	8.15E6	ND	1.11E10
Pr-143	6.25E4	2.51E4	3.10E3	ND	1.45E4	ND	2.74E8
Nd-147	3.39E4	3.89E4	2.33E3	ND	2.27E4	ND	1.87E8

*R Values in units of mrem/yr per micro-Ci/m^3 for inhalation and tritium, and in units of m^2 mrem/yr per micro-Ci/sec for all others. Reference NUREG 0133.

3.4 METHODOLOGY FOR RMS-11 SETPOINT (Air Particulate)

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

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

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

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

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

Q_i = the particulate release rate ($\mu Ci/sec$) for radionuclide "i".

= 472 $(C_i)(F)$

where:

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

C_i = ($\mu Ci/cc_i$ from analysis of containment vessel) (0.368) for CV flow of 35,000 cfm when RMS-11 sampling the Plant Vent.

= ($\mu Ci/cc_i$ from analysis of CV) (0.04) for CV pressure relief when CV flow is 2500 cfm, when RMS-11 is sampling the Plant Vent.

= ($\mu Ci/cc_i$) from analysis of CV for CV flow of 2500 cfm or 35,000 cfm when RMS-11 is sampling the CV

F = 95,000 cfm for CV purge.

= 62,500 cfm for CV pressure relief.

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

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

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 ($\mu Ci/cc$) for most critical organ "j".

Maximum Monitor Setpoint for Organ "j" =

$$(\Sigma_i\ C_i)\ /\ (PDRR_j)\quad (SF)\ (T_m)\ (TL)$$

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 RMS-11 particulate monitor.

TL = total activity/ $\Sigma_i C_i$ where the total activity is the sum of particulates of > 8 day half-lives and particulates of < 8 day half-lives. If this ratio is not known, use 1.0.

3.4.4 Determine the maximum monitor setpoint (cpm) for the most critical organ "j".

Setpoint = (Maximum total body setpoint in μCi/cc) (monitor

$$\text{eff}) + \text{Bkg} + 3.3\sqrt{\frac{\text{Bkg}}{2\tau}} \qquad (3.4\text{-}3)$$

Setpoint = (Maximum skin setpoint in μCi/cc) (monitor eff) +

$$\text{Bkg} + 3.3\sqrt{\frac{\text{Bkg}}{2\tau}} \qquad (3.4\text{-}4)$$

Monitor efficiency = obtained from the applicable effluent monitor efficiency curve located in the POM, Volume 15, Curve Book. Use the radioactivity concentration (μCi/cc) to find cpm.

Bkg = the monitor background (cpm)

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

4.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

TABLE 4.0-1 contains the sample point description, sampling and collection frequency, analysis, and analysis frequency for various exposure pathways in the vicinity of HBR for the Radiological Monitoring Program. Figures 4.0-1a and 4.0-1b show the location of the various sampling points.

At the time of initial preparation of this manual, the limiting cow milk location was 1.3 miles in the NE sector. As of the time of submittal of this manual, there is no longer a cow present at this location. The radiological environmental monitoring program has been altered to reflect this change. However, the X/Q, and D/Q values associated with this location have been retained for future reference.

TABLE 4.0-1

H. B. ROBINSON RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
1. Airborne Particulates and Radioiodine	1.	Florence, S. C. (Control Station)[2] 26 miles ESE @ 119°	Continuous operating sampler with sample collection at least weekly	Weekly Weekly Quarterly	I-131 for Air Cartridges Gross Beta[3] Gamma Scan[4] of composite (by location)
	2.	Information Center 0.2 mile S @ 180°			
	3.	Microwave tower 0.7 mile N @ 5°			
	4.	Spillway 0.4 mile ESE @ 110°			
	5.	East Shore of lake across from plant intake Johnson's Landing 0.9 mile ENE @ 73°			
	6.	Information Center 0.3 mile SW @ 214°			
	7.	CP&L Hartsville substation, 6.3 miles ESE @ 109°			
2. Direct Radiation	1.	Florence, S.C. (Control Station)[2] 26 miles ESE @ 119°	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose[5]

Table 4.0-1 (continued)

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
2. Direct Radiation (continued)	2.	Information Center 0.2 mile S @ 180°	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose[5]
	3.	Microwave tower 0.7 mile N @ 5°			
	4.	Spillway 0.4 mile ESE @ 110°			
	5.	East shore of lake across from plant intake Johnson's landing 0.9 mile ENE @ 73°			
	6.	Information Center 0.3 mile SW @ 214°			
	7.	CP&L Hartsville substation 6.3 miles ESE @ 109°			
	8.	On transmission poles intersecting with different transmission lines directly from HBR, approximately two pole sections down from railroad tracks 0.8 mile SSE.			
	9.	Second transmission pole from 151 Highway 1.0 mile S.			
	10.	Power pole at corner of The Church of God cemetary 1.0 mile WSW.			
	11.	Third power pole from the Old Camden Road 1.0 mile SW.			
	12.	Pine tree located at the second intersection of dirt road. Yellow mark on tree 1.2 miles SSW.			

Table 4.0-1 (continued)

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
2. Direct Radiation (continued)	13.	Corner pine tree where dirt road splits 1.0 mile W.	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose[5]
	14.	Power pole by Highway 151 on front of Pine Ridge Church 0.9 mile WNW.			
	15.	Pine tree down dirt road off Highway 151 directly adjacent to ash pond on CP&L property 1.0 miles NW.			
	16.	Southeast fence at Darlington County I.C. Turbine Plant 1.0 mile NNW.			
	17.	Small pine tree, right side of road, 1.0 mile down Discharge Canal road at Old Unit One Weir 1.1 miles N.			
	18.	Left side of train trestle over Black Creek 0.7 mile SE.			
	19.	Third power pole on Road #S-16-23 from intersection with 1.0 mile E.			
	20.	Power Pole #47 at right side of Road #S-16-39 going north 1.3 miles ENE.			
	21.	Power pole in the yard of A. Atkinson at Atkinson's boat landing.			
	22.	Shady Rest at light pole near the dock 1.9 miles NNE.			
	23.	Power Pole #41E-5 on Road #41E-5 on Road #S-16-39 1.2 miles ESE.			
	24.	151 north past peach farm, first paved Road #S-13-711 left. Fifth pole left side of road. Yellow marking 5.0 miles NW.			

Table 4.0-1 (continued)

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
2. Direct Radiation (continued)	25.	Road #S-13-346 off 151 North. Cross railroad tracks and proceed 3/8 mile. Walk down right fence line into the woods towards pond. Badge on right pine tree f 18 yards directly in front of fence marked "No Trespassing" 4.6 miles NNW.	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose[5]
	26.	Power pole #32J-6 across old yellow house on Road #S-13-346 5.0 miles N.			
	27.	Road #S-13-763, f 1.3 miles from intersection 5.0 miles NNE.			
	28.	Power Pole #30-4-A near dumpster on road #S-13-39 4.8 miles NE.			
	29.	Transmission pole nearest Road #S-16-20 f 1/2 mile south of lookout tower.			
	30.	Located on Road #S-16-20, power pole in front yard of Johnson Fence and Awning 4.6 miles E.			
	31.	Lakeshore Drive, Pole #1122 right side of road. Yellow marking 4.6 miles ESE.			
	32.	Straight down the end of Kalber Drive, 12 feet up the transmission tower. Yellow marking 4.5 miles SE.			
	33.	Power Pole #25-4, left side of Road #S-16-493 near Harley Segar's driveway 4.6 miles SSE.			
	34.	Transmission pole nearest Road #S-16-772 4.6 miles S.			

Table 4.0-1 (continued)

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
2. Direct Radiation (continued)	35.	Power pole at corner of Road #S-31-51 off Road #S-16-12 4.4 miles SSW.	Continuous measurement with readout at least once per quarter (TLDs)	Quarterly	Gamma Dose[5]
	36.	Power pole 1 3/4 mile down paved road off Road #S-16-85. Pole is in front of old house 4.7 miles SW.			
	37.	Transmission tower closest to Clay Road 5.0 miles WSW.			
	38.	Transmission pole right side of Road S-16-231 next to Union Church 4.9 miles W.			
	39.	Power pole, right side of road in middle of field. Yellow paint 5.0 miles WNW.			
3. Waterborne a. Surface Water	40.	Black Creek at Road 1623 0.6 mile ESE (Indicator).	Composite sample[6] over one-month period	Monthly	Gamma Scan[4] H-3
	41.	Black Creek (Control Station[2] 7.2 miles NNW.			
b. Groundwater	40.	Artesian well 0.6 mile ESE.	Grab Sample	Monthly	Gamma Scan[4] H-3
	42.	Unit 1 deep well			
	43.	Unit 2 deep well			
c. Drinking Water		Not required[7].			
d. Shoreline Sediment	44.	East Shore of Lake, Shady Rest Club 1.9 miles NNE.	Semiannually	Semiannually	Gamma Scan[4]

Table 4.0-1 (continued)

Exposure Pathway and/or Sample	Sample Point	Sample Point Description, Distance, and Direction	Sampling and Collection Frequency	Analysis[1] Frequency	Analysis[1]
4. Ingestion a. Milk	53.	Lyndale Farm 9.0 miles SW (control station)	Semimonthly when animals are on pasture; monthly @ other times	Semimonthly when animals are on pasture; monthly @ other times	Gamma Scan[4] and I-131 analysis semi-monthly when animals are on pasture; monthly @ other times
	54.	Auburndale Plantation[8] 10.1 miles E.			
b. Fish	45.	Site varies within Lake Robinson.	Semiannually (collect comparable species at all three locations)	Each sample	Gamma Scan[4] Edible portion
	46.	Prestwood Lake 4.9 miles ESE.			
	47.	Bee Lake (Control Station)[2] 13 miles NNW or May Lake 12.5 miles NW.			
c. Food Products leafy vegetables	58.	One location within 3 miles of site in the sector with the highest deposition rate based on the latest information or historical data (location may vary).	Annual at Harvest	Each sample	Gamma Scan[4]
	49.	One location greater than 5 miles from plant site with the least deposition rate (Control Station)[2].			
	54.	Auburndale Plantation[8] 10.1 miles E.			
d. Broad-leaf vegetation	50.	0.25 mile SSE CP&L property[9].	Monthly when available (3 different kinds of broad-leaf vegetation)	Each sample	Gamma Scan[4] I-131
	51.	0.25 NNE CP&L property[9].			
	52.	10 miles W Bethune (Control Station)[2].			

FOOTNOTES:

1. The LLD for each analysis is specified in Table 3.17-3 of the HBR Technical Specifications.

2. Control stations are locations outside the influence of plant effluents.

3. Airborne particulate sample filter shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate is greater than ten times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

4. Gamma scan means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

5. Thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters.

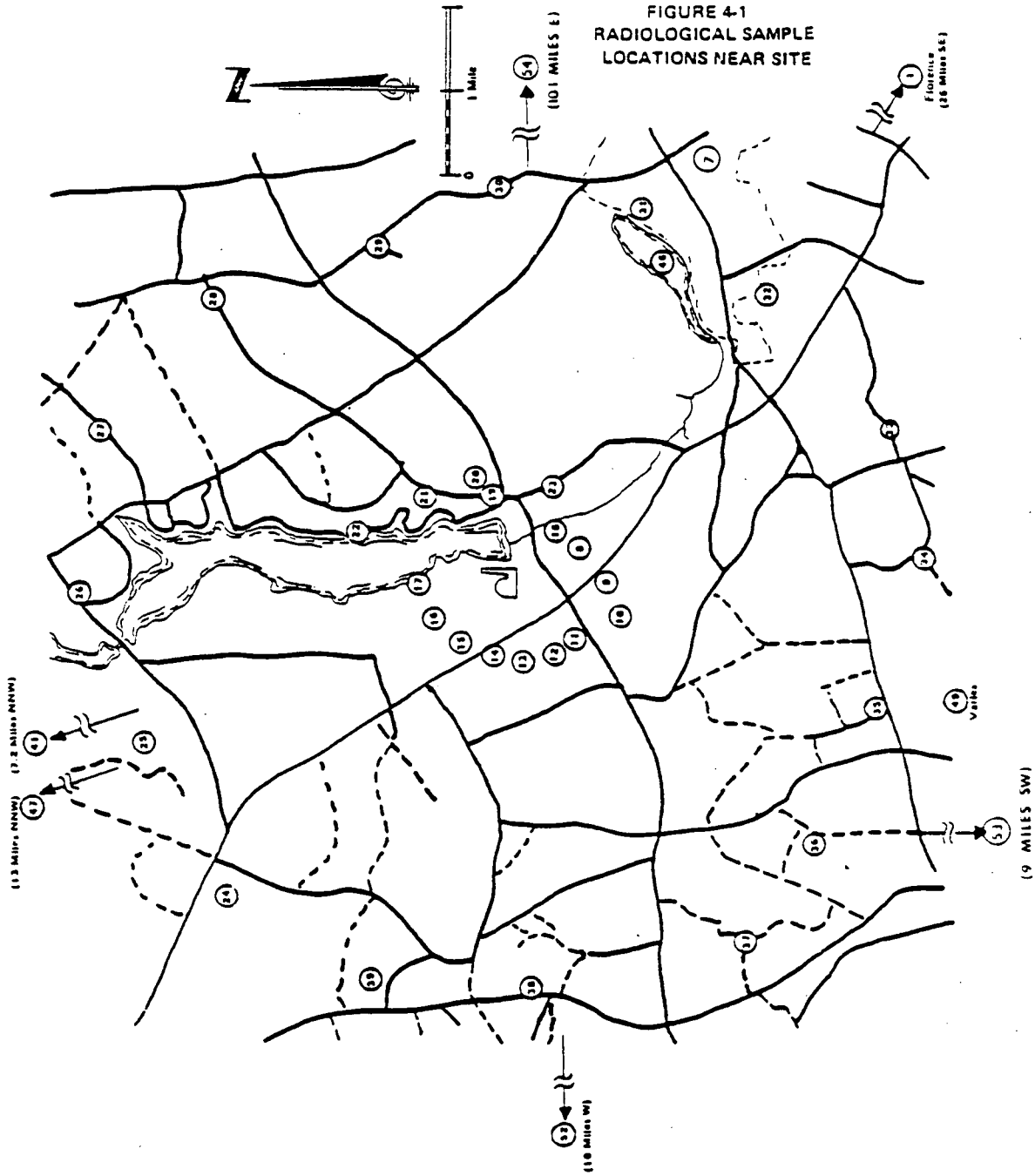
6. Composite sample aliquots shall be collected at time intervals that are short (5 or 6 times daily) relative to the compositing period (monthly in order to assure obtaining a representative sample).

7. Collection of drinking water samples is not required since there are no known reservoirs on Black Creek used for drinking purposes.

8. Water from Black Creek is used to irrigate feed and fodder for Arburndale Plantation's Dairy operation. This dairy is located *f* 11 miles east @ 90° from plant.

9. Sample Points 50 and 51 are the highest and the second highest D/Q values, respectively. These locations are more restrictive than site boundary locations.

FIGURE 4-1
RADIOLOGICAL SAMPLE
LOCATIONS NEAR SITE



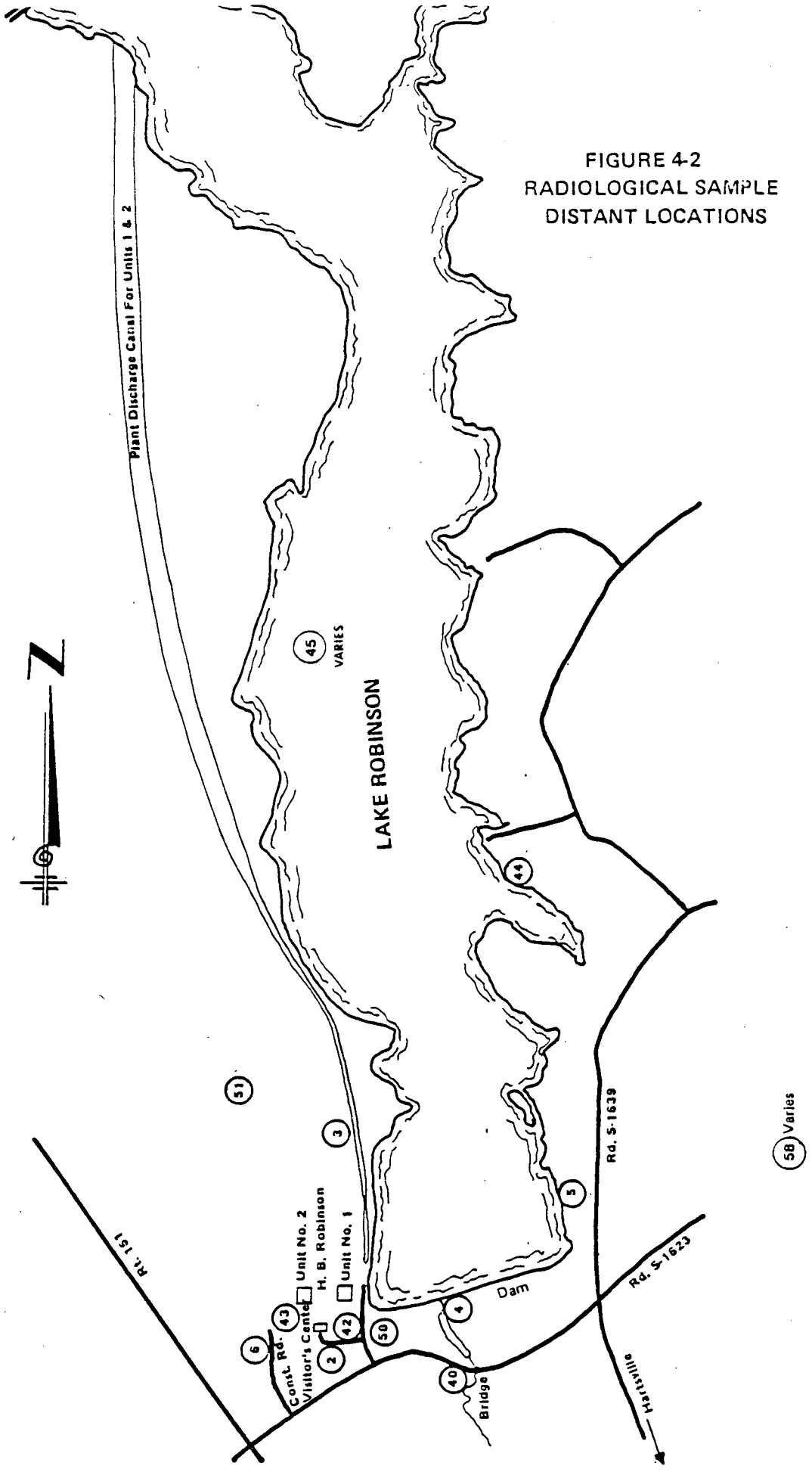


FIGURE 4-2
RADIOLOGICAL SAMPLE
DISTANT LOCATIONS

5.0 INTERLABORATORY COMPARISON STUDIES

5.1 OBJECTIVE

The objective of this program is to evaluate the total laboratory analysis process by comparing results with results obtained by a separate laboratory or laboratories for an equivalent sample.

5.2 PROGRAM

5.2.1 Environmental Sample Analyses Comparison Program

Environmental samples from the HBR environs are to be analyzed by the Harris Energy & Environmental Center or by a qualified contracting laboratory. These laboratories will participate at least annually in a nationally recognized interlaboratory comparison study. The results of the laboratories' performances in the study will be provided to HBR E&RC and will be included in the Annual Radiological Environmental Operating Report.

5.2.2 Effluent Release Analyses Program

HBR E&RC will perform sample analyses for gamma-emitting radionuclides in effluent releases. The E&RC radiochemistry laboratory will participate annually in a corporate interlaboratory comparison study or an equivalent study. The results of these studies will be provided to the NRC upon request.

5.2.3 Abnormal Results

If the CP&L laboratory or vendor laboratory results lie at greater than three sigma from the "recognized value," an evaluation will be performed to identify any recommended remedial actions to reduce anomalous errors. Complete documentation on the evaluation will be available to HBR and will be provided to the NRC upon request.

6.0 TOTAL DOSE (40CFR190 CONFORMANCE)

6.1 COMPLIANCE WITH 40CFR190

Compliance with 40CFR190 as prescribed by Specification 3.9.6 is to be demonstrated only when one or more of Specifications 3.9.2.1.a, 3.9.2.1.b, 3.9.4.1a, 3.9.4.1.b, 3.9.5.1.a, and 3.9.5.1.b is exceeded by a factor of 2. Once this occurs the Company has 30 days to submit this report in accordance with Specification 6.9.4(d).

6.2 CALCULATIONS EVALUATING CONFORMANCE WITH 40CFR190

To perform the calculations to evaluate conformance with 40CFR190, an effort is made to develop doses that are realistic by removing assumptions that lead to overestimates of dose to a MEMBER OF THE PUBLIC (i.e., calculations for compliance with 10CFR50, App. I). To accomplish this the following calculational rules are used:

(1) Doses to a MEMBER OF THE PUBLIC via the liquid release pathway will be calculated.

(2) Doses to a MEMBER OF THE PUBLIC due to a milk pathway will be evaluated only as can be shown to exist. Otherwise, doses via this pathway will be estimated as <1 mrem/yr.

(3) Environmental sampling data which demonstrate that no pathway exists may be used to delete a pathway to man from a calculation.

(4) To sum numbers represented as "less than" (<), use the value of the largest number in the group.

(i.e. <5 + <1 + <1 + <3 = 5)

(5) When doses via direct radiation are added to doses via inhalation pathway, they will be calculated for the same distance in the same sector.

(6) The calculational locations for a MEMBER OF THE PUBLIC will only be at residences or places of employment.

NOTE: Additional assumptions may be used to provide situation-specific parameters, provided they are documented along with their concomitant bases.

6.3 CALCULATIONS OF TOTAL BODY DOSE

Estimates will be made for each of the following exposure pathways to the same location by age class. Only those age classes known to exist at a location are considered.

6.3.1 Direct Radiation

The component of dose to a MEMBER OF THE PUBLIC due to direct radiation will be determined by:

(1) Determining the direct radiation dose at the plant boundary in each sector, $D_{B,\theta}$.

(2) Extrapolate that dose to the calculational location as follows:

$$D_{L,\theta} = \frac{D_{B,\theta}\ (1.49\ E{+}6)}{(X_{L,\theta})^2}$$

$D_{L,\theta}$ = dose at calculational location in sector θ.

1.49E+6 = square of mean distance to the site boundary (1220 m).

$X_{L,\theta}$ = Distance to calculational locations in sector θ in meters.

6.3.2 Inhalation Dose

The inhalation dose will be determined at the calculational locations for each age class at risk according to the methods outlined in Section 3.3 of this manual.

6.3.3 Ingestion Pathway

The dose via the ingestion pathway will be calculated at the consumer locations for the consumers at risk. If no milk pathway exists in a sector, the dose via this pathway will be treated as <1 mrem/yr.

6.3.4 Other Uranium Fuel Cycle Sources

The dose from other fuel cycle sources will be treated as <1 mrem/yr.

6.4 THYROID DOSE

The dose to the thyroid will be calculated for each sector as the sum of inhalation dose and milk ingestion dose (if existing). The calculational methods will be those identified in Section 3.3 of this manual.

6.5 DOSE PROJECTIONS

Dose projections are to incorporate planned plant operations such as power reduction or outages for the projected period.

APPENDIX A
METEOROLOGICAL DISPERSION FACTOR COMPUTATIONS

Carolina Power & Light Company (CP&L) engaged the services of Dames & Moore to assess the transport and dispersion of the effluent in the atmosphere as outlined in Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants, NUREG 0133 (USNRC 1978). The methodology for this assessment was based on guidelines presented in Regulatory Guide (RG) 1.111, Revision 1 (USNRC 1977). The results of the assessment were to provide the relative deposition flux and relative concentrations (undepleted and depleted) based on numercial models acceptable for use in Appendix I evaluations.

Regulatory Guide 1.111 presented three acceptable diffusion models for use in estimating deposition flux and concentrations. These were (1) particle-in-cell model (a variable trajectory model based on the gradient-transport theory), (2) puff-advection model (a variable trajectory model based on the statistical approach to diffusion), and (3) the constant mean wind direction model referred to here as the straight-line trajectory Gaussian diffusion model (the most widely used model based on a statistical approach). It was resolved that for operational efficiency, the straight-line described in XOQDOQ Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations (Draft), NUREG 0324 (USNRC September 1977) would be used for generating the required analyses of Appendix I. To provide a more realistic accounting of the variability of wind around the plant site, terrain/recirculation correction factors (TCF) were to be determined from a combined puff-advection/straight-line scheme for a one-year meteorological data base.

Dames & Moore was provided a one-year record of meteorological data from the on-site meteorological program at the H. B. Robinson Steam Electric Plant. These data consisted of all collected parameters at both the 11.03-meter and 62.39-meter tower levels for the year 1977. Dames & Moore computed dispersions and depositions using the model described in the reference. The following tables from the reference provide the basis for the meteorological dilution factor development of the technical specifications for Appendix I and were the source of the X/Q and D/Q values used to show compliance with 10CFR20 and 10CFR50 for noble gases and radioiodines and particulates.

Tables A-1 through A-6	Relative undepleted concentration, relative depleted concentration, and relative deposition flux estimates for ground level releases for both standard distances and special locations for long-term releases.
Tables A-7 through A-9	Relative undepleted concentration, relative depleted concentration, and relative deposition flux estimates for ground level releases for special locations for short-term releases.

The X/Q and D/Q values which are used in Appendix B for showing compliance with 10CFR20 and 10CFR50 when the HBR Plant vent has been modified such that it qualifies as a mixed mode release were based upon the following tables:

Tables A-10 through A-15	Relative undepleted concentration, relative depleted concentration, and relative deposition flux estimates for elevated release for both standard distances and special locations for long-term releases.
Tables A-16 through A-18	Relative undepleted concentration, relative depleted concentration, and relative deposition flux estimates for mixed mode releases for special locations for short-term releases.

It should be noted that the short-term releases were based upon 100 hours per year of containment purges.

Future Operation Computations

The NRC "XOQDOQ" Program (Revision 1) was obtained and installed on the CP&L computer system. In general, Dames & Moore concluded that the straight-line model is as reasonable a projection of concentrations as the puff-advection

model. By inclusion of the terrain correction factors developed by a combination of the puff-advection/straight-line scheme with the results of the XOQDOQ Program, ready evaluation of on-site meteorological data may be made.

For routine meteorological dispersion evaluations, the "XOQDOQ" Program will be run with the appropriate physical plant data, appropriate meteorological information for the standard distances, and special locations of interest without a terrain/recirculation factor. The resulting computations will have applied the TCFs to produce a final atmospheric diffusion estimate for the site. The input to "XOQDOQ" for ground level releases at HBR are presented in Table A-19 and for mixed mode releases at HBR in Table A-20.

Reference

Chandler, Martin W. and George Hoopes, Revised Radiological Effluent Technical Specifications. Gaseous Effluent Dilution Factors, Prepared for Carolina Power & Light Company, Robinson Facility, Dames & Moore, January 18, 1979.

TABLE A-1

X/Q Values for Long-Term Ground Level Releases at Special Locations (sec/m^3)*

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Straight Line (ANNX0Q9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	6.67E-06	4.13E-06	0.00	6.26E-06	5.56E-06
NE	3.02E-06	2.56E-06	2.13E-06	2.44E-06	2.13E-06
ENE	4.41E-06	4.93E-07	0.00	4.18E-06	7.36E-07
E	6.39E-06	3.02E-07	1.44E-07	3.51E-06	3.68E-07
ESE	1.12E-05	1.18E-06	0.00	7.90E-06	7.90E-06
SE	3.28E-05	0.00	0.00	3.27E-05	3.27E-05
SSE	8.08E-05	0.00	0.00	6.01E-05	6.01E-05
S	3.29E-05	4.22E-07	0.00	2.78E-05	1.65E-05
SSW	2.10E-05	5.61E-07	0.00	2.04E-05	8.07E-06
SW	8.91E-06	2.61E-07	2.14E-07**	6.90E-06	5.38E-06
WSW	3.97E-06	1.16E-07	0.00	3.22E-06	1.83E-06
W	2.11E-06	3.89E-08	0.00	1.38E-06	1.38E-06
WNW	1.62E-06	5.32E-08	0.00	1.03E-06	6.06E-07
NW	7.93E-07	5.06E-07	0.00	7.39E-07	7.39E-07
NNW	1.31E-06	4.78E-07	0.00	4.42E-07	3.82E-07
N	1.45E-06	6.44E-07	0.00	6.67E-07	6.67E-07

* Zeroes indicate that this point was not calculated

** A milk goat is located here

TABLE A-2

Depleted X/Q Values for Long-Term Ground Level Releases at Special Locations (sec/m^3)*

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Depleted Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Straight Line (ANNXOQ9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	5.84E-06	3.38E-06	0.00	5.25E-06	4.77E-06
NE	2.68E-06	2.21E-06	1.79E-06	2.09E-06	1.79E-06
ENE	3.95E-06	3.99E-07	0.00	3.72E-06	5.93E-07
E	5.79E-06	2.42E-07	1.08E-07	3.12E-06	2.86E-07
ESE	1.01E-05	9.72E-07	0.00	7.11E-06	7.11E-06
SE	3.08E-05	0.00	0.00	3.05E-05	3.05E-05
SSE	7.46E-05	0.00	0.00	5.61E-05	5.61E-05
S	3.11E-05	3.42E-07	0.00	2.61E-05	1.53E-05
SSW	1.91E-05	4.55E-07	0.00	1.96E-05	7.35E-06
SW	8.25E-06	2.14E-07	2.44E-07**	6.44E-06	4.88E-06
WSW	3.68E-06	8.92E-08	0.00	2.94E-06	1.68E-06
W	1.98E-06	2.96E-08	0.00	1.26E-06	1.26E-06
WNW	1.47E-06	4.07E-08	0.00	9.26E-07	5.42E-07
NW	6.71E-07	4.19E-07	0.00	6.31E-07	6.31E-07
NNW	1.09E-06	3.80E-07	0.00	3.48E-07	2.98E-07
N	1.24E-06	5.11E-07	0.00	5.24E-07	5.24E-07

* Zeroes indicate that this point was not calculated

** A milk goat is located here

TABLE A-3

D/Q Values for Long-Term Ground Level Releases at Special Locations (m^{-2})*

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Deposition Rate ($Meter^{-2}$)
Calculation Points: Special
Model: Straight Line (ANNXOQ9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	9.80E-09	5.63E-09	0.00	9.09E-09	7.74E-09
NE	5.59E-09	4.65E-09	3.70E-09	4.42E-09	3.70E-09
ENE	8.06E-09	6.96E-10	0.00	7.59E-09	1.05E-09
E	1.24E-08	4.13E-10	1.80E-10	6.43E-09	5.11E-10
ESE	1.71E-08	1.46E-09	0.00	1.20E-08	1.20E-08
SE	4.23E-08	0.00	0.00	4.14E-08	4.14E-08
SSE	8.08E-08	0.00	0.00	6.21E-08	6.21E-08
S	4.39E-08	4.77E-10	0.00	3.82E-08	2.33E-08
SSW	5.92E-08	1.38E-09	0.00	6.12E-08	2.33E-08
SW	2.80E-08	6.49E-10	5.17E-10**	2.15E-08	1.65E-08
WSW	1.91E-08	4.37E-10	0.00	1.54E-08	8.84E-09
W	8.84E-09	1.09E-10	0.00	5.75E-09	5.75E-09
WNW	8.10E-09	1.88E-10	0.00	5.08E-09	2.97E-09
NW	2.44E-09	1.45E-09	0.00	2.16E-09	2.16E-09
NNW	2.44E-09	7.45E-10	0.00	6.83E-10	5.73E-10
N	1.76E-09	6.44E-10	0.00	6.67E-10	6.67E-10

* Zeroes indicate that this point was not calculated

** A milk goat is located here

TABLE A-4

X/Q Values for Long-Term Ground Level Releases at Standard Distances (sec/m^3)

Carolina Power & Light Company - Robinson

Release Type: Annual

Release Mode: Ground Level

Variable: Relative Concentration (Sec./Cubic Meter)

Calculation Points: Standard

Model: Straight Line (ANNX009)

Application of Terrain Correction Factors: Yes

Number of Observations: 8703

BASE DISTANCE IN MILES/KILOMETERS

Aftd Sect	Design Dist MI	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	8.8E-05	1.5E-05	6.4E-06	3.5E-06	2.3E-06	1.7E-06	1.1E-06	8.0E-07	5.5E-07	3.7E-07
NE	0.	3.9E-05	4.6E-06	2.0E-06	1.1E-06	6.9E-07	4.6E-07	3.5E-07	2.8E-07	2.2E-07	1.7E-07
ENE	0.	3.2E-05	5.2E-06	1.8E-06	9.7E-07	5.3E-07	3.8E-07	2.6E-07	2.1E-07	1.7E-07	1.5E-07
E	0.	2.9E-05	4.5E-06	1.6E-06	8.3E-07	6.2E-07	3.3E-07	2.7E-07	1.9E-07	1.3E-07	9.5E-08
ESE	0.	3.6E-05	5.4E-06	2.3E-06	1.3E-06	9.2E-07	6.2E-07	5.1E-07	3.6E-07	2.7E-07	1.9E-07
SE	0.	4.0E-05	5.4E-06	2.6E-06	1.3E-06	8.5E-07	4.8E-07	3.6E-07	2.1E-07	1.9E-07	1.6E-07
SSE	0.	8.2E-05	1.2E-05	5.0E-06	2.6E-06	1.5E-06	9.2E-07	6.5E-07	5.5E-07	4.5E-07	4.0E-07
S	0.	3.6E-05	4.4E-06	1.7E-06	9.1E-07	4.2E-07	3.3E-07	2.6E-07	2.1E-07	1.7E-07	1.4E-07
SSW	0.	2.5E-05	4.6E-06	1.9E-06	7.9E-07	4.5E-07	3.0E-07	2.1E-07	1.6E-07	1.2E-07	9.8E-08
SW	0.	1.5E-05	2.2E-06	8.3E-07	3.7E-07	2.3E-07	1.6E-07	1.2E-07	8.8E-08	7.1E-08	5.9E-08
WSW	0.	6.5E-06	1.0E-06	3.7E-07	2.0E-07	1.6E-07	1.0E-07	6.9E-08	5.8E-08	4.8E-08	3.7E-08
W	0.	6.5E-06	8.3E-07	3.2E-07	1.7E-07	1.3E-07	8.8E-08	6.7E-08	4.3E-08	3.0E-08	2.4E-08
WNW	0.	6.1E-06	7.8E-07	3.0E-07	1.9E-07	1.3E-07	9.6E-08	7.1E-08	5.4E-08	4.0E-08	3.0E-08
NW	0.	1.1E-05	1.6E-06	7.4E-07	4.2E-07	2.4E-07	1.3E-07	8.0E-08	6.7E-08	5.3E-08	4.4E-08
NNW	0.	2.0E-05	3.6E-06	1.9E-06	1.4E-06	9.4E-07	5.2E-07	2.7E-07	1.8E-07	1.2E-07	9.2E-08
N	0.	5.2E-05	8.0E-06	3.3E-06	1.6E-06	1.0E-06	7.1E-07	4.9E-07	3.7E-07	2.9E-07	2.4E-07

Number of Valid Observations	=	8703
Number of Invalid Observations	=	57
Number of Calms Lower Level	=	398
Number of Calms Upper Limit	=	0

TABLE A-5

Depleted X/Q Values for Long-Term Ground Level Releases at Standard Distances (sec/m^3)

Carolina Power & Light Company - Robinson

Release Type: Annual

Release Mode: Ground Level

Variable: Relative Concentration (Sec./Cubic Meter)

Calculation Points: Standard

Model: Straight Line (ANNX009)

Application of Terrain Correction Factors: Yes

Number of Observations: 8703

BASE DISTANCE IN MILES/KILOMETERS

Aftd Sect	Design Dist MI	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	8.3E-05	1.3E-05	5.4E-06	3.0E-06	2.0E-06	1.3E-07	8.3E-06	6.2E-07	4.1E-07	2.7E-07
NE	0.	3.6E-05	4.1E-06	1.7E-06	9.2E-07	5.6E-07	3.6E-07	2.7E-07	2.1E-07	1.6E-07	1.3E-07
ENE	0.	3.1E-05	4.6E-06	1.5E-06	8.3E-07	4.3E-07	3.0E-07	2.0E-07	1.6E-07	1.3E-07	1.1E-07
E	0.	2.7E-05	4.1E-06	1.3E-06	6.9E-07	5.0E-07	2.7E-07	2.1E-07	1.4E-07	9.4E-08	7.2E-08
ESE	0.	3.4E-05	4.9E-06	2.0E-06	1.1E-06	7.4E-07	5.0E-07	4.0E-07	2.9E-07	2.1E-07	1.5E-07
SE	0.	3.8E-05	4.9E-06	2.2E-06	1.1E-06	7.0E-07	3.8E-07	2.8E-07	1.7E-07	1.4E-07	1.2E-07
SSE	0.	7.8E-05	1.1E-05	4.4E-06	2.2E-06	1.3E-06	7.6E-07	5.1E-07	4.3E-07	3.3E-07	2.9E-07
S	0.	3.5E-05	3.9E-06	1.4E-06	7.6E-07	3.5E-07	2.6E-07	2.0E-07	1.6E-07	1.3E-07	1.1E-07
SSW	0.	2.3E-05	4.1E-06	1.6E-06	6.6E-07	3.7E-07	2.4E-07	1.7E-07	1.2E-07	8.9E-08	6.9E-08
SW	0.	1.4E-05	1.9E-06	7.1E-07	3.1E-07	1.9E-07	1.2E-07	9.8E-08	6.7E-08	5.0E-08	4.3E-08
WSW	0.	6.2E-06	9.2E-07	3.2E-07	1.7E-07	1.3E-07	8.0E-08	5.4E-08	4.4E-08	3.6E-08	2.7E-08
W	0.	6.1E-06	7.5E-07	2.8E-07	1.4E-07	1.1E-07	6.8E-08	5.2E-08	3.3E-08	2.3E-08	1.8E-08
WNW	0.	5.8E-06	7.0E-07	2.6E-07	1.5E-07	1.1E-07	7.6E-08	5.5E-08	4.2E-08	3.0E-08	2.2E-08
NW	0.	1.1E-05	1.4E-06	6.4E-07	1.4E-07	2.0E-07	1.0E-07	6.1E-08	5.0E-08	4.0E-08	3.3E-08
NNW	0.	1.9E-05	3.1E-06	1.6E-06	1.1E-06	7.6E-07	4.2E-07	2.0E-07	1.3E-07	8.8E-08	7.1E-08
N	0.	4.9E-05	7.2E-06	2.8E-06	1.4E-06	8.1E-07	5.6E-07	3.8E-07	2.9E-07	2.2E-07	1.8E-07

Number of Valid Observations	=	8703
Number of Invalid Observations	=	57
Number of Calms Lower Level	=	398
Number of Calms Upper Limit	=	0

TABLE A-6

D/Q Values for Long-Term Ground Level Releases at Standard Distances (m^{-2})

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Ground Level
Variable: Relative Concentration (Meter-^{2})
Calculation Points: Standard
Model: Straight Line (ANNXOQ9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

BASE DISTANCE IN MILES/KILOMETERS

Aftd Sect	Design Dist MI	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	1.3E-07	2.4E-08	9.3E-09	4.8E-09	3.0E-09	2.0E-09	1.2E-09	8.2E-10	5.4E-10	3.4E-10
NE	0.	7.1E-08	8.9E-09	3.4E-09	1.8E-09	1.0E-09	6.5E-10	4.6E-10	3.4E-10	2.6E-10	2.0E-10
ENE	0.	5.5E-08	9.6E-09	3.1E-09	1.5E-09	7.9E-10	5.1E-10	3.3E-10	2.6E-10	1.9E-10	1.6E-10
E	0.	5.1E-08	8.7E-09	2.7E-09	1.4E-09	9.4E-10	4.7E-10	3.6E-10	2.4E-10	1.5E-10	1.1E-10
ESE	0.	5.0E-08	8.2E-09	3.2E-09	1.6E-09	1.1E-09	6.9E-10	5.1E-10	3.6E-10	2.5E-10	1.8E-10
SE	0.	4.8E-08	7.0E-09	3.1E-09	1.5E-09	8.6E-10	4.5E-10	3.1E-10	1.8E-10	1.5E-10	1.2E-10
SSE	0.	8.2E-08	1.3E-08	5.2E-09	2.6E-09	1.4E-09	7.7E-10	4.9E-10	3.9E-10	3.0E-10	2.5E-10
S	0.	4.8E-08	6.3E-09	2.2E-09	1.2E-09	4.8E-10	3.5E-10	2.6E-10	1.9E-10	1.6E-10	1.2E-10
SSW	0.	7.2E-08	1.4E-08	5.1E-09	2.0E-09	1.1E-09	6.8E-10	4.5E-10	3.2E-10	2.3E-10	1.8E-10
SW	0.	4.2E-08	6.5E-09	2.3E-09	1.0E-09	5.7E-10	3.7E-10	2.7E-10	1.8E-10	1.4E-10	1.1E-10
WSW	0.	3.0E-08	4.9E-09	1.7E-09	8.5E-10	6.3E-10	3.8E-10	2.5E-10	1.9E-10	1.6E-10	1.2E-10
W	0.	2.7E-08	3.4E-09	1.2E-09	6.1E-10	4.4E-10	2.7E-10	2.0E-10	1.3E-10	8.5E-11	6.7E-11
WNW	0.	3.0E-08	3.9E-09	1.4E-09	7.4E-10	5.4E-10	3.7E-10	2.6E-10	2.0E-10	1.4E-10	1.0E-10
NW	0.	3.4E-08	5.2E-09	2.2E-09	1.2E-09	6.3E-10	3.2E-10	1.8E-10	1.5E-10	1.1E-10	9.0E-11
NNW	0.	4.1E-08	7.4E-09	3.6E-09	2.5E-09	1.6E-09	8.0E-10	3.9E-10	2.4E-10	1.5E-10	1.2E-10
N	0.	6.7E-08	1.1E-08	4.1E-09	2.0E-09	1.1E-09	7.2E-10	4.7E-10	3.3E-10	2.5E-10	2.0E-10

Number of Valid Observations	=	8703
Number of Invalid Observations	=	57
Number of Calms Lower Level	=	398
Number of Calms Upper Limit	=	0

TABLE A-7

X/Q Values for Short-Term Ground Level Releases at Special Locations (sec/m^3)*

Carolina Power & Light Company - Robinson
Release Type: Purge
Release Mode: Ground Level
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Purge (ACNPURG2)
Application of Terrain Correction Factors: No
Number of Observations: 8703
Purge Time: 100 Hours

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	7.20E-06	5.00E-06	0.00	6.80E-06	6.20E-06
NE	5.30E-06	4.60E-06	4.00E-06	4.40E-06	4.00E-06
ENE	6.90E-06	1.50E-06	0.00	6.70E-06	1.90E-06
E	1.00E-05	1.10E-06	6.40E-07	6.20E-06	1.20E-06
ESE	1.50E-05	2.60E-06	0.00	1.10E-05	1.10E-05
SE	3.40E-05	0.00	0.00	3.30E-05	3.30E-05
SSE	5.10E-05	0.00	0.00	4.10E-05	4.10E-05
S	3.00E-05	1.20E-06	0.00	2.60E-05	1.80E-05
SSW	2.10E-05	1.30E-06	0.00	2.00E-05	9.80E-06
SW	1.10E-05	7.80E-07	6.70E-07**	9.10E-06	7.20E-06
WSW	8.10E-06	5.50E-07	0.00	6.90E-06	4.20E-06
W	5.50E-06	3.00E-07	0.00	4.20E-06	4.20E-06
WNW	5.30E-06	3.90E-07	0.00	3.70E-06	2.50E-06
NW	2.30E-06	1.70E-06	0.00	2.20E-06	2.20E-06
NNW	2.40E-06	1.20E-06	0.00	1.20E-06	1.10E-06
N	2.70E-06	1.50E-06	0.00	1.50E-06	1.50E-06

* Zeroes indicate that this point was not calculated

** A milk goat is located here

TABLE A-8

Depleted X/Q Values for Short-Term Ground Level Releases at Special Locations (sec/m^3)*

Carolina Power & Light Company - Robinson
Release Type: Purge
Release Mode: Ground Level
Variable: Relative Depleted Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Purge (ACNPURG2)
Application of Terrain Correction Factors: No
Number of Observations: 8703
Purge Time: 100 Hours

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	6.30E-06	4.09E-06	0.00	5.71E-06	5.31E-06
NE	4.71E-06	3.97E-06	3.37E-06	3.77E-06	3.37E-06
ENE	6.19E-06	1.21E-06	0.00	5.96E-06	1.53E-06
E	9.06E-06	8.80E-07	4.80E-07	5.51E-06	9.34E-07
ESE	1.36E-05	2.14E-06	0.00	9.90E-06	9.90E-06
SE	3.19E-05	0.00	0.00	3.08E-05	3.08E-05
SSE	4.71E-05	0.00	0.00	3.83E-05	3.83E-05
S	2.83E-05	9.74E-07	0.00	2.44E-05	1.67E-05
SSW	1.91E-05	1.05E-06	0.00	1.92E-05	8.93E-06
SW	1.02E-05	6.38E-07	7.64E-07**	8.49E-06	6.52E-06
WSW	7.50E-06	4.23E-07	0.00	6.30E-06	3.85E-06
W	5.16E-06	2.28E-07	0.00	3.85E-06	3.85E-06
WNW	4.82E-06	2.98E-07	0.00	3.33E-06	2.23E-06
NW	1.95E-06	1.41E-06	0.00	1.88E-06	1.88E-06
NNW	1.99E-06	9,53E-07	0.00	9.46E-07	8.59E-07
N	2.31E-06	1.19E-06	0.00	1.18E-06	1.18E-06

* Zeroes indicate that this point was not calculated

** A milk goat is located here

TABLE A-9

D/Q Values for Short-Term Ground Level Releases at Special Locations (m^{-2})*

Carolina Power & Light Company - Robinson
Release Type: Purge
Release Mode: Ground Level
Variable: Relative Deposition Rate (Meter^{-2})
Calculation Points: Special
Model: Purge (ACNPURG2)
Application of Terrain Correction Factors: No
Number of Observations: 8703
Purge Time: 100 Hours

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	1.06E-08	6.80E-09	0.00	9.86E-09	8.62E-09
NE	9.80E-09	8.37E-09	6.96E-09	7.96E-09	6.96E-09
ENE	1.26E-08	2.12E-09	0.00	1.21E-08	2.72E-09
E	1.94E-08	1.51E-09	8.00E-10	1.13E-08	1.67E-09
ESE	2.29E-08	3.22E-09	0.00	1.68E-08	1.68E-08
SE	4.25E-08	0.00	0.00	4.19E-08	4.19E-08
SSE	5.10E-08	0.00	0.00	4.22E-08	4.22E-08
S	3.99E-08	1.36E-09	0.00	3.59E-08	2.54E-08
SSW	5.92E-08	3.18E-09	0.00	6.00E-08	2.83E-08
SW	3.46E-08	1.93E-09	1.61E-09**	2.83E-08	2.20E-08
WSW	3.90E-08	2.07E-09	0.00	3.30E-08	2.03E-08
W	2.30E-08	8.40E-10	0.00	1.75E-08	1.75E-08
WNW	2.65E-08	1.38E-09	0.00	1.82E-08	1.22E-08
NW	7.08E-09	4.86E-09	0.00	6.42E-09	6.42E-09
NNW	4.46E-09	1.87E-09	0.00	1.86E-09	1.65E-09
N	3.27E-09	1.50E-09	0.00	1.50E-09	1.50E-09

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* Zeroes indicate that this point was not calculated

** A milk goat is located here

TABLE A-10

X/Q Values for Long-Term Mixed Mode Releases at Special Locations (sec/m^3)*

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Straight Line (ANNXOQ9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	3.33E-07	2.82E-07	0.00	3.23E-07	3.18E-07
NE	1.34E-07	1.40E-07	1.23E-07	1.39E-07	1.23E-07
ENE	2.74E-07	1.23E-07	0.00	2.79E-07	8.51E-08
E	2.40E-07	1.11E-07	5.39E-08	2.53E-07	1.33E-07
ESE	2.75E-07	1.25E-07	0.00	2.17E-07	2.17E-07
SE	5.13E-07	0.00	0.00	5.23E-07	5.23E-07
SSE	9.94E-07	0.00	0.00	7.61E-07	7.61E-07
S	4.57E-07	3.61E-08	0.00	4.00E-07	2.50E-07
SSW	5.54E-07	1.27E-07	0.00	5.71E-07	2.69E-07
SW	2.31E-07	5.38E-08	4.72E-08**	1.84E-07	1.51E-07
WSW	2.06E-07	4.64E-08	0.00	1.68E-07	1.02E-07
W	9.36E-08	1.87E-08	0.00	7.13E-08	7.13E-08
WNW	1.02E-07	4.28E-08	0.00	9.55E-08	9.80E-08
NW	1.52E-07	1.30E-07	0.00	1.54E-07	1.54E-07
NNW	1.71E-07	8.86E-08	0.00	8.30E-08	7.28E-08
N	9.32E-08	5.66E-08	0.00	5.80E-08	5.80E-08

* Zeroes indicate that this point was not calculated

** A milk goat is located here

TABLE A-11

Depleted X/Q Values for Long-Term Mixed Mode Releases at Special Locations (sec/m^3)*

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Straight Line (ANNXOQ9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	3.33E-07	2.82E-07	0.00	3.23E-07	2.98E-07
NE	1.23E-07	1.28E-07	1.23E-07	1.28E-07	1.23E-07
ENE	2.59E-07	1.23E-07	0.00	2.63E-07	8.12E-08
E	2.40E-07	1.11E-07	4.39E-08	2.53E-07	1.23E-07
ESE	2.54E-07	1.18E-07	0.00	1.96E-07	1.96E-07
SE	4.93E-07	0.00	0.00	5.02E-07	5.02E-07
SSE	9.32E-07	0.00	0.00	7.21E-07	7.21E-07
S	4.39E-07	3.42E-08	0.00	3.82E-07	2.33E-07
SSW	5.35E-07	1.27E-07	0.00	5.51E-07	2.51E-07
SW	2.31E-07	5.14E-08	5.31E-08**	1.84E-07	1.45E-07
WSW	2.06E-07	4.46E-08	0.00	1.68E-07	9.91E-08
W	9.10E-08	1.82E-08	0.00	6.90E-08	6.90E-08
WNW	9.88E-08	4.07E-08	0.00	9.26E-08	9.54E-08
NW	1.51E-07	1.27E-07	0.00	1.54E-07	1.54E-07
NNW	1.64E-07	8.44E-08	0.00	8.04E-08	6.92E-08
N	8.91E-08	5.42E-08	0.00	5.56E-08	5.56E-08

* Zeroes indicate that this point was not calculated

** A milk goat is located here

TABLE A-12

D/Q Values for Long-Term Mixed Mode Releases at Special Locations (m^{-2})*

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Deposition Rate ($Meter^{-2}$)
Calculation Points: Special
Model: Straight Line (ANNXOQ9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	2.29E-09	1.39E-09	0.00	2.22E-09	1.89E-09
NE	1.79E-09	1.51E-09	1.23E-09	1.39E-09	1.23E-09
ENE	3.19E-09	3.41E-10	0.00	3.10E-09	4.78E-10
E	4.99E-09	2.31E-10	1.15E-10	2.92E-09	2.76E-10
ESE	4.86E-09	5.90E-10	0.00	3.75E-09	3.75E-09
SE	6.98E-09	0.00	0.00	7.20E-09	7.20E-09
SSE	6.22E-09	0.00	0.00	5.21E-09	5.21E-09
S	7.31E-09	1.77E-10	0.00	6.60E-09	5.17E-09
SSW	1.01E-08	7.41E-10	0.00	1.06E-08	6.81E-09
SW	4.62E-09	3.32E-10	2.66E-10**	4.14E-09	3.87E-09
WSW	4.85E-09	2.59E-10	0.00	4.34E-09	3.35E-09
W	2.64E-09	6.74E-11	0.00	1.95E-09	1.95E-09
WNW	2.59E-09	1.25E-10	0.00	1.94E-09	1.29E-09
NW	1.20E-09	7.66E-10	0.00	1.12E-09	1.12E-09
NNW	7.77E-10	2.53E-10	0.00	2.41E-10	2.03E-10
N	3.62E-10	1.41E-10	0.00	1.51E-10	1.51E-10

* Zeroes indicate that this point was not calculated

** A milk goat is located here

TABLE A-13

X/Q Values for Long-Term Mixed Mode Releases at Standard Distances (sec/m^3)

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Standard
Model: Straight Line (ANNX009)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

BASE DISTANCE IN MILES/KILOMETERS

Aftd Sect	Design Dist MI	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	1.5E-06	3.9E-07	3.1E-07	2.7E-07	2.3E-07	2.0E-07	1.6E-07	1.4E-07	9.8E-08	6.5E-08
NE	0.	1.0E-06	1.5E-07	1.1E-07	9.0E-08	6.7E-08	5.2E-08	7.8E-08	3.8E-08	5.4E-08	3.4E-08
ENE	0.	8.6E-07	2.6E-07	1.9E-07	1.7E-07	1.2E-07	1.1E-07	7.4E-08	6.2E-08	4.8E-08	4.2E-08
E	0.	7.2E-07	2.6E-07	2.2E-07	2.0E-07	2.1E-07	1.2E-07	9.4E-08	7.0E-08	4.7E-08	3.6E-08
ESE	0.	7.8E-07	1.9E-07	1.7E-07	1.3E-07	1.0E-07	7.6E-08	6.6E-08	4.9E-08	3.8E-08	2.9E-08
SE	0.	5.9E-07	1.0E-07	7.5E-08	5.1E-08	3.8E-08	2.4E-08	1.9E-08	1.2E-08	1.2E-08	1.1E-08
SSE	0.	1.0E-06	1.8E-07	1.2E-07	8.0E-08	5.4E-08	3.6E-08	2.6E-08	2.3E-08	1.9E-08	1.8E-08
S	0.	5.0E-07	9.4E-08	7.0E-08	5.9E-08	3.5E-08	3.2E-08	2.9E-08	2.5E-08	2.2E-08	1.9E-08
SSW	0.	6.3E-07	2.7E-07	2.4E-07	1.5E-07	1.2E-07	8.4E-08	6.3E-08	4.7E-08	3.6E-08	3.1E-08
SW	0.	3.5E-07	9.9E-08	8.8E-08	6.1E-08	4.6E-08	3.7E-08	3.2E-08	2.3E-08	2.0E-08	1.7E-08
WSW	0.	3.0E-07	6.5E-08	6.2E-08	5.4E-08	5.4E-08	4.1E-08	3.0E-08	2.7E-08	2.4E-08	1.9E-08
W	0.	2.4E-07	6.2E-08	6.0E-08	4.9E-08	4.9E-08	3.5E-08	3.0E-08	2.0E-08	1.5E-08	1.2E-08
WNW	0.	2.8E-07	8.4E-08	8.6E-08	6.8E-08	6.3E-08	5.2E-08	4.2E-08	3.6E-08	3.6E-08	3.4E-08
NW	0.	3.8E-07	1.2E-07	1.5E-07	1.2E-07	9.2E-08	6.5E-08	4.7E-08	4.1E-08	3.5E-08	2.9E-08
NNW	0.	4.2E-07	1.8E-07	1.4E-07	1.6E-07	1.4E-07	9.2E-08	5.4E-08	3.7E-08	2.5E-08	2.1E-08
N	0.	7.8E-07	1.7E-07	1.3E-07	9.3E-08	7.2E-08	5.9E-08	4.5E-08	3.8E-08	3.3E-08	2.9E-08

Number of Valid Observations	=	8703
Number of Invalid Observations	=	57
Number of Calms Lower Level	=	60
Number of Calms Upper Limit	=	5

TABLE A-14

Depleted X/Q Values for Long-Term Mixed Mode Releases at Standard Distances (sec/m^3)

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Depeleted Concentration (Sec./Cubic Meter)
Calculation Points: Standard
Model: Straight Line (ANNXOQ9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

BASE DISTANCE IN MILES/KILOMETERS

Aftd Sect	Design Dist MI	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	1.5E-06	3.7E-07	3.1E-07	2.5E-07	2.2E-07	1.8E-07	1.5E-07	1.3E-07	8.9E-08	6.1E-08
NE	0.	9.8E-07	1.4E-07	1.1E-07	8.5E-08	6.4E-08	4.9E-08	7.8E-08	3.6E-08	5.2E-08	3.1E-08
ENE	0.	8.3E-07	2.5E-07	1.8E-07	1.6E-07	1.2E-07	1.0E-07	6.9E-08	5.7E-08	4.5E-08	4.0E-08
E	0.	7.0E-07	2.4E-07	2.0E-07	1.9E-07	2.1E-07	1.1E-07	9.4E-08	6.6E-08	4.5E-08	3.4E-08
ESE	0.	7.3E-07	1.8E-07	1.6E-07	1.2E-07	9.6E-08	7.2E-08	6.1E-08	4.6E-08	3.6E-08	2.7E-08
SE	0.	5.7E-07	9.6E-08	6.9E-08	4.7E-08	3.6E-08	2.3E-08	1.8E-08	1.2E-08	1.0E-08	9.9E-09
SSE	0.	9.6E-07	1.7E-07	1.1E-07	7.4E-08	4.9E-08	3.3E-08	2.4E-08	2.1E-08	1.7E-08	1.6E-08
S	0.	4.8E-07	8.9E-08	6.7E-08	5.8E-08	3.8E-08	3.1E-08	2.7E-08	2.4E-08	2.1E-08	1.8E-08
SSW	0.	6.1E-07	2.5E-07	2.4E-07	1.5E-07	1.1E-07	8.0E-08	6.0E-08	4.5E-08	3.4E-08	2.9E-08
SW	0.	3.4E-07	9.5E-08	8.5E-08	5.8E-08	4.4E-08	3.6E-08	3.1E-08	2.2E-08	1.9E-08	1.6E-08
WSW	0.	2.9E-07	6.3E-08	6.1E-08	5.2E-08	5.2E-08	4.0E-08	2.9E-08	2.6E-08	2.2E-08	1.8E-08
W	0.	2.4E-07	6.0E-08	5.9E-08	4.8E-08	4.7E-08	3.4E-08	2.9E-08	1.9E-08	1.4E-08	1.2E-08
WNW	0.	2.6E-07	8.3E-08	8.4E-08	6.6E-08	6.2E-08	5.0E-08	4.0E-08	3.4E-08	3.4E-08	3.2E-08
NW	0.	3.8E-07	1.1E-07	1.5E-07	1.1E-07	9.0E-08	6.3E-08	4.5E-08	3.9E-08	3.0E-08	2.4E-08
NNW	0.	4.1E-07	1.2E-07	1.4E-07	1.6E-07	1.4E-07	8.8E-08	5.2E-08	3.5E-08	2.4E-08	2.0E-08
N	0.	7.5E-07	1.5E-07	1.2E-07	8.8E-08	6.9E-08	5.7E-08	4.3E-08	3.6E-08	3.1E-08	2.7E-08

Number of Valid Observations = 8703
Number of Invalid Observations = 57
Number of Calms Lower Level = 60
Number of Calms Upper Limit = 5

TABLE A-15

D/Q Values for Long-Term Mixed Mode Releases at Standard Distances (m^{-2})

Carolina Power & Light Company - Robinson
Release Type: Annual
Release Mode: Mixed Mode
Variable: Relative Deposition Rate ($Meter^{-2}$)
Calculation Points: Standard
Model: Straight Line (ANNXOQ9)
Application of Terrain Correction Factors: Yes
Number of Observations: 8703

BASE DISTANCE IN MILES/KILOMETERS

Afld Sect	Design Dist MI	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	1.6E-08	5.0E-09	2.1E-09	1.2E-09	7.5E-10	5.2E-10	3.4E-10	2.7E-10	2.0E-10	1.4E-10
NE	0.	1.1E-08	2.6E-09	1.2E-09	6.2E-10	3.5E-10	2.3E-10	1.8E-10	1.2E-10	1.2E-10	1.0E-10
ENE	0.	1.1E-08	3.8E-09	1.4E-09	7.6E-10	3.7E-10	2.7E-10	1.8E-10	1.4E-10	1.2E-10	1.1E-10
E	0.	1.1E-08	3.7E-09	1.4E-09	7.2E-10	5.0E-10	2.6E-10	2.1E-10	1.4E-10	1.0E-10	7.8E-11
ESE	0.	8.6E-09	2.7E-09	1.2E-09	6.7E-10	4.3E-10	2.8E-10	2.1E-10	1.5E-10	1.0E-10	7.3E-11
SE	0.	7.0E-09	1.9E-09	9.5E-10	4.7E-10	2.8E-10	1.5E-10	1.1E-10	5.9E-11	5.0E-11	4.2E-11
SSE	0.	6.2E-09	1.8E-09	8.6E-10	4.6E-10	2.6E-10	1.5E-10	9.5E-11	7.7E-11	5.9E-11	5.0E-11
S	0.	7.1E-09	1.8E-09	7.6E-10	4.2E-10	1.8E-10	1.3E-10	9.9E-11	7.3E-11	6.1E-11	4.8E-11
SSW	0.	1.0E-08	5.0E-09	2.6E-09	1.1E-09	6.1E-10	3.9E-10	2.6E-10	1.8E-10	1.3E-10	1.0E-10
SW	0.	5.0E-09	2.0E-09	9.8E-10	4.7E-10	2.9E-10	1.9E-10	1.5E-10	9.8E-11	7.6E-11	6.4E-11
WSW	0.	4.9E-09	1.9E-09	8.4E-10	4.8E-10	3.7E-10	2.3E-10	1.5E-10	1.2E-10	1.0E-10	7.1E-11
W	0.	4.0E-09	1.4E-09	6.3E-10	3.4E-10	2.6E-10	1.6E-10	1.3E-10	7.9E-11	5.4E-11	4.1E-11
WNW	0.	4.6E-09	1.5E-09	7.1E-10	4.2E-10	3.2E-10	2.2E-10	1.6E-10	1.2E-10	9.9E-11	7.4E-11
NW	0.	5.6E-09	2.2E-09	1.1E-09	6.4E-10	3.6E-10	1.9E-10	1.2E-10	1.0E-10	1.1E-10	9.6E-11
NNW	0.	4.5E-09	1.9E-09	1.1E-09	8.1E-10	5.2E-10	2.7E-10	1.4E-10	8.8E-11	5.7E-11	4.5E-11
N	0.	5.9E-09	1.8E-09	8.2E-10	4.0E-10	2.4E-10	1.6E-10	1.0E-10	7.4E-11	5.8E-11	4.7E-11

Number of Valid Observations	=	8703
Number of Invalid Observations	=	57
Number of Calms Lower Level	=	60
Number of Calms Upper Limit	=	5

TABLE A-16

X/Q Values for Short-Term Mixed Mode Releases at Special Locations (sec/m^3)*

Carolina Power & Light Company - Robinson
Release Type: Purge
Release Mode: Mixed Mode
Variable: Relative Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Purge (ACNPURG2)
Application of Terrain Correction Factors: No
Number of Observations: 8703
Purge Time: 100 Hours

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	8.40E-07	7.00E-07	0.00	8.30E-07	7.90E-07
NE	5.40E-07	5.30E-07	4.70E-07	5.20E-07	4.70E-07
ENE	8.90E-07	4.20E-07	0.00	8.80E-07	3.10E-07
E	1.00E-06	4.00E-07	2.50E-07	9.20E-07	4.50E-07
ESE	1.24E-06	4.70E-07	0.00	1.00E-06	1.00E-06
SE	2.20E-06	0.00	0.00	2.10E-06	2.10E-06
SSE	2.90E-06	0.00	0.00	2.40E-06	2.40E-06
S	1.90E-06	2.00E-07	0.00	1.70E-06	1.20E-06
SSW	2.00E-06	4.00E-07	0.00	2.00E-06	1.10E-06
SW	1.10E-06	2.40E-07	2.10E-07**	9.50E-07	7.70E-07
WSW	1.20E-06	2.20E-07	0.00	9.90E-07	6.30E-07
W	7.40E-07	1.30E-07	0.00	5.90E-07	5.90E-07
WNW	7.90E-07	2.20E-07	0.00	6.80E-07	6.20E-07
NW	6.30E-07	5.10E-07	0.00	6.20E-07	6.20E-07
NNW	5.10E-07	3.20E-07	0.00	3.10E-07	2.90E-07
N	3.50E-07	2.30E-07	0.00	2.40E-07	2.40E-07

* Zeroes indicate that this point was not calculated

** A milk goat is located here

TABLE A-17

Depleted X/Q Values for Short-Term Mixed Mode Releases at Special Locations (sec/m^3)*

Carolina Power & Light Company - Robinson
Release Type: Purge
Release Mode: Mixed Mode
Variable: Relative Depleted Concentration (Sec./Cubic Meter)
Calculation Points: Special
Model: Purge (ACNPURG2)
Application of Terrain Correction Factors: No
Number of Observations: 8703
Purge Time: 100 Hours

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	8.40E-07	7.00E-07	0.00	8.30E-07	7.41E-07
NE	4.95E-07	4.86E-07	4.70E-07	4.77E-07	4.70E-07
ENE	8.40E-07	4.20E-07	0.00	8.31E-07	2.96E-07
E	1.00E-06	4.00E-07	2.03E-07	9.20E-07	4.15E-07
ESE	1.11E-06	4.44E-07	0.00	9.00E-07	9.00E-07
SE	2.11E-06	0.00	0.00	2.01E-06	2.01E-06
SSE	2.72E-07	0.00	0.00	2.27E-06	2.27E-06
S	1.82E-06	1.90E-07	0.00	1.63E-06	1.12E-06
SSW	1.93E-06	4.00E-07	0.00	1.93E-06	1.03E-06
SW	1.10E-06	2.29E-07	2.35E-07**	9.50E-07	7.36E-07
WSW	1.20E-06	2.12E-07	0.00	9.90E-07	6.11E-07
W	7.19E-07	1.26E-07	0.00	5.71E-07	5.71E-07
WNW	7.65E-07	2.09E-07	0.00	6.59E-07	6.04E-07
NW	6.24E-07	4.99E-07	0.00	6.20E-07	6.20E-07
NNW	4.90E-07	3.05E-07	0.00	3.00E-07	2.76E-07
N	3.35E-07	2.20E-07	0.00	2.30E-07	2.30E-07

* Zeroes indicate that this point was not calculated

** A milk goat is located here

TABLE A-18

D/Q Values for Short-Term Mixed Mode Releases at Special Locations (m^{-2})*

Carolina Power & Light Company - Robinson
Release Type: Purge
Release Mode: Mixed Mode
Variable: Relative Deposition Rate ($Meter^{-2}$)
Calculation Points: Special
Model: Purge (ACNPURG2)
Application of Terrain Correction Factors: No
Number of Observations: 8703
Purge Time: 100 Hours

Affected Sector	Site Boundary	Meat	Dairy	Resident	Garden
NNE	5.77E-09	3.45E-09	0.00	5.70E-09	4.68E-09
NE	7.18E-09	5.72E-09	4.70E-09	5.20E-09	4.70E-09
ENE	1.04E-08	1.16E-09	0.00	9.77E-09	1.74E-09
E	2.08E-08	8.36E-10	5.32E-10	1.06E-08	9.36E-10
ESE	2.12E-08	2.22E-09	0.00	1.73E-08	1.73E-08
SE	2.99E-08	0.00	0.00	2.88E-08	2.88E-08
SSE	1.81E-08	0.00	0.00	1.64E-08	1.64E-08
S	3.04E-08	9.84E-10	0.00	2.80E-08	2.48E-08
SSW	3.66E-08	2.33E-09	0.00	3.72E-08	2.78E-08
SW	2.20E-08	1.48E-09	1.18E-09**	2.14E-08	1.97E-08
WSW	2.83E-08	1.23E-09	0.00	2.55E-08	2.07E-08
W	2.09E-08	4.69E-10	0.00	1.62E-08	1.62E-08
WNW	2.01E-08	6.45E-10	0.00	1.38E-08	8.18E-09
NW	4.98E-09	3.00E-09	0.00	4.53E-09	4.53E-09
NNW	2.32E-09	9.15E-10	0.00	8.99E-10	8.09E-10
N	1.36E-09	5.75E-10	0.00	6.24E-10	6.24E-10

* Zeroes indicate that this point was not calculated

** A milk goat is located here

TABLE A-19

Robinson Plant Site Information To Be Used for Ground Level Calculations with NRC "XOQDOQ" Program

Card Type	Columns	Description	Value To Be Used in XOQDOQ
1	1	Print input data	1
	38	Calculate annual X/Qs for points of interest	1
	39	Calculate annual X/Q averages for site radial segments	1
	41	Print out set distance X/Qs and D/Qs	1
	55	Calculate annual D/Q averages for the set radial segments	1
	56	Allow depleted X/Qs (if Decays (1), (2), or (3) are negative)	1
	58	Calculate annual D/Qs for points of interest	1
2	1-80	Title card	N/A
3	1-5	Number of wind velocity categories	7
	6-10	Number of stability categories	7
	11-15	Number of distances within terrain data for each sector	5
	16-20	Total number of hours in joint wind frequency distribution	(1)
	21-25	Increment in % for which plotted results are to be printed	5
	26-30	Number of titles of receptor types	5
	31-35	Number of release exit locations	3
4	1-5	Height of the measured wind (meters)	11
	6-20	Half-life (days) used in the X/Q calculations	101.00 226 -8.00
5	N/A	N/A	—
6	1-80	Joint wind frequency distribution	(1)

TABLE A-19 (continued)

Card Type	Columns	Description	Value To Be Used in XOQDOQ
7	1-5	Wind velocity units correction	200.00
	6-75	Maximum wind speed in each wind class (m/sec)	0.75 3.50 7.50 12.50 18.50 25.00 26.00
8	1-80	Distance in meters at which terrain heights are given	(2)
9	1-80	Terrain heights (in meters, above plant grade) correspond to distances in Card Type 8	(2)
10	1-25	Number of receptor locations for a particular receptor type	Site boundary = 16 Dairy = 1 Meat = 14 Residence = 16 Garden = 16
11	1-16	Title of receptor type for receptor locations	Site Boundary Dairy Meat Residence Garden
12	1-80	Receptor direction and distance	(See Table 1)
13	1-80	Title for release point whose characteristics are described on Card Type 14	(1)

TABLE A-19 (continued)

Card Type	Columns	Description	Value To Be Used in XOQDOQ
14	1-5	Vent average velocity (m/sec)	20.1
	6-10	Vent inside diameter (m)	1.0
	11-15	Height of vent release point (m)	0.000
	16-20	Height of the vent's building (m)	59.0
	21-25	Minimum cross-sectional area for the vent's building (m^2)	1370.0
	26-30	Wind height used for vent elevated release	11.0
	31-35	Vent heat emission rate (cal/sec)	0.0
15	1	Identification for release point	A
	2-5	Intermittent releases	1
	6-10	Number of intermittent releases per year for this release point	100
	11-15	Average number of hours per intermittent release	1

(1) Appropriate data to be supplied

(2) Obtained from cross-sectional topographic maps

TABLE A-20

Robinson Plant Site Information To Be Used for Mixed Mode Release Calculations with NRC "XOQDOQ" Program

Card Type	Columns	Description	Value To Be Used in XOQDOQ
1	1	Print input data	1
	38	Calculate annual X/Qs for points of interest	1
	39	Calculate annual X/Q averages for site radial segments	1
	41	Print out set distance X/Qs and D/Qs	1
	55	Calculate annual D/Q averages for the set radial segments	1
	56	Allow depleted X/Qs (if Decays (1), (2), or (3) are negative)	1
	58	Calculate annual D/Qs for points of interest	1
2	1-80	Title card	N/A
3	1-5	Number of wind velocity categories	7
	6-10	Number of stability categories	7
	11-15	Number of distances within terrain data for each sector	5
	16-20	Total number of hours in joint wind frequency distribution	(1)
	21-25	Increment in % for which plotted results are to be printed	5
	26-30	Number of titles of receptor types	5
	31-35	Number of release exit locations	3
4	1-5	Height of the measured wind (meters)	11
	6-20	Half-life (days) used in the X/Q calculations	101.00 226 -8.00
5	N/A	N/A	—
6	1-80	Joint wind frequency distribution	(1)

TABLE A-20 (continued)

Card Type	Columns	Description	Value To Be Used in XOQDOQ
7	1-5	Wind velocity units correction	200.00
	6-75	Maximum wind speed in each wind class (m/sec)	0.75 3.50 7.50 12.50 18.50 25.00 26.00
8	1-80	Distance in meters at which terrain heights are given	(2)
9	1-80	Terrain heights (in meters, above plant grade) corresponding to distances in Card Type 8	(2)
10	1-25	Number of receptor locations for a particular receptor type	Site boundary = 16 Dairy = 1 Meat = 14 Residence = 16 Garden = 16
11	1-16	Title of receptor type for receptor locations	Site Boundary Dairy Meat Residence Garden
12	1-80	Receptor direction and distance	(See Table 1)
13	1-80	Title for release point whose characteristics are described on Card Type 14	(1)

TABLE A-20 (continued)

Card Type	Columns	Description	Value To Be Used in XOQDOQ
14	1-5	Vent average velocity (m/sec)	20.1
	6-10	Vent inside diameter (m)	1.0
	11-15	Height of vent release point (m)	60.7
	16-20	Height of the vent's building (m)	59.0
	21-25	Minimum cross-sectional area for the vent's building (m^2)	1370.0
	26-30	Wind height used for vent elevated release	11.
	31-35	Vent heat emission rate (cal/sec)	0.
15	1	Identification for release point	A
	2-5	Intermittent releases	1
	6-10	Number of intermittent releases per year for this release point	100
	11-15	Average number of hours per intermittent release	1

(1) Appropriate data to be supplied

(2) Obtained from cross-sectional topographic maps

APPENDIX B

DOSE PARAMETERS FOR RADIOIODINES, PARTICULATES, AND TRITIUM

This appendix contains the methodology which was used to calculate the dose parameters for radioiodines, particulates, and tritium to show compliance with 10CFR20 and Appendix I of 10CFR50 for gaseous effluents. These dose parameters, P_i and R_i, were calculated using the methodology outlined in NUREG 0133 along with Regulatory Guide 1.109, Revision 1. The following sections provide the specific methodology which was utilized in calculating the P_i and R_i values for the various exposure pathways.

B.1 Calculation of P_i

The dose parameter, P_i, contained in the radioiodine and particulates portion of Section 3.2 includes pathway transport parameters of the "i" radionuclide, the receptor's usage of the pathway media, and the dosimetry of the exposure. Pathway usage rates and the internal dosimetry are functions of the receptor's age; however, the youngest age group, the infant, will always receive the maximum dose under the exposure conditions for Technical Specification 3.9.3.1.b. For the infant exposure, separate values of P_i may be calculated for the inhalation pathway which is combined with a W parameter based on (X/Q) and the food (milk) and ground pathway which is combined with a W parameter normally based on (D/Q) except for tritium. The following sections provide in detail the methodology which was used in calculating the P_i values for inclusion into this ODCM.

B.1.1 Inhalation Pathway

The evaluation of this pathway consists of estimating the maximum dose to the most critical organ received by an infant through inhalation by:

$$P_{i_I} = K'(BR)\ DFA_i \qquad (B.1\text{-}1)$$

where:

P_{i_I} = Dose parameter for radionuclide "i" for the inhalation pathway, mrem/yr per $\mu Ci/m^3$;

K' = A constant of unit conversion;
= 10^6 pCi/μCi;

BR = The breathing rate of the infant age group, m^3/yr;

DFA_i = The maximum organ inhalation dose factor for the infant age group for radionuclide "i," mrem/pCi.

The age group considered is the infant group. The infant's breathing rate is taken as 1400 m^3/yr from Table E-5 of Regulatory Guide 1.109, Revision 1. The inhalation dose factors for the infant, DFA_i, are presented in Table E-10 of Regulatory Guide 1.109 in units of mrem/pCi. The total body is considered as an organ in the selection of DFA_i.

The incorporation of breathing rate of an infant and the unit conversion factor results in the following equation:

$$P_{i_I} = 1.4 \times 10^9 \, DFA_i \qquad (B.1\text{-}2)$$

B.1.2 Ground Plane Pathway

The dose factor from ground plane pathway is calculated by:

$$P_{i_G} = K'K''DFG_i \, (1-e^{-\lambda_i t})/\lambda_i \qquad (B.1\text{-}3)$$

where:

P_{i_G} = Dose parameter for radionuclide "i" for the ground plane pathway, mrem/yr per $\mu Ci/sec$ per m^{-2};

K' = A constant of unit conversion;
= 10^6 pCi/μCi;

K'' = A constant of unit conversion;
= 8760 hr/yr;

λ_i = The radiological decay constant for radionuclide "i," sec^{-1};

t = The exposure period;
= 3.15×10^7 sec (1 year);

DFG_i = The ground plane dose conversion factor for radionuclide "i," mrem/hr per pCi/m^2.

The deposition rate onto the ground plane results in a ground plane concentration that is assumed to persist over a year with radiological decay--the only operating removal mechanism for each radionuclide. The ground plane dose conversion factors for radionuclide "i," DFG_i, are presented in Table E-6 of Regulatory Guide 1.109, Revision 1.

Resolution of the units yields:

$$P_{i_G} = 8.76 \times 10^9 \, DFG_i \, (1-e^{-\lambda_i t})/\lambda_i \qquad (B.1\text{-}4)$$

B.1.3 Milk

The dose factor from the cow/goat-milk-man pathway is calculated by:

$$P_{i_M} = \frac{K' r \, Q_F \, (U_{ap}) \, F_m}{Y_p \, (\lambda_i + \lambda_w)} \, DFL_i \, e^{-\lambda_i t_f} \qquad (B.1\text{-}5)$$

where:

P_{i_M} = Dose parameter for radionuclide "i" for the cow milk or goat milk pathway, mrem/yr per $\mu Ci/sec$ per m^{-2};

K' = A constant of unit conversion;
= 10^6 $pCi/\mu Ci$;

Q_F = The cow's or goat's consumption rate of feed, kg/day (wet weight);

U_{ap} = The infant's milk consumption rate, liters/yr;

Y_p = The agricultural productivity by unit area, kg/m^2;

F_m = The stable element transfer coefficient, pCi/liter per pCi/day;

r = Fraction of deposited activity retained on cow's or goat's feed grass;

DFL_i = The maximum organ ingestion dose factor for radionuclide "i," mrem/pCi;

λ_i = The radiological decay constant for radionuclide "i," sec^{-1};

λ_w = The decay constant for removal of activity on leaf and plant surfaces by weathering, sec^{-1};

= 5.73×10^{-7} sec^{-1} (corresponding to a 14-day half-life);

t_f = The transport time from pasture cow or goat to milk to infant, sec.

A fraction of the airborne deposition is captured by the ground plane vegetation cover. The captured material is removed from the vegetation (grass) by both radiological decay and weathering processes.

Various parameters which were utilized to determine the P_i values for the cow and goat milk pathways are provided in Table B-1. Table E-1 of Regulatory Guide 1.109, Revision 1, provides the stable element transfer coefficients, F_m; and Table E-14 of the same regulatory guide provides the ingestion dose factors, DFL_i, for the infant's organs. The organ with the maximum value of DFL_i was used in the determination of P_i for this pathway. The incorporation of the various constants of Table B-1 into Equation B.1-5 results in the following:

For radioiodines and particulates from cow's milk:

$$P_{i_M} = 2.4 \times 10^{10} \frac{rF_m}{\lambda_i + \lambda_w} DFL_i \, e^{-\lambda_i t_f} \quad (B.1\text{-}6)$$

For radioiodines and particulates from goat's milk pathway:

$$P_{i_M} = 2.8 \times 10^{9} \frac{rF_m}{\lambda_i + \lambda_w} DFL_i \, e^{-\lambda_i t_f} \quad (B.1\text{-}7)$$

The concentration of tritium in milk is based on its airborne concentration rather than the depostion rate and is calculated by:

$$P_{T_M} = K'K'''F_m Q_F U_{ap} DFL_T \, 0.75(0.5/H) \quad (B.1\text{-}8)$$

where:

P_{T_M} = Dose parameter for tritium for the cow milk and goat milk pathways, mrem/yr per $\mu Ci/m^3$;

K''' = A constant of unit conversion;
= 10^3 gm/kg;

H = Absolute humidity of the atmosphere, gm/m^3;

0.75 = The fraction of total feed that is water;

0.5 = The ratio of the specific activity of the feed grass water to the atmospheric water;

DFL_T = Maximum organ ingestion dose factor for tritium, mrem/pCi.

B.2 Calculation of R_i Following Regulatory Guide 1.109 Methodology

The radioiodine and particulate Technical Specification 3.9.5.1 is applicable to the location in the unrestricted area where the combination of existing pathways and receptor age groups indicates that the maximum potential exposure occurs. The inhalation and ground plane exposure pathways shall be considered to exist at all locations. The grass-goat-milk, the grass-cow-milk, grass-cow-meat, and vegetation pathways are considered based on their existence at the various locations. R_i values have been calculated for the adult, teen, child, and infant age groups for the ground plane, cow milk, goat milk, vegetable, and beef ingestion pathways. The methodology which was utilized to calculate these values (see Tables 3.3-1 through 3.3-19) is presented below and follows the guidance given in Regulatory Guide 1.109.

B.2.1 Inhalation Pathway

The dose factor from the inhalation pathway is calculated by:

$$R_{i_I} = K' (BR)_a (DFA_i)_a \qquad (B.2.-1)$$

where:

R_{i_I} = Dose factor for each identified radionuclide "i" of the organ of interest, mrem/yr per $\mu Ci/m^3$;

K' = A constant of unit conversion;
= 10^6 pCi/μCi;

$(BR)_a$ = Breathing rate of the receptor of age group a, m^3/yr;

$(DFA_i)_a$ = Organ inhalation dose factor for radionuclide "i" for the receptor of age group a, mrem/pCi.

The breathing rates $(BR)_a$ for the various age groups are tabulated below, as given in Table E-5 of Regulatory Guide 1.109, Revision 1.

Age Group (a)	Breathing Rate (m^3/yr)
Infant	1400
Child	3700
Teen	8000
Adult	8000

Inhalation dose factors $(DFA_i)_a$ for the various age groups are given in Tables E-7 through E-10 of Regulatory Guide 1.109, Revision 1.

B.2.2 Ground Plane Pathway

The ground plane pathway dose factor is calculated by:

$$R_{i_G} = I_i \, K'K''(SF)DFG_i \, (1-e^{-\lambda_i t})/\lambda_i \qquad \text{(B.2-2)}$$

where:

R_{i_G} = Dose factor for the ground plane pathway for each identified radionuclide "i" for the organ of interest, mrem/yr per μCi/sec per m^{-2};

K' = A constant of unit conversion;
= 10^6 pCi/μCi;

K'' = A constant of unit conversion;
= 8760 hr/year;

λ_i = The radiological decay constant for radionuclide "i," sec^{-1};

t = The exposure time, sec;
= 4.73×10^8 sec (15 years);

DFG_i = The ground plane dose conversion factor for radionuclide "i;" mrem/hr per pCi/m^2;

A tabulation of DFG_i values is presented in Table E-6 of Regulatory Guide 1.109, Revision 1.

SF = The shielding factor (dimensionless);

A shielding factor of 0.7 is suggested in Table E-15 of Regulatory Guide 1.109, Revision 1.

I_i = Factor to account for fractional deposition of radionuclide "i."

For radionuclides other than iodine, the factor I_i is equal to one. For radioiodines, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Table 3.3-2.

B.2.3 Grass Cow or Goat Milk Pathway

The dose factor for the cow milk or goat milk pathway for each radionuclide for each organ is calculated by:

$$R_{i_M} = I_i K' Q_F U_{ap} F_m (DFL_i)_a e^{-\lambda_i t_f} \left[f_p f_s \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_p \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] + (1-f_p f_s) \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_s \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] e^{-\lambda_i t_h} \right] \quad (B.2\text{-}3)$$

where:

R_{i_M} = Dose factor for the cow milk or goat milk pathway, for each identified radionuclide "i" for the organ of interest, mrem/yr per μCi/sec per m^{-2};

K' = A constant of unit conversion;
= 10^6 pCi/μCi;

Q_F = The cow's or goat's feed consumption rate, kg/day (wet weight);

U_{ap} = The receptor's milk consumption rate for age group a, liters/yr;

Y_p = The agricultural productivity by unit area of pasture feed grass, kg/m^2;

Y_s = The agricultural productivity by unit area of stored feed, kg/m^2;

F_m = The stable element transfer coefficients, pCi/liter per pCi/day;

r = Fraction of deposited activity retained on cow's feed grass;

$(DFL_i)_a$ = The organ ingestion dose for radionuclide "i" for the receptor in age group a, mrem/pCi;

λ_{E_i} = $\lambda_i + \lambda_w$;

λ_i = The radiological decay constant for radionuclide "i," sec^{-1};

λ_w = The decay constant for removal of activity on leaf and plant surfaces by weathering, sec^{-1};

= 5.73×10^{-7} sec^{-1} (corresponding to a 14 day half-life);

t_f = The transport time from feed to cow, or goat to milk, to receptor, sec;

t_h = The transport time for harvest, to cow or goat, to consumption, sec;

t_b = Period of time that sediment is exposed to gaseous effluents, sec;

B_{iv} = Concentration factor for uptake of radionuclide "i" from the soil by the edible parts of crops, pCi/Kg (wet weight) per pCi/Kg (dry soil);

P = Effective surface density for soil, Kg (dry soil)/m^2;

f_p = Fraction of the year that the cow or goat is on pasture;

f_s = Fraction of the cow feed that is pasture grass while the cow is on pasture;

t_e = Period of pasture grass and crop exposure during the growing season, sec;

I_i = Factor to account for fractional deposition of radionuclide "i."

For radionuclides other than iodine, the factor I_i is equal to one. For radioiodines, the value of I_i may vary. However, a value of 1.0 was used in calcuating the R values in Tables 3.3-9 through 3.3-16.

Milk cattle and goats are considered to be fed from two potential sources, pasture grass and stored feeds. Following the development in Regulatory Guide 1.109, Revision 1, the value of f_s was considered unity in lieu of site-specific information. The value of f_p was 0.667 based upon an 8-month grazing period.

Table B-1 contains the appropriate parameter values and their source in Regulatory Guide 1.109, Revision 1.

The concentration of tritium in milk is based on the airborne concentration rather than the deposition. Therefore, the R_i is based on X/Q:

$$R_{T_M} = K'K'''F_m Q_F U_{ap} (DFL_i)_a \, 0.75(0.5/H) \qquad (B.2\text{-}4)$$

where:

R_{T_M} = Dose factor for the cow or goat milk pathway for tritium for the organ of interest, mrem/yr per $\mu Ci/m^3$;

K''' = A constant of unit conversion;
= 10^3 gm/kg;

H = Absolute humidity of the atmosphere, gm/m^3;

0.75 = The fraction of total feed that is water;

0.5 = The ratio of the specific activity of the feed grass water to the atmospheric water.

and other parameters and values are given above. A value of H = 8 grams/meter^3, was used in lieu of site-specific information.

B.2.4 Grass-Cow-Meat Pathway

The integrated concentration in meat follows in a similar manner to the development for the milk pathway, therefore:

$$R_{i_B} = I_i K' Q_F U_{ap} F_f (DFL_i)_a \, e^{-\lambda_i t_s} \left[f_p f_s \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_p \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] + (1-f_p f_s) \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_s \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] e^{-\lambda_i t_h} \right] \qquad (B.2\text{-}5)$$

where:

R_{i_B} = Dose factor for the meat ingestion pathway for radionuclide "i" for any organ of interest, mrem/yr per $\mu Ci/sec$ per m^{-2};

F_f = The stable element transfer coefficients, pCi/Kg per pCi/day;

U_{ap} = The receptor's meat consumption rate for age group a, kg/yr;

t_s = The transport time from slaughter to consumption, sec;

t_h = The transport time from harvest to animal consumption, sec;

t_e = Period of pasture grass and crop exposure during the growing season, sec;

I_i = Factor to account for fractional deposition of radionuclide "i."

For radionuclides other than iodine, I_i is equal to one. For radioiodines, the value of I_i may vary. However, a value of 1.0 was used in calculating the R values in Tables 3.3-6 through 3.3-8.

All other terms remain the same as defined in Equation B.2-3. Table B-2 contains the values which were used in calculating R_i for the meat pathway.

The concentration of tritium in meat is based on its airborne concentration rather than the deposition. Therefore, the R_i is based on X/Q.

$$R_{T_B} = K'K'''F_f Q_F U_{ap} (DFL_i)_a \, 0.75(0.5/H) \qquad (B.2\text{-}6)$$

where:

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

All other terms are defined in Equations B.2-4 and B.2-5.

B.2.5 Vegetation Pathway

The integrated concentration in vegetation consumed by man follows the expression developed in the derivation of the milk factor. Man is considered to consume two types of vegetation (fresh and stored) that differ only in the time period between harvest and consumption, therefore:

$$R_{i_v} = I_i K' (DFL_i)_a \left[U_a^L f_L e^{-\lambda_i t_L} \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_v \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] + U_a^S f_g e^{-\lambda_i t_h} \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_v \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] \right] \quad (B.2\text{-}7)$$

where:

R_{i_V} = Dose factor for vegetable pathway for radionuclide "i" for the organ of interest, mrem/yr per μCi/sec per m^{-2};

K' = A constant of unit conversion;
= 10^6 pCi/μCi;

U_a^L = The consumption rate of fresh leafy vegetation by the receptor in age group a, kg/yr;

U_a^S = The consumption rate of stored vegetation by the receptor in age group a, kg/yr;

f_L = The fraction of the annual intake of fresh leafy vegetation grown locally;

f_g = The fraction of the annual intake of stored vegetation grown locally;

t_L = The average time between harvest of leafy vegetation and its consumption, sec;

t_h = The average time between harvest of stored vegetation and its consumption, sec;

Y_v = The vegetation areal density, kg/m^2;

t_e = Period of leafy vegetable exposure during growing season, sec;

I_i = Factor to account for fractional deposition of radionuclide "i."

All other factors as defined before.

For radionuclides other than iodine, the factor I_i is equal to one. For radioiodines, the value of I_i may vary. However, a value of 1.0 was used in Tables 3.3-3 through 3.3-5.

Table B-3 presents the appropriate parameter values and their source in Regulatory Guide 1.109, Revision 1.

In lieu of site-specific data default values for f_L and f_g, 1.0 and 0.76, respectively, were used in the calculations on R_i. These values were obtained from Table E-15 of Regulatory Guide 1.109, Revision 1.

The concentration of tritium in vegetation is based on the airborne concentration rather than the deposition. Therefore, the R_i is based on X/Q:

$$R_{T_V} = K'K'''\left[U_a^L f_L + U_a^S f_g\right](DFL_i)_a \quad 0.75(0.5/H) \qquad (B.2\text{-}8)$$

where:

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

All other terms remain the same as those in Equations B.2-4 and B.2-7.

TABLE B-1

Parameters For Cow and Goat Milk Pathways

Parameter	Value	Reference (Reg. Guide 1.109, Rev. 1
Q_F (kg/day)	50 (cow) 6 (goat)	Table E-3 Table E-3
Y_p (kg/m^2)	0.7	Table E-15
T_f (seconds)	1.73×10^5 (2 days)	Table E-15
r	1.0 (radioiodines) 0.2 (particulates)	Table E-15 Table E-15
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	Tables E-11 to E-14
F_m (pCi/day per pCi/liter)	Each stable element	Table E-1 (cow) Table E-2 (goat)
T_b (seconds)	4.73×10^8 (15 yr)	Table E-15
Y_s (kg/m^2)	2.0	Table E-15
Y_p (kg/m^2)	0.7	Table E-15
t_h (seconds)	7.78×10^6 (90 days)	Table E-15
U_{ap} (liters/yr)	330 infant 330 child 400 teen 310 adult	Table E-5 Table E-5 Table E-5 Table E-5
t_e (seconds)	2.59×10^6 (pasture) 5.18×10^6 (stored feed)	Table E-15
B_{iv} (pCi/kg [wet weight] per pCi/kg [dry soil])	Each stable element	Table E-1
P kg (dry soil/m^2)	240	Table E-15

TABLE B-2

Parameters For The Meat Pathway

Parameter	Value	Reference (Reg. Guide 1.109, Rev. 1
r	1.0 (radioiodines) 0.2 (particulates)	Table E-15 Table E-15
F_f (pCi/kg per pCi/day)	Each stable element	Table E-1
U_{ap} (kg/yr)	0 infant 41 child 65 teen 110 adult	Table E-5 Table E-5 Table E-5 Table E-5
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	Tables E-11 to E-14
Y_p (kg/m^2)	0.7	Table E-15
Y_s (kg/m^2)	2.0	Table E-15
T_b (seconds)	4.73×10^8 (15 yr)	Table E-15
T_s (seconds)	1.73×10^6 (20 days)	Table E-15
t_h (seconds)	7.78×10^6 (90 days)	Table E-15
t_e (seconds)	2.59×10^6 (pasture) 5.18×10^6 (stored feed)	Table E-15
Q_F (kg/day)	50	Table E-3
B_{iv} (pCi/kg [wet weight] per pCi/kg [dry soil])	Each stable element	Table E-1
P (kg [dry soil/m^2])	240	Table E-15

TABLE B-3

Parameters for The Vegetable Pathway

Parameter	Value	Reference (Reg. Guide 1.109, Rev. 1
r (dimensionless)	1.0 (radioiodines) 0.2 (particulates)	Table E-1 Table E-1
$(DFL_i)_a$ (mrem/Ci)	Each radionuclide	Tables E-11 to E-14
Q_F (kg/day)	50 (cow) 6 (goat)	Table E-3 Table E-3
U_a^L (kg/yr) - Infant	0	Table E-5
- Child	26	Table E-5
- Teen	42	Table E-5
- Adult	64	Table E-5
U_a^S (kg/yr) - Infant	0	Table E-5
- Child	520	Table E-5
- Teen	630	Table E-5
- Adult	520	Table E-5
T_L (seconds)	8.6×10^4 (1 day)	Table E-15
t_h (seconds)	5.18×10^6 (60 days)	Table E-15
Y_v (kg/m^2)	2.0	Table E-15
t_e (seconds)	5.18×10^6 (60 days)	Table E-15
T_b (seconds)	4.73×10^8 (15 yr)	Table E-15
P (kg [dry soil/m^2])	240	Table E-15
B_{iv} (pCi/kg [wet weight] per pCi/kg [dry soil])	Each stable element	Table E-1

B.3 Calculation of R_i Following NUREG 0133 Methodology

The Grass-Cow-Milk pathway, Grass-Cow-Meat Pathway and the Vegetation Pathway can also be evaluated using the simpler methodology of NUREG 0133. The following sections describe this simpler approach and provide the basis for Tables 3.4-1 through 3.4-10.

B.3.1: Grass-Cow-Milk Pathway (R_i^C [D/Q])

$$R_i^C [D/Q] = K' \left[\frac{Q_F (U_{ap})}{\lambda_i + \lambda_w}\right] F_m (r) (DFL_i)_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s}\right] e^{-\lambda_i t_f}$$

where: Units = $m^2 \cdot$ mrem/yr per µci/sec

		Reference Table, R.G. 1.10
K' =	A constant of unit conversion, 10^6 pCi/µCi.	
Q_F =	The cow's consumption rate, 50 kg/day (wet weight)	E-3
U_{ap} =	The receptor's milk consumption rate for age (a), in liters/yr 330 infant and child 400 teen 310 adult	E-5
Y_p =	The agricultural productivity by unit area of pasture feed grass 0.7 kg/m^2	E-15
Y_s =	The agricultural productivity by unit area of stored feed 2.0 kg/m^2	E-15
F_m =	The stable element transfer coefficients, in days/liter.	E-1
r =	Fraction of deposited activity retained on cow's feed grass 1.0 radioiodine 0.2 particulates	E-15 E-15
$(DFL_i)a$ =	The maximum organ ingestion dose factor for the ith radionuclide for the receptor in age group (a), in mrem/pCi	E-11 to E-14
λ_i =	The decay constant for the ith radionuclide, in sec^{-1}	
λ_w =	The decay constant for removal of activity on leaf and plant surfaces by weathering 5.73×10^{-7} sec^{-1} (corresponding to a 14 day half-life).	
t_f =	The transport time from pasture to cow, to milk, to receptor 1.73×10^{-5} sec (2 days)	E-15
t_h =	The transport time from pasture, to harvest, to cow, to milk, to receptor 7.78×10^6 sec (90 days)	E-15
f_p =	Fraction of the year that the cow is on pasture (dimensionless) = 1*	
f_s =	Fraction of the cow feed that is pasture grass while the cow is on pasture (dimensionless) = 1*.	

*Milk cattle are considered to be fed from two potential sources, pasture grass and stored feeds. Following the development in Regulatory Guide 1.109 (Ref. 6), the values of f_p and f_s will be considered unity, in lieu of site-specific information provided in the annual land census report by the licensee.

Note: The above equation does not apply to the concentration of tritium in milk. A separate equation is provided in NUREG 0133, Section 5.3.1.3 to determine tritium values.

Reference: The equation deriving R_i^C (D/Q) was taken from NUREG 0133, Section 5.3.1.3.

B.3.2: Grass-Cow-Meat Pathway (R_i^m [D/Q])

$$R_i^m [D/Q] = K' \left[\frac{Q_F(U_{ap})}{\lambda_i + \lambda_w}\right] F_f (r) (DFL_i)_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s)e^{-\lambda_i t_h}}{Y_s}\right] e^{-\lambda_i t_f}$$

where: Units = $m^2 \cdot$ mrem/yr per μci/sec

		Reference Table, R.G. 1.10
K' =	A constant of unit conversion, 10^6 pCi/μCi.	
Q_F =	The cow's consumption rate, 50 kg/day (wet weight)	E-3
U_{ap} =	The receptor's milk consumption rate for age (a), in liters/yr	E-5
	Infant--0	
	Child--41	
	Teen--65	
	Adult--110	
Y_p =	The agricultural productivity by unit area of pasture feed grass	E-15
	0.7 kg/m^2	
Y_s =	The agricultural productivity by unit area of stored feed	E-15
	2.0 kg/m^2	
F_f =	The stable element transfer coefficients, in days/liter.	E-1
r =	Fraction of deposited activity retained on cow's feed grass	
	1.0 radioiodine	E-15
	0.2 particulates	E-15
t_f =	Transport time from pasture to receptor, in sec.	E-15
	1.73×10^6 sec (20 days)	
t_h =	Transport time from crop field to receptor, in sec.	E-15
	7.78×10^6 sec. (90 days)	
$(DFL_i)_a$ =	The maximum organ ingestion dose factor for the ith radionuclide for the receptor in age group (a), in mrem/pCi	E-11 to E-14
λ_i =	The decay constant for the ith radionuclide, in sec^{-1}	
λ_w =	The decay constant for removal of activity on leaf and plant surfaces by weathering 5.73×10^{-7} sec^{-1} (corresponding to a 14 day half-life).	
f_p =	Fraction of the year that the cow is on pasture (dimensionless) = 1*	
f_s =	Fraction of the cow feed that is pasture grass while the cow is on pasture (dimensionless) = 1*.	

*Milk cattle are considered to be fed from two potential sources, pasture grass and stored feeds. Following the development in Regulatory Guide 1.109 (Ref. 6), the values of f_p and f_s will be considered unity, in lieu of site-specific information provided in the annual land census report by the licensee.

Note: The above equation does not apply to the concentration of tritium in milk. A separate equation is provided in NUREG 0133, Section 5.3.1.3 to determine tritium values.

Reference: The equation deriving R_i^m (D/Q) was taken from NUREG 0133, Section 5.3.1.4.

B.3.3: Vegetation Pathway (R_i^V [D/Q])

$$R_i^V [D/Q] = K' \left[\frac{(r)}{Y_v (\Lambda_i + \Lambda_w)}\right] (DFL_i) \left[U_a^L f_L e^{-\Lambda_i t_L} + U_a^S f_g e^{-\Lambda_i t_h}\right]$$

where: Units = $m^2 \cdot$ mrem/yr per μCi/sec

Reference Table, R.G. 1.10

K' = A constant of unit conversion, 10^6 pCi/μCi. — E-5

U_a^L = The consumption rate of fresh leafy vegetation by the receptor in age group (a), in kg/yr.
Infant--0
Child--26
Teen--42
Adult--64

U_a^S = The consumption rate of stored vegetation by the receptor in age group (a), in kg/yr — E-5
Infant--0
Child--520
Teen--630
Adult--520

$(DFL_i)a$ = The maximum organ ingestion dose factor for the ith radionuclide for the receptor in age group (a), in mrem/pCi — E-11 to E-14

f_L = The fraction of the annual intake of fresh leafy vegetation grown locally (Default 1.0) the cow is on pasture

f_g = The fraction of the annual intake of stored vegetation grown locally (Default 0.76)

t_L = The average time between harvest of leafy vegetation and its consumption, 8.6×10^4, seconds (1 day) to receptor
1.73×10^{-5} sec (2 days)

t_h = The average time between harvest of stored vegetation and its consumption, 5.18×10^6 seconds (60 days) — E-15
7.78×10^6 sec (90 days)

Y_v = The vegetation areal density, 2.0 kg/m^2

r = Fraction of deposited activity retained on the vegetation — E-15

Λ_w = The decay constant for removal of activity on leaf
1.0 radioiodine
0.2 particulates

λ_i = The decay constant for the ith radionuclide in sec^{-1}

λ_w = The decay constant for removal of activity on leaf and plant surfaces by weathering, 5.73×10^{-7} sec^{-1} (corresponding to a 14 day half-life).

Note: The above equation does not apply to the concentration of tritium in milk. A separate equation is provided in NUREG 0133, Section 5.3.1.3 to determine tritium values.

Reference: The equation deriving R_i^V (D/Q) was taken from NUREG 0133, Section 5.3.1.5.

B.4

The calculations that support the 2500 CFM maximum instantaneous flow rate for a C.V. pressure relief as calculated by CP&L Nuclear Fuels Section, Project 86-0015, are found in File 2486-0015 and were performed by Mr. Talmage Clements, 10 February 1986.

APPENDIX C
LOWER LIMIT OF DETECTABILITY

The LLD[1,2] is defined, for purposes of these specifications, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{4.66\ s_b}{E \cdot V \cdot 2.22 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

where:

LLD = "A priori" lower limit of detection as defined above, as picocuries per unit mass or volume;

s_b = Standard deviation of the background counting rate or of the counting rate of a blank sample, as appropriate, as counts per minute;

E = Counting efficiency, as counts per disintegration;

V = Sample size in units of mass or volume;

2.22 = Number of disintegrations per minute per picocurie;

Y = Fractional radiochemical yield, when applicable;

λ = Radioactive decay constant for the particular radionuclide; and

Δt = The elapsed time between sample collection or end of the sample collection period and time of counting;

Typical values of efficiency, volume/mass, chemical yield, and radionuclide decay corrections are to be used in the calculation.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unadvoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report pursuant to Specification 6.9.1.E.[3]

References

1. HASL-300 (Suppl. 4), HASL Procedures Manual, (1972).

2. NBS SP456 "The Minimum Detectable Activity Concept," J. C. Lockamy (1976).

3. Technical Specifications for H. B. Robinson Unit 2.

TABLE D-1

Liquid Process Monitors

Name	RMS #	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	19	R-19	997261

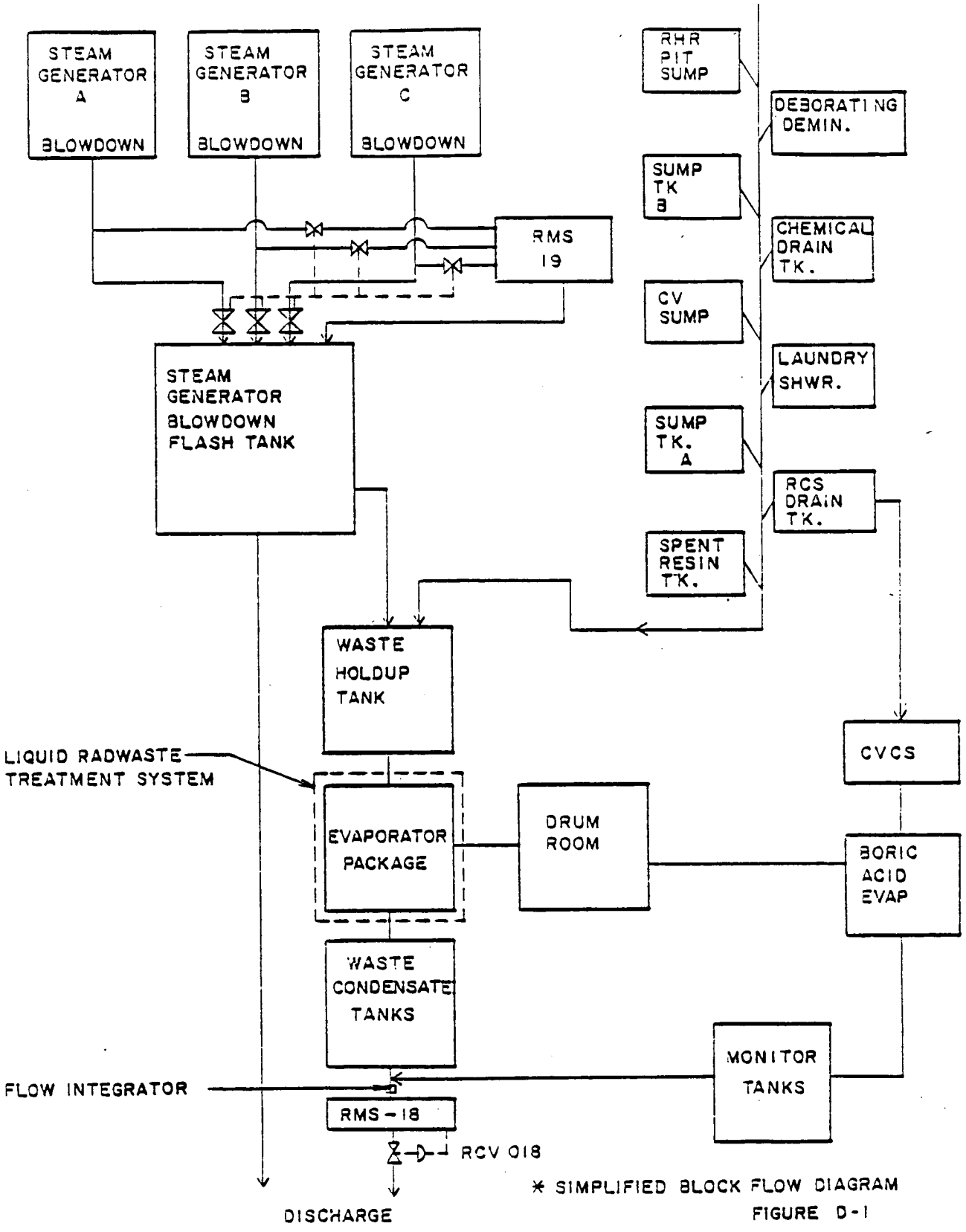
Liquid Radwaste Flow Measurement Devices

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

TABLE D-2
Gaseous Process Monitors

Name	RMS #	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	14	R-14	D997704	UGC Microflow 3000	UGC Microflow 3000
Condenser Vacuum Pump Vent	15	R-15	D997299	Condenser Vacuum Pump Flowmeter (on pump)	Condenser Vacuum Flowmeter (on pump)
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	C998233	Fisher Porter Flowmeter Mod. 1043565 Mod. 6908A0837A1	None (Use fan ratings)
PING 2A Effluent Monitoring System	34	R-34	Eberline Pins 2-A Manual	Dwyer Flowmeter VRFA27	UGC Microflow 3000
Plant Vent High Range	36	R-36	Harshaw Manual NR-75	None	UGC Microflow 3000

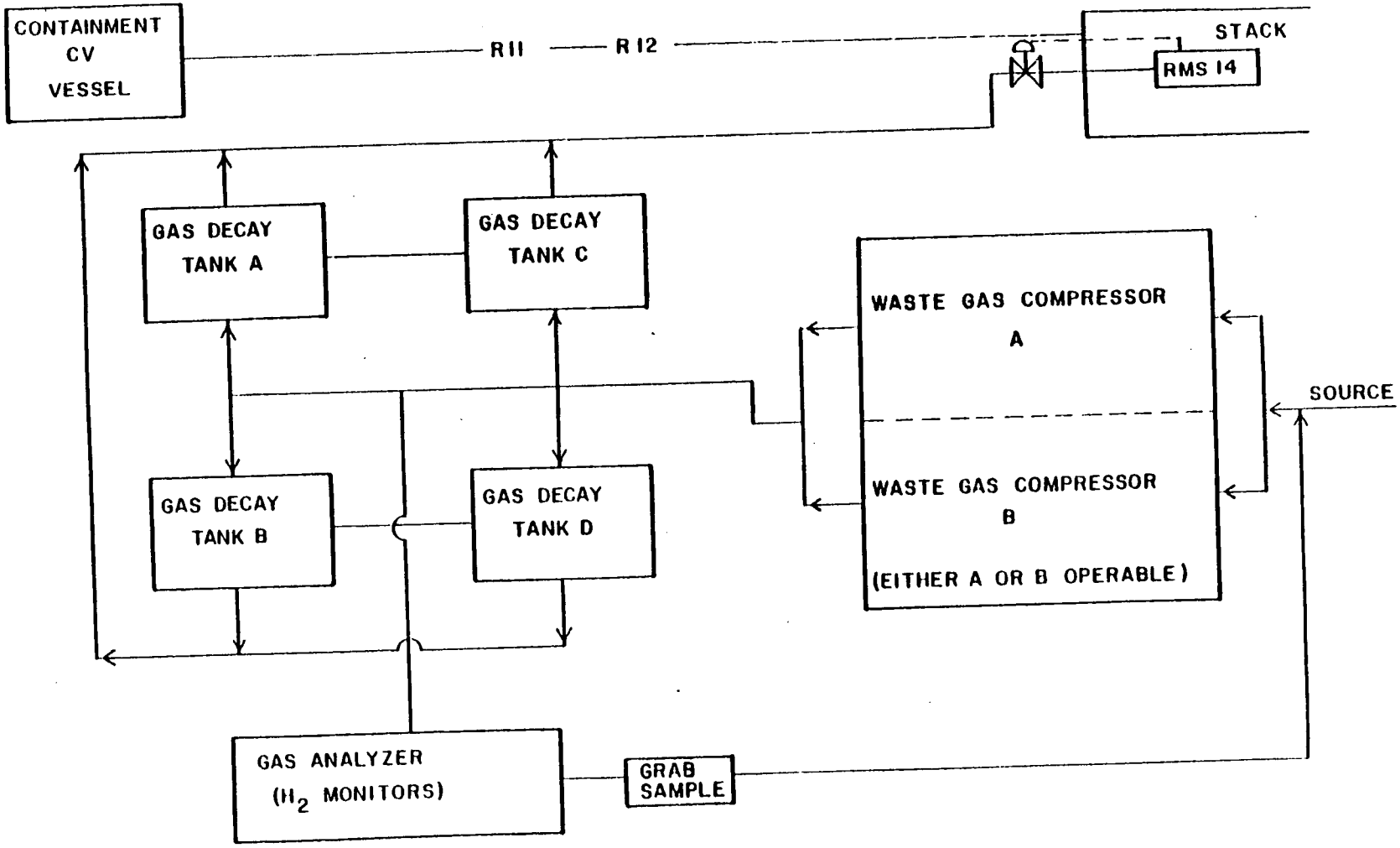
H. B. ROBINSON LIQUID RADWASTE PROCESS/EFFLUENT SYSTEM *



* SIMPLIFIED BLOCK FLOW DIAGRAM

FIGURE D-1

H.B. ROBINSON GASEOUS RADWASTE EFFLUENT SYSTEM *



* SIMPLIFIED BLOCK FLOW DIAGRAM

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

FIGURE D-2