SEMIANNUAL RADIOACTIVE EFFLUENT

RELEASE REPORT

CALLAWAY NUCLEAR PLANT

UNION ELECTRIC COMPANY

LICENSE NPF - 30

JULY - DECEMBER 1987

TABLE OF CONTENTS

1.0 INTRODUCTION

This Semiannual Radioactive Effluent Release Report is for Union Electric Company's Callaway Plant and is submitted in accordance with the requirements of Technical Specification 6.9.1.7. The report covers the period from July 1, 1987 through December 31, 1987.

This report includes a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the plant. The information is presented in accordance with the format outlined in Appendix B of Regulatory Guide 1.21, Revision 1, June 1974.

All liquid and gaseous effluents discharged during this reporting period were in compliance with the limits of the Callaway Plant Technical Specifications.

2.0 SUPPLEMENTAL INFORMATION

2.1 Regulatory Limits

Specified as follows are the technical specification limits applicable to the release of radioactive material in liquid and gaseous effluents.

2.1.1 Fission and Activation Gases (Noble Gases)

The dose rate due to radioactive noble gases released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin.

The air dose due to noble gases released in gaseous effluents, from each unit, to areas at and beyond the site boundary shall be limited to the following:

a. During any calendar quarter: Less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation and,

b. During any calendar year: Less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

2.1.2 Radioiodine, Tritium, and Particulates

The dose rate due to Iodine 131 and 133, tritium and all radionuclides in particulate form with half lives greater than eight (8) days released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to less than or equal to 1500 mrem/yr to any organ.

The dose to a member of the public from Iodine 131 and 133, tritium, and all radionuclides in particulate form with half-lives greater than eight (8) days in gaseous effluents released to areas at and beyond the site boundary shall be limited to the following:

a. During any calendar quarter: Less than or equal to 7.5 mrem to any organ and,

b. During any calendar year: Less than or equal to 15 mrem to any organ.

2.1.3 Liquid Effluents

The concentration of radioactive material released in liquid effluents to unrestricted areas shall be limited to the concentrations specified in 10 CFR Part 20, 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 2.0E-04 microcuries/ml total activity.

The dose or dose commitment to an Individual from radioactive materials in liquid effluents released to unrestricted areas shall be limited:

a. During any calendar quarter to less than or equal to 1.5 mrem to the total body and less than or equal to 5 mrem to any organ, and

b. During any calendar year to less than or equal to 3 mrem to the whole body and to less than or equal to 10 mrem to any organ.

2.1.4 Uranium Fuel Cycle Sources

The annual (calendar year) dose or dose commitment to any member of the public due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to less than or equal to 25 mrem to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem.

2.2 Maximum Permissible Concentrations

2.2.1 The maximum permissible concentration values specified in 10CFR20, Appendix B, Table II, Column 2 are used to calculate release rates and permissible concentrations of liquid radioactive effluents at the unrestricted area boundary. A value of 2.0E-4 microcuries/ml is used as the MPC for dissolved and entrained noble gases in liquid effluents.

2.2.2 For gaseous effluents, maximum permissible concentrations are not directly used in release rate calculations since the applicable limits are stated in terms of dose rate at the unrestricted area boundary.

2.3 Average Energy

This is not applicable to the Callaway Plant's radiological effluent technical specifications.

2.4 Measurements and Approximations of Total Radioactivity

The quantification of radioactivity in liquid and gaseous effluents was accomplished by performing the sampling and radiological analysis of effluents in accordance with the requirements of Table 4.11-1 and Table 4.11-2 of the Callaway Plant Technical Specifications (See NUREG-1058, "Technical Specifications, Callaway Plant, Unit No. 1" (October, 1984)).

Gamma spectroscopy was the primary analysis technique used to determine the radionuclide composition and concentration of liquid and gaseous effluents. Composite samples were analyzed for Sr-89, Sr-90, and Fe-55 by an independent laboratory. Tritium and alpha were measured for both liquid and gaseous effluents using liquid scintillation counting and gas flow proportional counting techniques, respectively.

The total radioactivity in effluent releases was determined from the measured concentrations of each radionuclide present and the total volume of effluents discharged. Gross beta or gamma radioactivity measurement techniques were not utilized to approximate the total radioactivity in effluents.

2.5 Batch Releases

2.5.1 Liquid

Number of batch releases: 124

Total time period for batch releases: 3.774E4 minutes

Maximum time period for a batch release: 1151 minutes

Average time period for batch releases: 304 minutes

Minimum time period for a batch release: 15 minutes

Average stream flow during periods of release of effluent into a flowing stream: 76,957 cfs*

*Letter, L. A. Waite (US Geological Survey) to C. C. Graham (Union Electric Co.) dated 1-4-88.

2.5.2 Gaseous

	Total for the Reporting Period	Non-Outage Related
Number of batch releases	65	55
Total time period for batch releases	67,220 minutes	11,104 minutes
Maximum time period for a batch release	24,836 minutes	791 minutes
Average time period of batch releases	1,034 minutes	202 minutes
Minimum time period for a batch release	9 minutes	60 minutes

2.6 Abnormal Releases

2.6.1 Liquid

Number of releases: 0

Total Activity released: 0

2.6.2 Gaseous

Number of releases: 1

Total Activity released: 1.54 E-4 Ci

3.0 SUMMARY OF GASEOUS RADIOACTIVE EFFLUENTS

3.1 The quantities of radioactive material released in gaseous effluents are summarized in Table 1A and 1B. Note that for this reporting period no gaseous effluents were considered as elevated releases.

4.0 SUMMARY OF LIQUID RADIOACTIVE EFFLUENTS

4.1 The quantities of radioactive material released in liquid effluents are summarized in Table 2A and 2B.

5.0 SOLID WASTE

5.1 The quantities of radioactive material released in shipments of solid waste and irradiated fuel transported from the site during the reporting period are summarized in Table 3. The activity and fractional abundance of each nuclide was determined for each waste type by an independent laboratory based upon radiochemical analysis of samples of that waste type. The curie amount of each nuclide listed in Table 3 was determined as the product of the fractional abundance and the total curies shipped. Those nuclides which comprise at least 1% of the total activity for a particular waste type are presented in Table 3. Additionally, as noted in the "Solid Waste Disposition" section of Table 3, nine total shipments were released with eventual disposal at the Beatty, NV disposal facility. Two of these shipments are listed separately due to their being consigned initially to a waste processor for supercompaction prior to disposal. A third shipment was also released to the waste processor during the reporting period. None of the waste from this third shipment was disposed of in a burial facility during this period. This volume will be accounted for during the next reporting period.

6.0 RELATED INFORMATION

6.1 Unplanned Releases

Unplanned releases are inadvertant or unanticipated releases of radioactive material, or releases of radioactive material via normal pathways without a release permit or proper authorization, or without proper sampling and analysis, or releases which are conducted in such a manner as to result in significant deviation from the requirements of the release permit.

There was one unplanned release during the reporting period.

On 9-22-87, I-131 activity was identified in an Auxiliary Boiler sample at a concentration of 3.8E-7 µCi/ml. Administrative controls had previously been placed on this system to ensure that boiler blowdown and drains would be routed to liquid radwaste if contaminated. These controls were verified and operation of the Auxiliary Boiler was continued.

On 10-14-87 it was discovered that the Auxiliary Boiler was being continuously vented to atmosphere to prevent tripping the boiler on low load. The boiler had been operated in this mode for approximately 2½ days. Operation of the boiler was immediately secured and samples were taken for analysis. The concentration of I-131 was found to be 3.6E-7 µCi/ml. The boiler was drained to liquid radwaste, filled, and resampled to ensure that no activity was present.

On 10-17-87 the Auxiliary Boiler was started up and at 0937 activity was again detected at a concentration of 1E-7 µCi/ml I-131. Boiler operation was continued but without venting steam to atmosphere. The activity was determined to be coming from the Secondary Liquid Waste Evaporator Vent Gas Cooler drains and the steam trap, Secondary Liquid Waste Evaporator density cell wash. Recycle of Radwaste Building steam loads to the Aux Boiler was secured and redirected to Radwaste systems for processing/discharge.

Identified corrective actions are: 1) Until the source of the contamination can be corrected, the Auxiliary Boiler will be sampled daily when operating; 2) If activity is present in the Auxiliary Boiler, it will be operated without blowdown or venting of steam; 3) The possibility of a leak in the Secondary Liquid Waste Evaporator has been investigated and a design change has been initiated to redirect the two identified sources of contamination to contaminated radwaste drains, and, when repaired, will return to normal sytem lineup of the Auxiliary Steam System.

The dose at the SITE BOUNDARY was calculated to be 9.6E-5 mrem from the release of approximately 1.54E-4 Ci of I-131. The calculated dose represents a small fraction (1E-3%) of the quarterly limit of Technical Specification 3.11.2.2. This event did not adversely affect or endanger the health or safety of the public.

This event is documented by Incident Report 87-223, and a Safety Evaluation has been performed in accordance with 10CFR50.59.

6.2 Changes to the Process Control Program

Revision 8 to the Callaway Process Control Program (PCP) was issued October 14, 1987. This revision incorporated revised boundary conditions/ratios used in the development of batch solidification formulations, revised acceptance criteria for determining structural stability, and addition of full scale (55 gallon) test solidification. Minor text revisions were required due to these changes. Attachment 1 includes documentation of the fact that the change has been reviewed and found acceptable by the On-Site Review Committee (ORC).

6.3 Changes to the Offsite Dose Calculation Manual

Revision 4 to the Callaway Plant's Offsite Dose Calculation Manual (ODCM) was issued February 23, 1987, but was inadvertently not described in the previous Semiannual Radioactive Effluent Release Report, and is therefore being reported herein. A complete copy of the ODCM (Rev. 4) is included with this report as Attachment 1. There were no changes to the ODCM during the period July 1 - December 31, 1987.

There were several minor clarifications which were incorporated into Rev. 4; however, these did not change the methodology, parameters, or intent, and are not further enumerated.

Pages 7 & 13: The definition of C_a and C_t were revised to delete the reference to a "monthly composite sample". Although the minimum sampling frequency is defined by Technical Specification 3.11.1.1 as monthly, more frequent sampling may be performed.

Page 23: Added methodology for performing the 31-day dose projection required by Technical Specification 3.11.1.3. This was not previously described in the ODCM.

Page 24: Rev. 3 erroneously stated that radiation monitor setpoints were based on the "instantaneous concentration limits of 10CFR20, Appendix B, Table II, Column 1". This has been revised to properly state that the setpoints are based on the instantaneous dose limits of Technical Specification 3.11.2.1. It should be noted that there were no changes to the methodology or equations.

Page 65: Added methodology for performing the 31-day dose projection required by Technical Specification 3.11.2.4. This was not previously described in the ODCM.

Pages 67,68,71,& 72: Revised the following to reflect current information regarding the use of areas within the SITE BOUNDARY: (1) The description of the MEMBER OF THE PUBLIC; (2) The description of the utilization of areas within the SITE BOUNDARY; (3) The description of the dose pathways for the MEMBER OF THE PUBLIC; (4) Location for assessment of direct radiation dose from outdoor storage tanks and from the operation of the unit.

6.4 Major Changes to Radwaste Treatment Systems

There were no major changes to Radwaste Treatment Systems during the reporting period.

6.5 Land Use Census Changes

There were no changes in critical receptor locations for dose calculations during the reporting period.

6.6 Inoperability of Effluent Monitoring Instrumentation

All effluent monitoring instrumentation was OPERABLE within the limits specified by Specifications 3.3.3.9 and 3.3.3.10 during the reporting period.

7.0 METEOROLOGICAL DATA

Meteorological data for the year is presented in Table 4 as Cumulative Joint Frequency Distributions for both 10 and 60 meter elevations.

8.0 ASSESSMENT OF DOSES

The assessment of doses to the maximum exposed individual from Gaseous and Liquid effluents was performed for locations representing the maximum dose. In all cases, doses were well below Technical Specification limits.

8.1 Dose at the SITE BOUNDARY and Nearest Residence From Gaseous Effluents

An assessment of doses from gaseous effluents was performed in accordance with the Callaway Plant ODCM for the maximum exposed individual at the SITE BOUNDARY and Nearest Residence location with the highest ground level concentration of radioactive material, based upon actual meteorological conditions existing during the year. Doses were assessed at each location considering the noble gas exposure, inhalation, ground plane, and ingestion pathways. The ingestion pathways considered were the produce, vegetable, goat's milk, cow's milk, and meat pathways. This assessment was performed for each age group, with the Child age group receiving the highest dose.

The results of the assessment for the Child age group are presented in Table 5. It must be noted that the calculations for the SITE BOUNDARY location conservatively assume a hypothetical maximum exposed individual, while the calculations for Nearest Residence are for a real individual. It is conservatively assumed that each ingestion pathway exists at the site boundary and the Nearest Residence locations..

8.2 Dose to the MEMBER OF THE PUBLIC from Activities Within the SITE BOUNDARY

The assessment of dose to the MEMBER OF THE PUBLIC from activities within the SITE BOUNDARY was performed in accordance with Chapter 4 of the Callaway Plant ODCM. The dose to the MEMBER OF THE PUBLIC from activities within the SITE BOUNDARY is presented in Table 6.

8.3 Total Dose Due to the Uranium Fuel Cycle

Since there are no other uranium fuel cycle facilities within 8 km of the Callaway Plant, the total dose to the most likely exposed MEMBER OF THE PUBLIC results from direct radiation and radioactive effluents from the Callaway Plant. The methodology for assessing this dose is described in Chapter 4 of the Callaway Plant ODCM.

The Total Dose from the Uranium Fuel Cycle was evaluated for the MEMBER OF THE PUBLIC who may use portions of the area within the SITE BOUNDARY for purposes not associated with plant operations, and for the Nearest Resident, who is assumed to receive an insignificant dose from activities within the SITE BOUNDARY.

The Total Dose to the MEMBER OF THE PUBLIC is from the dose due to activities within the SITE BOUNDARY (Table 6) and the dose due to gaseous effluents at his residence. The food ingestion pathways do not exist at the residence location.

The Total Dose at the Nearest Residence is due to the dose from gaseous effluents, assuming that each food ingestion pathway exists at this location (Table 5).

In each case, the whole body gamma dose from Noble Gases and ground plane exposure is added to the organ dose from the inhalation and ingestion pathways.

The Total Dose from the Uranium Fuel Cycle is presented in Table 7.

8.4 Dose Due to Liquid Effluents

The total dose to the maximum exposed Individual from liquid effluents released from the Callaway Plant during the year is presented in Table 8.

TABLE 1A

SEMIANNUAL SUMMATION OF GASEOUS RELEASES
ALL AIRBORNE EFFLUENTS
QUARTERS 3 AND 4, 1987

TYPE OF EFFLUENT	UNIT	QUARTER 3	QUARTER 4	EST TOTAL ERROR %
A. FISSION AND ACTIVATION GASES				
1. TOTAL RELEASE	CURIES	9.35E2	1.14E2	20
2. AVERAGE RELEASE RATE FOR PERIOD	UCI/SEC	1.18E2	1.43E1	
3. PERCENT OF TECH SPEC LIMIT	%	6.76E-3	8.24E-4	
B. RADIOIODINES				
1. TOTAL IODINE-131	CURIES	5.50E-5	6.36E-5	23
2. AVERAGE RELEASE RATE FOR PERIOD	UCI/SEC	6.92E-3	8.00E-6	
3. PERCENT OF TECH SPEC LIMIT	%	6.59E-3	7.62E-6	
C. PARTICULATES				
1. PARTICULATES (HALF-LIVES > 8 DAYS)	CURIES	1.54E-5	1.41E-6	30
2. AVERAGE RELEASE RATE FOR PERIOD	UCI/SEC	1.94E-6	1.77E-7	
3. PERCENT OF TECH SPEC LIMIT	%	1.26E-7	1.15E-8	
4. GROSS ALPHA RADIOACTIVITY	CURIES	2.45E-6	1.27E-6	
D. TRITIUM				
1. TOTAL RELEASE	CURIES	6.04E0	6.99E0	14
2. AVERAGE RELEASE RATE FOR PERIOD	UCI/SEC	7.60E-1	8.79E-1	
3. PERCENT OF TECH SPEC LIMIT	%	5.00E-5	5.79E-5	

TABLE 1B

SEMIANNUAL AIRBORNE CONTINUOUS AND BATCH RELEASES
GROUND LEVEL RELEASES
FISSION GASES, IODINES, AND PARTICULATES
QUARTERS 3 AND 4, 1987

		CONTINUOUS RELEASES		BATCH RELEASES	
NUCLIDE	UNIT	QUARTER 3	QUARTER 4	QUARTER 3	OUARTER 4
1. FISSION GASES					
Kr-85M	CURIES	3.49E0	6.86E-2	1.41E-2	4.97E-5
Kr-85	CURIES	0	0	4.59E0	1.75E1
Kr-87	CURIES	4.76E-2	0	0	0
Kr-88	CURIES	3.65E0	0	0	0
Xe-131M	CURIES	0	0	4.66E0	1.38E1
Xe-133M	CURIES	3.11E0	0	2.38E0	3.43E-3
Xe-133	CURIES	4.12E2	3.00E1	4.56E2	4.89E1
Xe-135M	CURIES	3.70E-2	0	0	0
Xe-135	CURIES	4.35E1	3.32E0	1.54E-1	1.73E-2
Xe-138	CURIES	0	0	0	0
Ar-41	CURIES	0	0	6.48E-1	5.80E-2
TOTAL FOR PERIOD	CURIES	4.66E2	3.34E1	4.68E2	8.03E1
2. IODINES					
I-131	CURIES	1.96E-6	1.14E-5	5.30E-5	5.22E-5
I-133	CURIES	0	0	0	8.58E-10
I-135	CURIES	0	0	3.88E-7	0
TOTAL FOR PERIOD	CURIES	1.96E-6	1.14E-5	5.34E-5	5.22E-5
3. PARTICULATES					
H-3	CURIES	4.52E0	5.06E0	1.52E0	1.93E0
Co-58	CURIES	9.45E-6	1.44E-7	0	9.93E-10
Co-60	CURIES	8.47E-7	0	0	0
Rb-88	CURIES	7.94E-6	0	4.64E-4	1.96E-6
Sr-89	CURIES	0	0	0	0
Cs-134	CURIES	1.24E-6	0	0	0
Cs-137	CURIES	1.41E-6	0	0	0
Cs-138	CURIES	0	0	1.00E-4	0
Sr-90	CURIES	0	0	0	0
G ALPHA	CURIES	6.19E-7	1.03E-6	1.83E-6	2.39E-7
TOTAL FOR PERIOD	CURIES	4.52E0	5.06E0	1.52E0	1.93EC

TABLE 2A

SEMIANNUAL SUMMATION OF LIQUID RELEASES
ALL LIQUID EFFLUENTS
QUARTERS 3 AND 4, 1987

TYPE OF EFFLUENT	UNIT	QUARTER 3	QUARTER 4	EST TOTAL ERROR %
A. FISSION AND ACTIVATION PRODUCTS				
1. TOTAL RELEASE (NOT INCLUDING TRITIUM, GASES, ALPHA)	CURIES	9.75E-2	3.61E-1	20
2. AVERAGE DILUTED CONCENTRATION DURING PERIOD	UCI/ML	1.50E-7	9.37E-7	
3. PERCENT OF APPLICABLE LIMIT	%	4.73	4.52	
B. TRITIUM				
1. TOTAL RELEASE	CURIES	1.12E2	3.66E1	14
2. AVERAGE DILUTED CONCENTRATION DURING PERIOD	UCI/ML	1.73E-4	9.66E-5	
3. PERCENT OF APPLICABLE LIMIT	%	5.76	3.22	
C. DISSOLVED AND ENTRAINED GASES				
1. TOTAL RELEASE	CURIES	2.66E0	1.12E-2	27
2. AVERAGE DILUTED CONCENTRATION DURING PERIOD	UCI/ML	4.10E-6	2.96E-8	
3. PERCENT OF APPLICABLE LIMIT	%	2.05	1.49E-2	
D. GROSS ALPHA RADIOACTIVITY				
1. TOTAL RELEASE	CURIES	5.64E-4	6.94E-4	29
E. WASTE VOL RELEASED (PRE-DILUTION)	GAL	6.15E6	4.99E6	10
F. VOLUME OF DILUTION WATER USED	GAL	1.65E8	9.51E7	10

TABLE 2B

SEMIANNUAL LIQUID CONTINUOUS AND BATCH RELEASES
TOTALS FOR EACH NUCLIDE RELEASED
QUARTER 3 AND 4, 1987

		CONTINUOUS RELEASES		BATCH RELEASES	
NUCLIDE	UNIT	QUARTER 3	QUARTER 4	QUARTER 3	QUARTER 4
ALL NUCLIDES					
H-3	CURIES	0	0	1.12E2	3.66E1
Cr-51	CURIES	0	0	1.61E-3	4.81E-2
Mn-54	CURIES	0	0	2.79E-3	1.10E-2
Fe-55	CURIES	0	0	6.03E-4	9.96E-3
Fe-59	CURIES	0	0	1.80E-4	3.83E-3
Co-57	CURIES	0	0	0	6.11E-4
Co-58	CURIES	0	0	6.55E-2	1.63E-1
Co-60	CURIES	0	0	7.32E-3	4.86E-2
Rb-88	CURIES	0	0	3.22E-4	0
Sr-89	CURIES	0	0	0	1.77E-3
Zr-95	CURIES	0	0	4.04E-4	7.44E-3
Nb-95	CURIES	0	0	7.18E-4	1.31E-2
Mo-99	CURIES	0	0	9.47E-4	0
Tc-99M	CURIES	0	0	1.09E-3	0
Ru-103	CURIES	0	0	0	6.38E-4
Ag-110M	CURIES	0	0	1.54E-4	0
Sb-124	CURIES	0	0	0	7.76E-5
Sb-125	CURIES	0	0	0	1.82E-3
Sn-113	CURIES	0	0	0	7.20E-4
I-131	CURIES	0	0	8.78E-3	1.53E-3
I-133	CURIES	0	0	6.23E-5	0
Cs-134	CURIES	0	0	1.75E-3	1.98E-2
Cs-136	CURIES	0	0	1.12E-4	0
Cs-137	CURIES	0	0	1.79E-3	2.57E-2
Cs-138	CURIES	0	0	4.53E-4	0
Ba-140	CURIES	0	0	1.70E-3	5.28E-5
La-140	CURIES	0	0	1.12E-4	8.37E-6
Ce-144	CURIES	0	0	2.90E-4	3.69E-3
Kr-85	CURIES	0	0	1.25E-3	0
Kr-85M	CURIES	0	0	2.91E-4	0
Xe-131M	CURIES	0	0	2.40E-2	4.64E-4
Xe-133	CURIES	0	0	2.56E0	1.06E-2
Xe-133M	CURIES	0	0	3.80E-2	0
Xe-135	CURIES	0	0	3.96E-2	2.07E-4
Sr-90	CURIES	0	0	0	1.28E-3
G ALPHA	CURIES	0	0	5.64E-4	6.94E-4
TOTAL FOR PERIOD	CURIES	0	0	1.15E2	3.69E1

TABLE 3

SOLID WASTE & IRRADIATED FUEL SHIPMENTS
QUARTERS 3 & 4, 1987

A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (DOES NOT INCLUDE IRRADIATED FUEL)

	TYPE OF WASTE		6-MONTH PERIOD	EST. TOTAL ERROR (%)
a.	Spent resins, filter sludges evaporator bottoms, etc.		65.1 m^3 2.74E+01Ci	+/- 25%
	Co-58	23%	6.21E+00 Ci	
	Cs-137	16%	4.27E+00 Ci	
	Fe-55	15%	4.14E+00 Ci	
	Cs-134	11%	3.07E+00 Ci	
	Co-60	10%	2.73E+00 Ci	
	Ni-63	8%	2.15E+00 Ci	
	Sb-125	7%	1.97E+00 Ci	
	H-3	5%	1.47E+00 Ci	
	Mn-54	2%	6.20E-01 Ci	
	Sb-124	2%	4.73E-01 Ci	
b.	Dry compressible waste, contaminated equipment, etc.		113.1 m^3 7.46E0 Ci	+/- 25%
	Cr-51	30%	2.26E+00 Ci	
	Co-58	19%	1.43E+00 Ci	
	Nb-95	12%	8.83E-01 Ci	
	Fe-55	12%	8.60E-01 Ci	
	C-14	8%	5.94E-01 Ci	
	Zr-95	6%	4.40E-01 Ci	
	Co-60	4%	3.30E-01 Ci	
	Ni-63	3%	2.40E-01 Ci	
	Mn-54	3%	2.15E-01 Ci	
	Ce-144	1%	1.06E-01 Ci	
c.	Irradiated components, control rods, etc.		0 m^3 0 Ci	
d.	Other		0 m^3 0 Ci	

Solid Waste Disposition

Number of Shipments	Mode of Transportation	Destination	Class of Solid Waste Shipped	Type of Container
7	truck	Richland, WA	A	LSA
7	truck	Beatty, NV	A	LSA
2	truck	Beatty, NV (via SEG)	A	LSA

TABLE 3 (cont.)

Solidification Agent

Cement (applicable to waste type "a" only)

B. IRRADIATED FUEL SHIPMENTS (DISPOSITION)

Number of Shipments	Mode of Transportation	Destination
0	N/A	N/A

TABLE 4

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 12
REPORT START TIME : 0:00 HRS = 12:00AM JANUARY 1, 1987
REPORT END TIME : 4343:59 HRS = 11:59PM JUNE 30, 1987
STABILITY CLASS : A
ELEVATION : 10 METERS

WIND SPEED(MPH) AT 10 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
NNE	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
NE	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
ENE	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
E	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
ESE	1.00E 00	2.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	3.00E 00
SE	0.00E-01	3.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	3.00E 00
SSE	0.00E-01	2.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.00E 00
S	0.00E-01	2.00E 00	2.00E 00	1.00E 00	0.00E-01	0.00E-01	5.00E 00
SSW	0.00E-01	1.00E 00	4.00E 00	0.00E-01	0.00E-01	0.00E-01	5.00E 00
SW	1.00E 00	3.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	4.00E 00
WSW	0.00E-01	2.00E 00	2.00E 00	2.00E 00	0.00E-01	0.00E-01	6.00E 00
W	0.00E-01	1.00E 00	1.00E 00	0.00E-01	0.00E-01	0.00E-01	2.00E 00
WNW	0.00E-01	0.00E-01	4.00E 00	0.00E-01	0.00E-01	0.00E-01	4.00E 00
NW	0.00E-01	0.00E-01	5.00E 00	0.00E-01	0.00E-01	0.00E-01	5.00E 00
NNW	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
TOT	2.00E 00	1.60E 01	1.80E 01	3.00E 00	0.00E-01	0.00E-01	3.90E 01

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 0.000E-01

APPROVED BY: CC Graham TITLE: SUPV HPTS DATE: 2/1/88

TABLE 4

REPORT CATEGORY : METEROLOGICAL DATA, QUARTERLY TOTALS OF HOURS AT EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 12
REPORT START TIME : 0:00 HRS = 12:00AM JANUARY 1, 1987
REPORT END TIME : 4343:59 HRS = 11:59PM JUNE 30, 1987
STABILITY CLASS : B
ELEVATION : 10 METERS

WIND SPEED(MPH) AT 10 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
NNE	0.00E-01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 00
NE	0.00E-01	0.00E-01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	1.00E 00
ENE	0.00E-01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 00
E	0.00E-01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 00
ESE	0.00E-01	2.00E 00	1.00E 00	0.00E-01	0.00E-01	0.00E-01	3.00E 00
SE	0.00E-01	2.00E 00	1.00E 00	0.00E-01	0.00E-01	0.00E-01	3.00E 00
SSE	0.00E-01	2.00E 00	0.00E-01	1.00E 00	0.00E-01	0.00E-01	3.00E 00
S	0.00E-01	2.00E 00	7.00E 00	1.00E 00	0.00E-01	0.00E-01	1.00E 01
SSW	0.00E-01	4.00E 00	7.00E 00	0.00E-01	0.00E-01	0.00E-01	1.10E 01
SW	0.00E-01	2.00E 00	6.00E 00	1.00E 00	0.00E-01	0.00E-01	9.00E 00
WSW	0.00E-01	0.00E-01	2.00E 00	0.00E-01	0.00E-01	0.00E-01	2.00E 00
W	0.00E-01	6.00E 00	1.00E 00	0.00E-01	0.00E-01	0.00E-01	7.00E 00
WNW	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
NW	0.00E-01	1.00E 00	3.00E 00	0.00E-01	0.00E-01	0.00E-01	4.00E 00
NNW	0.00E-01	0.00E-01	2.00E 00	0.00E-01	0.00E-01	0.00E-01	2.00E 00
TOT	0.00E-01	2.40E 01	3.10E 01	3.00E 00	0.00E-01	0.00E-01	5.80E 01

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 0.000E-01

APPROVED BY: C C Gamas TITLE: Supv HPTS DATE: 2/1/88

TABLE 4

REPORT CATEGORY : METEROLOGICAL DATA, QUARTERLY TOTALS OF HOURS AT EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 12
REPORT START TIME : 0:00 HRS = 12:00AM JANUARY 1, 1987
REPORT END TIME : 4343:59 HRS = 11:59PM JUNE 30, 1987
STABILITY CLASS : C
ELEVATION : 10 METERS

WIND SPEED(MPH) AT 10 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	0.00E-01	0.00E-01	2.00E 00	0.00E-01	0.00E-01	2.00E 00
NNE	0.00E-01	6.00E 00	3.00E 00	0.00E-01	0.00E-01	0.00E-01	9.00E 00
NE	0.00E-01	4.00E 00	3.00E 00	0.00E-01	0.00E-01	0.00E-01	7.00E 00
ENE	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
E	0.00E-01	3.00E 00	5.00E 00	0.00E-01	0.00E-01	0.00E-01	8.00E 00
ESE	1.00E 00	1.00E 00	2.00E 00	0.00E-01	0.00E-01	0.00E-01	4.00E 00
SE	0.00E-01	6.00E 00	4.00E 00	1.00E 00	0.00E-01	0.00E-01	1.10E 01
SSE	0.00E-01	9.00E 00	9.00E 00	1.00E 00	0.00E-01	0.00E-01	1.90E 01
S	0.00E-01	1.10E 01	1.10E 01	3.00E 00	0.00E-01	0.00E-01	2.50E 01
SSW	0.00E-01	1.00E 01	1.40E 01	.00E-01	0.00E-01	0.00E-01	2.40E 01
SW	0.00E-01	7.00E 00	1.70E 01	1.00E 00	0.00E-01	0.00E-01	2.50E 01
WSW	0.00E-01	3.00E 00	2.00E 00	2.00E 00	0.00E-01	0.00E-01	7.00E 00
W	0.00E-01	4.00E 00	3.00E 00	0.00E-01	0.00E-01	0.00E-01	7.00E 00
WNW	1.00E 00	3.00E 00	2.00E 00	0.00E-01	0.00E-01	0.00E-01	6.00E 00
NW	0.00E-01	1.00E 00	1.10E 01	0.00E-01	0.00E-01	0.00E-01	1.20E 01
NNW	0.00E-01	2.00E 00	7.00E 00	0.00E-01	0.00E-01	0.00E-01	9.00E 00
TOT	2.00E 00	7.00E 01	9.30E 01	1.00E 01	0.00E-01	0.00E-01	1.75E 02

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 1.000E 00

APPROVED BY: CCGrass TITLE: SUPV HPTS DATE: 2/1/88

TABLE 4

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 12
REPORT START TIME : 0:00 HRS = 12:00AM JANUARY 1, 1987
REPORT END TIME : 4343:59 HRS = 11:59PM JUNE 30, 1987
STABILITY CLASS : D
ELEVATION : 10 METERS

WIND SPEED(MPH) AT 10 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	2.00E 00	6.00E 00	2.00E 01	4.00E 00	0.00E-01	0.00E-01	3.20E 01
NNE	2.00E 00	3.50E 01	6.50E 01	2.00E 00	0.00E-01	0.00E-01	1.04E 02
NE	9.00E 00	4.00E 01	5.20E 01	6.00E 00	0.00E-01	0.00E-01	1.07E 02
ENE	6.00E 00	2.60E 01	4.00E 01	1.10E 01	0.00E-01	0.00E-01	8.30E 01
E	2.00E 00	3.30E 01	4.40E 01	4.00E 00	3.00E 00	0.00E-01	8.60E 01
ESE	5.00E 00	3.20E 01	1.40E 01	8.00E 00	0.00E-01	0.00E-01	5.90E 01
SE	3.00E 00	3.80E 01	2.40E 01	5.00E 00	0.00E-01	0.00E-01	7.00E 01
SSE	3.00E 00	2.80E 01	1.80E 01	3.00E 00	0.00E-01	0.00E-01	5.20E 01
S	9.00E 00	3.50E 01	4.40E 01	7.00E 00	0.00E-01	0.00E-01	9.50E 01
SSW	4.00E 00	4.50E 01	3.40E 01	5.00E 00	1.00E 00	0.00E-01	8.90E 01
SW	5.00E 00	4.70E 01	6.20E 01	7.00E 00	1.00E 00	0.00E-01	1.22E 02
WSW	6.00E 00	1.90E 01	2.70E 01	8.00E 00	1.00E 00	0.00E-01	6.10E 01
W	5.00E 00	4.50E 01	3.20E 01	6.00E 00	1.00E 00	1.00E 00	9.00E 01
WNW	9.00E 00	2.50E 01	3.30E 01	2.00E 00	0.00E-01	1.00E 00	7.00E 01
NW	6.00E 00	3.00E 01	4.20E 01	6.00E 00	0.00E-01	0.00E-01	8.40E 01
NNW	1.00E 00	3.80E 01	4.60E 01	2.10E 01	5.00E 00	0.00E-01	1.11E 02
TOT	7.70E 01	5.22E 02	5.97E 02	1.05E 02	1.20E 01	2.00E 00	1.32E 03

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 1.300E 01

APPROVED BY: CLGrant TITLE: SUPV HPTS DATE: 2/1/88

TABLE 4

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 12
REPORT START TIME : 0:00 HRS = 12:00AM JANUARY 1, 1987
REPORT END TIME : 4343:59 HRS = 11:59PM JUNE 30, 1987
STABILITY CLASS : E
ELEVATION : 10 METERS

WIND SPEED(MPH) AT 10 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	5.00E 00	2.00E 01	1.50E 01	1.00E 00	0.00E-01	0.00E-01	4.10E 01
NNE	4.00E 00	4.80E 01	2.40E 01	1.00E 00	0.00E-01	0.00E-01	7.70E 01
NE	1.50E 01	4.00E 01	1.00E 01	4.00E 00	0.00E-01	0.00E-01	6.90E 01
ENE	1.90E 01	4.40E 01	3.50E 01	0.00E-01	0.00E-01	0.00E-01	9.80E 01
E	2.10E 01	5.90E 01	3.70E 01	1.40E 01	4.00E 00	1.00E 00	1.36E 02
ESE	1.40E 01	5.00E 01	3.50E 01	1.70E 01	0.00E-01	0.00E-01	1.16E 02
SE	1.20E 01	5.80E 01	4.20E 01	1.00E 01	1.00E 00	0.00E-01	1.23E 02
SSE	5.00E 00	6.60E 01	3.00E 01	1.00E 00	0.00E-01	0.00E-01	1.02E 02
S	1.50E 01	6.80E 01	4.20E 01	3.00E 00	0.00E-01	0.00E-01	1.28E 02
SSW	1.00E 01	4.70E 01	2.50E 01	4.00E 00	0.00E-01	0.00E-01	8.60E 01
SW	5.00E 00	3.90E 01	3.40E 01	4.00E 00	0.00E-01	0.00E-01	8.20E 01
WSW	1.30E 01	3.80E 01	2.50E 01	4.00E 00	0.00E-01	0.00E-01	8.00E 01
W	1.30E 01	4.50E 01	2.80E 01	7.00E 00	0.00E-01	0.00E-01	9.30E 01
WNW	1.10E 01	4.80E 01	3.30E 01	1.10E 01	1.00E 00	0.00E-01	1.04E 02
NW	9.00E 00	4.40E 01	4.10E 01	4.00E 00	0.00E-01	0.00E-01	9.80E 01
NNW	1.20E 01	4.80E 01	3.30E 01	4.00E 00	0.00E-01	0.00E-01	9.70E 01
TOT	1.83E 02	7.62E 02	4.89E 02	8.90E 01	6.00E 00	1.00E 00	1.53E 03

PERIODS OF CALM(HOURS): 9.000E 00
HOURS OF INVALID DATA : 2.000E 00

APPROVED BY: C C Gama TITLE: SUPV HPTS DATE: 2/1/88

TABLE 4

REPORT CATEGORY : METEROLOGICAL DATA, QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 12
REPORT START TIME : 0:00 HRS = 12:00AM JANUARY 1, 1987
REPORT END TIME : 4343:59 HRS = 11:59PM JUNE 30, 1987
STABILITY CLASS : F
ELEVATION : 10 METERS

WIND SPEED(MPH) AT 10 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	3.00E 00	7.00E 00	0.00E-01	1.00E 00	0.00E-01	0.00E-01	1.10E 01
NNE	7.00E 00	1.20E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.90E 01
NE	2.10E 01	2.10E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	4.20E 01
ENE	2.10E 01	2.10E 01	8.00E 00	0.00E-01	0.00E-01	0.00E-01	5.00E 01
E	1.70E 01	1.60E 01	7.00E 00	4.00E 00	0.00E-01	0.00E-01	4.40E 01
ESE	1.90E 01	2.10E 01	4.00E 00	4.00E 00	2.00E 00	0.00E-01	5.00E 01
SE	1.20E 01	6.10E 01	7.00E 00	1.00E 00	0.00E-01	0.00E-01	8.10E 01
SSE	9.00E 00	9.20E 01	5.00E 00	0.00E-01	0.00E-01	0.00E-01	1.06E 02
S	1.70E 01	7.30E 01	8.00E 00	0.00E-01	0.00E-01	0.00E-01	9.80E 01
SSW	1.00E 01	5.50E 01	1.30E 01	0.00E-01	0.00E-01	0.00E-01	7.80E 01
SW	1.30E 01	3.20E 01	1.70E 01	0.00E-01	0.00E-01	0.00E-01	6.20E 01
WSW	1.80E 01	3.10E 01	3.00E 00	0.00E-01	0.00E-01	0.00E-01	5.20E 01
W	9.00E 00	2.90E 01	2.00E 00	1.00E 00	0.00E-01	0.00E-01	4.10E 01
WNW	1.10E 01	2.00E 01	7.00E 00	1.00E 00	0.00E-01	0.00E-01	3.90E 01
NW	6.00E 00	3.90E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	4.50E 01
NNW	7.00E 00	1.20E 01	2.00E 00	0.00E-01	0.00E-01	0.00E-01	2.10E 01
TOT	2.00E 02	5.42E 02	8.30E 01	1.20E 01	2.00E 00	0.00E-01	8.39E 02

PERIODS OF CALM(HOURS): 7.000E 00
HOURS OF INVALID DATA : 4.000E 00

APPROVED BY: C C Graham TITLE: SUPV HPTS DATE: 2/1/88

TABLE 4

REPORT CATEGORY : METEROLOGICAL DATA, QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 12
REPORT START TIME : 0:00 HRS = 12:00AM JANUARY 1, 1987
REPORT END TIME : 4343:59 HRS = 11:59PM JUNE 30, 1987
STABILITY CLASS : G
ELEVATION : 10 METERS

WIND SPEED(MPH) AT 10 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 00
NNE	1.30E 01	5.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.80E 01
NE	9.00E 00	5.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.40E 01
ENE	5.00E 00	2.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	7.00E 00
E	8.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	8.00E 00
ESE	7.00E 00	3.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 01
SE	6.00E 00	3.00E 00	1.00E 00	0.00E-01	0.00E-01	0.00E-01	1.00E 01
SSE	8.00E 00	1.50E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.30E 01
S	9.00E 00	1.20E 01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	2.20E 01
SSW	5.00E 00	1.90E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.40E 01
SW	1.50E 01	1.90E 01	4.00E 00	0.00E-01	0.00E-01	0.00E-01	3.80E 01
WSW	7.00E 00	4.00E 00	2.00E 00	0.00E-01	0.00E-01	0.00E-01	1.30E 01
W	7.00E 00	4.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.10E 01
WNW	2.00E 01	1.90E 01	0.00E-01	3.00E 00	0.00E-01	0.00E-01	4.20E 01
NW	4.00E 00	3.20E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	3.60E 01
NNW	2.00E 00	8.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 01
TOT	1.25E 02	1.51E 02	8.00E 00	3.00E 00	0.00E-01	0.00E-01	2.87E 02

PERIODS OF CALM(HOURS): 2.000E 00
HOURS OF INVALID DATA : 2.000E 00
HOURS OF GOOD DATA : 4.261E 03 = 98.1% OF TOTAL HOURS

APPROVED BY: CCGrant TITLE: SUPV HPTS DATE: 2/1/88

TABLE 4

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 12
REPORT START TIME : 0:00 HRS = 12:00AM JANUARY 1, 1987
REPORT END TIME : 4343:59 HRS = 11:59PM JUNE 30, 1987
STABILITY CLASS : A
ELEVATION : 60 METERS

WIND SPEED(MPH) AT 60 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
NNE	0.00E-01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 00
NE	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
ENE	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
E	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
ESE	0.00E-01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 00
SE	0.00E-01	4.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	4.00E 00
SSE	0.00E-01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 00
S	0.00E-01	3.00E 00	2.00E 00	2.00E 00	0.00E-01	0.00E-01	7.00E 00
SSW	0.00E-01	2.00E 00	0.00E-01	4.00E 00	0.00E-01	0.00E-01	6.00E 00
SW	1.00E 00	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.00E 00
WSW	0.00E-01	0.00E-01	3.00E 00	0.00E-01	2.00E 00	0.00E-01	5.00E 00
W	0.00E-01	1.00E 00	0.00E-01	2.00E 00	0.00E-01	0.00E-01	3.00E 00
WNW	0.00E-01	0.00E-01	1.00E 00	3.00E 00	0.00E-01	0.00E-01	4.00E 00
NW	0.00E-01	0.00E-01	1.00E 00	4.00E 00	0.00E-01	0.00E-01	5.00E 00
NNW	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
TOT	1.00E 00	1.40E 01	7.00E 00	1.50E 01	2.00E 00	0.00E-01	3.90E 01

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 0.000E-01

APPROVED BY: [signature] TITLE: SUPV HPTS DATE: 2/1/88

TABLE 4

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 12
REPORT START TIME : 0:00 HRS = 12:00AM JANUARY 1, 1987
REPORT END TIME : 4343:59 HRS = 11:59PM JUNE 30, 1987
STABILITY CLASS : B
ELEVATION : 60 METERS

WIND SPEED(MPH) AT 60 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
NNE	0.00E-01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 00
NE	0.00E-01	0.00E-01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	1.00E 00
ENE	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
E	0.00E-01	2.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.00E 00
ESE	0.00E-01	2.00E 00	2.00E 00	0.00E-01	0.00E-01	0.00E-01	4.00E 00
SE	0.00E-01	0.00E-01	2.00E 00	0.00E-01	0.00E-01	0.00E-01	2.00E 00
SSE	0.00E-01	3.00E 00	1.00E 00	1.00E 00	0.00E-01	0.00E-01	5.00E 00
S	0.00E-01	1.00E 00	3.00E 00	3.00E 00	0.00E-01	0.00E-01	7.00E 00
SSW	0.00E-01	1.00E 00	8.00E 00	1.00E 00	0.00E-01	0.00E-01	1.00E 01
SW	0.00E-01	1.00E 00	4.00E 00	4.00E 00	1.00E 00	0.00E-01	1.00E 01
WSW	0.00E-01	0.00E-01	2.00E 00	0.00E-01	0.00E-01	0.00E-01	2.00E 00
W	0.00E-01	1.00E 00	7.00E 00	0.00E-01	0.00E-01	0.00E-01	8.00E 00
WNW	0.00E-01	0.00E-01	0.00E-01	1.00E 00	0.00E-01	0.00E-01	1.00E 00
NW	0.00E-01	0.00E-01	1.00E 00	3.00E 00	0.00E-01	0.00E-01	4.00E 00
NNW	0.00E-01	0.00E-01	0.00E-01	1.00E 00	0.00E-01	0.00E-01	1.00E 00
TOT	0.00E-01	1.20E 01	3.10E 01	1.40E 01	1.00E 00	0.00E-01	5.80E 01

PERIODS OF CALM(HOURS) : 0.000E-01
HOURS OF INVALID DATA : 0.000E-01

APPROVED BY: CCGrant TITLE: SUPV HPTS DATE: 2/1/88

TABLE 4

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 12
REPORT START TIME : 0:00 HRS = 12:00AM JANUARY 1, 1987
REPORT END TIME : 4343:59 HRS = 11:59PM JUNE 30, 1987
STABILITY CLASS : C
ELEVATION : 60 METERS

WIND SPEED(MPH) AT 60 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	0.00E-01	0.00E-01	1.00E 00	0.00E-01	0.00E-01	1.00E 00
NNE	0.00E-01	3.00E 00	6.00E 00	4.00E 00	0.00E-01	0.00E-01	1.30E 01
NE	0.00E-01	4.00E 00	4.00E 00	0.00E-01	0.00E-01	0.00E-01	8.00E 00
ENE	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
E	0.00E-01	1.00E 00	2.00E 00	2.00E 00	0.00E-01	0.00E-01	5.00E 00
ESE	1.00E 00	1.00E 00	0.00E-01	2.00E 00	0.00E-01	0.00E-01	4.00E 00
SE	0.00E-01	7.00E 00	4.00E 00	1.00E 00	0.00E-01	0.00E-01	1.20E 01
SSE	0.00E-01	3.00E 00	1.20E 01	2.00E 00	0.00E-01	0.00E-01	1.70E 01
S	0.00E-01	9.00E 00	1.10E 01	5.00E 00	1.00E 00	0.00E-01	2.60E 01
SSW	0.00E-01	3.00E 00	1.40E 01	6.00E 00	0.00E-01	0.00E-01	2.30E 01
SW	0.00E-01	4.00E 00	1.30E 01	6.00E 00	1.00E 00	0.00E-01	2.40E 01
WSW	0.00E-01	0.00E-01	3.00E 00	3.00E 00	0.00E-01	0.00E-01	6.00E 00
W	1.00E 00	3.00E 00	4.00E 00	1.00E 00	1.00E 00	0.00E-01	1.00E 01
WNW	0.00E-01	1.00E 00	3.00E 00	2.00E 00	0.00E-01	0.00E-01	6.00E 00
NW	0.00E-01	0.00E-01	5.00E 00	5.00E 00	0.00E-01	0.00E-01	1.00E 01
NNW	0.00E-01	0.00E-01	1.00E 00	1.00E 01	0.00E-01	0.00E-01	1.10E 01
TOT	2.00E 00	3.90E 01	8.20E 01	5.00E 01	3.00E 00	0.00E-01	1.76E 02

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 0.000E-01

APPROVED BY: CCGnash TITLE: Supv HPTS DATE: 2/1/88

TABLE 4

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 12
REPORT START TIME : 0:00 HRS = 12:00AM JANUARY 1, 1987
REPORT END TIME : 4343:59 HRS = 11:59PM JUNE 30, 1987
STABILITY CLASS : D
ELEVATION : 60 METERS

WIND SPEED(MPH) AT 60 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	1.00E 00	1.60E 01	2.00E 01	2.00E 00	1.00E 00	4.00E 01
NNE	2.00E 00	2.10E 01	5.80E 01	2.50E 01	0.00E-01	0.00E-01	1.06E 02
NE	5.00E 00	3.20E 01	5.00E 01	2.60E 01	1.00E 00	0.00E-01	1.14E 02
ENE	3.00E 00	2.00E 01	4.40E 01	1.90E 01	3.00E 00	0.00E-01	8.90E 01
E	1.00E 00	1.70E 01	4.50E 01	1.00E 01	4.00E 00	2.00E 00	7.90E 01
ESE	5.00E 00	3.60E 01	1.80E 01	9.00E 00	1.00E 00	0.00E-01	6.90E 01
SE	1.00E 00	2.90E 01	2.40E 01	7.00E 00	1.00E 00	0.00E-01	6.20E 01
SSE	4.00E 00	2.30E 01	2.50E 01	1.40E 01	0.00E-01	0.00E-01	6.60E 01
S	3.00E 00	2.60E 01	4.00E 01	2.10E 01	1.00E 00	0.00E-01	9.10E 01
SSW	5.00E 00	2.90E 01	4.40E 01	1.70E 01	2.00E 00	0.00E-01	9.70E 01
SW	2.00E 00	1.80E 01	6.00E 01	2.60E 01	5.00E 00	1.00E 00	1.12E 02
WSW	3.00E 00	1.90E 01	2.70E 01	1.60E 01	4.00E 00	3.00E 00	7.20E 01
W	1.00E 00	1.90E 01	3.10E 01	1.20E 01	5.00E 00	2.00E 00	7.00E 01
WNW	4.00E 00	2.80E 01	2.70E 01	2.00E 01	3.00E 00	1.00E 00	8.30E 01
NW	2.00E 00	2.20E 01	2.00E 01	2.60E 01	5.00E 00	0.00E-01	7.50E 01
NNW	3.00E 00	1.40E 01	3.50E 01	3.30E 01	1.10E 01	6.00E 00	1.02E 02
TOT	4.40E 01	3.54E 02	5.64E 02	3.01E 02	4.80E 01	1.60E 01	1.33E 03

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 1.000E 00

APPROVED BY: CCCrowder TITLE: SUPV HPTS DATE: 2/1/88

TABLE 4

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 12
REPORT START TIME : 0:00 HRS = 12:00AM JANUARY 1, 1987
REPORT END TIME : 4343:59 HRS = 11:59PM JUNE 30, 1987
STABILITY CLASS : E
ELEVATION : 60 METERS

WIND SPEED(MPH) AT 60 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	6.00E 00	2.40E 01	1.00E 01	0.00E-01	0.00E-01	4.00E 01
NNE	3.00E 00	1.10E 01	6.10E 01	1.50E 01	0.00E-01	0.00E-01	9.00E 01
NE	7.00E 00	2.60E 01	4.30E 01	5.00E 00	1.00E 00	0.00E-01	8.20E 01
ENE	1.00E 00	1.30E 01	5.90E 01	2.20E 01	0.00E-01	0.00E-01	9.50E 01
E	4.00E 00	2.20E 01	6.80E 01	2.40E 01	8.00E 00	7.00E 00	1.33E 02
ESE	2.00E 00	1.70E 01	6.10E 01	3.10E 01	8.00E 00	0.00E-01	1.19E 02
SE	2.00E 00	2.20E 01	4.70E 01	4.10E 01	1.00E 01	1.00E 00	1.23E 02
SSE	1.00E 00	2.00E 01	4.80E 01	2.70E 01	4.00E 00	0.00E-01	1.00E 02
S	2.00E 00	1.80E 01	4.70E 01	3.10E 01	4.00E 00	0.00E-01	1.02E 02
SSW	2.00E 00	1.30E 01	5.20E 01	3.60E 01	2.00E 00	0.00E-01	1.05E 02
SW	1.00E 00	1.80E 01	3.50E 01	3.50E 01	4.00E 00	0.00E-01	9.30E 01
WSW	1.00E 00	4.00E 00	3.10E 01	1.90E 01	6.00E 00	2.00E 00	6.30E 01
W	0.00E-01	1.50E 01	4.40E 01	3.20E 01	1.20E 01	1.00E 00	1.04E 02
WNW	1.00E 00	1.10E 01	4.00E 01	3.30E 01	8.00E 00	7.00E 00	1.00E 02
NW	0.00E-01	1.00E 01	3.00E 01	3.20E 01	6.00E 00	0.00E-01	7.80E 01
NNW	0.00E-01	1.40E 01	5.00E 01	4.50E 01	4.00E 00	1.00E 00	1.14E 02
TOT	2.70E 01	2.40E 02	7.40E 02	4.38E 02	7.70E 01	1.90E 01	1.54E 03

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 0.000E-01

APPROVED BY: CCGrahm TITLE: SUPV HPTS DATE: 2/1/88

TABLE 4

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 12
REPORT START TIME : 0:00 HRS = 12:00AM JANUARY 1, 1987
REPORT END TIME : 4343:59 HRS = 11:59PM JUNE 30, 1987
STABILITY CLASS : F
ELEVATION : 60 METERS

WIND SPEED(MPH) AT 60 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	1.00E 00	2.00E 00	1.10E 01	3.00E 00	0.00E-01	0.00E-01	1.70E 01
NNE	1.00E 00	4.00E 00	1.20E 01	1.00E 01	0.00E-01	0.00E-01	2.70E 01
NE	2.00E 00	5.00E 00	2.70E 01	2.00E 00	0.00E-01	0.00E-01	3.60E 01
ENE	0.00E-01	6.00E 00	3.00E 01	5.00E 00	0.00E-01	0.00E-01	4.20E 01
E	3.00E 00	7.00E 00	3.80E 01	3.00E 00	2.00E 00	0.00E-01	5.30E 01
ESE	0.00E-01	1.60E 01	3.70E 01	8.00E 00	2.00E 00	2.00E 00	6.50E 01
SE	2.00E 00	6.00E 00	2.90E 01	1.10E 01	0.00E-01	0.00E-01	4.80E 01
SSE	2.00E 00	1.50E 01	4.30E 01	2.10E 01	0.00E-01	0.00E-01	8.10E 01
S	0.00E-01	1.10E 01	6.50E 01	1.80E 01	0.00E-01	0.00E-01	9.40E 01
SSW	0.00E-01	5.00E 00	4.50E 01	4.60E 01	0.00E-01	0.00E-01	9.60E 01
SW	2.00E 00	2.00E 00	3.20E 01	4.70E 01	6.00E 00	0.00E-01	8.90E 01
WSW	0.00E-01	1.40E 01	1.90E 01	1.80E 01	1.00E 00	0.00E-01	5.20E 01
W	0.00E-01	5.00E 00	2.30E 01	1.40E 01	0.00E-01	0.00E-01	4.20E 01
WNW	1.00E 00	4.00E 00	1.90E 01	2.00E 01	3.00E 00	1.00E 00	4.80E 01
NW	0.00E-01	5.00E 00	7.00E 00	5.00E 00	0.00E-01	0.00E-01	1.70E 01
NNW	1.00E 00	1.00E 00	1.30E 01	1.60E 01	0.00E-01	0.00E-01	3.10E 01
TOT	1.50E 01	1.08E 02	4.50E 02	2.48E 02	1.40E 01	3.00E 00	8.38E 02

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 1.200E 01

APPROVED BY: CCGMan TITLE: Supv HPTS DATE: 2/1/88

TABLE 4

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 12
REPORT START TIME : 0:00 HRS = 12:00AM JANUARY 1, 1987
REPORT END TIME : 4343:59 HRS = 11:59PM JUNE 30, 1987
STABILITY CLASS : G
ELEVATION : 60 METERS

WIND SPEED(MPH) AT 60 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	1.00E 00	6.00E 00	3.00E 00	0.00E-01	0.00E-01	1.00E 01
NNE	0.00E-01	5.00E 00	6.00E 00	0.00E-01	0.00E-01	0.00E-01	1.10E 01
NE	0.00E-01	1.00E 00	4.00E 00	1.00E 00	0.00E-01	0.00E-01	6.00E 00
ENE	0.00E-01	3.00E 00	1.00E 01	8.00E 00	0.00E-01	0.00E-01	2.10E 01
E	0.00E-01	5.00E 00	5.00E 00	2.00E 00	0.00E-01	0.00E-01	1.20E 01
ESE	0.00E-01	7.00E 00	3.00E 00	1.00E 00	0.00E-01	0.00E-01	1.10E 01
SE	0.00E-01	1.00E 01	0.00E-01	1.00E 00	0.00E-01	0.00E-01	1.10E 01
SSE	1.00E 00	3.00E 00	5.00E 00	1.00E 00	0.00E-01	0.00E-01	1.00E 01
S	0.00E-01	4.00E 00	1.10E 01	1.00E 00	0.00E-01	0.00E-01	1.60E 01
SSW	0.00E-01	5.00E 00	1.10E 01	8.00E 00	0.00E-01	0.00E-01	2.40E 01
SW	0.00E-01	1.00E 00	1.50E 01	1.70E 01	1.00E 00	0.00E-01	3.40E 01
WSW	0.00E-01	3.00E 00	7.00E 00	1.00E 01	1.00E 00	0.00E-01	2.10E 01
W	0.00E-01	4.00E 00	1.40E 01	3.00E 00	0.00E-01	0.00E-01	2.10E 01
WNW	0.00E-01	0.00E-01	6.00E 00	7.00E 00	1.00E 00	2.00E 00	1.60E 01
NW	0.00E-01	2.00E 00	1.90E 01	1.20E 01	0.00E-01	0.00E-01	3.30E 01
NNW	0.00E-01	0.00E-01	5.00E 00	2.10E 01	0.00E-01	0.00E-01	2.60E 01
TOT	1.00E 00	5.40E 01	1.27E 02	9.60E 01	3.00E 00	2.00E 00	2.83E 02

PERIODS OF CALM(HOURS) : 0.000E-01
HOURS OF INVALID DATA : 8.000E 00
HOURS OF GOOD DATA : 4.262E 03 = 98.1% OF TOTAL HOURS

APPROVED BY: CCGrass TITLE: SUPV HPTS DATE: 2/1/88

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 34
REPORT START TIME : 4344:00 HRS = 12:00AM JULY 1, 1987
REPORT END TIME : 8759:00 HRS = 11:00PM DECEMBER 31, 1987
STABILITY CLASS : A
ELEVATION : 10 METERS

WIND SPEED(MPH) AT 10 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
NNE	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
NE	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
ENE	0.00E-01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 00
E	0.00E-01	4.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	4.00E 00
ESE	0.00E-01	2.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.00E 00
SE	0.00E-01	7.00E 00	3.00E 00	0.00E-01	0.00E-01	0.00E-01	1.00E 01
SSE	0.00E-01	7.00E 00	4.00E 00	0.00E-01	0.00E-01	0.00E-01	1.10E 01
S	0.00E-01	1.10E 01	1.80E 01	4.00E 00	0.00E-01	0.00E-01	3.30E 01
SSW	0.00E-01	7.00E 00	1.80E 01	1.00E 00	0.00E-01	0.00E-01	2.60E 01
SW	0.00E-01	6.00E 00	5.00E 00	1.00E 00	0.00E-01	0.00E-01	1.20E 01
WSW	0.00E-01	2.00E 00	1.00E 00	0.00E-01	0.00E-01	0.00E-01	3.00E 00
W	0.00E-01	3.00E 00	3.00E 00	0.00E-01	0.00E-01	0.00E-01	6.00E 00
WNW	0.00E-01	0.00E-01	5.00E 00	2.00E 00	0.00E-01	0.00E-01	7.00E 00
NW	0.00E-01	0.00E-01	3.00E 00	4.00E 00	0.00E-01	0.00E-01	7.00E 00
NNW	0.00E-01	0.00E-01	0.00E-01	1.00E 00	0.00E-01	0.00E-01	1.00E 00
TOT	0.00E-01	5.00E 01	6.00E 01	1.30E 01	0.00E-01	0.00E-01	1.23E 02

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 2.000E 00

APPROVED BY: CCCarlan TITLE: SUM, HPTS DATE: 2/1/88

REPORT CATEGORY : METEROLOGICAL DATA, QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 34
REPORT START TIME : 4344:00 HRS = 12:00AM JULY 1, 1987
REPORT END TIME : 8759:00 HRS = 11:00PM DECEMBER 31, 1987
STABILITY CLASS : B
ELEVATION : 10 METERS

WIND SPEED(MPH) AT 10 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
NNE	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 00
NE	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
ENE	1.00E 00	2.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	3.00E 00
E	0.00E-01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 00
ESE	1.00E 00	8.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	9.00E 00
SE	0.00E-01	9.00E 00	2.00E 00	0.00E-01	0.00E-01	0.00E-01	1.10E 01
SSE	0.00E-01	3.00E 00	3.00E 00	1.00E 00	0.00E-01	0.00E-01	7.00E 00
S	0.00E-01	7.00E 00	1.30E 01	2.00E 00	0.00E-01	0.00E-01	2.20E 01
SSW	0.00E-01	1.00E 01	1.80E 01	4.00E 00	0.00E-01	0.00E-01	3.20E 01
SW	0.00E-01	4.00E 00	1.10E 01	4.00E 00	0.00E-01	0.00E-01	1.90E 01
WSW	0.00E-01	4.00E 00	6.00E 00	0.00E-01	0.00E-01	0.00E-01	1.00E 01
W	0.00E-01	8.00E 00	8.00E 00	0.00E-01	0.00E-01	0.00E-01	1.60E 01
WNW	0.00E-01	7.00E 00	9.00E 00	2.00E 00	0.00E-01	0.00E-01	1.80E 01
NW	0.00E-01	4.00E 00	9.00E 00	2.00E 00	0.00E-01	0.00E-01	1.50E 01
NNW	0.00E-01	0.00E-01	0.00E-01	1.00E 00	0.00E-01	0.00E-01	1.00E 00
TOT	3.00E 00	6.70E 01	7.90E 01	1.60E 01	0.00E-01	0.00E-01	1.65E 02

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 4.000E 00

APPROVED BY: CC Graham TITLE: SUPV HPTS DATE: 2/1/88

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 34
REPORT START TIME : 4344:00 HRS = 12:00AM JULY 1, 1987
REPORT END TIME : 8759:00 HRS = 11:00PM DECEMBER 31, 1987
STABILITY CLASS : C
ELEVATION : 10 METERS

WIND SPEED(MPH) AT 10 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	1.00E 00	1.00E 00	0.00E-01	0.00E-01	0.00E-01	2.00E 00
NNE	0.00E-01	0.00E-01	0.00E-01	1.00E 00	0.00E-01	0.00E-01	1.00E 00
NE	0.00E-01	2.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.00E 00
ENE	0.00E-01	3.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	3.00E 00
E	0.00E-01	5.00E 00	4.00E 00	0.00E-01	0.00E-01	0.00E-01	9.00E 00
ESE	1.00E 00	2.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	3.00E 00
SE	0.00E-01	6.00E 00	5.00E 00	0.00E-01	0.00E-01	0.00E-01	1.10E 01
SSE	0.00E-01	9.00E 00	1.00E 01	1.00E 00	0.00E-01	0.00E-01	2.00E 01
S	3.00E 00	8.00E 00	1.10E 01	4.00E 00	0.00E-01	0.00E-01	2.60E 01
SSW	1.00E 00	6.00E 00	3.00E 00	1.00E 00	0.00E-01	0.00E-01	1.10E 01
SW	0.00E-01	1.10E 01	1.30E 01	2.00E 00	0.00E-01	0.00E-01	2.60E 01
WSW	0.00E-01	8.00E 00	3.00E 00	2.00E 00	0.00E-01	0.00E-01	1.30E 01
W	0.00E-01	1.40E 01	8.00E 00	0.00E-01	0.00E-01	0.00E-01	2.20E 01
WNW	0.00E-01	1.50E 01	5.00E 00	6.00E 00	0.00E-01	0.00E-01	2.60E 01
NW	1.00E 00	7.00E 00	1.50E 01	2.00E 00	0.00E-01	0.00E-01	2.50E 01
NNW	0.00E-01	1.00E 00	1.30E 01	1.00E 00	0.00E-01	0.00E-01	1.50E 01
TOT	6.00E 00	9.80E 01	9.10E 01	2.00E 01	0.00E-01	0.00E-01	2.15E 02

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 0.000E-01

APPROVED BY: CCGrass TITLE: SUPV HPTS DATE: 2/1/88

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 34
REPORT START TIME : 4344:00 HRS = 12:00AM JULY 1, 1987
REPORT END TIME : 8759:00 HRS = 11:00PM DECEMBER 31, 1987
STABILITY CLASS : D
ELEVATION : 10 METERS

WIND SPEED(MPH) AT 10 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	2.00E 00	6.00E 00	1.40E 01	2.00E 00	0.00E-01	0.00E-01	2.40E 01
NNE	1.00E 00	1.90E 01	1.60E 01	1.00E 00	0.00E-01	0.00E-01	3.70E 01
NE	5.00E 00	8.00E 00	6.00E 00	0.00E-01	0.00E-01	0.00E-01	1.90E 01
ENE	1.00E 00	1.20E 01	2.00E 00	0.00E-01	0.00E-01	0.00E-01	1.50E 01
E	1.00E 00	2.40E 01	1.30E 01	1.00E 00	0.00E-01	0.00E-01	3.90E 01
ESE	3.00E 00	1.70E 01	2.10E 01	0.00E-01	0.00E-01	0.00E-01	4.10E 01
SE	2.00E 00	2.30E 01	2.10E 01	5.00E 00	0.00E-01	0.00E-01	5.10E 01
SSE	3.00E 00	3.70E 01	2.30E 01	6.00E 00	0.00E-01	0.00E-01	6.90E 01
S	1.00E 01	2.60E 01	5.00E 01	1.00E 01	0.00E-01	0.00E-01	9.60E 01
SSW	8.00E 00	4.60E 01	3.00E 01	1.00E 00	0.00E-01	0.00E-01	8.50E 01
SW	3.00E 00	2.80E 01	3.40E 01	1.00E 01	0.00E-01	0.00E-01	7.50E 01
WSW	5.00E 00	2.30E 01	1.70E 01	8.00E 00	0.00E-01	0.00E-01	5.30E 01
W	4.00E 00	3.00E 01	3.90E 01	8.00E 00	0.00E-01	0.00E-01	8.10E 01
WNW	6.00E 00	2.90E 01	4.80E 01	1.60E 01	4.00E 00	0.00E-01	1.03E 02
NW	2.00E 00	3.40E 01	5.00E 01	5.00E 00	1.00E 00	0.00E-01	9.20E 01
NNW	4.00E 00	2.40E 01	2.80E 01	4.00E 00	0.00E-01	0.00E-01	6.00E 01
TOT	6.00E 01	3.86E 02	4.12E 02	7.70E 01	5.00E 00	0.00E-01	9.40E 02

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 7.000E 00

APPROVED BY: CCGrant TITLE: SUPV, HPTS DATE: 2/1/88

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 34
REPORT START TIME : 4344:00 HRS = 12:00AM JULY 1, 1987
REPORT END TIME : 8759:00 HRS = 11:00PM DECEMBER 31, 1987
STABILITY CLASS : E
ELEVATION : 10 METERS

WIND SPEED(MPH) AT 10 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	2.00E 00	2.30E 01	3.10E 01	3.00E 00	0.00E-01	0.00E-01	5.90E 01
NNE	6.00E 00	3.90E 01	2.70E 01	4.00E 00	0.00E-01	0.00E-01	7.60E 01
NE	7.00E 00	3.90E 01	2.70E 01	1.00E 00	0.00E-01	0.00E-01	7.40E 01
ENE	7.00E 00	2.20E 01	1.20E 01	0.00E-01	0.00E-01	0.00E-01	4.10E 01
E	4.00E 00	3.60E 01	1.80E 01	0.00E-01	0.00E-01	0.00E-01	5.80E 01
ESE	8.00E 00	5.80E 01	2.70E 01	0.00E-01	0.00E-01	0.00E-01	9.30E 01
SE	7.00E 00	9.30E 01	4.20E 01	3.00E 00	0.00E-01	0.00E-01	1.45E 02
SSE	1.30E 01	6.70E 01	6.40E 01	2.00E 00	0.00E-01	0.00E-01	1.46E 02
S	9.00E 00	1.01E 02	6.80E 01	9.00E 00	0.00E-01	0.00E-01	1.87E 02
SSW	6.00E 00	3.40E 01	2.80E 01	5.00E 00	0.00E-01	0.00E-01	7.30E 01
SW	6.00E 00	3.10E 01	4.70E 01	9.00E 00	0.00E-01	0.00E-01	9.30E 01
WSW	2.60E 01	2.40E 01	2.90E 01	7.00E 00	0.00E-01	0.00E-01	8.60E 01
W	1.10E 01	4.80E 01	6.80E 01	7.00E 00	0.00E-01	0.00E-01	1.34E 02
WNW	1.70E 01	6.40E 01	4.00E 01	4.00E 00	1.00E 00	0.00E-01	1.26E 02
NW	1.60E 01	5.90E 01	3.60E 01	3.00E 00	0.00E-01	0.00E-01	1.14E 02
NNW	7.00E 00	4.30E 01	2.10E 01	7.00E 00	0.00E-01	0.00E-01	7.80E 01
TOT	1.52E 02	7.81E 02	5.85E 02	6.40E 01	1.00E 00	0.00E-01	1.58E 03

PERIODS OF CALM(HOURS): 2.000E 00
HOURS OF INVALID DATA : 0.000E-01

APPROVED BY: CCGrant TITLE: SUPV HPTS DATE: 2/1/88

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 34
REPORT START TIME : 4344:00 HRS = 12:00AM JULY 1, 1987
REPORT END TIME : 8759:00 HRS = 11:00PM DECEMBER 31, 1987
STABILITY CLASS : F
ELEVATION : 10 METERS

WIND SPEED(MPH) AT 10 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	5.00E 00	5.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 01
NNE	5.00E 00	9.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.40E 01
NE	1.40E 01	1.00E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.40E 01
ENE	8.00E 00	4.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.20E 01
E	1.40E 01	1.90E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	3.30E 01
ESE	1.70E 01	2.10E 01	3.00E 00	0.00E-01	0.00E-01	0.00E-01	4.10E 01
SE	1.50E 01	1.30E 02	2.30E 01	0.00E-01	0.00E-01	0.00E-01	1.68E 02
SSE	2.00E 01	1.47E 02	2.30E 01	0.00E-01	0.00E-01	0.00E-01	1.90E 02
S	1.50E 01	8.00E 01	1.10E 01	0.00E-01	0.00E-01	0.00E-01	1.06E 02
SSW	1.00E 01	3.80E 01	1.00E 01	0.00E-01	0.00E-01	0.00E-01	5.80E 01
SW	1.10E 01	5.10E 01	2.20E 01	0.00E-01	0.00E-01	0.00E-01	8.40E 01
WSW	1.20E 01	1.90E 01	3.00E 00	0.00E-01	0.00E-01	0.00E-01	3.40E 01
W	2.50E 01	2.50E 01	2.00E 00	0.00E-01	1.00E 00	0.00E-01	5.30E 01
WNW	2.90E 01	3.60E 01	2.00E 00	1.00E 00	4.00E 00	0.00E-01	7.20E 01
NW	9.00E 00	3.80E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	4.70E 01
NNW	1.30E 01	2.60E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	3.90E 01
TOT	2.22E 02	6.58E 02	9.90E 01	1.00E 00	5.00E 00	0.00E-01	9.85E 02

PERIODS OF CALM(HOURS): 3.000E 00
HOURS OF INVALID DATA : 1.000E 00

APPROVED BY: CC Gross TITLE: Supv HPTS DATE: 2/1/88

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS W
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 34
REPORT START TIME : 4344:00 HRS = 12:00AM JULY 1, 1987
REPORT END TIME : 8759:00 HRS = 11:00PM DECEMBER 31, 1987
STABILITY CLASS : G
ELEVATION : 10 METERS

WIND SPEED(MPH) AT 10 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	1.00E 00	4.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	5.00E 00
NNE	2.00E 00	3.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	5.00E 00
NE	4.00E 00	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	5.00E 00
ENE	6.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	6.00E 00
E	4.00E 00	3.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	7.00E 00
ESE	3.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	3.00E 00
SE	1.10E 01	2.80E 01	0.00E-01	1.00E 00	0.00E-01	0.00E-01	4.00E 01
SSE	1.50E 01	2.50E 01	1.00E 00	1.00E 00	0.00E-01	0.00E-01	4.20E 01
S	2.20E 01	1.40E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	3.60E 01
SSW	1.30E 01	1.30E 01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	2.70E 01
SW	1.70E 01	3.50E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	5.20E 01
WSW	1.20E 01	3.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.50E 01
W	1.40E 01	5.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.90E 01
WNW	1.50E 01	1.30E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.80E 01
NW	5.00E 00	1.60E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.10E 01
NNW	1.10E 01	2.10E 01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	3.20E 01
TOT	1.55E 02	1.84E 02	2.00E 00	2.00E 00	0.00E-01	0.00E-01	3.43E 02

PERIODS OF CALM(HOURS): 5.000E 00
HOURS OF INVALID DATA : 1.000E 00
HOURS OF GOOD DATA : 4.364E 03 = 98.8% OF TOTAL HOURS

APPROVED BY: [signature] TITLE: SUPV HPTS DATE: 2/1/88

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 34
REPORT START TIME : 4344:00 HRS = 12:00AM JULY 1, 1987
REPORT END TIME : 8759:00 HRS = 11:00PM DECEMBER 31, 1987
STABILITY CLASS : A
ELEVATION : 60 METERS

WIND SPEED(MPH) AT 60 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
NNE	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
NE	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
ENE	0.00E-01	1.00E 00	1.00E 00	0.00E-01	0.00E-01	0.00E-01	2.00E 00
E	0.00E-01	3.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	3.00E 00
ESE	0.00E-01	2.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.00E 00
SE	0.00E-01	2.00E 00	5.00E 00	0.00E-01	0.00E-01	0.00E-01	7.00E 00
SSE	0.00E-01	5.00E 00	7.00E 00	2.00E 00	0.00E-01	0.00E-01	1.40E 01
S	0.00E-01	9.00E 00	1.30E 01	7.00E 00	1.00E 00	0.00E-01	3.00E 01
SSW	0.00E-01	4.00E 00	1.20E 01	1.00E 01	0.00E-01	0.00E-01	2.60E 01
SW	0.00E-01	7.00E 00	6.00E 00	4.00E 00	0.00E-01	0.00E-01	1.70E 01
WSW	0.00E-01	0.00E-01	2.00E 00	0.00E-01	0.00E-01	0.00E-01	2.00E 00
W	0.00E-01	0.00E-01	3.00E 00	2.00E 00	0.00E-01	0.00E-01	5.00E 00
WNW	0.00E-01	1.00E 00	1.00E 00	4.00E 00	1.00E 00	0.00E-01	7.00E 00
NW	0.00E-01	0.00E-01	0.00E-01	4.00E 00	1.00E 00	3.00E 00	8.00E 00
NNW	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.00E 00	0.00E-01	2.00E 00
TOT	0.00E-01	3.40E 01	5.00E 01	3.30E 01	5.00E 00	3.00E 00	1.25E 02

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 0.000E-01

APPROVED BY: CC Gnaga TITLE: SUPV HPTS DATE: 2/1/88

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 34
REPORT START TIME : 4344:00 HRS = 12:00AM JULY 1, 1987
REPORT END TIME : 8759:00 HRS = 11:00PM DECEMBER 31, 1987
STABILITY CLASS : B
ELEVATION : 60 METERS

WIND SPEED(MPH) AT 60 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
NNE	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01	0.00E-01
NE	0.00E-01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	1.00E 00
ENE	1.00E 00	1.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.00E 00
E	0.00E-01	2.00E 00	2.00E 00	0.00E-01	0.00E-01	0.00E-01	4.00E 00
ESE	1.00E 00	4.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	5.00E 00
SE	0.00E-01	9.00E 00	4.00E 00	0.00E-01	0.00E-01	0.00E-01	1.30E 01
SSE	0.00E-01	2.00E 00	4.00E 00	2.00E 00	0.00E-01	0.00E-01	8.00E 00
S	0.00E-01	9.00E 00	6.00E 00	6.00E 00	1.00E 00	0.00E-01	2.20E 01
SSW	0.00E-01	6.00E 00	1.20E 01	7.00E 00	0.00E-01	0.00E-01	2.50E 01
SW	0.00E-01	4.00E 00	1.20E 01	1.00E 01	3.00E 00	0.00E-01	2.90E 01
WSW	0.00E-01	3.00E 00	6.00E 00	1.00E 00	0.00E-01	0.00E-01	1.00E 01
W	0.00E-01	1.00E 00	9.00E 00	3.00E 00	0.00E-01	0.00E-01	1.30E 01
WNW	0.00E-01	1.00E 00	1.30E 01	4.00E 00	1.00E 00	0.00E-01	1.90E 01
NW	0.00E-01	2.00E 00	3.00E 00	8.00E 00	0.00E-01	2.00E 00	1.50E 01
NNW	0.00E-01	0.00E-01	0.00E-01	1.00E 00	2.00E 00	0.00E-01	3.00E 00
TOT	2.00E 00	4.50E 01	7.10E 01	4.20E 01	7.00E 00	2.00E 00	1.69E 02

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 0.000E-01

APPROVED BY: CCAmuse TITLE: SUPV HPTS DATE: 2/1/88

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 34
REPORT START TIME : 4344:00 HRS = 12:00AM JULY 1, 1987
REPORT END TIME : 8759:00 HRS = 11:00PM DECEMBER 31, 1987
STABILITY CLASS : C
ELEVATION : 60 METERS

WIND SPEED(MPH) AT 60 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	0.00E-01	1.00E 00	0.00E-01	0.00E-01	0.00E-01	1.00E 00
NNE	0.00E-01	1.00E 00	0.00E-01	2.00E 00	0.00E-01	0.00E-01	3.00E 00
NE	0.00E-01	2.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.00E 00
ENE	0.00E-01	2.00E 00	0.00E-01	0.00E-01	0.00E-01	0.00E-01	2.00E 00
E	1.00E 00	6.00E 00	2.00E 00	0.00E-01	0.00E-01	0.00E-01	9.00E 00
ESE	0.00E-01	2.00E 00	2.00E 00	0.00E-01	0.00E-01	0.00E-01	4.00E 00
SE	0.00E-01	2.00E 00	6.00E 00	1.00E 00	0.00E-01	0.00E-01	9.00E 00
SSE	1.00E 00	7.00E 00	1.00E 01	5.00E 00	0.00E-01	0.00E-01	2.30E 01
S	0.00E-01	7.00E 00	1.00E 01	6.00E 00	0.00E-01	0.00E-01	2.30E 01
SSW	1.00E 00	6.00E 00	4.00E 00	4.00E 00	0.00E-01	0.00E-01	1.50E 01
SW	0.00E-01	1.00E 01	8.00E 00	7.00E 00	0.00E-01	0.00E-01	2.50E 01
WSW	0.00E-01	4.00E 00	5.00E 00	2.00E 00	2.00E 00	0.00E-01	1.30E 01
W	0.00E-01	6.00E 00	1.30E 01	0.00E-01	0.00E-01	0.00E-01	1.90E 01
WNW	0.00E-01	7.00E 00	9.00E 00	4.00E 00	2.00E 00	1.00E 00	2.30E 01
NW	0.00E-01	2.00E 00	1.30E 01	7.00E 00	3.00E 00	0.00E-01	2.50E 01
NNW	0.00E-01	2.00E 00	7.00E 00	9.00E 00	1.00E 00	0.00E-01	1.90E 01
TOT	3.00E 00	6.60E 01	9.00E 01	4.70E 01	8.00E 00	1.00E 00	2.15E 02

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 0.000E-01

APPROVED BY: CCGrimes TITLE: SUPV HPTS DATE: 2/1/88

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 34
REPORT START TIME : 4344:00 HRS = 12:00AM JULY 1, 1987
REPORT END TIME : 8759:00 HRS = 11:00PM DECEMBER 31, 1987
STABILITY CLASS : D
ELEVATION : 60 METERS

WIND SPEED(MPH) AT 60 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	2.00E 00	1.30E 01	8.00E 00	0.00E-01	0.00E-01	2.30E 01
NNE	0.00E-01	1.90E 01	2.60E 01	9.00E 00	0.00E-01	0.00E-01	5.40E 01
NE	1.00E 00	8.00E 00	7.00E 00	0.00E-01	0.00E-01	0.00E-01	1.60E 01
ENE	1.00E 00	1.30E 01	3.00E 00	0.00E-01	0.00E-01	0.00E-01	1.70E 01
E	3.00E 00	1.50E 01	1.50E 01	4.00E 00	0.00E-01	0.00E-01	3.70E 01
ESE	1.00E 00	1.20E 01	2.10E 01	3.00E 00	0.00E-01	0.00E-01	3.70E 01
SE	3.00E 00	1.60E 01	2.00E 01	6.00E 00	0.00E-01	0.00E-01	4.50E 01
SSE	1.00E 00	2.20E 01	3.20E 01	1.30E 01	5.00E 00	0.00E-01	7.30E 01
S	4.00E 00	2.30E 01	4.20E 01	1.80E 01	4.00E 00	0.00E-01	9.10E 01
SSW	3.00E 00	2.00E 01	3.50E 01	1.90E 01	0.00E-01	0.00E-01	7.70E 01
SW	3.00E 00	2.90E 01	3.20E 01	2.10E 01	5.00E 00	0.00E-01	9.00E 01
WSW	2.00E 00	2.20E 01	1.10E 01	2.20E 01	2.00E 00	0.00E-01	5.90E 01
W	1.00E 00	2.00E 01	2.20E 01	1.70E 01	6.00E 00	0.00E-01	6.60E 01
WNW	1.00E 00	2.00E 01	2.80E 01	4.00E 01	1.30E 01	6.00E 00	1.08E 02
NW	0.00E-01	1.80E 01	3.00E 01	3.70E 01	2.00E 00	5.00E 00	9.20E 01
NNW	1.00E 00	1.50E 01	2.60E 01	1.90E 01	1.00E 00	0.00E-01	6.20E 01
TOT	2.50E 01	2.74E 02	3.63E 02	2.36E 02	3.80E 01	1.10E 01	9.47E 02

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 0.000E-01

APPROVED BY: [signature] TITLE: SUPV HPTS DATE: 2/1/88

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 34
REPORT START TIME : 4344:00 HRS = 12:00AM JULY 1, 1987
REPORT END TIME : 8759:00 HRS = 11:00PM DECEMBER 31, 1987
STABILITY CLASS : E
ELEVATION : 60 METERS

WIND SPEED(MPH) AT 60 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	1.00E 00	5.00E 00	2.70E 01	1.20E 01	1.00E 00	0.00E-01	4.60E 01
NNE	2.00E 00	1.50E 01	6.50E 01	2.90E 01	2.00E 00	0.00E-01	1.13E 02
NE	2.00E 00	2.00E 01	4.80E 01	7.00E 00	1.00E 00	0.00E-01	7.80E 01
ENE	0.00E-01	1.20E 01	2.30E 01	4.00E 00	0.00E-01	0.00E-01	3.90E 01
E	4.00E 00	1.00E 01	4.20E 01	1.40E 01	0.00E-01	0.00E-01	7.00E 01
ESE	1.00E 00	1.90E 01	5.00E 01	7.00E 00	0.00E-01	0.00E-01	7.70E 01
SE	1.00E 00	1.00E 01	6.60E 01	4.20E 01	2.00E 00	0.00E-01	1.21E 02
SSE	4.00E 00	1.70E 01	6.10E 01	6.00E 01	0.00E-01	0.00E-01	1.42E 02
S	1.00E 00	1.90E 01	7.60E 01	7.30E 01	5.00E 00	0.00E-01	1.74E 02
SSW	3.00E 00	1.10E 01	3.70E 01	4.20E 01	2.00E 00	0.00E-01	9.50E 01
SW	3.00E 00	1.50E 01	3.20E 01	4.70E 01	6.00E 00	0.00E-01	1.03E 02
WSW	9.00E 00	1.40E 01	2.00E 01	2.80E 01	1.00E 01	3.00E 00	8.40E 01
W	3.00E 00	2.00E 01	3.00E 01	4.70E 01	5.00E 00	0.00E-01	1.05E 02
WNW	3.00E 00	6.00E 00	6.20E 01	4.80E 01	1.20E 01	3.00E 00	1.34E 02
NW	2.00E 00	1.20E 01	4.70E 01	4.80E 01	5.00E 00	0.00E-01	1.14E 02
NNW	0.00E-01	1.70E 01	4.90E 01	1.70E 01	6.00E 00	0.00E-01	8.90E 01
TOT	3.90E 01	2.22E 02	7.35E 02	5.25E 02	5.70E 01	6.00E 00	1.58E 03

PERIODS OF CALM(HOURS): 1.000E 00
HOURS OF INVALID DATA : 0.000E-01

APPROVED BY: CCGinna TITLE: SUPV HPTS DATE: 2/1/88

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 34
REPORT START TIME : 4344:00 HRS = 12:00AM JULY 1, 1987
REPORT END TIME : 8759:00 HRS = 11:00PM DECEMBER 31, 1987
STABILITY CLASS : F
ELEVATION : 60 METERS

WIND SPEED(MPH) AT 60 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	1.00E 00	2.00E 00	6.00E 00	1.00E 00	0.00E-01	0.00E-01	1.00E 01
NNE	2.00E 00	1.00E 00	1.50E 01	5.00E 00	0.00E-01	0.00E-01	2.30E 01
NE	3.00E 00	6.00E 00	1.50E 01	2.00E 00	0.00E-01	0.00E-01	2.60E 01
ENE	1.00E 00	4.00E 00	1.50E 01	0.00E-01	0.00E-01	0.00E-01	2.00E 01
E	2.00E 00	7.00E 00	2.10E 01	2.00E 00	0.00E-01	0.00E-01	3.20E 01
ESE	0.00E-01	4.00E 00	3.20E 01	4.00E 00	0.00E-01	0.00E-01	4.00E 01
SE	1.00E 00	4.00E 00	5.90E 01	1.70E 01	0.00E-01	0.00E-01	8.10E 01
SSE	1.00E 00	1.20E 01	7.90E 01	5.70E 01	0.00E-01	0.00E-01	1.49E 02
S	1.00E 00	1.30E 01	1.01E 02	4.50E 01	0.00E-01	0.00E-01	1.60E 02
SSW	1.00E 00	7.00E 00	5.40E 01	4.00E 01	0.00E-01	0.00E-01	1.02E 02
SW	1.00E 00	9.00E 00	3.50E 01	4.20E 01	0.00E-01	0.00E-01	8.70E 01
WSW	1.00E 00	3.00E 00	2.90E 01	1.40E 01	2.00E 00	0.00E-01	4.90E 01
W	0.00E-01	1.40E 01	2.60E 01	8.00E 00	0.00E-01	0.00E-01	4.80E 01
WNW	0.00E-01	9.00E 00	2.70E 01	1.90E 01	1.00E 00	5.00E 00	6.10E 01
NW	1.00E 00	3.00E 00	2.60E 01	2.20E 01	0.00E-01	1.00E 00	5.30E 01
NNW	0.00E-01	1.10E 01	1.20E 01	1.80E 01	0.00E-01	0.00E-01	4.10E 01
TOT	1.60E 01	1.09E 02	5.52E 02	2.96E 02	3.00E 00	6.00E 00	9.82E 02

PERIODS OF CALM(HOURS): 0.000E-01
HOURS OF INVALID DATA : 7.000E 00

APPROVED BY: CCCowan TITLE: Supv HPTS DATE: 2/1/88

REPORT CATEGORY : METEROLOGICAL DATA. QUARTERLY TOTALS OF HOURS AT
: EACH WIND SPEED AND DIRECTION
PERIOD OF RECORD : QUARTER # 34
REPORT START TIME : 4344:00 HRS = 12:00AM JULY 1, 1987
REPORT END TIME : 8759:00 HRS = 11:00PM DECEMBER 31, 1987
STABILITY CLASS : G
ELEVATION : 60 METERS

WIND SPEED(MPH) AT 60 METER LEVEL

	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.00E-01	3.00E 00	5.00E 00	3.00E 00	0.00E-01	0.00E-01	1.10E 01
NNE	1.00E 00	4.00E 00	1.00E 01	5.00E 00	0.00E-01	0.00E-01	2.00E 01
NE	1.00E 00	7.00E 00	1.10E 01	1.00E 00	0.00E-01	0.00E-01	2.00E 01
ENE	1.00E 00	4.00E 00	3.00E 00	0.00E-01	0.00E-01	0.00E-01	8.00E 00
E	0.00E-01	2.00E 00	2.00E 00	4.00E 00	0.00E-01	0.00E-01	8.00E 00
ESE	2.00E 00	3.00E 00	2.00E 00	0.00E-01	0.00E-01	0.00E-01	7.00E 00
SE	1.00E 00	2.00E 00	3.00E 00	2.00E 00	1.00E 00	0.00E-01	9.00E 00
SSE	2.00E 00	7.00E 00	8.00E 00	1.00E 00	1.00E 00	0.00E-01	1.90E 01
S	0.00E-01	8.00E 00	3.00E 01	3.00E 00	0.00E-01	0.00E-01	4.10E 01
SSW	2.00E 00	9.00E 00	3.00E 01	1.00E 00	0.00E-01	0.00E-01	4.20E 01
SW	0.00E-01	1.10E 01	2.00E 01	2.00E 01	0.00E-01	0.00E-01	5.10E 01
WSW	1.00E 00	1.30E 01	6.00E 00	9.00E 00	0.00E-01	0.00E-01	2.90E 01
W	1.00E 00	1.00E 01	7.00E 00	3.00E 00	0.00E-01	0.00E-01	2.10E 01
WNW	1.00E 00	5.00E 00	2.00E 00	6.00E 00	0.00E-01	0.00E-01	1.40E 01
NW	0.00E-01	5.00E 00	4.00E 00	1.10E 01	0.00E-01	0.00E-01	2.00E 01
NNW	1.00E 00	3.00E 00	6.00E 00	5.00E 00	0.00E-01	0.00E-01	1.50E 01
TOT	1.40E 01	9.60E 01	1.49E 02	7.40E 01	2.00E 00	0.00E-01	3.35E 02

PERIODS OF CALM(HOURS): 1.000E 00
HOURS OF INVALID DATA : 1.300E 01
HOURS OF GOOD DATA : 4.359E 03 = 98.7% OF TOTAL HOURS

APPROVED BY: CCGrisham TITLE: SUPV HPTS DATE: 2/1/88

TABLE 5

DOSE AT THE SITE BOUNDARY AND NEAREST RESIDENT FROM GASEOUS EFFLUENTS
1987

ORGAN	SITE BOUNDARY		NEAREST RESIDENT	
	Location: 2.2Km NNW Age Group: Child		Location: 2.9 km NNW Age Group: Child	
	DOSE	% LIMIT	DOSE	% LIMIT
Gamma Air Dose (mrad)	4.0E-2	0.4	2.6E-2	N/A
Beta Air Dose (mrad)	9.6E-2	0.5	6.2E-2	N/A
Whole Body (mrem)*	2.5E-2	N/A	1.6E-2	N/A
Skin (mrem)	6.6E-2	N/A	4.2E-2	N/A
Bone (mrem)	2.8E-4	N/A	1.7E-4	1E-3
Liver (mrem)	6.6E-3	N/A	4.2E-3	3E-2
Total Body (mrem)	6.4E-3	N/A	4.0E-3	3E-2
Thyroid (mrem)	5.9E-2	N/A	3.7E-2	2E-1
Kidney (mrem)	6.5E-3	N/A	4.2E-3	3E-2
Lung (mrem)	6.3E-3	N/A	3.9E-3	3E-2
GI-LLI (mrem)	6.3E-3	N/A	4.0E-3	3E-2

* Noble Gas Exposure Only

TABLE 6

DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES
WITHIN THE SITE BOUNDARY
1987

ORGAN	EFFLUENTS DOSE WITHIN THE SITE BOUNDARY (mrem)	DIRECT RADIATION FROM THE UNIT (mrem)	DIRECT RADIATION FROM OUTSIDE TANKS (mrem)	TOTAL DOSE FOR THE YEAR (mrem)
Skin	3.1E-3	5E-4	8E-3	1.2E-2
Bone	1.2E-3	5E-4	8E-3	9.7E-3
Liver	1.4E-3	5E-4	8E-3	9.9E-3
Total Body	1.4E-3	5E-4	8E-3	9.9E-3
Thyroid	2.3E-3	5E-4	8E-3	1.1E-2
Kidney	1.4E-3	5E-4	8E-3	9.9E-3
Lung	1.4E-3	5E-4	8E-3	9.9E-3
GI-LLI	1.4E-3	5E-4	8E-3	9.9E-3

TABLE 7
TOTAL DOSE DUE TO THE URANIUM
FUEL CYCLE
1987

ORGAN	DOSE TO THE NEAREST RESIDENT(mrem)	% LIMIT 40CRF190	DOSE TO THE MEMBER OF THE PUBLIC (mrem)	% LIMIT 40CFR190
Skin	4.2E-2	2E-1	4.2E-2	2E-1
Bone	1.6E-2	6E-2	2.4E-2	1E-1
Liver	2.0E-2	8E-2	2.4E-2	1E-1
Total Body	2.0E-2	8E-2	2.4E-2	1E-1
Thyroid	5.3E-2	7E-2	2.5E-2	3E-2
Kidney	2.0E-2	8E-2	2.4E-2	1E-1
Lung	2.0E-2	8E-2	2.4E-2	1E-1
GI-LLI	2.0E-2	8E-2	2.4E-2	1E-1

TABLE 8

DOSE DUE TO LIQUID EFFLUENTS
1987

Organ	Dose (mrem)	Limit* (mrem)	%Limit
BONE	1.3E-1	10	1
LIVER	2.3E-1	10	2
TOTAL BODY	1.7E-1	3	6
THYROID	8.9E-3	10	9E-2
KIDNEY	7.5E-2	10	8E-1
LUNG	2.6E-2	10	3E-1
GI-LLI	1.7E-1	10	2

* Annual Dose Limits of Technical Specification 3.11.1.2.

ATTACHMENT 1

CHANGES TO THE PROCESS CONTROL PROGRAM

"PCP"
Date October 9, 1987
Revision 8

UNION ELECTRIC COMPANY

CALLAWAY PLANT

PROCESS CONTROL PROGRAM

Approved: Blosser / Chariman, ORC — 10/12/87 / Date — 725 / ORC Meeting number

Reviewed: V J Shanks / Superintendent, Radwaste — 10/12/87 / Date

Prepared by Terry W. Hamilton — 10/12/87 / Date

DISCLOSURE STATEMENT

The Formulations contained in this document are considered proprietary to Union Electric Company and its installed Solid Radwaste System supplier and shall not be duplicated, used, or disclosed outside the Nuclear Regulatory Commission in whole or in part.

This document contains the following:

Pages	1	through	11
Attachments	1	through	4

TABLE OF CONTENTS

LIST OF ATTACHMENTS

RECORD OF REVISIONS

Revision Number	Revision Date	Reason for Revision
Rev. 0	October 1983	Initial issue.
Rev. 1	February 1984	Incorporation of NRC review comments.
Rev. 2	December 1984	Revised to generic, non-procedural format; updating of formulations for solidification of wastes.
Rev. 3	March 1985	Added solidification nomogram for concentrated borated wastes and renumbered attachments; clarified sample analysis documentation requirements.
Rev. 4	August 1985	Incorporated Class A "unstable" resin solidification formulation (based upon in-plant testing).
Rev. 5	March 1986	Update solidification formulation nomograms; revised coversheet and "preface" portion of document; removed section dealing with solidification agents from document; made formulations propietary documents.
Rev. 6	April 1986	Incorporated section dealing with control of vendor services for packaging of solid radioactive wastes; revised purpose to agree more closely with wording shown in Technical Specification definition for "Process Control Program"
Rev. 7	June 1987	Revised section dealing with contracted vendor services to clarify type of services involved.

RECORD OF REVISIONS

Rev. 8	September 1987	Revised recorded boundary conditions/ratios for batch solidification; revised acceptance criteria for structural stability incorporated wording regarding full scale test solidification; minor text wording changes.

CALLAWAY PLANT

PROCESS CONTROL PROGRAM MANUAL

(PCP)

1.0 PURPOSE AND SCOPE

1.1 The purpose of the Process Control Program (PCP) is to provide reasonable assurance and documentation that the processing and packaging of solid radioactive wastes based on actual or simulated wet solid wastes will be accomplished in such a way as to assure compliance with 10CFR20, 10CFR61, 10CFR71, the Radiological Effluent Technical Specifications, Federal and State regulations, burial ground requirements, and other requirements governing the disposal of the radioactive wastes.

1.2 The PCP contains the sampling, tests, analyses, and formulation determination by which waste classification and solidification of radioactive wastes from liquid systems is assured.

1.3 Processing of radioactive wastes using contracted vendor services will be controlled in accordance with Section 8.0 of the Callaway Plant PCP.

2.0 DEFINITIONS

2.1 Solidification - The conversion of wet wastes into a form that meets shipping and burial ground requirements.

2.2 Batch - A specified quantity of waste material requiring soldification any portion of which would have the same physical and chemical characteristics as the whole.

2.3 Waste Classification - The determination of waste class as outlined in 10CFR61 by radionuclide isotopic analysis and/or correlation with measured nuclides.

3.0 10CFR61 COMPLIANCE METHODOLOGY

3.1 All packaged radioactive wastes generated at the Callaway Plant shall meet the requirements of Title 10 Code of Federal Regulations Part 61 (10CFR61).

3.2 Waste Classification (10CFR61.55) requirements shall be met by the methodology established in plant operating procedure(s) governing Waste Classification.

3.3 Waste Characterization (10CFR61.56) requirements shall be met by a combination of the methodology stated in the Process Control Program (Section 6.0) and related Callaway Plant Operating Procedures. Stability requirements stated in 10CFR61.56 (b) and by burial site shall be met and ensured prior to shipping packaged radioactive waste offsite for burial.

3.4 Additionally, the use of NRC-approved topical reports may be utilized in meeting specific requirements of 10CFR61.

4.0 ADMINISTRATIVE CONTROLS

4.1 All samples shall be handled in accordance with applicable Callaway Plant procedures and in keeping with ALARA principles.

4.2 Test samples containing radioactive waste and contaminated disposable labware utilized in the performance of the methods described in the PCP shall be disposed of as radioactive waste.

4.3 The establishment of effective administrative controls governing the use and disposal of oils, greases and chelating agents shall be utilized as a means to control and/or limit the production of wastes containing these substances. In the event that chemical analysis of process wastes for these substances is impractical due to physical restrictions or analtytical constraints, determination of their presence (or absence) shall be made utilizing appropriate evaluation techniques.

5.0 COLLECTION AND ANALYSIS OF SAMPLES

5.1 GENERAL REQUIREMENTS

5.1.1 As required by Radiological Effluent Technical Specification 3.11.3, the PCP shall be used to verify the solidification of at least one representative test sample from at least every tenth batch of each type of wet radioactive waste processed.

5.1.2 For the purpose of the Callaway Plant PCP, a batch shall consist of a particular amount of liquid wastes/sludges requiring solidification (ie., the amount of waste content within a tank requiring solidification, or, the amount of waste content within two tanks requiring solidification if the contents of the two tanks are to be solidified together within a common drum). If new material is added to a tank's contents which is currently being processed, a new batch is created and further sampling must be performed prior to solidification.

5.1.3 If any sample fails to solidify, solidification of the batch under test shall be suspended until such time as additional test samples can be obtained, alternative solidification parameters can be determined in accordance with the Process Control Program, and a subsequent test verifies solidification. Solidification of the batch may then be resumed using the alternative solidification parameters determined.

5.1.4 If the initial test sample from a batch of waste fails to verify solidification, then representative test samples shall be collected from each consecutive batch of the same type of waste until three (3) consecutive initial test specimens demonstrate solidification.

5.1.5 For high activity wastes, where handling samples could result in personnel radiation exposures which are inconsistent with ALARA principles, representative non-radioactive samples may be test solidified. These samples shall be as close to the actual waste and chemical properties as possible. Typical unexpended mixed bead resin may be used to simulate the spent bead resin.

5.1.6 Where practical, all chemicals used to condition or solidify waste (or simulated waste) in solidification tests shall be identical to the actual chemicals to be used in full scale solidification.

5.2 COLLECTION OF SAMPLES

5.2.1 Sample Analysis Documentation

5.2.1.1 Pertinent information on the characteristics of test sample solidification shall be recorded in order to verify solidification of subsequent batches of similar waste without retesting.

5.2.1.2 The test sample data for waste shall include, but is not limited to: the type of wastes solidified; percent total solids; pH; amount of oil in the sample.

5.2.1.3 Additionally, recorded information will include the batch number, waste type, waste classification, total waste received, total portland cement added, total sodium metasilicate added and the date solidified.

5.2.1.4 If waste pretreatment is necessary prior to actual batch solidification per the results of section 6.1, the agent used and amount added shall be recorded.

5.2.2 Taking Samples

5.2.2.1 A sample(s) of the waste tank's contents requiring solidification shall be taken in order to determine the actual process formulation for solidification, any pretreatment of the waste needed prior to solidification, and the waste classification of the final solidified waste product.

5.2.2.1.1 Sample sizes, as determined by the Radwaste Department, shall be compatible with the standard size samples used for radioactivity and chemical analysis.

5.2.2.1.2 If the radioactivity levels are too high to permit full size samples to be taken, then smaller samples shall be taken with the results corrected accordingly.

5.2.2.2 Sufficient sampling lead time should be allotted prior to the planned waste solidification of a batch to allow adequate time to complete the required testing and verification of solidification, as applicable.

5.2.2.3 The contents of the waste tanks that are to be solidified shall be recirculated (mixed) prior to sampling to ensure that a representative sample is obtained.

5.2.2.4 If the contents of more than one tank are to be solidified in the same drum, then representative samples of each tank should be drawn.

5.2.2.4.1 These samples should be of a sufficient composition that if "X" percent of the total waste to be solidified is to be taken from one of the tanks, then the sample taken from that tank should be the same percentage in the composite sample.

5.2.2.4.2 The samples taken of each should be mixed in the proper proportions to yield a standard size sample as described in 5.2.2.1.1.

5.3 CHEMICAL ANALYSIS OF WASTE SAMPLES

5.3.1 Evaporator bottoms and chemical wastes shall be analyzed for total solids, oil content, boric acid concentration and pH.

5.3.2 Spent resin beads and charcoal shall be characterized by analyzing the water surrounding the beads and charcoal for oil content and pH. Boric acid concentration of spent resin beads shall be determined by an assay of the boric acid separated from the anion bead resin.

5.3.3 Results of chemical analysis shall be documented.

5.4 RADIOCHEMICAL ANALYSIS OF WASTE SAMPLES

5.4.1 A gamma isotopic analysis will be performed on each batch to be solidified.

5.4.2 This analysis will be used to determine acceptability for solidification as well as waste classification of the waste to be solidified (see Section 7.0).

5.4.3 The results of the gamma isotopic analysis shall be recorded on/attached to the documentation package.

6.0 TEST SOLIDIFICATION AND ACCEPTANCE CRITERIA

6.1 WASTE CONDITIONING

6.1.1 Prior to the test sample solidification, the pH of the tank shall be adjusted to a range of 7 to 9 pH.

6.1.1.1 Should adjustment be necessary, the agent and quantity used shall be recorded.

6.1.2 If oil is present in quantities greater than 1% by volume, dilution of the batch to below 1% is required prior to solidification.

6.1.2.1 If reduction of the oil content is impossible or impractical, solidification of the batch shall not be attempted using the Stock Solidification System, but shall be accomplished using a bulk processing method.

6.2 TEST SOLIDIFICATION

6.2.1 Whenever pretreatment of a batch is necessary, the tank contents shall have the required pretreatment accomplished prior to pulling the sample for test solidification analysis.

6.2.2 A test solidification container shall be prepared with a mixing device. This test solidification container could either be a small sample container, or, in certain applications, a full scale drum when actual full scale testing of a batch may be required or desirable.

6.2.3 The appropriate proportional amount of portland cement and sodium metasilicate, as applicable, determined from the appropriate solidification formulation nomograms/charts (Attachments 1 through 4) shall be added.

6.2.4 A known representative volume of the waste shall be transferred to the test solidification container.

6.2.5 Mixing of the waste, portland cement and sodium metasilicate shall be initiated. After appropriate mixing or when a homogenous mixture is obtained, the cement/waste mixture shall be allowed to stand for a specified time period.

6.2.6 Any free liquid observed on the top of the test solidification shall be decanted into a clear volumetric beaker (cylinder). The amount of liquid decanted shall be used to calculate the percent free liquid. Results of this analysis shall be documented.

6.3 TEST SOLIDIFICATION ACCEPTABILITY

6.3.1 The test sample solidification will be considered acceptable from a free liquid standpoint if the amount of free liquid is the lessor of either 1% by volume or burial site limits.

6.3.2 The test sample solidification will be considered acceptable from a solid mass standpoint (i.e., structural stability) if the surface of the sample resists penetration when probed with a spatula or comparable firm object.

6.3.3 If either or both of the above checks fail to meet the stated criteria, the waste sample analysis and/or the sample solidification formula shall be verified as being correct.

6.3.3.1 If this verification shows an error in waste sample analysis or sample solidification formula, a corrected solidification formula shall be obtained and sample solidification performed using this corrected formula.

6.3.3.2 In the event that the analysis and formula previously derived and used are correct, alternative solidification parameters shall be determined before solidification can proceed.

6.3.4 If the initial test solidification of a batch is unacceptable, then a representative sample shall be test solidified on each subsequent batch of the same type of waste until three consecutive test samples demonstrate solidification.

6.3.5 If a test sample fails to provide acceptable solidification of waste, equal volumes of dry cement and water shall be mixed to ensure that the problem is not due to a bad batch of cement.

7.0 PROCESS FORMULATIONS

7.1 GENERAL REQUIREMENTS

7.1.1 Prior to batch solidification of the waste to be solidified, waste classification and acceptability for near-surface disposal shall be determined. This will involve calculating the activity within the projected waste drums using the isotopic analysis determined per section 5.4 and the actual solidification formulas to be used.

7.1.2 Solidification formulations are based upon use of formulations/nomograms shown as Attachments 1 through 4 dependant upon the chemical analysis and type of waste to be solidified.

7.1.2.1 Instructions for use of these nomograms shall be described in plant operating procedures.

7.2 SPENT RESINS/CHARCOAL

7.2.1 Spent resins/charcoal shall be solidified utilizing the formulations of Attachment 1, Resin Solidification Formulas, and the operating sequences specified in plant operating procedures.

7.2.2 In the event that the boric acid assay of the bead resin yields boric acid in excess of 33.33 mg/ml, a corresponding amount of sodium metasilicate per Attachment 4, Sodium Metasilicate Addition, shall be added.

7.3 CHEMICAL DRAIN TANK WASTES

7.3.1 Chemical Drain Tank Wastes shall be solidified utilizing the formulation nomogram of Attachment 2, Concentrated Wastes (Non-Borated) Solidification, and the operating sequences specified in plant operating procedures.

7.3.2 In the event the boric acid analysis of the waste sample yields boric acid in excess of 33.33 mg/ml, solidification shall be based upon the formulation nomogram of Attachment 3, Concentrated Wastes (Borated) Solidification, with a corresponding amount of sodium metasilicate per Attachment 4, Sodium Metasilicate Addition, added.

7.4 EVAPORATOR BOTTOMS

7.4.1 Evaporator Bottoms shall be solidified utilizing the formulation nomogram of Attachment 2, Concentrated Wastes (Non-Borated) Solidification, and the operating sequences specified in plant operating procedures.

7.4.2 In the event the boric acid analysis of the waste sample yields boric acid in excess of 33.33 mg/ml, solidification shall be based upon the formulation nomogram of Attachment 3, Concentrated Wastes (Borated) Solidification, with a corresponding amount of sodium metasilicate per Attachment 4, Sodium Metasilicate Addition, added.

8.0 RADIOACTIVE WASTE PROCESSING USING CONTRACTED VENDOR SERVICES

8.1 GENERAL REQUIREMENTS

8.1.1 As required by Technical Specification 3/4.11.3.c, contracted vendor services shall be provided to process and package radioactive wastes to the required waste form to satisfy the applicable transportation and disposal requirements for those instances when the installed solid radioactive waste system is incapable of processing these wastes.

8.1.2 Contracted vendor services will be established for the packaging of wet radioactive wastes by vendor solidification and/or dewatering.

8.1.3 Contracted vendor services may be exercised when, in the opinion of plant management, any of the following conditions exist:

8.1.3.1 The installed system is declared out-of-service thereby reducing or eliminating the capability of Callaway Plant to efficiently and legally package radioactive wastes in accordance with all applicable requirements governing the disposal of the wastes; or,

8.1.3.2 The installed system is incapable of packaging these wastes in accordance with any of the applicable requirements (e.g., 10CFR61.) governing the disposal of these wastes; or,

8.1.3.3 When processing and packaging economics show an increased cost efficiency of vendor processing versus installed system processing.

8.1.4 Specific programmatic controls for these services will be handled in accordance with the vendor's Quality Assurance program. This program shall be approved by Union Electric Quality Assurance prior to implementation of the contracted services.

8.2 CONTROL OF VENDOR PROCEDURES AND DOCUMENTATION

8.2.1 Vendor Procedure Control

8.2.1.1 Vendor procedures covering equipment setup, operation, and removal shall be reviewed and approved in accordance with plant administrative procedures prior to implementation.

8.2.1.2 Vendor procedures covering the vendor's Process Control Program (PCP) in addition to the review and approval mentioned above shall also be reviewed and approved by the Onsite Review Committee prior to implementation.

8.2.1.2.1 The vendor PCP shall provide for the sampling, tests, analyses and formulation determination, where applicable, as required by plant Technical Specifications covering the Callaway Plant PCP.

8.2.1.2.2 Results of all testing and analyses shall be documented, as necessary, to ensure compliance with the vendor PCP and all applicable transportation and burial ground requirements governing these wastes.

8.2.2 Control of Vendor Documentation

8.2.2.1 Copies of all documentation attesting to compliance with the requirements of the vendor PCP as well as any plant operating procedures utilized in support of the contracted vendor service shall be retained by the plant for inclusion in plant files.

8.2.2.2 Documentation containing proprietary information shall be appropriately handled and controlled to ensure the required degree of confidentiality is met.

9.0 REFERENCES

9.1 STOCK EQUIPMENT COMPANY, General Process Control Program (M-135-0457)

9.2 10CFR20

9.3 10CFR61

9.4 10CFR71

9.5 Reg. Guide 8.8

9.6 Radiological Effluent Technical Specification 3.11.3

ATTACHMENT 2

CHANGES TO THE OFFSITE DOSE CALCULATION MANUAL

Rev. 4

UNION ELECTRIC COMPANY

CALLAWAY PLANT

OFFSITE DOSE CALCULATION MANUAL

Approved: G L Randolph — Chairman, ORC — 2/23/87 Date — 645 ORC meeting number

Reviewed: [illegible] — Superintendent, Health Physics — 2/17/87 Date

Prepared By: [illegible] — Supervisor, H. P. Tech. Support — 2/13/87 Date

This document contains the following:

Pages	1	through	104
Tables	1	through	12
Figures	4.1, 5.1A, 5.1B, 5.2A, 5.2B, 5.3		

Table of Contents

Table of Contents (continued)

Table of Contents (continued)

Table of Contents (continued)

Table of Contents (continued)

List of Figures

List of Tables

Record of Revisions

Revision Number	Date	Reason for Revision
Rev. 0	March 1983	
Rev. 1	November 1983	Revised to support the current RETS submittal and to incorporate NRC Staff comments
Rev. 2	March 1984	Revised to incorporate NRC Staff comments
Rev. 3	June 1985	Revised to incorporate errata identified by ULNRC-803 and changes to the Environmental Monitoring Program. Incorporate results of 1984 Land use Census.
Rev. 4	February 1987	Minor clarifications, incorporated 31-day projected dose methodology. Change in the utilization of areas within the Site Boundary.

1.0 PURPOSE AND SCOPE

The Offsite Dose Calculation Manual (ODCM) describes the methodology and parameters used in the calculation of offsite doses and dose rates due to radioactive liquid and gaseous effluents and in the calculation of liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints. The ODCM also contains a list and description of the specific sample locations for the radiological environmental monitoring program.

Changes in the calculational methodologies or parameters will be incorporated into the ODCM and documented in the Semi Annual Radioactive Effluent Release Report. The ODCM does not replace any station implementing procedures.

2.0 LIQUID EFFLUENTS

2.1 Technical Specification 3.3.3.10

The radioactive liquid effluent monitoring instrumentation channels shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Technical Specification 3.11.1.1 are not exceeded. The alarm/trip setpoints of these channels shall be adjusted to the values determined in accordance with the methodology and parameters in the ODCM.

2.2 Liquid Effluent Monitors

Gross radioactivity monitors which provide for automatic termination of liquid effluent releases are present on the liquid effluent lines. Flow rate measurement devices are present on the liquid effluent lines and the discharge line (cooling tower blowdown). Setpoints, precautions, and limitations applicable to the operation of the Callaway Plant liquid effluent monitors are provided in the appropriate Plant Procedures, which are contained in Volume 6 of the Plant Operating Manual. Setpoint values are calculated to assure that alarm and trip actions occur prior to exceeding the Maximum Permissible Concentration (MPC) limits in 10 CFR Part 20 at the release point to the UNRESTRICTED AREA. The calculated alarm and trip action setpoints for the liquid effluent line monitors and flow measuring devices must satisfy the following equation:

$$\frac{cf}{F + f} \leq C \qquad (2.1)$$

Where:

C = the liquid effluent concentration limit (MPC) implementing Technical Specification 3.11.1.1 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, which is inversely proportional to the volumetric flow of the effluent line and directly proportional to the volumetric flow of the dilution stream plus the effluent stream, represents a value, which, if exceeded, would result in concentrations exceeding the limits of 10 CFR Part 20 in the UNRESTRICTED AREA.

f = The flow setpoint as measured at the radiation monitor location, in volume per unit time, but in the same units as F, below.

F = The dilution water flow setpoint as measured prior to the release point, in volume per unit time. (If (F) is large compared to (f), then F + f ≈ F).

(Ref. 9.8.1)

If no dilution is provided, then $c \leq C$.

The radioactive liquid waste stream is diluted by the plant discharge line prior to entry into the Missouri River. Normally, the dilution flow is obtained from the cooling tower blowdown, but should this become unavailable, the plant water treatment facility supplies the necessary dilution flow via a bypass line. The batch release limiting concentration (c) which corresponds to the liquid radwaste effluent line monitor setpoint is to be calculated using methodology from the expression above.

Thus, the expression for determining the setpoint on the liquid radwaste effluent line monitor becomes:

$$c \leq \frac{C(F + f)}{f} \quad (\mu Ci/ml) \qquad (2.2)$$

2.2.1 Continuous Liquid Effluent Monitors

The radiation detection monitors associated with continuous liquid effluent releases are (Ref. 9.6.1, 9.6.2):

Monitor I.D.	Description
BM-RE-52	Steam Generator Blowdown Discharge Monitor
LE-RE-59	Turbine Building Drain Monitor

These effluent streams are not considered to be radioactive unless radioactivity has been detected by the associated effluent radiation monitor or by laboratory analysis. The sampling frequency, minimum analysis frequency, and type of analysis performed are as per Technical Specification Table 4.11-1.

The steam generator blowdown discharge monitor continuously monitors the blowdown discharge pump outlet to detect radioactivity due to system demineralizer break through and to provide backup to the steam generator blowdown process radioactivity monitor to prevent discharge of radioactive fluid. The sample point is located on the discharge of the pump in order to monitor discharge or recycled blowdown fluid and upstream of the discharge isolation valve to permit termination of the radioactive release prior to exceeding the instantaneous concentration limits of 10 CFR Part 20. The high radioactivity alarm/trip (alarm and trip) setpoint initiates control room alarm annunciation and automatic isolation of the blowdown isolation valves and the blowdown discharge valve.

The turbine building drain effluent monitor is provided to monitor turbine building liquid effluents prior to release to the environs. The fixed-volume detector assembly continuously monitors the drain effluent line upstream of the drain line isolation valve. The high radioactivity alarm/trip setpoint initiates control room annunciation and automatic isolation of the drain line isolation valve to prevent the release of radioactive fluids. The sample location ensures that all potentially radioactive turbine building liquid effluents are monitored prior to discharge.

Each monitor channel is provided with a two level system which provides sequential alarms on increasing

Each monitor channel is provided with a two level system which provides sequential alarms on increasing radioactivity levels. These setpoints are designated as alert setpoints and alarm/trip setpoints. (Ref. 9.6.3)

The alarm/trip setpoints are determined through the use of Equation (2.2) methodology to ensure that Technical Specification 3.11.1.1 limits are not exceeded at the UNRESTRICTED AREA. The alert setpoints have been administratively established below the alarm/trip setpoints, thus providing an additional margin of safety.

The alarm/trip setpoint calculations are based on the minimum dilution flow rate (cooling tower blowdown, 5000 gpm), the maximum effluent stream flow rate, and the actual isotopic analysis. Due to the possibility of a simulataneous release from more than one release pathway, a portion of the total site release limit is allocated to each pathway. The determination and usage of the allocation factor is discussed in Section 2.3.1. In the event the alarm/trip setpoint is reached, the radiation monitor setpoint (c), will be reevaluated using the actual dilution flow rate (F), the actual effluent stream flow rate (f), and the actual isotopic analysis. This evaluation will then be used to ensure that Radiological Effluent Technical Specification 3.11.1.1 limits were not exceeded.

2.2.2 Radioactive Liquid Batch Release Effluent Monitor

The two radiation monitors which are associated with the liquid effluent batch release systems are (Ref. 9.6.4, 9.6.5):

MONITOR I.D.	Description
HB-RE-18	Liquid Radwaste Discharge Monitor
HF-RE-45	Secondary Liquid Waste System Monitor

The liquid radwaste radiation monitor continuously monitors the discharge of the liquid radwaste processing system to prevent the discharge of radioactive fluid to the environs. The fixed-volume detector assembly continuously monitors the system discharge line upstream of the discharge valve. The high radioactiv-

ity alarm/trip setpoint initiates control room alarm annunciation and automatic isolation of the liquid radwaste system discharge valve to terminate discharge. The sample point is located to ensure that all potentially radioactive fluids from the liquid radwaste processing system are monitored prior to discharge.

The secondary liquid waste system discharge radioactivity monitor continuously monitors secondary liquid waste system effluents prior to discharge to the environs. The fixed-volume detector assembly monitors the discharge line upstream of the discharge isolation valve. The high radioactivity alarm/trip setpoint initiates control room alarm annunciation and automatic isolation of the secondary liquid waste system discharge valve to prevent the discharge of radioactive fluid. The sample location ensures that all potentially radioactive sources from the system are monitored prior to discharge.

The setpoint for these monitors is determined according to the methodology described by Equation (2.2) and is a function of the dilution flow rate (F), the radioactive effluent line flow rate (f) and the tank liquid effluent concentration, as determined by a pre-release isotopic analysis. Based on these factors, a setpoint is calculated for the appropriate monitor to ensure that Technical Specification 3.11.1.1 limits are not exceeded at the UNRESTRICTED AREA (Figure 5.2A).

2.3 ODCM Methodology for the Determination of Liquid Effluent Monitor Setpoints

The dependence of the setpoint (c), on the radionuclide distribution, yields, calibration, and monitor parameters, requires that several variables be considered in setpoint calculations. (Ref. 9.8.1)

2.3.1 Development of ODCM Methodology for the Determination of Liquid Effluent Monitor Setpoints

The isotopic concentration of the release being considered must be determined. This is obtained from the sum of the measured concentrations as determined by the analysis required per Technical Specifications Table 4.11-1:

$$C_T = \left(\sum_i (C_g)_i\right) + C_a + C_S + C_t + C_F \qquad (2.3)$$

Where:

C_T = the total concentration of radionuclides as determined by the analysis of the waste sample.

$\sum_i (C_g)_i$ = the sum of the concentrations (C_g) of each measured gamma emitting nuclide observed by gamma-ray spectroscopy of the waste sample.

C_a* = the measured concentrations (C_a) of alpha emitting nuclides observed by gross alpha analysis.

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

C_t* = the measured concentration of H-3 in liquid waste.

C_F* = the measured concentration of Fe-55 in liquid waste as determined by analysis of the quarterly composite sample.

The C_g term is included in the analysis of each batch; terms for alpha, Sr-89, Sr-90, Fe-55, and tritium are included as appropriate.

*Values for these concentrations will be based on previous composite sample analyses as required by Table 4.11-1 of Technical Specifications.

The measured radionuclide concentrations are used to calculate a Dilution Factor (F_d), which is the ratio of total dilution flow rate to tank flow rate required to assure that the limiting concentrations of Technical Specification 3.11.1.1 are met at the point of discharge. This is referred to as the required Dilution Factor and is determined according to:

$$F_d = \sum_i \left\{ \frac{(C_g)_i}{(MPC_g)_i} + \frac{C_a}{MPC_a} + \frac{C_s}{MPC_s} + \frac{C_t}{MPC_t} + \frac{C_F}{MPC_F} \right\} + F_S \qquad (2.4)$$

Where:

C_g, C_a, C_s, C_t, C_F = measured concentrations as defined in 2.3.1.1. Terms C_a, C_s, C_F, and C_t will be included in the calculation as appropriate.

MPC_g, MPC_s, MPC_a, MPC_F, MPC_t = are limiting concentrations of the appropriate radionuclides from 10CFR 20, Appendix B, Table II, Column 2. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} µCi/ml total activity.

F_s = the safety factor; a conservative factor used to compensate for statistical fluctuations and errors of measurements. (For example, $F_S = 0.5$ corresponds to a 100 percent variation.) Default value is $F_S = 0.9$.

For the case $F_d \leq 1$, the monitor tank effluent concentration meets the limits of Radiological Effluent Technical Specification 3.11.1.1 without dilution and the effluent may be released at any desired flow rate. If $F_d > 1$ then dilution is required to ensure compliance with Technical Specification 3.11.1.1 concentration limits. If simultaneous releases are occuring or are anticipated, a modified dilution factor (F_{dn}), must be determined so that available dilution flow may be apportioned among simultaneous discharge pathways.

$$F_{dn} = F_d + F_a \tag{2.5}$$

Where:

F_a = the allocation factor which will modify the required dilution factor such that simultaneous liquid releases may be made without exceeding the limits of Technical Specification 3.11.1.1.

The most straight-forward determination of the allocation factor is:

$$F_a = \frac{1}{n} \tag{2.6}$$

Where:

n = the number of liquid discharge pathways for which $F_d > 1$ and which are planned for simultaneous release.

However, this value for F_a may be unnecessarily restrictive in that all release pathways are apportioned the same fraction of the available dilution stream,

regardless of the relative concentrations of each of the sources.

Since the radionuclide concentration of the two continuous sources is less than that of the batch release source, it is acceptable to allocate smaller portions of the dilution stream to the continuous releases and a larger portion to the batch releases.

Therefore, F_a is necessarily defined as a flexible quantity with a default value of 1/n. Prior to initiating a simultaneous release, a check must be made to assure that the sum of the allocation factors assigned to pathways for the simultaneous release is ≤ 1.

The calculated maximum permissible waste tank effluent flow rate, (f_{max}), is based on the modified dilution factor, (F_{dn}), and the effective dilution flow rate, (F_{eff}). The effective dilution flow rate is given by:

$$F_{eff} = (0.9)F_e \qquad (2.7)$$

Where:

F_e = the cooling tower blowdown flow rate and/or bypass dilution flow.

A conservative value for F_e would be the minimum allowable cooling tower blowdown of 5000gpm which is used as a default value.

Having established the values of F_{dn} and F_{eff}, the calculated maximum permissible waste tank flow rate can be calculated by.

$$f_{max} \leq \frac{F_{eff} + f_p}{F_{dn}} \approx \frac{F_{eff}}{F_{dn}} \qquad (\text{for } f_p << F_{eff}) \qquad (2.8)$$

Where:

f_p = the expected undiluted effluent flow rate.

Thus, the effluent flow rate is set at or below f_{max}. Even though the value of f_{max} may be larger than the actual effluent pump capacity, (f_p), it does represent the upper limit to the effluent flow rate whereby the requirements of Technical Specification 3.11.1.1 may still be met. If $F_d \leq 1$, the effluent flow rate setpoint may be assigned any value since the waste tank effluent concentration meets the limits of Technical Specification 3.11.1.1 without dilution and the release may be made without regard to the setpoints for other release pathways. For those discharge pathways selected to be secured during the release under consideration, the flow rate setpoint should be set at as low a value as practicable to detect any inadvertent release.

The liquid radiation monitor setpoint may now be determined based on the values of C_T, and f_{max}, which were specified to provide compliance with the limits of Technical Specification 3.11.1.1.

The monitor response is primarily to gamma radiation, therefore, the actual setpoint is based on $\sum_i (C_g)_i$. The calculated monitor setpoint concentration is determined as follows:

$$c = A \sum_i (C_g)_i \quad \frac{\mu Ci}{ml} \qquad (2.9)$$

(Refer to Note Following)

Where:

A = Adjustment factor which will allow the setpoint to be established in a practical manner for convenience and to prevent spurious alarms.

$$A = \frac{f_{max}}{f_p} \qquad (2.10)$$

(Refer to Note Following)

If A > 1: Calculate c and determine the maximum value for the actual monitor setpoint (μCi/ml).

If A ≤ 1: No release may be made. This condition must be flagged and the operator instructed to re-evaluate F_{dn} and F_{eff} (i.e., reduce effluent flow rate or return radwaste for reprocessing).

NOTE

If F_d < 1, no further dilution is required and the release may be made without regard to available dilution or to other releases made simultaneously. However, it is necessary to establish a monitor setpoint which will provide alarm should the release concentration inadvertently exceed Technical Specification 3.11.1.1 limits. This can be accomplished by establishing the adjustment factor as follows:

$$A = \frac{1}{F_d} \qquad (2.11)$$

2.3.2 Summary, Setpoint Calculation Methodology for Liquid Effluent Monitors

The methodology described in 2.3.1 is used to determine setpoints for each of the radiation monitors assigned an effluent monitoring function. The limiting release concentration can be increased by reducing the discharge flow-rate and by increasing the cooling tower blowdown flow-rate.

2.4 Liquid Effluent Concentration Measurements

2.4.1 Technical Specification 3.11.1.1

The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS shall be limited to the concentrations specified in 10 CFR Part 20, 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 2.0 E-04 µCi/ml total activity.

2.4.2 Liquid Effluent Concentration Measurements

Liquid batch releases are discharged as a discrete volume and each release is authorized based upon the sample analysis and the dilution flow rate existing in the discharge line at time of release. To assure representative sampling, each liquid monitor tank is isolated and thoroughly mixed by recirculation of tank contents prior to sample collection. The methods for mixing, sampling, and analyzing each batch are outlined in applicable plant procedures. The allowable release rate limit is calculated for each batch based upon the pre-release analysis, dilution flow-rate, and other procedural conditions, prior to authorization for release. The radwaste liquid effluent discharge is monitored prior to entering the dilution discharge line and will automatically be terminated if the preselected alarm/trip setpoint is exceeded. Concentrations are determined primarily from the gamma isotopic, H-3, & gross alpha analyses of the liquid batch sample. For Sr-89, Sr-90, & Fe-55, the measured concentration from the previous composite analysis is used. Composite samples are collected for each batch release and quarterly analyses are performed in accordance with Technical Specification Table 4.11-1.

Dose contributions from liquids discharged as continuous releases are determined by utilizing the last measured values of samples required in accordance with Technical Specifications Table 4.11-1.

2.5 Individual Dose Due to Liquid Effluents

2.5.1 Radiological Effluent Technical Specification 3.11.1.2

The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, to UNRESTRICTED AREAS shall be limited:

a. During any calendar quarter to less than or equal to 1.5 mrem to the whole body and less than or equal to 5 mrem to any organ, and

b. During any calendar year to less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ.

2.5.2 The Maximum Exposed Individual

The cumulative dose determination considers the dose contributions from the maximum exposed individual's consumption of fish and potable water, as appropriate. Normally, the adult is considered to be the maximum exposed individual. (Ref. 9.8.3, 9.8.4)

The Callaway Plant's liquid effluents are discharged to the Missouri River. As there are no potable water intakes within 50 miles of the discharge point (Ref. 9.7.1, 9.6.6), this pathway does not require routine evaluation. Therefore, the dose contribution from fish consumption is expected to account for more than 95% of the total man-rem dose from discharges to the Missouri River. Dose from recreational activities is expected to contribute the additional 5%, which is considered to be negligible. (Ref. 9.6.7)

2.5.3 ODCM Methodology for Determining Dose Contributions From Liquid Effluents

2.5.3.1 Calculation of Dose Contributions

The dose contributions for the total time period

$$\sum_{\ell=1}^{m} \Delta t_\ell$$

are calculated at least once each 31 days and a cumulative summation of the total body and individual organ doses is maintained for each calendar quarter. These dose contributions are calculated for all radionuclides identified in liquid effluents released to UNRESTRICTED AREAS using the following expression (Ref. 9.8.3)

$$D_\tau = \sum_i \left[A_{i\tau} \sum_{\ell=1}^{m} \Delta t_\ell \, C_{i\ell} \, F_\ell \right] \qquad (2.12)$$

Where:

D_τ = the cumulative dose commitment to the total body or any organ, τ, from the liquid effluents for the total period

$$\sum_{\ell=1}^{m} \Delta t_\ell$$

in mrem.

Δt_ℓ = the length of the ℓth time period over which $C_{i\ell}$ and F_ℓ are averaged for all liquid releases, in hours.

$C_{i\ell}$ = the average measured concentration of radionuclide, i, in undiluted liquid effluent during time period Δt_ℓ from any liquid release, in (μCi/ml).

A_{it} = the site related ingestion dose commitment factor to the total body or any organ τ for each identified principal gamma and beta emitter listed in Technical Specifications, Table 4.11-1, (in mrem/hr) per (μCi/ml). These factors are given in Table 1, as derived through the use of Equation (2.16).

F_ℓ = the near field average dilution factor for $C_{i\ell}$ during any liquid effluent release.

$$f_\ell = \frac{f_{max}}{(f_e + f_{max})\ 89.77}$$

Where:

f_{max} = maximum undiluted effluent flow rate during the release

f_e = average flow rate from the site discharge structure to unrestricted receiving waters (dilution flow)

89.77 = site specific applicable factor for the mixing effect of the discharge structure. (Ref 9.5.1)

The term $C_{i\ell}$ is the undiluted concentration of radioactive material in liquid waste at the common release point determined in accordance with Technical Specification 3.11.1.1, Table 4.11-1, "Radioactive Liquid Waste Sampling and Analysis Program". All dilution factors beyond the sample point(s) are included in the F_ℓ term.

2.5.3.2 Dose Factor Related to Liquid Effluents

Calculating dose contributions via Equation (2.13) requires the use of a dose factor $A_{i\tau}$ for each nuclide, i, which embodies the dose factors, pathway transfer factors (e.g., bioaccumulation factors), pathway usage factors, and dilution factors for the points of pathway origin. The adult total body dose factor and the maximum adult organ dose factor for each radionuclide is used from Table E-11 of Regulatory Guide 1.109; thus, Table 1 contains critical organ dose factors for various organs. The dose factor is calculated according to (Ref. 9.8.4):

$$A_{i\tau} = k_o(U_w/D_w + U_F BF_i)DF_i \qquad (2.13)$$

Where:

$A_{i\tau}$ = composite dose parameter for the total body or critical organ of an adult for nuclide, i, for all appropriate pathways, as (mrem/hr) per (μCi/ml).

k_o = units conversion factor, derived according to:

1.14E05 = (1E06pCi/μCi x 1E03ml/kg) ÷ 8760 hr/yr.

U_F = adult fish consumption factor, equal to 21kg/yr (Regulatory Guide 1.109, Table E-5).

BF_i = Bioaccumulation factor for nuclide, i, in fish (Table 2), as (pCi/kg) per (pCi/ℓ).

DF_i = Dose conversion factor for nuclide, i, for adults in pre-selected organ, τ, as (mrem/pCi) (Regulatory Guide 1-109, Table E-11).

U_w = receptor individual's water consumption by age group as per Regulatory Guide 1.109, Table E-5. For adults, U_w = 730kg/yr.

D_w = dilution factor from the near field area within one-quarter mile of the release point to the potable water intake for the adult water consumption.

NOTE

The nearest municipal potable water intake downstream from the liquid effluent discharge point into the Missouri River is located near the city of St. Louis, Mo., approximately 78 miles downstream. As there are currently no potable water intakes within 50 river miles of the discharge point, the drinking water pathway is not included in dose estimates to the maximally exposed individual, or in dose estimates to the population. Should future water intakes be constructed within 10 river miles downstream of the discharge point, then this manual will be revised to include this pathway in dose estimates. (Ref. 9.6.6). Therefore, it is not necessary to evaluate (U_w/D_w) at this time, and Equation (2.13) simplies to:

$$A_{i\tau} = k_o\ (U_F BF_i)DF_i \qquad (2.14)$$

Inserting the appropriate usage factors from Regulatory Guide 1.109 into Equation (2.14) yields the following expression:

$$A_{i\tau} = 1.14E05\ (21BF_i)DF_i \qquad (2.15)$$

or $$A_{i\tau} = 2.39E06 \times BF_i \times DF_i \qquad (2.16)$$

2.5.4 Summary, Determination of Individual Dose Due to Liquid Effluents

The dose contribution for the total time period

$$\sum_{\ell=1}^{m} \Delta t_{\ell}$$

is determined by calculation at least once per 31 days and a cumulative summation of the total body and organ doses is maintained for each calendar quarter. The projected dose contribution from liquid effluents for which radionuclide concentrations are determined by periodic composite and grab sample analysis, may be approximated by using the last measured value. Dose contributions are determined for all radionuclides identified in liquid effluents released to UNRESTRICTED AREAS. Nuclides which are not detected in the analyses are reported as "less than" the nuclide's Minimum Detectable Activity (MDA) and are not reported as being present at the LLD level for that nuclide. The "less than" values are not used in the required dose calculations.

TABLE 1

INGESTION DOSE COMMITMENT FACTOR (A_{it}) FOR ADULT AGE GROUP

(mrem-hr per μci-ml)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
H-3	No Data	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	1.78E+06	No Data	No Data	No Data	5.19E+06
Cr-51	No Data	No Data	1.27E+00	7.62E-01	2.81-01	1.69E+00	3.2-E+02
Mn-54	No Data	4.38E+03	8.35E+02	No Data	1.30E+03	No Data	1.34E+04
Mn-56	No Data	1.10E+02	1.95E+01	No Data	1.40E+02	No Data	3.52E+03
Fe-55	6.57E+02	4.54E+02	1.06E+02	No Data	No Data	2.53E+02	2.61E+02
Fe-59	1.04E+03	2.44E+03	9.34E+02	No Data	No Data	6.81E+02	8.13E+03
Co-58	No Data	8.94E+01	2.00E+02	No Data	No Data	No Data	1.81E+03
Co-60	No Data	2.57E+02	5.66E+02	No Data	No Data	No Data	4.82E+03
Ni-63	3.11E+04	2.15E+03	1.04E+03	No Data	No Data	No Data	4.49E+02
Ni-65	1.26E+02	1.64E+01	7.48E+00	No Data	No Data	No Data	4.16E+02
Cu-64	NO Data	1.00E+01	4.69E+00	No Data	2.52E+01	No Data	8.52E+02
Zn-65	2.32E+04	7.38E+04	3.33E+04	No Data	4.93E+04	No Data	4.65E+04
Zn-69	4.93E+01	9.44E+01	6.56E+00	No Data	6.13E+01	No Data	1.42E+01
Br-83	No Data	No Data	4.04E+01	No Data	No Data	No Data	5.81E+01
Br-84	No Data	No Data	5.26E+01	No Data	No Data	No Data	4.13E-04
Br-85	No Data	No Data	2.15E+00	No Data	No Data	No Data	0
Rb-86	No Data	1.01E+05	4.71E+04	No Data	No Data	No Data	1.99E+04
Rb-88	No Data	2.90E+02	1.54E+02	No Data	No Data	No Data	4.00E-09
Rb-89	No Data	1.92E+02	1.35E+02	No Data	No Data	No Data	1.12E-11
Sr-89	2.21E+04	No Data	6.35E+02	No Data	No Data	No Data	3.55E+03
Sr-90	5.44E+05	No Data	1.34E+05	No Data	No Data	No Data	1.57E+04
Sr-91	4.07E+02	No Data	1.64E+01	No Data	No Data	No Data	1.94E+03
Sr-92	1.54E+02	No Data	6.68E+00	No Data	No Data	No Data	3.06E+03
Y-90	5.75E-01	No Data	1.54E-02	No Data	No Data	No Data	6.10E+03
Y-91M	5.44E-03	No Data	2.10E-04	No Data	No Data	No Data	1.60E-02
Y-91	8.43E+00	No Data	2.25E-01	No Data	No Data	No Data	4.64E+03
Y-92	5.05E-02	No Data	1.48E-03	No Data	No Data	No Data	8.85E+02
Y-93	1.60E-01	No Data	4.42E-03	No Data	No Data	No Data	5.08E+03
Zr-95	2.40E-01	7.70E-02	5.21E-02	No Data	1.21E-01	No Data	2.44E+02
Zr-97	1.33E-02	2.68E-03	1.22E-03	No Data	4.04E-03	No Data	8.30E+02
Nb-95	4.47E+02	2.48E+02	1.34E+02	No Data	2.46E+02	No Data	1.51E+06
Mo-99	No Data	1.03E+02	1.96E+01	No Data	2.33E+02	No Data	2.39E+02
Tc-99M	8.87E-03	2.51E-02	3.19E-01	No Data	3.81E-01	1.23E-02	1.48E+01
Tc-101	9.11E-03	1.31E-02	1.29E-01	No Data	2.36E-01	6.70E-03	0
Ru-103	4.42E+00	No Data	1.90E+00	No Data	1.69E+01	No Data	5.17E+02
Ru-105	3.68E-01	No Data	1.45E-01	No Data	4.76E+00	No Data	2.25E+02
Ru-106	6.57E+01	No Data	8.32E+00	No Data	1.27E+02	No Data	4.25E+03

TABLE 1 (Continued)

INGESTION DOSE COMMITMENT FACTOR (A_{it}) FOR ADULT AGE GROUP

(mrem-hr per uci-ml)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
Te-125M	2.57E+03	9.30E+02	3.44E+02	7.72E+02	1.04E+04	No Data	1.02E+04
Te-127M	6.47E+03	2.32E+03	7.90E+02	1.66E+03	2.63E+04	No Data	2.17E+04
Te-127	1.05E+02	3.78E+01	2.28E+01	7.80E+01	4.29E+02	No Data	8.30E+03
Te-129M	1.10E+04	4.11E+03	1.74E+03	3.78E+03	4.60E+04	No Data	5.54E+04
Te-129	3.01E+01	1.13E+01	7.33E+00	2.31E+01	1.26E+02	No Data	2.27E+01
Te-131M	1.66E+03	8.09E+02	6.75E+02	1.28E+03	8.21E+03	No Data	8.03E+04
Te-131	1.89E+01	7.88E+00	5.96E+00	1.55E+01	8.25E+01	No Data	2.67E+00
Te-132	2.41E+03	1.56E+03	1.47E+03	1.72E+03	1.50E+04	No Data	7.38E+04
I-130	2.71E+01	8.01E+01	3.16E+01	6.79E+03	1.25E+02	No Data	6.89E+01
I-131	1.49E+02	2.14E+02	1.22E+02	7.00E+04	3.66E+02	No Data	5.64E+01
I-132	7.29E+00	1.95E+01	6.82E+00	6.82E+02	3.11E+01	No Data	3.66E+00
I-133	5.10E+01	8.87E+01	2.70E+01	1.30E+04	1.55E+02	No Data	7.97E+01
I-134	3.81E+00	1.03E+01	3.70E+00	1.79E+02	1.64E+01	No Data	9.01E-03
I-135	1.59E+01	4.16E+01	1.54E+01	2.75E+03	6.68E+01	No Data	4.70E+01
Cs-134	2.98E+05	7.09E+05	5.80E+05	No Data	2.29E+05	7.62E+04	1.24E+04
Cs-136	3.12E+04	1.23E+05	8.86E+04	No Data	6.85E+04	9.39E+03	1.40E+04
Cs-137	3.82E+05	5.22E+05	3.42E+05	No Data	1.77E+05	5.89E+04	1.01E+04
Cs-138	2.64E+02	5.22E+02	2.59E+02	No Data	3.84E+02	3.79E+01	2.23E-03
Ba-139	9.29E-01	6.62E-04	2.72E-02	No Data	6.19E-04	3.76E-04	1.65E+00
Ba-140	1.94E+02	2.44E-01	1.27E+01	No Data	8.31E-02	1.40E-01	4.00E+02
Ba-141	4.50E-01	3.40E-04	1.52E-02	No Data	3.16E-04	1.93E-04	2.12E-10
Ba-142	2.04E-01	2.09E-04	1.28E-02	No Data	1.77E-04	1.19E-04	0
La-140	1.50E-01	7.53E-02	1.99E-02	No Data	No Data	No Data	5.53E+03
La-142	7.65E-03	3.48E-03	8.66E-04	No Data	No Data	No Data	2.54E+01
Ce-141	2.24E-02	1.51E-02	1.72E-03	No Data	7.03E-03	No Data	5.78E+01
Ce-143	3.94E-03	2.92E+00	3.23E-04	No Data	1.28E-03	No Data	1.09E+02
Ce-144	1.17E+00	4.88E-01	6.26E-02	No Data	2.89E-01	No Data	3.94E+02
Pr-143	5.50E-01	2.21E-01	2.73E-02	No Data	1.27E-01	No Data	2.41E+03
Nd-147	3.76E-01	4.35E-01	2.60E-02	No Data	2.54E-01	No Data	2.09E+03
W-187	2.96E+02	2.47E+02	8.64E+01	No Data	No Data	No Data	8.09E+04
Np-239	2.84E-02	2.80E-03	1.54E-03	No Data	8.72E-03	No Data	5.74E+02

TABLE 2

BIOACCUMULATION FACTOR (BF_i) USED IN THE ABSENCE OF SITE-SPECIFIC DATA[a]

(pCi/kg) per (pCi/liter)

Element	BF_i Fish (Freshwater)
H	9.0 E - 01
C	4.6 E + 03
Na	1.0 E + 02
P	1.0 E + 05
Cr	2.0 E + 02
Mn	4.0 E + 02
Fe	1.0 E + 02
Co	5.0 E + 01
Ni	1.0 E + 02
Cu	5.0 E + 01
Zn	2.0 E + 03
Br	4.2 E + 02
Rb	2.0 E + 03
Sr	3.0 E + 01
Y	2.5 E + 01
Zr	3.3 E + 00
Nb	3.0 E + 04
Mo	1.0 E + 01
Tc	1.5 E + 01
Ru	1.0 E + 01
Rh	1.0 E + 01
Te	4.0 E + 02
I	1.5 E + 01
Cs	2.0 E + 03
Ba	4.0 E + 00
La	2.5 E + 01
Ce	1.0 E + 00
Pr	2.5 E + 01
Nd	2.5 E + 01
W	1.2 E + 03
Np	1.0 E + 01

(a) Values taken from Regulatory Guide 1.109, Rev 1, Table A-1.

2.6 LIQUID RADWASTE TREATMENT SYSTEM

2.6.1 Technical Specification 3.11.1.3

The LIQUID RADWASTE TREATMENT SYSTEM Shall be OPERABLE and appropriate portions of the system shall be used to reduce releases of radioactivty when the projected doses due to the liquid effluent, to UNRESTRICTED AREAS, would exceed 0.06 mrem to the total body or 0.2 mrem to any organ in a 31 day period.

2.6.2 OPERABILITY Of The LIQUID RADWASTE TREATMENT SYSTEM

The LIQUID RADWASTE TREATMENT SYSTEM is capable of varying treatment, depending on waste type and product desired. It is capable of concentrating, gas stripping, and distillation of liquid wastes through the use of the evaporator system. The demineralization system is capable of removing radioactive ions from solutions to be reused as makeup water. Filtration is performed on certain liquid wastes and it may, in some cases, be the only required treatment prior to release. The system has the ability to absorb halides through the use of charcoal filters prior to their release.

The design and operation requirements of the LIQUID RADWASTE TREATMENT SYSTEM provide assurance that releases of radioactive materials in liquid effluents will be kept "As Low As Reasonably Achievable" (ALARA).

The OPERABILITY of the LIQUID RADWASTE TREATMENT SYSTEM ensures this system will be available for use when liquids require treatment prior to their release to the environment. OPERABILITY is demonstrated through compliance with Technical Specifications 3.11.1.1 and 3.11.1.2.

Projected doses due to liquid releases to UNRESTRICTED AREAS are determined each 31 days by dividing the cumulative annual total by the number of elapsed months.

3.0 GASEOUS EFFLUENTS

3.1 Technical Specification 3.3.3.11

The radioactive gaseous effluent monitoring instrumentation channels shall be OPERABLE with their Alarm/Trip Setpoints set to ensure that the limits of Specification 3.11.2.1 are not exceeded. The Alarm/Trip Setpoints of these channels shall be adjusted to the values determined in accordance with the methodology and parameters in the ODCM.

3.2 Technical Specification 3.11.2.1

The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY shall be limited to the following:

a. For noble gases: Less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin, and

b. For Iodine - 131 and 133, for tritium, and for all radionuclides in particulate form with half lives greater than 8 days: Less than or equal to 1500 mrem/yr. to any organ, from the inhalation pathway only.

3.3 Gaseous Effluent Monitors

Noble gas activity monitors, iodine monitors, and particulate monitors are present on the containment building ventilation system, plant unit ventilation system, and radwaste building ventilation system.

The alarm/trip (alarm & trip) setpoint for any gaseous effluent radiation monitor is determined based on the instantaneous noble gas total body and skin dose rate limits of Technical Specification 3.11.2.1, at the SITE BOUNDARY location with the highest annual average X/Q value. (Figure 5.1B)

Each monitor channel is provided with a two level system which provides sequential alarms on increasing radioactivity levels. These setpoints are designated as alert setpoints and alarm/trip setpoints. (Ref. 9.6.3)

The radiation monitor alarm/trip setpoints for each release point are based on the radioactive noble gases in gaseous effluents. It is not considered practicable to apply instantaneous alarm/trip setpoints to integrating radiation monitors sensitive to radioiodines, radioactive materials in particulate form and radionuclides other than noble gases. Conservative assumptions may be necessary in establishing setpoints to account for system variables, such as the measurement system efficiency and detection capabilities during normal, anticipated, and unusual operating conditions, the variability in release flow and principal radionuclides, and the time lag between alarm/trip action and the final isolation of the radioactive effluent. (Ref. 9.8.6.) Technical Specifications Table 4.3-13 provides the instrument surveillance requirements, such as calibration, source checking, functional testing, and channel checking.

3.3.1 Continuous Release Gaseous Effluent Monitors

The radiation detection monitors associated with continuous gaseous effluent releases are (Ref. 9.6.8, 9.6.9):

Monitor I.D.	Description
GT-RE-21	Unit Vent
GH-RE-10	Radwaste Building Vent

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

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

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

The sample extracted by the isokinetic nozzle is passed through the fixed filter (particulate), charcoal filter (iodine), and fixed-volume (gaseous) detector assemblies and then through the pumping system for discharge back to the unit vent. Indication is provided on the radioactivity monitoring system CRT in the control room.

The Radwaste Building Ventilation effluent monitor continuously monitors for particulate, halogen, and gaseous radioactivity in the effluent duct downstream of the exhaust filter and fans. The sample point is located downstream of the last possible point of radioactive influent, including the waste gas decay tank discharge line. The flow path provides ventilation exhaust for all parts of the building structure and components within the building and provides a discharge path for the waste gas decay tank release line. These components represent potential sources for the release of gaseous and air particulate and iodine activities in addition to the drainage sumps, tanks, and equipment purged by the waste processing system.

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

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

This monitor will isolate the waste gas decay tank discharge line if the radioactivity release rate is above

the present limit when the waste gas discharge valve has been deliberately or inadvertently opened.

The continuous gaseous effluent monitor setpoints are established using the methodology described in Section 3.4. Since there are two continuous gaseous effluent release points, a fraction of the total MPC will be allocated to each release point. Neglecting the batch releases, the plant Unit Vent monitor has been allocated 0.7 MPC and the Radwaste Building Vent monitor has been allocated 0.3 MPC. These will be changed as required, but limited to 1 MPC. Therefore, a particular monitor reaching the fractional MPC setpoint would not necessarily mean the MPC limit at the site boundary is being exceeded. The alarm only indicates that the specific release point is contributing a greater fraction of the MPC limit than was allocated to the associated monitor and will necessitate an evaluation of both systems.

3.3.2 Batch Release Gaseous Monitors

The radiation monitors associated with batch release gaseous effluents are (Ref. 9.6.9, 9.6.10, 9.6.11):

Monitor I.D.	Description
GT-RE-22 GT-RE-33	Containment Purge System Monitors
GT-RE-31 GT-RE-32	Containment Atmosphere Radioactivity Monitors
GH-RE-10	Radwaste Building Vent

The Containment Purge System continuously monitors the containment purge exhaust duct during purge operations for particulate, iodine, and gaseous radioactivity. The purpose of these monitors is to isolate the containment purge system on high gaseous activity via the ESFAS. These monitors also serve as backup indication for personnel protection and reactor coolant pressure boundary leakage detection for the containment atmosphere radioactivity monitors.

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

Each monitor is provided with two isokinetic nozzles to ensure that representative samples are obtained for both normal purge and minipurge flow rates. The sample is extracted through the selected nozzle and then passed through the selector valve, the fixed filter (particulate), charcoal filter (iodine), and fixed-volume gaseous detectors. The sample then passes through the pumping system and is discharged back to the duct.

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

The Containment Atmosphere Radioactivity monitors, continuously monitor the containment atmosphere for particulate, iodine, and gaseous radioactivity. They isolate the containment purge system on high gaseous activity via the ESFAS. These monitors also serve for reactor coolant pressure boundary leakage detection and for personnel protection. The containment atmosphere radioactivity monitors provide backup indication for the containment purge monitors.

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

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

The Radwaste Building Vent monitors are described in Section 3.3.1.

The batch gaseous effluent monitors setpoints are normally established using the methodology described in Section 3.4.

A pre-release isotopic analysis is performed for each batch release to determine the identity and quantity of the principal radionuclides. The alarm/trip setpoint(s) are adjusted accordingly to ensure that the limits of Radiological Effluent Technical Specification 3.11.2.1 are not exceeded.

3.4 ODCM Methodology for the Determination of Gaseous Effluent Monitor Setpoints

3.4.1 Development of ODCM Methodology for the Determination of Gaseous Effluent Monitor Setpoints

The alarm/trip setpoint for gaseous effluent monitors is determined based on the lesser of the total body dose rate and skin dose rate, as calculated for the SITE BOUNDARY.

3.4.1.1 Total Body Dose Rate Setpoint Calculations

To ensure that the limits of Technical Specification 3.11.2.1 are met, the alarm/trip setpoint based on the total body dose rate is calculated according to:

$$S_{tb} \leq D_{tb} R_{tb} F_s F_a \qquad (3.1)$$

Where:

S_{tb} = the alarm/trip setpoint based on the total body dose rate (μCi/cc).

D_{tb} = Technical Specification 3.11.2.1 limit of 500 mrem/yr, conservatively interpreted as a continuous release over a one year period.

F_s = the safety factor; a conservative factor used to compensate for statistical fluctuations and errors of measurement. (For example, $F_s = 0.5$ corresponds to a 100% variation.) Default value is $F_s = 1.0$.

F_a = the allocation factor which will modify the required dilution factor such that simultaneous gaseous releases may be made without exceeding the limits of Radiological

Effluent Technical Specification 3.11.2.1. The default value is 1/n, where n is the number of pathways planned for release.

R_{tb} = factor used to convert dose rate to the effluent concentration as measured by the effluent monitor, in (μCi/cc) per (mrem/yr) to the total body, determined according to:

$$R_{tb} = C \div [(\overline{X/Q}) \sum_i K_i Q_i] \quad (3.2)$$

Where:

C = monitor reading of a noble gas monitor corresponding to the sample radionuclide concentrations for the batch to be released. Concentrations are determined in accordance with Technical Specifications Table 4.11-2. The mixture of radionuclides determined via grab sampling of the effluent stream or source is correlated to a calibration factor to determine monitor response. The monitor response is based on concentrations, not release rate, and is in units of (μCi/cc).

$\overline{X/Q}$ = the highest calculated annual average relative concentration for any area at or beyond the SITE BOUNDARY in (sec/m^3). Refer to Tables 9, 10, and 12.

K_i = the total body dose factor due to gamma emissions for each identified noble gas radionuclide, in (mrem/yr) per ($\mu Ci/m^3$). (Table 3)

Q_i = rate of release of noble gas radionuclide, i, in (μCi/sec).

Q_i is calculated as the product of the ventilation path design flow rate and the measured activity of the effluent stream as determined by grab sampling. Flow rates for the ventilation pathways can be found in references 9.6.21, 9.6.22, 9.6.23, and 9.6.24.

3.4.1.2 Skin Dose Rate Setpoint Calculation

To ensure that the limits of Technical Specification 3.11.2.1 are met, the alarm/trip setpoint based on the skin dose rate is calculated according to:

$$S_s \leq D_s R_s F_s F_a \qquad (3.3)$$

Where:

F_s and F_a are as previously defined in Section 3.4.1.1.

S_s = the alarm/trip setpoint based on the skin dose rate.

D_s = Technical Specification 3.11.2.1 limit of 3000 mrem/yr, conservatively interpreted as a continuous release over a one year period.

R_s = factor used to convert dose rate to the effluent concentration as measured by the effluent monitor, in (μCi/cc) per (mrem/yr) to the skin, determined according to:

$$R_s = C \div [(\overline{X/Q}) \sum_i (L_i + 1.1M_i) Q_i] \quad (3.4)$$

Where:

L_i = the skin dose factor due to beta emissions for each identified noble gas radionuclide, in (mrem/yr) per ($\mu Ci/m^3$). (Table 3)

1.1 = conversion factor: 1 mrad air dose = 1.1 mrem skin dose.

M_i = the air dose factor due to gamma emissions for each identified noble gas radionuclide, in (mrad/yr) per ($\mu Ci/m^3$). (Table 3)

C, $(\overline{X/Q})$ and Q_i are as previously defined.

3.4.1.3 Gaseous Effluent Monitors Setpoint Determination

The results of Equation (3.1) and Equation (3.3) are compared. The setpoint is then selected as the lesser of the two values.

TABLE 3

DOSE FACTORS FOR EXPOSURE TO A SEMI-INFINITE CLOUD OF NOBLE GASES[a]

Radionuclide	Total Body Dose Factor K_i (mrem/yr) per (μCi/m³)	Skin Dose Factor L_i (mrem/yr) per (μCi/m³)	Gamma Air Dose Factor M_i (mrad/yr) per (μCi/m³)	Beta Air Dose Factor N_i (mrad/yr) per (μCi/m³)
Kr-83m	7.56 E-02	- - -	1.93 E+01	2.88 E+02
Kr-85m	1.17 E+03	1.46 E+03	1.23 E+03	1.97 E+03
Kr-85	1.61 E+01	1.34 E+03	1.72 E+01	1.95 E+03
Kr-87	5.92 E+03	9.73 E+03	6.17 E+03	1.03 E+04
Kr-88	1.47 E+04	2.37 E+03	1.52 E+04	2.93 E+03
Kr-89	1.66 E+04	1.01 E+04	1.73 E+04	1.06 E+04
Kr-90	1.56 E+04	7.29 E+03	1.63 E+04	7.83 E+03
Xe-131m	9.15 E+01	4.76 E+02	1.56 E+02	1.11 E+03
Xe-133m	2.51 E+02	9.94 E+02	3.27 E+02	1.48 E+03
Xe-133	2.94 E+02	3.06 E+02	3.53 E+02	1.05 E+03
Xe-135m	3.12 E+03	7.11 E+02	3.36 E+03	7.39 E+02
Xe-135	1.81 E+03	1.86 E+03	1.92 E+03	2.46 E+03
Xe-137	1.42 E+03	1.22 E+04	1.51 E+03	1.27 E+04
Xe-138	8.83 E+03	4.13 E+03	9.21 E+03	4.75 E+03
Ar-41	8.84 E+03	2.69 E+03	9.30 E+03	3.28 E+03

(a) The listed dose factors are derived from Reg. Guide 1.109, Table B-1 (Rev. 1, 1977).

3.4.2 Summary, Gaseous Effluent Monitors Setpoint Determination

The gaseous effluent monitors setpoints are calculated according to equations (3.1) and (3.3), as described in Section 3.4. However, it should be noted that a batch release will alter the flow rate characteristics at the Unit Vent and therefore the concentration as sensed by the monitor. For example, in the case of a mini-purge, the setpoint for the Unit Vent monitor must be re-calculated to include both the continuous and batch sources.

3.5 ODCM Methodology for Determining Dose Contributions From Gaseous Effluents

Dose rate calculations are performed for gaseous effluents to ensure compliance with Radiological Effluent Technical Specification 3.11.2.1 as stated in Section 3.2.

3.5.1 Determination of Dose Rate

The following methodology is applicable to the location (SITE BOUNDARY or beyond) characterized by the values of the parameter (X/Q) which results in the maximum total body or skin dose rate. In the event that the analysis indicates a different location for the total body and skin dose limitations, the location selected for consideration is that which minimizes the allowable release values. (Ref. 9.8.7)

The factors K_i, L_i, and M_i relate the radionuclide airborne concentrations to various dose rates, assuming a semi-infinite cloud model, and are tabulated in Table 3.

3.5.1.1 Noble Gases

The release rate limit for noble gases is determined according to the following general relationships (Ref. 9.8.7):

$$D_{tb} = \sum_i [K_i((\overline{X/Q})Q_i)] \leq 500 \text{ mrem/yr} \qquad (3.5)$$

$$D_s = \sum_i [(L_i + 1.1\ M_i)((\overline{X/Q})Q_i)] \leq 3000 \text{ mrem/yr} \qquad (3.6)$$

Where:

D_{tb} = Total body dose rate, conservatively averaged over a period of one year.

K_i = Total body dose factor due to gamma emissions for each identified noble gas radionuclide, in (mrem/yr) per ($\mu Ci/m^3$). (Table 3)

$(\overline{X/Q})$ = The highest calculated annual average relative concentration for any area at or beyond the SITE BOUNDARY. Refer to Tables 9, 10, and 12.

Q_i = The release rate of noble gas radionuclides, i, in gaseous effluents, from all vent releases in ($\mu Ci/sec$).

Q_i is calculated as the product of the ventilation path design flow rate and the measured activity of the effluent stream as determined by grab sampling. Flow rates for the ventilation pathways can be found in references 9.6.21, 9.6.22, 9.6.23, and 9.6.24.

D_s = Skin dose rate, conservatively averaged over a period of one year.

L_i = Skin dose factor due to beta emissions for each identified noble gas radionuclide, in (mrem/yr) per ($\mu Ci/m^3$) (Table 3).

1.1 = Units conversion factor; 1 mrad air dose = 1.1 mrem skin dose.

M_i = Air dose factor due to gamma emissions for each identified noble gas radionuclide, in (mrad/yr) per ($\mu Ci/m^3$) (Table 3).

3.5.1.2 Radionuclides Other Than Noble Gases

The release rate limit for Iodine-131 and-133, for tritium, and for all radioactive materials in particulate form with half lives greater than 8 days is determined according to (Ref. 9.8.8):

$$D_o = \sum_i P_i[(\overline{X/Q})Q_i] \leq 1500 \text{ mrem/yr} \qquad (3.7)$$

Where:

D_o = Dose rate to any critical organ, in (mrem/yr).

P_i = Dose parameter for radionuclides other than noble gases for the inhalation pathway for the child, based on the critical organ, in (mrem/yr) per ($\mu Ci/m^3$). (Table 4)

Q_i = The release rate of radionuclide, i, in gaseous effluents, from all vent releases, in ($\mu Ci/sec$). Q_i is calculated as the product of the ventilation path design flow rate and the measured activity of the effluent stream as determined by grab sampling. Flow rates for the ventilation pathways can be found in references 9.6.21, 9.6.22, 9.6.23, and 9.6.24.

$(\overline{X/Q})$ is as previously defined.

The dose parameter (P_i) includes the internal dosimetry of radionuclide, i, and the receptor's breathing rate, which are functions of the receptor's age. Therefore the child age group has been selected as the limiting age group.

For the child exposure, separate values of P_i are tabulated in Table 4 for the inhalation pathway. These values were calculated according to (Ref. 9.8.9):

$$P_i = K' (BR) DFA_i \quad (3.8)$$

Where:

K' = Units conversion factor: 1μCi = 1E06 pCi.

BR= The breathing rate of the maximum exposed child age group, 3700 m^3/yr. (Regulatory Guide 1.109, Table E-5).

DFA_i = The maximum organ inhalation dose factor for the child age group for the ith radionuclide, in (mrem/pCi). The total body is considered as an organ in the selection of DFA_i. (Regulatory Guide 1.109, Table E-9)

Note: All radioiodines are assumed to be released in elemental form. (Ref.9.8.8)

TABLE 4

DOSE PARAMETER (P_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES [a]

Inhalation Pathway

(mrem/yr) per ($\mu Ci/m^3$)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	1.12E3	1.12E3	1.12E3	1.12E3	1.12E3	1.12E3
C-14	3.59E4	6.73E3	6.73E3	6.73E3	6.73E3	6.73E3	6.73E3
Na-24	1.61E4	1.61E4	1.61E4	1.61E4	1.61E4	1.61E4	1.61E4
P-32	2.60E6	1.14E5	9.88E4	ND	ND	ND	4.22E4
Cr-51	ND	ND	1.54E2	8.55E1	2.43E1	1.70E4	1.08E3
Mn-54	ND	4.29E4	9.51E3	ND	1.00E4	1.58E6	2.29E4
Mn-56	ND	1.66E0	3.12E-1	ND	1.67E0	1.31E4	1.23E5
Fe-55	4.74E4	2.52E4	7.72E3	ND	ND	1.11E5	2.87E3
Fe-59	2.07E4	3.34E4	1.67E4	ND	ND	1.27E6	7.07E4
Co-58	ND	1.77E3	3.16E3	ND	ND	1.11E6	3.44E4
Co-60	ND	1.31E4	2.26E4	ND	ND	7.07E6	9.26E4
Ni-63	8.21E5	4.63E4	2.80E4	ND	ND	2.75E5	6.33E3
Ni-65	2.99E0	2.96E-1	1.64E-1	ND	ND	8.18E3	8.40E4
Cu-64	ND	1.99E0	1.07E0	ND	6.03E0	9.58E3	3.67E4
Zn-65	4.26E4	1.13E5	7.03E4	ND	7.14E4	9.95E5	1.63E4
Zn-69	6.70E-2	9.66E-2	8.92E-3	ND	5.85E-2	1.42E3	1.02E4
Br-83	ND	ND	4.74E2	ND	ND	ND	0
Br-84	ND	ND	5.48E2	ND	ND	ND	0
Br-85	ND	ND	2.53E1	ND	ND	ND	0
Rb-86	ND	1.98E5	1.14E5	ND	ND	ND	7.99E3
Rb-88	ND	5.62E2	3.66E2	ND	ND	ND	1.72E1
Rb-89	ND	3.45E2	2.90E2	ND	ND	ND	1.89E0
Sr-89	5.99E5	ND	1.72E4	ND	ND	2.16E6	1.67E5
Sr-90	1.01E8	ND	6.44E6	ND	ND	1.48E7	3.43E5
Sr-91	1.21E2	ND	4.59E0	ND	ND	5.33E4	1.74E5

TABLE 4 (Cont'd.)

DOSE PARAMETER (P_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES [a]

Inhalation Pathway

(mrem/yr) per ($\mu Ci/m^3$)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
Sr-92	1.31E1	ND	5.25E-1	ND	ND	2.40E4	2.42E5
Y-90	4.11E3	ND	1.11E2	ND	ND	2.62E5	2.68E5
Y-91m	5.07E-1	ND	1.84E-2	ND	ND	2.81E3	1.72E3
Y-91	9.14E3	ND	2.44E4	ND	ND	2.63E6	1.84E5
Y-92	2.04E1	ND	5.81E-1	ND	ND	2.39E4	2.39E5
Y-93	1.86E2	ND	5.11E0	ND	ND	7.44E4	3.89E5
Zr-95	1.90E5	4.18E4	3.70E4	ND	5.96E4	2.23E6	6.11E4
Zr-97	1.88E2	2.72E1	1.60E1	ND	3.89E1	1.13E5	3.51E5
Nb-95	2.33E4	9.18E3	6.55E3	ND	8.62E3	6.14E5	3.70E4
Mo-99	ND	1.72E2	4.26E1	ND	3.92E2	1.35E5	1.27E5
Tc-99m	1.78E-3	3.48E-3	5.77E-2	ND	5.07E-2	9.51E2	4.81E3
Tc-101	8.10E-5	8.51E-5	1.08E-3	ND	1.45E-3	5.85E2	1.63E1
Ru-103	2.79E3	ND	1.07E3	ND	7.03E3	6.62E5	4.48E4
Ru-105	1.53E0	ND	5.55E-1	ND	1.34E0	1.59E4	9.95E4
Ru-106	1.36E5	ND	1.69E4	ND	1.84E5	1.43E7	4.29E5
Ag-110m	1.69E4	1.14E4	9.14E3	ND	2.12E4	5.48E6	1.00E5
Te-125m	6.73E3	2.33E3	9.14E2	1.92E3	ND	4.77E5	3.38E4
Te-127m	2.49E4	8.55E3	3.02E3	6.07E3	6.36E4	1.48E6	7.14E4
Te-127	2.77E0	9.51E-1	6.11E-1	1.96E0	7.07E0	1.00E4	5.62E4
Te-129m	1.92E4	6.85E3	3.04E3	6.33E3	5.03E4	1.76E6	1.82E5
Te-129	9.77E-2	3.50E-2	2.38E-2	7.14E-2	2.57E-1	2.93E3	2.55E4
Te-131m	1.34E2	5.92E1	5.07E1	9.77E1	4.00E2	2.06E5	3.08E5
Te-131	2.17E-2	8.44E-3	6.59E-3	1.70E-2	5.88E-2	2.05E3	1.33E3
Te-132	4.81E2	2.72E2	2.63E2	3.17E2	1.77E3	3.77E5	1.38E5
I-130	8.18E3	1.64E4	8.44E3	1.85E6	2.45E4	ND	5.11E3

TABLE 4 (Cont'd.)

DOSE PARAMETER (P_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES [a]

Inhalation Pathway

(mrem/yr) per ($\mu Ci/m^3$)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
I-131	4.81E4	4.81E4	2.73E4	1.62E7	7.88E4	ND	2.84E3
I-132	2.12E3	4.07E3	1.88E3	1.94E5	6.25E3	ND	3.20E3
I-133	1.66E4	2.03E4	7.70E3	3.85E6	3.38E4	ND	5.48E3
I-134	1.17E3	2.16E3	9.95E2	5.07E4	3.30E3	ND	9.55E2
I-135	4.92E3	8.73E3	4.14E3	7.92E5	1.34E4	ND	4.44E3
Cs-134	6.51E5	1.01E6	2.25E5	ND	3.03E5	1.21E5	3.85E3
Cs-136	6.51E4	1.71E5	1.16E5	ND	9.55E4	1.45E4	4.18E3
Cs-137	9.07E5	8.25E5	1.28E5	ND	2.72E5	1.04E5	3.62E3
Cs-138	6.33E2	8.40E2	5.55E2	ND	6.22E2	6.81E1	2.70E2
Ba-139	1.84E0	9.84E-4	5.37E-2	ND	8.62E-4	5.77E3	5.77E4
Ba-140	7.40E4	6.48E1	4.33E3	ND	2.11E1	1.74E6	1.02E5
Ba-141	2.19E-1	1.09E-4	6.36E-3	ND	9.47E-5	2.92E3	2.75E2
Ba-142	5.00E-2	3.60E-5	2.79E-3	ND	2.91E-5	1.64E3	2.74E0
La-140	6.44E2	2.25E2	7.55E1	ND	ND	1.83E5	2.26E5
La-142	1.30E0	4.11E-1	1.29E-1	ND	ND	8.70E3	7.59E4
Ce-141	3.92E4	1.95E4	2.90E3	ND	8.55E3	5.44E5	5.66E4
Ce-143	3.66E2	1.99E2	2.87E1	ND	8.36E1	1.15E5	1.27E5
Ce-144	6.77E6	2.12E6	3.61E5	ND	1.17E6	1.20E7	3.89E5
Pr-143	1.85E4	5.55E3	9.14E2	ND	3.00E3	4.33E5	9.73E4
Pr-144	5.96E-2	1.85E-2	3.00E-3	ND	9.77E-3	1.57E3	1.97E2
Nd-147	1.08E4	8.73E3	6.81E2	ND	4.81E3	3.28E5	8.21E4
W-187	1.63E1	9.66E0	4.33E0	ND	ND	4.11E4	9.10E4
Np-239	4.66E2	3.34E1	2.35E1	ND	9.73E1	5.81E4	6.40E4

(a) The child age group determination; Table E-9 Reg. Guide 1.109, Rev. 1, 1977

3.5.2 Individual Dose Due To Gaseous Effluents

3.5.2.1 Technical Specification 3.11.2.2

The air dose due to noble gases released in gaseous effluents, to areas at and beyond the SITE BOUNDARY shall be limited to the following:

a. During any calendar quarter: Less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation and,

b. During any calendar year: Less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

3.5.2.1.1 Noble Gases

The air dose at the SITE BOUNDARY due to noble gases released from the site is determined according to the following methodology (Ref. 9.8.10):

During any calendar quarter, for gamma radiation:

$$D_g = 3.17 \text{ E-08} \sum_i [M_i \{(\overline{X/Q}) Q_i + (X/q) q_i\}] \leq 5 \text{ mrad} \quad (3.9)$$

During any calendar quarter, for beta radiation:

$$D_b = 3.17 \text{ E-08} \sum_i [N_i \{(\overline{X/Q}) Q_i + (X/q) q_i\}] \leq 10 \text{ mrad} \quad (3.10)$$

During any calendar year, for gamma radiation:

$$D_g = 3.17 \text{ E-08} \sum_i [M_i \{(\overline{X/Q}) Q_i + (X/q) q_i\}] \leq 10 \text{ mrad} \quad (3.11)$$

During any calendar year, for beta radiation:

$$D_b = 3.17 \text{ E-08} \sum_i [N_i \{(\overline{X/Q}) Q_i + (X/q) q_i\}] \leq 20 \text{ mrad} \quad (3.12)$$

Where:

D_g = Air dose from gamma radiation due to noble gases released in gaseous effluent.

D_b = Air dose from beta radiation due to noble gases released in gaseous effluents.

(X/q) = The relative concentration for areas at or beyond the SITE BOUNDARY for short-term releases (equal to or less than 500 hrs/year). Refer to Tables 9, 10, 11, and 12.

q_i = The average release of noble gas radionuclides, i, in gaseous effluents from all vent releases for short-term releases (equal to or less than 500 hrs/year), in (µCi). Releases are cumulative over the calendar quarter or year, as appropriate.

N_i = The air dose factor due to beta emissions for each identified noble gas radionuclide, i, in (mrad/yr) per (µCi/m³). (Table 3)

Q_i = The average release of noble gas radionuclides, i, in gaseous effluents from all vent releases for long-term releases (greater than 500 hrs/year), in (µCi). Releases are cumulative over the calendar quarter or year, as appropriate.

$(\overline{X/Q})$ = The highest calculated annual average relative concentration for areas at or beyond the SITE BOUNDARY for long-term releases (greater than 500 hrs/yr). Refer to Tables 9, 10, and 12.

3.17E-08 = The inverse of the number of seconds per year.

M_i is as previously defined. (Refer to Section 3.4.1.2)

3.5.2.2 Technical Specification 3.11.2.3

The dose to a MEMBER OF THE PUBLIC from Iodine-131 and 133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released, to areas at and beyond the SITE BOUNDARY shall be limited to the following (Ref. 9.8.10):

a. During any calendar quarter: Less than or equal to 7.5 mrem to any organ and,

b. During any calendar year: Less than or equal to 15 mrem to any organ.

3.5.2.2.1 Radionuclides Other Than Noble Gases

The dose to a MEMBER OF THE PUBLIC from Iodine-131 and 133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released, to areas at and beyond the SITE BOUNDARY, is determined according to the following expressions:

During any calendar quarter:

$$D_i = 3.17E\text{-}08 \sum_i R_i [W Q_i + w q_i] \leq 7.5 \text{ mrem} \qquad (3.13)$$

During any calendar year:

$$D_i = 3.17E\text{-}08 \sum_i R_i [W Q_i + w q_i] \leq 15 \text{ mrem} \qquad (3.14)$$

Where:

D_i = Dose to a MEMBER OF THE PUBLIC from radionuclides other than noble gases.

Q_i = The releases of radionuclides, radioactive materials in particulate form, and radionuclides other than noble gases, i, in gaseous effluents, for all vent releases for long-term releases (greater than 500 hrs/yr), in (uCi).

Releases are cumulative over the calendar quarter or year as appropriate.

q_i = The releases of radionuclides, radioactive materials in particulate form and radionuclides other than noble gases, i, in gaseous effluents for all vent releases for short-term releases (equal to or less than 500 hrs/yr), in (μCi). Releases are cumulative over the calendar quarter or year as appropriate.

R_i = The dose factor for each identified radionuclide, i, in m^2(mrem/yr) per (μCi/sec) or (mrem/yr) per (μCi/m^3). (Table 5)

W = The dispersion parameter for estimating the dose to an individual at the controlling location for long-term releases (greater than 500 hrs/yr):

W = $(\overline{X/Q})$ for the inhalation and tritium pathways, in(sec/m^3).

W = $(\overline{D/Q})$ for the food and ground plane pathways, in(meters^{-2}). Refer to Tables 9, 10, and 12.

w = The dispersion parameter for estimating the dose to an individual at the controlling location for short-term releases (equal to or less than 500 hrs/yr):

w = (X/q) for the inhalation pathway, in(sec/m^3)

w = (D/q) for the food and ground plane pathway, in (meters^{-2}). Refer to Tables 9, 10, 11, and 12.

3.17 E-08 = The inverse of the number of seconds per year.

$(\overline{D/Q})$ = the average relative deposition of the effluent at or beyond the SITE BOUNDARY, considering depletion of the plume during transport, for long term releases (greater than 500 hrs/yr), in (meters^{-2}).

(D/q) = the relative deposition of the effluent at or beyond the SITE BOUNDARY, considering depletion of the plume during transport, for short term releases (less than or equal to 500 hrs/yr), in ($meters^{-2}$).

Note: For the direction sectors with existing pathways within 5 miles from the site, the appropriate R_i values are used. If no real pathway exists within 5 miles from the center of the building complex, the cow-milk R_i value is used, and it is assumed that this pathway exists at the 4.5 to 5.0 mile distance in the limiting-case sector. If the R_i for an existing pathway within 5 miles is less than a cow-milk R_i at 4.5 to 5.0 miles, then the value of the cow-milk R_i at 4.5 to 5.0 miles is used. (Rev. 9.8.10.)

Although the annual average relative concentration (X/Q) and the average relative deposition rate (D/Q) are generally considered to be at the approximate receptor location in lieu of the SITE BOUNDARY for these calculations, it is acceptable to consider the ingestion, inhalation, and ground plane pathways to coexist at the location of the nearest residence with the highest value of (X/Q). (Ref. 9.8.10) The Total Body dose from ground plane deposition is added to the dose for each individual organ. (Ref. 9.11.3)

TABLE 5

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

Inhalation Pathway

(mrem/yr) per ($\mu Ci/m^3$)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	1.12E3	1.12E3	1.12E3	1.12E3	1.12E3	1.12E3
C-14	3.59E4	6.73E3	6.73E3	6.73E3	6.73E3	6.73E3	6.73E3
Na-24	1.61E4	1.61E4	1.61E4	1.61E4	1.61E4	1.61E4	1.61E4
P-32	2.60E6	1.14E5	9.88E4	ND	ND	ND	4.22E4
Cr-51	ND	ND	1.54E2	8.55E1	2.43E1	1.70E4	1.08E3
Mn-54	ND	4.29E4	9.51E3	ND	1.00E4	1.58E6	2.29E4
Mn-56	ND	1.66E0	3.12E-1	ND	1.67E0	1.31E4	1.23E5
Fe-55	4.74E4	2.52E4	7.72E3	ND	ND	1.11E5	2.87E3
Fe-59	2.07E4	3.34E4	1.67E4	ND	ND	1.27E6	7.07E4
Co-58	ND	1.77E3	3.16E3	ND	ND	1.11E6	3.44E4
Co-60	ND	1.31E4	2.26E4	ND	ND	7.07E6	9.26E4
Ni-63	8.21E5	4.63E4	2.80E4	ND	ND	2.75E5	6.03E3
Ni-65	2.99E0	2.96E-1	1.64E-1	ND	ND	8.18E3	8.40E4
Cu-64	ND	1.99E0	1.07E0	ND	6.03E0	9.58E3	3.67E4
Zn-65	4.26E4	1.13E5	7.03E4	ND	7.14E4	9.95E5	1.63E4
Zn-69	6.70E-2	9.66E-2	8.92E-3	ND	5.85E-2	1.42E3	1.02E4
Br-83	ND	ND	4.74E2	ND	ND	ND	0
Br-84	ND	ND	5.48E2	ND	ND	ND	0
Br-85	ND	ND	2.53E1	ND	ND	ND	0
Rb-86	ND	1.98E5	1.14E5	ND	ND	ND	7.99E3
Rb-88	ND	5.62E2	3.66E2	ND	ND	ND	1.72E1
Rb-89	ND	3.45E2	2.90E2	ND	ND	ND	1.89E0
Sr-89	5.99E5	ND	1.72E4	ND	ND	2.16E6	1.67E5
Sr-90	1.01E8	ND	6.44E6	ND	ND	1.48E7	3.43E5
Sr-91	1.21E2	ND	4.59E0	ND	ND	5.33E4	1.74E5

TABLE 5 (Cont'd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

Inhalation Pathway

(mrem/yr) per ($\mu Ci/m^3$)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
Sr-92	1.31E1	ND	5.25E-1	ND	ND	2.40E4	2.42E5
Y-90	4.11E3	ND	1.11E2	ND	ND	2.62E5	2.68E5
Y-91m	5.07E-1	ND	1.84E-2	ND	ND	2.81E3	1.72E3
Y-91	9.14E5	ND	2.44E4	ND	ND	2.63E6	1.84E5
Y-92	2.04E1	ND	5.81E-1	ND	ND	2.39E4	2.39E5
Y-93	1.86E2	ND	5.11E0	ND	ND	7.44E4	3.89E5
Zr-95	1.90E5	4.18E4	3.70E4	ND	5.96E4	2.23E6	6.11E4
Zr-97	1.88E2	2.72E1	1.60E1	ND	3.89E1	1.13E5	3.51E5
Nb-95	2.33E4	9.18E3	6.55E3	ND	8.62E3	6.14E5	3.70E4
Mo-99	ND	1.72E2	4.26E1	ND	3.92E2	1.35E5	1.27E5
Tc-99m	1.78E-3	3.48E-3	5.77E-2	ND	5.07E-2	9.51E2	4.81E3
Tc-101	8.10E-5	8.51E-5	1.08E-3	ND	1.45E-3	5.85E2	1.63E1
Ru-103	2.79E3	ND	1.07E3	ND	7.03E3	6.62E5	4.48E4
Ru-105	1.53E0	ND	5.55E-1	ND	1.34E0	1.59E4	9.95E4
Ru-106	1.36E5	ND	1.69E4	ND	1.84E5	1.43E7	4.29E5
Ag-110m	1.69E4	1.14E4	9.14E3	ND	2.12E4	5.48E6	1.00E5
Te-125m	6.73E3	2.33E3	9.14E2	1.92E3	ND	4.77E5	3.38E4
Te-127m	2.49E4	8.55E3	3.02E3	6.07E3	6.36E4	1.48E6	7.14E4
Te-127	2.77E0	9.51E-1	6.11E-1	1.96E0	7.07E0	1.00E4	5.62E4
Te-129m	1.92E4	6.85E3	3.04E3	6.33E3	5.03E4	1.76E6	1.82E5
Te-129	9.77E-2	3.50E-2	2.38E-2	7.14E-2	2.57E-1	2.93E3	2.55E4
Te-131m	1.34E2	5.92E1	5.07E1	9.77E1	4.00E2	2.06E5	3.08E5
Te-131	2.17E-2	8.44E-3	6.59E-3	1.70E-2	5.88E-2	2.05E3	1.33E3
Te-132	4.81E2	2.72E2	2.63E2	3.17E2	1.77E3	3.77E5	1.38E5
I-130	8.18E3	1.64E4	8.44E3	1.85E6	2.45E4	ND	5.11E3

TABLE 5 (Cont'd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

Inhalation Pathway

(mrem/yr) per ($\mu Ci-m^3$)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
I-131	4.81E4	4.81E4	2.73E4	1.62E7	7.88E4	ND	2.84E3
I-132	2.12E3	4.07E3	1.88E3	1.94E5	6.25E3	ND	3.20E3
I-133	1.66E4	2.03E4	7.70E3	3.85E6	3.38E4	ND	5.48E3
I-134	1.17E3	2.16E3	9.95E2	5.07E4	3.30E3	ND	9.55E2
I-135	4.92E3	8.73E3	4.14E3	7.92E5	1.34E4	ND	4.44E3
Cs-134	6.51E5	1.01E6	2.25E5	ND	3.03E5	1.21E5	3.85E3
Cs-136	6.51E4	1.71E5	1.16E5	ND	9.55E4	1.45E4	4.18E3
Cs-137	9.07E5	8.25E5	1.28E5	ND	2.72E5	1.04E5	3.62E3
Cs-138	6.33E2	8.40E2	5.55E2	ND	6.22E2	6.81E1	2.70E2
Ba-139	1.84E0	9.84E-4	5.37E-2	ND	8.62E-4	5.77E3	5.77E4
Ba-140	7.40E4	6.48E1	4.33E3	ND	2.11E1	1.74E6	1.02E5
Ba-141	2.19E-1	1.09E-4	6.36E-3	ND	9.47E-5	2.92E3	2.75E2
Ba-142	5.00E-2	3.60E-5	2.79E-3	ND	2.91E-5	1.64E3	2.74E0
La-140	6.44E2	2.25E2	7.55E1	ND	ND	1.83E5	2.26E5
La-142	1.30E0	4.11E-1	1.29E-1	ND	ND	8.70E3	7.59E4
Ce-141	3.92E4	1.95E4	2.90E3	ND	8.55E3	5.44E5	5.66E4
Ce-143	3.66E2	1.99E2	2.87E1	ND	8.36E1	1.15E5	1.27E5
Ce-144	6.77E6	2.12E6	3.61E5	ND	1.17E6	1.20E7	3.89E5
Pr-143	1.85E4	5.55E3	9.14E2	ND	3.00E3	4.33E5	9.73E4
Pr-144	5.96E-2	1.85E-2	3.00E-3	ND	9.77E-3	1.57E3	1.97E2
Nd-147	1.08E4	8.73E3	6.81E2	ND	4.81E3	3.28E5	8.21E4
W-187	1.63E1	9.66E0	4.33E0	ND	ND	4.11E4	9.10E4
Np-239	4.66E2	3.34E1	2.35E1	ND	9.73E1	5.81E4	6.40E4

(a) The child age group determination; Table E-9 Reg. Guide 1.109, Rev. 1, 1977

TABLE 5 (Contd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

Ground Plane Pathway

(M^2 mrem/yr) per (μCi/sec)

Nuclide	Total Body	Skin
Na-24	1.19E7	1.39E7
Cr-51	4.65E6	5.51E6
Mn-54	1.39E9	1.63E9
Mn-56	9.03E5	1.07E6
Fe-59	2.72E8	3.20E8
Co-58	3.79E8	4.44E8
Co-60	2.15E10	2.53E10
Ni-65	2.97E5	3.45E5
Cu-64	6.07E5	6.88E5
Zn-65	7.47E8	8.59E8
Br-83	4.87E3	7.08E3
Br-84	2.03E5	2.36E5
Rb-86	8.99E6	1.03E7
Rb-88	3.31E4	3.78E4
Rb-89	1.23E5	1.48E5
Sr-89	2.16E4	2.51E4
Sr-91	2.15E6	2.51E6
Sr-92	7.77E5	8.63E5
Y-90	4.49E3	5.31E3
Y-91m	1.00E5	1.16E5
Y-91	1.07E6	1.21E6
Y-92	1.80E5	2.14E5
Y-93	1.83E5	2.51E5
Zr-95	2.45E8	2.84E8
Zr-97	2.96E6	3.44E6
Nb-95	1.37E8	1.61E8
Mo-99	3.98E6	4.62E6
Tc-99m	1.84E5	2.11E5
Tc-101	2.04E4	2.26E4
Ru-103	1.08E8	1.26E8
Ru-105	6.36E5	7.21E5
Ru-106	4.22E8	5.07E8
Ag-110m	3.44E9	4.01E9
Te-125m	1.55E6	2.13E6
Te-127m	9.16E4	1.08E5

TABLE 5 (Contd.)

Ground Plane Pathway

(M^2 mrem/yr) per (μCi/sec)

Nuclide	Total Body	Skin
Te-127	2.98E3	3.28E3
Te-129m	1.98E7	2.31E7
Te-129	2.62E4	3.10E4
Te-131m	8.03E6	9.46E6
Te-131	2.92E4	3.45E4
Te-132	4.23E6	4.98E6
I-130	5.51E6	6.69E6
I-131	1.72E7	2.09E7
I-132	1.23E6	1.45E6
I-133	2.45E6	2.98E6
I-134	4.47E5	5.30E5
I-135	2.51E6	2.93E6
Cs-134	6.86E9	8.00E9
Cs-136	1.53E8	1.74E8
Cs-137	1.03E10	1.20E10
Cs-138	3.59E5	4.10E5
Ba-139	1.06E5	1.19E5
Ba-140	2.05E7	2.35E7
Ba-141	4.15E4	4.73E4
Ba-142	4.44E4	5.06E4
La-140	1.92E7	2.18E7
La-142	7.40E5	8.89E5
Ce-141	1.37E7	1.54E7
Ce-143	2.31E6	2.63E6
Ce-144	6.96E7	8.04E7
Pr-144	1.84E3	2.11E3
Nd-147	8.41E6	1.01E7
W-187	2.36E6	2.74E6
Np-239	1.71E6	1.98E6

TABLE 5 (Contd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

MEAT PATHWAY

(m^2 mrem/yr) per (μCi/sec)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	2.34E2	2.34E2	2.34E2	2.34E2	2.34E2	2.34E2
C-14	3.83E8	7.67E7	7.67E7	7.67E7	7.67E7	7.67E7	7.67E7
Na-24	1.78E-3	1.78E-3	1.78E-3	1.78E-3	1.78E-3	1.78E-3	1.78E-3
P-32	7.41E9	3.47E8	2.86E8	ND	ND	ND	2.05E8
Cr-51	ND	ND	8.79E3	4.88E3	1.33E3	8.91E3	4.66E5
Mn-54	ND	8.01E6	2.13E6	ND	2.25E6	ND	6.72E6
Mn-56	ND	0	0	ND	0	ND	0
Fe-55	4.57E8	2.42E8	7.51E7	ND	ND	1.37E8	4.49E7
Fe-59	3.76E8	6.09E8	3.03E8	ND	ND	1.76E8	6.34E8
Co-58	ND	1.64E7	5.02E7	ND	ND	ND	9.58E7
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
Ni-65	0	0	0	ND	ND	ND	0
Cu-64	ND	2.97E-7	1.79E-7	ND	7.17E-7	ND	1.39E-5
Zn-65	3.75E8	1.00E9	6.22E8	ND	6.30E8	ND	1.76E8
Zn-69	0	0	0	ND	0	ND	0
Br-83	ND	ND	ND	ND	ND	ND	ND
Br-84	ND	ND	ND	ND	ND	ND	ND
Br-85	ND	ND	ND	ND	ND	ND	ND
Rb-86	ND	5.82E8	3.58E8	ND	ND	ND	3.74E7
Rb-88	ND	0	0	ND	ND	ND	0
Rb-89	ND	0	0	ND	ND	ND	0
Sr-89	4.82E8	ND	1.38E7	ND	ND	ND	1.86E7
Sr-90	1.04E10	ND	2.64E9	ND	ND	ND	1.40E8
Sr-91	2.40E-10	ND	0	ND	ND	ND	5.29E-10

TABLE 5 (Contd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

MEAT PATHWAY

(m^2 mrem/yr) per (uCi/sec)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
Sr-92	0	ND	0	ND	ND	ND	0
Y-90	1.71E2	ND	4.59E0	ND	ND	ND	4.88E5
Y-91m	0	ND	0	ND	ND	ND	0
Y-91	1.80E6	ND	4.82E4	ND	ND	ND	2.40E8
Y-92	0	ND	0	ND	ND	ND	0
Y-93	0	ND	0	ND	ND	ND	1.55E-7
Zr-95	2.66E6	5.85E5	5.21E5	ND	8.38E5	ND	6.11E8
Zr-97	3.20E-5	4.63E-6	2.73E-6	ND	6.65E-6	ND	7.02E-1
Nb-95	3.09E6	1.20E6	8.61E5	ND	1.13E6	ND	2.23E9
Mo-99	ND	1.15E5	2.84E4	ND	2.46E5	ND	9.51E4
Tc-99m	0	0	0	ND	0	0	0
Tc-101	0	0	0	ND	0	0	0
Ru-103	1.55E8	ND	5.96E7	ND	3.90E8	ND	4.01E9
Ru-105	0	ND	0	ND	0	ND	0
Ru-106	4.44E9	ND	5.54E8	ND	5.99E9	ND	6.90E10
Ag-110m	8.40E6	5.67E6	4.53E6	ND	1.06E7	ND	6.75E8
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-127	4.11E-10	1.11E-10	0	2.85E-10	1.17E-9	ND	1.61E-8
Te-129m	1.79E9	4.99E8	2.77E8	5.76E8	5.25E9	ND	2.18E9
Te-129	0	0	0	0	0	ND	0
Te-131m	7.00E2	2.42E2	2.58E2	4.98E2	2.34E3	ND	9.82E3
Te-131	0	0	0	0	0	ND	0
Te-132	2.09E6	9.26E5	1.12E6	1.35E6	8.60E6	ND	9.33E6
I-130	3.04E-6	6.13E-6	3.16E-6	6.76E-4	9.17E-6	ND	2.87E-6

TABLE 5 (Contd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

MEAT PATHWAY

(m^2 mrem/yr) per (μCi/sec)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
I-131	1.66E7	1.66E7	9.46E6	5.50E9	2.73E7	ND	1.48E6
I-132	0	0	0	0	0	ND	0
I-133	6.16E-1	7.61E-1	2.88E-1	1.41E2	1.27E0	ND	3.07E-1
I-134	0	0	0	0	0	ND	0
I-135	0	0	0	0	0	ND	0
Cs-134	9.22E8	1.51E9	3.19E8	ND	4.69E8	1.68E8	8.16E6
Cs-136	1.61E7	4.43E7	2.86E7	ND	2.36E7	3.51E6	1.56E6
Cs-137	1.33E9	1.28E9	1.88E8	ND	4.16E8	1.50E8	7.99E6
Cs-138	0	0	0	ND	0	0	0
Ba-139	0	0	0	ND	0	0	0
Ba-140	4.38E7	3.84E4	2.56E6	ND	1.25E4	2.29E4	2.22E7
Ba-141	0	0	0	ND	0	0	0
Ba-142	0	0	0	ND	0	0	0
La-140	5.69E-2	1.99E-2	6.70E-3	ND	ND	ND	5.54E2
La-142	0	0	0	ND	ND	ND	0
Ce-141	2.22E4	1.11E4	1.64E3	ND	4.85E3	ND	1.38E7
Ce-143	3.17E-2	1.72E1	2.49E-3	ND	7.21E-3	ND	2.52E2
Ce-144	2.32E6	7.26E5	1.24E5	ND	4.02E5	ND	1.89E8
Pr-143	3.35E4	1.00E4	1.66E3	ND	5.44E3	ND	3.61E7
Pr-144	0	0	0	ND	0	ND	0
Nd-147	1.17E4	9.50E3	7.35E2	ND	5.21E3	ND	1.50E7
W-187	3.35E-2	1.98E-2	8.91E-3	ND	ND	ND	2.79E0
Np-239	4.20E-1	3.02E-2	2.12E-2	ND	8.72E-2	ND	2.23E3

TABLE 5 (Contd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

Grass-Cow-Milk Pathway

(m^2 mrem/yr) per (μCi/sec)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
.	ND	1.57E3	1.57E3	1.57E3	1.57E3	1.57E3	1.57E3
C-14	1.19E9	2.39E8	2.39E8	2.39E8	2.39E8	2.39E8	2.39E8
Na-24	8.89E6	8.89E6	8.89E6	8.89E6	8.89E6	8.89E6	8.89E6
P-32	7.77E10	3.64E9	3.00E9	ND	ND	ND	2.15E9
Cr-51	ND	ND	1.03E5	5.65E4	1.56E4	1.04E5	5.40E6
Mn-54	ND	2.10E7	5.59E6	ND	5.88E6	ND	1.76E7
Mn-56	ND	1.29E-2	2.90E-3	ND	1.56E-2	ND	1.86E0
Fe-55	1.12E8	5.93E7	1.84E7	ND	ND	3.35E7	1.10E7
Fe-59	1.20E8	1.94E8	9.69E7	ND	ND	5.64E7	2.02E8
Co-58	ND	1.21E7	3.71E7	ND	ND	ND	7.07E7
Co-60	ND	4.32E7	1.27E8	ND	ND	ND	2.39E8
Ni-63	2.69E10	1.59E9	1.01E9	ND	ND	ND	1.07E8
Ni-65	1.[illegible]E0	1.56E-1	9.01E-2	ND	ND	ND	1.91E1
Cu-64	[illegible]	7.46E4	4.51E4	ND	1.80E5	ND	3.50E6
Zn-65	4.13E9	1.10E10	6.85E9	ND	6.94E9	ND	1.93E9
Zn-69	0	0	0	ND	0	ND	1.12E-9
Br-83	ND	ND	ND	ND	ND	ND	ND
Br-84	ND	ND	ND	ND	ND	ND	ND
Br-85	ND	ND	ND	ND	ND	ND	ND
Rb-86	ND	8.80E9	5.41E9	ND	ND	ND	5.66E8
Rb-88	ND	0	0	ND	ND	ND	0
Rb-89	ND	0	0	ND	ND	ND	0
Sr-89	6.62E9	ND	1.89E8	ND	ND	ND	2.56E8
Sr-90	1.12E11	ND	2.83E10	ND	ND	ND	1.51E9
Sr-91	1.30E5	ND	4.92E3	ND	ND	ND	2.88E5

TABLE 5 (Contd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

Grass-Cow-Milk Pathway

(m^2 mrem/yr) per (μCi/sec)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
Sr-92	2.18E0	ND	8.75E-2	ND	ND	ND	4.13E1
Y-90	3.22E2	ND	8.62E0	ND	ND	ND	9.17E5
Y-91m	0	ND	0	ND	ND	ND	0
Y-91	3.90E4	ND	1.04E3	ND	ND	ND	5.20E6
Y-92	2.53E-4	ND	7.24E-6	ND	ND	ND	7.31E0
Y-93	1.05E0	ND	2.90E-2	ND	ND	ND	1.57E4
Zr-95	3.83E3	8.42E2	7.50E2	ND	1.21E3	ND	8.79E5
Zr-97	1.92E0	2.77E-1	1.64E-1	ND	3.98E-1	ND	4.20E4
Nb-95	3.18E5	1.24E5	8.84E4	ND	1.16E5	ND	2.29E8
Mo-99	ND	8.14E7	2.01E7	ND	1.74E8	ND	6.73E7
Tc-99m	1.32E1	2.59E1	4.29E2	ND	3.76E2	1.32E1	1.47E4
Tc-101	0	0	0	ND	0	0	0
Ru-103	4.28E3	ND	1.65E3	ND	1.08E4	ND	1.11E5
Ru-105	3.82E-3	ND	1.39E-3	ND	3.36E-2	ND	2.49E0
Ru-106	9.24E4	ND	1.15E4	ND	1.25E5	ND	1.44E6
Ag-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-127	3.05E3	8.22E2	6.54E2	2.11E3	8.67E3	ND	1.19E5
Te-129m	2.71E8	7.57E7	4.21E7	8.74E7	7.96E8	ND	3.31E8
Te-129	0	0	0	0	2.90E-9	ND	6.17E-8
Te-131m	1.60E6	5.53E5	5.89E5	1.14E6	5.35E6	ND	2.24E7
Te-131	0	0	0	0	0	ND	0
Te-132	1.02E7	4.52E6	5.46E6	6.58E6	4.20E7	ND	4.55E7
I-130	1.73E6	3.49E6	1.80E6	3.84E8	5.22E6	ND	1.63E6

TABLE 5 (Contd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

Grass-Cow-Milk Pathway

(m^2 mrem/yr) per (μCi/sec)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
I-131	1.30E9	1.31E9	7.45E8	4.33E11	2.15E9	ND	1.17E8
I-132	6.02E-1	1.11E0	5.08E-1	5.13E1	1.69E0	ND	1.30E0
I-133	1.74E7	2.15E7	8.13E6	3.99E9	3.58E7	ND	8.66E6
I-134	0	0	0	0	0	ND	0
I-135	5.40E4	9.72E4	4.60E4	8.61E6	1.49E5	ND	7.40E4
Cs-134	2.26E10	3.72E10	7.84E9	ND	1.15E10	4.13E9	2.00E8
Cs-136	1.01E9	2.77E9	1.79E9	ND	1.48E9	2.20E8	9.74E7
Cs-137	3.22E10	3.09E10	4.56E9	ND	1.01E10	3.62E9	1.93E8
Cs-138	0	0	0	ND	0	0	0
Ba-139	1.89E-7	0	5.48E-9	ND	0	0	1.09E-5
Ba-140	1.17E8	1.03E5	6.84E6	ND	3.34E4	6.12E4	5.93E7
Ba-141	0	0	0	ND	0	0	0
Ba-142	0	0	0	ND	0	0	0
La-140	1.95E1	6.80E0	2.29E0	ND	ND	ND	1.90E5
La-142	0	0	0	ND	ND	ND	2.90E-6
Ce-141	2.19E4	1.09E4	1.62E3	ND	4.78E3	ND	1.36E7
Ce-143	1.87E2	1.02E5	1.47E1	ND	4.26E1	ND	1.49E6
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	7.75E5
Pr-144	0	0	0	ND	0	ND	0
Nd-147	4.45E2	3.61E2	2.79E1	ND	1.98E2	ND	5.71E5
W-187	2.91E4	1.73E4	7.73E3	ND	ND	ND	2.42E6
Np-239	1.72E1	1.23E0	8.68E-1	ND	3.57E0	ND	9.14E4

TABLE 5 (Contd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

Grass-Goat-Milk Pathway

(m^2 mrem/yr) per (μCi/sec)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	3.20E3	3.20E3	3.20E3	3.20E3	3.20E3	3.20E3
C-14	1.19E9	2.39E8	2.39E8	2.39E8	2.39E8	2.39E8	2.39E8
Na-24	1.07E6	1.07E6	1.07E6	1.07E6	1.07E6	1.07E6	1.07E6
P-32	9.33E10	4.37E9	3.60E9	ND	ND	ND	2.58E9
Cr-51	ND	ND	1.23E4	6.78E3	1.87E3	1.25E4	6.48E5
Mn-54	ND	2.52E6	6.70E5	ND	7.06E5	ND	2.11E6
Mn-56	ND	1.54E-3	3.49E-4	ND	1.87E-3	ND	2.24E-1
Fe-55	1.45E6	7.71E5	2.39E5	ND	ND	4.36E5	1.43E5
Fe-59	1.56E6	2.53E6	1.26E6	ND	ND	7.33E5	2.63E6
Co-58	ND	1.45E6	4.45E6	ND	ND	ND	8.49E6
Co-60	ND	5.18E6	1.53E7	ND	ND	ND	2.87E7
Ni-63	3.56E9	1.90E8	1.21E8	ND	ND	ND	1.28E7
Ni-65	1.99E-1	1.87E-2	1.09E-2	ND	ND	ND	2.29E0
Cu-64	ND	8.31E3	5.02E3	ND	2.01E4	ND	3.90E5
Zn-65	4.96E8	1.32E9	8.22E8	ND	8.33E8	ND	2.32E8
Zn-69	0	0	0	ND	0	ND	1.35E-10
Br-83	ND	ND	ND	ND	ND	ND	ND
Br-84	ND	ND	ND	ND	ND	ND	ND
Br-85	ND	ND	ND	ND	ND	ND	ND
Rb-86	ND	1.06E9	6.50E8	ND	ND	ND	6.80E7
Rb-88	ND	0	0	ND	ND	ND	0
Rb-89	ND	0	0	ND	ND	ND	0
Sr-89	1.39E10	ND	3.97E8	ND	ND	ND	5.38E8
Sr-90	2.35E11	ND	5.95E10	ND	ND	ND	3.16E9
Sr-91	2.74E5	ND	1.03E4	ND	ND	ND	6.04E5

TABLE 5 (Contd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

Grass-Goat-Milk Pathway

(m^2 mrem/yr) per (μCi/sec)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
Sr-92	4.58E0	ND	1.84E-1	ND	ND	ND	8.68E1
Y-90	3.87E1	ND	1.03E0	ND	ND	ND	1.10E5
Y-91m	0	ND	0	ND	ND	ND	0
Y-91	4.68E3	ND	1.25E2	ND	ND	ND	6.24E-5
Y-92	3.04E-5	ND	8.69E-7	ND	ND	ND	8.77E-1
Y-93	1.27E-1	ND	3.48E-3	ND	ND	ND	1.89E3
Zr-95	4.60E2	1.01E2	9.00E1	ND	1.45E2	ND	1.05E5
Zr-97	2.30E-1	3.33E-2	1.96E-2	ND	4.78E-2	ND	5.04E3
Nb-95	3.81E4	1.48E4	1.06E4	ND	1.39E4	ND	2.75E7
Mo-99	ND	9.76E6	2.42E6	ND	2.09E7	ND	8.08E6
Tc-99m	1.59E0	3.11E0	5.15E1	ND	4.52E1	1.58E0	1.77E3
Tc-101	0	0	0	ND	0	0	0
Ru-103	5.14E2	ND	1.98E2	ND	1.29E3	ND	1.33E4
Ru-105	4.58E-4	ND	1.66E-4	ND	4.03E-3	ND	2.99E-1
Ru-106	1.11E4	ND	1.38E3	ND	1.50E4	ND	1.72E5
Ag-110m	2.51E7	1.69E7	1.35E7	ND	3.15E7	ND	2.01E9
Te-125m	8.85E6	2.40E6	1.18E6	2.48E6	ND	ND	8.54E6
Te-127m	2.50E7	6.72E6	2.96E6	5.97E6	7.12E7	ND	2.02E7
Te-127	3.66E2	9.86E1	7.85E1	2.53E2	1.04E3	ND	1.43E4
Te-129m	3.25E7	9.09E6	5.05E6	1.05E7	9.55E7	ND	3.97E7
Te-129	0	0	0	0	0	ND	7.40E-9
Te-131m	1.92E5	6.64E4	7.07E4	1.37E5	6.43E5	ND	2.69E6
Te-131	0	0	0	0	0	ND	0
Te-132	1.23E6	5.42E5	6.55E5	7.90E5	5.04E6	ND	3.46E6
I-130	2.07E6	4.19E6	2.16E6	4.61E8	6.26E6	ND	1.96E6

TABLE 5 (Contd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

Grass-Goat-Milk Pathway

(m^2 mrem/yr) per (μCi/sec)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
I-131	1.56E9	1.57E9	8.94E8	5.20E11	2.58E9	ND	1.40E8
I-132	7.22E-1	1.33E0	6.10E-1	6.15E1	2.03E0	ND	1.56E0
I-133	2.09E7	2.58E7	9.76E6	4.79E9	4.30E7	ND	1.04E7
I-134	0	0	0	0	0	ND	0
I-135	6.48E4	1.17E5	5.52E4	1.03E7	1.79E5	ND	8.88E4
Cs-134	6.79E10	1.11E11	2.35E10	ND	3.45E10	1.24E10	6.01E8
Cs-136	3.03E9	8.32E9	5.38E9	ND	4.43E9	6.61E8	2.92E8
Cs-137	9.67E10	9.26E10	1.37E10	ND	3.02E10	1.09E10	5.80E8
Cs-138	0	0	0	ND	0	0	0
Ba-139	2.27E-8	0	0	ND	0	0	1.31E-6
Ba-140	1.41E7	1.23E4	8.20E5	ND	4.01E3	7.34E3	7.12E6
Ba-141	0	0	0	ND	0	0	0
Ba-142	0	0	0	ND	0	0	0
La-140	2.34E0	8.17E-1	2.75E-1	ND	ND	ND	2.28E4
La-142	0	0	0	ND	ND	ND	3.49E-7
Ce-141	2.62E3	1.31E3	1.94E2	ND	5.74E2	ND	1.63E6
Ce-143	2.25E1	1.22E4	1.77E0	ND	5.12E0	ND	1.79E5
Ce-144	1.95E5	6.11E4	1.04E4	ND	3.38E4	ND	1.59E7
Pr-143	8.62E1	2.59E1	4.28E0	ND	1.40E1	ND	9.30E4
Pr-144	0	0	0	ND	0	ND	0
Nd-147	5.34E1	4.33E1	3.35E0	ND	2.37E1	ND	6.85E4
W-187	3.49E3	2.07E3	9.27E2	ND	ND	ND	2.90E5
Np-239	2.06E0	1.48E-1	1.04E-1	ND	4.28E-1	ND	1.10E4

TABLE 5 (Contd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

Vegetation Pathway

(m^2 mrem/yr) per (μCi/sec)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
H-3	ND	4.01E3	4.01E3	4.01E3	4.01E3	4.01E3	4.01E3
C-14	8.89E8	1.78E8	1.78E8	1.78E8	1.78E8	1.78E8	1.78E8
Na-24	3.75E5	3.75E5	3.75E5	3.75E5	3.75E5	3.75E5	3.75E5
P-32	3.37E9	1.57E8	1.30E8	ND	ND	ND	9.30E7
Cr-51	ND	ND	1.17E5	6.50E4	1.78E4	1.19E5	6.21E6
Mn-54	ND	6.65E8	1.77E8	ND	1.86E8	ND	5.58E8
Mn-56	ND	1.88E1	4.24E0	ND	2.27E1	ND	2.72E3
Fe-55	8.01E8	4.25E8	1.32E8	ND	ND	2.40E8	7.87E7
Fe-59	3.97E8	6.43E8	3.20E8	ND	ND	1.86E8	6.69E8
Co-58	ND	6.44E7	1.97E8	ND	ND	ND	3.76E8
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
Ni-65	1.05E2	9.89E0	5.77E0	ND	ND	ND	1.21E3
Cu-64	ND	1.10E4	6.64E3	ND	2.66E4	ND	5.16E5
Zn-65	8.12E8	2.16E9	1.35E9	ND	1.36E9	ND	3.80E8
Zn-69	1.09E-5	1.57E-5	1.45E-6	ND	9.52E-6	ND	9.11E-4
Br-83	ND	ND	5.37E0	ND	ND	ND	0
Br-84	ND	ND	0	ND	ND	ND	0
Br-85	ND	ND	0	ND	ND	ND	0
Rb-86	ND	4.58E8	2.82E8	ND	ND	ND	2.94E7
Rb-88	ND	0	0	ND	ND	ND	0
Rb-89	ND	0	0	ND	ND	ND	0
Sr-89	3.59E10	ND	1.03E9	ND	ND	ND	1.39E9
Sr-90	1.24E12	ND	3.15E11	ND	ND	ND	1.67E10
Sr-91	5.24E5	ND	1.98E4	ND	ND	ND	1.16E6

TABLE 5 (Contd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

Vegetation Pathway

(m^2 mrem/yr) per (μCi/sec)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
Sr-92	7.38E2	ND	2.92E1	ND	ND	ND	1.38E4
Y-90	2.31E4	ND	6.18E2	ND	ND	ND	6.57E7
Y-91m	8.87E-9	ND	3.23E-10	ND	ND	ND	1.74E-5
Y-91	1.86E7	ND	4.99E5	ND	ND	ND	2.48E9
Y-92	1.58E0	ND	4.53E-2	ND	ND	ND	4.58E4
Y-93	3.01E2	ND	8.25E0	ND	ND	ND	4.48E6
Zr-95	3.86E6	8.45E5	7.55E5	ND	1.21E6	ND	8.84E8
Zr-97	5.70E2	8.24E1	4.86E1	ND	1.18E2	ND	1.25E7
Nb-95	4.10E5	1.55E5	1.14E5	ND	1.50E5	ND	2.95E8
Mo-99	ND	7.71E6	1.91E6	ND	1.65E7	ND	6.38E6
Tc-99m	4.71E0	9.24E0	1.53E2	ND	1.34E2	4.69E0	5.26E3
Tc-101	0	0	0	ND	0	0	0
Ru-103	1.54E7	ND	5.90E6	ND	3.87E7	ND	3.97E8
Ru-105	9.16E1	ND	3.32E1	ND	8.05E2	ND	5.98E4
Ru-106	7.45E8	ND	9.30E7	ND	1.01E9	ND	1.16E10
Ag-110m	3.22E7	2.17E7	1.74E7	ND	4.05E7	ND	2.58E9
Te-125m	3.51E8	9.50E7	4.67E7	9.84E7	ND	ND	3.38E8
Te-127m	1.32E9	3.56E8	1.57E8	3.16E8	3.77E9	ND	1.07E9
Te-127	1.00E4	2.69E3	2.14E3	6.91E3	2.84E4	ND	3.90E5
Te-129m	8.38E8	2.34E8	1.30E8	2.70E8	2.46E9	ND	1.02E9
Te-129	1.16E-3	3.23E-4	2.75E-4	8.26E-4	3.39E-3	ND	7.20E-2
Te-131m	1.54E6	5.33E5	5.68E5	1.10E6	5.16E6	ND	2.16E7
Te-131	0	0	0	0	0	ND	0
Te-132	6.98E6	3.09E6	3.73E6	4.50E6	2.87E7	ND	3.11E7
I-130	6.16E5	1.24E6	6.38E5	1.37E8	1.86E6	ND	5.79E5

TABLE 5 (Contd.)

PATHWAY DOSE FACTORS (R_i) FOR RADIONUCLIDES OTHER THAN NOBLE GASES

Vegetation Pathway

(m^2 mrem/yr) per (μCi/sec)

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
I-131	1.43E8	1.44E8	8.17E7	4.75E10	2.36E8	ND	1.28E7
I-132	8.58E1	1.58E2	7.25E1	7.31E3	2.41E2	ND	1.86E2
I-133	3.56E6	4.40E6	1.67E6	8.18E8	7.34E6	ND	1.77E6
I-134	1.55E-4	2.88E-4	1.32E-4	6.62E-3	4.40E-4	ND	1.91E-4
I-135	6.62E4	1.13E5	5.33E4	9.97E6	1.70E5	ND	8.58E4
Cs-134	1.60E10	2.63E10	5.55E9	ND	8.15E9	2.93E9	1.42E8
Cs-136	8.17E7	2.25E8	1.45E8	ND	1.20E8	1.78E7	7.90E6
Cs-137	2.39E10	2.29E10	3.38E9	ND	7.46E9	2.68E9	1.43E8
Cs-138	0	0	0	ND	0	0	0
Ba-139	4.80E-2	2.56E-5	1.39E-3	ND	2.24E-5	1.51E-5	2.77E0
Ba-140	2.77E8	2.42E5	1.62E7	ND	7.89E4	1.45E5	1.40E8
Ba-141	0	0	0	ND	0	0	0
Ba-142	0	0	0	ND	0	0	0
La-140	3.25E3	1.14E3	3.83E2	ND	ND	ND	3.17E7
La-142	2.50E-4	7.98E-5	2.50E-5	ND	ND	ND	1.58E1
Ce-141	6.56E5	3.27E5	4.86E4	ND	1.43E5	ND	4.08E8
Ce-143	1.72E3	9.31E5	1.35E2	ND	3.91E2	ND	1.36E7
Ce-144	1.27E8	3.98E7	6.78E6	ND	2.21E7	ND	1.04E10
Pr-143	1.46E5	4.38E4	7.25E3	ND	2.37E4	ND	1.58E8
Pr-144	0	0	0	ND	0	ND	0
Nd-147	7.17E4	5.81E4	4.50E3	ND	3.19E4	ND	9.20E7
W-187	6.47E4	3.83E4	1.72E4	ND	ND	ND	5.38E6
Np-239	2.35E3	1.83E2	1.29E2	ND	5.30E2	ND	1.36E7

TABLE 5 NOTES

The values presented in Table 5 were calculated according to the methodology and guidance provided in NUREG 0133, Rev. 0 (1978)

Specific parameters utilized are:

Parameter	Value	Reference
SF	0.7	Ref. 9.11.2
f_p	1.0	Ref. 9.8.2
f_s	1.0	Ref. 9.8.2
H	8.0 g/m³	Ref. 9.8.2
f_L	1.0	Ref. 9.8.5
f_g	0.76	Ref. 9.8.5

The cumulative critical organ doses for a monthly, quarterly or annual evaluation are based on the calculated dose contribution from each specified time period occurring during the reporting period.

3.6 Gaseous Radwaste Treatment System

3.6.1 Technical Specification 3.11.2.4

The VENTILATION EXHAUST TREATMENT SYSTEM and the WASTE GAS HOLDUP SYSTEM shall be OPERABLE and appropriate portions of these systems shall be used to reduce releases of radioactivity when the projected doses in 31 days due to gaseous effluent releases, from each unit, to areas at and beyond the SITE BOUNDARY would exceed:

a. 0.2 mrad to air from gamma radiation, or
b. 0.4 mrad to air from beta radiation, or
c. 0.3 mrem to any organ of an Individual

3.6.2 Description of the Gaseous Radwaste Treatment System

The gaseous radwaste treatment system and the ventilation exhaust system are available for use whenever gaseous effluents require treatment prior to being released to the environment. The gaseous radwaste treatment system is designed to allow for the retention of all gaseous fission products to be discharged from the reactor coolant system. The retention system consists of eight (8) waste gas decay tanks, six (6) for use during normal operations and two (2) for use during shutdown conditions. These systems will provide reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept ALARA.

3.6.3 OPERABILITY of the Gaseous Radwaste Treatment System

The OPERABILITY of the gaseous radwaste treatment system ensures this system will be available for use when gases require treatment prior to their release to the environment. OPERABILITY is demonstrated through compliance with Technical Specifications 3.11.2.1, 3.11.2.2, and 3.11.2.3.

Projected doses (gamma air, beta air, and organ dose) due to gaseous effluents at or beyond the SITE BOUNDARY are determined each 31 days by dividing the cumulative annual total by the number of elapsed months.

4.0 DOSE AND DOSE COMMITMENT FROM URANIUM FUEL CYCLE SOURCES

4.1 Technical Specification 3.11.4

The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to less than or equal to 25 mrem to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem.

4.2 ODCM Methodology for Determining Dose and Dose Commitment from Uranium Fuel Cycle Sources

The annual dose or dose commitment to a MEMBER OF THE PUBLIC for Uranium Fuel Cycle Sources is determined as:

a) Dose to the total body due to gamma ray exposure from immersion in a cloud of radioactive noble gases and direct radiation from the unit and outside storage tanks;

b) Dose to the skin due to beta radiation from immersion in a cloud of radioactive noble gases;

c) Thyroid dose due to inhalation and ingestion of radioiodines.

d) Organ dose due to inhalation and ingestion of radioactive material.

Since the doses via liquid releases are very conservatively evaluated, there is reasonable assurance that no real individual will receive a significant dose from radioactive liquid release pathways (<1 mrem /yr/ reactor). Therefore, only doses to individuals via airborne pathways and doses resulting from direct radiation are considered in determining compliance to 40 CFR 190. (Ref. 9.12.3)

It should be noted that there are no other Uranium Fuel Cycle Sources within 8km of the Callaway Plant.

The annual dose or dose commitment to a MEMBER OF THE PUBLIC from Uranium Fuel Cycle Sources, is determined whenever the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceed

twice the limits of Technical Specifications 3.11.1.2a, 3.11.1.2b, 3.11.2.2a, 3.11.2.2b, 3.11.2.3a, or 3.11.2.3b. (Ref. 9.12.1 and 9.12.2.) For those situations where these limits are not exceeded by substantial amounts, it should be possible to demonstrate continued compliance with 40 CFR 190 through reevaluation of the exceeded Appendix I design objective dose using more realistic assumptions. (Ref. 9.12.3 and 9.12.4.)

4.2.1 Identification of the MEMBER OF THE PUBLIC

The MEMBER OF THE PUBLIC is considered to be a real individual, including all persons not occupationally associated with the Callaway Plant, but who may use portions of the plant site for recreational or other purposes not associated with the plant. (Ref. 9.13.1 and 9.8.11.) Accordingly, it is necessary to characterize this individual with respect to his utilization of areas both within and at or beyond the SITE BOUNDARY and identify, as far as possible, major assumptions which can be reevaluated as previsously mentioned.

4.2.1.1 Utilization of Areas Within the SITE BOUNDARY

The Union Electric Company has entered into an agreement with the State of Missouri Department of Conservation for management of the residual lands surrounding the Callaway Plant, including some areas within the SITE BOUNDARY. Under the terms of this agreement, certain areas have been opened to the public for low intensity recreational uses (hunting, hiking, sightseeing, etc.) but recreational use is excluded in an area immediately surrounding the plant site (Refer to Figure 4.1). Much of the residual lands within the SITE BOUNDARY are leased to area farmers by the Department of Conservation to provide income to support management and development costs. Activities conducted under these leases are primarily comprised of farming (animal feed), grazing, and forestry. (Ref 9.7.2, 9.7.4, 9.14, 9.14.1).

Based on the utilization of areas within the SITE BOUNDARY, it is reasonable to assume that the maximum exposed member of the public is a farmer. The current tenant has estimated that he spends approximately 1100 hours per year working in this area (Ref 9.5.6). Occupancy of areas within the SITE BOUNDARY is assumed to be averaged over a period of one year.

Any reevaluation of assumptions should include a reevaluation of the occupancy period at the locations of real exposure (e.g. a real individual would not simultaneously exist at each point of maximum exposure).

4.2.2 Total Dose from Gaseous Effluents

The annual dose to a MEMBER OF THE PUBLIC from gaseous effluents is determined through the use of the methodology presented by equations (3.11), (3.12), and (3.14), using the appropriate atmospheric dispersion parameters from Table 9 and Table 10 for the maximum exposed real individual. Doses are evaluated for the plume exposure, inhalation, and grass-cow-meat pathways.

4.2.3 Total Dose from Direct Radiation

4.2.3.1 Direct Radiation Dose from Outside Storage Tanks

The Refueling Water Storage Tank (RWST) has the highest potential for receiving significant amounts of radioactive materials, and constitutes the only potentially significant source of direct radiation dose from outside storage tanks to a MEMBER OF THE PUBLIC. (Ref. 9.6.17, 9.6.18, 9.6.19, and 9.6.20.)

The direct radiation dose from the RWST is determined by isotopic measurement of the tank contents and calculation of the direct dose using the methodology presented below.

Direct radiation dose from the RWST to a MEMBER OF THE PUBLIC is determined at the nearest point of the Owner Controlled Area fence which is not obscured by significant plant structures. This has been determined to be 450 meters from the RWST.

The RWST is approximately 12 meters in diameter, 14 meters in height with a capacity of approximately 1,514,000 liters. (Ref. 9.6.20.) The walls are of type 304 stainless steel and have an average thickness of .87 cm. (Ref. 9.16.1.)

Assuming that the RWST approximates a point source at this distance, and neglecting attenuation provided by the walls of the tank, the exposure rate from monoen-

ergetic gamma radiation is given by:

$$ER = \frac{BA\Gamma}{d^2} \exp(\mu_{en} d) \qquad (4.1)$$

Where:

ER = Exposure rate at distance d from a point source of strength A, (in Roentgens/hour).

B = Buildup factor.

A = Activity of the source, (in Curies).

d = Distance from the source, (in meters).

μ_{en} = Linear attenuation coefficient for air, in (m^{-1}).

Γ = Exposure rate constant, (in R - m^2/Ci - hr.).

The exposure rate constant Γ is given by:

$$\Gamma = K f E \mu_a \qquad (4.2)$$

Where:

E = Energy of the gamma radiation, in (MeV).

μ_a = Linear absorption coefficient for air, (in m^{-1}).

f = Number of photons emitted per disintegration.

K = Constant, 1.49 E04 R - m^3/hr - MeV - Ci.

Γ = Is as previously defined.

For nuclides emitting multiple gamma rays, equation (4.1) becomes:

$$ER = \frac{KA}{d^2} \sum_i B_i (f_i E_i \mu_{ai}) \exp(-\mu_{eni} d) \qquad (4.3)$$

Where:

B_i = Buildup factor for ith photon.

E_i = Energy of the ith photon, (in MeV).

μ_{ai} = Linear absorption coefficient for air, for the ith photon, (in m^{-1}).

μ_{eni} = Linear attenuation coefficient for air, for the ith photon, (in m^{-1}).

fi = Number of ith photons emitted per disintegration.

ER, K,A, and d are as previously defined.

For photon energies in the range of 60 KeV to 2 MeV, the value of the linear absorption coefficient for air is relatively constant ($\pm$ 15%), therefore, equation (4.3) can be approximated as:

$$ER = \frac{K'A}{d^2} \sum_i B_i (f_i E_i) \exp(-\mu_{eni} d) \qquad (4.4)$$

Where:

K' = A constant, 0.48 R-m^2/hr - MeV - Ci.

ER, A, d, f_i, E_i, B_i, and μ_{eni} are as previously defined.

Through the use of equation (4.4), the exposure rate for a particular nuclide can be determined. The total exposure rate from the RWST is calculated as:

$$ER_{total} = \sum_j ER_j \qquad (4.5)$$

ER_{total} = Total exposure rate at the location of the MEMBER OF THE PUBLIC from the RWST, (in Roentgen/hour).

ER_j = Calculated exposure rate from the jth nuclide, (in Roentgen/hr).

The total direct radiation dose rate from the RWST to a MEMBER OF THE PUBLIC is given by:

$$DR_{total} = ER_{total} \qquad (4.6)$$

Where:

DR_{total} = Total dose rate from the RWST (in rem/hr).

ER_{total} is as previously defined.

The direct radiation dose to a MEMBER OF THE PUBLIC is then determined for a specific time period:

$$D_{DR} = 1.23 \ (DR_{total}) \ (t) \qquad (4.7)$$

D_{DR} = Direct radiation dose to a MEMBER OF THE PUBLIC for the specific time interval, (in rem).

3.01 = Occupancy factor (1100 hours/year ÷ 365.25 days/year), (in hours/day).

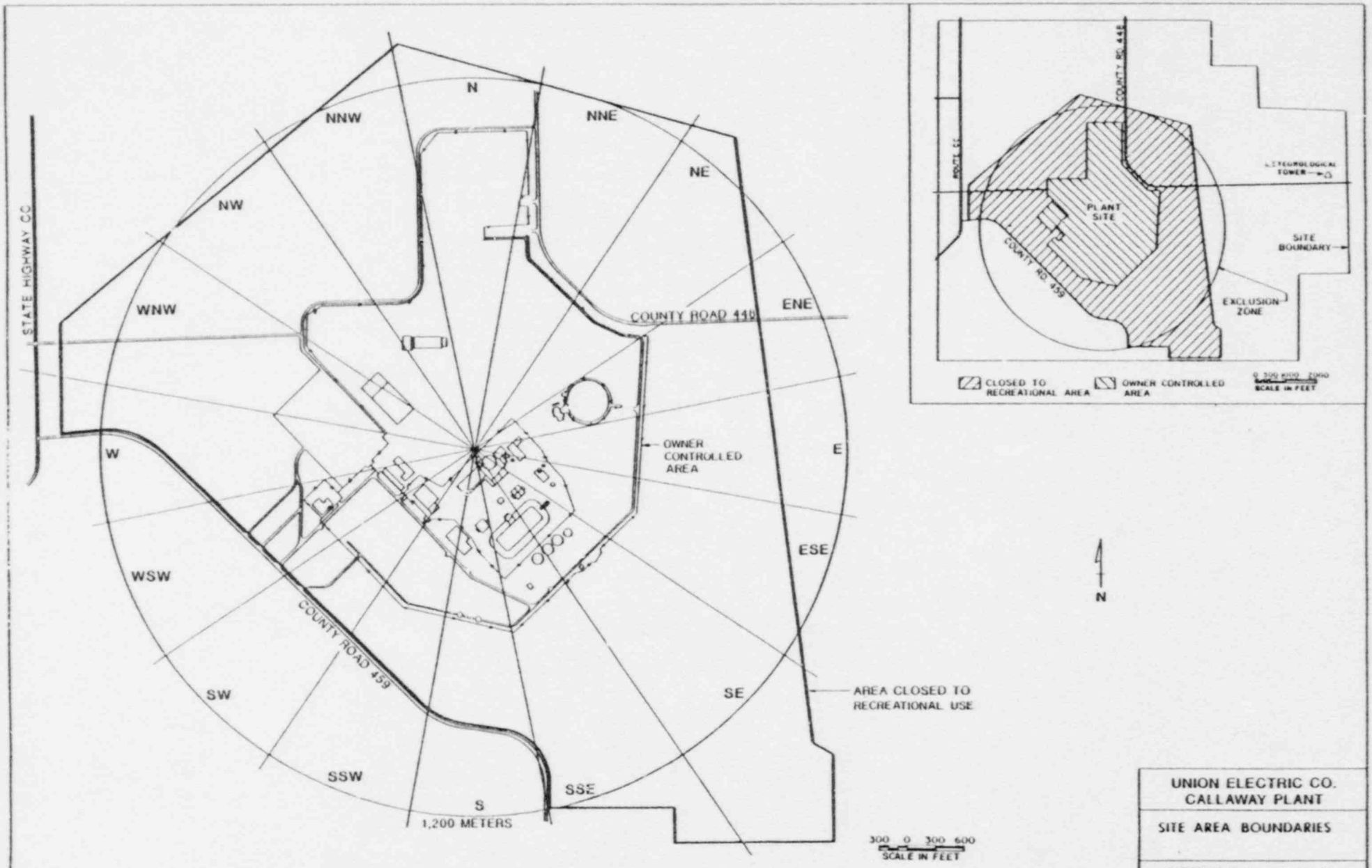
t = Length of specific time period, (in days).

DR_{total} is as previously defined.

4.2.3.2 Direct Radiation Dose from the Reactor

The maximum direct radiation dose from the Unit to a MEMBER OF THE PUBLIC has been determined to be 7E-2 mrads/calendar year, based on a point source of primary coolant N-16 in the steam generators. This source term was then projected onto the inside surface of the containment dome, taking credit for shielding provided by the containment dome and for distance attenuation. No credit was allowed for shielding by other buildings. A number of gammas per second was generated and then converted to a dose rate at the given distance by use of ANSI/ANS-6.6.1, "Calculation and Measurement of Direct and Scattered Gamma Radiation from LWR Nuclear Power Plant 1979". This method considers attenuation and buildup in air. The final value is based on one unit operating at 100% Power. The distance was determined to be 367 meters, which is approximately the closest point of the boundary of the Owner Controlled Area fence, which is not obscurred by significant plant structures. (Ref. 9.16.4)

The maximum direct radiation dose from the Unit to a MEMBER OF THE PUBLIC due to activities within the SITE BOUNDARY is thus approximately 9E-3 mrads per year, assuming a maximum occupancy of 1100 hours per year.



UNION ELECTRIC CO.
CALLAWAY PLANT

SITE AREA BOUNDARIES

FIGURE 4.1 REV. 4

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING

5.1 Radiological Effluent Technical Specification 3.12.1

The radiological environmental monitoring program shall be conducted as specified in Table 3.12-1. (ODCM Table 6).

5.2 Description of the Radiological Environmental Monitoring Program

The Radiological Enviormental Monitoring Program is intended to act as a background data base for preoperation and to supplement the radiological effluent release monitoring program during plant operation. Radiation exposure to the public from the various specific pathways and direct radiation can be adequately evaluated by this program.

Some deviations from the sampling frequency may be necessary due to seasonal unavailability, hazardous conditions, or other legitimate bases. Efforts are made to obtain all required samples within time frame outlines. Any deviation(s) in sampling frequency or location is documented in the Annual Radiological Environmental Operating Report.

The Environmental samples are collected and analyzed at the frequency outlined in Table 6. Reporting levels and lower limits of detection (LLD) are outlined in Tables 7 and 8.

Samples collected under the monitoring program are analyzed by an independent, third-party laboratory. This laboratory is required to participate in the Environmental Protection Agency's (EPA) Environmental Radioactivity Laboratory Intercomparison Studies (Crosscheck) Program or an equivalent program. Participation includes all of the determinations (sample medium - radionuclide combination) that are offered by the EPA and that are also included in the monitoring program.

TABLE 6

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
1. Direct Radiation[b]	40 routine monitoring station either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows: An inner ring of sixteen stations, one in each meteorological sector in the general area of the SITE BOUNDARY.	At least once per 92 days.	Gamma Dose

Station Code	Sector	Site Description	Location
4	A	0.6 Miles East of Hwy O and CC Junction	1.9 mi. @ 354° N
47	B	County Road 335, 0.9 Miles South of Hwy O	0.9 mi. @ 20° NNE
48	C	Plant Security and Wildlife Management Area Sign Post (Heavy Haul Road)	0.5 mi. @ 47° NE
5	D	Primary Meteorological Tower	1.3 mi. @ 76° ENE
49	E	Callaway Electric Cooperative Utility Pole No. 06959	1.7 mi. @ 94° E
52	F	Light Pole Near East Plant Security Fence	0.3 mi. @ 111° ESE
51	G	Located in the "Y" of the Railroad Spur, NW of Sludge Lagoon	0.7 mi. @ 132° SE
50	H	Heavy Haul Road, Intake/Discharge Pipeline Marker	1.1 mi. @ 157° SSE
7	J	Callaway Electric Cooperative Utility Pole No. 18715	1.3 mi. @ 173° S
37	K	Piezometer M8 and M6	0.5 mi. @ 204° SSW
43	L	Plant Security and Wildlife Management Area Sign (Heavy Haul Road)	0.5 mi. @ 224° SW

TABLE 6 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Station Code	Sector	Site Description	Location
44	M	Callaway Electric Cooperative Utility Pole No. 18769	1.7 mi. @ 249° WSW
6	N	Akers Farm	1.8 mi. @ 277° W
45	P	NW Side of Intersection of CC and AD	0.9 mi. @ 287° WNW
3	Q	Callaway Electric Cooperative Utility Pole No. 18450	1.6 mi. @ 322° NW
46	R	0.3 Mile South of the CC and O Junction	1.5 mi. @ 333° NNW
		An outer ring of sixteen stations, one in each meteorological sector in the 6- to 8-km range from the site	
36	A	Callaway Electric Cooperative Utility Pole No. 19137	4.9 mi. @ 8° N
21	B	Callaway Electric Cooperative Utility Pole No. 19100	3.8 mi. @ 28° NNE
20	C	Callaway Electric Cooperative Utility Pole No. 12630	4.8 mi. @ 45° NE
16	D	Callaway Electric Cooperative Utility Pole No. 12976	4.1 mi. @ 75° ENE
17	E	0.5 Miles East of Hwy D, 1.5 Miles South of Hwy D and O Junction	4.0 mi. @ 88° E
15	F	Lamb Farm	4.2 mi. @ 117° ESE
11	G	City of Portland	5.0 mi. @ 136° SE
10	H	Callaway Electric Cooperative Utility Pole No. 12179	4.0 mi. @ 156° SE
9	J	NW Side of the Heavy Haul Road and Hwy 94 Junction	3.7 mi. @ 181° S
30	K	City of Steedman	4.5 mi. @ 203° SSW
42	L	Callaway Electric Cooperative Utility Pole No. 06326	4.4 mi. @ 230° SW

TABLE 6 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Station Code	Sector	Site Description	Location
32	M	D. Bartley Farm	5.1 mi. @ 241° WSW
41	N	Callaway Electric Cooperative Utility Pole No. 18239	4.8 mi. @ 227° W
40	P	Callaway Electric Cooperative Utility Pole No. 18145	4.2 mi. @ 291° WNW
39	Q	Callaway Electric Cooperative Utility Pole No. 17516	5.4 mi. @ 312° NW
38	R	Callaway Electric Cooperative Utility Pole No. 34708	4.5 mi. @ 334° NNW
		Eight Stations to be placed in special interest areas such as population centers, nearby residences, schools, and in 1 or 2 areas to serve as control stations.	
33		City of Hams Prairie	7.3 mi. @ 271° W
31		City of Mokane	7.6 mi. @ 218° SW
26		Town of Americus	12.1 mi. @ 82° E
27		Town of Bluffton	9.5 mi. @ 112° ESE
35		City of Toledo	5.8 mi. @ 340° NNW
23		City of Yucatan	6.7 mi. @ 14° NNE
11		City of Portland	5.0 mi. @ 136° SE
20		City of Readsville	4.8 mi. @ 45° NE
34 (P-Control)		2.5 Miles South of O and C Junction	9.5 mi. @ 291° WNW
1 (Q-Control)		City Limits of Fulton on Hwy Z	10.6 mi. @ 311° NW

TABLE 6 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Station Code	Sector	Site Description	Location	
2. Airborne				
Radioiodine and Particulates		Samples from five locations	Continuous operations of sampler with sample collection as required by dust loading, but at least once per 7 days.	Radioiodine Canister: Analyze at least once per 7 days for I-131.
		Three samples from close to the three SITE BOUNDARY locations, in different sectors, of the highest calculated annual average ground level D/Q.		Particulate Sampler: Analyze for gross beta radioactivity ≥ 24 hours following filter change. Perform gamma isotopic analysis[d] on those samples for which the gross beta activity is > 10 times the yearly mean of control samples. Perform gamma isotopic analysis[d] on composite samples (by location) at least once per 92 days.
A-1	D	Primary Meteorological Tower	1.3 mi. @ 76° ENE	
A-8	B	County Road 448, 0.9 mi. South of Highway 0	.9 mi. @ 20° NNE	
B-3	A	0.6 mile east of Highway 0 and CC Junction	1.9 mi. @ 355° NNW	
		One sample from the community with the highest D/Q		
A-9	R	Community of Reform	1.7 mi. @ 336° NNW	
		One sample from a control location, as for example 15-30 km distant and in the least prevalent wind direction.		

TABLE 6 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Station Code	Sector	Site Description	Location		
A-7	Q	C. Bartley farm	9.5 mi. @ 312° NW		
3. Waterborne a. Surface[e]		One sample upstream	Composite sample[f] over a period of less than or equal to 31 days.		Gamma isotopic analysis[d] of each sample. Tritium analysis of composite sample at least once per 92 days.
S01	H	84 feet upstream of discharge, north bank	4.8 mi. @ 144° SE		
		One sample downstream			
S02	G	1.1 miles downstream of discharge, north bank	5.2 mi. @ 133° SE		
b. Drinking		One sample of each of one to three of the nearest water supplies within 10 miles downstream, that could be affected by its discharge. One sample from a control location.	Composite sample over 2-week period when I-131 analysis is performed, monthly composite otherwise.		I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than 1 mrem per year Composite for gross beta and gamma isotopic analysis monthly. Composite for tritium analysis quarterly.
As there are no drinking water intakes within 10 miles downstream of the discharge point, the drinking water pathway is currently not included as part of the Callaway Plant Radiological Environmental Monitoring Program. Should future water intakes be constructed within 10 river miles downstream of the discharge point, then the program will be revised to include this pathway. (Ref. 9.6.6)					
c. Sediment from Shoreline		One sample from downstream area with existing or potential recreational value.	Semiannually		Gamma isotopic analysis ([d]) semiannually.

TABLE 6 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Station Code	Sector	Site Description	Location		
C	G	1.0 river mile downstream of discharge, north bank	5.1 mi. @ 135° SE		
4. Ingestion					
a. Milk		Samples from milking animals in three location within 5 km distance having the highest dose potential g. If there are none, then one sample from milking animals in each of three areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per year	Semimonthly when animals are on pasture, monthly at other times.	Gamma isotopic ([d]) and I-131 analysis semimonthly when animals are on pasture; monthly at other times.	
		One sample from milking animals at a control location, 15 to 30 km distant and in the least prevalent wind direction.			
Due to a lack of milk animals which satisfy these requirements, the milk pathway is currently not included as a part of the Callaway Plant Radiological Environmental Monitoring Program. Should the Annual Land Use Census identify the existence of milking animals in locations which satisfy these requirements, then the program will be revised to include this pathway.					
b. Fish		One sample of each commercially and recreationally important species in vicinity of plant discharge area.	Sample in season, or semiannually if they are not seasonal.	Gamma isotopic analysis[d] on edible portions.	
C	G	1.0 river mile downstream of discharge, north bank	5.1 mi. @ 135° SE		
		One sample of same species in areas not influenced by plant discharge.			

TABLE 6 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Station Code	Sector	Site Description	Location		
A	H	0.6 river miles upstream of discharge, north bank	4.9 mi. @ 154° SSE		
c. Food Products		One sample of each principal class of products from any area that is irrigated by water in which liquid plant wastes have been discharged.	At time of harvest [h]	Gamma isotpic analyses [d] on edible portion.	

As there are no areas irrigated by water in which liquid plant wastes have been discharged within 50 river miles downstream of the discharge point, this sample type is not currently included as part of the Callaway Plant Radiological Environmental Monitoring Program. Should furture irrigation water intakes be constructed within 10 river miles downstream of the discharge point, then the program will be revised to include this sample type. (Ref. 9.7.6 and 9.7.7)

		Samples of three different kinds of broad leaf vegetation grown nearest each of two different offsite locations of highest predicted annual average ground-level D/Q if milk sampling is not performed.	Monthly when available	Gamma isotopic [d] and I-131 analysis.	
V-6	R	Becker farm	1.8 mi. @ 344° NNW		
V-7	A	Meehan farm	1.8 mi. @ 356° N		
		One sample of each of the similar broad leaf vegetation grown 15 to 30 km distant in the least prevalent wind direction if milk sampling is not performed.	Monthly when available	Gamma isotopic [d] analysis.	
V-3	L	Hazlett Farm	15 mi. @ 224° SW		

TABLE 6 (continued)

TABLE NOTATION

(a) Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment, and other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, every effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report. It is recognized that, at times, it may not be possible or practical to continue to obtain samples of the media of choice at the most desired location or time. In these instances, suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the Radiological Environmental Monitoring Program. Identify the cause of the unavailability of samples for that pathway and identify the new location(s) for obtaining replacement samples in the next Semi-Annual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

(b) One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purpose of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. The 40 stations is not an absolute number. The number of direct radiation monitoring stations may be reduced according to geographical limitiations; e.g., at an ocean site, some sectors will be over water so that the number of dosimeters may be reduced accordingly. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading.

(c) The purpose of this sample is to obtain background informatin. If it is not practical to establish control locations in accordance with the distance and wind direction criteria, other sites that provide valid background data may be substituted.

(d) Gamma isotopic analysis is defined as the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

(e) The "upstream" sample shall be taken at a distance beyond significant influence of the discharge. The "downstream" sample shall be taken in an area beyond, but near the mixing zone.

(f) In this program, constant volume sample aliquots are collected at time intervals that are short (e.g., hourly) relative to the compositing period (e.g., monthly).

(g) The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

(h) If harvest occurs more than once a year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. Attention shall be paid to including samples of tuberous and root food products.

TABLE 7

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/kg), wet	Milk (pCi/l)	Food Product (pCi/kg, wet)
H-3	20,000 *				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zr-Nb-95	400 **				
I-131	2	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200 **			300**	

* For drinking water samples. For surface water samples a value of 30,000 pCi/l is used.

** Total activity, parent plus daughter activity.

TABLE 8 (CONTINUED)
TABLE NOTATION

(a) The LLD is defined for purposes of compliance with the Radiological Effluent Technical 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 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 = The lower limit of detection as defined above (as picocurie per unit mass or volume).

S_b = The standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute).

E = The counting efficiency (as counts per disintegration).

V = The sample size (in units of mass or volume).

2.22 = The number of disintegrations per minute per picocurie.

Y = The fractional radiochemical yield (when applicable).

λ = The radioactive decay constant for the particular radionuclide and,

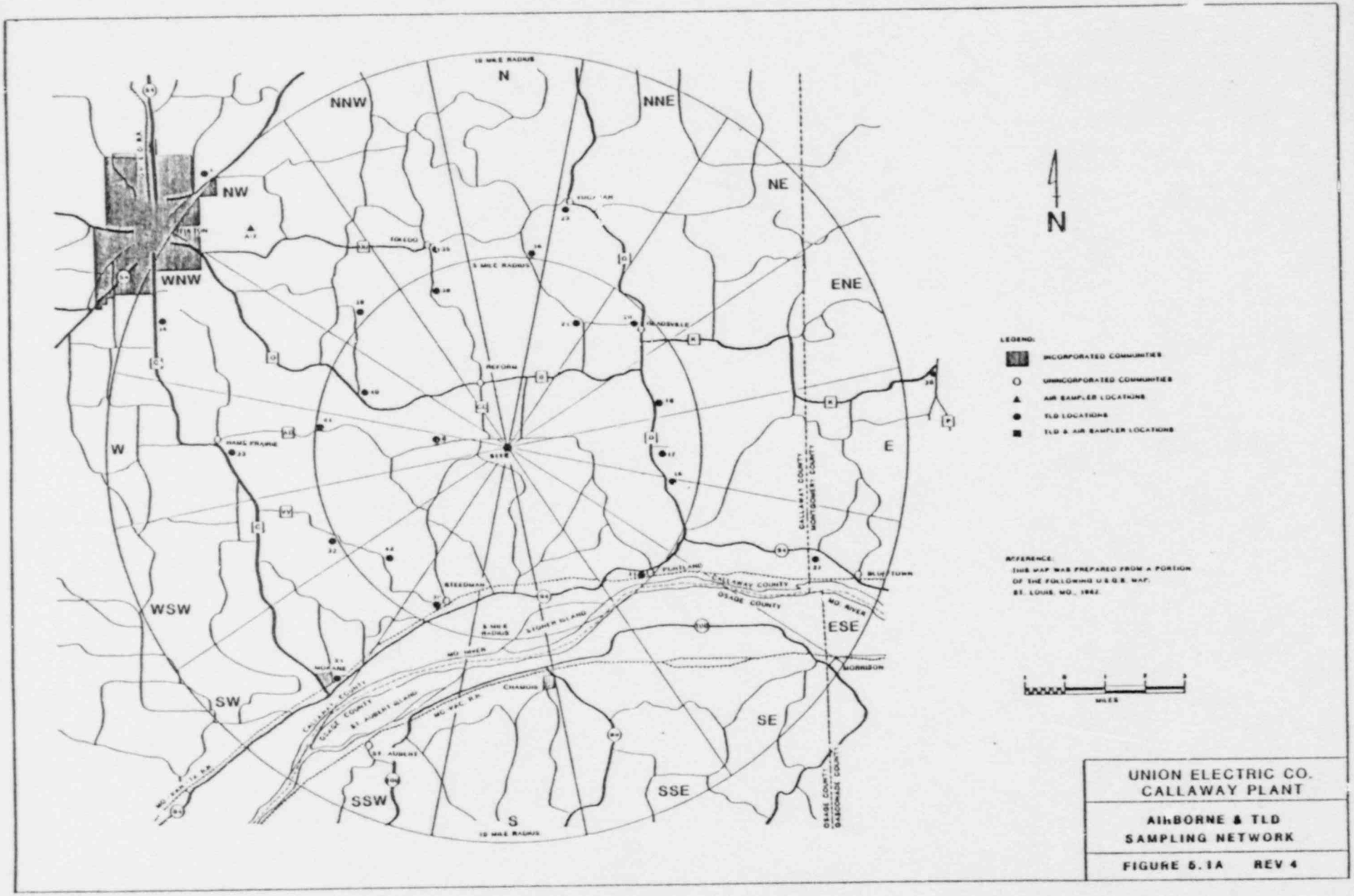
Δt = the elapsed time between sample collection (or end of the smaple collection period) and time of counting (for environmental samples, not plant effluent samples).

Typical values of E, V, Y and Δt shall be used in the calculations.

It should be recognized that the LLD is defined as a 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 are performed in such a manner that the stated LLDs are achieved under routine conditions. Occassionally background fluctuations, unavoidable 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.

(b) This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be anlayzed and reported in the Annual Radiological Environmental Operating Report.

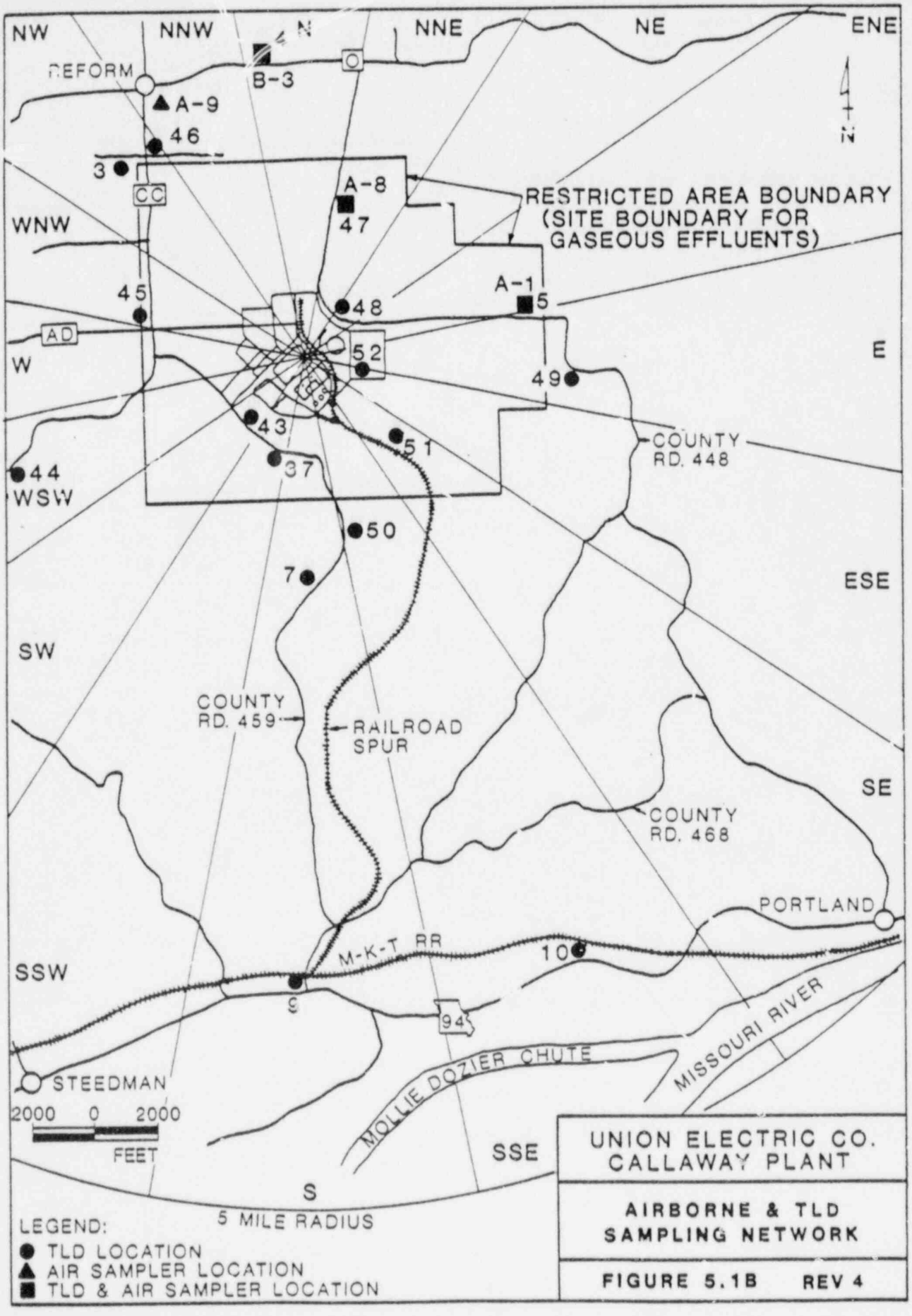
(c) Required detection capabilities for thermoluminescent dosimeters used for environmental measurements shall be in accordance with the reccommendations of Regulatory Guide 4.13, Revision 1, July 1977.

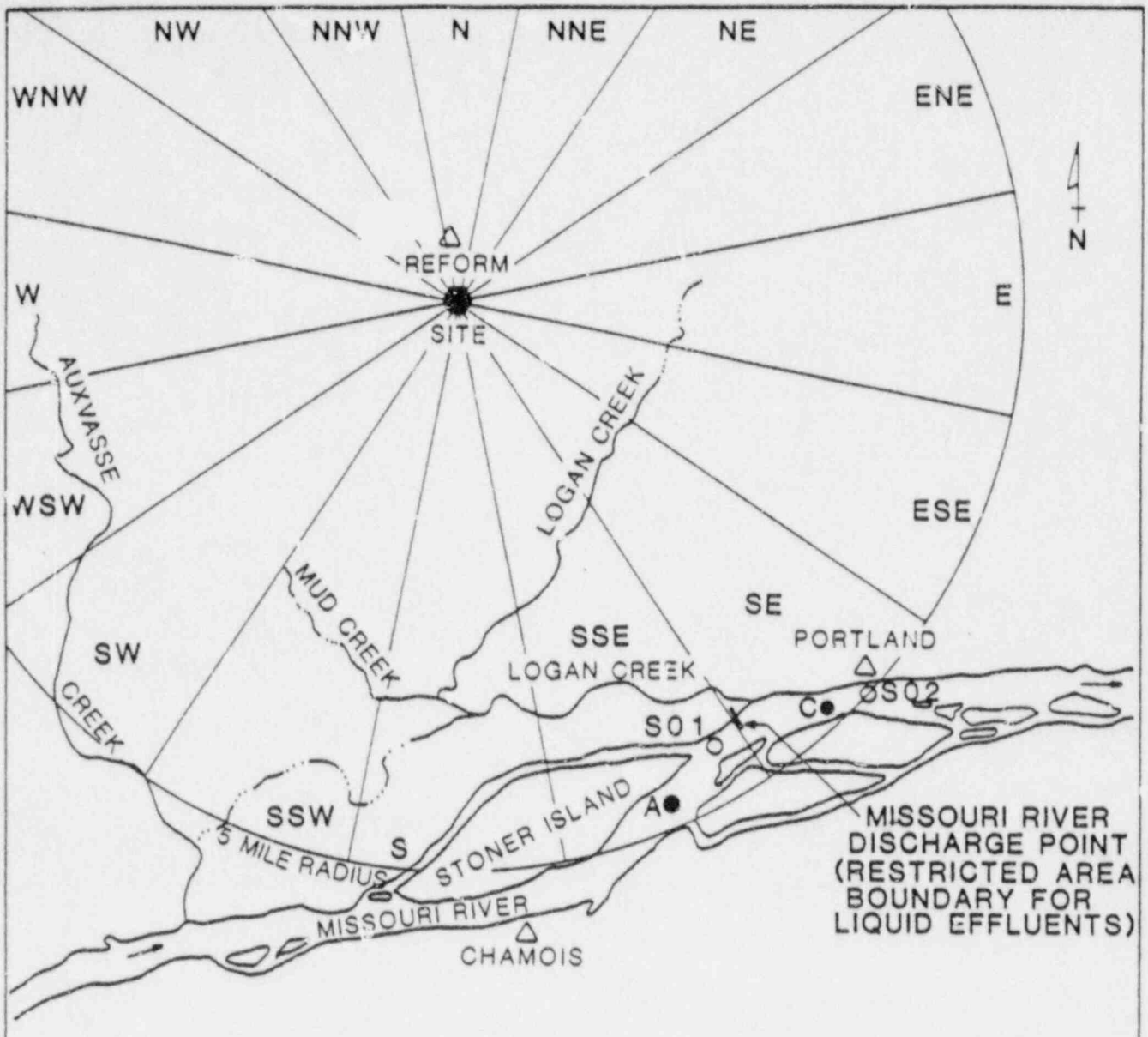


UNION ELECTRIC CO.
CALLAWAY PLANT

AIrBORNE & TLD
SAMPLING NETWORK

FIGURE 5.1A REV 4


NW
NNW
N
NNE
NE
ENE
REFORM
B-3
A-9
46
3
CC
A-8
47
RESTRICTED AREA BOUNDARY
(SITE BOUNDARY FOR
GASEOUS EFFLUENTS)
WNW
45
A-1
5
48
AD
W
52
E
49
43
51
COUNTY
RD. 448
44
WSW
37
50
7
ESE
SW
COUNTY
RD. 459
RAILROAD
SPUR
SE
COUNTY
RD. 468
PORTLAND
M-K-T RR
10
SSW
9
94
MISSOURI RIVER
MOLLIE DOZIER CHUTE
STEEDMAN
2000 0 2000
FEET
SSE
S
5 MILE RADIUS
LEGEND:
TLD LOCATION
AIR SAMPLER LOCATION
TLD & AIR SAMPLER LOCATION
UNION ELECTRIC CO.
CALLAWAY PLANT
AIRBORNE & TLD
SAMPLING NETWORK
FIGURE 5.1B REV 4



LEGEND:

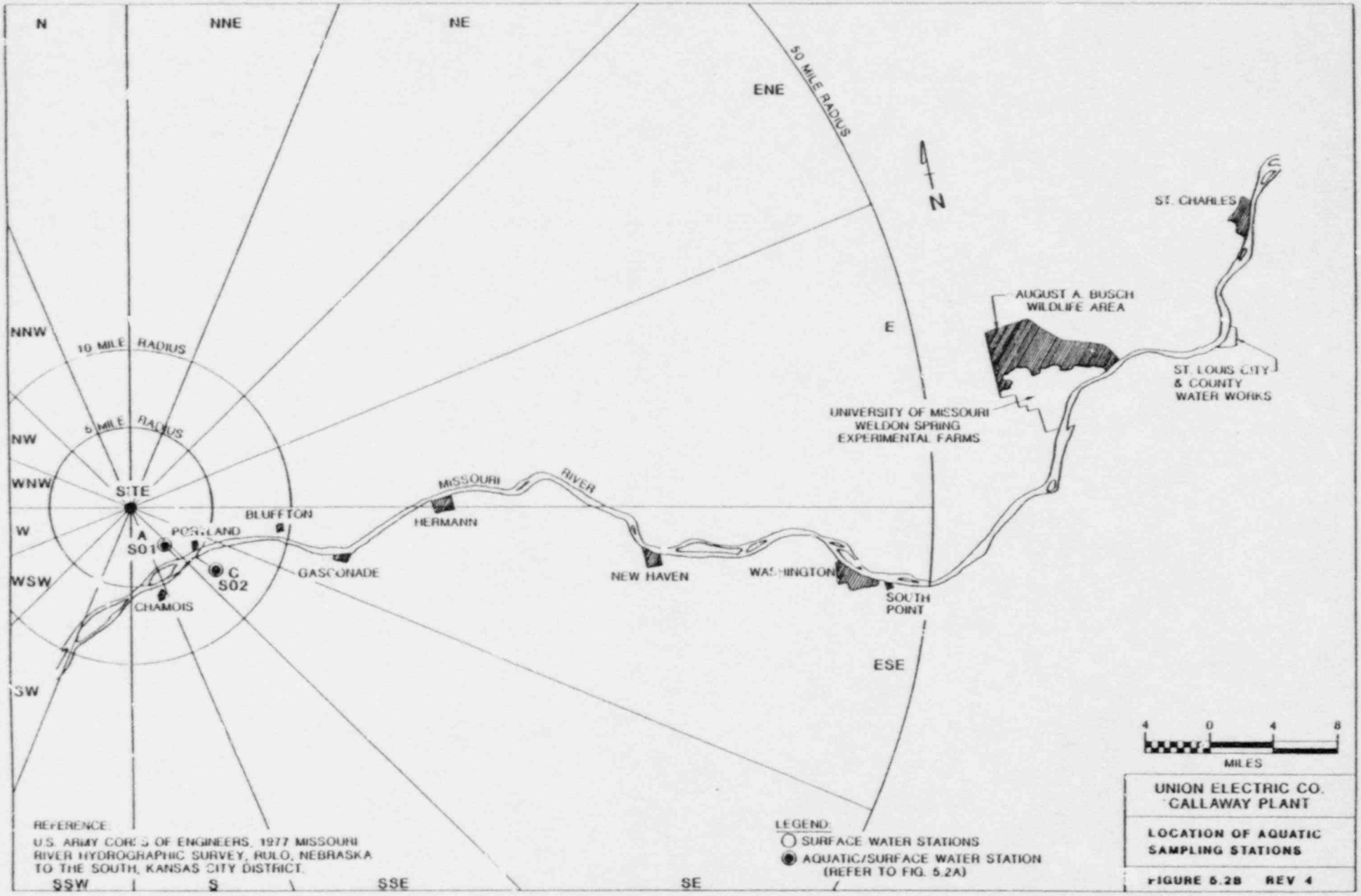
- △ TOWNS
- — ·· — INTERMITTENT STREAMS
- ——— CONTINUOUS STREAMS
- ● AQUATIC SAMPLING STATIONS
- ○ COMPOSITE SURFACE WATER

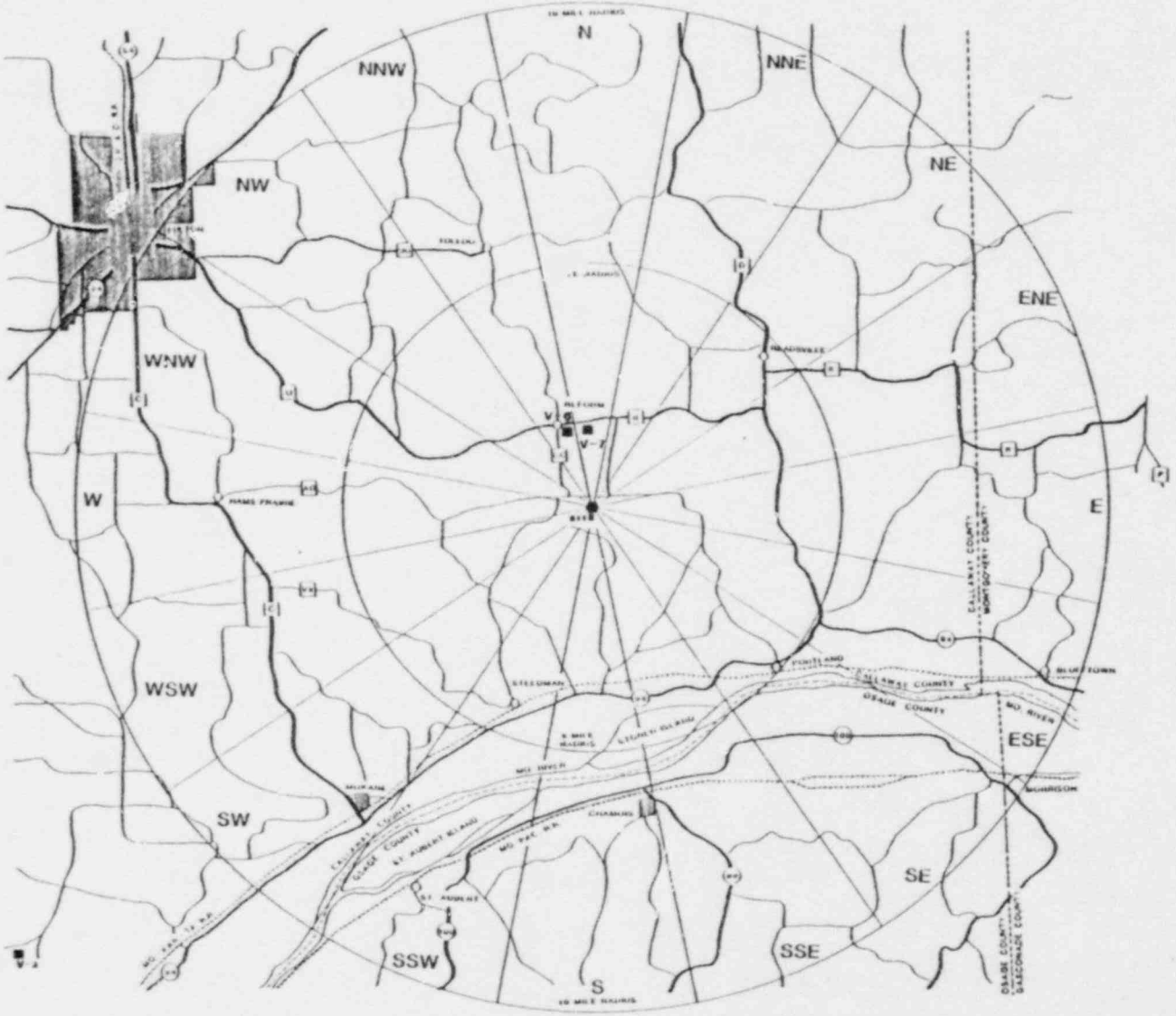
1 0 1
MILES

UNION ELECTRIC CO.
CALLAWAY PLANT

LOCATION OF AQUATIC SAMPLING STATIONS

FIGURE 5.2A REV 4


N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
50 MILE RADIUS
10 MILE RADIUS
5 MILE RADIUS
SITE
A
S01
C
S02
PORTLAND
BLUFFTON
GASCONADE
CHAMOIS
MISSOURI RIVER
HERMANN
NEW HAVEN
WASHINGTON
SOUTH POINT
UNIVERSITY OF MISSOURI
WELDON SPRING
EXPERIMENTAL FARMS
AUGUST A. BUSCH
WILDLIFE AREA
ST. CHARLES
ST. LOUIS CITY
& COUNTY
WATER WORKS
4 0 4 8
MILES
REFERENCE:
U.S. ARMY CORPS OF ENGINEERS, 1977 MISSOURI RIVER HYDROGRAPHIC SURVEY, RULO, NEBRASKA TO THE SOUTH, KANSAS CITY DISTRICT.
LEGEND:
SURFACE WATER STATIONS
AQUATIC/SURFACE WATER STATION
(REFER TO FIG. 5.2A)
UNION ELECTRIC CO.
CALLAWAY PLANT
LOCATION OF AQUATIC
SAMPLING STATIONS
FIGURE 5.2B REV 4



UNION ELECTRIC CO.
CALLAWAY PLANT

FOOD PRODUCTS
SAMPLING LOCATIONS

FIGURE 5.3 REV 4

6.0 DETERMINATION OF ANNUAL AVERAGE AND SHORT TERM ATMOSPHERIC DISPERSION PARAMETERS

6.1 Atmospheric Dispersion Parameters

The values presented in Table 9 and Table 10 were determined through the analysis of on-site meterological data collected during the three year period of May 4, 1973 to May 5, 1975 and March 16, 1978 to March 16, 1979.

The PUFF (fluctuating plume) model and the straight-line Gaussian (constant mean wind direction) model were used for determination of the long-term atmospheric dispersion parameters. A more detailed discussion of the methodology and data utilized to calculate these parameters can be found elsewhere (Ref. 9.6.12).

The terrain within 80 km of the site is gently rolling with no important ranges of hills or mountains. There are several small lakes and reservoirs in the region, however none are large enough to significantly affect the ambient dispersion parameters (Ref. 9.6.13).

6.1.1 Long Term Dispersion Estimates

6.1.1.1 The PUFF Model

The general equation for the PUFF model is (Ref. 9.10.1):

$$X/Q = 2[(2\Pi)^{3/2}\sigma_H^{\ 2}\sigma_z]^{-1} \exp - 1/2(r^2/\sigma_H^2 + h_e^2/\sigma_z^2) \qquad (6.1)$$

Where:

$r^2 =$ $(x-ut)^2 + y^2$

and $\sigma_H = \sigma_y = \sigma_x$

$h_e =$ Effective release height (in meters).

$Q =$ Effluent emission over the time interval (in Curies).

$t =$ Travel time (in seconds).

$u =$ mean windspeed at the height of the release point (in m/sec).

x = Distance from center of PUFF in the direction of flow (n meters).

y = Distance from center of PUFF in the crossflow direction (in meters).

σ_x = Plume spread along the direction of flow (in meters).

σ_y = Lateral plume spread (in meters).

σ_z = Vertical plume spread (in meters).

X = Atmospheric concentration of effluent in a PUFF at ground level and at distance, x, from the PUFF center (in Ci/m^3).

Calculations utilizing the PUFF model were performed for 22 standard distances to obtain the desired dispersion parameters. Dispersion parameters at the SITE BOUNDARY and at special receptor locations were estimated by logarithmic interpolation according to (Ref. 9.6.14):

$$X = X_1 \left(\frac{d}{d_1}\right)^B \qquad (6.2)$$

Where:

B = $\ln (X_2/X_1)/\ln (d_2/d_1)$.

X_1, X_2 = Atmospheric concentrations at distances d_1 and d_2, respectively, from the source (in Ci/m^3).

The distances d_1 and d_2 were selected such that $d_1 < d < d_2$.

6.1.1.2 The Straight-Line Gaussian Diffusion Model.

The U.S. Nuclear Regulatory Commission computer program XOQDOQ (Ref. 9.17) was used to determine the ground-level relative atmospheric dispersion factors, X/Q, and deposition factors, D/Q, from the unit vent and from the radwaste building vent release points. XOQDOQ utilizes a straight-line trajectory Gaussian plume model in which diffusion of material released to the atmosphere is described by a Gaussian distribution within the plume and plume transport is described by a

straight-line trajectory. The plume concentration was also depleted by dry deposition and radioactive decay.

6.1.1.2.1 Mixed Mode and Elevated Release Model.

The Unit Vent and Radwaste Building Vent releases are at elevations 66.5 meters and 20 meters above grade, respectively. Both release points are within the building wake of the structures on which they are located, and the Unit Vent is equipped with a rain cover which effectively eliminates the possibility of the exit velocity exceeding five times the horizontal wind speed. All gaseous releases are thus considered to be ground-level releases, and therefore no mixed mode or elevated release dispersion parameters were determined. (Ref. 9.5.2)

6.1.1.2.2 Gound-Level Release Model.

Gound-level release concentrations were determined according to (Ref. 9.17.1):

$$\overline{X/Q}(x,K) = \frac{2.032}{x} RF(x,K) \sum_{i,j}^{N7} DEPL_{ij}(x,K)\, DEC_i(x)\, f_{ij}(K) \left[\bar{U}_i(\sigma_{z_j}^2(x) + CD_z^2/\pi)^{1/2}\right]^{-1} \quad (6.3)$$

$$\overline{X/Q}(x,K) = \frac{2.032}{x} RF(x,K) \sum_{i,j}^{N7} DEPL_{ij}(x,K) DEC_i(x) f_{ij}(K) \left[\sqrt{3}\bar{U}_i \sigma_{z_j}(x)\right]^{-1} \quad (6.4)$$

Where:

(X/Q) (x,K) = average effluent concentration normalized by source strength at distance x in directional sector K (seconds/cubic meter).

x = the downwind distance (meters).

i = the ith wind-speed class.

j = the jth atmospheric stability class, grouped into seven classes according to Regulatory Guide 1.23.

K = kth wind-direction class.

U_i = mid-point value of the ith wind-speed class.

$\sigma z_j(x)$ = the vertical plume spread for stability class j at distance x (meters).

6.1.1.2.3 Decay, Depletion and Deposition Methodology.

The reduction factor due to radioactive decay was determined according to (Ref. 9.17.2):

$$DEC_i(x) = EXP\ (-0.693\ t_i/T) \qquad (6.5)$$

Where:

t_i = $x/(86400 \cdot U_i)$

T = half-life, in days, of the radioactive material.

t_i = travel time, in days.

x = downwind or travel distance, in meters.

U_i = Midpoint of the ith wind-speed class in meters/second.

Halflives of 2.26 days (decayed and undepleted) and 8.0 days (decayed depleted) were utilized.

The effect of plume depletion due to dry deposition was also considered, using the plume depletion curves presented in Ref. 9.10.2.

For each directional sector, relative deposition was computed by the following relationship for a specific downwind distance (Ref. 9.17.3):

$$\overline{D/Q}(x,K) = \frac{RF(x,K) \sum_{ij}^{N7} D_{ij} f_{ij}(K)}{(2\pi/16)\, x} \qquad (6.6)$$

Where:

$(D/Q)(x,K)$ = average relative deposition per unit area at a downwind distance x and direction K, in meters.

D_{ij} = The relative deposition rate from Ref. 9.10.3 for the ith wind-speed class (since plume height is dependent on wind speed) and the jth stability class, in meters.

$f_{ij}(K)$ = joint probability of the ith wind-speed class, jth stability class, and Kth wind-direction sector.

x = downwind distance, in meters.

= 3.14159265

RF(x,K) = correction factor for air recirculation and stagnation at distance x and Kth wind direction.

The resultant deposition amounts were modified according to site specific terrain/recirculation factors as given in Ref. 9.6.25 and 9.6.26.

$f_{ij}(k)$ = joint probability of occurrence of the ith wind-speed class, jth stability class, and Kth wind-direction sector.

$DEC_i(x)$ = reduction factor due to radioactive decay at distance x for the ith wind-speed class.

$DEPL_{ij}(x,K)$ = reduction factor due to plume depletion at distance x for the ith wind-speed class, jth stability class, and Kth wind-direction class.

$RF(x,K)$ = correction factor for recirculation and stagnation at downwind distance x and Kth wind-direction class. Site specific terrain/recirculation factors used are given in Ref. 9.6.25 and 9.6.26.

D_z = building height used to compute additional atmospheric dispersion due to the building wake, based on Yanskey et al. (1966).

Equation (6.4) represents the maximum additional dispersion due to the building wake. XOQDOQ compares the results from Equations (6.3) and (6.4) and retains the higher (more conservative) X/Q value.

The required joint frequency distribution of meteorological data is based on the three years of on-site date (Refer to Section 6.1).

6.1.2 Short Term Dispersion Estimates

Airborne releases are classified as short term if they are less than or equal to 500 hours during a calendar year and not more than 150 hours in any quarter. Short term dispersion estimates are determined by multiplying the appropriate long term dispersion estimate by a correction factor (Ref. 9.9.1 and 9.17.4):

$$F = (T_s/T_a)^S \qquad (6.7)$$

Where:

T_S = The total number of hours of the short term release.

T_a = The total number of hours in the data collection period from which the long term diffusion estimate was determined (Refer to Section 6.1).

Values of the slope factor (S), are presented in TABLE 11.

Short term dispersion estimates are applicable to short term releases which are not sufficiently random in both time of day and duration (e.g., the short term release periods are not dependent solely on atmospheric conditions or time of day) to be represented by the annual average dispersion conditions. (Ref. 9.8.12.)

6.1.2.1 The Determination of the Slope Factor (S).

The general approach employed by subroutine PURGE of XOQDOQ (Ref. 9.17.4) was utilized to produce values of the slope of the (X/Q) curves (Slope Factor (S)) for both the Radwaste Building Vent and the Unit Vent. However, instead of using approximation procedures to produce the 15 precentile (X/Q) values, the 15 percentile (X/Q) value for each release and at each location was determined by ranking all the 1-hour $(X/Q)_1$ values for that release and at the location in descending order. The $(X/Q)_1$ value which corresponded to the 15 percentile of all the calculated (X/Q) values within a sector was extracted for use in the intermittent release (X/Q) calculation.

The intermittent release (X/Q) curve was constructed using the calculated 1-hour 15 percentile $(X/Q)_1$ and its corresponding annual average $(X/Q)_a$. A graphic representation, of how the computational procedure works is illustrated by Figure 4.8 of reference 9.17.4. The straight line connecting these points represents $(X/Q)_i$ values for intermittent releases, ranging in duration from one (1) hour to 8760 hours. The slope (S) of the curve is expressed as:

$$S = \left\{ \frac{-\log \left((X/Q)_1 / (X/Q)_a \right)}{\log (Ta/T_1)} \right\} \qquad (6.8)$$

or

$$S = \left\{ \frac{-(\log (X/Q)_1 - \log (X/Q)_a)}{\log Ta - \log T_1} \right\} \qquad (6.9)$$

TABLE 9

HIGHEST ANNUAL AVERAGE ATMOSPHERIC DISPERSION PARAMETERS (a)

RADWASTE BUILDING VENT

LOCATION (b)	SECTOR	DISTANCE (METERS)	X/Q	X/Q Decayed/Undepleted	X/Q Decayed/Depleted	D/Q
			(sec/m^3)	(sec/m^3)	(sec/m^3)	(m^{-2})
SITE BOUNDARY	S	1300	1.3E-6	1.3E-6	1.2E-6	4.4E-9
Nearest Cow (c)	NW	5053	4.3E-7	4.2E-7	3.3E-7	1.1E-9
Nearest Goat (c)	NW	5053	4.3E-7	4.2E-7	3.3E-7	1.1E-9
Nearest Meat Animal	NNW	2736	7.6E-7	7.6E-7	6.4E-8	2.4E-9
Nearest Vegtable (c) Garden	NNW	2865	8.2E-7	8.1E-7	6.8E-7	2.5E-9
Nearest Residence(c)	NNW	2865	8.2E-7	8.1E-7	6.8E-7	2.5E-9
Owner Controlled Area fence (c)	NNW	594	1.1E-5	1.1E-5	1.1E-5	4.0E-8

(a) Values given are from FSAR, Table 2.3-84, and Table 2.3-86

(b) Data from 1986 Land Use Census

(c) Values derived from FSAR, Table 2.3-81, using the methodology presented in Equation (6.2) (Ref. 9.16.2 and 9.16.3)

Building Shape Parameter (C) = 0.5 (Ref. 9.5.4)
Vertical Height of Highest Adjacent Building (V) = 19.96 meters (Ref. 9.5.4)

TABLE 10

HIGHEST ANNUAL AVERAGE ATMOSPHERIC DISPERSION PARAMETERS (a)

UNIT VENT

LOCATION (b)	SECTOR	DISTANCE (METERS)	X/Q (sec/m^3)	X/Q Decayed/Undepleted (sec/m^3)	X/Q Decayed/Depleted (sec/m^3)	D/Q (m^{-2})
SITE BOUNDARY	S	1300	9.9E-7	9.8E-7	8.8E-7	4.4E-9
Nearest Cow (c)	NW	5053	3.6E-7	3.6E-7	2.8E-7	1.1E-9
Nearest Goat (c)	NW	5053	3.6E-7	3.6E-7	2.8E-7	1.1E-9
Nearest Meat Animal	NNW	2736	5.9E-7	5.9E-7	5.0E-7	2.4E-9
Nearest Vegtable (c) Garden	NNW	2865	6.4E-7	6.3E-7	5.3E-7	2.5E-9
Nearest Residence(c)	NNW	2865	6.4E-7	6.3E-7	5.3E-7	2.5E-9
Owner Controlled Area fence (c)	NNW	594	8.2E-6	8.2E-6	7.6E-6	4.0E-8

(a) Values given are from FSAR, Table 2.3-82, and Table 2.3-85
(b) Data from 1986 Land Use Census
(c) Values derived from FSAR, Table 2.3-83, using the methodology presented in Equation (6.2) (Ref. 9.16.2 and 9.16.3)

Building Shape Parameter (C) = 0.5 (Ref. 9.5.4)
Vertical Height of Highest Adjacent Building (V) = 56.45 meters (Ref. 9.5.4)

TABLE 11

SHORT TERM DISPERSION PARAMETERS (a) (c)

Location (b)	Sector	Distance (meters)	Slope Factor(S) Unit Vent	Slope Factor(S) Radwaste Building Vent
Site Boundary	S	1300	-.328	-.320
Nearest Cow	NW	5053	-.263	-.266
Nearest Goat	NW	5053	-.263	-.266
Nearest Meat Animal	NNW	2736	-.262	-.268
Nearest Vegetable Garden	NNW	2865	-.264	-.268
Nearest Residence	NNW	2865	-.264	-.268

(a) Reference 9.5.4
(b) Data from 1986 Land Use Census
(c) Recirculation Factor = 1.0

TABLE 12

APPLICATION OF ATMOSPHERIC DISPERSION PARAMETERS

DOSE PATHWAY	ODCM REFERENCE	DISPERSION PARAMETER	CONTROLLING AGE GROUP
Noble Gas, Beta Air	3.5.2.1	X/Q, decayed/undepleted	--
Noble Gas, Gamma Air	3.5.2.1	X/Q, decayed/undepleted	--
Noble Gas, Total Body	3.4.1 & 3.5.1.1	X/Q, decayed/undepleted	--
Noble Gas, Skin	3.4.1 & 3.5.1.1	X/Q, decayed/undepleted	--
Ground Plane Deposition	3.5.2.2.1	D/Q	--
Inhalation	3.5.2.2.1	X/Q, decayed/depleted	Child
Vegetation	3.5.2.2.1	D/Q*	Child
Milk	3.5.2.2.1	D/Q*	Child
Meat	3.5.2.2.1	D/Q*	Child

*For H-3 and C-14, X/Q, decayed/depleted is used instead of D/Q (Reference 9.11.1).

7.0 SEMI-ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

Routine Radioactive Effluent Release Reports covering the operation of the unit during the previous 6 months of operation are submitted within 60 days after January 1 and July 1 of each year. The period of the first report begins with the date of initial criticality.

The Radioactive Effluent Release Reports include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof. For solid wastes, the format for Table 3 in Appendix B is supplemented with three additional categories: class of solid waste (as defined by 10 CFR Part 61), type of container (e.g., LSA, Type A, Type B, Large Quantity), and SOLIDIFICATION agent or absorbent (e.g., cement, urea formaldehyde).

The Radioactive Effluent Release Report to be submitted within 60 days after January 1 of each year includes an annual summary of hourly meteorological data collected over the previous year which may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation, or in the form of joint frequency distributions of wind speed wind direction, and atmospheric stability.* This same report includes an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the unit or station during the previous calendar year. This same report also includes, the asessment of the radiation doses from radioactive liquid and gaseous effluents to MEMBERS OF THE PUBLIC due to their activities inside the SITE BOUNDARY during the report period. All assumptions used in making these assessments, i.e., specific activity, exposure time and location, is included in these reports. Acceptable methods for calculating the dose contributions from liquid and gaseous effluents are given in Regulatory Guide 1.109, and the ODCM.

The Radioactive Effluent Release Report to be submitted 60 days after January 1 of each year also includes, as required by Technical Specification 3.11.4, an assess-

ment of radition doses to the likely most exposed MEMBER OF THE PUBLIC from Reactor releases and other nearby uranium fuel cycle sources, including doses from primary effluent pathways and direct radiation, for the previous calender year to show conformance with 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operation".

The Radioactive Effluent Release Reports include a list and description of unplanned releases from the site to UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

The Radioactive Effluent Release Reports include any changes made during the reporting period to the PROCESS CONTROL PROGRAM and to the ODCM, pursuant to Specification 6.13 and 6.14, respectively, as well as any major change to Liquid, Gaseous, or Solid Radwaste Treatment System, pursuant to Specificatior 6.15. It also includes a listing of new locations for dose calculations and or environmental monitoring identified by the Land Use Census pursuant to Specification 3.12.2.

The Radioactive Effluent Release Reports also include the following information: An explanation as to why the inoperability of liquid or gaseous effluent monitoring instrumentation was not corrected within the time specified in Specification 3.3.3.10 or 3.3.3.11, respectively; and description of the events leading to liquid holdup tanks or gas storage tanks exceeding the limits of Specification 3.11.1.4 or 3.11.2.5, respectively.

*In lieu of submission, the Union Electric Company has the option of retaining this summary of required meteorological data on site in a file that shall be provided to the NRC upon request.

(Ref.9.4)

8.0 IMPLEMENTATION OF ODCM METHODOLOGY

The ODCM provides the mathematical relationships used to implement the Radiological Effluent Technical Specifications.

For routine effluent release and dose assessment, computer codes are utilized to implement the ODCM methodologies. These codes have been evaluated by a qualified independent reviewer to ensure that they produce results consistent with the methodologies presented in the ODCM. (Ref. 9.5.5)

9.0 REFERENCES

9.1 Title 10, "Energy", Chapter 1, Code of Federal Regulations, Part 20; U.S. Government Printing Office, Washington, D.C. 20402.

9.2 Title 10, "Energy", Chapter 1, Code of Federal Regulations, Part 50, Appendix I; U.S. Government Printing Office, Washington, D.C. 20402.

9.3 Title 40, "Protection of Environment", Chapter 1, Code of Federal Regulations, Part 190; U.S. Government Printing Office, Washington, D.C. 20402.

9.4 Callaway Technical Specifications, Section 3.3.3.9, 3.3.3.10, 3/4.11, 3/4.12, and 6.9.1.7 as submitted to the U.S. Nuclear Regulatory Commisssion, August 1983.

9.5 Communications

9.5.1 Letter NEO-54, D.W. Capone to S.E. Miltenberger, dated January 5, 1983; Union Electric Company correspondence.

9.5.2 Letter BLUE 1285, "Callaway Annual Average X/Q and D/Q Values", J. H. Smith (Bechtel Power Corporation), to D. W. Capone (Union Electric Co.), dated February 27, 1984.

| 9.5.3 (Reference Deleted)

9.5.4 Letter BLUE 1232, "Callaway Annual Average X/Q Values and "S" Values", J. H. Smith (Bechtel Power Corporation) to D. W. Capone (Union Elecctric Co.), dated February 9, 1984.

9.5.5 Letter BLUE 1358, "Comparison of Callaway Plant Offsite Dose Calculations for Routine Effluents", J.H. Smith (Bechtel Power Corporation) to D.W. Capone (Union Electric Company), dated March 22, 1984.

| 9.5.6 Private Communication, H.C. Lindeman & B.F. | Holderness, August 6, 1986

9.6 Union Electric Company Callaway Plant, Unit 1, Final Safety Analysis Report.

9.6.1 Section 11.5.2.2.3.1

9.6.2 Section 11.5.2.2.3.4

9.6.3 Section 11.5.2.1.2

9.6.4 Section 11.5.2.2.3.2

9.6.5 Section 11.5.2.2.3.3

9.6.6 Section 11.2.3.3.4

9.6.7 Section 11.2.3.4.3

9.6.8 Section 11.5.2.3.3.1

9.6.9 Section 11.5.2.3.3.2

9.6.10 Section 11.5.2.3.2.3

9.6.11 Section 11.5.2.3.2.2

9.6.12 Section 2.3.5

9.6.13 Section 2.3.5.1

9.6.14 Section 2.3.5.2.1.2

9.6.15 (Reference Deleted)

9.6.16 (Reference Deleted)

9.6.17 Section 9.2.6

9.6.18 Section 9.2.7.2.1

9.6.19 Section 6.3.2.2

9.6.20 Table 11.1-6

9.6.21 Table 9.4-6

9.6.22 Table 9.4-8

9.6.23 Table 9.4-11

9.6.24 Table 9.4-12

9.6.25 Table 2.3-66

9.6.26 Table 2.3-68

9.7 Union Electric Company Callaway Plant Environmental Report, Operating License Stage.

9.7.1 Table 2.1-19

9.7.2 Section 2.1.2.3

| 9.7.3 (Reference Deleted)

9.7.4 Section 2.1.3.3.4

| 9.7.5 (Reference Deleted)

9.7.6 Section 5.2.4.1

9.7.7 Table 2.1-19

9.8 U.S. Nuclear Regulatory Commission, "Preparation of Radiological Effluent Technical Specification For Nuclear Power Plants", USNRC NUREG-0133, Washington, D.C. 20555, October 1978.

9.8.1 Pages AA-1 through AA-3

9.8.2 Section 5.3.1.3

9.8.3 Section 4.3

9.8.4 Section 4.3.1

9.8.5 Section 5.3.1.5

9.8.6 Section 5.1.1

9.8.7 Section 5.1.2

9.8.8 Section 5.2.1

9.8.9 Section 5.2.1.1

9.8.10 Section 5.3.1

9.8.11 Section 3.8

9.8.12 Section 3.3

9.9 U.S. Nuclear Regulatory Commission, "XOQDOQ, Program For the Meterological Evaluation Of Routine Effluent Releases At Nuclear Power Stations", USNRC NUREG-0324, Washington, D.C. 20555.

9.9.1 Pages 19-20 Subroutine PURGE

9.10 Regulatory Guide 1.111, "Methods For Estimating Atmospheric Transport And Dispersion of Gaseous Effluents In Routine Releases From Light-Water-Cooled Reactors", Revision 1, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, July, 1977.

9.10.1 Section c.1.b

9.10.2 Figures 3 through 6

9.10.3 Figures 7 through 10

9.10.4 (Reference Deleted)

9.10.5 Section c.4

9.11 Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases Of Reactor Effluents For the Purpose Of Evaluating Compliance With 10 CFR Part 50, Appendix I", Revision 1, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, October 1977.

9.11.1 Appendix C, Section 3.a

9.11.2 Appendix E, Table E-15

9.11.3 Appendix C, Section 1

9.12 U.S. Nuclear Regulatory Commission, "Methods for Demonstrating LWR Compliance with the EPA Uranium Fuel Cycle Standard (40 CFR Part 190)", USNRC NUREG-0543, Washington, D.C. 20555, January 1980.

9.12.1 Section I, Page 2

9.12.2 Section IV, Page 8

9.12.3 Section IV, Page 9

9.12.4 Section III, Page 6

9.13 U.S. Nuclear Regulatory Commission, "Standard Radiological Effluent Technical Specifications for Pressurized Water Reactors", USNRC NUREG-0472, Draft Revision 3, Washington, D.C. 20555, January 1983.

9.13.1 Definition 1.7, Page 1-2

9.14 Management Agreement for the Public Use of Lands, Union Electric Company and the State of Missouri Department of Conservation, December 21, 1982.

9.14.1 Exhibit A

| 9.15 (Reference Deleted)

9.16 Miscellaneous References

9.16.1 Drawing Number M-109-0007-06, Revision 5.

| 9.16.2 HPCI 87-01, "Determination of Annual Average Dispersion Parameters at the Owner Controlled Area Fence", January 28, 1987.

| 9.16.3 HPCI 87-02, "1986 Land Use Census and Dispersion Parameters", January 28, 1987.

| 9.16.4 UENE Safety Analysis Calculation 87-001-00.

9.17 U.S. Nuclear Regulatory Commission, "XOQDOQ: Computer Program for the Meterological Evaluation of Routine Effluent Releases at Nuclear Power Stations", USNRC NUREG/CR-2929, September, 1982, Washington, D.C. 20555.

9.17.1 Section 4.1, "Subroutine ANNUAL", pages 23-25.

9.17.2 Section 4.1, "Subroutine ANNUAL", page 25.

9.17.3 Section 4.2, "Subroutine DEPOS", page 26.

9.17.4 Section 4, "Subroutine PURGE", pages 27 and 28.