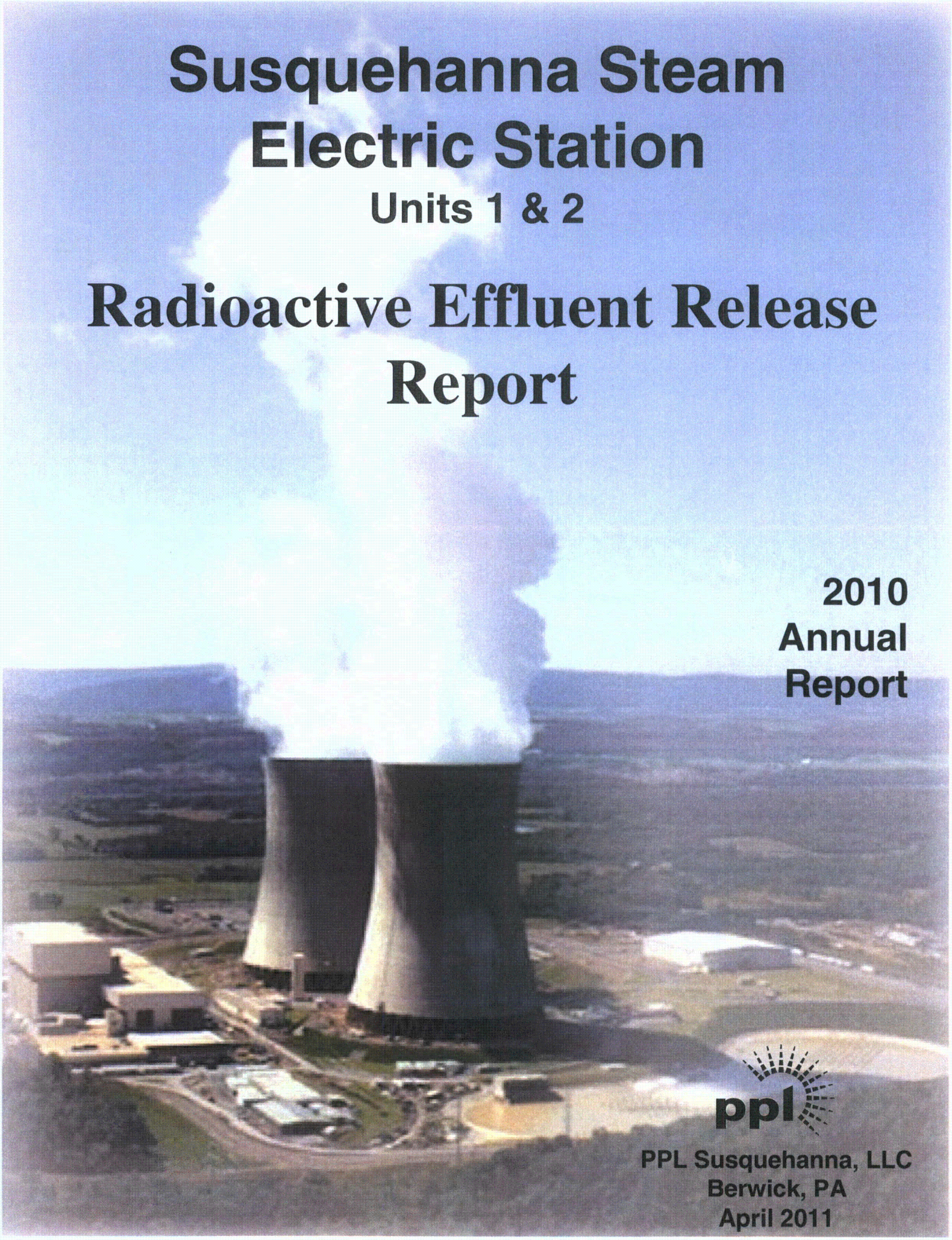
Susquehanna Steam Electric Station

Units 1 & 2

Radioactive Effluent Release Report

2010 Annual Report



PPL Susquehanna, LLC
Berwick, PA
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Attachment 1 to PLA-6710

Radioactive Effluent Release Report for SSES Units 1 and 2

RADIOACTIVE EFFLUENT RELEASE REPORT

REPORT PERIOD: 01/01/10 - 12/31/10

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SECTION 1

INTRODUCTION, SUMMARY AND SUPPLEMENTAL INFORMATION

INTRODUCTION

The submittal of the 2010 Radioactive Effluent Release Report is in accordance with PPL Susquehanna, LLC Tech Spec. 5.6.3. The enclosed information is consistent with the objectives outlined in the Offsite Dose Calculation Manual (ODCM) and Process Control Program (PCP). The 2010 Radioactive Effluent Release Report is in conformance with 10CFR50.36a and 10CFR50, Appendix I, Section IV.B.1.

PPL Susquehanna, LLC is located in Salem Township, Luzerne County, Pennsylvania. It is on the west bank of the Susquehanna River, 8 km northeast of Berwick. The station consists of two boiling water reactor generating units. Each unit is progressing through an Extended Power Uprate process which will result in an increase of licensed thermal power from 3489 MWt (megawatt thermal) to 3952 MWt. Unit-1 completed the power uprate in 2010 and Unit 2 is scheduled to complete the uprate in 2011. The reactor and generating units were supplied by General Electric, while the Bechtel Corporation served as architect-engineer and constructor.

Construction of the Station began in the early 1970s. Fuel load began in Unit 1 in July of 1982. Initial criticality was achieved in the Unit 1 reactor on September 10, 1982. The reactor reached 100% power for the first time on February 4, 1983. Commercial operation of Unit 1 was declared on June 8, 1983. Initial criticality of Unit 2 occurred on May 8, 1984. Unit 2 was declared commercial on February 12, 1985.

Airborne effluents are released from the Station via five rooftop vents on the reactor building (see Figure 1-1). Continuous sampling for particulates and iodines is performed at each vent as well as continuous monitoring for noble gases. A program of periodic sampling and analysis for tritium and noble gases along with periodic analysis of particulate and iodine samples is conducted as specified in the plant Technical Requirements. All waterborne effluents are released in batch mode and are sampled and analyzed prior to release. Waterborne effluents from the site are released into the cooling tower blowdown line for dilution prior to release to the Susquehanna River (see Figure 1-2). Blowdown line flow rates are at least 5,000 gpm during periods of liquid radwaste release. The diluted effluent is introduced to the river by way of a perforated diffuser pipe placed on the river bed. The diffuser serves to rapidly and uniformly mix the station discharge with the main flow of the river.

This report presents a summary of the quantities of radioactive materials which were released from the Station during the period from January 1, 2010 to December 31, 2010. In addition, this report serves as a medium for notifying the US Nuclear Regulatory Commission staff of changes to the ODCM, PCP and documentation of any exceptions to the effluent monitoring program which must be reported per Technical Requirements.

Airborne and waterborne radioactive effluent releases to the environment during the report period were sampled and analyzed in accordance with the Technical

Requirements. All radioactive effluent releases were within the concentration and release limits specified in the Technical Requirements. Calculations and terms utilized in this report are those outlined in the ODCM.

Section 1 contains supplemental information pertaining to effluents from the Susquehanna plant. Included are regulatory limits (Table 1-1), sampling and analysis methods, characterization of the number and duration of batch and abnormal releases and a brief summary of the applicable year's effluents.

Section 2 contains effluent and waste disposal data for the report period. Table 2-1 contains a summation of all airborne releases, grouped into the radionuclide categories of gases, particulates, iodines, and tritium. Average release rates are presented and compared to the applicable limits. Table 2-2 presents the activity totals of specific radionuclides in airborne effluents.

Waterborne effluents are summarized in Table 2-3. Average diluted concentrations are presented and compared to the applicable limits. Table 2-4 presents the release quantities of specific radionuclides in waterborne effluents over the report period. Figures 2-1 and 2-2 present the Susquehanna River Monthly Average Flow Rates for 2010 and the Monthly Liquid Radwaste Discharge Totals for 2010, respectively.

Table 2-5 contains estimates of the errors associated with the measurements involved in quantifying effluents. Sampling errors, counting errors, and errors associated with determining effluent flow rates and volumes all contribute to the total error of effluent measurements. Error estimates are presented for each category of radionuclide detected in airborne and waterborne effluents and solid wastes during the report period.

Tables 2-7 through 2-12 present a characterization of the solid radioactive waste shipped offsite during the report period. An estimate of major nuclide composition is presented for each waste type. Also included are the volumes and curie contents associated with each type of solid waste. The number of waste shipments from the site transported directly for burial or disposal are listed in Table 2-6.

Section 3 presents meteorological data for 2010, including data recovery, joint frequency distribution of wind speed and direction, stability class distribution, and atmospheric dispersion estimates for selected locations.

Section 4 of this report contains an assessment of the calculated doses attributed to the reported radiological effluents for the calendar year. The Radioactive Effluent Tracking and Dose Assessment Software (RETDAS) computer code was used for calculation of doses from waterborne effluents. Site-specific parameters used in the calculations for the Danville receiver are shown in Table 4-1. The RETDAS code was also used for calculation of doses from airborne effluents. The calculated doses and direct radiation estimates can be used to estimate the doses to maximally exposed members of the public. Table 4-2 summarizes maximum calculated doses to members of the public from airborne and waterborne effluents. Table 4-3 presents calculated collective doses

to members of the public within the Riverlands/Energy Information Center Complex. Table 4-4 summarizes the calculated doses for residences and other occupied areas within the site boundary and the nearest dairy.

Section 5 of this report documents changes to the Offsite Dose Calculation Manual, Technical Requirements Manual and the Solid Radioactive Waste Process Control Program.

Section 6 presents a listing of cases (if any) in which airborne or waterborne effluent monitoring instrumentation was declared inoperable and was not restored to operability within the time period specified in Technical Requirements 3.11.1.4, 3.11.1.5 and 3.11.2.6 Action Statements. In addition, this section presents issues (if any) with the collection of milk or fresh leafy vegetables per Technical Requirement 3.11.4.1 and changes due to the land use census per Technical Requirement 3.11.4.2. Section 6 also includes reporting associated with the Nuclear Energy Institute (NEI) Groundwater Protection Initiative.

Section 7 contains corrections (if any) to previous Radioactive Effluent Release Reports.

Section 8 contains information on effluent and offsite dose from the systems classified as insignificant effluent pathways.

SUMMARY

During 2010 there were two hundred six (206) liquid batch releases resulting in a total release volume of two million seven hundred two thousand (2,702,000) gallons. Fifty four (54) of the two hundred six (206) liquid batch releases were from the Unit-1 condenser area flood event which occurred in July 2010. The Unit-1 condenser flood event resulted in approximately nine hundred thousand (900,000) gallons of low activity water being discharged in addition to the water discharged from our liquid radwaste processing system. The total number of liquid batch releases and total volume released in 2010 was higher than the corresponding values for 2009 (83 releases resulting in 532,000 gallons released in 2009). The predominant radionuclide released in liquid effluents during 2010 was tritium. Approximately fifty-seven (57) curies of tritium were released in liquid effluents in 2010, compared to twenty-three (23) curies released in 2009. When compared with all radionuclides released in liquid effluents in 2010, Co-60, Zn-65 and Cs-137 were the main contributors to the resultant offsite dose. Consistent with previous years, the offsite dose from liquid releases in 2010 was less than one percent (1%) of the annual limits for both organ and whole body dose.

In 2010 an industry initiative was established to evaluate and report Carbon-14 (C-14) in the 2010 Radioactive Effluent Release Report. The initiative is rooted in Regulatory Guide 1.21, Revision 2, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste", in that the NRC has recommended that U.S. nuclear power plants evaluate whether C-14 is a "principal radionuclide", and if so, report the amount of C-14 released. The C-14 released from the Susquehanna station in 2010 was calculated using conservative guidance provided by the Electric Power Research Institute (EPRI Report No. 1021106). Based on the EPRI methodology, approximately 24.5 Curies of C-14 were released in gaseous effluents in 2010. Historically, tritium has been the predominant radionuclide (both in Curies and resultant offsite dose) released in gaseous effluents from the Susquehanna station. Approximately thirty-one (31) curies of tritium were released in gaseous effluents in 2010 compared to thirty-eight (38) curies in 2009. The resultant maximum offsite dose due to gaseous effluents in 2010 is primarily due to inclusion of the C-14 released from each unit (see section 4 for additional details on the calculation of C-14 released in airborne effluents). The resultant maximum offsite organ dose due to gaseous effluents from Unit-1 for 2010 was 3.00 mrem, which is twenty percent (20%) of the per unit annual limit of fifteen (15) mrem. The resultant maximum offsite organ dose due to gaseous effluents from Unit-2 for 2010 was 3.73 mrem, which is twenty-five percent (25%) of the per unit annual limit of fifteen (15) mrem. The maximum offsite dose from gaseous effluents was higher in 2010 when compared with 2009 due to the inclusion of the calculated release of C-14.

FIGURE 1-1

AIRBORNE EFFLUENT RELEASE POINTS

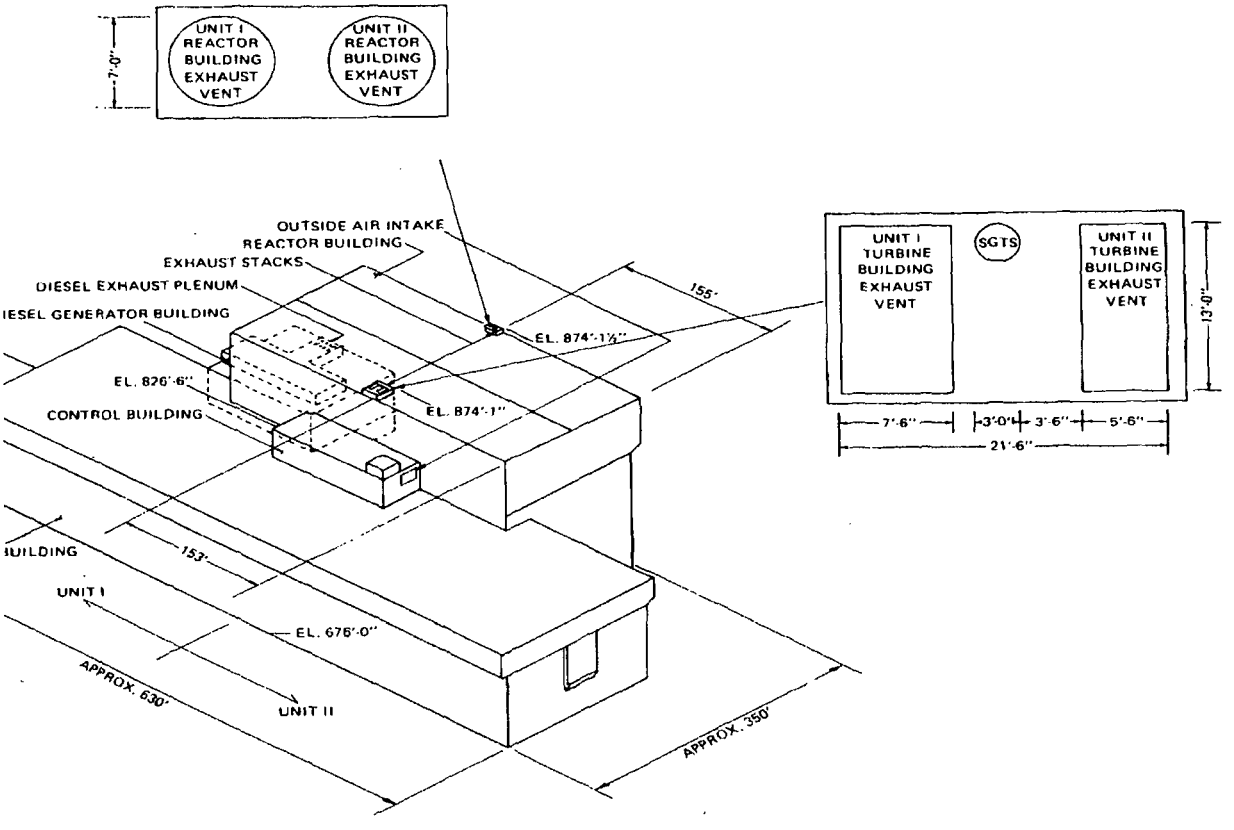
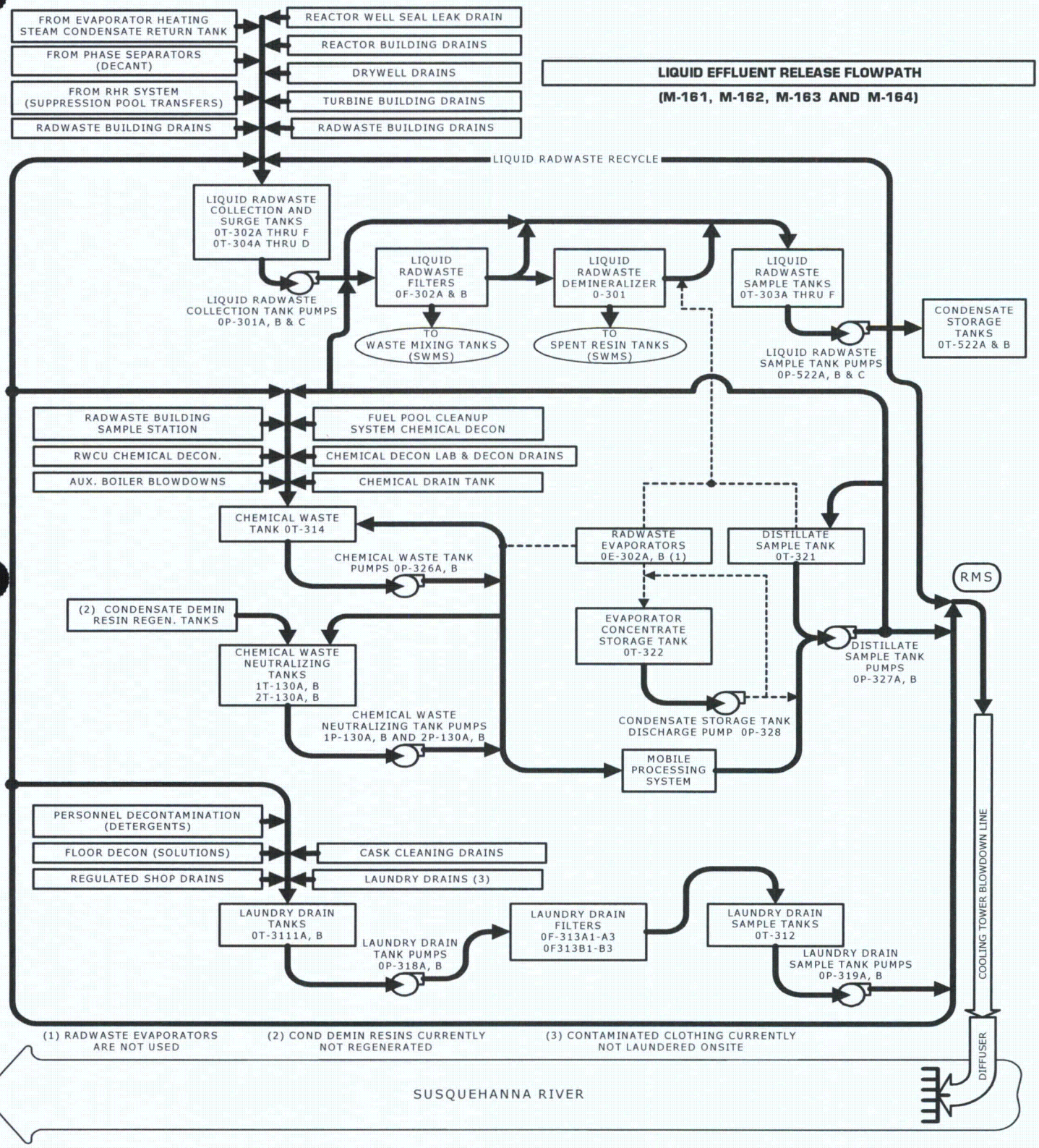


FIGURE 1-2

WATERBORNE EFFLUENT PATHWAY



SUPPLEMENTAL INFORMATION

1. Regulatory Limits

Technical Requirements 3.11.1 and 3.11.2 outline requirements for release of radioactive liquid and gaseous effluents, respectively. Concentration of radioactive materials released in liquid effluents and resulting dose are limited in unrestricted areas. Dose and dose rate due to radioactive materials released in gaseous effluents are limited in areas at or beyond the site boundary. Technical Requirement limits are listed in Table 1-1.

2. Maximum Permissible Concentrations in Waterborne Effluents

The concentration of radioactive material released in liquid effluents to unrestricted areas is limited to 10 times the concentrations specified in 10 CFR Part 20 Appendix B Table 2, Column 2, for radionuclides other than dissolved or entrained noble gases.

For dissolved or entrained noble gases, the concentration is limited to 2.0E-04 μCi/ml total activity (TRO 3.11.1.1).

3. Average Energy of Fission and Activation Gas

The Calculation of Noble Gas Effluent Average Energies E-Bar Beta and Gamma for 2010 resulted in an annual E-Bar Beta value of 5.38E-01 MeV and E-Bar Gamma value of 9.89E-01 MeV.

4. Measurements and Approximations of Total Radioactivity

Analyses of specific radionuclides in effluent samples are used to evaluate the radioactive composition and concentration of effluents.

5. Methods of Quantifying Effluents

a. **Fission and Activation Gases**: Gas samples are routinely collected monthly and analyzed with a high resolution (HPGE) detector system which incorporates a data reduction program to determine radionuclide composition in terms of specific activity. Data from the continuous vent monitors are used to determine the average concentration of noble gases. The high resolution (HPGE) isotopic scan is used to convert the continuous vent monitor activity to actual activity based on the determined nuclide mixture. The vent and sample flow rates are continuously monitored and the average flow rates for each vent are used to calculate the total activity released in a given time period. When the continuous monitors are out of service, manual grab samples are taken from each vent once every eight hours (once every four

hours for the standby gas treatment vent when standby gas treatment system is in service).

b. **Iodines**: Iodine is continuously collected on charcoal or silver zeolite cartridges via an isokinetic sampling assembly in each vent. Filters are normally exchanged once per week and analyzed on a high resolution (HPGE) system. The daily average flow rates for the vents and sample pumps are averaged for the duration of the sampling period and a ratio of vent flow rate to sample flow rate is determined. The ratio is used to determine the total activity of each isotope released during the time period in question. When the continuous samplers are out of service, iodine is continuously collected from alternate sampling ports available on the sample lines or directly from the affected rooftop vent(s).

c. **Particulates**: Particulates are continuously collected via an isokinetic sampling assembly in each vent. Filters are normally exchanged once per week and analyzed on a high resolution (HPGE) system. Flow rate corrections are performed as for iodines. When the continuous samplers are out of service, particulates are continuously collected from alternate sampling ports available on the sample lines or directly from the affected rooftop vent(s).

d. **Tritium**: Airborne tritium is collected monthly via bubbler sampler. The sample is collected for one hour at a flow rate of approximately 1000 cc/min. Tritium activity in the bubbler sample is determined by liquid scintillation counting. The liquid sample tritium concentration is then converted to air concentration by volume proportion.

e. **Waterborne Effluents**: Each tank of liquid radwaste is sampled and analyzed for principal gamma emitters prior to release. Each sample tank is recirculated for a sufficient amount of time prior to sampling to ensure that a representative sample is obtained. Samples are analyzed on a high resolution (HPGE) system and release permits are generated based on the values obtained from the isotopic analysis and the most recent values for tritium, gross alpha, iron-55, and strontium-89 and -90. An aliquot based on release volume is saved and added to monthly and quarterly composite containers. The monthly tritium analysis is done in-house. A monthly composite is sent to a vendor laboratory for gross alpha analysis. A quarterly composite is sent to a vendor laboratory for iron-55, strontium-89 and-90 analyses.

The concentration of each radionuclide in each batch is multiplied by the volume of the batch to determine the total quantity of each nuclide released in each batch. The isotopic totals for each batch are summed to determine the total source term for the report period.

TABLE 1-1

TECHNICAL REQUIREMENT LIMITS

A. NOBLE GASES:

1. ≤500 mrem/year - TOTAL BODY
   ≤3000 mrem/year - SKIN

   - dose rate limit at and beyond the site boundary
     (TRO 3.11.2.1.I)

2. ≤5 mrad - AIR GAMMA
   ≤10 mrad - AIR BETA

   - quarterly air dose limits per reactor unit at and beyond the site boundary
     (TRO 3.11.2.2a)

3. ≤10 mrad - AIR GAMMA
   ≤20 mrad - AIR BETA

   - annual air dose limits per reactor unit at and beyond the site boundary
     (TRO 3.11.2.2.b)

B. AIRBORNE I-131, I-133, TRITIUM, PARTICULATES WITH HALF-LIVES > 8 DAYS:

1. ≤1500 mrem/year - ORGAN
   (inhalation pathways only)

   - dose rate limit at and beyond the site boundary
     (TRO 3.11.2.1.II.A)

2. ≤7.5 mrem - ORGAN

   - quarterly dose limit per reactor unit at and beyond the site boundary
     (TRO 3.11.2.3.a)

3. ≤15 mrem - ORGAN

   - annual dose limit per reactor unit at and beyond the site boundary
     (TRO 3.11.2.3.b)

C. LIQUID EFFLUENTS:

1. ≤1.5 mrem - TOTAL BODY
   ≤5.0 mrem - ORGAN
   - quarterly dose limits per unit (TRO 3.11.1.2.a)

2. ≤3.0 mrem - TOTAL BODY
   ≤10.0 mrem - ORGAN
   - annual dose limits per unit (TRO 3.11.1.2.b)

D. AIRBORNE EFFLUENT: BASES FOR PERCENT OF APPLICABLE LIMIT VALUES IN TABLE 2-1

Fission and Activation Gases

Derived release rate limits based on the Technical Requirement (TRO 3.11.2.1.I.A and B) limits of 500 mrem/yr to the total body and 3000 mrem/yr to the skin were calculated (PPL calculation EC-ENVR-1041 Rev. 2) from the expected mix of noble gas radionuclides presented in Attachment A of ODCM-QA-003, Effluent Monitor Setpoints. The lower limit of 1.00E+06 µCi/min (1.67E+04 µCi/sec) based on total body dose rate is used.

Iodine-131

A derived release rate limit for I-131 based on the Technical Requirement (TRO 3.11.2.1.II.A) limit of 1500 mrem/yr from I-131, I-133, tritium and particulates with half-lives greater than 8 days was calculated (PPL calculation EC-ENVR-1041 Rev. 2) based on the ratio of the expected annual release quantities of I-131 and I-133 provided in Attachment E of ODCM-QA-004, Airborne Effluent Dose Calculations. The limit is 1.04E+02 µCi/min I-131 (1.73E+00 µCi/sec).

Particulates

A derived release rate limit for particulate activity other than iodines based on the Technical Requirement (TRO 3.11.2.1.II.A) limit of 1500 mrem/yr from I-131, I-133, tritium and particulates with half-lives greater than 8 days was calculated (PPL calculation EC-ENVR-1041 Rev. 2) based on the expected annual release quanities of particulate radionuclides provided in Attachment E of ODCM-QA-004, Airborne Effluent Dose Calculations. The limit is 3.02E+03 µCi/min (5.03E+01 µCi/sec).

Tritium

A derived release rate was calculated based on the 10 CFR 20, Appendix B, Table 2, Column 1, Effluent Concentration Limit for tritium (1.0E-07 µCi/cc) to unrestricted areas. A relative concentration of 4.1E-05 sec/m^3 was assumed (PPL calculation EC-ENVR-1040). The limit is 1.46E+05 µCi/min (2.44E+03 µCi/sec).

Radionuclide Fractional Summation

The sum of the percents of applicable limits for particulates, iodine and tritium must be less than 100%.

E. WATERBORNE EFFLUENT: BASES FOR PERCENT OF APPLICABLE LIMIT VALUES IN TABLE 2-3

Fission and Activation Products

Concentrations of fission and activation products in liquid effluent from radwaste effluent are determined for each batch prior to release. Each isotope concentration is compared to ten times the 10CFR20 Appendix B, Table 2, Column 2 Effluent Concentration Values (TRO 3.11.1.1).

Tritium

Liquid effluent quarterly tritium concentrations are compared to ten times the 10 CFR 20 Appendix B, Table 2, Column 2, Effluent Concentration value of 1.0E-03 µCi/ml to unrestricted areas.

Dissolved and Entrained Gases

Liquid effluent concentrations for dissolved and entrained gases are compared to the limiting value for total noble gas activity of 2.0E-04 µCi/ml (TRO 3.11.1.1).

Radionuclide Fractional Summation

The sum of the percents of applicable limits for fission and activation products, tritium and dissolved and entrained gases must be less than 100%.

SECTION 2

EFFLUENT AND WASTE DISPOSAL DATA

Airborne Effluents

Summaries of the radionuclide total curie activities and average release rates are included in Tables 2-1 and 2-2. Carbon-14 (C-14) activity released is not included in Tables 2-1 or 2-2. C-14 released in airborne effluents is calculated based on conservative methodology provided by the Electric Power Research Institute (EPRI Report No. 1021106). See Section 4 for additional details on the calculation of C-14 released in 2010 from the Susquehanna station. If a radionuclide was not detected, zero activity was used for that isotope in dose calculations and the activity is listed as "<MDC" (less than the minimum detectable concentration) in Tables 2-1 and 2-2. <MDC indicates that no activity was positively detected in any sample when samples were analyzed with techniques which achieved the required Lower Limits of Detection (LLD) as specified in the Technical Requirement (TRO) Table 3.11.2.1-1, Radioactive Gaseous Effluent Sampling and Analysis Program. In all cases, the measurement laboratory MDCs were at or below the LLD levels required by Technical Requirements. The following are typical measurement laboratory MDCs.

Typical MDCs

Radionuclide	MDC (µCi/cc)
Kr-87	4.3 E-08
Kr-88	4.6 E-08
Xe-133	3.0 E-08
Xe-133m	1.1 E-07
Xe-135	1.5 E-08
Xe-135m	8.0 E-08
Xe-138	1.5 E-07
Mn-54	2.9 E-13
Fe-59	2.8 E-13
Co-58	1.8 E-13
Co-60	3.8 E-13
Zn-65	1.0 E-13
Mo-99	1.0 E-12
Cs-134	2.4 E-13
Cs-137	1.1 E-13
Ce-141	1.0 E-13
Ce-144	5.0 E-13
I-131	4.4 E-14
Sr-89	1.1 E-13
Sr-90	1.3 E-14
H-3	1.5 E-08
Gross Alpha	2.3 E-14

Batch Releases

1. Number of Batch Releases:	0
2. Total Time Period for Batch Release:	NA
3. Maximum Time Period for a Batch Release:	NA
4. Average Time Period for a Batch Release:	NA
5. Minimum Time Period for a Batch Release:	NA

Abnormal Releases

1. Number of Releases	1*
2. Total Activity Released	NA

*The Unit-1 Hydrogen Water Chemistry (HWC) system was identified as being contaminated with tritium on 5/21/10. Airborne release to the environment due to contamination of the Unit-1 HWC system is based on conservative assumptions and identified tritium concentration levels resulting in a release of 5.64 uCi. Offsite dose due to the release of 5.64 uCi of tritium from the Unit-1 HWC contamination event is included in the maximum dose to the public from insignificant effluents in Section 8.

TABLE 2-1

AIRBORNE EFFLUENT - SUMMATION OF ALL RELEASES

A. Fission and Activation Gas	Unit	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Total Release	Ci	<MDC	2.47E+00	<MDC	<MDC
Average Release Rate for Period	µCi/sec	0	3.14E-01	0	0
Percent of Applicable Limit (1.67E+04 µCi/sec)	%	0	1.88E-03	0	0

B. Iodines

Total I-131	Ci	<MDC	<MDC	<MDC	<MDC
Average Release Rate for Period	µCi/sec	0	0	0	0
Percent of Applicable Limit (1.73E+00 µCi/sec)	%	0	0	0	0

C. Particulate

Particulate with Half-Life >8 Days	Ci	8.92E-05	7.55E-05	<MDC	<MDC
Average Release Rate for Period	µCi/sec	1.15E-05	9.61E-06	0	0
Percent of Applicable Limit (5.03E+01 µCi/sec)	%	2.28E-05	1.91E-05	0	0
Gross Alpha Radioactivity	Ci	<MDC	<MDC	<MDC	<MDC

D. Tritium

Total Release	Ci	1.81E+01	5.16E+00	7.45E+00	2.98E-01
Average Release Rate for Period	µCi/sec	2.33E+00	6.56E-01	9.37E-01	3.75E-02
Percent of Applicable Limit (2.44E+03 µCi/sec)	%	9.55E-02	2.69E-02	3.84E-02	1.54E-03

E. Radionuclide Fractional Summation

Sum of Percent of Applicable Limit During Period for B, C and D (Limit = 100%)	%	0.10	0.03	0.04	0.002

TABLE 2-2

AIRBORNE EFFLUENT - RADIONUCLIDES RELEASED

		Releases in Continuous Mode			
Nuclides Released	**Unit**	**First Quarter**	**Second Quarter**	**Third Quarter**	**Fourth Quarter**
A. Fission and Activation Gases					
N-13	Ci	<MDC	2.33E+00	<MDC	<MDC
Ar-41	Ci	<MDC	9.42E-03	<MDC	<MDC
Kr-85	Ci	<MDC	<MDC	<MDC	<MDC
Kr-85m	Ci	<MDC	3.00E-04	<MDC	<MDC
Kr-87	Ci	<MDC	1.98E-03	<MDC	<MDC
Kr-88	Ci	<MDC	1.04E-03	<MDC	<MDC
Kr-89	Ci	<MDC	<MDC	<MDC	<MDC
Xe-133	Ci	<MDC	<MDC	<MDC	<MDC
Xe-135	Ci	<MDC	9.78E-04	<MDC	<MDC
Xe-135m	Ci	<MDC	6.18E-03	<MDC	<MDC
Xe-137	Ci	<MDC	9.42E-02	<MDC	<MDC
Xe-138	Ci	<MDC	2.30E-02	<MDC	<MDC
Total for Period	**Ci**	**0**	**2.47E+00**	**0**	**0**
B. Iodines					
I-131	Ci	<MDC	<MDC	<MDC	<MDC
I-133	Ci	<MDC	<MDC	<MDC	<MDC
I-135	Ci	<MDC	<MDC	<MDC	<MDC
Total for Period	**Ci**	**0**	**0**	**0**	**0**
C. Particulate					
Cr-51	Ci	8.92E-05	5.13E-05	<MDC	<MDC
Mn-54	Ci	<MDC	<MDC	<MDC	<MDC
Fe-59	Ci	<MDC	<MDC	<MDC	<MDC
Co-57	Ci	<MDC	<MDC	<MDC	<MDC
Co-58	Ci	<MDC	4.20E-06	<MDC	<MDC
Co-60	Ci	<MDC	2.00E-05	<MDC	<MDC
Zn-65	Ci	<MDC	<MDC	<MDC	<MDC
Sr-89	Ci	<MDC	<MDC	<MDC	<MDC
Sr-90	Ci	<MDC	<MDC	<MDC	<MDC
Cs-134	Ci	<MDC	<MDC	<MDC	<MDC
Cs-137	Ci	<MDC	<MDC	<MDC	<MDC
Ce-141	Ci	<MDC	<MDC	<MDC	<MDC
Ce-144	Ci	<MDC	<MDC	<MDC	<MDC
Nb-95	Ci	<MDC	<MDC	<MDC	<MDC
Ba-La-140	Ci	<MDC	<MDC	<MDC	<MDC
Total for Period	**Ci**	**8.92E-05**	**7.55E-05**	**0**	**0**

Waterborne Effluents

Summaries of the radionuclide total curie activities, average diluted concentrations, and percent of applicable Technical Requirement limits are included in Tables 2-3 and 2-4.

	Batch Releases*	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Annual
1.	Number of Batch Releases	34	50	107	15	206
2.	Total Time Period for a Batch Release	2.99E+03	9.42E+03	1.26E+04	1.21E+03	2.62E+04
3.	Maximum Time Period for a Batch Release	3.13E+02	3.08E+02	3.15E+02	3.03E+02	3.15E+02
4.	Average Time Period for a Batch Release	8.78E+01	1.88E+02	1.18E+02	8.03E+01	1.27E+02
5.	Minimum Time Period for a Batch Release	1.20E+01	3.00E+01	1.70E+01	2.80E+01	1.20E+01
6.	Average Cooling Tower Blowdown Flow Rate During Periods of Release	7.35E+03	6.18E+03	8.47E+03	1.17E+04	7.67E+03
7.	Susquehanna River Flow Rate	1.01E+07	5.36E+06	1.15E+06	8.88E+06	6.35E+06

*Units of time and flow are expressed in minutes and gallons per minute (gpm), respectively.

If a radionuclide was not detected, zero activity was used for that isotope in dose calculations and the activity is listed as "<MDC" (less than the miniumum detectable concentration) in Tables 2-3 and 2-4. <MDC indicates that no activity was positively detected in any sample when samples were analyzed with techniques which achieved the required Lower Limits of Detection (LLD) as specified in the Technical Requirement 3.11.1.1-1, Radioactive Liquid Waste Sampling and Analysis Program. In all cases, the measurement laboratory MDCs were at or below the LLD levels required by Technical Requirements. The following are typical measurement laboratory MDCs.

Radionuclide	MDC (µCi/ml)
Mn-54	4.5 E-08
Fe-59	5.0 E-08
Co-58	4.0 E-08
Co-60	5.4 E-08
Zn-65	4.9 E-08
Mo-99	1.7 E-07
I-131	2.0 E-08
Cs-134	2.2 E-08
Cs-137	2.6 E-08
Ce-141	3.2 E-08
Ce-144	1.3 E-07
Sr-89	4.4 E-08
Sr-90	1.6 E-08
Fe-55	8.2 E-07
H-3	3.6 E-06
Gross Alpha	3.7 E-09

Abnormal Releases

1.	Number of releases	0	0	54	0
2.	Volume Released (Gallons)	N/A	N/A	9.02E+05	N/A
3.	Total Activity Released (Ci)	N/A	N/A	2.30E+00	N/A

On July 16, 2010 a Unit-1 circulating water system leak resulted in a large volume (approximately 1 million gallons) of high conductivity cooling tower basin water flooding the Unit-1 Turbine Building Condenser Bay area. The circulating system water which flooded the Unit-1 Turbine Building Condenser Bay area became cross contaminated with low level radioactivity. Releasing the low level activity flood water through the normal liquid waste processing system would limit the release throughput time and possibly increase the total activity released due to the impact of the high conductivity water on the processing system demineralizers.

Approximately 902,000 gallons of the referenced flood water was pumped to tankers staged outside of the Unit-1 Turbine Building. Fifty four (54) individual liquid batch releases were made from these tankers. The release process for the tankers paralleled Technical Requirement Manual (TRM) guidance when the liquid radwaste discharge radiation monitor is inoperable, including obtaining two representative samples from each tanker (prior to discharge) to confirm the radioactive concentration. Similar to normal liquid effluent releases, the tankers were discharged to the Susquehanna River via the cooling tower blowdown line.

The total radioactivity released from the Unit-1 circulating water system leak was 2.30 Curies of tritium and 2.04E-3 Curies of gamma emitting radioisotopes. The above referenced volume and radioactivity released as a result of the Unit-1 circulating water system leak is included in Tables 2-3 and 2-4.

The dose due to all 54 tanker discharges is equally divided between both units. The rational for this decision is that radioactive liquids from both Unit-1 and Unit-2 (waste collection sumps) contaminated the flood water during the event. This methodology is also consistent with normal liquid releases since the liquid waste management system is a common system. Offsite dose from the above referenced fifty four (54) liquid batch releases is a small percentage (<2%) of the offsite total body and organ dose due to liquid effluent releases in 2010.

TABLE 2-3

WATERBORNE EFFLUENT - SUMMATION OF ALL RELEASES

A. Fission and Activation Products	Unit	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
1. Total Release (excluding: Tritium, Ent. Gases, Alpha)	Ci	1.14E-02	1.80E-02	7.79E-02	4.33E-03
2. Average Diluted Concentration During Period	µCi/ml	1.37E-07	8.16E-08	1.92E-07	8.12E-08
3. Sum of Average Diluted C_n/L_n Ratio During Period	Unitless	3.18E-03	1.98E-03	3.02E-03	1.77E-03
4. Percent of Applicable Limit (Ratio < 1.0)	%	0.30	0.20	0.30	0.20
B. Tritium					
1. Total Release	Ci	1.07E+01	2.63E+01	1.73E+01	3.00E+00
2. Average Diluted Concentration During Period	µCi/ml	1.29E-04	1.19E-04	4.27E-05	5.62E-05
3. Percent of Applicable Limit (1.0E-2 µCi/ml)	%	1.29	1.19	0.43	0.56
C. Dissolved and Entrained Gases					
1. Total Release	Ci	<MDC	<MDC	<MDC	<MDC
2. Average Diluted Concentration During Period	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Percent of Applicable Limit (2.0E-4 µCi/ml)	%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Radionuclide Fractional Summation					
1. Sum of Percent of Applicable Limit During Period for A, B and C (Limit = 100%)	%	1.59	1.39	0.73	0.76
E. Gross Alpha Radioactivity					
1. Total Release	Ci	8.66E-06	2.38E-06	1.61E-05	1.34E-06
F. Volume of Water Released (Prior to Dilution)	Gallons	2.12E+05	7.51E+05	1.65E+06	8.41E+04
	Liters	8.03E+05	2.84E+06	6.26E+06	3.18E+05
G. Volume of Dilution Water Used During Period of Release	Gallons	2.17E+07	5.76E+07	1.05E+08	1.40E+07
	Liters	8.23E+07	2.18E+08	3.98E+08	5.30E+07
H. Volume of Dilution Water Used Over Entire Period	Gallons	1.06E+09	1.14E+09	1.53E+09	1.38E+09
	Liters	4.01E+09	4.30E+09	5.79E+09	5.24E+09

TABLE 2-4

WATERBORNE EFFLUENT - RADIONUCLIDES RELEASED

		Releases in Batch Mode			
Nuclides Released	**Unit**	**First Quarter**	**Second Quarter**	**Third Quarter**	**Fourth Quarter**
A. Fission and Activation Products					
Na-24	Ci	<MDC	<MDC	2.41E-03	<MDC
Cr-51	Ci	9.55E-04	6.82E-04	1.72E-02	6.71E-04
Mn-54	Ci	3.22E-05	9.23E-04	1.33E-02	2.74E-05
Fe-55	Ci	<MDC	<MDC	<MDC	<MDC
Co-58	Ci	2.20E-03	3.16E-03	1.19E-02	5.71E-04
Fe-59	Ci	4.54E-06	2.42E-06	2.95E-04	<MDC
Co-60	Ci	6.75E-03	1.15E-02	3.00E-02	2.28E-03
Zn-65	Ci	1.38E-03	1.70E-03	1.90E-03	7.77E-04
Sr-89	Ci	<MDC	<MDC	<MDC	<MDC
Sr-90	Ci	<MDC	<MDC	<MDC	<MDC
Nb-95	Ci	3.74E-07	<MDC	2.22E-05	<MDC
Tc-99m	Ci	6.22E-05	<MDC	3.34E-05	<MDC
Sb-124	Ci	<MDC	<MDC	7.90E-05	1.99E-06
Cs-137	Ci	<MDC	<MDC	6.56E-04	<MDC
Sb-125	Ci	<MDC	<MDC	2.19E-05	<MDC
Ta-182	Ci	3.21E-06	2.05E-06	<MDC	<MDC
Total for Period	**Ci**	**1.14E-02**	**1.80E-02**	**7.79E-02**	**4.33E-03**
B. Tritium					
Total for Period	**Ci**	**1.07E+01**	**2.63E+01**	**1.73E+01**	**3.00E+00**
C. Dissolved and Entrained Gases					
Ar-41	Ci	<MDC	<MDC	<MDC	<MDC
Kr-85	Ci	<MDC	<MDC	<MDC	<MDC
Kr-85m	Ci	<MDC	<MDC	<MDC	<MDC
Kr-87	Ci	<MDC	<MDC	<MDC	<MDC
Kr-88	Ci	<MDC	<MDC	<MDC	<MDC
Xe-131m	Ci	<MDC	<MDC	<MDC	<MDC
Xe-133m	Ci	<MDC	<MDC	<MDC	<MDC
Xe-133	Ci	<MDC	<MDC	<MDC	<MDC
Xe-135m	Ci	<MDC	<MDC	<MDC	<MDC
Xe-135	Ci	<MDC	<MDC	<MDC	<MDC
Total for Period	**Ci**	**0**	**0**	**0**	**0**

Figure 2-1

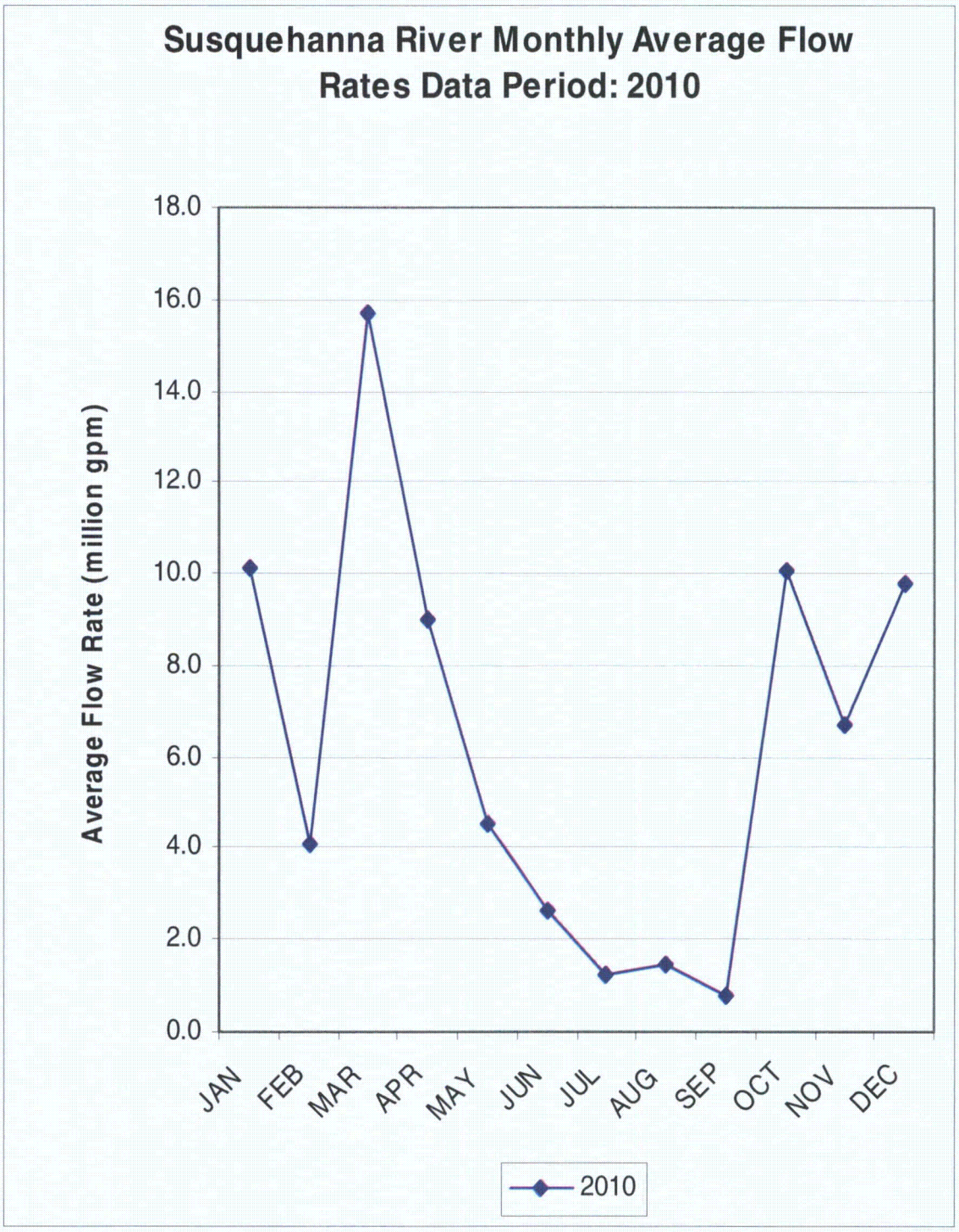

Susquehanna River Monthly Average Flow Rates Data Period: 2010
Average Flow Rate (million gpm)
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
2010

Figure 2-2

Monthly Liquid Radwaste Discharge Totals

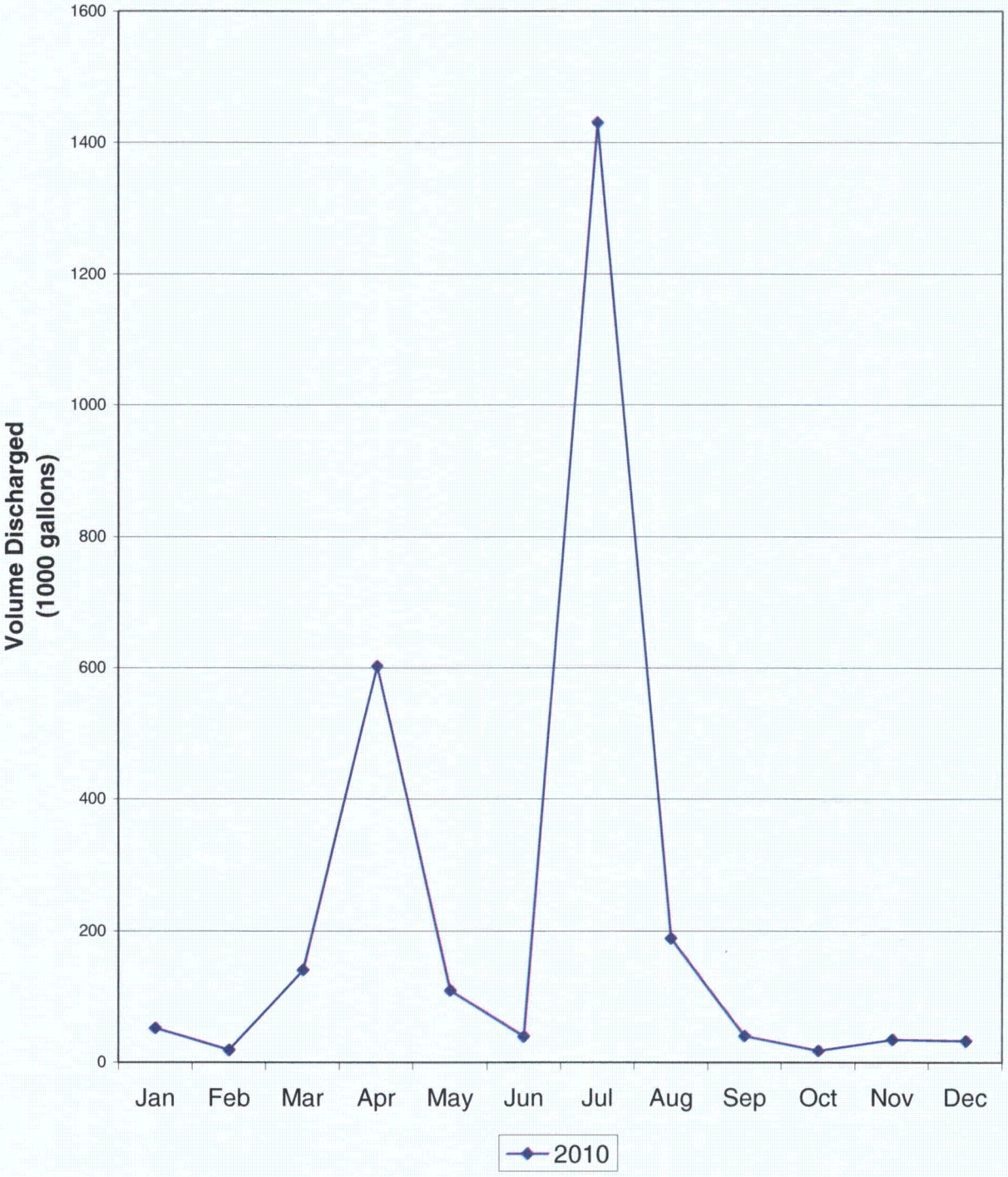


TABLE 2-5

ESTIMATED TOTAL ERRORS ASSOCIATED WITH EFFLUENTS MEASUREMENTS

MEASUREMENT	ESTIMATED TOTAL ERROR
1. Airborne Effluents	
a. Fission and Activation Gases	15.9%
b. I-131	13.3%
c. Particulates (incl. Gross Alpha)	15.8%
d. Tritium	13.6%
2. Waterborne Effluents	
a. Fission and Activation Products	5.0%
b. Tritium	3.3%
c. Dissolved and Entrained Gases	8.4%
d. Gross Alpha Activity	6.0%
e. Volume of Waste Released (Prior to Dilution)	5.0%
f. Volume of Dilution Water Used During Period	15.0%
	ESTIMATED MAXIMUM MEASUREMENT ERROR
3. Solid Wastes	
a. CFS Backwash Media – Class A HIC (Pyrolysis)	±25%
b. CFS Filters– Class A HIC (Pyrolysis)	±25%
c. Condensate Demineralizer / Radwaste Demineralizer - Class A HIC (Pyrolysis)	±25%
d. Contaminated Waste Oil – Class A Fuel Blending for Co-Generation	±25%
e. Liquid Radwaste Filter Media – Class A HIC (Pyrolysis)	±25%
f. Processed DAW – Class A Strong Tight Container (Compacted)	±25%

SUSQUEHANNA STEAM ELECTRIC STATION

RADIOACTIVE WASTE REPORT

RADIOACTIVE EFFLUENT RELEASE REPORT

SOLID RADIOACTIVE WASTE

DATA PERIOD: JANUARY 1, 2010 - DECEMBER 31, 2010

PREPARED BY:

MICHAEL C. MICCA
HEALTH PHYSICIST

APPROVED BY:

RICK KESSLER
RADIOLOGICAL OPERATIONS SUPERVISOR

REPORT NOTES

1. All activities reported in Milli-Curies (mCi) unless otherwise noted.

2. Reported activities, as indicated with the (<) sign, are comprised in whole or part of MDL values.

3. Estimated maximum measurement error is ±25%.

TABLE 2-6

WASTE DISPOSITION

Data Period: January 1, 2010 - December 31, 2010

A. SOLID WASTE SHIPPED OFF-SITE FOR BURIAL OR DISPOSAL

Number of Shipments	Mode of Transportation	Destination
NONE		

B. IRRADIATED FUEL SHIPMENTS

Number of Shipments	Mode of Transportation	Destination
NONE		

NOTE: The number of shipments listed in A include only the shipments from PPL Susquehanna, LLC to a disposal site. It does not include shipments made to or from volume reduction vendors.

Table 2-7

Annual Waste Release Summary Report

Year: 2010
Class: A Volume Reduction Vendor: Yes
Source: CFS Backwash Media
Container: HIC (High Integrity Container)
Process: Pyrolysis

Nuclides	Activity (mCi)	% of Total
C-14	4.270E+00	0.03 %
CO-58	6.880E+01	0.46 %
CO-60	6.280E+03	41.86 %
CR-51	2.347E+01	0.16 %
CS-137	6.760E+00	0.05 %
FE-55	7.040E+03	46.93 %
FE-59	6.880E+00	0.05 %
H-3	4.200E+01	0.28 %
I-129	1.296E-01	0.00 %
MN-54	1.110E+03	7.40 %
NB-95	1.674E+00	0.01 %
NI-59	2.619E+01	0.17 %
NI-63	7.360E+01	0.49 %
SR-90	4.540E-02	0.00 %
TC-99	1.346E+00	0.01 %
ZN-65	3.170E+02	2.11 %
Total Activity (Ci)	15.002	100.00 %
Container Volume	30.170 ft3	0.854 m3

Table 2-8

Annual Waste Release Summary Report

Year: 2010
Class: A Volume Reduction Vendor: Yes
Source: CFS Filters
Container: HIC (High Integrity Container)
Process: Pyrolysis

Nuclides	Activity (mCi)	% of Total
C-14	6.501E+00	0.03 %
CE-144	8.560E-51	0.00 %
CO-60	9.762E+03	42.11 %
CS-137	1.034E+01	0.04 %
FE-55	1.116E+04	48.12 %
H-3	3.422E+01	0.15 %
I-129	1.180E-01	0.00 %
MN-54	1.800E+03	7.76 %
NI-59	6.804E-01	0.00 %
NI-63	1.125E+02	0.49 %
SR-90	6.933E-02	0.00 %
TC-99	1.234E+00	0.01 %
ZN-65	3.007E+02	1.30 %
Total Activity (Ci)	23.184	100.00 %
Container Volume	91.430 ft3	2.589 m3

Table 2-9

Annual Waste Release Summary Report

Year: 2010
Class: A Volume Reduction Vendor: Yes
Source: Condensate Demineralizer / Radwaste Demineralizer
Container: HIC (High Integrity Container)
Process: Pyrolysis

Nuclides	Activity (mCi)	% of Total
C-14	2.761E+03	23.07 %
CE-144	2.607E-50	0.00 %
CO-58	3.352E+02	2.80 %
CO-60	4.875E+03	40.75 %
CR-51	2.386E+01	0.20 %
CS-134	2.340E+01	0.20 %
CS-137	1.566E+01	0.13 %
FE-55	6.649E+02	5.56 %
FE-59	1.121E+01	0.09 %
H-3	9.639E+02	8.06 %
HF-181	4.912E-01	0.00 %
I-129	7.515E-01	0.01 %
I-131	3.212E-09	0.00 %
MN-54	1.436E+03	12.00 %
NB-95	1.390E+01	0.12 %
NI-63	2.016E+02	1.68 %
SB-124	1.950E+00	0.02 %
SB-125	3.631E+01	0.30 %
SR-90	8.330E-03	0.00 %
TA-182	6.790E+00	0.06 %
TC-99	8.313E+00	0.07 %
ZN-65	5.724E+02	4.78 %
ZR-95	1.139E+01	0.10 %
Total Activity (Ci)	11.964	100.00 %
Container Volume	368.350 ft3	10.431 m3

Table 2-10

Annual Waste Release Summary Report

Year: 2010
Class: A Volume Reduction Vendor: Yes
Source: Contaminated Waste Oil
Container: None
Process: Fuel Blending for Co-Generation

Nuclides	Activity (mCi)	% of Total
C-14	< 2.660E-04	0.02 %
CO-60	1.650E-01	11.63 %
CS-137	1.030E-03	0.07 %
FE-55	3.890E-01	27.41 %
H-3	8.480E-01	59.76 %
I-129	< 5.120E-05	0.00 %
MN-54	1.190E-02	0.84 %
NI-63	2.860E-03	0.20 %
TC-99	< 1.010E-03	0.07 %
Total Activity (Ci)	0.001	100.00 %
Container Volume	0.000 ft3	0.000 m3

Table 2-11

Annual Waste Release Summary Report

Year: 2010
Class: A Volume Reduction Vendor: Yes
Source: Liquid Radwaste Filter Media
Container: HIC (High Integrity Container)
Process: Pyrolysis

Nuclides	Activity (mCi)	% of Total
C-14	1.890E-01	0.00 %
CO-58	1.346E+02	0.75 %
CO-60	3.559E+03	19.71 %
CR-51	5.730E+01	0.32 %
CS-137	3.890E-01	0.00 %
FE-55	1.290E+04	71.45 %
FE-59	1.425E+01	0.08 %
H-3	2.794E+01	0.15 %
I-129	4.700E-02	0.00 %
MN-54	1.023E+03	5.67 %
NB-95	9.680E+00	0.05 %
NI-63	6.160E+01	0.34 %
SB-124	4.070E+00	0.02 %
SR-90	2.781E-02	0.00 %
TA-182	2.600E+01	0.14 %
TC-99	4.410E-01	0.00 %
ZN-65	2.261E+02	1.25 %
ZR-95	1.108E+01	0.06 %
Total Activity (Ci)	18.056	100.00 %
Container Volume	10.380 ft3	0.294 m3

Table 2-12

Annual Waste Release Summary Report

Year: 2010
Class: A Volume Reduction Vendor: Yes
Source: Processed DAW
Container: Strong Tight Container
Process: Compacted

Nuclides	Activity (mCi)	% of Total
C-14	3.034E-01	0.00 %
CO-58	7.320E+01	0.66 %
CO-60	2.982E+03	27.05 %
CR-51	5.570E+00	0.05 %
CS-137	3.351E+00	0.03 %
FE-55	6.973E+03	63.26 %
FE-59	1.020E+00	0.01 %
H-3	1.347E+02	1.22 %
I-129	1.011E-02	0.00 %
MN-54	4.604E+02	4.18 %
NB-95	1.020E+01	0.09 %
NI-63	7.249E+01	0.66 %
SB-124	2.550E-01	0.00 %
SR-89	1.810E+00	0.02 %
SR-90	3.030E-03	0.00 %
TA-182	1.360E+00	0.01 %
TC-99	1.280E-01	0.00 %
ZN-65	3.022E+02	2.74 %
ZR-95	6.770E-01	0.01 %
Total Activity (Ci)	11.023	100.00 %
Container Volume	9189.050 ft3	260.210 m3

SECTION 3

METEOROLOGICAL DATA AND DISPERSION ESTIMATES

METEOROLOGY AND DISPERSION DATA

Meteorological data have been collected at the PPL Susquehanna, LLC site since the early 1970s. At the present time, the meteorological system is based on a 300-foot high tower located approximately 1,000 feet to the southeast of the plant. Wind sensors are mounted at the 10m and 60m elevations on this tower. Vertical temperature differential is measured with redundant sensor pairs between the 10m and 60m levels. Sigma theta (the standard deviation of horizontal wind direction) is calculated from wind direction at both levels. Dew point and ambient temperature sensors are present at the 10m level. Precipitation is measured at ground level.

A back-up meteorological tower was erected in 1982. It is a 10m tower providing alternate measurements of wind speed, wind direction, and sigma theta. A 10m supplemental downriver meteorological tower is also available. This tower measures wind speed, wind direction, sigma theta, temperature and dew point.

Meteorological data are transmitted to the plant Control Room, Technical Support Center, Emergency Operations Facility for emergency response availability, and ABSG Consulting, Inc. ABSG Consulting, Inc., located in Rockville, Maryland, provides meteorological consulting services to PPL Susquehanna, LLC.

Regulatory Guide 1.23 (Safety Guide 23) requires at least 90% data recovery for meteorological instrumentation. During 2010, all meteorological instrumentation met the 90% data recovery requirement. Table 3-1 lists the percent valid data recovery values for the parameters monitored as part of the PPL Susquehanna Meteorological Monitoring Program.

Dispersion modeling for effluents from normal operation is done using the MIDAS system XDCALC program, a straight-line Gaussian plume model designed to estimate average relative concentration. The model was developed in accordance with Regulatory Guide 1.111. For periods when the wind speed is calm, the actual wind direction that last occurred is used.

XDCALC and the XQINTR program that interpolates X/Q values to exact locations both use terrain correction factors to account for the temporal and spatial variations in the airflow in the region. A straight-line trajectory model assumes that a constant mean wind transports and diffuses effluents in the direction of airflow at the release point within the entire region of interest. The terrain correction factors were taken from FSAR Table 2.3-128.

Tables 3-2 and 3-3 provide the joint frequency distribution of wind speed and direction (as a function of delta temperature) at the 10 and 60 meter elevations of the primary meteorological tower. Table 3-4 lists no decay, undepleted X/Q values at various distances from the site. Table 3-5 lists 2.26 day decay, undepleted X/Q values at various distances from the site. Table 3-6 lists 8-day decay, depleted X/Q values at various distances from the site and Table 3-7 is a listing of D/Q (relative deposition) values at various distances from the site.

TABLE 3-1

METEOROLOGICAL DATA RECOVERY FOR 2010

Parameter	Percent Valid Data Recovery
Wind Speed 10m - Primary (1) Wind Speed 60m – Primary Wind Speed 10m – Backup (2) Wind Speed 10m – Downriver (3)	98.2 98.2 91.7 100.0
Wind Direction 10m - Primary Wind Direction 60m – Primary Wind Direction 10m – Backup Wind Direction 10m – Downriver	98.2 98.2 91.7 100.0
Temperature 10m – Primary Dew Point 10m – Primary	99.6 99.6
Delta Temperature 60m – Primary	98.1
Sigma Theta 10m – Primary Sigma Theta 60m – Primary Sigma Theta 10m – Backup Sigma Theta 10m – Downriver	98.2 98.2 91.7 100.0
Precipitation – Primary	99.2
Composite Parameters	
Wind Speed and Direction 10m, Delta Temperature 60-10m	98.1
Wind Speed and Direction 60m, Delta Temperature 60-10m	98.1

(1) SSES "Primary" meteorological tower

(2) SSES "Backup" meteorological tower

(3) SSES "Downriver" meteorological tower

TABLE 3-2

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 10m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: Speed: 10_SPD **Direction:** 10_WD **Lapse:** DT60-10A
Stability Class A Delta Temperature Extremely Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	0	1	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	1	1	0	0	0	0	2
ENE	0	1	0	0	0	0	1
E	0	1	0	0	0	0	1
ESE	1	0	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	1	0	0	0	0	1
S	0	0	2	0	0	0	2
SSW	1	6	8	0	0	0	15
SW	2	4	37	1	0	0	44
WSW	0	0	4	0	0	0	4
W	0	0	1	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Total	5	15	52	1	0	0	73

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	168
Valid Hours for this Stability Class for:	**Total Period**	73
Total Hours for Period		8760

TABLE 3-2
(continued)

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 10m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010 (Continued)

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: **Speed:** 10_SPD **Direction:** 10_WD **Lapse:** DT60-10A
Stability Class B Delta Temperature Moderately Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	0	0	3	0	0	0	3
NNE	0	2	3	1	0	0	6
NE	2	4	0	0	0	0	6
ENE	0	0	0	0	0	0	0
E	1	0	0	0	0	0	1
ESE	1	0	0	0	0	0	1
SE	0	1	1	0	0	0	2
SSE	0	2	4	0	0	0	6
S	0	1	4	0	0	0	5
SSW	0	14	4	0	0	0	18
SW	0	21	36	5	0	0	62
WSW	0	5	20	2	0	0	27
W	0	1	3	0	0	0	4
WNW	0	0	1	0	0	0	1
NW	0	0	0	0	0	0	0
NNW	0	1	0	0	0	0	1
Total	4	52	79	8	0	0	143

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	168
Valid Hours for this Stability Class for:	**Total Period**	143
Total Hours for Period		8760

TABLE 3-2
(continued)

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 10m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010 (Continued)

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: Speed: 10_SPD **Direction:** 10_WD **Lapse:** DT60-10A
Stability Class C Delta Temperature Slightly Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	0	6	20	1	0	0	27
NNE	0	9	8	2	0	0	19
NE	1	11	4	0	0	0	16
ENE	0	4	0	0	0	0	4
E	1	6	0	0	0	0	7
ESE	1	2	0	0	0	0	3
SE	1	2	2	0	0	0	5
SSE	0	8	4	0	0	0	12
S	1	13	8	0	0	0	22
SSW	1	32	6	0	0	0	39
SW	1	43	63	3	0	0	110
WSW	0	16	41	9	0	0	66
W	0	4	12	3	0	0	19
WNW	0	3	9	0	0	0	12
NW	0	6	12	3	0	0	21
NNW	0	5	19	4	0	0	28
Total	7	170	208	25	0	0	410

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	168
Valid Hours for this Stability Class for:	**Total Period**	410
Total Hours for Period		8760

TABLE 3-2
(continued)

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 10m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010 (Continued)

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: Speed: 10_SPD **Direction:** 10_WD **Lapse:** DT60-10A
Stability Class D Delta Temperature Neutral

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	20	182	184	6	0	0	392
NNE	56	189	77	0	0	0	322
NE	78	174	23	3	0	0	278
ENE	90	48	16	12	0	0	166
E	95	24	4	0	0	0	123
ESE	90	41	8	1	0	0	140
SE	100	67	8	3	0	0	178
SSE	77	77	15	5	1	0	175
S	72	93	24	1	0	0	190
SSW	67	167	10	0	0	0	244
SW	59	256	173	5	0	0	493
WSW	32	150	187	46	6	0	421
W	21	96	117	29	1	0	264
WNW	6	83	123	11	0	0	223
NW	12	104	235	61	0	0	412
NNW	8	132	264	37	0	0	441
Total	883	1883	1468	220	8	0	4462

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	168
Valid Hours for this Stability Class for:	**Total Period**	4462
Total Hours for Period		8760

TABLE 3-2
(continued)

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 10m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010 (Continued)

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: Speed: 10_SPD **Direction:** 10_WD **Lapse:** DT60-10A
Stability Class E Delta Temperature Slightly Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	19	50	6	0	0	0	75
NNE	49	96	5	0	0	0	150
NE	127	54	0	0	0	0	181
ENE	179	11	0	0	0	0	190
E	181	7	0	0	0	0	188
ESE	114	14	1	0	0	0	129
SE	72	14	0	3	0	0	89
SSE	90	31	10	14	1	0	146
S	130	72	7	4	0	0	213
SSW	84	95	2	0	0	0	181
SW	46	119	9	0	0	0	174
WSW	16	42	7	0	0	0	65
W	5	35	4	0	0	0	44
WNW	2	10	1	0	0	0	13
NW	0	31	5	0	0	0	36
NNW	4	35	6	0	0	0	45
Total	1118	716	63	21	1	0	1919

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	168
Valid Hours for this Stability Class for:	**Total Period**	1919
Total Hours for Period		8760

TABLE 3-2
(continued)

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 10m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010 (Continued)

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: Speed: 10_SPD **Direction:** 10_WD **Lapse:** DT60-10A
Stability Class F Delta Temperature Moderately Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	4	2	0	0	0	0	6
NNE	22	10	0	0	0	0	32
NE	92	9	0	0	0	0	101
ENE	387	28	0	0	0	0	415
E	179	0	0	0	0	0	179
ESE	58	0	0	0	0	0	58
SE	43	1	0	0	0	0	44
SSE	19	1	0	0	0	0	20
S	26	2	0	0	0	0	28
SSW	23	5	0	0	0	0	28
SW	4	8	0	0	0	0	12
WSW	3	2	0	0	0	0	5
W	0	0	0	0	0	0	0
WNW	1	0	0	0	0	0	1
NW	0	0	0	0	0	0	0
NNW	0	1	0	0	0	0	1
Total	861	69	0	0	0	0	930

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	168
Valid Hours for this Stability Class for:	**Total Period**	930
Total Hours for Period		8760

TABLE 3-2
(continued)

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 10m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010 (Continued)

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: Speed: 10_SPD **Direction:** 10_WD **Lapse:** DT60-10A
Stability Class G Delta Temperature Extremely Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	5	0	0	0	0	0	5
NNE	13	2	0	0	0	0	15
NE	90	4	0	0	0	0	94
ENE	355	20	0	0	0	0	375
E	110	0	0	0	0	0	110
ESE	16	0	0	0	0	0	16
SE	18	0	0	0	0	0	18
SSE	6	1	0	0	0	0	7
S	6	0	0	0	0	0	6
SSW	4	0	0	0	0	0	4
SW	2	0	0	0	0	0	2
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	1	0	0	0	0	0	1
NNW	1	1	0	0	0	0	2
Total	627	28	0	0	0	0	655

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	168
Valid Hours for this Stability Class for:	**Total Period**	655
Total Hours for Period		8760

TABLE 3-2
(continued)

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 10m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010 (Continued)

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Summary of All Stability Classes

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: **Speed:** 10_SPD **Direction:** 10_WD **Lapse:** DT60-10A

Delta Temperature

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	48	241	213	7	0	0	509
NNE	140	308	93	3	0	0	544
NE	391	257	27	3	0	0	678
ENE	1011	112	16	12	0	0	1151
E	567	38	4	0	0	0	609
ESE	281	57	9	1	0	0	348
SE	234	85	11	6	0	0	336
SSE	192	121	33	19	2	0	367
S	235	181	45	5	0	0	466
SSW	180	319	30	0	0	0	529
SW	114	451	318	14	0	0	897
WSW	51	215	259	57	6	0	588
W	26	136	137	32	1	0	332
WNW	9	96	134	11	0	0	250
NW	13	141	252	64	0	0	470
NNW	13	175	289	41	0	0	518
Total	3505	2933	1870	275	9	0	8592

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	168
Valid Hours for this Stability Class for:	**Total Period**	8592
Total Hours for Period		8760

TABLE 3-3

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 60m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: Speed: 60_SPD **Direction:** 60_WD **Lapse:** DT60-10A
Stability Class A Delta Temperature Extremely Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	0	0	0	0	0	0	0
NNE	0	1	0	0	0	0	1
NE	1	1	0	0	0	0	2
ENE	0	0	0	0	0	0	0
E	0	1	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	1	1	0	0	0	2
S	1	0	0	2	0	0	3
SSW	1	2	9	2	0	0	14
SW	0	1	19	25	0	0	45
WSW	0	0	1	3	0	0	4
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	1	0	0	0	1
Total	3	7	31	32	0	0	73

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	169
Valid Hours for this Stability Class for:	**Total Period**	73
Total Hours for Period		8760

TABLE 3-3
(continued)

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 60m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010 (Continued)

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: **Speed:** 60_SPD **Direction:** 60_WD **Lapse:** DT60-10A
Stability Class B Delta Temperature Moderately Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	0	1	1	3	0	0	5
NNE	0	5	1	3	0	0	9
NE	1	1	0	0	0	0	2
ENE	1	0	0	0	0	0	1
E	1	0	0	0	0	0	1
ESE	0	0	1	0	0	0	1
SE	0	0	2	0	0	0	2
SSE	0	0	5	0	0	0	5
S	0	0	4	1	0	0	5
SSW	0	5	14	3	0	0	22
SW	0	3	43	18	3	0	67
WSW	0	0	7	11	2	0	20
W	0	0	2	1	0	0	3
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Total	3	15	80	40	5	0	143

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	169
Valid Hours for this Stability Class for:	**Total Period**	143
Total Hours for Period		8760

TABLE 3-3
(continued)

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 60m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010 (Continued)

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: Speed: 60_SPD **Direction:** 60_WD **Lapse:** DT60-10A
Stability Class C Delta Temperature Slightly Unstable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	0	6	11	11	1	0	29
NNE	0	8	15	1	0	0	24
NE	0	7	1	0	0	0	8
ENE	0	4	1	0	0	0	5
E	2	2	0	0	0	0	4
ESE	0	0	1	0	0	0	1
SE	1	1	4	0	0	0	6
SSE	0	2	5	2	0	0	9
S	1	3	10	4	0	0	18
SSW	1	21	19	3	1	0	45
SW	0	14	75	36	2	0	127
WSW	0	3	20	21	10	1	55
W	0	1	14	3	1	0	19
WNW	0	0	8	2	0	0	10
NW	0	4	12	10	0	0	26
NNW	0	4	10	10	0	0	24
Total	5	80	206	103	15	1	410

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	169
Valid Hours for this Stability Class for:	**Total Period**	410
Total Hours for Period		8760

TABLE 3-3
(continued)

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 60m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010 (Continued)

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: **Speed:** 60_SPD **Direction:** 60_WD **Lapse:** DT60-10A
Stability Class D Delta Temperature Neutral

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	12	118	171	44	0	0	345
NNE	44	145	158	60	2	2	411
NE	72	77	33	16	10	0	208
ENE	39	28	12	7	6	0	92
E	38	20	16	1	4	0	79
ESE	32	28	29	6	0	0	95
SE	44	52	38	5	6	3	148
SSE	29	38	36	12	1	1	117
S	54	55	41	18	7	0	175
SSW	52	117	68	19	0	0	256
SW	29	208	212	126	7	1	583
WSW	8	79	186	224	48	8	553
W	13	53	137	99	4	1	307
WNW	0	39	141	110	9	0	299
NW	2	42	220	164	9	0	437
NNW	9	33	208	96	10	0	356
Total	477	1132	1706	1007	123	16	4461

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	169
Valid Hours for this Stability Class for:	**Total Period**	4461
Total Hours for Period		8760

TABLE 3-3

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 60m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010 (Continued)

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: Speed: 60_SPD **Direction:** 60_WD **Lapse:** DT60-10A
Stability Class E Delta Temperature Slightly Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	11	98	36	2	0	0	147
NNE	70	150	54	3	0	0	277
NE	70	40	20	1	0	0	131
ENE	42	18	7	0	0	0	67
E	29	27	12	0	0	0	68
ESE	35	25	7	1	0	0	68
SE	37	31	15	4	14	3	104
SSE	39	45	27	6	4	2	123
S	49	44	45	13	4	2	157
SSW	27	71	60	6	2	0	166
SW	23	91	120	22	0	0	256
WSW	13	41	75	29	1	0	159
W	7	28	15	1	0	0	51
WNW	3	17	21	3	0	0	44
NW	2	12	46	1	0	0	61
NNW	5	11	23	1	0	0	40
Total	462	749	583	93	25	7	1919

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	169
Valid Hours for this Stability Class for:	**Total Period**	1919
Total Hours for Period		8760

TABLE 3-3
(continued)

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 60m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010 (Continued)

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: Speed: 60_SPD **Direction:** 60_WD **Lapse:** DT60-10A
Stability Class F Delta Temperature Moderately Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	≥ 25	Total
N	29	147	5	0	0	0	181
NNE	71	205	9	0	0	0	285
NE	92	31	0	0	0	0	123
ENE	43	3	0	0	0	0	46
E	21	4	1	0	0	0	26
ESE	22	0	0	0	0	0	22
SE	19	6	0	0	0	0	25
SSE	18	11	0	0	0	0	29
S	15	14	0	0	0	0	29
SSW	17	32	4	0	0	0	53
SW	11	26	18	2	0	0	57
WSW	5	8	11	4	0	0	28
W	3	1	1	0	0	0	5
WNW	3	2	0	0	0	0	5
NW	5	3	2	0	0	0	10
NNW	3	3	0	0	0	0	6
Total	377	496	51	6	0	0	930

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	169
Valid Hours for this Stability Class for:	**Total Period**	930
Total Hours for Period		8760

TABLE 3-3
(continued)

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 60m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010 (Continued)

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00
Elevation: Speed: 60_SPD **Direction:** 60_WD **Lapse:** DT60-10A
Stability Class G Delta Temperature Extremely Stable

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	9	72	8	0	0	0	89
NNE	46	172	2	0	0	0	220
NE	54	41	0	0	0	0	95
ENE	37	13	0	0	0	0	50
E	27	6	0	0	0	0	33
ESE	19	1	0	0	0	0	20
SE	20	3	1	0	0	0	24
SSE	15	5	0	0	0	0	20
S	9	9	1	0	0	0	19
SSW	7	11	5	0	0	0	23
SW	5	14	6	0	0	0	25
WSW	2	1	5	1	0	0	9
W	3	0	0	0	0	0	3
WNW	1	2	1	0	0	0	4
NW	3	4	4	0	0	0	11
NNW	1	8	1	0	0	0	10
Total	258	362	34	1	0	0	655

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	169
Valid Hours for this Stability Class for:	**Total Period**	655
Total Hours for Period		8760

TABLE 3-3
(continued)

SSES JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND WIND DIRECTION 60m VERSUS DELTA TEMPERATURE 60-10m FOR THE PERIOD OF JANUARY 1, 2010 THROUGH DECEMBER 31, 2010 (Continued)

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Summary of All Stability Classes

Total Period

Period of Record = 1/1/2010 00:00 - 12/31/2010 23:00

Elevation: **Speed:** 60_SPD **Direction:** 60_WD **Lapse:** DT60-10A

Delta Temperature

Wind Speed (mph)

Wind Direction	1 - 4	4 - 8	8 - 13	13 - 19	19 - 25	> 25	Total
N	61	442	232	60	1	0	796
NNE	231	686	239	67	2	2	1227
NE	290	198	54	17	10	0	569
ENE	162	66	20	7	6	0	261
E	118	60	29	1	4	0	212
ESE	108	54	38	7	0	0	207
SE	121	93	60	9	20	6	309
SSE	101	102	74	20	5	3	305
S	129	125	101	38	11	2	406
SSW	105	259	179	33	3	0	579
SW	68	357	493	229	12	1	1160
WSW	28	132	305	293	61	9	828
W	26	83	169	104	5	1	388
WNW	7	60	171	115	9	0	362
NW	12	65	284	175	9	0	545
NNW	18	59	243	107	10	0	437
Total	1585	2841	2691	1282	168	24	8591

Calm Hours not Included above for :	**Total Period**	0
Variable Direction Hours for:	**Total Period**	0
Invalid Hours for:	**Total Period**	169
Valid Hours for this Stability Class for:	**Total Period**	8591
Total Hours for Period		8760

TABLE 3-4

2010 SSES Annual Relative Concentrations - No Decay, Undepleted X/Q (sec/m^3)

	Miles									
Direction From	**0 - 1**	**1 - 2**	**2 - 3**	**3 - 4**	**4 - 5**	**5 - 10**	**10 - 20**	**20 - 30**	**30 - 40**	**40 - 50**
N	4.28E-06	7.94E-07	3.27E-07	1.72E-07	1.10E-07	4.02E-08	1.08E-08	5.17E-09	3.22E-09	2.26E-09
NNE	6.74E-06	1.33E-06	5.96E-07	3.21E-07	2.07E-07	7.65E-08	2.09E-08	1.03E-08	6.50E-09	4.64E-09
NE	1.39E-05	2.56E-06	1.17E-06	6.66E-07	4.42E-07	1.75E-07	5.34E-08	2.69E-08	1.73E-08	1.26E-08
ENE	4.13E-05	7.56E-06	3.71E-06	2.21E-06	1.48E-06	5.86E-07	1.71E-07	8.32E-08	5.39E-08	3.97E-08
E	2.09E-05	3.76E-06	1.66E-06	9.47E-07	6.35E-07	2.59E-07	8.26E-08	4.19E-08	2.71E-08	1.98E-08
ESE	1.02E-05	1.99E-06	9.01E-07	5.02E-07	3.32E-07	1.33E-07	3.68E-08	1.61E-08	1.03E-08	7.46E-09
SE	9.69E-06	1.87E-06	8.59E-07	4.88E-07	3.23E-07	1.31E-07	3.27E-08	1.20E-08	7.68E-09	5.52E-09
SSE	7.25E-06	1.42E-06	6.23E-07	3.46E-07	2.31E-07	9.84E-08	2.54E-08	8.97E-09	5.69E-09	4.06E-09
S	6.26E-06	1.33E-06	6.45E-07	3.72E-07	2.55E-07	1.18E-07	3.24E-08	1.11E-08	7.04E-09	5.03E-09
SSW	7.00E-06	1.40E-06	6.40E-07	3.62E-07	2.40E-07	9.89E-08	2.56E-08	9.69E-09	6.13E-09	4.37E-09
SW	6.63E-06	1.33E-06	6.25E-07	3.56E-07	2.38E-07	1.03E-07	2.63E-08	8.75E-09	5.48E-09	3.86E-09
WSW	4.21E-06	8.12E-07	3.76E-07	2.20E-07	1.50E-07	7.03E-08	2.17E-08	8.04E-09	4.09E-09	2.22E-09
W	2.05E-06	3.90E-07	1.67E-07	9.07E-08	5.92E-08	2.40E-08	6.36E-09	2.54E-09	1.56E-09	1.08E-09
WNW	1.57E-06	2.82E-07	1.12E-07	5.84E-08	3.69E-08	1.33E-08	3.52E-09	1.64E-09	9.98E-10	6.83E-10
NW	2.89E-06	5.28E-07	2.08E-07	1.06E-07	6.66E-08	2.37E-08	6.10E-09	2.84E-09	1.73E-09	1.19E-09
NNW	3.35E-06	6.21E-07	2.59E-07	1.37E-07	8.58E-08	2.94E-08	7.17E-09	3.35E-09	2.05E-09	1.42E-09

TABLE 3-5

2010 SSES Annual Relative Concentrations - 2.26-Day Decay, Undepleted X/Q (sec/m^3)

	Miles									
Direction From	**0 - 1**	**1 - 2**	**2 - 3**	**3 - 4**	**4 - 5**	**5 - 10**	**10 - 20**	**20 - 30**	**30 - 40**	**40 - 50**
N	4.27E-06	7.91E-07	3.25E-07	1.70E-07	1.08E-07	3.92E-08	1.03E-08	4.76E-09	2.87E-09	1.94E-09
NNE	6.73E-06	1.33E-06	5.90E-07	3.16E-07	2.03E-07	7.41E-08	1.96E-08	9.20E-09	5.57E-09	3.81E-09
NE	1.39E-05	2.54E-06	1.15E-06	6.53E-07	4.32E-07	1.68E-07	4.92E-08	2.34E-08	1.43E-08	9.84E-09
ENE	4.12E-05	7.50E-06	3.65E-06	2.16E-06	1.44E-06	5.61E-07	1.57E-07	7.19E-08	4.40E-08	3.05E-08
E	2.08E-05	3.72E-06	1.64E-06	9.24E-07	6.15E-07	2.46E-07	7.45E-08	3.53E-08	2.13E-08	1.45E-08
ESE	1.01E-05	1.97E-06	8.86E-07	4.90E-07	3.22E-07	1.27E-07	3.31E-08	1.35E-08	8.06E-09	5.42E-09
SE	9.66E-06	1.86E-06	8.46E-07	4.77E-07	3.14E-07	1.25E-07	2.98E-08	1.03E-08	6.20E-09	4.19E-09
SSE	7.23E-06	1.41E-06	6.14E-07	3.39E-07	2.26E-07	9.46E-08	2.34E-08	7.85E-09	4.72E-09	3.19E-09
S	6.24E-06	1.33E-06	6.38E-07	3.66E-07	2.49E-07	1.14E-07	3.01E-08	9.82E-09	5.95E-09	4.05E-09
SSW	6.99E-06	1.39E-06	6.34E-07	3.57E-07	2.35E-07	9.58E-08	2.40E-08	8.72E-09	5.30E-09	3.62E-09
SW	6.62E-06	1.32E-06	6.21E-07	3.52E-07	2.35E-07	1.01E-07	2.51E-08	8.07E-09	4.89E-09	3.34E-09
WSW	4.21E-06	8.09E-07	3.74E-07	2.18E-07	1.48E-07	6.88E-08	2.08E-08	7.49E-09	3.70E-09	1.95E-09
W	2.05E-06	3.89E-07	1.66E-07	8.99E-08	5.85E-08	2.35E-08	6.12E-09	2.38E-09	1.42E-09	9.58E-10
WNW	1.57E-06	2.81E-07	1.11E-07	5.79E-08	3.65E-08	1.31E-08	3.40E-09	1.54E-09	9.19E-10	6.13E-10
NW	2.88E-06	5.26E-07	2.07E-07	1.05E-07	6.60E-08	2.33E-08	5.91E-09	2.69E-09	1.61E-09	1.08E-09
NNW	3.34E-06	6.19E-07	2.58E-07	1.36E-07	8.50E-08	2.90E-08	6.94E-09	3.17E-09	1.90E-09	1.28E-09

TABLE 3-6

2010 SSES Annual Relative Concentrations - 8-Day Decay, Depleted X/Q (sec/m^3)

	Miles									
Direction From	0 - 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 10	10 - 20	20 - 30	30 - 40	40 - 50
N	3.91E-06	6.73E-07	2.65E-07	1.33E-07	8.23E-08	2.80E-08	6.68E-09	2.79E-09	1.56E-09	9.94E-10
NNE	6.16E-06	1.13E-06	4.82E-07	2.48E-07	1.55E-07	5.32E-08	1.29E-08	5.50E-09	3.11E-09	2.01E-09
NE	1.27E-05	2.16E-06	9.42E-07	5.15E-07	3.30E-07	1.22E-07	3.27E-08	1.43E-08	8.19E-09	5.39E-09
ENE	3.77E-05	6.40E-06	2.99E-06	1.71E-06	1.10E-06	4.06E-07	1.05E-07	4.41E-08	2.55E-08	1.69E-08
E	1.91E-05	3.18E-06	1.34E-06	7.31E-07	4.74E-07	1.79E-07	5.02E-08	2.20E-08	1.27E-08	8.33E-09
ESE	9.30E-06	1.69E-06	7.27E-07	3.88E-07	2.48E-07	9.22E-08	2.24E-08	8.47E-09	4.82E-09	3.13E-09
SE	8.85E-06	1.58E-06	6.93E-07	3.77E-07	2.41E-07	9.06E-08	1.99E-08	6.37E-09	3.62E-09	2.35E-09
SSE	6.62E-06	1.20E-06	5.03E-07	2.67E-07	1.73E-07	6.82E-08	1.55E-08	4.78E-09	2.70E-09	1.74E-09
S	5.71E-06	1.13E-06	5.22E-07	2.88E-07	1.90E-07	8.17E-08	1.99E-08	5.92E-09	3.36E-09	2.17E-09
SSW	6.40E-06	1.18E-06	5.18E-07	2.81E-07	1.79E-07	6.87E-08	1.57E-08	5.20E-09	2.95E-09	1.90E-09
SW	6.06E-06	1.13E-06	5.06E-07	2.76E-07	1.78E-07	7.20E-08	1.63E-08	4.73E-09	2.66E-09	1.70E-09
WSW	3.85E-06	6.88E-07	3.05E-07	1.71E-07	1.13E-07	4.90E-08	1.34E-08	4.36E-09	1.99E-09	9.83E-10
W	1.87E-06	3.31E-07	1.35E-07	7.04E-08	4.44E-08	1.67E-08	3.94E-09	1.38E-09	7.62E-10	4.79E-10
WNW	1.43E-06	2.39E-07	9.07E-08	4.53E-08	2.77E-08	9.31E-09	2.18E-09	8.89E-10	4.88E-10	3.04E-10
NW	2.64E-06	4.47E-07	1.69E-07	8.20E-08	5.00E-08	1.65E-08	3.79E-09	1.55E-09	8.50E-10	5.32E-10
NNW	3.06E-06	5.27E-07	2.10E-07	1.06E-07	6.44E-08	2.05E-08	4.45E-09	1.82E-09	1.01E-09	6.32E-10

TABLE 3-7

2010 SSES Annual Relative Concentrations - D/Q (m^{-2})

	Miles									
Direction From	0 - 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 10	10 - 20	20 - 30	30 - 40	40 - 50
N	2.96E-08	4.36E-09	1.79E-09	8.48E-10	5.01E-10	1.59E-10	3.80E-11	1.40E-11	7.47E-12	4.69E-12
NNE	2.97E-08	4.61E-09	2.00E-09	9.50E-10	5.59E-10	1.74E-10	4.06E-11	1.50E-11	7.98E-12	5.02E-12
NE	3.46E-08	5.22E-09	2.23E-09	1.08E-09	6.41E-10	2.07E-10	5.06E-11	1.86E-11	9.95E-12	6.25E-12
ENE	6.26E-08	9.72E-09	4.33E-09	2.12E-09	1.25E-09	3.96E-10	9.03E-11	3.16E-11	1.69E-11	1.06E-11
E	3.21E-08	4.69E-09	1.91E-09	9.13E-10	5.45E-10	1.80E-10	4.55E-11	1.67E-11	8.94E-12	5.61E-12
ESE	2.12E-08	3.20E-09	1.36E-09	6.58E-10	3.93E-10	1.30E-10	2.96E-11	9.57E-12	5.11E-12	3.21E-12
SE	2.44E-08	3.71E-09	1.62E-09	8.00E-10	4.80E-10	1.62E-10	3.38E-11	9.24E-12	4.93E-12	3.10E-12
SSE	2.53E-08	3.77E-09	1.61E-09	7.93E-10	4.83E-10	1.73E-10	3.80E-11	1.01E-11	5.39E-12	3.38E-12
S	2.29E-08	3.68E-09	1.73E-09	8.87E-10	5.53E-10	2.14E-10	4.99E-11	1.28E-11	6.84E-12	4.30E-12
SSW	3.13E-08	4.78E-09	2.15E-09	1.09E-09	6.58E-10	2.29E-10	5.10E-11	1.45E-11	7.76E-12	4.88E-12
SW	4.77E-08	7.58E-09	3.57E-09	1.84E-09	1.14E-09	4.29E-10	9.68E-11	2.47E-11	1.32E-11	8.27E-12
WSW	3.57E-08	5.51E-09	2.57E-09	1.38E-09	8.76E-10	3.61E-10	1.02E-10	2.94E-11	1.29E-11	6.31E-12
W	1.69E-08	2.53E-09	1.10E-09	5.47E-10	3.34E-10	1.19E-10	2.91E-11	9.13E-12	4.87E-12	3.06E-12
WNW	1.41E-08	2.04E-09	8.22E-10	3.93E-10	2.33E-10	7.56E-11	1.87E-11	6.87E-12	3.67E-12	2.30E-12
NW	2.86E-08	4.18E-09	1.68E-09	7.80E-10	4.61E-10	1.46E-10	3.51E-11	1.29E-11	6.90E-12	4.33E-12
NNW	3.19E-08	4.74E-09	2.00E-09	9.68E-10	5.67E-10	1.73E-10	3.89E-11	1.43E-11	7.65E-12	4.80E-12

TABLE 3-8

2010 ATMOSPHERIC DISPERSION ESTIMATES FOR RETDAS INPUT AT SELECTED LOCATIONS

AFFECTED SECTOR	LOCATION	MILES	X/Q (1)	X/Q DEC (2)	X/Q DEC+ DEP (3)	DEPOSITION (4)
12/WSW	Maximum (X/Q) Site Boundary	1.22	1.04E-05	1.03E-05	8.94E-06	1.38E-08
9/S	Closest (X/Q) Site Boundary	0.38	6.52E-06	6.51E-06	6.07E-06	4.78E-08
12 / WSW	Maximum (X/Q) Residence	1.3	9.44E-06	9.36E-06	8.07E-06	1.24E-08
7 / SE	Maximum (D/Q) Residence	0.5	2.88E-06	2.88E-06	2.63E-06	2.85E-08
7 / SE	Maximum (D/Q) Garden	0.6	2.17E-06	2.17E-06	1.96E-06	2.07E-08
12 / WSW	Maximum (D/Q) Dairy	1.7	6.36E-06	6.29E-06	5.32E-06	7.99E-09
12 / WSW	Maximum (D/Q) Meat Producer	1.7	6.36E-06	6.29E-06	5.32E-06	7.99E-09
3 / NE	Riverlands / EIC	0.7	4.05E-06	4.04E-06	3.62E-06	2.72E-08
12 / WSW	Tower's Club	0.5	4.12E-05	4.11E-05	3.77E-05	6.25E-08

NEAREST RESIDENCE WITHIN A 5-MILE RADIUS BY SECTOR

SECTOR NUMBER	AFFECTED SECTOR	NAME	MILES	X/Q	X/Q DEC	X/Q DEC +DEP	DEPOSITION
1	N	H. Burd	1.3	1.63E-06	1.62E-06	1.4E-06	4.67E-09
2	NNE	E. Ashbridge III	1	2.53E-06	2.52E-06	2.2E-06	9.57E-09
3	NE	W. Tuggle	0.9	2.81E-06	2.80E-06	2.46E-06	1.78E-08
4	ENE	R. Dickosky	2.1	4.89E-07	4.86E-07	4.02E-07	3.34E-09
5	E	L.Kozlowski/M. Witts	1.4	4.33E-07	4.32E-07	3.69E-07	2.86E-09
6	ESE	R. Panetta	0.5	1.57E-06	1.56E-06	1.43E-06	1.41E-08
7	SE	J. Futoma	0.5	2.88E-06	2.88E-06	2.63E-06	2.85E-08
8	SSE	J. Naunczek	0.6	2.53E-06	2.52E-06	2.28E-06	2.32E-08
9	S	S. Slusser	1	1.48E-06	1.47E-06	1.29E-06	8.85E-09
10	SSW	S. Molnar	0.9	2.83E-06	2.82E-06	2.49E-06	1.10E-08
11	SW	F. Michael	1.5	2.56E-06	2.54E-06	2.17E-06	5.23E-09
12	WSW	F. Michael	1.3	9.44E-06	9.36E-06	8.07E-06	1.24E-08
13	W	F. Hummel	1.2	5.33E-06	5.28E-06	4.58E-06	6.94E-09
14	WNW	R. Orlando	0.8	5.07E-06	5.03E-06	4.48E-06	9.42E-09
15	NW	B. Kramer	0.7	5.86E-06	5.83E-06	5.23E-06	1.37E-08
16	NNW	G. John	0.6	5.53E-06	5.51E-06	4.98E-06	1.84E-08

NEAREST GARDEN WITHIN A 5-MILE RADIUS BY SECTOR

SECTOR NUMBER	AFFECTED SECTOR	NAME	MILES	X/Q	X/Q DEC	X/Q DEC +DEP	DEPOSITION
1	N	J. Wojcik	3.2	4.31E-07	4.24E-07	3.37E-07	1.06E-09
2	NNE	R. Chapin	2.3	7.27E-07	7.20E-07	5.92E-07	2.45E-09
3	NE	M. Welch	2.7	5.50E-07	5.45E-07	4.41E-07	3.07E-09
4	ENE	G. Dennis	2.4	4.00E-07	3.98E-07	3.25E-07	2.74E-09
5	E	L. Kozlowski/M. Witts	1.4	4.33E-07	4.32E-07	3.69E-07	2.86E-09
6	ESE	B. Smith	3.1	7.38E-08	7.33E-08	5.81E-08	5.12E-10
7	SE	T. Scholl	0.6	2.17E-06	2.17E-06	1.96E-06	2.07E-08
8	SSE	H. Roinick	2.9	1.96E-07	1.95E-07	1.56E-07	1.45E-09
9	S	T. Stemrich	2.7	2.82E-07	2.80E-07	2.26E-07	1.51E-09
10	SSW	S. Bodnar	1.2	1.85E-06	1.84E-06	1.6E-06	6.73E-09
11	SW	R. Broody	1.9	1.78E-06	1.76E-06	1.47E-06	3.53E-09
12	WSW	F. Michael	1.3	9.44E-06	9.36E-06	8.07E-06	1.24E-08
13	W	F. Hummel	1.2	5.33E-06	5.28E-06	4.58E-06	6.94E-09
14	WNW	P. Moskaluk	1.3	2.47E-06	2.44E-06	2.11E-06	4.09E-09
15	NW	D. Goff	1.8	1.42E-06	1.40E-06	1.18E-06	2.76E-09
16	NNW	P. Culver	4	2.79E-07	2.73E-07	2.12E-07	6.09E-10

TABLE 3-8
(continued)

NEAREST ANIMAL RAISED FOR MEAT CONSUMPTION WITHIN A 5-MILE RADIUS BY SECTOR

SECTOR NUMBER	AFFECTED SECTOR	NAME	MILES	X/Q	X/Q DEC	X/Q DEC+DEP	DEPOSITION
2	NNE	R.Chapin	2.3	7.27E-07	7.20E-07	5.92E-07	2.45E-09
4	ENE	G.Dennis	2.4	4.00E-07	3.98E-07	3.25E-07	2.74E-09
6	ESE	B. Smith	3.1	7.39E-08	7.33E-08	5.82E-08	5.13E-10
10	SSW	K. & C. Drasher	3.5	3.21E-07	3.16E-07	2.48E-07	9.49E-10
12	WSW	T. & M Berger	1.7	6.36E-06	6.29E-06	5.32E-06	7.99E-09

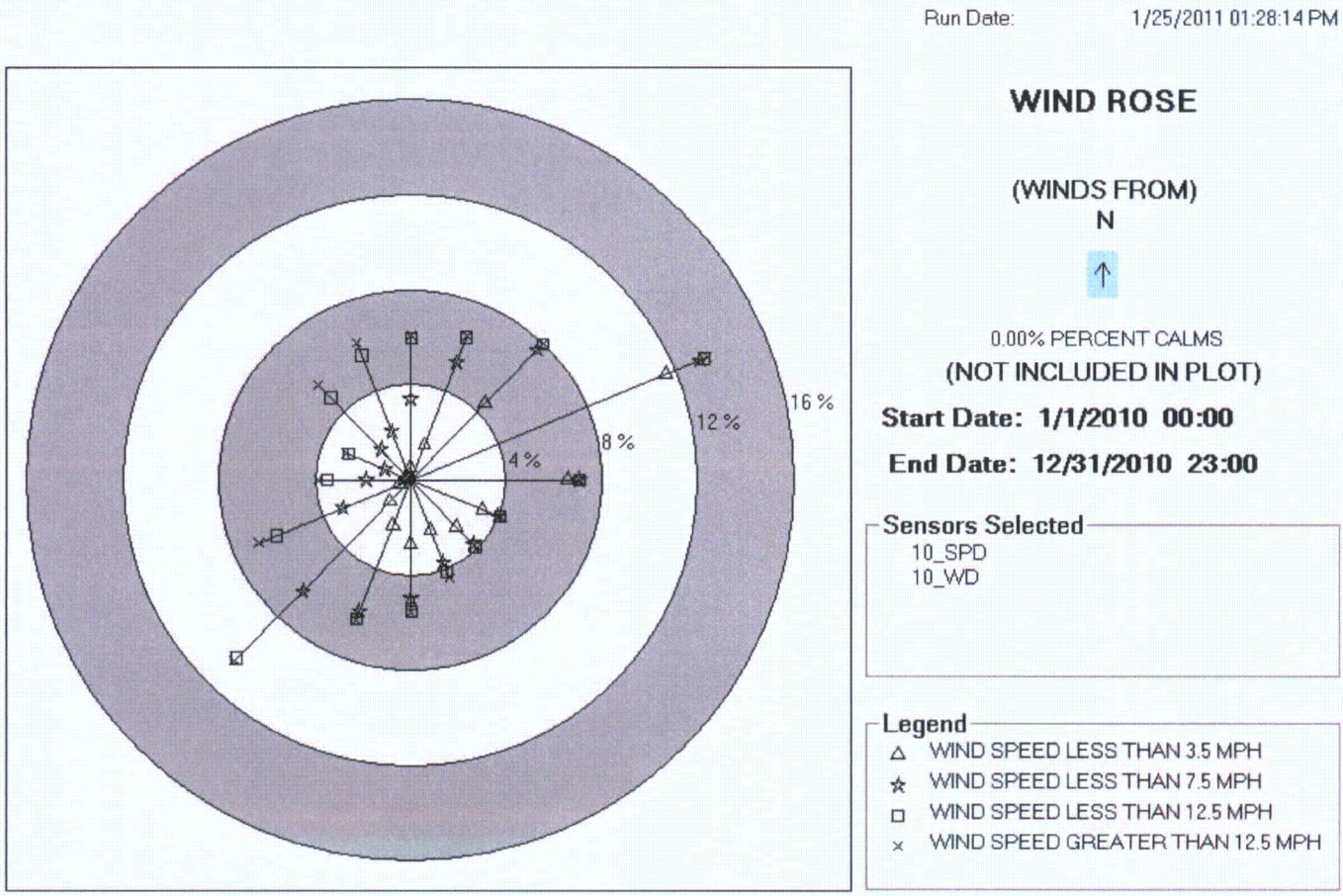
ALL DAIRY LOCATIONS

SECTOR NUMBER	AFFECTED SECTOR	NAME	MILES	X/Q	X/Q DEC	X/Q DEC+DEP	DEPOSITION
5	E	W.Bloss	4.5	5.92E-08	5.85E-08	4.44E-08	3.33E-10
10	SSW	K. & C. Drasher	3.5	3.21E-07	3.16E-07	2.48E-07	9.49E-10
10	SSW	K.Davis	14.01	2.38E-08	2.24E-08	1.48E-08	4.69E-11
12	WSW	T. & M. Berger	1.7	6.36E-06	6.29E-06	5.32E-06	7.99E-09
13	W	J. Dent	5	5.27E-07	5.09E-07	3.87E-07	4.33E-10

1	X/Q	RELATIVE CONCENTRATION (SEC/M^3)
2	X/Q DEC	DECAYED AND UNDEPLETED, HALF-LIFE 2.26 DAYS (SEC/M^3)
3	X/Q DEC+DEP	DECAYED AND DEPLETED, HALF-LIFE 8 DAYS (SEC/M^3)
4	DEPOSITION	RELATIVE DEPOSITION RATE (1/M^2)

FIGURE 3-1

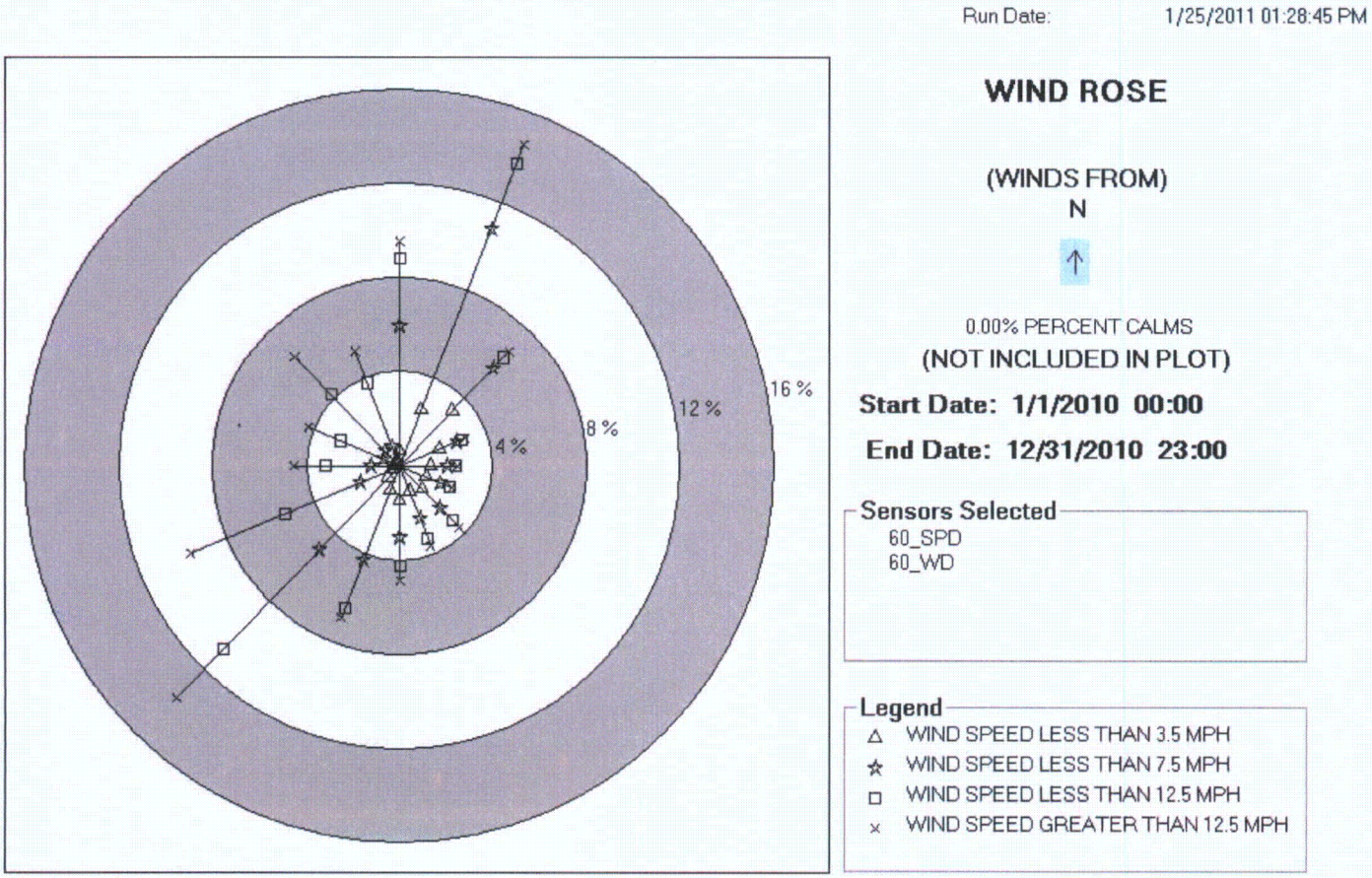
2010 ANNUAL WIND ROSE 10M LEVEL – PRIMARY TOWER



This wind rose displays the frequency of hourly average wind direction from a given sector. In 2010, the predominant wind direction occurred 13.4 % of the time from the ENE sector. The average wind speed was 5.4 mph and the average wind speed for the predominant sector (ENE) was 2.8 mph. The sector with the highest average wind speed was NW (9.0 mph).

FIGURE 3-2

2010 ANNUAL WIND ROSE 60M LEVEL – PRIMARY TOWER

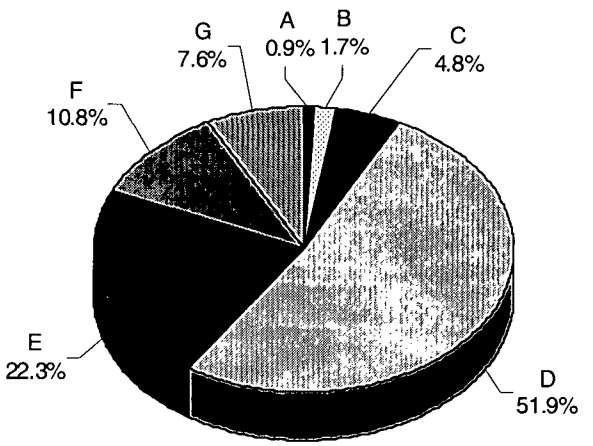


This wind rose displays the frequency of hourly average wind direction from a given sector. In 2010, the predominant wind direction occurred 14.3 % of the time from the NNE sector. The average wind speed was 8.1 mph and the average wind speed for the predominant sector (NNE) was 6.2 mph. The sector with the highest average wind speed was WSW (11.9 mph.).

FIGURE 3-3

PASQUIL STABILITY CLASS PREVALENCES DATA
Period: 2010

Joint Frequency Distributions at 10 Meters
Wind Speed and Direction 10M vs. Delta Temperature 60-10M
(Based on 8,592 Valid Hours)



SECTION 4

DOSE MEASUREMENTS AND ASSESSMENTS

Radiological Impact on Man

Sampling and analysis of airborne and waterborne effluents were performed in accordance with the frequencies, types of analysis, and Lower Limit of Detection (LLD) outlined in the PPL Susquehanna, LLC Technical Requirements Manual.

Radioactive material was detected in some of the airborne and waterborne effluent samples analyzed. Dose calculations using measured and calculated effluent activity levels, meteorological data from the current reporting period and average river flow dilution factors resulted in estimated doses to individuals at levels below 10 CFR 20 and 10 CFR 50, Appendix I limits. Direct radiation resulting from plant operation (reported in the 2010 Annual Radiological Environmental Operating Report) contributed a maximum of 6.99E-1 mrem (measured at TLD Location 9S2 and based on an occupancy time by a member of the public of 20 hours per quarter) at the Protected Area Boundary south of the plant. Based on airborne effluent sample data, the maximum organ (including thyroid)/total body dose is 2.82E-1 mrem (CHILD, LUNG Table 4-2). The maximum organ/total body dose from all liquid effluent is 4.12E-2 mrem (TEEN, LIVER Table 4-2). Conservatively adding the maximum organ/total body dose from liquid and gaseous effluent and the maximum total body dose determined from direct radiation results in a dose of 1.02 mrem, which is 4.1% of the 40CFR190 limit of 25 mrem to total body/organ (except thyroid) and 1.4% of the 40CFR190 limit of 75 mrem to the thyroid.

Doses to a maximally exposed member of the public from waterborne effluents are calculated for fish ingestion and shoreline exposure at the plant outfall, and drinking water ingestion at Danville, PA. Site specific parameters used in the calculations for the Danville receiver, specific for actual average blowdown and river level for the entire year are shown in Table 4-1.

TABLE 4-1

SITE-SPECIFIC PARAMETERS USED FOR RETDAS CALCULATIONS (DANVILLE RECEIVER) FOR 2010

PARAMETER	ENTIRE YEAR
Cooling Tower Blowdown (CFS)	21.7
Average Net River Level (ft.)	6.5
Dilution Factor at Danville[1]	366.3
Transit time to Danville (hr.)[1]	26.9

[1]From ODCM-QA-005, Att. E

Summaries of maximum individual doses resulting from airborne and waterborne radioactive effluent releases from each unit are given in Table 4-2. Meteorological data from Section 3 were used to calculate the dose from airborne effluents.

The Radioactive Effluent Release Report includes an assessment of the radiation dose from radioactive effluents to members of the public within the site boundary. Within the Site Boundary there are several areas frequented by members of the public. There are no significant exposure pathways from waterborne effluents in these areas. Doses from airborne effluent are calculated for members of the public for the following locations: Riverlands Energy Information Center, the Towers Club, and residence with the maximum X/Q value; the garden, dairy and meat producing farm with the maximum D/Q value; and the site boundary with the maximum X/Q value. Summaries of the calculated maximum doses within the site boundary and selected locations beyond the site boundary resulting from airborne effluents are presented in Table 4-4. The above referenced locations are shown on Figure 4-1.

In the area comprising the Riverlands recreation area, which surrounds the Energy Information Center, three pathways of radiation exposure can be identified: plume, ground, and inhalation. There are no significant exposure pathways from waterborne effluents in this area. There are approximately 100,000 visitors to the Riverlands/Energy Information Center complex each year. For dose calculations, it is assumed the visitor stays in the area for one hour. The calculated dose rate and collective dose for visitors to the Riverlands/Energy Information Center during 2010 are shown on Table 4-3.

Use of the RETDAS code yields calculated doses for the Riverlands area for the report period. These doses assume an occupancy factor of 100% for a member of the public during 2010. These calculated dose values are shown on Table 4-4.

In Regulatory Guide 1.21, Revision 2, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste", the NRC has recommended that U.S. nuclear power plants evaluate whether C-14 is a "principal radionuclide", and if so, report the amount of C-14 released. Radioactive effluent releases of C-14 have not increased but the decline in releases of other radionuclides has resulted in C-14 possibly becoming more prominent, specifically in airborne effluents. This regulatory guidance has led to an industry initiative to evaluate and report C-14 in the 2010 Radioactive Effluent Release Report (as well as future reports).

Carbon-14 (C-14), with a half-life of 5730 years, is a naturally occurring isotope of carbon produced by cosmic ray interactions in the atmosphere. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. C-14 is also produced in commercial nuclear reactors, but the amounts produced are much less than those produced naturally or from weapons testing.

In December 2010 the Electric Power Research Institute (EPRI) published Report 1021106, "Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents", which provides conservative technical guidance to support the calculation of C-14 released in radioactive effluents. The calculation of C-14 discharged from the Susquehanna station and resultant offsite dose during 2010 is based upon the methodology outlined in the referenced EPRI report. In a BWR the majority of C-14 is generated in the reactor core by neutron activation of reactor coolant, specifically $^{17}O(n,\alpha)\ ^{14}C$. Thus C-14 generation is directly proportional to reactor power. As documented in the EPRI report, approximately 99% of the C-14 produced in the reactor core is discharged as gaseous effluent (primarily as CO_2) through the offgas system and released from the Turbine Building vents. The remaining 1% is released in the form of solid radwaste. There is minimal (<1%) C-14 released in the liquid effluent pathway. Based on the EPRI methodology, approximately 24.5 Curies of C-14 were released in gaseous effluents in 2010.

The airborne effluent pathway with the highest offsite dose potential (for C-14 releases) is the vegetation ingestion pathway. The maximum expected annual dose from C-14 released from Susquehanna Unit-1 (2.90 mrem) and Unit-2 (3.55 mrem) has been calculated based on methodology in Regulatory Guide 1.109 and includes site specific parameters (e.g., nearest garden with highest X/Q value, producing both broad leaf and non-broad leaf vegetation). The maximum organ dose from airborne effluent C-14 released from the Susquehanna station in 2010 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit). The annual dose to the maximally exposed individual from all gaseous releases of C-14 (calculated by the above referenced methodology) is 6.45 mrem to the critical organ (bone) and 1.29 mrem to the total body.

Conservatively adding the maximum organ/total body dose from Table 4-4 to the maximum dose due to the calculated release of C-14 (6.45 mrem, CHLD, BONE) bounds the dose that any member of the public receives from station operations to 7.47 mrem, which is 30% of the 40CFR190 limit of 25 mrem to total body/organ (except thyroid) and 10% of the 40CFR190 limit of 75 mrem to the thyroid.

TABLE 4-2

SUMMARY OF MAXIMUM INDIVIDUAL DOSES TO MEMBERS OF THE PUBLIC [4]

DATA PERIOD: 1/1/10 TO 12/31/10

UNIT	EFFLUENT	AGE GROUP	APPLICABLE ORGAN	ESTIMATED MAXIMUM DOSE (MREM/MRAD)	LOCATION		PERCENT OF LIMIT	LIMIT (MREM/ MRAD)[2]
					DIST (MILES)	AFFECTED SECTOR		
1	Liquid[1]	Teen	Total Body	1.17E-02	(3)		0.4	3
1	Liquid[1]	Teen	Liver	2.06E-02	(3)		0.2	10
1	Noble Gas	N/A	Air Dose (Gamma-MRAD)	6.44E-04	0.5	WSW	0.01	10
1	Noble Gas	N/A	Air Dose (Beta-MRAD)	1.79E-03	0.5	WSW	0.01	20
1	Airborne Iodine, Tritium and Particulates	Child	Lung	1.02E-01	0.5	WSW	1.0	15
2	Liquid[1]	Teen	Total Body	1.17E-02	(3)		0.4	3
2	Liquid[1]	Teen	Liver	2.06E-02	(3)		0.2	10
2	Noble Gas	N/A	Air Dose (Gamma-MRAD)	0	0.5	WSW	0	10
2	Noble Gas	N/A	Air Dose (Beta-MRAD)	0	0.5	WSW	0	20
2	Airborne Iodine, Tritium and Particulates	Child	Liver	1.80E-01	0.5	WSW	1.2	15

[1] Estimated dose is based on a site total activity release equally divided between Unit 1 and Unit 2.

[2] 10 CFR 50, Appendix I limits are in terms of mrad or mrem/reactor-year for airborne and waterborne effluent from each unit.

[3] Doses from liquid effluent are estimated from fish ingestion and shoreline exposure at the site outfall and from the drinking water pathway at Danville, PA.

[4] Dose due to calculated release of C-14 not included:

TABLE 4-3

CALCULATED COLLECTIVE DOSES TO MEMBERS OF THE PUBLIC WITHIN THE RIVERLANDS/ENERGY INFORMATION CENTER COMPLEX

DATA PERIOD: 1/1/10 TO 12/31/10

EFFLUENT	AGE GROUP	APPLICABLE ORGAN	DOSE RATE[1] (MREM/HR)	COLLECTIVE DOSE[2] (PERSON-REM)
Noble Gas	N/A	Total Body	7.23E-09	7.23E-07
Noble Gas	N/A	Skin	2.01E-08	2.01E-06
Iodine, Tritium and Particulates[3]	Child	GI-LLI	3.21E-06	3.21E-04

[1]Estimated dose and dose rate is based on annual site total activity release.

[2]Collective dose is based on 100,000 person-hours.

[3] Dose due to calculated release of C-14 not included.

TABLE 4-4

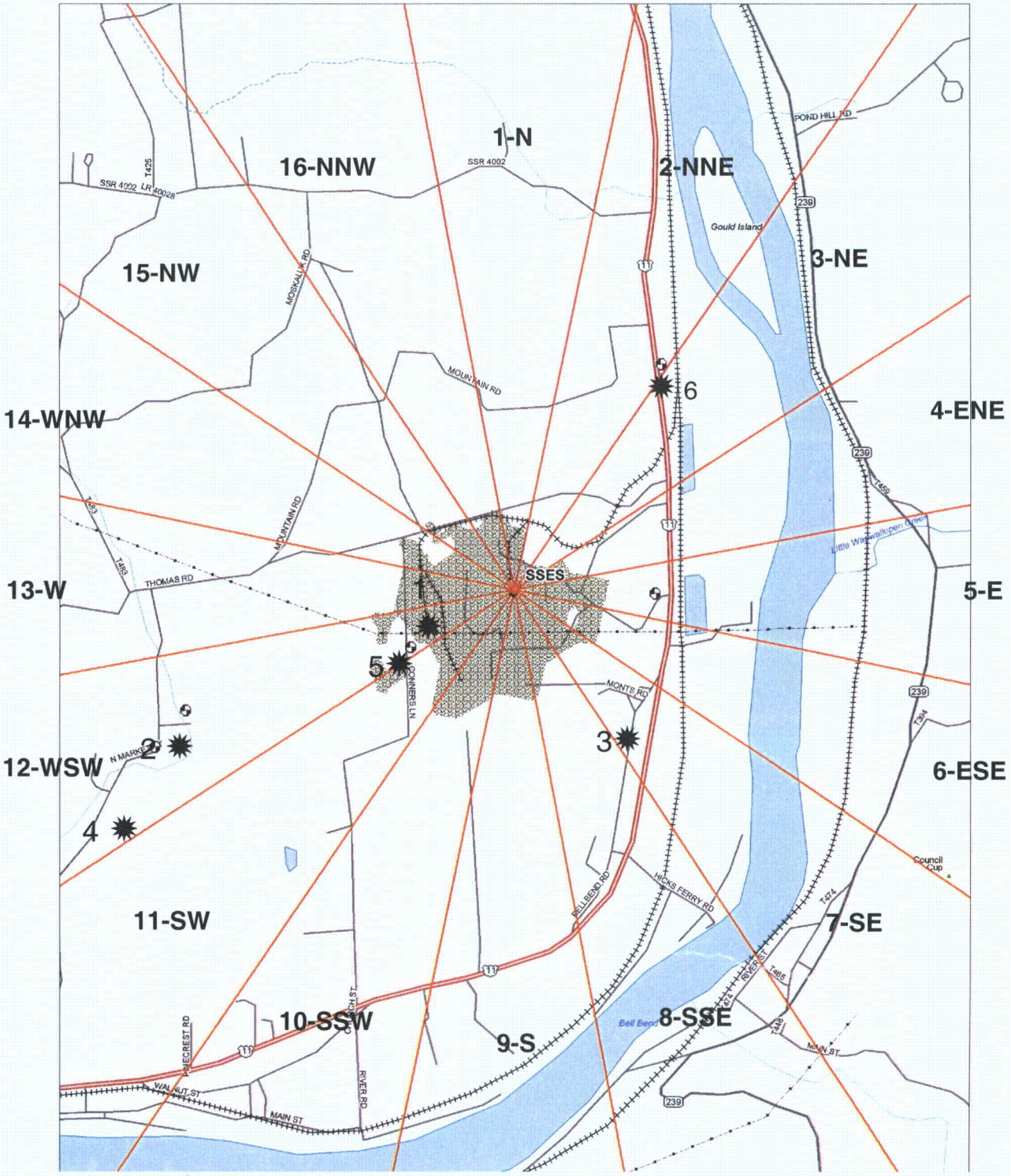
SUMMARY OF MAXIMUM INDIVIDUAL DOSES FROM AIRBORNE EFFLUENT

LOCATION	PATHWAY	MAXIMUM TOTAL BODY DOSE (MREM)		MAXIMUM ORGAN DOSE (MREM)		MAXIMUM THYROID DOSE (MREM)	
1. Maximum site boundary X/Q	Total (All)	7.12E-02	(CHILD)	7.12E-02	(CHILD, LUNG)	7.11E-02	(CHILD)
2. Maximum X/Q Residence	Total (All)	6.46E-02	(CHILD)	6.46E-02	(CHILD, LUNG)	6.46E-02	(CHILD)
3. Maximum D/Q Garden	Total (All)	1.51E-02	(CHILD)	1.51E-02	(CHILD,GI-LLI)	1.51E-02	(CHILD)
4. Maximum D/Q Dairy + Maximum D/Q Meat	Total (All)	4.35E-02	(CHILD)	4.35E-02	(CHILD, LUNG)	4.35E-02	(CHILD)
5. Tower's Club	Total (All)	2.82E-01	(CHILD)	2.82E-01	(CHILD, LUNG)	2.82E-01	(CHILD)
6. Riverland/EIC	Total (All)	2.80E-02	(CHILD)	2.81E-02	(CHILD, GI-LLI)	2.80E-02	(CHILD)

Note: The doses shown above are based on 100% occupancy at the indicated locations. They are based on a composite of all pathways resulting in a total dose to the maximally exposed individual due to airborne effluents from both Unit-1 and Unit-2 operations. Dose due to calculated release of C-14 not included.

FIGURE 4-1

AIRBORNE-DOSE CALCULATION LOCATIONS



✸ Indicates airborne-dose calculation location per Table 4-4

SECTION 5

CHANGES TO THE OFFSITE DOSE CALCULATION MANUAL (ODCM), TECHNICAL REQUIREMENTS MANUAL (TRM) AND THE SOLID RADIOACTIVE WASTE PROCESS CONTROL PROGRAM

CHANGES TO THE OFFSITE DOSE CALCULATION MANUAL

The PPL Susquehanna, LLC ODCM consists of nine (9) individual procedures.

ODCM-QA-003, Effluent Monitor Setpoints, was revised twice in 2010. Revision 5 was issued on February 8, 2010. The revision: 1) updated position titles; 2) clarified the process for liquid effluent setpoint determination in support of the implementation of the RETDAS software program and 3) updated guidance for post-release evaluations.

ODCM-QA-003 Revision 6 was issued May 11, 2010. The revision included alternate titles for the liquid discharge radiation monitor "calibration factor" and updated position titles.

ODCM-QA-005, Waterborne Effluent Dose Calculations, was revised on February 8, 2010. The revision: 1) updated position titles and clarified the data used to support dose projections and 2) added dose factors for U-235 and Pu-239 which were not previously in the ODCM but were included in the software used to calculate offsite dose from liquid effuents.

CHANGES TO THE TECHNICAL REQUIREMENTS MANUAL

Section 3.11 and 3.6.1 of the Unit-1 and Unit-2 Technical Requirements Manual (TRM) by reference are part of the ODCM. The following limits and requirements are contained in Section 3.11: liquid and gaseous effluent dose limits, liquid and gaseous effluent treatment system operability criteria (based on effluent dose), liquid and gaseous effluent treatment system operability criteria and the conduct of the Radiological Environmental Monitoring Program. Section 3.6.1 contains requirements for venting or purging of primary containment.

Section B3.11.4.1 of the Unit-1 and Unit-2 TRM was revised on June 30, 2010. The revision: 1) clarified the waterborne surface water downstream sample location description and 2) added a reference to NUREG-1302, Offsite Dose Calculation Manual Guidance: "Standard Radiological Effluent Controls for Boiling Water Reactors," April 1991.

PROCESS CONTROL PROGRAM CHANGES

The following changes were made to the Process Control Program and implementing procedures during 2010. None of the changes reduce the overall conformance of the solidified waste product to existing criteria for solid wastes. All changes were reviewed and approved by PORC (as necessary) as documented on the attached summary of procedure changes. The following procedures were changed:

1. WM-RP-107, Transfer and Dewater A (B) RWCU Phase Separator

2. WM-RP-113, Transfer and Dewatering of Waste Mix Tanks

3. WM-RP-106, Transfer and Dewatering Bead Resin

4. WM-RP-010, Liner Decanting

5. WM-RP-104, Gross Dewatering

6. WM-RP-112, Dewatering Waste to Disposal Criteria

7. WM-PS-351, Use of the CNS 21-300 Shipping Package

NDAP-QA-0646 continues to fully implement the requirements and intent of the following:

1. Sections 11.4 and 13.5 of the FSAR
2. Section 3.7.4 of the Technical Requirements Manual
3. 10 CFR 20, 10 CFR 61, 10 CFR 71, 49 CFR 100-177, and 40 CFR 261

Compliance with all applicable regulatory requirements listed above continues to be met as the result of these changes to the program. These changes to the Process Control Program will not reduce the overall conformance of the solidified waste product to existing criteria for solid wastes.

PROCEDURE REVISION SUMMARY
WM-RP-107, TRANSFER AND DEWATER A (B) RWCU PHASE SEPARATOR

1. Revised procedure to add step 6.4, press Control Power Reset.

PROCEDURE REVISION SUMMARY
WM-RP-113, TRANSFER AND DEWATERING OF WASTE MIX TANKS

1. Revised procedure to add step 6.4, Press Control Power Reset.

PROCEDURE REVISION SUMMARY
WM-RP-106, TRANSFER AND DEWATERING BEAD RESIN

1. Revised procedure to add step 6.4 Press Control Power Reset.

PROCEDURE REVISION SUMMARY
WM-RP-010, LINER DECANTING

1. Revised procedure to add step 6.2.6, Energize Control Panel.
2. Revised procedure to add step 6.2.7, Press Control Power Reset.

PROCEDURE REVISION SUMMARY
WM-RP-104, GROSS DEWATERING

1. Revised procedure to add step 6.1.2.a, Energize Control Panel.
2. Revised procedure to add step 6.1.2.b, Press Control Power Reset.

PROCEDURE REVISION SUMMARY
WM-RP-112, DEWATERING WASTE TO DISPOSAL CRITERIA

1. Revised procedure to add step 6.2.1, Energize Control Panel.
2. Revised procedure to add step 6.2.2, Press Control Power Reset.

PROCEDURE REVISION SUMMARY
WM-PS-351, USE OF THE CNS 21-300 SHIPPING PACKAGE

1. Updated the procedure with various administrative changes including: referencing the vendor procedure number; specifying size of the cask nuts and added requirements to contact the vendor if the gasket needs possible replacement.

SECTION 6

MISCELLANEOUS TECHNICAL REQUIREMENTS MANUAL (TRM), FSAR, 40CFR190 AND NEI GROUNDWATER PROTECTION INITIATIVE REPORTING

1. TRM Action 3.11.1.4.F.2 requires the reporting of Liquid Radwaste Effluent Monitoring Instrumentation inoperability not corrected in a timely manner.

   None to report for 2010.

2. TRM Action 3.11.1.5.C.1 requires the reporting of Radioactive Liquid Process Effluent Monitoring Instrumentation inoperability not corrected in a timely manner.

   None to report for 2010.

3. TRM Action 3.11.2.6.K requires an explanation for Radioactive Gaseous Effluent Monitoring Instrumentation required actions and completion times not met.

   On 10/11/10 at 0400 the Unit-1 Reactor Building vent low range noble gas monitor was declared inoperable and TRO 3.11.2.6 Conditions B & D were entered. Per TRO 3.11.2.6 Condition B, Required Action B.1, noble gas grab samples are required every 8 hours. Initial noble gas sample was taken at 0430 on 10/11/10 and the next sample was due to be taken at 1230. The sample which was due at 1230 was not obtained until 1855 on 10/11/10. The noble gas sample was missed due to confusion by the Chemistry technician in interpreting procedural guidance when ventilation exhaust flow appeared to be zero based on instrumentation.

4. TRM Action 3.11.4.1.F.2 requires reporting the cause of the unavailability of milk or fresh leafy vegetable samples and identify the new locations for obtaining replacements.

   None to report for 2010.

5. TRM Action 3.11.4.2.A requires reporting when land use census identifies a new location which yields a calculated dose or dose commitment greater than the values currently being calculated in Requirement 3.11.2.3 (Gaseous Effluent Dose due to Iodine, Tritium, and Radionuclides in Particulate Form).

   None to report for 2010.

6. TRM Action 3.11.4.2.B requires reporting when land use census identifies locations that yield a calculated dose or dose commitment (via the same exposure pathway) 20 percent greater than at a location from which samples are currently being obtained in accordance with Requirement 3.11.4.1 (Radiological Environmental Monitoring Program).

   None to report for 2010.

7. The limits outlined in 40CFR190.10 (Environmental Standards for the Uranium Fuel Cycle-Standards for Normal Operations) were not exceeded by station operations during 2010. Refer to Section 2 and Section 4 for specific values.

8. FSAR Section 11.6.11 requires the reporting of airborne radioactivity detected in the Low Level Radwaste Holding Facility.

   No airborne radioactivity detected above analysis MDC's in air samples from the Low Level Radwaste Holding Facility during 2010.

9. The PPL Susquehanna station has implemented an Action Plan in response to the NEI Initiative on Groundwater Protection. Part of the Action Plan includes the assessment of the current groundwater monitoring program. Groundwater is sampled and analyzed quarterly as part of the Radiological Environmental Monitoring Program (REMP). REMP groundwater sampling locations are defined in ODCM-QA-008 Attachment G. In August 2006, additional groundwater sampling was initiated at locations which are not listed in the ODCM. The additional locations are three manholes which collect water from a perimeter drain system. The perimeter drain system consists of perforated piping installed just above the footing along the exterior base of the vertical walls of the reactor, turbine and radwaste buildings. Outlined in Table 6-1 are the tritium analysis results from sampling of the perimeter drain system. No gamma emitting radionuclides were identified above analysis MDC's for the perimeter drain samples in 2010. The tritium results reported in Table 6-1 did not exceed any Reporting Level thresholds in the PPL Susquehanna Technical Requirements Manual or any reporting criteria established in response to the NEI Groundwater Protection Initiative. Figure 6-1 is a trend graph of airborne and waterborne effluent tritium releases from the PPL Susquehanna Station starting in 1982.

TABLE 6-1

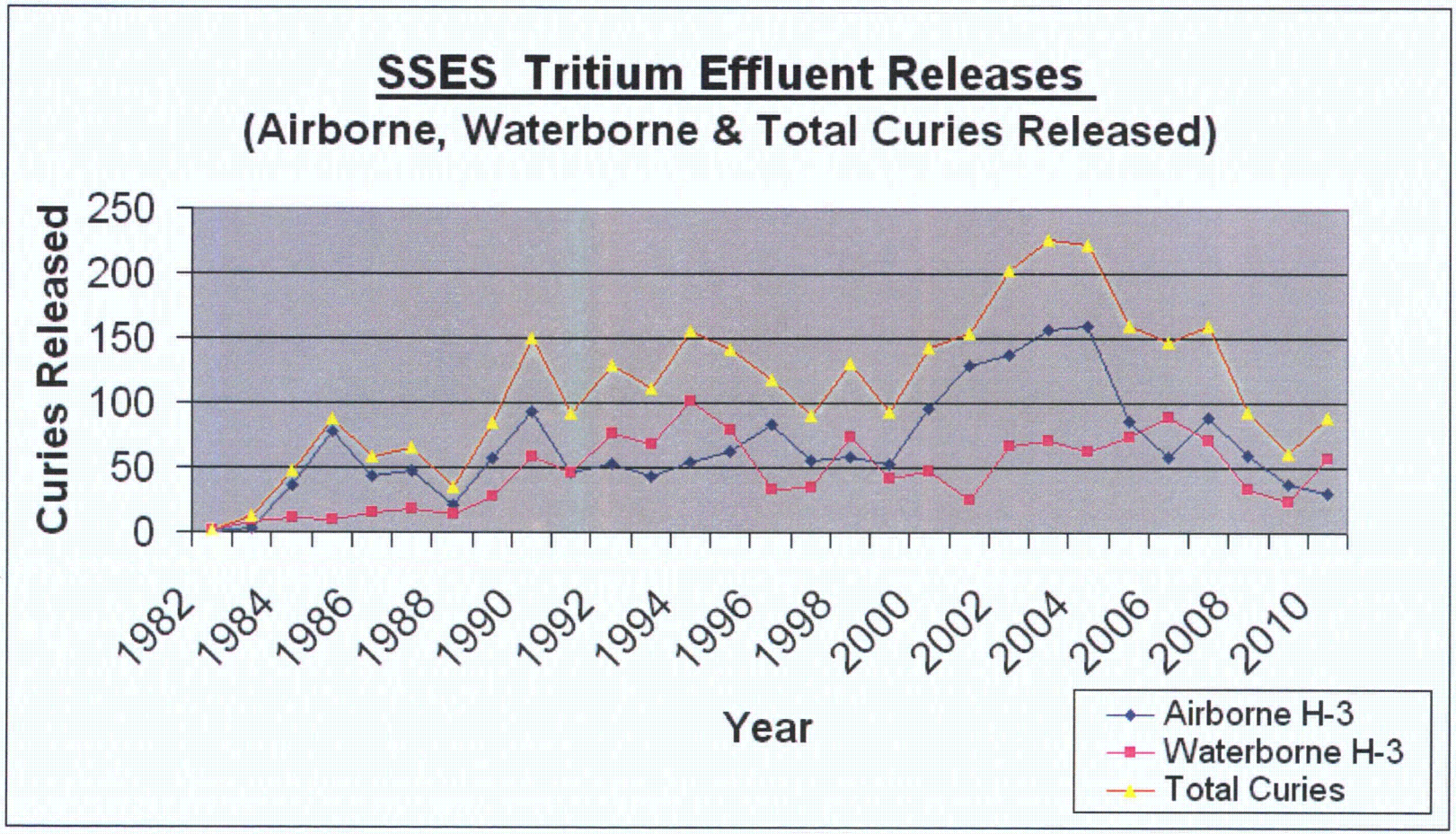
NEI Ground Water Protection Initiative Reporting

Perimeter Drain Sampling Results: 2010

	Manhole FD-1 (7S9 - E of U2 CST)	Manhole FD-2 (16S3- NW corner of RW Bldg.)	Manhole FD-3 (9S3 - I/S RCA @ U2 HP Cont. Pt. Closet)
Date	Tritium (pCi/liter)	Tritium (pCi/liter)	Tritium (pCi/liter)
2/8/2010	378	334	251
/14/2010	363	336	307
*7/26/2010	271	326	234
8/5/2010	239	515	225
11/8/2010	451	285	327

*Perimeter drain sampling in response to U1 Condenser area flood event.

Figure 6-1


SSES Tritium Effluent Releases
(Airborne, Waterborne & Total Curies Released)
Curies Released
250
200
150
100
50
0
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Airborne H-3
Waterborne H-3
Total Curies

SECTION 7

CORRECTIONS TO PREVIOUS RADIOACTIVE EFFLUENT RELEASE REPORTS

CORRECTIONS TO PREVIOUS
RADIOACTIVE EFFLUENT RELEASE REPORTS

No corrections to previous Radioactive Effluent Release Reports are submitted for this report period.

SECTION 8

EFFLUENT FROM SYSTEMS CLASSIFIED AS INSIGNIFICANT EFFLUENT PATHWAYS

EFFLUENT FROM SYSTEMS CLASSIFIED AS INSIGNIFICANT EFFLUENT PATHWAYS

Insignificant Effluent Pathways are: 1) evaporation from the Unit 1 and Unit 2 Condensate Storage Tanks (CST's); 2) evaporation from the common Refueling Water Storage Tank (RWST); 3) gaseous effluent from the Hydrogen Seal Oil, Main Turbine and RFPT lubrication oil mist eliminators which vent to the turbine building roofs.

These pathways are not continuously monitored. The CSTs and RWST are sampled monthly to determine the concentration of radionuclides present in these tanks. Tritium analysis on these samples is performed quarterly. Airborne release to the environment from the tanks is estimated based on conservative estimates of the evaporation rates from each of the tanks using a modified method established within Chapter 7 of EPA AP-42. A conservative carry-over fraction of radionuclides from the water to the evaporated liquid is then assumed. Airborne release to the environment from the demisters conservatively assumes the maximum moisture (condensate) concentration of the lubrication oil as measured via sampling during 2010. The calculation also assumes immediate removal of 100% of the water by the oil mist eliminators as it passes through the turbines.

The Unit-1 Hydrogen Water Chemistry (HWC) system was identified as being contaminated with tritium on 5/21/10. Prior to confirming tritium contamination in the HWC piping (and prior to draining the water from the system), the system was purged twice (once on 5/20/10 and once on 5/21/10) with compressed nitrogen. Since the HWC system purge evolutions occurred while tritiated water was in the system piping, it is possible that an unmonitored release of a small amount of tritium could have occurred. On 5/21/10 the Turbine building roof was surveyed by Health Physics at the hydrogen system vent area. No radiological contamination or indication of water on the roof was identified in the area of the vent (thus no indication of a release of tritiated water on the Turbine building roof as a result of the HWC system purge). Airborne release to the environment from the Unit-1 HWC system contamination is based on conservative assumptions and identified tritium concentration levels resulting in a release of 5.64 uCi. Offsite dose due to the release of 5.64 uCi of tritium from the Unit-1 HWC system contamination event is included in the maximum dose to the public from insignificant effluents.

The annual release of tritium, iodines and particulates with half-lives greater than 8 days was calculated based on the conservative assumptions outlined above. The calculated releases are shown in Table 8-1. All nuclides, except for tritium, released from insignificant effluent pathways are negligible compared to the airborne release data shown in Tables 2-1 and 2-2. The maximum dose to the public from a release of 3.77 Ci of tritium is calculated to be 1.04E-2 mrem (child). This is a small fraction of the maximum dose from airborne effluent reported in Section 4.

TABLE 8-1

ANNUAL RELEASE FROM SYSTEMS CLASSIFIED AS INSIGNIFICANT EFFLUENT PATHWAYS

Nuclide	RWST (Ci)	U1-CST and Main Turbine/RFPT Lube Oil Systems (Ci)	U2-CST and Main Turbine/RFPT Lube Oil Systems (Ci)	U1 HWC System (Ci)	Total (Ci)
H-3	4.07E-02	1.74E+00	1.99E+00	5.64E-06	3.77E+00
Mn-54	1.41E-09	9.44E-08	7.17E-09	0.00E+00	1.03E-07
Co-60	9.81E-08	3.41E-07	3.87E-08	0.00E+00	4.78E-07
Sb-124	0.00E+00	2.48E-09	0.00E+00	0.00E+00	2.48E-09
Co-58	7.67E-11	6.62E-08	0.00E+00	0.00E+00	6.63E-08
Zn-65	0.00E+00	7.24E-09	0.00E+00	0.00E+00	7.24E-09