Entergy

Entergy Nuclear Operations, Inc.
Pilgrim Nuclear Power Station
600 Rocky Hill Road
Plymouth, MA 02360

May 12, 2017

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

SUBJECT: Annual Radioactive Effluent Release Report for January 1 through December 31, 2016

Pilgrim Nuclear Power Station
Docket No. 50-293
Renewed License No. DPR-35

LETTER NUMBER: 2.17.033

Dear Sir or Madam:

In accordance with Pilgrim Nuclear Power Station Technical Specification 5.6.3, Entergy Nuclear Operations, Inc. submits the attached Annual Radioactive Effluent Release Report for January 1 through December 31, 2016.

If you have any questions or require additional information, please contact me at (508) 830-8323.

There are no regulatory commitments contained in this letter.

Sincerely,

Everett P. Perkins, Jr.
Manager, Regulatory Assurance

EPP/rb

Attachment: Pilgrim Nuclear Power Station Annual Radioactive Effluent Release Report

IE48
NRR

cc: Mr. Daniel H. Dorman
Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
2100 Renaissance Boulevard, Suite 100
King of Prussia, PA 19406-2713

Mr. John Lamb, Senior Project Manager
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Mail Stop 8 B1A
Washington, DC 20555

Mr. John Giarrusso, Jr.
Planning, Preparedness & Nuclear Section Chief
Mass. Emergency Management Agency
400 Worcester Road
Framingham, MA 01702

NRC Senior Resident Inspector
Pilgrim Nuclear Power Station

Attachment

Letter Number 2.17.033

PILGRIM NUCLEAR POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

PILGRIM NUCLEAR POWER STATION

Facility Operating License DPR-35

Annual Radioactive Effluent Release Report

January 1 through December 31, 2016

PILGRIM NUCLEAR POWER STATION
Facility Operating License DPR-35

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

JANUARY 01 THROUGH DECEMBER 31, 2016

Prepared by: _____ 22-Mar-2017
K.J. Sejkora
Senior HP/Chemistry Specialist

Reviewed by: _____ 28-April-2017
G.W. Blankenbiller
Chemistry Manager

Reviewed by: _____ 30 April 2017
A. Zelie
Radiation Protection Manager

TABLE OF CONTENTS

LIST OF TABLES

EXECUTIVE SUMMARY

PILGRIM NUCLEAR POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
JANUARY 01 THROUGH DECEMBER 31, 2016

INTRODUCTION

This report quantifies the radioactive gaseous, liquid, and radwaste releases, and summarizes the local meteorological data for the period from January 01 through December 31, 2016. This document has been prepared in accordance with the requirements set forth in the Pilgrim Nuclear Power Station (PNPS) Technical Specifications and Revision 1 of Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Material in Liquid and Gaseous Effluents from Light Water Cooled Nuclear Power Plants". This document has been prepared in accordance with the requirements of PNPS Technical Specifications section 5.6.3.

The quantity of radioactive material released from PNPS was determined from sample analyses and continuous on-line monitoring of gaseous releases from the main stack, reactor building vent, turbine building, and various decontamination facilities, and liquid releases into the discharge canal.

The quantity and volume of radioactive waste shipped offsite from PNPS for processing and burial were determined from data contained on the radwaste shipping documentation. The meteorological data were obtained from monitoring instruments located on the 220-foot meteorological tower located at Pilgrim Station.

GASEOUS EFFLUENTS

Gaseous radioactive releases for the reporting period are quantified in Tables 2.2-A, 2.2-B, and 2.2-C. Radioactive noble gases released during the period totaled 0.20 Curies. Releases of radioactive iodines and particulates with half-life of greater than 8 days totaled 0.0020 Curies, tritium releases totaled 64 Curies, and carbon-14 totaled 7.8 Curies. No gross alpha radioactivity was detected in gaseous effluents.

Noble gases released in gaseous effluents resulted in a maximum total body dose of 0.00000093 mrem, with a corresponding skin dose of 0.0000023 mrem. The release of radioactive particulates, iodines, tritium, and carbon-14 in gaseous effluents from PNPS during the reporting period resulted in a total body dose to the maximum-exposed hypothetical individual of about 0.017 mrem. The maximum hypothetical dose to any organ from radioactive particulates, iodines, tritium, and carbon-14 was about 0.077 mrem. The maximum, hypothetical total body dose from the combined release of all airborne radioactivity in gaseous effluents was 0.017 mrem.

The maximum individual doses from gaseous radioactive effluents were compared to the applicable ODCM dose limits. Noble gas doses were less than 0.000014% of the corresponding 10CFR50 dose objectives. Maximum doses resulting from releases of particulates, iodines, tritium, and carbon-14 in gaseous effluents were less than 0.52% of corresponding 10CFR50 objectives.

LIQUID EFFLUENTS

Liquid radioactive releases for the reporting period are quantified in Tables 2.3-A and 2.3-B. Two discharges of liquid effluents containing radioactivity occurred during the reporting period. These discharges contained 0.0015 Curies of tritium, and 0.0000081 Curies of fission and activation products. The resulting maximum total body dose was 0.00000026 mrem, with a corresponding organ dose of 0.00000046 mrem. All doses from liquid discharges were less than 0.000014% of corresponding 10CFR50 objectives.

METEOROLOGICAL DATA

Meteorological joint frequency distributions are listed in Appendix A. Data recovery for the entire annual period was 96% for the 33-ft and 96% for the 220-ft levels of the tower. The predominant wind direction was from the south-southwest, which occurred approximately 14% of the time during the reporting period. The predominant stability class was Class D, which occurred about 41% of the time during the reporting period

OFFSITE AMBIENT RADIATION MEASUREMENTS

Ambient radiation exposure was evaluated to complete the assessment of radiological impact on humans. A small number of thermoluminescent dosimeters (TLDs) indicated an elevation in ambient radiation exposure on Entergy property in close proximity to the station, when compared to background levels in the region. This elevation is due to nitrogen-16 contained within the plant steam system, as opposed to radioactive effluent released from the plant. The dose to the maximum-exposed member of the public at the PNPS Health Club, even though they are within the owner-controlled area, was estimated as being about 1.6 mrem during 2016. There was no measurable increase during 2016 in ambient radiation measurements at the location of the nearest resident 0.8 km southeast of PNPS.

COMBINED DOSE IMPACT

The collective total body dose to a maximum-exposed hypothetical member of the public from airborne radioactivity, liquid-borne radioactivity, and ambient radiation exposure resulting from PNPS operation during 2016 was calculated as being about 0.77 mrem. This amount is about 0.12% of the typical dose of 620 mrem received each year by an average person from other sources of natural and man-made radiation. Although this calculated collective dose occurs to a maximum-exposed hypothetical individual, it is also well below the NRC dose limit of 100 mrem/yr specified in 10CFR20.1301, as well as the EPA dose limit of 25 mrem/yr specified in 40CFR190. Both of these limits are to be applied to real members of the general public, so the fact that the dose to the hypothetical maximum-exposed individual is within the limits ensures that any dose received by a real member of the public would be smaller and well within any applicable limit.

RADIOACTIVE SOLID WASTE DISPOSAL

Solid radioactive wastes shipped offsite for processing and disposal during the reporting period are described in Table 7.0. Approximately 427 cubic meters of solid waste, containing 1040 Curies of radioactivity, were shipped during the reporting period.

ONSITE GROUNDWATER MONITORING PROGRAM

In response to the Nuclear Energy Institute Groundwater Protection Initiative, Pilgrim Station instituted a groundwater monitoring program during 2007. Four monitoring wells were installed onsite during the fourth quarter of 2007, and the first samples were collected in late November 2007. Additional sampling wells were added in 2010, 2011, 2012, 2013, and 2014. As of the end of 2016, samples are being collected from a total of 23 monitoring wells. Low levels of tritium, a radioactive isotope of hydrogen, were detected in several of these onsite wells. No other plant-related radioactivity was detected in the groundwater samples. The average concentration of tritium detected in these onsite monitoring wells during 2016 was well below the voluntary communications reporting level established by the EPA Drinking Water Standard of 20,000 pCi/L. Although the EPA Standard provides a standard for comparison, no drinking water sources are affected by this tritium. The maximum hypothetical dose resulting from tritium in groundwater presumed to enter Cape Cod Bay is calculated to be 0.0000000055 mrem/yr. Results of the groundwater monitoring program are presented in Appendix B.

CONCLUSION

The PNPS Offsite Dose Calculation Manual contains effluent controls to limit doses resulting from releases of radioactivity to the environment. None of the effluent controls associated with liquid or gaseous effluents were exceeded during the reporting period, as confirmed by conservative dose assessments performed at weekly and monthly intervals. Conformance to the PNPS ODCM effluent control limits ensures that releases of radioactivity in liquid and gaseous effluents are kept as low as reasonably achievable in accordance with 10 CFR Part 50, Appendix I. Compliance with the ODCM also demonstrates that requirements of the Environmental Protection Agency's nuclear fuel cycle standard, 40CFR190.10, Subpart B, have been met. Based on the dose assessment results for 2016, there was no significant radiological impact on the general public from PNPS operation.

2.0 RADIOACTIVE EFFLUENT DATA

Radioactive gaseous and liquid releases for the reporting period are given in the standard format presented in Tables 1A, 1B, 1C, 2A, 2B, and Supplemental Information table from NRC Regulatory Guide 1.21 (Reference 1) format.

2.1 Supplemental Effluent Release Data

Supplemental information related to radioactive gaseous and liquid releases for the reporting period are given in the standard NRC Regulatory Guide 1.21 format in Table 2.1.

2.2 Gaseous Effluent Data

Gaseous radioactivity is released from Pilgrim Station to the atmosphere from the main stack, reactor building vent, turbine building, and various decontamination facilities. Combined gaseous effluent releases from all release points are summarized in Table 2.2-A. No alpha activity was detected on any of the particulate filters collected during the reporting period. The total gaseous releases for various categories of radionuclides, as well as the corresponding average release rates, can be summarized as follows:

- Noble gases: 0.195 Ci, 0.00617 μCi/sec
- Iodines and particulates with half-life greater than 8 days: 0.0020 Ci, 0.0000633 μCi/sec
- Tritium: 66.9 Ci, 2.12 μCi/sec
- Carbon-14: 7.82 Ci, 0.248 uCi/sec

Effluent releases from the main stack are detailed in Table 2.2-B. The main stack is 335 feet tall, and represents an elevated release point with a total height of approximately 400 feet above sea level. The main stack is located about 700 feet west-northwest of the reactor building.

Ground-level effluent releases are detailed in Table 2.2-C. Data in this table include releases from the reactor building vent, turbine building, and assorted equipment decontamination facilities (e.g., hot machine shop, carbon dioxide pellet decon trailer, plastic media decon trailer, etc.) used during the period. Due to the close proximity of the reactor building, all of these release points are considered to be mixed-mode/ground level release points.

Following the revision of Regulatory Guide 1.21 in 2009, the nuclear industry re-assessed their gaseous effluent releases in accordance with the new definition of "principal radionuclide". Under this new definition, any radionuclide that contributed greater than 1% of the effluent dose calculated to demonstrate compliance with 10CFR50 Appendix I, or contributed more than 1% of the total activity for that type of effluent release, would be classified as a principal radionuclide. Although Carbon-14 (C-14) had been exempted from gaseous effluent calculations in the 1970s, industry assessments in 2009 revealed that Carbon-14 would qualify as a principal radionuclide. Based on this 2009 re-assessment, licensees were required to begin reporting C-14 gaseous effluents in the Annual Radioactive Effluent Release Report beginning with calendar-year 2010. Carbon-14 releases for 2016 are summarized in Tables 2.2-A through 2.2-C, and the dose consequences from C-14 are incorporated into the dose assessments documented in Section 4.2 of this report.

Table 3.1-2 of the PNPS ODCM requires that if any of the gaseous effluent monitors are inoperable for more than 30-days, such events are to be reported in the Annual Radioactive Effluent Release Report with an explanation of why the affected monitor was not returned to operable status in a timely manner. During 2016, the Turbine Building Gaseous Effluent Monitor (C-3003) was out of service for 42-days from 12-Feb-2016 to 25-Mar-2016 due to a failure of the sample pump and flow controller circuitry. The Feed Pump Gaseous Effluent Monitor (C-3004) was out of service for 238-days from 07-May-2016 to 31-Dec-2016 due to a failure of the detector and flow controller circuitry. Both of these monitors are subject to obsolescence issues and it was difficult to obtain replacement parts necessary to perform repairs. In both of these situations compensatory sampling was performed by collecting noble gas samples twice per week. There were no instances in 2016 when both channels of a dual-channel effluent monitor (Main Stack, Reactor Building Vent) were out of service at the same time during a 30 consecutive day period.

2.3 Liquid Effluent Data

Liquid radioactivity is released from PNPS to Cape Cod Bay via the circulating water discharge canal. These effluents enter Cape Cod Bay at the outfall of the canal, which is located about 1100 feet north of the reactor building.

Liquid effluent releases are summarized in Table 2.3-A. Detailed breakdowns for individual radionuclides are listed in Table 2.3-B. There were two discharges of liquid effluents containing radioactivity during the reporting period. Total releases for the various categories of radionuclides, as well as their corresponding mean concentrations, can be summarized as follows:

- Total Effluent Volume: 73,600 Liters
- Total Dilution Volume: 612 billion Liters
- Fission/Activation products: 0.00000806 Ci, 0.0000000000000132 μCi/mL
- Tritium: 0.00147 Ci, 0.00000000000240 μCi/mL
- Dissolved/entrained noble gases: 0.00 Ci, 0.00 μCi/mL

Table 2.1
Pilgrim Nuclear Power Station
Annual Radioactive Effluent Release Report
Supplemental Information
January-December 2016

FACILITY: PILGRIM NUCLEAR POWER STATION **LICENSE: DPR-35**

1. REGULATORY LIMITS					
a. Fission and activation gases:	500 mrem/yr total body and 3000 mrem/yr for skin at site boundary				
b,c. Iodines, particulates with half-life: >8 days, tritium	1500 mrem/yr to any organ at site boundary				
d. Liquid effluents:	0.06 mrem/month for whole body and 0.2 mrem/month for any organ (without radwaste treatment)				
2. EFFLUENT CONCENTRATION LIMITS					
a. Fission and activation gases:	10CFR20 Appendix B Table II				
b. Iodines:	10CFR20 Appendix B Table II				
c. Particulates with half-life > 8 days:	10CFR20 Appendix B Table II				
d. Liquid effluents:	2E-04 μCi/mL for entrained noble gases; 10CFR20 Appendix B Table II values for all other radionuclides				
3. AVERAGE ENERGY	Not Applicable				
4. MEASUREMENTS AND APPROXIMATIONS OF TOTAL RADIOACTIVITY					
a. Fission and activation gases: b. Iodines: c. Particulates: d. Liquid effluents:	High purity germanium gamma spectroscopy for all gamma emitters; radiochemistry analysis for H-3, Fe-55 (liquid effluents), Sr-89, and Sr-90				
5. BATCH RELEASES	Jan-Mar 2016	Apr-Jun 2016	Jul-Sep 2016	Oct-Dec 2016	Jan-Dec 2016
a. Liquid Effluents					
1. Total number of releases:	N/A	1.00E+00	1.00E+00	N/A	2.00E+00
2. Total time period (minutes):	N/A	8.70E+02	9.60E+02	N/A	1.83E+03
3. Maximum time period (minutes):	N/A	8.70E+02	9.60E+02	N/A	9.60E+02
4. Average time period (minutes):	N/A	8.70E+02	9.60E+02	N/A	9.15E+02
5. Minimum time period (minutes):	N/A	8.70E+02	9.60E+02	N/A	8.70E+02
6. Average stream flow during periods of release of effluents into a flowing stream (Liters/min):	N/A	1.19E+06	1.19E+06	N/A	1.19E+06
b. Gaseous Effluents	None	None	None	None	None
6. ABNORMAL RELEASES					
a. Liquid Effluents	None	None	None	None	None
b. Gaseous Effluents	None	None	None	None	None

Table 2.2-A
Pilgrim Nuclear Power Station
Annual Radioactive Effluent Release Report
Gaseous Effluents - Summation of All Releases
January-December 2016

RELEASE PERIOD	Jan-Mar 2016	Apr-Jun 2016	Jul-Sep 2016	Oct-Dec 2016	Jan-Dec 2016	Est. Total Error
A. FISSION AND ACTIVATION GASES						
Total Release: Ci	0.00E+00	3.96E-02	6.98E-02	8.52E-02	1.95E-01	±22%
Average Release Rate: μCi/sec	0.00E+00	5.02E-03	8.85E-03	1.08E-02	6.17E-03	
Percent of Effluent Control Limit*	*	*	*	*	*	
B. IODINE-131						
Total Iodine-131 Release: Ci	1.04E-04	1.06E-04	9.75E-05	1.01E-04	4.09E-04	±20%
Average Release Rate: μCi/sec	1.32E-05	1.34E-05	1.24E-05	1.28E-05	1.30E-05	
Percent of Effluent Control Limit*	*	*	*	*	*	
C. PARTICULATES WITH HALF-LIVES > 8 DAYS						
Total Release: Ci	7.19E-06	3.51E-05	5.88E-05	5.46E-05	1.56E-04	±21%
Average Release Rate: μCi/sec	9.12E-07	4.45E-06	7.45E-06	6.92E-06	4.94E-06	
Percent of Effluent Control Limit*	*	*	*	*	*	
Gross Alpha Radioactivity: Ci	NDA	NDA	NDA	NDA	NDA	
D. TRITIUM						
Total Release: Ci	1.62E+01	1.76E+01	1.52E+01	1.51E+01	6.41E+01	±20%
Average Release Rate: μCi/sec	2.06E+00	2.23E+00	1.92E+00	1.91E+00	2.03E+00	
Percent of Effluent Control Limit*	*	*	*	*	*	
E. CARBON-14						
Total Release: Ci	2.03E+00	2.11E+00	1.73E+00	1.95E+00	7.82E+00	N/A
Average Release Rate: μCi/sec	2.58E-01	2.68E-01	2.20E-01	2.47E-01	2.48E-01	
Percent of Effluent Control Limit*	*	*	*	*	*	

Notes for Table 2.2-A:

* Percent of Effluent Control Limit values based on dose assessments are provided in Section 6 of this report.

1. NDA stands for No Detectable Activity.
2. LLD for airborne gross alpha activity listed as NDA is 1E-11 μCi/cc.
3. N/A stands for not applicable.

Table 2.2-B
Pilgrim Nuclear Power Station
Annual Radioactive Effluent Release Report
Gaseous Effluents – Elevated Release
January-December 2016

CONTINUOUS MODE RELEASES FROM ELEVATED RELEASE POINT					
Nuclide Released	Jan-Mar 2016	Apr-Jun 2016	Jul-Sep 2016	Oct-Dec 2016	Jan-Dec 2016
1. FISSION AND ACTIVATION GASES: Ci					
Ar-41	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85m	0.00E+00	3.96E-02	6.98E-02	8.52E-02	1.95E-01
Kr-87	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-131m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-133m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-135	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-135m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	0.00E+00	3.96E-02	6.98E-02	8.52E-02	1.95E-01
2. IODINES: Ci					
I-131	1.29E-06	2.99E-07	6.05E-06	1.29E-06	8.93E-06
I-133	1.63E-06	0.00E+00	6.24E-06	0.00E+00	7.87E-06
Total for Period	2.92E-06	2.99E-07	1.23E-05	1.29E-06	1.68E-05
3. PARTICULATES WITH HALF-LIVES > 8 DAYS: Ci					
Cr-51	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mn-54	0.00E+00	0.00E+00	7.08E-07	0.00E+00	7.08E-07
Fe-59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-58	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-60	0.00E+00	0.00E+00	1.81E-06	0.00E+00	1.81E-06
Zn-65	0.00E+00	0.00E+00	1.06E-06	0.00E+00	1.06E-06
Sr-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba/La-140	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	0.00E+00	0.00E+00	3.58E-06	0.00E+00	3.58E-06
4. TRITIUM: Ci					
H-3	2.52E-02	5.02E-02	6.16E-02	4.91E-02	1.86E-01
5. CARBON-14: Ci					
C-14	1.97E+00	2.05E+00	1.68E+00	1.89E+00	7.58E+00

Notes for Table 2.2-B:

1. N/A stands for not applicable.
2. NDA stands for No Detectable Activity.
3. LLDs for airborne radionuclides listed as NDA are as follows:
   Fission Gases: 1E-04 µCi/cc
   Iodines: 1E-12 µCi/cc
   Particulates: 1E-11 µCi/cc

Table 2.2-B (continued)
Pilgrim Nuclear Power Station
Annual Radioactive Effluent Release Report
Gaseous Effluents – Elevated Release
January-December 2016

BATCH MODE RELEASES FROM ELEVATED RELEASE POINT					
Nuclide Released	Jan-Mar 2016	Apr-Jun 2016	Jul-Sep 2016	Oct-Dec 2016	Jan-Dec 2016
1. FISSION AND ACTIVATION GASES: Ci					
Ar-41	N/A	N/A	N/A	N/A	N/A
Kr-85	N/A	N/A	N/A	N/A	N/A
Kr-85m	N/A	N/A	N/A	N/A	N/A
Kr-87	N/A	N/A	N/A	N/A	N/A
Kr-88	N/A	N/A	N/A	N/A	N/A
Xe-131m	N/A	N/A	N/A	N/A	N/A
Xe-133	N/A	N/A	N/A	N/A	N/A
Xe-133m	N/A	N/A	N/A	N/A	N/A
Xe-135	N/A	N/A	N/A	N/A	N/A
Xe-135m	N/A	N/A	N/A	N/A	N/A
Xe-137	N/A	N/A	N/A	N/A	N/A
Xe-138	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
2. IODINES: Ci					
I-131	N/A	N/A	N/A	N/A	N/A
I-133	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
3. PARTICULATES WITH HALF-LIVES > 8 DAYS: Ci					
Cr-51	N/A	N/A	N/A	N/A	N/A
Mn-54	N/A	N/A	N/A	N/A	N/A
Fe-59	N/A	N/A	N/A	N/A	N/A
Co-58	N/A	N/A	N/A	N/A	N/A
Co-60	N/A	N/A	N/A	N/A	N/A
Zn-65	N/A	N/A	N/A	N/A	N/A
Sr-89	N/A	N/A	N/A	N/A	N/A
Sr-90	N/A	N/A	N/A	N/A	N/A
Ru-103	N/A	N/A	N/A	N/A	N/A
Cs-134	N/A	N/A	N/A	N/A	N/A
Cs-137	N/A	N/A	N/A	N/A	N/A
Ba/La-140	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
4. TRITIUM: Ci					
H-3	N/A	N/A	N/A	N/A	N/A
5. CARBON-14: Ci					
C-14	N/A	N/A	N/A	N/A	N/A

Notes for Table 2.2-B:

1. N/A stands for not applicable.
2. NDA stands for No Detectable Activity.
3. LLDs for airborne radionuclides listed as NDA are as follows:
   Fission Gases: 1E-04 μCi/cc
   Iodines: 1E-12 μCi/cc
   Particulates: 1E-11 μCi/cc

Table 2.2-C
Pilgrim Nuclear Power Station
Annual Radioactive Effluent Release Report
Gaseous Effluents – Ground-Level Release
January-December 2016

CONTINUOUS MODE RELEASES FROM GROUND-LEVEL RELEASE POINT					
Nuclide Released	Jan-Mar 2016	Apr-Jun 2016	Jul-Sep 2016	Oct-Dec 2016	Jan-Dec 2016
1. FISSION AND ACTIVATION GASES: Ci					
Ar-41	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-87	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-131m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-133m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-135	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-135m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for period	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. IODINES: Ci					
I-131	1.03E-04	1.06E-04	9.15E-05	9.99E-05	4.00E-04
I-133	3.24E-04	3.77E-04	3.52E-04	3.51E-04	1.40E-03
Total for period	4.27E-04	4.83E-04	4.43E-04	4.51E-04	1.80E-03
3. PARTICULATES WITH HALF-LIVES > 8 DAYS: Ci					
Cr-51	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mn-54	4.23E-06	0.00E+00	2.02E-05	4.13E-05	6.57E-05
Fe-59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-58	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-60	2.96E-06	0.00E+00	8.53E-06	0.00E+00	1.15E-05
Zn-65	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	0.00E+00	0.00E+00	1.41E-05	1.33E-05	2.73E-05
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba/La-140	0.00E+00	3.51E-05	1.24E-05	0.00E+00	4.75E-05
Total for period	7.19E-06	3.51E-05	5.52E-05	5.46E-05	1.52E-04
4. TRITIUM: Ci					
H-3	1.62E+01	1.76E+01	1.51E+01	1.50E+01	6.39E+01
5. CARBON-14: Ci					
C-14	6.09E-02	6.33E-02	5.20E-02	5.83E-02	2.34E-01

Notes for Table 2.2-C:

1. N/A stands for not applicable.
2. NDA stands for No Detectable Activity.
3. LLDs for airborne radionuclides listed as NDA are as follows:
   - Fission Gases: 1E-04 μCi/cc
   - Iodines: 1E-12 μCi/cc
   - Particulates: 1E-11 μCi/cc

Table 2.2-C (continued)
Pilgrim Nuclear Power Station
Annual Radioactive Effluent Release Report
Gaseous Effluents – Ground-Level Release
January-December 2016

BATCH MODE RELEASES FROM GROUND-LEVEL RELEASE POINT					
Nuclide Released	Jan-Mar 2016	Apr-Jun 2016	Jul-Sep 2016	Oct-Dec 2016	Jan-Dec 2016
1. FISSION AND ACTIVATION GASES: Ci					
Ar-41	N/A	N/A	N/A	N/A	N/A
Kr-85	N/A	N/A	N/A	N/A	N/A
Kr-85m	N/A	N/A	N/A	N/A	N/A
Kr-87	N/A	N/A	N/A	N/A	N/A
Kr-88	N/A	N/A	N/A	N/A	N/A
Xe-131m	N/A	N/A	N/A	N/A	N/A
Xe-133	N/A	N/A	N/A	N/A	N/A
Xe-133m	N/A	N/A	N/A	N/A	N/A
Xe-135	N/A	N/A	N/A	N/A	N/A
Xe-135m	N/A	N/A	N/A	N/A	N/A
Xe-137	N/A	N/A	N/A	N/A	N/A
Xe-138	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
2. IODINES: Ci					
I-131	N/A	N/A	N/A	N/A	N/A
I-133	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
3. PARTICULATES WITH HALF-LIVES > 8 DAYS: Ci					
Cr-51	N/A	N/A	N/A	N/A	N/A
Mn-54	N/A	N/A	N/A	N/A	N/A
Fe-59	N/A	N/A	N/A	N/A	N/A
Co-58	N/A	N/A	N/A	N/A	N/A
Co-60	N/A	N/A	N/A	N/A	N/A
Zn-65	N/A	N/A	N/A	N/A	N/A
Sr-89	N/A	N/A	N/A	N/A	N/A
Sr-90	N/A	N/A	N/A	N/A	N/A
Ru-103	N/A	N/A	N/A	N/A	N/A
Cs-134	N/A	N/A	N/A	N/A	N/A
Cs-137	N/A	N/A	N/A	N/A	N/A
Ba/La-140	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
4. TRITIUM: Ci					
H-3	N/A	N/A	N/A	N/A	N/A
5. CARBON-14: Ci					
C-14	N/A	N/A	N/A	N/A	N/A

Notes for Table 2.2-C:

1. N/A stands for not applicable.
2. NDA stands for No Detectable Activity.
3. LLDs for airborne radionuclides listed as NDA are as follows:
   Fission Gases: 1E-04 μCi/cc
   Iodines: 1E-12 μCi/cc
   Particulates: 1E-11 μCi/cc

Table 2.3-A
Pilgrim Nuclear Power Station
Annual Radioactive Effluent Release Report
Liquid Effluents - Summation of All Releases
January-December 2016

RELEASE PERIOD	Jan-Mar 2016	Apr-Jun 2016	Jul-Sep 2016	Oct-Dec 2016	Jan-Dec 2016	Est. Total Error
A. FISSION AND ACTIVATION PRODUCTS						
Total Release (not including tritium, gases, alpha): Ci	N/A	6.23E-06	1.83E-06	N/A	8.06E-06	
Average Diluted Concentration During Period: µCi/mL	N/A	4.10E-14	1.19E-14	N/A	1.32E-14	±12%
Percent of Effluent Concentration Limit*	N/A	4.10E-06%	1.19E-06%	N/A	1.32E-06%	
B. TRITIUM						
Total Release: Ci	N/A	4.96E-04	9.71E-04	N/A	1.47E-03	
Average Diluted Concentration During Period: µCi/mL	N/A	3.26E-12	6.30E-12	N/A	2.40E-12	±9.4%
Percent of Effluent Concentration Limit*	N/A	3.26E-07%	6.30E-07%	N/A	2.40E-07%	
C. DISSOLVED AND ENTRAINED GASES						
Total Release: Ci	N/A	NDA	NDA	N/A	NDA	
Average Diluted Concentration During Period: µCi/mL	N/A	NDA	NDA	N/A	NDA	±16%
Percent of Effluent Concentration Limit*	N/A	0.00E+00%	0.00E+00%	N/A	0.00E+00%	
D. GROSS ALPHA RADIOACTIVITY						
Total Release: Ci	N/A	NDA	NDA	N/A	NDA	±34%
E. VOLUME OF WASTE RELEASED PRIOR TO DILUTION						
Waste Volume: Liters	0.00E+00	3.54E+04	3.82E+04	0.00E+00	7.36E+04	±5.7%
F. VOLUME OF DILUTION WATER USED DURING PERIOD						
Dilution Volume: Liters	1.52E+11	1.52E+11	1.54E+11	1.54E+11	6.12E+11	±10%

Notes for Table 2.3-A:

* Additional percent of Effluent Control Limit values based on dose assessments are provided in Section 6 of this report.

1. N/A stands for not applicable.
2. NDA stands for No Detectable Activity.
3. LLD for dissolved and entrained gases listed as NDA is 1E-05 µCi/mL.
4. LLD for liquid gross alpha activity listed as NDA is 1E-07 µCi/mL.

Table 2.3-B
Pilgrim Nuclear Power Station
Annual Radioactive Effluent Release Report
Liquid Effluents
January-December 2016

CONTINUOUS MODE RELEASES					
Nuclide Released	Jan-Mar 2016	Apr-Jun 2016	Jul-Sep 2016	Oct-Dec 2016	Jan-Dec 2016
1. FISSION AND ACTIVATION PRODUCTS: Ci					
Cr-51	N/A	N/A	N/A	N/A	N/A
Mn-54	N/A	N/A	N/A	N/A	N/A
Fe-55	N/A	N/A	N/A	N/A	N/A
Fe-59	N/A	N/A	N/A	N/A	N/A
Co-58	N/A	N/A	N/A	N/A	N/A
Co-60	N/A	N/A	N/A	N/A	N/A
Zn-65	N/A	N/A	N/A	N/A	N/A
Zn-69m	N/A	N/A	N/A	N/A	N/A
Sr-89	N/A	N/A	N/A	N/A	N/A
Sr-90	N/A	N/A	N/A	N/A	N/A
Zr/Nb-95	N/A	N/A	N/A	N/A	N/A
Mo/Tc-99	N/A	N/A	N/A	N/A	N/A
Ag-110m	N/A	N/A	N/A	N/A	N/A
Sb-124	N/A	N/A	N/A	N/A	N/A
I-131	N/A	N/A	N/A	N/A	N/A
I-133	N/A	N/A	N/A	N/A	N/A
Cs-134	N/A	N/A	N/A	N/A	N/A
Cs-137	N/A	N/A	N/A	N/A	N/A
Ba/La-140	N/A	N/A	N/A	N/A	N/A
Ce-141	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
2. DISSOLVED AND ENTRAINED GASES: Ci					
Xe-133	N/A	N/A	N/A	N/A	N/A
Xe-135	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A

Notes for Table 2.3-B:

1. N/A stands for not applicable.
2. NDA stands for No Detectable Activity.
3. LLDs for liquid radionuclides listed as NDA are as follows:
   - Strontium: 5E-08 μCi/mL
   - Iodines: 1E-06 μCi/mL
   - Noble Gases: 1E-05 μCi/mL
   - All Others: 5E-07 μCi/mL

Table 2.3-B (continued)
Pilgrim Nuclear Power Station
Annual Radioactive Effluent Release Report
Liquid Effluents
January-December 2016

BATCH MODE RELEASES					
Nuclide Released	Jan-Mar 2016	Apr-Jun 2016	Jul-Sep 2016	Oct-Dec 2016	Jan-Dec 2016
1. FISSION AND ACTIVATION PRODUCTS: Ci					
Na-24	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Cr-51	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Mn-54	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Fe-55	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Fe-59	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Co-58	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Co-60	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Zn-65	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Zn-69m	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Sr-89	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Sr-90	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Zr/Nb-95	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Mo/Tc-99	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Ag-110m	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Sb-124	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
I-131	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
I-133	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Cs-134	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Cs-137	N/A	6.23E-06	1.83E-06	N/A	8.06E-06
Ba/La-140	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Ce-141	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Ce-144	N/A	0.00E+00	0.00E+00	N/A	0.00E+00
Total for period	N/A	6.23E-06	1.83E-06	N/A	8.06E-06
2. DISSOLVED AND ENTRAINED GASES: Ci					
Xe-133	N/A	NDA	NDA	N/A	NDA
Xe-135	N/A	NDA	NDA	N/A	NDA
Total for period	N/A	NDA	NDA	N/A	NDA

Notes for Table 2.3-B:

1. N/A stands for not applicable.
2. NDA stands for No Detectable Activity.
3. LLDs for liquid radionuclides listed as NDA are as follows:
   - Strontium: 5E-08 μCi/mL
   - Iodines: 1E-06 μCi/mL
   - Noble Gases: 1E-05 μCi/mL
   - All Others: 5E-07 μCi/mL

3.0 METEOROLOGICAL DATA

Meteorological data are summarized for the reporting period in Appendix A, in the standard joint frequency distribution format as given in NRC Regulatory Guide 1.21.

The predominant meteorological conditions observed during the annual reporting period can be summarized with their corresponding frequencies as follows:

- Stability Class: Class D, 41%
- 33-ft Wind Direction (from): South-southwest, 14%
- 33-ft Wind Speed: 3.5-7.5 mph, 56%
- 220-ft Wind Direction (from): Southwest, 13%
- 220-ft Wind Speed: 12.5-18.5 mph, 34%

Joint data recovery for the 33-ft level was 96.3% and for the 220-ft level of the tower was 96.3%, both of which meet the 90% annual data recovery goal specified by the NRC. Problems were encountered in December 2015 when the main power supply for the 220-ft tower meteorological dataloggers failed, resulting in the loss of two weeks of data at the beginning of 2016. Although a new backup 160-ft tower was constructed in late October-2015, it was not put into service until mid-January 2016. In addition, beginning in late September 2016 and continuing through the end of the year, some anomalous delta-T readings were observed on the 220-ft tower. Wind speed and wind direction values from the 220-ft tower were not affected. To maintain consistency with readings collected from the 220-ft tower during the remainder of the year, delta-T readings from the 160-ft tower were scaled by a factor of 1.47 to account for the difference in tower heights, and these scaled delta-T values from the 160-ft tower were substituted for the anomalous 220-ft tower readings for the affected period.

4.0 MAXIMUM INDIVIDUAL DOSES

Doses to the maximum exposed individual resulting from radionuclides in effluents released offsite were calculated using methods presented in the PNPS Offsite Dose Calculation Manual (ODCM, Reference 2), NRC Regulatory Guide 1.109 (Reference 3), NRC Regulatory Guide 1.111 (Reference 4), and the Pilgrim Station Unit 1 Appendix I Evaluation (Reference 5). Maximum individual doses are calculated separately for: (1) noble gases in gaseous effluents, (2) particulates, iodines, and tritium in gaseous effluents; and, (3) liquid effluents. Maximum consumption and use factors for various pathways from Table E-5 of the PNPS ODCM are used for calculating the doses to the maximum exposed individual.

Information related to liquid and gaseous effluent releases are summarized Section 2 of this report. These effluent release data were used as input to computer programs to calculate the resulting doses. PNPS ODCM methodologies were used to calculate the dose contributions to the various organs in each age class from major exposure pathways.

4.1 Doses From Noble Gas Releases

Gaseous effluent release data presented in Tables 2.2-A, 2.2-B, and 2.2-C from this effluent release report were used as input to a dose assessment computer program to calculate radiation doses. These data include gaseous releases from the PNPS main stack, reactor building vent, and turbine building roof exhausters. Meteorological data obtained from the PNPS 220-foot meteorological tower during the 10-year period from 1994 through 2003 were used as input to the "AEOLUS-3" computer program (Reference 6). This program was used to calculate the annual average atmospheric dispersion and deposition factors used in the dose assessment computer program to calculate maximum individual doses.

The maximum individual doses resulting from radioactive noble gases released in gaseous effluents are presented in Table 4.1 according to specific receptor locations. This table includes all noble gas doses for the individual calendar quarters and total calendar year.

Noble gases released in gaseous effluents from PNPS during 2016 resulted in a maximum total body dose of 0.000000926 mrem. The maximum skin dose was 0.00000231 mrem. Both of these doses occurred to a hypothetical individual, assumed to be present 24 hours per day, 365 days per year, at the site boundary location yielding the highest dose (0.63 km SSW of the Reactor Building). For the more "realistic" individuals at offsite locations, the maximum total body dose was 0.000000859 mrem (nearest residence, 0.86 kilometers WNW from the Reactor Building), while the maximum skin dose was 0.00000134 mrem (nearest residence, 2.39 kilometers SSW from the Reactor Building).

Table 4.1

Maximum Doses From Noble Gas Releases During 2016[a]

Release Period	Gamma Air Dose mrad/period (location)	Beta Air Dose mrad/period (location)	Total Body Dose mrem/period (location)	Skin Dose mrem/period (location)
Jan-Mar	0.00E+00 (0.52 km SSE)	0.00E+00 (0.64 km ESE)	0.00E+00 (0.52 km SSE)	0.00E+00 (0.54 km NW)
Apr-Jun	2.83E-07 (0.63 km SSW)	3.38E-07 (0.63 km SSW)	1.88E-07 (0.63 km SSW)	4.71E-07 (0.63 km SSW)
Jul-Sep	4.99E-07 (0.64 km ESE)	5.96E-07 (0.64 km ESE)	3.32E-07 (0.64 km ESE)	8.30E-07 (0.64 km ESE)
Oct-Dec	6.09E-07 (0.63 km SSW)	7.28E-07 (0.63 km SSW)	4.05E-07 (0.63 km SSW)	1.01E-06 (0.63 km SSW)
Jan-Dec	1.39E-06 (0.63 km SSW)	1.66E-06 (0.64 km ESE)	9.26E-07 (0.63 km SSW)	2.31E-06 (0.63 km SSW)

[a] All directions and distances are with respect to the reactor building vent.

4.2 Doses From Gaseous Effluent Releases

Gaseous effluent release data presented in Tables 2.2-A, 2.2-B, and 2.2-C from this effluent release report were used as input to a dose assessment computer program to calculate radiation doses. These data include gaseous releases from the PNPS main stack, reactor building vent, and turbine building roof exhausters. Meteorological data obtained from the PNPS 220-foot meteorological tower during the 10-year period from 2005 through 2014 were used as input to the NRC XOQDOQ computer program (Reference 7). This program was used to calculate the annual average atmospheric dispersion and deposition factors used in the dose assessment computer program to calculate maximum individual doses.

The maximum individual doses resulting from radioactive particulates, radioiodines, tritium and carbon-14 released in gaseous effluents are presented in Tables 4.2-A through 4.2-E. These tables cover the individual calendar quarters and the total calendar year, respectively. Doses resulting from releases of noble gases are addressed independently in the PNPS ODCM. Therefore, none of these tables for maximum individual doses include any dose contribution from noble gases. The presentation and analysis of doses resulting from noble gases are addressed in Section 4.1 of this report.

Tables 4.2-A through 4.2-E summarize the maximum total body and organ doses for the adult, teen, child, and infant age classes resulting from the major gaseous exposure pathways. These tables present the dose data according to specific receptor location and the exposure pathways assumed to occur at that location. For example, the second column of the tables presents the information for the hypothetical maximum-exposed at the most restrictive site boundary location, where only inhalation and ground deposition exposure pathways are assumed to occur. Since this is a shoreline location controlled by Entergy, the other pathways of garden vegetable production, milk production, and meat production are assumed not to occur. Doses for other offsite locations not under Entergy control, where other exposure pathways can and do occur, are presented in subsequent columns of the tables, and represent the potential maximum doses to individuals at these locations. For consistency, all distances listed in the first row of Tables 4.2-A through 4.2-E are measured from the Reactor Building Vent. However, doses at the specific receptor locations are calculated based on the actual distances from the applicable release points (PNPS main stack, reactor building vent, and turbine building roof exhausters).

Radioactivity (particulates, radioiodines, tritium, and carbon-14) released in gaseous effluents from PNPS during 2016 resulted in a maximum total body dose of 0.0167 mrem (child age class at nearest meat animal, 3.82 kilometers S from the Reactor Building), while the maximum organ dose was 0.0774 mrem (child bone at nearest meat animal, 3.82 kilometers S from the Reactor Building). Carbon-14 contributed 93% of the child total body dose and >99% of the child bone dose at the location of the nearest meat animal.

Table 4.2-A

Maximum Individual Organ Dose at Receptor Location -- mrem
From Gaseous Release Period: Jan-Mar 2016

Receptor: Direction: Distance[1]: Pathway[2]:	Bound WNW 0.24km DI	Resident S 2.22 km DI	Garden S 3.44 km DIV[3]	Cow/Goat W 3.75 km DIVCG[3]	Cow/Meat W 5.17 km DIVCM[3]	Meat S 3.82 km DIVM[3]
Age Class: Adult						
Bone	6.29E-05	1.45E-04	4.56E-03	2.64E-03	2.33E-03	6.16E-03
GI-LLI	1.00E-04	9.56E-05	1.11E-03	8.03E-04	6.50E-04	1.45E-03
Kidney	1.01E-04	9.57E-05	1.11E-03	8.04E-04	6.50E-04	1.45E-03
Liver	1.00E-04	9.56E-05	1.11E-03	8.03E-04	6.50E-04	1.45E-03
Lung	1.01E-04	9.57E-05	1.11E-03	8.03E-04	6.49E-04	1.45E-03
Thyroid	1.14E-04	1.07E-04	1.15E-03	1.01E-03	7.67E-04	1.50E-03
T.Body	1.00E-04	9.56E-05	1.11E-03	8.03E-04	6.50E-04	1.45E-03
Age Class: Teen						
Bone	9.00E-05	2.07E-04	7.37E-03	4.45E-03	3.52E-03	8.70E-03
GI-LLI	1.06E-04	1.08E-04	1.69E-03	1.20E-03	9.06E-04	1.96E-03
Kidney	1.06E-04	1.08E-04	1.69E-03	1.21E-03	9.06E-04	1.96E-03
Liver	1.06E-04	1.08E-04	1.69E-03	1.21E-03	9.06E-04	1.96E-03
Lung	1.07E-04	1.08E-04	1.69E-03	1.20E-03	9.05E-04	1.96E-03
Thyroid	1.24E-04	1.22E-04	1.73E-03	1.50E-03	1.07E-03	2.01E-03
T.Body	1.06E-04	1.08E-04	1.69E-03	1.20E-03	9.06E-04	1.96E-03
Age Class: Child						
Bone	1.24E-04	2.86E-04	1.76E-02	1.07E-02	8.27E-03	**2.01E-02**
GI-LLI	1.02E-04	1.15E-04	3.82E-03	2.60E-03	1.94E-03	4.33E-03
Kidney	1.02E-04	1.15E-04	3.82E-03	2.60E-03	1.94E-03	4.33E-03
Liver	1.02E-04	1.15E-04	3.82E-03	2.60E-03	1.94E-03	4.33E-03
Lung	1.02E-04	1.15E-04	3.82E-03	2.60E-03	1.94E-03	4.33E-03
Thyroid	1.24E-04	1.31E-04	3.88E-03	3.17E-03	2.26E-03	4.39E-03
T.Body	1.02E-04	1.15E-04	3.82E-03	2.60E-03	1.94E-03	**4.33E-03**
Age Class: Infant						
Bone	9.16E-05	2.11E-04	1.39E-04	6.73E-03	4.71E-03	1.38E-04
GI-LLI	6.38E-05	7.73E-05	5.63E-05	1.66E-03	1.13E-03	5.56E-05
Kidney	6.39E-05	7.74E-05	5.63E-05	1.67E-03	1.13E-03	5.57E-05
Liver	6.39E-05	7.74E-05	5.63E-05	1.67E-03	1.13E-03	5.57E-05
Lung	6.39E-05	7.74E-05	5.64E-05	1.66E-03	1.13E-03	5.57E-05
Thyroid	8.34E-05	9.28E-05	6.85E-05	2.94E-03	1.84E-03	6.77E-05
T.Body	6.38E-05	7.73E-05	5.63E-05	1.66E-03	1.13E-03	5.56E-05

[1] Distances are measured with respect to the reactor building vent.

[2] Pathway designations are as follows:

D = Deposition (Ground Plane) I = Inhalation V = Vegetable Garden
C = Cow Milk G = Goat Milk M = Meat

[3] Doses are conservative since it is unlikely for vegetables to be grown outside or for animals to be fed on pasture during winter months.

Table 4.2-B

Maximum Individual Organ Dose at Receptor Location -- mrem
From Gaseous Release Period: Apr-Jun 2016

Receptor: Direction: Distance[1]: Pathway[2]:	Bound WNW 0.24km DI	Resident S 2.22 km DI	Garden S 3.44 km DIV[3]	Cow/Goat W 3.75 km DIVCG[3]	Cow/Meat W 5.17 km DIVCM[3]	Meat S 3.82 km DIVM[3]
Age Class: Adult						
Bone	6.53E-05	1.50E-04	5.31E-03	2.75E-03	2.42E-03	6.40E-03
GI-LLI	1.08E-04	1.02E-04	1.31E-03	8.47E-04	6.83E-04	1.51E-03
Kidney	1.08E-04	1.02E-04	1.31E-03	8.47E-04	6.83E-04	1.51E-03
Liver	1.08E-04	1.02E-04	1.31E-03	8.47E-04	6.83E-04	1.51E-03
Lung	1.08E-04	1.03E-04	1.31E-03	8.46E-04	6.83E-04	1.51E-03
Thyroid	1.23E-04	1.14E-04	1.36E-03	1.05E-03	8.03E-04	1.56E-03
T.Body	1.08E-04	1.02E-04	1.31E-03	8.47E-04	6.83E-04	1.51E-03
Age Class: Teen						
Bone	9.35E-05	2.15E-04	8.59E-03	4.62E-03	3.66E-03	9.04E-03
GI-LLI	1.15E-04	1.15E-04	1.99E-03	1.27E-03	9.50E-04	2.05E-03
Kidney	1.15E-04	1.15E-04	1.99E-03	1.27E-03	9.50E-04	2.05E-03
Liver	1.14E-04	1.15E-04	1.99E-03	1.27E-03	9.50E-04	2.05E-03
Lung	1.15E-04	1.15E-04	1.99E-03	1.27E-03	9.49E-04	2.05E-03
Thyroid	1.34E-04	1.30E-04	2.04E-03	1.57E-03	1.12E-03	2.10E-03
T.Body	1.14E-04	1.15E-04	1.99E-03	1.27E-03	9.50E-04	2.05E-03
Age Class: Child						
Bone	1.29E-04	2.97E-04	2.05E-02	1.11E-02	8.59E-03	**2.09E-02**
GI-LLI	1.10E-04	1.22E-04	4.48E-03	2.72E-03	2.03E-03	4.51E-03
Kidney	1.10E-04	1.22E-04	4.48E-03	2.72E-03	2.03E-03	4.51E-03
Liver	1.10E-04	1.22E-04	4.48E-03	2.72E-03	2.03E-03	4.51E-03
Lung	1.10E-04	1.22E-04	4.48E-03	2.72E-03	2.03E-03	4.51E-03
Thyroid	1.33E-04	1.40E-04	4.55E-03	3.30E-03	2.36E-03	4.57E-03
T.Body	1.10E-04	1.22E-04	4.48E-03	2.72E-03	2.03E-03	**4.51E-03**
Age Class: Infant						
Bone	9.52E-05	2.19E-04	1.62E-04	6.99E-03	4.89E-03	1.43E-04
GI-LLI	6.83E-05	8.19E-05	6.79E-05	1.74E-03	1.18E-03	5.91E-05
Kidney	6.84E-05	8.20E-05	6.80E-05	1.74E-03	1.18E-03	5.91E-05
Liver	6.84E-05	8.20E-05	6.80E-05	1.74E-03	1.18E-03	5.91E-05
Lung	6.85E-05	8.21E-05	6.81E-05	1.74E-03	1.18E-03	5.92E-05
Thyroid	8.95E-05	9.86E-05	8.33E-05	3.05E-03	1.91E-03	7.21E-05
T.Body	6.83E-05	8.19E-05	6.80E-05	1.74E-03	1.18E-03	5.91E-05

[1] Distances are measured with respect to the reactor building vent.

[2] Pathway designations are as follows:

D = Deposition (Ground Plane) I = Inhalation V = Vegetable Garden
C = Cow Milk G = Goat Milk M = Meat

Table 4.2-C

Maximum Individual Organ Dose at Receptor Location -- mrem
From Gaseous Release Period: Jul-Sep 2016

Receptor: Direction: Distance[1]: Pathway[2]:	Bound WNW 0.24km DI	Resident S 2.22 km DI	Garden S 3.44 km DIV[3]	Cow/Goat W 3.75 km DIVCG[3]	Cow/Meat W 5.17 km DIVCM[3]	Meat S 3.82 km DIVM[3]
Age Class: Adult						
Bone	5.37E-05	1.23E-04	4.36E-03	2.26E-03	1.99E-03	5.26E-03
GI-LLI	9.28E-05	8.71E-05	1.08E-03	7.08E-04	5.69E-04	1.25E-03
Kidney	9.28E-05	8.71E-05	1.08E-03	7.08E-04	5.69E-04	1.25E-03
Liver	9.27E-05	8.70E-05	1.08E-03	7.07E-04	5.69E-04	1.25E-03
Lung	9.35E-05	8.77E-05	1.08E-03	7.07E-04	5.69E-04	1.25E-03
Thyroid	1.06E-04	9.79E-05	1.13E-03	8.94E-04	6.77E-04	1.30E-03
T.Body	9.27E-05	8.70E-05	1.08E-03	7.07E-04	5.69E-04	1.25E-03
Age Class: Teen						
Bone	7.69E-05	1.77E-04	7.06E-03	3.80E-03	3.00E-03	7.42E-03
GI-LLI	9.78E-05	9.76E-05	1.64E-03	1.05E-03	7.89E-04	1.70E-03
Kidney	9.79E-05	9.76E-05	1.64E-03	1.05E-03	7.89E-04	1.69E-03
Liver	9.78E-05	9.76E-05	1.64E-03	1.05E-03	7.89E-04	1.69E-03
Lung	9.89E-05	9.85E-05	1.64E-03	1.05E-03	7.89E-04	1.69E-03
Thyroid	1.15E-04	1.11E-04	1.69E-03	1.33E-03	9.44E-04	1.74E-03
T.Body	9.77E-05	9.75E-05	1.64E-03	1.05E-03	7.89E-04	1.69E-03
Age Class: Child						
Bone	1.06E-04	2.44E-04	1.69E-02	9.16E-03	7.06E-03	**1.71E-02**
GI-LLI	9.35E-05	1.03E-04	3.70E-03	2.25E-03	1.68E-03	3.72E-03
Kidney	9.36E-05	1.03E-04	3.69E-03	2.25E-03	1.68E-03	3.72E-03
Liver	9.36E-05	1.03E-04	3.69E-03	2.25E-03	1.68E-03	3.72E-03
Lung	9.45E-05	1.03E-04	3.69E-03	2.25E-03	1.68E-03	3.72E-03
Thyroid	1.14E-04	1.19E-04	3.76E-03	2.78E-03	1.98E-03	3.78E-03
T.Body	9.35E-05	1.03E-04	3.69E-03	2.25E-03	1.68E-03	**3.72E-03**
Age Class: Infant						
Bone	7.82E-05	1.80E-04	1.33E-04	5.75E-03	4.02E-03	1.17E-04
GI-LLI	5.80E-05	6.88E-05	5.72E-05	1.44E-03	9.72E-04	4.97E-05
Kidney	5.81E-05	6.88E-05	5.72E-05	1.44E-03	9.75E-04	4.97E-05
Liver	5.81E-05	6.88E-05	5.72E-05	1.44E-03	9.74E-04	4.97E-05
Lung	5.87E-05	6.93E-05	5.77E-05	1.44E-03	9.72E-04	5.01E-05
Thyroid	7.72E-05	8.41E-05	7.13E-05	2.62E-03	1.63E-03	6.16E-05
T.Body	5.80E-05	6.88E-05	5.72E-05	1.44E-03	9.73E-04	4.97E-05

[1] Distances are measured with respect to the reactor building vent.

[2] Pathway designations are as follows:

D = Deposition (Ground Plane) I = Inhalation V = Vegetable Garden
C = Cow Milk G = Goat Milk M = Meat

Table 4.2-D

Maximum Individual Organ Dose at Receptor Location -- mrem
From Gaseous Release Period: Oct-Dec 2016

Receptor: Direction: Distance[1]: Pathway[2]:	Bound WNW 0.24km DI	Resident S 2.22 km DI	Garden S 3.44 km DIV[3]	Cow/Goat W 3.75 km DIVCG[3]	Cow/Meat W 5.17 km DIVCM[3]	Meat S 3.82 km DIVM[3]
Age Class: Adult						
Bone	6.03E-05	1.39E-04	4.37E-03	2.54E-03	2.24E-03	5.91E-03
GI-LLI	9.35E-05	8.96E-05	1.06E-03	7.62E-04	6.17E-04	1.38E-03
Kidney	9.36E-05	8.96E-05	1.06E-03	7.62E-04	6.17E-04	1.38E-03
Liver	9.35E-05	8.96E-05	1.06E-03	7.61E-04	6.17E-04	1.38E-03
Lung	9.40E-05	8.99E-05	1.06E-03	7.61E-04	6.17E-04	1.38E-03
Thyroid	1.08E-04	1.01E-04	1.10E-03	9.58E-04	7.31E-04	1.43E-03
T.Body	9.35E-05	8.95E-05	1.06E-03	7.61E-04	6.17E-04	1.38E-03
Age Class: Teen						
Bone	8.63E-05	1.98E-04	7.07E-03	4.26E-03	3.37E-03	8.34E-03
GI-LLI	9.91E-05	1.01E-04	1.61E-03	1.15E-03	8.62E-04	1.88E-03
Kidney	9.92E-05	1.01E-04	1.61E-03	1.15E-03	8.62E-04	1.88E-03
Liver	9.92E-05	1.01E-04	1.61E-03	1.15E-03	8.62E-04	1.88E-03
Lung	9.99E-05	1.02E-04	1.61E-03	1.14E-03	8.61E-04	1.88E-03
Thyroid	1.17E-04	1.16E-04	1.65E-03	1.43E-03	1.03E-03	1.92E-03
T.Body	9.91E-05	1.01E-04	1.61E-03	1.14E-03	8.61E-04	1.88E-03
Age Class: Child						
Bone	1.19E-04	2.74E-04	1.69E-02	1.03E-02	7.93E-03	**1.93E-02**
GI-LLI	9.56E-05	1.08E-04	3.66E-03	2.47E-03	1.85E-03	4.14E-03
Kidney	9.57E-05	1.08E-04	3.66E-03	2.48E-03	1.85E-03	4.14E-03
Liver	9.56E-05	1.08E-04	3.66E-03	2.48E-03	1.85E-03	4.14E-03
Lung	9.62E-05	1.08E-04	3.66E-03	2.47E-03	1.85E-03	4.14E-03
Thyroid	1.17E-04	1.25E-04	3.71E-03	3.03E-03	2.16E-03	4.20E-03
T.Body	9.56E-05	1.08E-04	3.66E-03	2.47E-03	1.85E-03	**4.14E-03**
Age Class: Infant						
Bone	8.78E-05	2.02E-04	1.33E-04	6.45E-03	4.51E-03	1.32E-04
GI-LLI	5.97E-05	7.30E-05	5.31E-05	1.59E-03	1.08E-03	5.24E-05
Kidney	5.98E-05	7.31E-05	5.31E-05	1.59E-03	1.08E-03	5.25E-05
Liver	5.98E-05	7.31E-05	5.31E-05	1.59E-03	1.08E-03	5.25E-05
Lung	6.02E-05	7.34E-05	5.34E-05	1.59E-03	1.08E-03	5.27E-05
Thyroid	7.96E-05	8.87E-05	6.55E-05	2.83E-03	1.77E-03	6.47E-05
T.Body	5.97E-05	7.30E-05	5.31E-05	1.59E-03	1.08E-03	5.25E-05

[1] Distances are measured with respect to the reactor building vent.

[2] Pathway designations are as follows:

D = Deposition (Ground Plane) I = Inhalation V = Vegetable Garden
C = Cow Milk G = Goat Milk M = Meat

[3] Doses are conservative since it is unlikely for vegetables to be grown outside or for animals to be fed on pasture during winter months.

Table 4.2-E

Maximum Individual Organ Dose at Receptor Location -- mrem
From Gaseous Release Period: Jan-Dec 2016

Receptor: Direction: Distance[1]: Pathway[2]:	Bound WNW 0.24km DI	Resident S 2.22 km DI	Garden S 3.44 km DIV[3]	Cow/Goat W 3.75 km DIVCG[3]	Cow/Meat W 5.17 km DIVCM[3]	Meat S 3.82 km DIVM[3]
Age Class: Adult						
Bone	2.42E-04	5.56E-04	1.76E-02	1.02E-02	8.98E-03	2.37E-02
GI-LLI	3.95E-04	3.75E-04	4.29E-03	3.12E-03	2.52E-03	5.59E-03
Kidney	3.95E-04	3.75E-04	4.28E-03	3.12E-03	2.52E-03	5.59E-03
Liver	3.95E-04	3.75E-04	4.28E-03	3.12E-03	2.52E-03	5.59E-03
Lung	3.97E-04	3.76E-04	4.28E-03	3.12E-03	2.52E-03	5.59E-03
Thyroid	4.52E-04	4.20E-04	4.46E-03	3.91E-03	2.98E-03	5.78E-03
T.Body	3.95E-04	3.75E-04	4.28E-03	3.12E-03	2.52E-03	5.59E-03
Age Class: Teen						
Bone	3.47E-04	7.97E-04	2.84E-02	1.71E-02	1.36E-02	3.35E-02
GI-LLI	4.18E-04	4.22E-04	6.53E-03	4.67E-03	3.51E-03	7.59E-03
Kidney	4.18E-04	4.22E-04	6.53E-03	4.67E-03	3.51E-03	7.59E-03
Liver	4.18E-04	4.22E-04	6.53E-03	4.67E-03	3.51E-03	7.59E-03
Lung	4.20E-04	4.24E-04	6.53E-03	4.67E-03	3.50E-03	7.59E-03
Thyroid	4.90E-04	4.79E-04	6.69E-03	5.83E-03	4.17E-03	7.76E-03
T.Body	4.18E-04	4.22E-04	6.53E-03	4.67E-03	3.51E-03	7.59E-03
Age Class: Child						
Bone	4.79E-04	1.10E-03	6.79E-02	4.13E-02	3.19E-02	**7.74E-02**
GI-LLI	4.01E-04	4.47E-04	1.48E-02	1.00E-02	7.50E-03	1.67E-02
Kidney	4.02E-04	4.47E-04	1.48E-02	1.00E-02	7.50E-03	1.67E-02
Liver	4.01E-04	4.47E-04	1.48E-02	1.00E-02	7.50E-03	1.67E-02
Lung	4.03E-04	4.49E-04	1.48E-02	1.00E-02	7.50E-03	1.67E-02
Thyroid	4.88E-04	5.16E-04	1.50E-02	1.23E-02	8.76E-03	1.69E-02
T.Body	4.01E-04	4.47E-04	1.48E-02	1.00E-02	7.50E-03	**1.67E-02**
Age Class: Infant						
Bone	3.53E-04	8.11E-04	5.34E-04	2.59E-02	1.81E-02	5.29E-04
GI-LLI	2.50E-04	3.01E-04	2.19E-04	6.42E-03	4.36E-03	2.17E-04
Kidney	2.50E-04	3.01E-04	2.20E-04	6.44E-03	4.37E-03	2.17E-04
Liver	2.50E-04	3.01E-04	2.20E-04	6.43E-03	4.36E-03	2.17E-04
Lung	2.51E-04	3.02E-04	2.20E-04	6.42E-03	4.36E-03	2.18E-04
Thyroid	3.30E-04	3.64E-04	2.69E-04	1.14E-02	7.16E-03	2.66E-04
T.Body	2.50E-04	3.01E-04	2.19E-04	6.42E-03	4.36E-03	2.17E-04

[1] Distances are measured with respect to the reactor building vent.

[2] Pathway designations are as follows:

D = Deposition (Ground Plane) I = Inhalation V = Vegetable Garden
C = Cow Milk G = Goat Milk M = Meat

[3] Doses are conservative since it is unlikely for vegetables to be grown outside or for animals to be fed on pasture during winter months.

4.3 Doses From Liquid Effluent Releases

Liquid effluent release data presented in Tables 2.3-A and 2.3-B were used as input to the dose assessment computer program to calculate radiation doses. The maximum individual doses resulting from radionuclides released in liquid effluents are presented in Tables 4.3-A through 4.3-E. These tables cover the individual calendar quarters and the total calendar year, respectively.

Tables 4.3-A through 4.3-E summarize the maximum total body and organ doses for the adult, teen, and child age classes resulting from the major liquid exposure pathways. NRC Regulatory Guide 1.109 does not recognize the infant age class as being exposed to the liquid effluent pathways. Therefore, doses for this age class are not included in any of the tables.

It should be noted that doses calculated for the entire year might not equal the sum of the doses for the individual quarters. Doses from liquid effluents are based on the concentration (activity divided by volume) of radionuclides released in the effluent, as prescribed by the NRC in Regulatory Guide 1.109. If a larger proportion of activity is released with a relatively smaller volume of dilution water during a given quarter, the resulting concentration for that quarter will be higher than concentrations from other quarters. This will result in a proportionally higher dose for that quarter. However, when that quarter's activity values are included in the annual sum, and divided by the total annual dilution flow, the resulting dose contribution will be smaller. In such a situation, the annual dose will actually be less than the sum of the individual quarterly doses.

Radioactivity released in liquid effluents from PNPS during the reporting period resulted in a maximum total body dose (teen age class) of 0.000000257 mrem. The maximum organ dose (teen age class, Liver) was 0.000000460 mrem.

Table 4.3-A

Maximum Individual Organ Doses -- mrem
From Liquid Release Period: Jan-Mar 2016

Organ	Age Class Organ Dose – mrem *		
	Adult	Teen	Child
Bone	N/A	N/A	N/A
GI-LLI	N/A	N/A	N/A
Kidney	N/A	N/A	N/A
Liver	N/A	N/A	N/A
Lung	N/A	N/A	N/A
Thyroid	N/A	N/A	N/A
T.Body	N/A	N/A	N/A

* These doses are conservative since the same usage factor was applied for each quarter. In reality, it is unlikely that anyone would be swimming or boating during the entire year. However, the resulting dose is considerably lower than those from other pathways and does not contribute much to the total dose.

Table 4.3-B

Maximum Individual Organ Doses -- mrem
From Liquid Release Period: Apr-Jun 2016

Organ	Age Class Organ Dose – mrem		
	Adult	Teen	Child
Bone	1.95E-07	2.97E-07	2.59E-07
GI-LLI	2.58E-08	1.19E-07	2.58E-08
Kidney	1.02E-07	1.98E-07	9.78E-08
Liver	2.59E-07	**3.57E-07**	2.49E-07
Lung	4.80E-08	1.48E-07	5.08E-08
Thyroid	2.11E-08	1.16E-07	2.44E-08
T.Body	1.77E-07	**2.00E-07**	5.76E-08

Table 4.3-C

Maximum Individual Organ Doses -- mrem
From Liquid Release Period: Jul-Sep 2016

Organ	Age Class Organ Dose – mrem		
	Adult	Teen	Child
Bone	5.64E-08	8.60E-08	7.52E-08
GI-LLI	8.24E-09	3.51E-08	7.98E-09
Kidney	3.03E-08	5.79E-08	2.88E-08
Liver	7.59E-08	**1.04E-07**	7.28E-08
Lung	1.47E-08	4.34E-08	1.52E-08
Thyroid	6.90E-09	3.41E-08	7.57E-09
T.Body	5.21E-08	**5.85E-08**	1.72E-08

Table 4.3-D

Maximum Individual Organ Doses -- mrem
From Liquid Release Period: Oct-Dec 2016

Organ	Age Class Organ Dose – mrem *		
	Adult	Teen	Child
Bone	N/A	N/A	N/A
GI-LLI	N/A	N/A	N/A
Kidney	N/A	N/A	N/A
Liver	N/A	N/A	N/A
Lung	N/A	N/A	N/A
Thyroid	N/A	N/A	N/A
T.Body	N/A	N/A	N/A

* These doses are conservative since the same usage factor was applied for each quarter. In reality, it is unlikely that anyone would be swimming or boating during these months. However, the resulting dose is considerably lower than those from other pathways and does not contribute much to the total dose.

Table 4.3-E

Maximum Individual Organ Doses -- mrem
From Liquid Release Period: Jan-Dec 2016

Organ	Age Class Organ Dose – mrem *		
	Adult	Teen	Child
Bone	2.50E-07	3.81E-07	3.33E-07
GI-LLI	3.39E-08	1.54E-07	3.37E-08
Kidney	1.32E-07	2.55E-07	1.26E-07
Liver	3.34E-07	**4.60E-07**	3.21E-07
Lung	6.25E-08	1.90E-07	6.58E-08
Thyroid	2.80E-08	1.49E-07	3.19E-08
T.Body	2.28E-07	**2.57E-07**	7.46E-08

* These doses are conservative since the same usage factor was applied for each quarter. In reality, it is unlikely that anyone would be swimming or boating during the entire year. However, the resulting dose is considerably lower than those from other pathways and does not contribute much to the total dose.

5.0 OFFSITE AMBIENT RADIATION MEASUREMENTS

The PNPS ODCM does not contain control limits related specifically to offsite ambient radiation exposure. However, Regulatory Guide 1.21 (Reference 1) recommends calculation of ambient radiation exposure as part of the overall assessment of radiological impact on man.

Thermoluminescent dosimeters (TLDs) are located at 86 sites beyond the boundary of the PNPS restricted/protected area. A number of these TLDs are located within the site boundary, on Entergy property in close proximity to the station proper. The TLDs are collected on a quarterly basis and used to calculate the ambient radiation exposure in milliRoentgen (mR) over the exposure period. These TLDs are grouped into four zones of increasing distance from the station. Average exposure values for each of these zones were calculated for each calendar quarter and the total year. The average exposure values (mR) for the four zones are presented in Table 5.0.

In addition to responding to ambient radiation exposure, TLDs will also record radiation resulting from noble gases (plume and immersion exposure), particulate materials deposited on the ground, cosmic rays from outer space, and from naturally-occurring radioactivity in the soil and air. Typically, the exposure from cosmic rays and other natural radioactivity components is about 40 to 70 mR/year. As calculated in Sections 4.1 and 4.2 of this report, the ambient radiation component of doses from PNPS effluent emissions are below 1 mrem/yr and would not be discernible above the natural radiation exposure levels.

The major source of ambient radiation exposure from PNPS results from high-energy gamma rays emitted from nitrogen-16 (N-16) contained in steam flowing through the turbine. Although the N-16 is enclosed in the process lines and turbine and is not released into the environment, the ambient radiation exposure and sky shine from this contained source accounts for the majority of the radiation dose, especially in close proximity to the station. Other sources of ambient radiation exposure include radiation emitted from contained radioactive materials and/or radwaste at the facility. Despite these sources of ambient radiation exposure at PNPS, increases in exposure from ambient radiation are typically not observable above background levels at locations beyond Entergy controlled property.

The average exposure values presented in Table 5.0 appear to indicate an elevation in ambient exposures in Zone 1, those TLDs within 2 miles of PNPS. Most of this elevation is due to increases in exposure levels measured at TLD locations on Entergy property in close proximity to the station proper. For example, the annual exposure at TLD location OA, located at the Overlook Area near the PNPS Health Club (I&S Building), was 204 mR for the entire year. This location is immediately adjacent to the station proper and overlooks the turbine building, therefore receiving the highest direct ambient and sky shine exposure. When the near-site TLDs (those located within 0.6 km of the Reactor Building) are removed from the calculation of averages, the mean annual exposure in Zone 1 falls from 74.8 ± 26.2 mR/yr to 62.6 ± 8.0 mR/yr. Such a corrected dose is not statistically different from the Zone 4 average of 60.1 ± 8.3 mR/yr, and is indicative of natural background radiation.

Although the annual exposure at TLD location OA was 144 mR above the average Zone 4 exposure, members of the general public do not continuously occupy this area. When adjusted for such occupancy, a hypothetical member of the public who was at this location for 40 hours per year would only receive an incremental dose of 0.66 mrem over natural background radiation levels. At the nearest residence 0.8 kilometers (0.5 miles) southeast of the PNPS Reactor Building, the annual exposure was calculated as being 61.6 ± 3.6 mR (based on continuous occupancy at this location), which compares quite well to the Zone 4 annual average background radiation level of 60.1 ± 8.3 mR. Statistically, there is no difference between these two values.

Pilgrim Station began moving spent fuel to the Independent Spent Fuel Storage Installation (ISFSI) located within the protected area immediately west of the PNPS Reactor Building. Three new TLDs were installed at the beginning of 2016 to monitor any incremental dose from this facility. TLD ISF-1 was located on Rocky Hill Road 0.35 km (0.21 mi) southwest of the reactor building. The annual exposure at this location was calculated as being 76.7 ± 4.0 mR (based on continuous occupancy at this location), or 16.6 mR above the Zone 4 average of 60.1 mR. However, the area is not continuously occupied, and when corrected for an exposure time of 365 hours/year, the estimated exposure to a person walking along this section of Rocky Hill Road would be 0.69 mR/year.

It must be emphasized that the projected ambient exposures discussed above and on the previous page are calculated to occur to a maximum-exposed hypothetical individual. Even though conservative assumptions are made in the projection of these dose consequences, all of the projected doses are well below the NRC dose limit of 100 mrem/yr specified in 10CFR20.1301, as well as the EPA dose limit of 25 mrem/yr specified in 40CFR190. Both of these limits are to be applied to real members of the general public, so the fact that the dose to the hypothetical maximum-exposed individual is within the limits ensures that any dose received by a real member of the public would be smaller and well within any applicable limit.

In 1994, Pilgrim Station opened the old training facility (I&S Building) overlooking the plant as a health club for its employees. This site is immediately adjacent to the protected area boundary near monitoring location OA and receives appreciable amounts of direct ambient and sky shine exposure from the turbine building. Although personnel using this facility are employees of Entergy, they are considered to be members of the public. Due to their extended presence in the facility (500 hr/yr, assuming utilization of the facility for 2 hr/day, 5 days a week, for 50 weeks/yr), these personnel represent the most conservative case in regards to ambient radiation exposure to a member of the public within the PNPS owner controlled area. Their annual incremental radiation dose above background during 2016 is estimated as being about 1.6 mrem, based on the average exposure measured by the TLD in the building.

The exposures measured by the TLD located in the health club would also include any increase in ambient radiation resulting from noble gases and/or particulate activity deposited on the ground from gaseous releases. However, they would not indicate any internal dose received by personnel in this facility from inhalation of small amounts of PNPS-related radioactivity contained in the air. An environmental air sampler located immediately adjacent to the health club did not indicate any PNPS-related activity during 2016. Dose calculations performed in the same manner as those outlined in Section 4.2 for airborne effluent releases yielded a projected total body dose to the maximum-exposed individual (500 hr/yr exposure) of about 0.0016 mrem, resulting from inhalation.

Again, it must be emphasized that the above-described exposures were received by personnel who are employees or contractors of Entergy, accessing areas or facilities on property under the ownership and control of Entergy. Since this exposure was received within the owner-controlled area, it is not used for comparison to the annual dose limit of 25 mrem/yr specified in 40CFR190. This regulation explicitly applies to areas at or beyond the owner-controlled property, and is not applicable in this situation. As stated earlier, TLDs at and beyond the site boundary do not indicate elevated ambient radiation levels resulting from the operation of Pilgrim Station.

Although some of the TLDs in close proximity to PNPS indicate increases in exposure levels from ambient radiation, such increases are localized to areas under Entergy control. For members of the general public who are not employed or contracted with Entergy and are accessing Entergy controlled areas (e.g., parking lots, etc.), such increases in dose from ambient radiation exposure are estimated as being less than 0.7 mrem/year.

Table 5.0

Average TLD Exposures By Distance Zone During 2016

Exposure Period	Average Exposure ± Standard Deviation: mR/period			
	Zone 1* 0-3 km	Zone 2 3-8 km	Zone 3 8-15 km	Zone 4 >15 km
Jan-Mar	18.2 ± 6.7	14.2 ± 2.0	13.6 ± 1.6	14.3 ± 2.3
Apr-Jun	19.6 ± 7.0	15.0 ± 2.0	14.5 ± 1.5	15.7 ± 2.0
Jul-Sep	19.3 ± 6.1	15.0 ± 1.9	14.7 ± 1.6	15.7 ± 1.9
Oct-Dec	17.6 ± 6.3	13.3 ± 1.8	13.2 ± 1.4	14.3 ± 2.1
Jan-Dec	74.8 ± 26.2**	57.6 ± 8.0	55.9 ± 6.3	60.1 ± 8.3

* Zone 1 extends from the PNPS restricted/protected area boundary outward to 3 kilometers (2 miles), and includes several TLDs located within the site boundary.

** When corrected for TLDs located within the site boundary, the Zone 1 annual average is calculated to be 62.6 ± 8.0 mR/yr.

6.0 PERCENT OF ODCM EFFLUENT CONTROL LIMITS

The PNPS ODCM contains dose and concentration limits for radioactive effluents. In addition, the effluent controls specified ensure that radioactive releases are maintained as low as reasonably achievable. The percentage of the PNPS ODCM Control limit values were determined from doses calculated in Section 4, the effluent releases summarized in Section 2, and the ODCM Control limits/objectives listed in Tables 6.1 and 6.2.

The percent of applicable control limit values are provided to supplement the information provided in the Section 2 of this report. The format for the percent of applicable limits is modified from that prescribed in Regulatory Guide 1.21 (Reference 1) to accommodate the Radioactive Effluents Technical Specifications (RETS) that became effective March 01, 1986. The percentages have been grouped according to whether the releases were via liquid or gaseous effluent pathways.

6.1 Gaseous Effluent Releases

Dose-based effluent controls related to exposures arising from gaseous effluent releases are presented in Table 6.1. The maximum quarterly air doses and annual whole body doses listed in Table 4.1 were used to calculate the percentage values shown in Table 6.1. All doses resulting from noble gas exposure were a small percentage of the applicable effluent control.

Organ dose limits for the maximum-exposed individual from radioactive particulates, iodines, and tritium from the PNPS ODCM are also shown in Table 6.1. The maximum quarterly and annual organ doses from Tables 4.2-A through 4.2-E were used to calculate the percentages shown in Table 6.1. The resulting organ doses from Pilgrim Station's gaseous releases during 2016 were a small percentage of the corresponding effluent control.

Table 6.1

Percent of ODCM Effluent Control Limits
for Gaseous Effluent Releases During 2016

A. Instantaneous Dose Rate Limit - Noble Gases
PNPS ODCM Control 3.3.1.a
Limit: 500 mrem/yr Total Body Dose

Period	Value - mrem/yr	Fraction of Limit
Jan-Dec	9.26E-07	1.85E-07%

B. Instantaneous Dose Rate Limit - Noble Gases
PNPS ODCM Control 3.3.1.a
Limit: 3000 mrem/yr Skin Dose

Period	Value - mrem/yr	Fraction of Limit
Jan-Dec	2.31E-06	7.71E-08%

C. Instantaneous Dose Rate Limit - Particulates, Iodines, & Tritium
PNPS ODCM Control 3.3.1.b
Limit: 1500 mrem/yr Organ Dose

Period	Value - mrem/yr	Fraction of Limit
Jan-Dec	7.74E-02	5.16E-03%

D. Quarterly Dose Objective - Noble Gas Gamma Air Dose
PNPS ODCM Control 3.3.2.a
Objective: 5 mrad Gamma Air Dose

Period	Value – mrad	Fraction of Limit
Jan-Mar	0.00E+00	0.00E+00%
Apr-Jun	2.83E-07	5.66E-06%
Jul-Sep	4.99E-07	9.98E-06%
Oct-Dec	6.09E-07	1.22E-05%

E. Annual Dose Objective - Noble Gas Gamma Air Dose
PNPS ODCM Control 3.3.2.b
Objective: 10 mrad Gamma Air Dose

Period	Value - mrad/yr	Fraction of Limit
Jan-Dec	1.39E-06	1.39E-05%

Table 6.1 (continued)

Percent of ODCM Effluent Control Limits
for Gaseous Effluent Releases During 2016

F. Quarterly Dose Objective - Noble Gas Beta Air Dose
PNPS ODCM Control 3.3.2.a
Objective: 10 mrad Beta Air Dose

Period	Value - mrad	Fraction of Limit
Jan-Mar	0.00E+00	0.00E+00%
Apr-Jun	3.38E-07	3.38E-06%
Jul-Sep	5.96E-07	5.96E-06%
Oct-Dec	7.28E-07	7.28E-06%

G. Annual Dose Objective - Noble Gas Beta Air Dose
PNPS ODCM Control 3.3.2.b
Objective: 20 mrad Beta Air Dose

Period	Value - mrad/yr	Fraction of Limit
Jan-Dec	1.66E-06	8.31E-06%

H. Quarterly Dose Objective - Particulates, Iodines, Tritium, and Carbon-14
PNPS ODCM Control 3.3.3.a
Objective: 7.5 mrem Organ Dose

Period	Value - mrem	Fraction of Limit
Jan-Mar	2.01E-02	2.68E-01%
Apr-Jun	2.09E-02	2.78E-01%
Jul-Sep	1.71E-02	2.29E-01%
Oct-Dec	1.93E-02	2.57E-01%

I. Annual Dose Objective - Particulates, Iodines, Tritium, and Carbon-14
PNPS ODCM Control 3.3.3.b
Objective: 15 mrem Organ Dose

Period	Value - mrem/yr	Fraction of Limit
Jan-Dec	7.74E-02	5.16E-01%

6.2 Liquid Effluent Releases

Liquid effluent concentration limits and dose objectives from the PNPS ODCM are shown in Table 6.2. The quarterly average concentrations from Table 2.3-A were used to calculate the percent concentration limits. The maximum quarterly and annual whole body and organ doses from Tables 4.3-A through 4.3-E were used to calculate the percentages shown in Table 6.2. The resulting concentrations, as well as organ and total body doses from Pilgrim Station's liquid releases during the reporting period were a small percentage of the corresponding effluent controls.

Table 6.2

Percent of ODCM Effluent Control Limits
for Liquid Effluent Releases During 2016

A. Fission and Activation Product Effluent Concentration Limit
PNPS ODCM Control 3.2.1
Limit: 10CFR20 Appendix B, Table 2, Column 2 Value

Period	Value - μCi/mL	Fraction of Limit
Jan-Mar	N/A	N/A
Apr-Jun	4.10E-14	4.10E-06%
Jul-Sep	1.19E-14	1.19E-06%
Oct-Dec	N/A	N/A
Jan-Dec	1.32E-14	1.32E-06%

B. Tritium Average Concentration Limit
PNPS ODCM Control 3.2.1
Limit: 1.0E-03 μCi/mL

Period	Value - μCi/mL	Fraction of Limit
Jan-Mar	N/A	N/A
Apr-Jun	3.26E-12	3.26E-07%
Jul-Sep	6.30E-12	6.30E-07%
Oct-Dec	N/A	N/A
Jan-Dec	2.40E-12	2.40E-07%

C. Dissolved and Entrained Noble Gases Concentration Limit
PNPS ODCM Control 3.2.1
Limit: 2.0E-04 μCi/mL

Period	Value - μCi/mL	Fraction of Limit
Jan-Mar	N/A	N/A
Apr-Jun	0.00E+00	0.00E+00%
Jul-Sep	0.00E+00	0.00E+00%
Oct-Dec	N/A	N/A
Jan-Dec	0.00E+00	0.00E+00%

Table 6.2 (continued)

Percent of ODCM Effluent Control Limits
for Liquid Effluent Releases During 2016

D. Quarterly Total Body Dose Objective
PNPS ODCM Control 3.2.2.a
Objective: 1.5 mrem Total Body Dose

Period	Value - mrem	Fraction of Limit
Jan-Mar	N/A	N/A
Apr-Jun	2.00E-07	1.33E-05%
Jul-Sep	5.85E-08	3.90E-06%
Oct-Dec	N/A	N/A

E. Annual Total Body Dose Objective
PNPS ODCM Control 3.2.2.b
Objective: 3 mrem Total Body Dose

Period	Value - mrem	Fraction of Limit
Jan-Dec	2.57E-07	8.58E-06%

F. Quarterly Organ Dose Objective
PNPS ODCM Control 3.2.2.a
Objective: 5 mrem Organ Dose

Period	Value - mrem	Fraction of Limit
Jan-Mar	N/A	N/A
Apr-Jun	3.57E-07	7.14E-06%
Jul-Sep	1.04E-07	2.08E-06%
Oct-Dec	N/A	N/A

G. Annual Organ Dose Objective
PNPS ODCM Control 3.2.2.b
Objective: 10 mrem Organ Dose

Period	Value - mrem	Fraction of Limit
Jan-Dec	4.60E-07	4.60E-06%

7.0 RADIOACTIVE WASTE DISPOSAL DATA

Radioactive wastes that were shipped offsite for processing and disposal during the reporting period are described in Table 7.0, in the standard NRC Regulatory Guide 1.21 format.

The total quantity of radioactivity in Curies and the total volume in cubic meters are summarized in Table 7.0 for the following waste categories:

- Spent resins, filter sludges, and evaporator bottoms;
- Dry activated wastes, contaminated equipment, etc.;
- Irradiated components, control rods, etc.; and,
- Other.

During the reporting period approximately 83.7 cubic meters of spent resins, filter sludges, etc., containing a total activity of about 1040 Curies were shipped from PNPS for processing and disposal. Dry activated wastes and contaminated equipment shipped during the period totaled 343 cubic meters and contained 0.427 Curies of radioactivity. There were no shipments of irradiated components during the reporting period. There were no shipments of "Other wastes" during the reporting period. There were no shipments of irradiated fuel during the reporting period.

Estimates of major radionuclides, those comprising greater than 1% of the total activity in each waste category shipped, are listed in Table 7.0. There were 21 shipments to Energy Solutions' Bear Creek Facility in Oak Ridge, TN; 2 shipments to Energy Solutions Erwin Resin Solutions' Facility in Erwin, TN.; and 2 shipments to Alaron Nuclear Services, Wampum, PA.

Table 7.0
Pilgrim Nuclear Power Station
Annual Radioactive Effluent Release Report
Solid Waste and Irradiated Fuel Shipments
January-December 2016

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

1. Estimate of volume and activity content by type of waste

Type of waste	Jan-Dec 2016		
	Volume - m^3	Curies	Total Error
a. Spent resins, filters, filter sludges, evaporator bottoms, etc.	8.37E+01	1.04E+03	± 25%
b. Dry activated waste, contaminated equipment, etc.	3.43E+02	4.27E-01	± 25%
c. Irradiated components, control rods, etc.	0.00E+00	0.00E+00	N/A
d. Other (describe):	0.00E+00	0.00E+00	N/A

2. Estimate of major nuclide composition by type of waste[1]

Type of waste	Radionuclide	Abundance	Total Error
a. Spent resins, filters, filter sludge's, evaporator bottoms, etc.	Mn-54	12.02%	± 25%
	Fe-55	55.12%	± 25%
	Co-60	23.82%	± 25%
	Zn-65	5.16%	± 25%
	Cs-137	1.97%	± 25%
b. Dry activated waste, contaminated equipment, etc.	Mn-54	2.36%	± 25%
	Fe-55	80.07%	± 25%
	Co-60	14.65%	± 25%
	Ni-63	1.87%	± 25%
c. Irradiated components, control rods, etc.	N/A	N/A	N/A
d. Other (describe): Contaminated oil and water	N/A	N/A	N/A

[1] *"Major" is defined as any radionuclide comprising >1% of the total activity in the waste category.*

3. Solid Waste Disposition

Number of Shipments	Mode of Transportation	Destination
21	Tractor-trailer (Hittman Transport)	Energy Solutions, Bear Creek Facility[2] Oak Ridge, TN
2	Tractor-trailer (Hittman Transport)	Energy Solutions, Erwin Resin Solutions[2] Erwin, TN
2	Tractor-trailer (Hittman Transport)	Alaron Nuclear Services[2] Wampum, PA

[2] *This processor provides volume reduction services for dry compressible waste, contaminated equipment, etc. Remaining radioactive wastes will be shipped to Envirocare, Inc. in Clive, UT for final disposal.*

B. IRRADIATED FUEL SHIPMENTS & DISPOSITION

Number of Shipments	Mode of Transportation	Destination
None	N/A	N/A

8.0 OFFSITE DOSE CALCULATION MANUAL REVISIONS

The PNPS Offsite Dose Calculation Manual (ODCM) was not revised during the calendar year of 2016. Information regarding revisions to the ODCM can be found attached as Appendix D of this report.

9.0 PROCESS CONTROL PROGRAM REVISIONS

The following list summarizes changes made during 2016 to various procedures related to the Process Control Program (PCP):

EN-RW-102, "Radioactive Shipping Procedure", Rev.14:
The primary purpose of this revision is to update the procedure to ensure compliance with current and upcoming changes to 49 CFR, especially those changes stemming from HM-215M and HM-250 (changes are as recommended by review of EN-RW-102 by WMG). Additionally, the issue identified in NIOS audit QA-14/15-2015-IP-01 regarding retention of DOT Spec 7A test and engineering evaluation is addressed.

- Added a bullet item to step 7.0[2] specifying that shipment records are to include documentation of tests and engineering evaluations for DOT Spec 7A packages
- Step 2.0[10]: Corrected reference to WMG software packages
- Step 5.1[12]: replaced specific shipping names with generic statement regarding Marking and Labeling
- Step 5.2[11](c), Attachment 9.10: Updated terminology for Industrial Package
- Step 5.2[11](c): Added requirement to cover Specification Marking
- Step 5.2[16]: Added reference for requirements for multiple hazard radioactive material
- Step 5.2[19]: Revised step to indicate that the survey only releases the vehicle back to exclusive use service
- Added step 5.2[20] for unconditional release of formerly exclusive use vehicle.
- Step 7.0[1]: Added an additional reference for record retention
- Step 7.0[2]: Added bullet item requiring that documentation of tests and engineering evaluations be kept for records
- Attachment 9.1: replaced RAMSHP with RADMAN and replaced obsolete reference to Studsvik with Erwin Resin Solutions
- Attachment 9.2, step 21: replaced Studsvik with Erwin Resin Solutions
- Attachment 9.3, step 12: combined sub-step "a" with step 12 as there is no step "b"
- Attachment 9.3, step 13: replaced Studsvik with Erwin Resin Solutions
- Attachment 9.3, step 24: added requirement for DOT 7A test and engineering documentation
- Attachment 9.4, step 14: replaced Studsvik with Erwin Resin Solutions
- Attachment 9.4: Added a new step #5 for verifying the licensee is a registered user of Type B package
- Attachment 9.5, step #9: added reference to requirements of 49CFR173.422
- Attachment 9.6, step #8: added reference to requirements of 49CFR173.422
- Attachment 9.7, step #10: added reference to requirements of 49CFR173.422
- Attachment 9.8, step #7: added reference to requirements of 49CFR173.422
- Attachment 9.9, step #6: added reference to requirements of 49CFR173.422
- Attachment 9.10: updated references for Industrial Package (I, II, and III changed to Type 1,2,3)
- Attachment 9.11, sheet 2: updated contamination limits to reflect latest regulations
- Attachment 9.14: updated definition of Exclusive Use according to WMG recommendation
- Updated section 8.0 and related procedure steps per GGNS Commitment Review

EN-RW-106, "Integrated Transportation Security Plan", Rev.5:
The purpose of this revision is to address:

- A QA-identified issue regarding documentation of preplanning activities
- Correct the NRC email address
- Add a requirement for contacting ANI
- Added step 2.0[20] for reference to NUREG-2155 (which is the basis for preplanning documentation requirements)
- Step 3.0[1] added: ANI (American Nuclear Insurers), MCC – Movement Control Center, SAS – Secondary Alarm Station
- Step 5.3[4]: corrected step reference
- Step 5.7.4.1[3]: corrected the NRC email address
- Added steps 5.7.5.2[8] and 5.7.5.3[7] for ANI notification in the event of an accident.
- Step 5.7.6.1[2]: expanded requirements for documentation of preplanning activities
- Step 5.8[2] is reworded for clarity

EN-RW-108, "Radioactive Shipment Accident Response", Rev.2:
The primary purpose of this revision is to add instruction for contacting ANI in the event of an accident covered
by this procedure. Specifically:

- ANI is added to the definitions section, section 3.0
- Step 5.4[1] is expanded to address contacting ANI

This is a complete rewrite of the procedure in order to align the procedure format with EN-AD-101-01. Content changes are made only to correct grammatical errors or to change step levels to correct formatting and are editorial. No change bars are used to reflect the changes made due to the rewrite. Changes worth noting are:

- Sections 5.1 and 5.2 are reversed in order for alignment with EN-AD-101-01
- Section 5.3.2: "CAUTION" is changed to "NOTE" in the box associated with ion chambers versus GM instruments as the associated statement does not qualify as a caution statement.
- The Note statement in section 5.4[3] (of Rev. 1) regarding evaluation for fatigue is changed to an instructional step as the statement is not appropriate for a Note statement.
- The statement in section 5.4[3] (of Rev. 1) regarding the reference to EN-OM-123 is changed to an instructional step as the statement is not appropriate for a Note statement or a Caution statement.
- The last Note statement in section 5.0 regarding disposition of documents is changed to a step as the contents are not appropriate for a Note statement
- Attachment 9.1: changed note on page one to a step because the content is inappropriate for a Note.

10.0 REFERENCES

1. U.S. Nuclear Regulatory Commission, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water Cooled Nuclear Power Plants", Regulatory Guide 1.21, Revision 1, June 1974.

2. "Pilgrim Nuclear Power Station Offsite Dose Calculation Manual", Revision 10, May 2009.

3. U.S. Nuclear Regulatory Commission, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50 Appendix I", Regulatory Guide 1.109, Revision 1, October 1977.

4. U.S. Nuclear Regulatory Commission, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors", Regulatory Guide 1.111; July 1977.

5. Boston Edison Company, "Pilgrim Station Unit 1 Appendix I Evaluation", April 1977.

6. Entech Engineering Inc., P100-R19, "AEOLUS-3 - A Computer Code for the Determination of Atmospheric Dispersion and Deposition of Nuclear Power Plant Effluents During Continuous, Intermittent and Accident Conditions in Open-Terrain Sites, Coastal Sites and Deep-River Valleys".

7. U.S. Nuclear Regulatory Commission, "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations", NUREG/CR2919, September 1982.

APPENDIX A

Meteorological Joint Frequency Distributions

Table A-1
Joint Frequency Distribution of Wind Directions and Speeds
For the 33-ft level of the 220-ft Tower

Jan-Mar 2016

Class A Freq: 0.066

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
3.5-7.5	12	16	15	8	6	3	1	0	0	1	0	2	8	6	6	3	87
7.5-12.5	4	2	1	2	0	1	0	0	0	2	1	0	9	11	0	2	35
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	16	18	16	11	6	4	1	0	0	3	1	2	17	17	6	5	123

Class B Freq: 0.024

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	1	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	4
3.5-7.5	1	1	3	1	6	2	0	0	0	0	0	1	2	1	2	0	20
7.5-12.5	1	0	0	3	1	0	2	0	2	2	2	0	2	1	1	2	19
12.5-18.5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3	2	3	4	8	2	2	1	2	2	2	1	4	2	4	2	44

Class C Freq: 0.044

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3
3.5-7.5	4	3	2	3	3	1	0	0	0	0	0	0	1	1	3	1	22
7.5-12.5	2	2	2	3	1	0	4	0	4	12	3	0	5	1	4	2	45
12.5-18.5	0	0	0	0	0	0	2	0	0	6	1	0	0	0	2	0	11
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	8	5	5	6	4	1	6	0	4	18	4	0	6	2	9	3	81

Class D Freq: 0.390

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	4	6	6	7	3	1	0	1	0	2	3	2	2	5	7	5	54
3.5-7.5	27	22	18	20	21	17	13	3	5	25	20	9	13	25	34	16	288
7.5-12.5	12	10	5	10	7	4	3	0	9	63	9	4	13	64	37	10	260
12.5-18.5	2	7	3	7	0	0	1	4	1	8	6	0	0	41	34	1	115
18.5-24	0	3	1	1	0	0	0	3	0	0	0	0	0	0	0	0	8
>24	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
TOTAL	45	48	33	46	31	22	17	11	15	98	38	15	28	135	112	32	726

Table A-1 (continued)

Jan-Mar 2016

Class E Freq: 0.423

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	4	4	3	4	6	3	6	4	14	11	8	14	11	9	6	3	110
3.5-7.5	13	4	3	7	24	7	15	15	28	24	30	41	59	43	19	18	350
7.5-12.5	5	8	0	3	6	1	5	8	15	55	47	9	10	25	16	5	218
12.5-18.5	3	11	1	2	0	0	2	7	21	20	1	0	0	0	2	5	75
18.5-24	2	8	3	3	0	0	0	3	7	0	0	0	0	0	0	0	26
>24	0	0	6	1	0	0	0	0	1	0	0	0	0	0	0	0	8
TOTAL	27	35	16	20	36	11	28	37	86	110	86	64	80	77	43	31	787

Class F Freq: 0.050

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	2	0	1	0	1	0	0	2	3	1	3	1	1	0	3	18
3.5-7.5	0	0	1	1	0	0	0	3	8	6	22	14	7	2	1	1	66
7.5-12.5	0	0	0	0	0	0	0	4	2	0	3	0	1	0	0	0	10
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	2	1	2	0	1	0	7	12	9	26	17	9	3	1	4	94

Class G Freq: 0.004

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5-7.5	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	3
7.5-12.5	0	0	0	0	0	0	0	1	0	0	2	1	0	0	0	0	4
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	1	0	1	2	3	0	0	0	0	7

Class All Freq: 1.000

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	11	13	10	13	10	5	6	5	16	16	12	19	14	15	14	11	190
3.5-7.5	57	46	42	40	60	30	29	21	41	57	72	69	90	78	65	39	836
7.5-12.5	24	22	8	21	15	6	14	13	32	134	67	14	40	102	58	21	591
12.5-18.5	5	18	4	9	0	0	5	12	22	34	8	0	0	41	38	6	202
18.5-24	2	11	4	4	0	0	0	6	7	0	0	0	0	0	0	0	34
>24	0	0	6	2	0	0	0	0	1	0	0	0	0	0	0	0	9
TOTAL	99	110	74	89	85	41	54	57	119	241	159	102	144	236	175	77	1862

Table A-1 (continued)

Apr-Jun 2016

Class A Freq: 0.120

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	4	0	1	0	1	0	0	0	0	0	0	0	0	0	2	1	9
3.5-7.5	32	47	20	32	14	3	1	1	1	1	0	0	15	12	10	12	201
7.5-12.5	3	17	0	0	0	0	1	0	6	5	0	1	16	4	0	0	53
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	39	64	21	32	15	3	2	1	7	6	0	1	31	16	12	13	263

Class B Freq: 0.040

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	4
3.5-7.5	1	8	6	10	8	4	2	0	0	0	2	3	7	3	2	0	56
7.5-12.5	0	0	0	0	0	0	1	1	10	8	1	0	1	1	0	0	23
12.5-18.5	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	8	6	10	8	4	4	1	10	12	3	3	8	5	3	1	87

Class C Freq: 0.066

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	3	2	1	0	3	0	0	0	1	0	0	0	1	1	2	1	15
3.5-7.5	0	11	7	9	12	5	5	0	1	5	5	5	7	1	2	3	78
7.5-12.5	0	5	1	0	0	0	2	0	23	16	2	0	2	0	0	0	51
12.5-18.5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3	18	9	9	15	5	7	0	25	22	7	5	10	2	4	4	145

Class D Freq: 0.408

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	26	15	20	21	26	6	6	5	9	6	4	3	10	10	12	13	192
3.5-7.5	18	28	39	49	33	29	23	12	73	59	31	19	35	12	8	5	473
7.5-12.5	3	35	2	0	1	0	12	11	50	72	6	5	10	0	2	0	209
12.5-18.5	0	0	0	0	0	0	0	10	6	1	0	0	0	0	0	0	17
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	47	78	61	70	60	35	41	38	138	138	41	27	55	22	22	18	891

Table A-1 (continued)

Apr-Jun 2016

Class E Freq: 0.248

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	7	5	8	9	15	6	9	15	12	6	6	11	16	16	11	4	156
3.5-7.5	13	16	1	12	5	5	12	17	20	39	41	65	25	14	9	14	308
7.5-12.5	0	0	0	0	0	0	1	1	3	51	15	3	1	0	0	0	75
12.5-18.5	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	20	21	9	21	20	11	22	33	37	96	62	79	42	30	20	18	541

Class F Freq: 0.092

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
0.95-3.5	1	1	0	2	3	2	5	3	3	4	13	14	23	5	4	0	83
3.5-7.5	0	0	0	3	4	1	1	4	1	14	30	21	6	2	0	1	88
7.5-12.5	0	0	0	0	0	0	0	0	0	15	15	0	0	0	0	0	30
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	1	0	5	7	4	6	7	4	33	58	35	29	7	4	1	202

Class G Freq: 0.025

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	1	0	0	0	1	0	4	7	3	0	0	1	17
3.5-7.5	0	0	0	2	0	0	0	0	0	1	21	2	0	0	0	0	26
7.5-12.5	0	0	0	0	0	0	0	0	0	4	8	0	0	0	0	0	12
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	2	1	0	0	0	1	5	33	9	3	0	0	1	55

Class All Freq: 1.000

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
0.95-3.5	41	23	30	32	49	14	21	23	26	16	27	35	53	33	32	21	476
3.5-7.5	64	110	73	117	76	47	44	34	96	119	130	115	95	44	31	35	1230
7.5-12.5	6	57	3	0	1	0	17	13	92	171	47	9	30	5	2	0	453
12.5-18.5	0	0	0	0	0	0	0	10	8	6	0	0	0	0	0	0	24
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	111	190	106	149	126	62	82	80	222	312	204	159	178	82	65	56	2184

Table A-1 (continued)

Jul-Sep 2016

Class A Freq: 0.103

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	10	6	10	2	0	2	0	0	0	0	0	0	0	3	0	4	37
3.5-7.5	12	27	32	19	12	13	5	0	1	0	3	0	10	16	11	2	163
7.5-12.5	0	4	0	0	0	0	6	0	7	8	1	0	0	0	0	0	26
12.5-18.5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	22	37	42	21	12	15	11	0	9	8	4	0	10	19	11	6	227

Class B Freq: 0.055

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	2	2	1	3	0	0	0	0	0	0	0	1	0	6	5	20
3.5-7.5	1	10	1	12	6	9	1	1	0	2	20	3	6	1	1	3	77
7.5-12.5	0	0	0	0	0	0	0	0	10	8	6	0	0	0	0	0	24
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	12	3	13	9	9	1	1	10	10	26	3	7	1	7	8	121

Class C Freq: 0.061

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	2	1	3	2	1	4	0	0	0	1	1	1	0	1	6	4	27
3.5-7.5	0	8	6	6	5	6	6	1	6	4	17	3	7	4	3	0	82
7.5-12.5	0	2	0	0	0	0	0	0	9	12	2	0	0	0	0	0	25
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2	11	9	8	6	10	6	1	15	17	20	4	7	5	9	4	134

Class D Freq: 0.379

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	16	23	23	31	21	13	9	2	6	4	8	5	12	9	8	9	199
3.5-7.5	5	64	39	40	21	16	28	13	60	152	46	18	12	8	4	9	535
7.5-12.5	0	8	1	0	0	0	1	1	22	68	2	0	0	0	0	0	103
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	21	95	63	71	42	29	38	16	88	224	56	23	24	17	12	18	837

Table A-1 (continued)

Jul-Sep 2016

Class E Freq: 0.267

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
0.95-3.5	5	17	10	13	18	15	10	10	10	15	16	17	21	16	22	11	226
3.5-7.5	8	4	2	8	3	2	6	21	33	132	62	28	12	2	8	5	336
7.5-12.5	0	0	0	0	0	0	0	0	1	20	4	0	0	0	0	0	25
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	13	21	12	21	21	17	17	31	44	167	82	45	33	18	30	16	588

Class F Freq: 0.112

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	3
0.95-3.5	2	0	2	3	0	1	2	7	7	6	25	39	27	10	7	2	140
3.5-7.5	1	0	0	0	0	0	1	2	2	17	55	8	1	0	0	1	88
7.5-12.5	0	0	0	0	0	0	0	0	0	2	14	0	0	0	0	0	16
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3	0	2	3	0	1	3	9	10	25	94	48	28	11	7	3	247

Class G Freq: 0.024

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	2
0.95-3.5	0	0	1	0	0	0	0	0	1	0	4	13	0	1	0	1	21
3.5-7.5	0	0	0	1	0	0	0	0	0	4	22	0	0	0	0	1	28
7.5-12.5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	1	2	0	0	0	1	1	5	26	13	0	1	0	2	52

Class All Freq: 1.000

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	1	0	0	1	1	1	0	0	1	0	1	0	0	6
0.95-3.5	35	49	51	52	43	35	21	19	24	26	54	75	61	40	49	36	670
3.5-7.5	27	113	80	86	47	46	47	38	102	311	225	60	48	31	27	21	1309
7.5-12.5	0	14	1	0	0	0	7	1	49	119	29	0	0	0	0	0	220
12.5-18.5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	62	176	132	139	90	81	76	59	177	456	308	136	109	72	76	57	2206

Table A-1 (continued)

Oct-Dec 2016

Class A Freq: 0.043

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	1	3	6	2	3	0	0	0	0	0	0	0	0	0	0	0	15
3.5-7.5	12	10	7	10	17	3	0	0	0	0	0	0	0	2	2	16	79
7.5-12.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	13	13	13	12	20	3	0	0	0	0	0	0	0	2	2	17	95

Class B Freq: 0.023

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	2	2	1	3	3	0	0	0	0	0	0	0	0	0	0	11
3.5-7.5	3	8	1	0	0	0	0	0	0	1	0	0	1	12	5	5	36
7.5-12.5	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	1	4
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3	10	3	1	3	3	0	0	0	1	1	0	1	14	5	6	51

Class C Freq: 0.034

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	1	0	0	3	1	0	1	0	0	0	0	0	0	2	0	0	8
3.5-7.5	0	5	2	1	1	1	1	0	0	1	0	6	8	21	6	2	55
7.5-12.5	0	0	0	0	0	0	0	0	1	0	3	2	1	4	0	0	11
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	5	2	4	2	1	2	0	1	1	3	8	9	27	6	2	74

Class D Freq: 0.446

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	16	14	8	8	8	1	5	1	2	4	4	2	12	10	20	21	136
3.5-7.5	23	55	29	14	16	13	26	10	19	25	39	76	109	106	77	35	672
7.5-12.5	2	7	0	0	1	1	14	4	9	7	14	35	41	16	12	8	171
12.5-18.5	0	0	0	0	0	0	4	0	0	0	1	0	1	0	0	0	6
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	41	76	37	22	25	15	49	15	30	36	58	113	163	132	109	64	985

Table A-1 (continued)

Oct-Dec 2016

Class E Freq: 0.370

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	5	7	4	6	5	8	10	8	17	16	15	42	26	26	14	6	215
3.5-7.5	8	4	1	1	4	11	25	43	24	38	85	126	43	23	29	5	470
7.5-12.5	3	8	0	0	1	9	18	9	6	40	14	10	2	2	0	0	122
12.5-18.5	0	0	0	0	0	0	1	3	0	2	3	0	0	0	0	0	9
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	16	19	5	7	10	28	54	63	47	96	117	178	71	51	43	11	816

Class F Freq: 0.069

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	3
0.95-3.5	2	1	0	0	0	0	0	3	9	6	11	35	10	4	3	1	85
3.5-7.5	0	0	0	0	0	0	0	3	10	7	30	5	2	0	0	0	57
7.5-12.5	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	7
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2	1	0	0	0	0	0	6	19	13	49	40	13	4	4	1	152

Class G Freq: 0.015

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	1	0	0	1	8	5	2	0	1	18
3.5-7.5	0	0	0	0	0	0	0	0	0	0	7	4	0	0	0	0	11
7.5-12.5	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	5
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	1	0	0	13	12	5	2	0	1	34

Class All Freq: 1.000

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	3
0.95-3.5	25	27	20	20	20	12	16	13	28	26	31	87	53	44	37	29	488
3.5-7.5	46	82	40	26	38	28	52	56	53	72	161	217	163	164	119	63	1380
7.5-12.5	5	15	0	0	2	10	32	13	16	47	44	47	44	24	12	10	321
12.5-18.5	0	0	0	0	0	0	5	3	0	2	4	0	1	0	0	0	15
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	76	124	60	46	60	50	105	85	97	147	241	351	262	232	169	102	2207

Table A-1 (continued)

Jan-Dec 2016

Class A Freq: 0.084

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	15	9	17	5	4	2	0	0	0	0	0	0	0	3	2	5	62
3.5-7.5	68	100	74	69	49	22	7	1	2	2	3	2	33	36	29	33	530
7.5-12.5	7	23	1	2	0	1	7	0	13	15	2	1	25	15	0	3	115
12.5-18.5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	90	132	92	76	53	25	14	1	16	17	5	3	58	54	31	41	708

Class B Freq: 0.036

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	1	5	4	2	7	3	1	0	0	0	0	0	1	1	8	6	39
3.5-7.5	6	27	11	23	20	15	3	1	0	3	22	7	16	17	10	8	189
7.5-12.5	1	0	0	3	1	0	3	1	22	18	10	0	3	4	1	3	70
12.5-18.5	0	0	0	0	0	0	0	1	0	4	0	0	0	0	0	0	5
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	8	32	15	28	28	18	7	3	22	25	32	7	20	22	19	17	303

Class C Freq: 0.051

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	8	3	5	5	5	4	1	0	1	1	1	1	1	4	8	5	53
3.5-7.5	4	27	17	19	21	13	12	1	7	10	22	14	23	27	14	6	237
7.5-12.5	2	9	3	3	1	0	6	0	37	40	10	2	8	5	4	2	132
12.5-18.5	0	0	0	0	0	0	2	0	0	7	1	0	0	0	2	0	12
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	14	39	25	27	27	17	21	1	45	58	34	17	32	36	28	13	434

Class D Freq: 0.407

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	62	58	57	67	58	21	20	9	17	16	19	12	36	34	47	48	581
3.5-7.5	73	169	125	123	91	75	90	38	157	261	136	122	169	151	123	65	1968
7.5-12.5	17	60	8	10	9	5	30	16	90	210	31	44	64	80	51	18	743
12.5-18.5	2	7	3	7	0	0	5	14	7	9	7	0	1	41	34	1	138
18.5-24	0	3	1	1	0	0	0	3	0	0	0	0	0	0	0	0	8
>24	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
TOTAL	154	297	194	209	158	101	145	80	271	496	193	178	270	306	255	132	3439

Table A-1 (continued)

Jan-Dec 2016

Class E Freq: 0.323

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
0.95-3.5	21	33	25	32	44	32	35	37	53	48	45	84	74	67	53	24	707
3.5-7.5	42	28	7	28	36	25	58	96	105	233	218	260	139	82	65	42	1464
7.5-12.5	8	16	0	3	7	10	24	18	25	166	80	22	13	27	16	5	440
12.5-18.5	3	11	1	2	0	0	3	10	23	22	4	0	0	0	2	5	86
18.5-24	2	8	3	3	0	0	0	3	7	0	0	0	0	0	0	0	26
>24	0	0	6	1	0	0	0	0	1	0	0	0	0	0	0	0	8
TOTAL	76	96	42	69	87	67	121	164	214	469	347	366	226	176	136	76	2732

Class F Freq: 0.082

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	1	0	0	1	0	1	1	1	1	1	0	7
0.95-3.5	5	4	2	6	3	4	7	13	21	19	50	91	61	20	14	6	326
3.5-7.5	1	0	1	4	4	1	2	12	21	44	137	48	16	4	1	3	299
7.5-12.5	0	0	0	0	0	0	0	4	2	17	39	0	1	0	0	0	63
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	6	4	3	10	7	6	9	29	45	80	227	140	79	25	16	9	695

Class G Freq: 0.017

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	2
0.95-3.5	0	0	1	0	1	0	0	1	2	0	9	28	8	3	0	3	56
3.5-7.5	0	0	0	3	0	0	0	0	0	6	50	8	0	0	0	1	68
7.5-12.5	0	0	0	0	0	0	0	1	0	5	15	1	0	0	0	0	22
12.5-18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	1	4	1	0	0	3	2	11	74	37	8	3	0	4	148

Class All Freq: 1.000

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	1	0	1	1	1	1	0	1	1	1	1	1	0	10
0.95-3.5	112	112	111	117	122	66	64	60	94	84	124	216	181	132	132	97	1824
3.5-7.5	194	351	235	269	221	151	172	149	292	559	588	461	396	317	242	158	4755
7.5-12.5	35	108	12	21	18	16	70	40	189	471	187	70	114	131	72	31	1585
12.5-18.5	5	18	4	9	0	0	10	25	31	42	12	0	1	41	38	6	242
18.5-24	2	11	4	4	0	0	0	6	7	0	0	0	0	0	0	0	34
>24	0	0	6	2	0	0	0	0	1	0	0	0	0	0	0	0	9
TOTAL	348	600	372	423	361	234	317	281	615	1156	912	748	693	622	485	292	8459

Table A-2
Joint Frequency Distribution of Wind Directions and Speeds
For the 220-ft level of the 220-ft Tower

Jan-Mar 2016

Class A Freq: 0.066

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5-7.5	0	3	1	2	1	0	0	0	0	0	0	0	1	2	0	1	11
7.5-12.5	6	6	7	1	10	2	1	0	0	0	0	1	2	1	4	3	44
12.5-18.5	2	4	6	0	0	3	0	0	0	2	2	0	4	5	0	4	32
18.5-24	3	1	0	2	0	0	0	0	0	0	0	0	7	1	0	4	18
>24	4	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	18
TOTAL	15	14	14	5	11	5	1	0	0	2	2	1	14	23	4	12	123

Class B Freq: 0.024

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5-7.5	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	2	5
7.5-12.5	2	0	1	2	0	1	0	0	0	0	0	1	0	2	1	1	11
12.5-18.5	0	0	0	0	1	2	0	0	1	2	2	0	0	1	1	1	11
18.5-24	0	0	0	2	4	0	2	0	0	1	0	0	1	0	1	1	12
>24	1	0	0	1	0	0	0	1	0	0	0	0	0	2	0	0	5
TOTAL	3	1	1	5	7	3	2	1	1	3	2	1	1	5	3	5	44

Class C Freq: 0.044

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5-7.5	2	1	2	1	0	0	0	0	0	0	0	0	0	1	1	0	8
7.5-12.5	1	2	1	0	1	3	0	0	0	1	0	0	0	0	1	0	10
12.5-18.5	1	0	1	1	0	0	3	0	1	8	5	0	2	2	3	1	28
18.5-24	1	0	0	3	2	0	2	0	0	5	0	0	3	1	3	1	21
>24	1	2	0	0	1	0	1	0	0	4	2	0	0	1	1	1	14
TOTAL	6	5	4	5	4	3	6	0	1	18	7	0	5	5	9	3	81

Class D Freq: 0.390

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	1	1	1	0	0	0	1	0	0	0	0	0	0	1	1	1	7
3.5-7.5	3	4	6	6	2	6	2	1	0	4	5	4	4	1	7	7	62
7.5-12.5	4	7	3	9	10	10	6	4	5	11	7	3	11	11	13	3	117
12.5-18.5	4	8	10	12	4	9	3	0	1	39	26	9	12	42	14	6	199
18.5-24	14	5	9	7	12	2	1	5	0	25	18	3	19	34	35	15	204
>24	18	6	3	15	2	0	0	2	1	3	3	0	5	38	24	17	137
TOTAL	44	31	32	49	30	27	13	12	7	82	59	19	51	127	94	49	726

Table A-2 (continued)

Jan-Mar 2016

Class E Freq: 0.423

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
0.95-3.5	1	0	2	2	1	1	1	2	0	2	1	1	0	0	2	1	17
3.5-7.5	5	2	1	1	4	7	9	7	3	1	3	7	9	5	1	3	68
7.5-12.5	8	3	4	8	3	8	10	14	12	12	11	11	37	31	15	8	195
12.5-18.5	8	3	1	8	5	5	5	7	15	29	49	21	21	47	14	16	254
18.5-24	4	6	0	3	6	1	4	5	13	45	42	6	8	8	11	6	168
>24	13	10	10	7	4	0	0	3	11	5	2	0	0	2	11	6	84
TOTAL	39	24	18	29	24	22	29	38	54	94	108	46	75	93	54	40	787

Class F Freq: 0.050

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	1	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	4
3.5-7.5	1	1	0	1	0	0	1	0	0	1	2	2	0	0	2	0	11
7.5-12.5	1	2	0	0	0	0	0	2	4	4	3	1	8	5	2	3	35
12.5-18.5	0	0	0	1	0	0	0	2	7	0	10	12	2	6	0	0	40
18.5-24	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	4
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3	4	0	2	0	0	1	4	11	6	18	17	10	11	4	3	94

Class G Freq: 0.004

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5-7.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.5-12.5	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	3
12.5-18.5	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2
18.5-24	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	0	1	0	3	2	1	0	0	0	7

Class All Freq: 1.000

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
0.95-3.5	3	2	3	2	1	1	2	2	0	3	1	2	0	1	3	2	28
3.5-7.5	11	12	10	11	9	13	12	8	3	6	10	13	14	9	11	13	165
7.5-12.5	22	20	16	20	24	24	17	20	21	28	22	18	59	50	36	18	415
12.5-18.5	15	15	18	22	10	19	11	9	26	80	95	42	41	103	32	28	566
18.5-24	22	12	9	17	24	3	9	10	13	76	64	11	38	44	50	27	429
>24	37	18	13	23	7	0	1	6	12	12	7	0	5	57	36	24	258
TOTAL	110	79	69	95	76	60	52	55	75	205	199	86	157	264	168	112	1862

Table A-2 (continued)

Apr-Jun 2016

Class A Freq: 0.120

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5-7.5	4	9	5	0	1	0	0	0	0	0	0	0	0	2	0	1	22
7.5-12.5	13	10	5	7	17	4	0	2	1	1	0	0	2	5	5	8	80
12.5-18.5	24	8	6	7	9	2	1	0	4	5	0	1	6	3	3	9	88
18.5-24	8	7	0	0	0	0	0	0	0	2	0	0	9	5	5	5	41
>24	13	4	0	0	0	0	0	0	0	0	0	0	7	6	1	1	32
TOTAL	62	38	16	14	27	6	1	2	5	8	0	1	24	21	14	24	263

Class B Freq: 0.040

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
3.5-7.5	0	3	1	4	1	0	0	0	0	0	0	0	1	0	3	0	13
7.5-12.5	2	1	0	3	4	7	1	0	2	0	1	1	1	0	0	1	24
12.5-18.5	1	1	3	1	1	2	2	1	6	10	2	1	2	2	0	0	35
18.5-24	0	1	1	0	0	0	0	0	0	4	0	0	4	1	1	0	12
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
TOTAL	3	6	5	8	6	9	3	2	8	14	3	2	8	5	4	1	87

Class C Freq: 0.066

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5-7.5	1	4	6	4	5	1	0	0	1	0	1	1	2	1	2	2	31
7.5-12.5	2	7	0	2	2	7	4	0	3	7	1	4	1	1	2	3	46
12.5-18.5	1	1	2	1	3	3	2	0	16	13	5	1	3	0	0	0	51
18.5-24	1	0	0	0	0	0	0	0	1	5	0	0	1	1	1	0	10
>24	1	4	0	0	0	0	0	0	0	0	0	0	0	2	0	0	7
TOTAL	6	16	8	7	10	11	6	0	21	25	7	6	7	5	5	5	145

Class D Freq: 0.408

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	2	3	3	3	1	2	1	0	1	1	0	0	0	0	0	0	17
3.5-7.5	9	11	22	16	27	15	5	6	7	2	4	1	2	3	8	6	144
7.5-12.5	15	15	17	14	22	26	21	10	36	47	14	8	7	3	6	15	276
12.5-18.5	5	5	9	6	8	5	17	5	30	87	34	11	14	3	3	9	251
18.5-24	10	7	4	7	4	0	0	7	5	42	6	5	16	6	5	4	128
>24	17	22	0	0	0	0	0	4	1	4	0	0	5	14	5	3	75
TOTAL	58	63	55	46	62	48	44	32	80	183	58	25	44	29	27	37	891

Table A-2 (continued)

Apr-Jun 2016

Class E Freq: 0.248

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	2	2	5	3	4	0	1	0	0	1	1	0	0	0	1	3	23
3.5-7.5	3	5	1	4	6	7	6	10	8	7	3	1	1	1	2	3	68
7.5-12.5	4	7	1	0	6	9	8	13	13	12	7	10	13	6	11	5	125
12.5-18.5	6	4	2	1	2	2	4	6	6	30	22	27	34	9	12	9	176
18.5-24	10	2	0	0	0	0	0	0	2	34	26	7	9	12	6	14	122
>24	1	0	0	0	0	0	0	0	0	14	5	0	0	5	1	1	27
TOTAL	26	20	9	8	18	18	19	29	29	98	64	45	57	33	33	35	541

Class F Freq: 0.092

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
0.95-3.5	0	1	0	0	1	0	2	0	3	0	0	1	0	0	0	1	9
3.5-7.5	1	1	2	0	4	3	3	2	3	4	3	3	1	3	5	0	38
7.5-12.5	2	1	0	0	1	3	5	2	6	4	3	6	8	6	9	3	59
12.5-18.5	1	0	0	0	0	0	1	1	0	5	6	6	16	7	5	3	51
18.5-24	0	0	0	0	0	0	0	0	0	17	10	6	3	0	1	1	38
>24	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	6
TOTAL	4	3	2	0	6	6	11	5	12	30	28	22	28	16	20	9	202

Class G Freq: 0.025

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	4
3.5-7.5	0	0	0	0	1	0	1	0	0	1	0	0	4	1	1	0	9
7.5-12.5	0	0	0	0	0	1	0	0	1	1	2	4	3	1	2	0	15
12.5-18.5	0	1	0	0	0	0	0	0	0	2	4	5	3	1	1	0	17
18.5-24	0	0	0	0	0	0	0	0	0	1	6	1	2	0	0	0	10
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	1	0	0	1	1	1	1	1	5	12	10	12	4	5	0	55

Class All Freq: 1.000

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
0.95-3.5	5	6	8	6	6	2	4	2	4	2	1	1	0	1	2	4	54
3.5-7.5	18	33	37	28	45	26	15	18	19	14	11	6	11	11	21	12	325
7.5-12.5	38	41	23	26	52	57	39	27	62	72	28	33	35	22	35	35	625
12.5-18.5	38	20	22	16	23	14	27	13	62	152	73	52	78	25	24	30	669
18.5-24	29	17	5	7	4	0	0	7	8	105	48	19	44	25	19	24	361
>24	32	30	0	0	0	0	0	4	1	18	11	0	12	29	7	5	149
TOTAL	160	147	95	83	130	99	85	71	156	363	172	111	180	113	108	111	2184

Table A-2 (continued)

Jul-Sep 2016

Class A Freq: 0.103

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5-7.5	3	6	13	2	2	0	0	1	1	0	0	0	0	2	3	3	36
7.5-12.5	15	6	5	9	10	16	3	0	0	0	1	1	6	10	2	3	87
12.5-18.5	7	11	14	1	3	7	5	0	5	8	2	1	4	7	1	2	78
18.5-24	4	1	2	3	1	0	0	0	0	2	0	0	2	2	1	1	19
>24	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	1	7
TOTAL	29	29	34	16	16	23	8	1	6	10	3	2	12	21	7	10	227

Class B Freq: 0.055

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5-7.5	2	3	3	2	4	0	0	0	0	0	0	1	1	1	2	4	23
7.5-12.5	2	2	0	4	2	11	0	1	0	2	7	5	4	2	1	5	48
12.5-18.5	2	1	4	1	1	2	2	0	7	8	14	3	0	2	0	0	47
18.5-24	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	3
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	6	6	8	7	7	13	2	1	7	11	22	9	5	5	3	9	121

Class C Freq: 0.061

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
3.5-7.5	3	1	4	4	0	2	1	0	1	2	1	1	1	1	4	4	30
7.5-12.5	0	0	0	0	2	11	6	1	2	4	8	5	1	3	0	2	45
12.5-18.5	0	0	7	0	0	1	1	0	5	13	9	0	3	4	2	1	46
18.5-24	0	1	2	1	0	0	0	0	0	3	1	0	0	1	0	0	9
>24	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
TOTAL	4	4	13	6	2	14	8	1	8	22	19	6	5	9	6	7	134

Class D Freq: 0.380

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
0.95-3.5	1	3	7	2	2	1	0	2	0	0	1	0	0	0	0	1	20
3.5-7.5	12	10	17	14	13	14	4	6	3	5	8	4	2	6	1	6	125
7.5-12.5	13	8	7	6	24	30	16	12	13	33	28	10	6	3	6	13	228
12.5-18.5	3	10	38	11	4	4	2	1	12	169	55	7	8	7	1	4	336
18.5-24	0	14	12	15	3	0	0	0	0	28	12	1	2	6	3	3	99
>24	2	11	0	13	1	0	0	0	0	0	0	0	0	0	0	2	29
TOTAL	31	56	81	61	47	49	22	21	29	235	104	22	18	22	11	29	838

Table A-2 (continued)

Jul-Sep 2016

Class E Freq: 0.267

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	2	1	5	0	4	0	1	0	0	1	0	1	0	0	0	15
3.5-7.5	4	4	6	7	6	7	4	4	9	1	3	3	2	3	5	8	76
7.5-12.5	3	4	9	7	11	7	14	11	7	11	14	11	12	9	8	9	147
12.5-18.5	9	2	2	8	2	0	6	4	5	84	58	21	19	11	13	12	256
18.5-24	3	1	0	0	0	0	0	0	0	48	23	0	0	2	5	6	88
>24	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	7
TOTAL	22	13	18	28	19	18	24	20	21	144	99	35	34	25	31	38	589

Class F Freq: 0.112

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	1	1	2	0	1	0	1	0	0	0	0	1	1	1	0	9
3.5-7.5	1	0	1	0	2	3	0	6	1	5	2	3	0	2	4	4	34
7.5-12.5	2	0	0	0	0	0	8	4	10	3	2	6	10	11	11	10	77
12.5-18.5	1	0	0	0	0	0	0	1	5	8	19	15	10	16	12	9	96
18.5-24	0	0	0	0	0	0	0	0	0	2	20	2	0	0	0	4	28
>24	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3
TOTAL	5	1	2	2	2	4	8	12	16	18	43	26	21	30	28	29	247

Class G Freq: 0.024

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	1	0	0	1	1	0	1	0	0	1	2	0	1	0	1	0	9
3.5-7.5	0	0	0	0	0	0	0	1	3	0	2	0	2	0	0	1	9
7.5-12.5	0	0	0	0	0	0	0	0	1	0	2	8	8	1	1	1	22
12.5-18.5	0	0	0	0	0	0	0	0	0	1	6	2	1	1	0	0	11
18.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
TOTAL	1	0	0	1	1	0	1	1	4	2	12	10	12	2	2	3	52

Class All Freq: 1.000

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
0.95-3.5	2	6	9	11	3	6	1	4	0	1	4	0	3	1	2	1	54
3.5-7.5	25	24	44	29	27	26	9	18	18	13	16	12	8	15	19	30	333
7.5-12.5	35	20	21	26	49	75	47	29	33	53	62	46	47	39	29	43	654
12.5-18.5	22	24	65	21	10	14	16	6	39	291	163	49	45	48	29	28	870
18.5-24	7	17	17	19	4	0	0	0	0	84	57	3	4	11	9	14	246
>24	7	18	0	15	1	0	0	0	0	0	0	0	0	0	0	9	50
TOTAL	98	109	156	121	94	121	73	57	91	442	302	110	107	114	88	125	2208

Table A-2 (continued)

Oct-Dec 2016

Class A Freq: 0.043

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5-7.5	0	8	6	3	3	3	0	0	0	0	0	0	0	0	0	0	23
7.5-12.5	2	3	2	1	7	10	0	0	0	0	0	0	0	0	0	1	26
12.5-18.5	7	1	3	0	7	0	0	0	0	0	0	0	0	1	1	7	27
18.5-24	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	9	13
>24	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	6
TOTAL	12	13	11	4	17	13	0	0	0	0	0	0	0	2	2	21	95

Class B Freq: 0.023

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5-7.5	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	7
7.5-12.5	0	1	2	0	1	1	1	0	0	0	1	0	0	4	1	1	13
12.5-18.5	4	2	0	0	0	0	0	0	0	0	1	0	0	6	2	1	16
18.5-24	1	2	0	0	0	0	0	0	0	0	0	0	0	3	2	4	12
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	3
TOTAL	6	6	3	1	2	2	2	0	0	0	2	0	0	15	5	7	51

Class C Freq: 0.034

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5-7.5	0	0	0	2	0	0	1	0	0	0	0	1	0	0	2	0	6
7.5-12.5	0	1	1	0	1	2	1	0	0	0	1	3	4	8	4	0	26
12.5-18.5	0	2	1	1	1	0	0	0	1	0	3	0	2	5	2	0	18
18.5-24	0	2	0	0	0	0	0	0	0	0	0	0	3	7	2	2	16
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	0	8
TOTAL	0	5	2	3	2	2	2	0	1	0	4	4	9	25	13	2	74

Class D Freq: 0.447

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	6	3	1	1	0	0	0	0	0	0	0	0	0	0	1	1	13
3.5-7.5	3	8	9	4	3	5	4	3	0	2	4	2	7	8	13	14	89
7.5-12.5	9	2	14	6	7	7	16	12	8	17	23	16	20	10	12	5	184
12.5-18.5	2	14	14	12	13	5	13	3	3	19	17	47	59	30	32	24	307
18.5-24	7	18	2	5	3	2	1	7	0	5	6	27	41	60	60	26	270
>24	22	7	0	5	0	0	0	0	0	0	3	0	6	21	37	21	122
TOTAL	49	52	40	33	26	19	34	25	11	43	53	92	133	129	155	91	985

Table A-2 (continued)

Oct-Dec 2016

Class E Freq: 0.369

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	1	0	3	0	1	1	2	2	2	1	0	0	0	1	0	2	16
3.5-7.5	3	1	2	4	5	3	10	2	6	3	1	4	7	4	10	5	70
7.5-12.5	3	5	1	3	2	6	19	17	8	10	22	10	27	26	12	6	177
12.5-18.5	3	5	1	4	3	4	19	23	20	12	47	60	56	29	32	16	334
18.5-24	6	0	0	0	4	5	6	4	1	18	54	24	24	15	11	6	178
>24	9	3	0	0	4	5	2	0	0	3	5	0	1	1	5	1	39
TOTAL	25	14	7	11	19	24	58	48	37	47	129	98	115	76	70	36	814

Class F Freq: 0.069

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
0.95-3.5	0	0	0	0	1	1	0	1	1	3	0	0	1	0	2	0	10
3.5-7.5	2	1	3	1	2	3	4	3	4	1	0	2	1	2	2	0	31
7.5-12.5	0	0	0	0	0	0	1	5	7	8	1	2	9	12	10	3	58
12.5-18.5	0	2	0	0	0	0	1	2	5	6	8	12	4	1	3	0	44
18.5-24	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	0	8
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2	3	3	1	3	4	6	11	17	18	13	21	15	15	17	3	152

Class G Freq: 0.015

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
3.5-7.5	1	3	1	0	1	0	0	0	0	1	0	1	2	0	1	1	12
7.5-12.5	2	1	0	0	0	0	0	0	1	0	1	1	4	3	0	0	13
12.5-18.5	0	0	0	0	0	0	0	0	0	0	3	2	2	0	0	0	7
18.5-24	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3	4	1	0	1	0	0	0	1	1	6	4	8	3	1	1	34

Class All Freq: 1.000

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
0.95-3.5	7	3	4	1	2	2	2	3	3	4	1	0	1	1	3	3	40
3.5-7.5	10	22	22	15	15	15	20	8	10	7	5	10	17	14	28	20	238
7.5-12.5	16	13	20	10	18	26	38	34	24	35	49	32	64	63	39	16	497
12.5-18.5	16	26	19	17	24	9	33	28	29	37	79	121	123	72	72	48	753
18.5-24	15	23	2	5	7	7	7	11	1	23	65	55	68	86	76	47	498
>24	33	10	0	5	4	5	2	0	0	3	8	0	7	29	45	27	178
TOTAL	97	97	67	53	70	64	102	84	67	109	207	219	280	265	263	161	2205

Table A-2 (continued)

Jan-Dec 2016

Class A Freq: 0.084

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5-7.5	7	26	25	7	7	3	0	1	1	0	0	0	1	6	3	5	92
7.5-12.5	36	25	19	18	44	32	4	2	1	1	1	2	10	16	11	15	237
12.5-18.5	40	24	29	8	19	12	6	0	9	15	4	2	14	16	5	22	225
18.5-24	16	10	2	5	1	0	0	0	0	4	0	0	18	9	7	19	91
>24	19	9	0	1	0	0	0	0	0	0	0	0	7	20	1	6	63
TOTAL	118	94	75	39	71	47	10	3	11	20	5	4	50	67	27	67	708

Class B Freq: 0.036

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
3.5-7.5	3	8	5	7	8	1	1	0	0	0	0	1	2	1	5	6	48
7.5-12.5	6	4	3	9	7	20	2	1	2	2	9	7	5	8	3	8	96
12.5-18.5	7	4	7	2	3	6	4	1	14	20	19	4	2	11	3	2	109
18.5-24	1	3	2	2	4	0	2	0	0	6	1	0	5	4	4	5	39
>24	1	0	0	1	0	0	0	1	0	0	0	0	0	6	0	1	10
TOTAL	18	19	17	21	22	27	9	4	16	28	29	12	14	30	15	22	303

Class C Freq: 0.051

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
3.5-7.5	6	6	12	11	5	3	2	0	2	2	2	3	3	3	9	6	75
7.5-12.5	3	10	2	2	6	23	11	1	5	12	10	12	6	12	7	5	127
12.5-18.5	2	3	11	3	4	4	6	0	23	34	22	1	10	11	7	2	143
18.5-24	2	3	2	4	2	0	2	0	1	13	1	0	7	10	6	3	56
>24	3	8	0	0	1	0	1	0	0	4	2	0	0	8	4	1	32
TOTAL	16	30	27	21	18	30	22	1	31	65	37	16	26	44	33	17	434

Class D Freq: 0.407

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
0.95-3.5	10	10	12	6	3	3	2	2	1	1	1	0	0	1	2	3	57
3.5-7.5	27	33	54	40	45	40	15	16	10	13	21	11	15	18	29	33	420
7.5-12.5	41	32	41	35	63	73	59	38	62	108	72	37	44	27	37	36	805
12.5-18.5	14	37	71	41	29	23	35	9	46	314	132	74	93	82	50	43	1093
18.5-24	31	44	27	34	22	4	2	19	5	100	42	36	78	106	103	48	701
>24	59	46	3	33	3	0	0	6	2	7	6	0	16	73	66	43	363
TOTAL	182	202	208	189	165	143	113	90	127	543	274	158	246	307	287	206	3440

Table A-2 (continued)

Jan-Dec 2016

Class E Freq: 0.323

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
0.95-3.5	4	4	11	10	6	6	4	5	2	4	3	1	1	1	3	6	71
3.5-7.5	15	12	10	16	21	24	29	23	26	12	10	15	19	13	18	19	282
7.5-12.5	18	19	15	18	22	30	51	55	40	45	54	42	89	72	46	28	644
12.5-18.5	26	14	6	21	12	11	34	40	46	155	176	129	130	96	71	53	1020
18.5-24	23	9	0	3	10	6	10	9	16	145	145	37	41	37	33	32	556
>24	26	13	10	8	8	5	2	3	11	22	12	0	1	8	17	11	157
TOTAL	112	71	52	76	80	82	130	135	141	383	400	224	281	227	188	149	2731

Class F Freq: 0.082

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2
0.95-3.5	1	3	1	2	2	2	2	2	4	4	0	2	2	1	3	1	32
3.5-7.5	5	3	6	2	8	9	8	11	8	11	7	10	2	7	13	4	114
7.5-12.5	5	3	0	0	1	3	14	13	27	19	9	15	35	34	32	19	229
12.5-18.5	2	2	0	1	0	0	2	6	17	19	43	45	32	30	20	12	231
18.5-24	0	0	0	0	0	0	0	0	0	19	37	13	3	0	1	5	78
>24	1	0	0	0	0	0	0	0	0	0	6	0	0	0	0	2	9
TOTAL	14	11	7	5	11	14	26	32	56	72	102	86	74	72	69	44	695

Class G Freq: 0.017

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95-3.5	2	0	0	1	1	0	1	1	0	1	3	0	1	1	2	0	14
3.5-7.5	1	3	1	0	2	0	1	1	3	2	2	1	8	1	2	2	30
7.5-12.5	2	1	0	0	0	1	0	0	3	1	6	14	16	5	3	1	53
12.5-18.5	0	1	0	0	0	0	0	0	1	3	14	9	6	2	1	0	37
18.5-24	0	0	0	0	0	0	0	0	0	1	8	2	2	0	0	0	13
>24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
TOTAL	5	5	1	1	3	1	2	2	7	8	33	26	33	9	8	4	148

Class All Freq: 1.000

mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Calm-0.95	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	1	4
0.95-3.5	17	17	24	20	12	11	9	11	7	10	7	3	4	4	10	10	176
3.5-7.5	64	91	113	83	96	80	56	52	50	40	42	41	50	49	79	75	1061
7.5-12.5	111	94	80	82	143	182	141	110	140	188	161	129	205	174	139	112	2191
12.5-18.5	91	85	124	76	67	56	87	56	156	560	410	264	287	248	157	134	2858
18.5-24	73	69	33	48	39	10	16	28	22	288	234	88	154	166	154	112	1534
>24	109	76	13	43	12	5	3	10	13	33	26	0	24	115	88	65	635
TOTAL	465	432	387	352	370	344	312	267	389	1119	880	526	724	756	627	509	8459

APPENDIX B

Results of Onsite Groundwater Monitoring Program

In response to the Nuclear Energy Institute (NEI) Groundwater Protection Initiative, Pilgrim Station instituted a groundwater monitoring program during 2007. Four monitoring wells were installed inside the protected area fence during the fourth quarter of 2007. The first samples were collected in November 2007. Since these are onsite wells, they are not considered part of the Radiological Environmental Monitoring Program (REMP), and data from these wells are being reported in the annual Radiological Effluent Release Report. Two pre-existing wells were incorporated into the groundwater monitoring program in early 2008. Additional wells were added to the program in 2010 (12 wells), 2011 (2 wells), 2012 (1 well), 2013 (3 wells), and 2014 (1 well). A total of 23 wells are being sampled on a routine basis.

In addition to sampling the onsite monitoring wells, samples of surface water are collected from two locations in the PNPS Intake Canal. These locations are along the shoreline in the same direction as the groundwater flow gradient.

All samples collected are analyzed for tritium, a radioactive isotope of hydrogen, and also for gamma emitting radionuclides. In accordance with industry practice established under the NEI initiative, lower limits of detection (LLDs) used for analysis of REMP samples were used when assessing these samples for the presence of radioactivity. Low levels of tritium were detected in many of the onsite wells. Although gamma spectroscopy indicated the presence of naturally-occurring radioactivity, such as Potassium-40 and radon daughters from the uranium/thorium decay chains, there was no indication of any plant-related radioactivity in the groundwater samples, other than tritium. Such levels of natural radioactivity are expected as these radionuclides are dissolved into the groundwater from the rocks and soil. The fact that these low levels of naturally-occurring radioactivity can be detected demonstrates the ability of the gamma spectroscopy analyses to detect radioactivity in groundwater. Analyses are also performed for hard-to-detect radionuclides, including Iron-55, Nickel-63, Strontium-89, and Strontium-90 on a less frequent basis. These hard-to-detect radionuclides were also non-detectable in all of the wells sampled and analyzed during 2016.

A summary of the results of the tritium analyses conducted in 2016 are presented in the following table. In this table, a value of "NDA < xx" in the columns indicates that no activity was detected in the sample when analyzed to the minimum-detectable level following the "<" sign. For example, the sample collected from MW201 on 16-Jan-2016 contained no detectable tritium, and a minimum detectable concentration of 369 pCi/L was achieved on that sample. The achieved sensitivity of 369 pCi/L is well below the required REMP LLD of 3000 pCi/L, and no tritium was detected even when counted to this more sensitive level of detection. No plant-related radioactivity (other than tritium) was detected in any of the monitoring wells, and no tritium or plant-related radioactivity was detected in surface water samples collected from the intake canal.

Monitoring Well ID	Installation Date	Number of Samples	Number of Positive Results	Minimum Concentration pCi/L	Maximum Concentration pCi/L
MW201	Nov-2007	4	3	NDA < 317	556
MW202	Nov-2007	4	2	NDA < 322	873
MW202-I	Apr-2010	4	1	NDA < 323	345
MW203	Nov-2007	Well decommissioned in 2013 during construction of ISFSI pad			
MW204	Nov-2007	4	1	NDA < 333	555
MW205	Apr-2010	4	4	500	877
MW206	Apr-2010	45	8	NDA < 265	1028
MW207	Apr-2010	4	2	NDA < 265	624
MW208-S	Apr-2010	4	0	NDA < 272	NDA < 336
MW208-I	Apr-2010	4	0	NDA < 326	NDA < 344
MW209	Aug-2010	24	24	453	1060
MW210	Aug-2010	4	4	690	1180
MW211	Aug-2010	34	34	1050	2080
MW212	Aug-2010	4	4	580	815
MW213	Aug-2010	4	0	NDA < 269	NDA < 330
MW214	Aug-2010	4	0	NDA < 324	NDA < 344
MW215	Dec-2011	32	32	589	1260
MW216	Sep-2012	45	45	903	5430
MW217	Dec-2011	4	2	NDA < 330	438
MW218	Nov-2013	45	45	1640	6070
MW219	Dec-2013	11	11	754	1370
MW220	Dec-2014	4	4	450	718
MW3	Jul-1987	4	0	NDA < 315	NDA < 337
MW4	Jul-1997	Well decommissioned in 2013 during installation of MW4R			
MW4-R	Nov-2013	4	0	NDA < 269	NDA < 321
All Wells	--	300	226	NDA < 265	6070
Intake Canal West	--	52	0	NDA < 174	NDA < 348
Intake Canal East	--	3	0	NDA < 305	NDA < 337

Concentrations of tritium detected in the onsite wells ranged from non-detectable at less than 174 pCi/L, up to a maximum concentration of 6070 pCi/L. The average concentrations from these onsite wells are well below the voluntary communication reporting level of 20,000 pCi/L as established by the EPA Drinking Water Standard. Although the EPA Standard provides a baseline for comparison, no drinking water sources are affected by this tritium. All of the affected wells are onsite, and the general groundwater flow pathway is under Pilgrim Station and out into the salt water of Cape Cod Bay. As such, there is no potential to influence any off-site drinking water wells. Even if worst-case assumptions were made and the water from monitoring well MW218 (average concentration = 3545 pCi/L) was consumed as drinking water for an entire year, the maximum dose consequence would be less than 0.31 mrem/yr. In actuality, any dose consequence would be much less than this, as any tritium-laden water potentially leaving the site would be diluted into the seawater of Cape Cod Bay before being incorporated into any ingestion pathways. No drinking water ingestion pathway exists at the Pilgrim Station site.

Although there are no indications that the groundwater containing detectable tritium is actually migrating offsite, a bounding calculation was performed to assess the potential dose impact of such a scenario. Based on the tritium concentrations detected during 2016, the annual average concentrations of tritium in groundwater in the four monitoring wells most closely adjacent to the shoreline (MW204, MW205, MW202, and MW201) were used to estimate potential tritium migration into the intake bay. Hydrological characteristics of the compacted backfill in the vicinity of these wells were measured in 2010 and indicate the hydraulic conductivity ranges from 0.002 cm/sec to about 0.006 cm/sec. When coupled with the hydraulic slope of 0.014 and average porosity of 0.3, the flow velocity was calculated as being between 0.08 and 0.23 meters per day. Using an assumed horizontal shoreline interface area 236 meters long by 3 meters deep that could potentially transmit groundwater into the intake bay, the annual discharge of groundwater would be about 12.5 million Liters of water per year. Assuming this volume of 12.5 million liters contained the segment-weighted average concentration of 468 pCi/L, the annual discharge of tritium into the intake bay under this hypothetical scenario would be 0.00585 Curies. This activity represents less than 0.009% of the annual airborne effluent of tritium released from the reactor building vent (see Table 2.2-C). Such airborne effluents can be washed down to the ground surface during precipitation events and infiltrate into the ground, thereby introducing tritium into the groundwater.

In the hypothetical scenario described above, the 0.00585 Curies of tritium entering the intake bay would be further diluted into the circulating water flow of the plant. As documented in Table 2.3-A, the total volume of circulating water flow during 2016 was 612 billion Liters, yielding an effective concentration of tritium in the intake bay of about 0.0096 pCi/L. Such a concentration would be well below the detection sensitivity of about 450 pCi/L used to analyze water collected from the discharge canal as part of the radiological environmental monitoring program (REMP). The calculated dose to the maximum-exposed member of the public from such a hypothetical release would be 0.0000000055 millirem, resulting from ingestion of tritium incorporated into fish and shellfish. Since the tritium would be incorporated into seawater, there is no drinking water ingestion pathway in the described scenario.

The following table lists the hydrological characteristics in the vicinity of each of the monitoring wells used to estimate tritium migration. Predicted flow velocities, annual discharge volumes, average tritium concentrations, and hypothetical tritium discharges are listed for each shoreline segment represented by each monitoring well.

Shoreline Segment Number	1	2	3	4
Monitoring Well Number	MW204	MW205	MW202	MW201
Hydraulic Conductivity - cm/sec	1.99E-03	4.27E-03	3.13E-03	5.64E-03
Hydraulic Slope	0.014	0.014	0.014	0.014
Porosity	0.300	0.300	0.300	0.300
Flow Velocity - m/day	8.02E-02	1.72E-01	1.26E-01	2.27E-01
Flow Velocity - ft/yr	9.61E+01	2.06E+02	1.51E+02	2.72E+02
Length of Shoreline Segment – m	61.0	38.1	45.7	91.4
Thickness of Water Layer – m	3.0	3.0	3.0	3.0
Volumetric Discharge - m^3/day	4.40E+00	5.90E+00	5.19E+00	1.87E+01
Volumetric Discharge - Liter/yr	1.61E+06	2.16E+06	1.90E+06	6.84E+06
Annual Average H-3 Concentration - pCi/L	3.95E+02	6.47E+02	5.12E+02	4.17E+02
Annual Segment Tritium Discharge - Ci/yr	6.34E-04	1.40E-03	9.71E-04	2.85E-03
Total Volumetric Discharge - L/yr	1.25E+07			
Total H-3 Discharge - Ci/yr	5.85E-03			
Annual Circulating Water Flow - Liter/yr	6.12E+11			
Discharge Canal H-3 Concentration - Ci/L	9.56E-15			
Discharge Canal H-3 Concentration - pCi/L	9.56E-03			
Max. Indiv. Dose Factor - mrem/yr per Ci/L	5.73E+05			
Maximum Individual Dose - mrem/yr	5.47E-09			

In conclusion, the only radionuclide detected in groundwater during the 2016 monitoring effort that is attributable to Pilgrim Station operations is tritium. Although some soil samples near the separation in the underground discharge line from the neutralizing sump indicated the presence of low-level gamma radioactivity, such activity has not been detected in the groundwater and indicates the radioactivity is immobile and confined to the soil. Even in the case of the three reportable events that occurred in 2013 and subsequent sample results in 2016, the total dose impact to a maximally-exposed member of the public would have been much less than 1 mrem/yr.

APPENDIX C

CORRECTIONS TO PREVIOUS EFFLUENT REPORTS

There were no corrections made to previous effluent reports during calendar-year 2016.

APPENDIX D

CHANGES TO PNPS
OFFSITE DOSE CALCULATION MANUAL

No revisions were made to the PNPS Offsite Dose Calculation Manual (ODCM) during calendar year 2016.