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

Donald C. Cook Nuclear Plant Units 1 and 2  
2018 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

In accordance with Technical Specification 5.6.3, Indiana Michigan Power Company, the licensee for Donald C. Cook Nuclear Plant (CNP) Units 1 and 2, is providing the Annual Radioactive Effluent Release Report as Enclosure 1 to this letter. This report covers the period January 1, 2018, through December 31, 2018.

This letter contains no new or modified regulatory commitments. Should you have any questions, please contact me at (269) 466-2649.

Sincerely,

Michael K. Scarpello  
Regulatory Affairs Director

JMT/ml

Enclosure: Donald C. Cook Nuclear Plant Units 1 and 2 - 2018 Annual Radioactive Effluent Release Report

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A009  
IE48  
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**ENCLOSURE to AEP-NRC-2019-19**

**DONALD C. COOK NUCLEAR PLANT UNITS 1 AND 2  
2018 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT**

## TABLE OF CONTENTS

	<u>Page</u>
Table of Contents	i
I. Introduction	1
II. Radioactive Releases and Radiological Impact on Man	1
Liquid Releases	2
Gaseous Releases	2
Solid Waste Disposition	2
III. Meteorological	3
IV. Offsite Dose Calculation Manual (ODCM) Changes	3
V. Total Dose	3
VI. Radiation Monitors Inoperable Greater Than 30 Days	4
VII. Noteworthy Conditions Identified in 2018	4
VIII. Conclusion	5
IX. Errata	6

## LIST OF APPENDICES

Appendix	Title
A1.1	2018 Effluent and Waste Disposal Annual Report – <u>Supplemental Information</u>
A1.2	Summary of Maximum Individual Doses: First Quarter, Second Quarter, Third Quarter, and Fourth Quarter 2018
A1.3	2018 Groundwater Protection Initiative (GPI) Sample Data
A2.1	Hours at Each Wind Speed and Direction: First Quarter, 2018
A2.2	Hours at Each Wind Speed and Direction: Second Quarter, 2018
A2.3	Hours at Each Wind Speed and Direction: Third Quarter, 2018
A2.4	Hours at Each Wind Speed and Direction: Fourth Quarter, 2018
A3.0	Offsite Dose Calculation Manual (ODCM) Changes

## I. INTRODUCTION

This report discusses the radioactive discharges from Unit 1 and Unit 2 of the Donald C. Cook Nuclear Plant (CNP) during 2018. This is in accordance with the requirements of CNP Technical Specification (TS) 5.6.3.

The table below summarizes the pertinent statistics concerning the Plant's operation during the period from January 1, 2018, to December 31, 2018. The data in this table and the descriptive information on plant operation are based upon the respective unit's Monthly Operating Reports, Performance Indicators, and Control Room Logs for 2018.

Parameter	Unit 1	Unit 2
Gross Electrical Energy Generation (Megawatt Hour (MWH))	9,601,477	8,554,617
Unit Service Factor (Percent (%))	100.0	80.6
Unit Capacity Factor (Maximum Dependable Capacity (MDC)) Net (%)	103.07	81.23

Unit 1 entered the reporting period in Mode 1 at Nominal Full Power (NFP). Small power adjustments were made to facilitate main turbine valve testing throughout the year. The unit performed a downpower to 57% to support repairs of the West Main Feed Pump on July 14, 2018 and returned to NFP following repairs on July 15, 2018. The unit exited the reporting period at NFP.

Unit 2 entered the reporting period in Mode 1 at Nominal Full Power (NFP). Small power adjustments were made to facilitate main turbine valve testing throughout the year. The unit performed a normal downpower and was manually tripped on March 1, 2018, entering refueling outage U2C24. The unit attained criticality on May 5, 2018, and performed a manual reactor trip from 30% during the subsequent startup due to a Moisture Separator Drain Tank Hi Level Alarm. The unit attained criticality on May 10, 2018 and attained NFP on May 18, 2018. The unit exited the reporting period at NFP.

## II. RADIOACTIVE RELEASES AND RADIOLOGICAL IMPACT ON MAN

Since a number of release points are common to both units, the release data from both units are combined to form this two-unit, Annual Radioactive Effluent Release Report (ARERR). Appendix A1.1 through A2.4 of this report present the information in accordance with Section 5.6.3 of Appendix A to the Facility Operating Licenses, as specified in the Technical Specifications, Regulatory Guide 1.21, and 10 CFR Part 50, Appendix I.

The "MIDAS System" is a computer code that calculates doses due to radionuclides that were released from the CNP.

All liquid and gaseous releases were well within Offsite Dose Calculation Manual (ODCM) limits and federal limits.

There were no abnormal liquid or gaseous releases in 2018. There were no spills or leaks of radioactive liquids requiring voluntary notifications per the Industry Groundwater Protection Initiative or site procedures.

The Independent Spent Fuel Storage Installation (ISFSI) impacts are included with Unit 1 and Unit 2 statistics. The ISFSI cask system does not create any radioactive materials or have any radioactive waste treatment systems. Therefore, specific operating procedures for the control of radioactive effluents are not required. Technical Specifications for the HI-Storm 100 Cask System, Specification 3.1.1, Multi-Purpose Canister (MPC), provides assurance that there are not radioactive effluents from the ISFSI.

### **Liquid Releases**

During 2018 there were 104 liquid batch releases performed. The number of liquid batch releases for the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup> quarters in 2018 were 32, 51, 10, and 11, respectively.

Estimated doses (in mrem) to maximally exposed individuals via the liquid release pathways are given in Appendix A1.2 of this report.

### **Gaseous Releases**

During the first quarter of 2018 there was one batch release from Gas Decay Tanks (GDT), one containment purge, one system tank vent, and 65 Containment Pressure Reliefs (CPR). During the second quarter there were two batch releases from GDTs and 72 CPR. During the third quarter there were five batch releases from GDTs, one system tank vent, and 78 CPR. During the fourth quarter there were four batch releases from GDTs and 80 CPR. The CPR continue to be listed as batch releases as described in Nuclear Regulatory Commission Inspections 50-315/89017 (DRSS); 50-316/89016 (DRSS) for CNP, dated June 13, 1989. Doses continue to be calculated utilizing continuous criteria as allowed by NUREG-0133. There were a total of 12 GDT releases, one containment purge, two system tank vents, and 295 CPR gaseous batch releases made during 2018.

In calculating the dose consequences for continuous and batch gaseous releases during 2018, the meteorological data measured at the time of the release were used.

The estimated doses (in mrem) to maximally exposed individuals via the gaseous release pathways are given in Appendix A1.2 of this report. For individuals that are within the site boundary, the occupancy time is sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the site boundary.

### **Solid Waste Disposition**

There were 26 shipments of radioactive waste made during 2018. These included shipments made from the site to various radioactive waste processors for ultimate disposal.

### III. METEOROLOGICAL

Appendices A2.1, A2.2, A2.3, and A2.4 of this report contain the cumulative joint frequency distribution tables of wind speed and wind direction, corresponding to the various atmospheric stability classes for the first, second, third, and fourth quarters of 2018. Hourly meteorological data is available for review and/or inspection upon request.

### IV. OFFSITE DOSE CALCULATION MANUAL (ODCM) CHANGES

The ODCM, PMP-6010-OSD-001, was not revised during the report period.

### V. TOTAL DOSE

Section 3.2.5 of the ODCM requires that the dose or dose commitment to a real individual from all uranium fuel cycle sources in Berrien County be limited to no more than 25 mrem to the total body or any organ (except the thyroid, which is limited to no more than 75 mrem) over a period of 12 consecutive months to show conformance with the requirements of 40 CFR Part 190. The maximum cumulative dose to an individual from liquid and gaseous effluents during 2018 was well within the ODCM limits. Measurements using thermoluminescent dosimeters (TLD) at 12 onsite stations indicate that the dose due to direct radiation is consistent with preoperational and current control (background) levels. This is fully evaluated in CNP's 2018 Annual Radiological Environmental Operating Report. Additional TLD dosimetry installed by Radiation Protection department programs monitor dose received by individuals on site as visitors.

The annual dose to the maximum individual will be estimated by first, summing the quarterly total body air dose, the quarterly skin air dose, the quarterly critical organ dose from iodines and particulates (I&P), the quarterly total body dose from liquid effluents, the quarterly critical organ dose from liquid effluents, and the Radiological Environmental Monitoring Program onsite direct radiation TLD data. These quarterly values are summed with the annual Carbon-14 dose and compared to the annual total body limit for conservative reasons. The table that follows here represents the above written description:

Dose (mrem)	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
I & P	2.64E-02	2.17E-02	2.78E-02	1.98E-02
Total Body Air	3.30E-04	3.10E-04	1.10E-03	4.00E-04
Skin	5.30E-04	7.50E-04	1.90E-03	6.90E-04
Liquid TB	2.64E-02	1.01E-02	1.81E-03	1.10E-02
Liquid Organ	2.67E-02	1.10E-02	1.82E-03	1.10E-02
Direct Radiation	0	0	0	0
Quarterly Dose Total	8.04E-02	4.39E-02	3.44E-02	4.29E-02
Sum of Quarter Doses				2.02E-01
C14 (Annual) Dose				2.25E+00
Grand Total Dose (Total Body or any other Organ) mrem				2.45E+00
Annual Dose Limit (mrem)				25
Percent of limit				9.81E+00

The following data reflects a comparison with 2009 annual dose data (the last year without calculating C-14 dose), 2018 annual dose data, and 2018 annual dose data with C-14 added. This indicates that 2018 annual dose was 'typical' for a single unit outage year in regards to radioactive effluents. The table is presented as follows:

	Annual Dose (mrem)	% of limit
2009	2.60E-01	1.04
2018	2.02E-01	0.81
2018 with C-14	2.45	9.81

**VI. RADIATION MONITORS INOPERABLE GREATER THAN 30 DAYS**

Steam Generator Blowdown Monitor R-19 was removed from service as part of the planned Radiation Monitor System (RMS) Replacement Project on October 15, 2018 and exited the year out of service. The appropriate compensatory sampling actions were taken throughout as releases on this pathway continued. The monitor is being upgraded and modernized, and this inoperable time period > 30days was planned for/ expected due to having to install all the hardware, wiring backbone, network, and displays. The monitor is expected to return to service following the Unit 1 U1C29 Outage in the spring 2019. The RMS replacement project will eventually upgrade and replace multiple effluent monitors, so additional reporting is anticipated in future annual reports. There were no other release pathways with inoperable monitors for greater than 30 days.

**VII. NOTEWORTHY CONDITIONS IDENTIFIED IN 2018**

The RMS Replacement Project initiated physical plant alterations in preparation of upgrading and modernizing the plant's ability to monitor radioactive effluents. The first effluent monitor to be physically removed and replaced was R-19, the steam generator blowdown effluent monitor. This major project will enhance reliability and capabilities while maintaining all regulatory requirements per our License and Technical Specifications. The Offsite Dose Calculation Manual revisions will be expected to occur in 2019 reflecting the transition and later again once the project is fully implemented. No changes were required in 2018 for the work that was performed.

**Carbon-14 Supplemental Information for the 2018 Annual Radioactive Effluent Release Report.**

C-14 has a 5730 year half-life and is a naturally occurring radionuclide produced by cosmic ray interactions in the atmosphere. C-14 is a relatively low energy beta emitter. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. C-14 is also produced in commercial nuclear reactors, but the amounts produced are much less than those produced naturally, from weapons testing, or coal burning power plants. The inventory of C-14 in Earth's biosphere is about 300 million Curies, of which most is in the oceans.

Since the U.S. Nuclear Regulatory Commission (NRC) published Regulatory Guide (RG) 1.21, Revision 1, in 1974, the analytical methods for determining C-14 have improved. Coincidentally, the radioactive effluents from commercial nuclear power plants over the same period have decreased to the point that C-14 is likely to be a principal radionuclide in gaseous effluents. Based on these reasons and a desire to adjust policy to align with international standards, the nuclear industry was required to report, starting in 2010, the quantity and dose impact of C-14 here in the United States. The dose will be reported both with and without C-14 so a comparison to 2009 can be made, keeping in mind the differing standards.

The quantity of C-14 released to the environment can be estimated by use of a C-14 source term scaling factor based on power generation (Ref. RG 1.21, Revision 2). A recent study recommends a source term scaling factor of approximately 9.0 to 9.8 Curies/GWe-yr for a Westinghouse Pressurized Water Reactor (Ref. EPRI 1021106, "Estimation of Carbon-14 in Nuclear Plant Gaseous Effluents", dated December 23, 2010). A scaling factor of 9.4 Curies/GWe-yr was assumed for this report. Using this source term scaling factor and actual electrical generation (in MWH) produced during 2018 results in a site total of 19.5 Curies produced.

C-14 releases from Pressurized Water Reactors (PWR) occur primarily as a mix of organic carbon (methane) and inorganic carbon (carbon dioxide). As a general rule, C-14 in the primary coolant is essentially all organic with a large fraction as gas. Any time the primary coolant is exposed to an oxidizing environment (during shutdown or refueling), a slow transformation from an organic to an inorganic species occurs. Various studies documenting measured C-14 releases from PWRs suggest an average 80% organic fraction with the remainder being carbon dioxide, of which 70% is assumed to be released from gaseous batch releases. This equates to 2.73 Curies released as carbon dioxide which is available for the food pathway through photosynthesis to vegetation.

Dose is calculated utilizing the methodology prescribed in RG 1.109, Appendix C, with the vegetation dose being the predominant. A 'p' factor of 0.33 is determined utilizing the time of batch gaseous releases performed during 2018 and the time available for photosynthesis in plants. A further reduction to the vegetation and leafy vegetable dose is warranted due to the limited growing season in Michigan, which was conservatively limited to nine months.

The final results indicated a calculated organ dose from C-14 to a child at the site boundary of 1.88 mrem to the bone and a whole body dose of 0.374 mrem, for a combined total C-14 dose of 2.25 mrem. This is less than the dose limit of 15 mrem/unit to any organ prescribed in 10 CFR 50, Appendix I, and the 40 CFR Part 190 limit of 25 mrem for total body and for any organ ( $\leq 75$  mrem for thyroid).

## VIII. CONCLUSION

Based on the information presented in this report, it is concluded that CNP Units 1 and 2 performed their intended design function with no demonstrable adverse effect on the health and safety of the general public.



IX. **ERRATA**

There are no errata documents attached for 2018.

2018 Effluent and Waste Disposal Annual Report

SUPPLEMENTAL INFORMATION

Facility: Donald C. Cook Nuclear Plant  
Licensee: Indiana Michigan Power Company

**1 REGULATORY LIMITS**

1.1 Noble Gases

The air dose in unrestricted areas due to noble gases released in gaseous effluents shall be limited to the following:

1.1.1 During any calendar quarter, to  $\leq 5$  mrad/unit for gamma radiation and  $\leq 10$  mrad/unit for beta radiation.

1.1.2 During any calendar year, to  $\leq 10$  mrad/unit for gamma radiation and  $\leq 20$  mrad/unit for beta radiation.

1.2 Iodines - Particulates

The dose to a member of the public from radioiodines, radioactive materials in particulate form, and radionuclides other than noble gases with half-lives greater than eight days in gaseous effluents released to unrestricted areas shall be limited to the following:

1.2.1 During any calendar quarter to  $\leq 7.5$  mrem/unit to any organ.

1.2.2 During any calendar year to  $\leq 15$  mrem/unit to any organ.

1.3 Liquid Effluents

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

1.3.1 During any calendar quarter to  $\leq 1.5$  mrem/unit to the total body and to  $\leq 5$  mrem/unit to any organ.

1.3.2 During any calendar year to  $\leq 3$  mrem/unit to the total body and to  $\leq 10$  mrem/unit to any organ.

## 2018 Effluent and Waste Disposal Annual Report

### 1.4 Total Dose

The dose or dose commitment to a real individual from all uranium fuel cycle sources is limited to  $\leq 25$  mrem to the total body or any organ (except the thyroid, which is limited to  $\leq 75$  mrem) over a period of 12 consecutive months.

## 2 MAXIMUM PERMISSIBLE CONCENTRATIONS

### 2.1 Gaseous Effluents

The dose rate due to radioactive materials released in gaseous effluents from the site shall be limited to the following:

2.1.1 For noble gases:  $\leq 500$  mrem/yr to the total body and  $\leq 3000$  mrem/yr to the skin.

2.1.2 For all radioiodines and for all radioactive materials in particulate form and radionuclides (other than noble gases) with half-lives greater than eight days:  $\leq 1500$  mrem/yr to any organ.

The above limits are provided to insure that radioactive material discharged in gaseous effluents will not result in the exposure of an individual in an unrestricted area to annual average concentrations exceeding the limits in 10 CFR Part 20, Appendix B, Table 2, Column 1.

### 2.2 Liquid Effluents

The concentration of radioactive material released at any time from the site to unrestricted areas shall be limited to the concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 2, for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to  $2 \times 10^{-4}$   $\mu\text{Ci/ml}$  total activity.

**3 AVERAGE ENERGY**

The average energy ( $\bar{E}$ ) of the radionuclide mixture in releases of fission and activation gases as defined in Regulatory Guide 1.21, Appendix B, Section A.3 is not applicable because the limits used for gaseous releases are based on calculated dose to members of the public. Release rates are calculated using an isotopic mix from actual samples rather than average energy.

**4 MEASUREMENTS and APPROXIMATIONS of TOTAL RADIOACTIVITY**

**4.1 Fission and Activation Gases**

Sampled and analyzed on an 8192 channel analyzer and HpGe detector. Tritium analysis is performed using liquid scintillation counters.

**4.2 Iodines**

Sampled on iodine adsorbing media, and analyzed on an 8192 channel analyzer and HpGe detector.

**4.3 Particulates**

Sampled on a glass filter and analyzed on an 8192 channel analyzer and HpGe detector. Sr-89 and Sr-90 analyses are performed by offsite vendor.

**4.4 Liquid Effluents**

Sampled and analyzed on an 8192 channel analyzer and HpGe detector. Tritium analysis is performed using liquid scintillation counters. Fe-55, Sr-89 and Sr-90 analyses are performed by an offsite vendor. Ni-63 is also currently being analyzed by the offsite vendor in response to evaluation of the 10 CFR 61 sample results.

2018 Effluent and Waste Disposal Annual Report

**5 BATCH RELEASES**

5.1 Liquid

5.1.1 Number of batch releases:

32 releases in the 1<sup>st</sup> quarter, 2018

51 releases in the 2<sup>nd</sup> quarter, 2018

10 releases in the 3<sup>rd</sup> quarter, 2018

11 releases in the 4<sup>th</sup> quarter, 2018

5.1.2 Total time period for batch releases:

47,675 minutes

5.1.3 Maximum time for a batch release:

1,659 minutes

5.1.4 Average time period for batch release:

458 minutes

5.1.5 Minimum time period for a batch release:

139 minutes

5.1.6 Average stream flow during periods of release of effluent into a flowing stream:

6.26E+5 gpm circulating water

2018 Effluent and Waste Disposal Annual Report

5.2 Gaseous

5.2.1 Number of batch releases:

68 releases in the 1<sup>st</sup> quarter, 2018  
74 releases in the 2<sup>nd</sup> quarter, 2018  
84 releases in the 3<sup>rd</sup> quarter, 2018  
84 releases in the 4<sup>th</sup> quarter, 2018

5.2.2 Total time period for batch releases:

13,169 minutes

5.2.3 Maximum time for a batch release:

354 minutes

5.2.4 Average time period for batch release:

42.5 minutes

5.2.5 Minimum time period for a batch release:

5 minutes

2018 Effluent and Waste Disposal Annual Report

6 ABNORMAL RELEASES

6.1 Liquid

6.1.1 Number of Releases:

<u>1<sup>st</sup> Quarter</u>	<u>2<sup>nd</sup> Quarter</u>	<u>3<sup>rd</sup> Quarter</u>	<u>4<sup>th</sup> Quarter</u>
0	0	0	0

6.1.2 Total activity released (Ci):

<u>1<sup>st</sup> Quarter</u>	<u>2<sup>nd</sup> Quarter</u>	<u>3<sup>rd</sup> Quarter</u>	<u>4<sup>th</sup> Quarter</u>
0	0	0	0

6.2 Gaseous

6.2.1 Number of Releases:

<u>1<sup>st</sup> Quarter</u>	<u>2<sup>nd</sup> Quarter</u>	<u>3<sup>rd</sup> Quarter</u>	<u>4<sup>th</sup> Quarter</u>
0	0	0	0

6.2.2 Total activity released (Ci):

<u>1<sup>st</sup> Quarter</u>	<u>2<sup>nd</sup> Quarter</u>	<u>3<sup>rd</sup> Quarter</u>	<u>4<sup>th</sup> Quarter</u>
0	0	0	0

2018 EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT  
GASEOUS EFFLUENTS-GROUND LEVEL RELEASES

CONTINUOUS MODE

Nuclides Released	Unit	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1. FISSION GASES					
H3	Ci	3.34E+01	1.91E+01	1.50E+01	2.19E+01
AR41	Ci	-----	-----	-----	-----
KR85	Ci	-----	-----	-----	-----
XE133	Ci	-----	-----	-----	-----
XE135	Ci	-----	-----	-----	-----
XE131m	Ci	-----	-----	-----	-----
XE133m	Ci	-----	-----	-----	-----
XE135m	Ci	-----	-----	-----	-----
Total for Period	Ci	3.34E+01	1.91E+01	1.50E+01	2.19E+01

2. IODINES					
I131	Ci	1.55E-05	3.18E-07	7.64E-07	1.53E-10
I132	Ci	-----	-----	-----	-----
I133	Ci	7.93E-05	1.46E-05	2.77E-05	1.23E-09
Total for Period	Ci	4.23E-05	9.66E-05	1.71E-04	1.29E-04

3. PARTICULATES					
MN54	Ci	-----	-----	-----	-----
CO60	Ci	-----	-----	-----	-----
CS137	Ci	-----	-----	-----	-----
Total for Period	Ci	-----	-----	-----	-----

\* DENOTES SUPPLEMENTAL ISOTOPES



2018 EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT  
GASEOUS EFFLUENTS-GROUND LEVEL RELEASES

BATCH MODE

Nuclides Released	Unit	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1. FISSION GASES					
H3	Ci	1.39E-01	4.77E-02	5.84E-02	7.49E-02
AR41	Ci	2.84E-01	2.27E-01	2.93E-01	2.82E-01
KR85	Ci	5.11E-02	1.23E-01	2.37E-01	1.18E-01
XE131M	Ci	-----	-----	-----	-----
XE133M	Ci	7.92E-04	-----	-----	-----
XE133	Ci	1.21E-01	7.93E-02	7.86E-02	5.82E-02
XE135m	Ci	-----	-----	-----	-----
XE135	Ci	1.71E-03	-----	1.05E-04	-----
Total for Period	Ci	5.98E-01	4.77E-01	6.67E-01	5.33E-01
2. IODINES					
I131	Ci	-----	-----	-----	-----
I133	Ci	-----	-----	-----	-----
Total for Period	Ci	-----	-----	-----	-----
3. PARTICULATES					
CS137	Ci	-----	2.85E-07	-----	-----
CO60	Ci	-----	-----	-----	-----
Total for Period	Ci	-----	2.85E-07	-----	-----

\* DENOTES SUPPLEMENTAL ISOTOPES

2018 EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT  
GASEOUS EFFLUENTS-SUMMATION OF ALL RELEASES

	Units	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Est. Total Error, %
A. FISSION AND ACTIVATION GASES						
1. Total Release	Ci	4.60E-01	4.29E-01	6.09E-01	4.58E-01	11.6
2. Average release rate for period	uCi/sec	5.91E-02	5.46E-02	7.66E-02	5.76E-02	
3. Percent of applicable limit*	% Gamma Beta	1.18E-02 2.36E-03	1.56E-02 1.93E-02	3.90E-02 8.69E-03	1.38E-02 3.04E-03	
B. IODINES						
1. Total I-131	Ci	1.55E-05	3.18E-07	7.64E-07	1.53E-10	21.9
2. Average release rate for period	uCi/sec	2.00E-06	4.05E-08	9.61E-08	1.92E-11	
3. Percent of applicable limit*	%	5.69E-06	1.15E-07	2.74E-07	5.48E-11	
C. PARTICULATES						
1. Particulates with half lives > 8 days	Ci	0.00E+00	2.85E-07	0.00E+00	0.00E+00	19.6
2. Average release rate for period	uCi/sec	0.00E+00	3.62E-08	0.00E+00	0.00E+00	
3. Percent of applicable limit*	%	0.00E+00	1.03E-07	0.00E+00	0.00E+00	
4. Gross alpha radioactivity	Ci	<8.64E-07	<7.20E-07	<8.57E-07	<3.36E-06	
D. TRITIUM						
1. Total Release	Ci	3.36E+01	1.90E+01	1.51E+01	2.20E+01	16.6
2. Average release rate for period	uCi/sec	4.32E+00	2.42E+00	1.90E+00	2.77E+00	
3. Percent of applicable limit*	%	2.46E-02	1.38E-02	1.08E-02	1.58E-02	

\* Applicable limits are expressed in terms of dose. See Appendices A1.2-1 through A1.2-4

2018 EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT  
LIQUID EFFLUENTS  
CONTINUOUS MODE

Nuclides Released	Unit	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
H3	Ci	-----	-----	-----	-----
CS137	Ci	-----	-----	-----	-----

BATCH MODE

Nuclides Released	Unit	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
H3	Ci	7.59E+02	3.11E+02	6.97E+01	3.46E+02
CR51	Ci	-----	-----	-----	-----
MN54	Ci	7.63E-07	-----	-----	-----
FE55	Ci	-----	-----	-----	-----
CO58	Ci	9.98E-05	1.00E-04	1.87E-05	2.45E-05
CO60	Ci	1.96E-05	1.94E-05	1.74E-05	3.99E-05
NI63	Ci	-----	-----	-----	-----
*KR85	Ci	-----	-----	-----	-----
ZR95	Ci	-----	-----	-----	-----
NB95	Ci	-----	-----	-----	-----
MO99	Ci	-----	1.66E-06	-----	-----
TC99m	Ci	1.89E-06	2.55E-06	-----	-----
AG110m	Ci	-----	-----	-----	-----
SB124	Ci	5.23E-06	-----	-----	-----
SB125	Ci	1.42E-05	2.55E-06	-----	-----
CS134	Ci	1.67E-05	4.81E-05	-----	-----
CS137	Ci	6.03E-05	2.44E-04	5.46E-06	2.76E-06
I131	Ci	-----	-----	-----	-----
*XE133	Ci	1.55E-03	7.58E-06	-----	1.52E-06
*XE133m	Ci	2.79E-05	-----	-----	-----
*XE135	Ci	5.19E-05	-----	-----	-----

\* DENOTES SUPPLEMENTAL ISOTOPES

2018 EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT  
LIQUID EFFLUENTS-SUMMATION OF ALL RELEASES  
BATCH MODE

		Units	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Est. Total Error, %
A.	FISSION AND ACTIVATION PRODUCTS						
1.	Total Release	Ci	2.18E-04	4.26E-04	4.15E-05	6.71E-05	12.8
2.	Average diluted concentration during period	uCi/ml	5.36E-12	1.13E-11	4.39E-12	2.65E-12	
3.	Percent of applicable limit	%	2.25E-04	8.22E-04	1.30E-04	6.81E-05	
B.	TRITIUM						
1.	Total Release	Ci	7.59E+02	3.11E+02	6.97E+01	3.46E+02	10.1
2.	Average diluted concentration during period	uCi/ml	1.87E-05	8.26E-06	7.37E-06	1.37E-05	
3.	Percent of applicable limit	%	1.87E+00	8.26E-01	7.37E-01	1.37E+00	
C.	DISSOLVED AND ENTRAINED GASES						
1.	Total Release	Ci	1.60E-03	7.58E-06	0.00E+00	1.52E-06	12.2
2.	Average diluted concentration during period	uCi/ml	3.94E-11	2.01E-13	0.00E+00	6.01E-14	
3.	Percent of applicable limit	%	1.89E-05	1.01E-07	0.00E+00	3.01E-08	
D.	GROSS ALPHA RADIOACTIVITY TOTAL RELEASE	Ci	<1.73E-04	<2.75E-04	<2.99E-04	<5.90E-05	N/A
E.	VOLUME OF WASTE RELEASED	Liters	1.86E+06	2.96E+06	3.22E+06	6.36E+05	2.00
F.	VOLUME OF DILUTION WATER USED DURING PERIOD	Liters	4.07E+10	3.77E+10	9.46E+09	2.53E+10	3.48

2018 EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT  
LIQUID EFFLUENTS-SUMMATION OF ALL RELEASES  
CONTINUOUS MODE

		Units	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Est. Total Error, %
A. FISSION AND ACTIVATION PRODUCTS							
1.	Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
2.	Average diluted concentration during period	uCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
3.	Percent of applicable limit	%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
B. TRITIUM							
1.	Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
2.	Average diluted concentration during period	uCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
3.	Percent of applicable limit	%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
C. DISSOLVED AND ENTRAINED GASES							
1.	Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
2.	Average diluted concentration during period	uCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
3.	Percent of applicable limit	%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
D. GROSS ALPHA RADIOACTIVITY TOTAL RELEASE							
		Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
E. VOLUME OF WASTE RELEASED							
		Liters	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00
F. VOLUME OF DILUTION WATER USED DURING PERIOD							
		Liters	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.48

## 2018 Effluent and Waste Disposal Annual Report Solid Waste and Irradiated Fuel Shipments

### Solid Waste Shipped Offsite for Burial or Disposal

1) Type of Waste	Unit	Estimated amount	Estimated Total Error, %
a) Spent resins, filters, sludge, evaporator bottoms, etc.	m <sup>3</sup> Curies	2.85E+01 2.18E+02	1.00E+00 3.75E+00
b) Dry compressible waste, contaminated equipment, etc.	m <sup>3</sup> Curies	6.11E+02 4.82E+00	1.00E+00 6.48E+00
c) Irradiated components, control rods, etc.	m <sup>3</sup> Curies		
d) Other (contaminated soil)	m <sup>3</sup> Curies		

### 2) Estimate of Principle Radionuclide Composition

a)	H-3	12.5 %	Co-58	2 %	Sb-125	1 %	Cs-137	8 %
	Mn-54	2 %	Co-60	10 %	Cs-134	4 %		
	Fe-55	8.5 %	Ni-63	51.5%	C-14	0.5 %		
b)	Ni-59	1 %	Co-58	1.5%	Sb-125	1 %		
	Mn-54	1.5 %	Co-60	39 %	Zr/Nb-95	7.5 %		
	Fe-55	34 %	Ni-63	13 %	Cs-137	1 %	C-14	0.5 %

### 3) Solid Waste Disposition

No. of Shipments	Mode of Transportation	Destination
26	Truck	Oak Ridge, TN

4) Type of Containers used for Shipment: Containers used are excepted packages, Type A, Sea Land, metal boxes, drums, tankers, and high integrity containers (HICs).

5) Solidification Agent: There were no solidifications performed during this report period.

## 2018 Effluent and Waste Disposal Annual Report Yearly Release Rates

<b>GASES</b>		
Fission and Activation Gases	Total Release	1.96E+00 Curies
	Average Release Rate	6.20E-02 $\mu$ Ci/sec
	% of Applicable Limits*	$\gamma$ 2.01E-02 % $\beta$ 8.35E-03 %
Iodines	Total I-131 Release	1.66E-05 Curies
	Average Release Rate	5.26E-07 $\mu$ Ci/sec
	% of Applicable Limit*	3.19E-01 %
Particulates	Total Release	2.85E-07 Curies
	Average Release Rate	3.62E-08 $\mu$ Ci/sec
	% of Applicable Limit*	1.03E-07 %
<b>LIQUIDS</b>		
Fission and Activation Products	Total Release	7.53E-04 Curies
	Average Diluted Concentration	6.66E-12 $\mu$ Ci/ml
	% of Applicable Limits*	Total Body 8.22E-01 % Organ 2.53E-01 %

\* Applicable limits are expressed in terms of the annual 10 CFR 50, Appendix I, dose limits.

### Site Boundary and Nearest Residence Listing

The following distances were used in the calculation of the maximum individual doses:

<u>Sector</u>	<u>Direction</u>	<u>Boundary (Meters)</u>	<u>Nearest Residence (Meters)</u>
A	N	651	659
B	NNE	617	660
C	NE	789	943
D	ENE	1497	1747
E	E	1274	1716
F	ESE	972	1643
G	SE	629	1640
H	SSE	594	964
J	S	594	997
K	SSW	629	942



## Summary of Maximum Individual Doses

First Quarter 2018

EFFLUENT	APPLICABLE ORGAN	ESTIMATED DOSE (mrem)	AGE GROUP	LOCATION DIST DIR (M) (Toward)	% OF APPLICABLE LIMIT	LIMIT (mrem) QTR
Liquid	Total Body	2.64E-02	Child	Receptor 1	1.76E+00	1.5E+0
Liquid	Liver	2.67E-02	Child	Receptor 1	5.33E-01	5.0E+0
Noble Gas	Air Dose (Gamma-mrad)	5.92E-04	Any Age	594 (SSE)	1.18E-02	5.0E+0
Noble Gas	Air dose (Beta-mrad)	2.36E-04	Any Age	594 (SSE)	2.36E-03	1.0E+1
Iodines and Particulates	Thyroid	2.64E-02	Child	659 (N)	3.52E-01	7.5E+0

## Summary of Maximum Individual Doses

Second Quarter 2018

EFFLUENT	APPLICABLE ORGAN	ESTIMATED DOSE (mrem)	AGE GROUP	LOCATION DIST DIR (M) (Toward)	% OF APPLICABLE LIMIT	LIMIT (mrem) QTR
Liquid	Total Body	1.01E-02	Child	Receptor 1	6.70E-01	1.5E+0
Liquid	Liver	1.10E-02	Child	Receptor 1	2.20E-01	5.0E+0
Noble Gas	Air Dose (Gamma-mrad)	7.81E-04	Any Age	594 (S)	1.56E-02	5.0E+0
Noble Gas	Air dose (Beta-mrad)	1.93E-03	Any Age	594 (SSE)	1.93E-02	1.0E+1
Iodines and Particulates	Total Body	2.17E-02	Child	660 (N)	2.89E-01	7.5E+0

## Summary of Maximum Individual Doses

Third Quarter 2018

EFFLUENT	APPLICABLE ORGAN	ESTIMATED DOSE (mrem)	AGE GROUP	LOCATION DIST DIR (M) (Toward)	% OF APPLICABLE LIMIT	LIMIT (mrem) QTR
Liquid	Total Body	1.81E-03	Child	Receptor 1	1.21E-01	1.5E+0
Liquid	Liver	1.82E-03	Child	Receptor 1	3.65E-02	5.0E+0
Noble Gas	Air Dose (Gamma-mrad)	1.95E-03	Any Age	651 (N)	3.90E-02	5.0E+0
Noble Gas	Air dose (Beta-mrad)	8.69E-04	Any Age	651 (N)	8.69E-03	1.0E+1
Iodines and Particulates	Total Body	2.78E-02	Child	659 (N)	3.70E-01	7.5E+0

## Summary of Maximum Individual Doses

Fourth Quarter 2018

EFFLUENT	APPLICABLE ORGAN	ESTIMATED DOSE (mrem)	AGE GROUP	LOCATION DIST DIR (M) (Toward)	% OF APPLICABLE LIMIT	LIMIT (mrem) QTR
Liquid	Total Body	1.10E-02	Child	Receptor 1	7.34E-01	1.5E+0
Liquid	Liver	1.10E-02	Child	Receptor 1	2.20E-01	5.0E+0
Noble Gas	Air Dose (Gamma-mrad)	6.90E-04	Any Age	594 (S)	1.38E-02	5.0E+0
Noble Gas	Air dose (Beta-mrad)	3.04E-04	Any Age	651 (N)	3.04E-03	1.0E+1
Iodines and Particulates	Total Body	1.98E-02	Child	8045 (WSW)	2.64E-01	7.5E+0

2018 GPI Sample Data

Samples analyzed for tritium. Values noted are in microcuries per milliliter (uCi/mL)  
Lower Limit of Detection = LLD

Date	MW-22D	MW-22M	MW-22S	MW-24D	MW-24M	MW-24S	MW-25D	MW-25M
02/01/2018							<LLD	<LLD
02/28/2018	<LLD	<LLD	<LLD*	<LLD	<LLD	<LLD		
04/26/2018							<LLD	<LLD*
05/01/2018	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD		
07/18/2018	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
11/16/2018	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD

(Note: Wells MW-22 through MW- 27 are multi-port wells installed in the Fall of 2009, with three sample points placed at different depths. S= Shallow M= Middle D= Deep.)

(Note: A "\*" symbol following a sample result denotes a gamma count was performed. Any gamma results above LLD will be additionally flagged and documented in the analysis section.)

2018 GPI Sample Data

Samples analyzed for tritium. Values noted are in microcuries per milliliter (uCi/mL)  
Lower Limit of Detection = LLD

Date	MW-25S	MW-26D	MW-26M	MW-26S	MW-27D	MW-27M	MW-27S
02/01/2018	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/26/2018	<LLD*	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
07/18/2018	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
11/16/2018	<LLD	<LLD	<LLD	<LLD	<LLD*	<LLD	<LLD

(Note: Wells MW-22 through MW- 27 are multi-port wells installed in the Fall of 2009, with three sample points placed at different depths. S= Shallow M= Middle D= Deep.)

(Note: A "\*" symbol following a sample result denotes a gamma count was performed. Any gamma results above LLD will be additionally flagged and documented in the analysis section.)

2018 GPI Sample Data

Samples analyzed for tritium. Values noted are in microcuries per milliliter (uCi/mL)

Lower Limit of Detection = LLD

Date	W-1	W-2	W-3	W-4	W-5	W-6	W-7	W-8
01/08/2018	<LLD							<LLD
01/09/2018		<LLD						
01/10/2018			<LLD					
01/12/2018							<LLD	
01/26/2018				<LLD	<LLD	<LLD		
02/28/2018				<LLD				
03/20/2018				<LLD				
04/06/2018	<LLD	<LLD	<LLD					
04/11/2018							<LLD	
04/13/2018								<LLD
04/19/2018				<LLD	<LLD	<LLD		
05/02/2018				<LLD				
07/10/2018	<LLD	<LLD	<LLD					
07/13/2018							<LLD	<LLD
07/18/2018				<LLD	<LLD	<LLD		
10/02/2018		<LLD						<LLD
10/04/2018							<LLD	
10/08/2018			<LLD					
10/09/2018	<LLD							
10/23/2018				<LLD	<LLD	<LLD		
11/28/2018				<LLD				

(Note: A "\*" symbol following a sample result denotes a gamma count was performed. Any gamma results above LLD will be additionally flagged and documented in the analysis section.)

2018 GPI Sample Data

Samples analyzed for tritium. Values noted are in microcuries per milliliter (uCi/mL)  
Lower Limit of Detection = LLD

Date	SG-1	SG-2	SG-4	SG-5	EW-19	MW-20	MW-21	EW-18
01/09/2018			<LLD					
01/10/2018		<LLD		<LLD				
01/12/2018	<LLD							
01/16/2018						<LLD	<LLD	
02/01/2018					<LLD			
03/24/2018								<LLD
04/11/2018		<LLD						
04/12/2018					<LLD			
04/13/2018						<LLD	<LLD	
04/17/2018	<LLD		<LLD	<LLD				
05/01/2018								<LLD
07/12/2018	<LLD	<LLD	<LLD	<LLD				
07/13/2018						<LLD	<LLD	
10/03/2018					<LLD			
10/04/2018							<LLD	
10/08/2018						<LLD		
10/09/2018		<LLD						
10/23/2018	<LLD		<LLD	<LLD				

(Note: A "\*" symbol following a sample result denotes a gamma count was performed. Any gamma results above LLD will be additionally flagged and documented in the analysis section.)

2018 GPI Sample Data

Samples analyzed for tritium. Values noted are in microcuries per milliliter (uCi/mL)  
Lower Limit of Detection = LLD

Date	W-9	W-10	W-11	W-12	W-13	W-14	W-15	
01/08/2018	<LLD							
01/11/2018		<LLD	<LLD					
01/12/2018					<LLD	<LLD		
01/16/2018				<LLD			<LLD	
04/11/2018			<LLD					
04/13/2018	<LLD	<LLD						
04/17/2018				<LLD	<LLD	<LLD	<LLD	
07/13/2018	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
10/04/2018		<LLD	<LLD	<LLD		<LLD		
10/08/2018	<LLD						<LLD	
10/09/2018					<LLD			

(Note: A "\*" symbol following a sample result denotes a gamma count was performed. Any gamma results above LLD will be additionally flagged and documented in the analysis section.)

2018 GPI Sample Data

Samples analyzed for tritium. Values noted are in microcuries per milliliter (uCi/mL)

Lower Limit of Detection = LLD

Date	OW-1	OW-2	OW-4	MW-28	MW-29	95-11A		
01/26/2018	<LLD	<LLD						
02/01/2018				1.39e-6	<LLD			
02/08/2018	<LLD	<LLD						
02/28/2018				1.08e-6	<LLD			
03/09/2018	<LLD			1.18e-6	<LLD			
04/19/2018		<LLD						
04/30/2018				<LLD	<LLD			
05/01/2018	<LLD			1.40e-6	<LLD			
05/02/2018			<LLD					
06/12/2018	<LLD		<LLD					
06/13/2018				1.14e-6	<LLD			
08/16/2018				<LLD*	<LLD			
08/24/2018			<LLD					
09/04/2018	<LLD			1.06e-6	<LLD			
10/17/2018	<LLD		<LLD					
10/23/2018		<LLD						
10/30/2018				1.03e-6	<LLD			
11/28/2018	<LLD		<LLD	<LLD	<LLD			
12/27/2018	<LLD		<LLD	1.21e-6	<LLD	<LLD		

(Note: A "\*" symbol following a sample result denotes a gamma count was performed. Any gamma results above LLD will be additionally flagged and documented in the analysis section.)



### Analysis of the Sample Data

The Groundwater Protection Initiative (GPI) Sample Data for 2018 indicates no groundwater contamination in excess of the reporting threshold of  $2.00E-5$  uCi/mL for tritium. Gamma spectroscopy was performed on all Radiological Environmental Monitoring Program wells quarterly. Those results are not actual GPI results so are not included in the ARERR, but are part of CNP's 2018 Annual Radiological Environmental Operating Report. There were no positively identified gamma radionuclides from plant effluents detected in any of the GPI well samples, and one well with trace levels of tritium just above detection limits.

The LLD value used for tritium counting of the samples varied between  $9.42E-7$  and  $9.98E-7$  uCi/mL, depending on which scintillation counter was used. This is well below the required maximum LLD value of  $2.00E-6$  uCi/mL per the ODCM.

No tritium values were found significantly above LLD for 2018, though values found above the LLD are not abnormal, unexpected, or inconsistent with past sampling history. The samples observed above LLD historically were expected results from the release of tritiated water into the Absorption Pond, a licensed pathway and part of plant design, or the result of recapture deposition of tritium from licensed radioactive gaseous release points. The 2018 results were within expected parameters considering the reduction in tritium released to the Absorption Pond and typical rainfall recapture of tritium experienced.

Wells located inside the Protected Area of the plant are subject to recapture deposition of tritium and may show occasional sample results above LLD values following rainfalls and snow melt. The results observed in 2018 continue to reflect normal expectations and behaviors as they relate to recaptured tritium for the weather conditions observed. Well MW-28 lies close to the vent stacks in the predominant wind direction, so it is expected to observe recaptured tritium from precipitation periodically.

The sample data indicates that no radioactive spills or unidentified leaks have occurred in 2018 impacting groundwater. The sample results indicate proper well placement to ensure the protection of the groundwater and early identification of any abnormal conditions involving groundwater. This is validated by the demonstrated ability to monitor percolation from the Absorption Pond and recaptured tritium in precipitation, with flow direction and behavior acting as described in the plant licensing documents.

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

**Total Period**

Period of Record =

1/1/2018 - 3/31/2018

Elevation: Speed: SPD60M

Direction: DIR60M

Lapse: DT60M

Stability Class A

Delta Temperature Extremely Unstable

**Wind Speed (mph)**

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	0	7	18	18	6	0	49
NNE	0	2	0	1	0	0	3
NE	0	3	1	4	0	0	8
ENE	0	0	2	1	1	0	4
E	0	3	2	10	0	0	15
ESE	0	3	2	11	1	0	17
SE	0	6	0	6	0	0	12
SSE	0	0	5	2	0	0	7
S	0	1	4	2	0	0	7
SSW	0	0	2	3	0	0	5
SW	0	0	0	3	1	0	4
WSW	0	3	3	9	4	0	19
W	0	1	4	1	0	0	6
WNW	0	0	9	4	0	0	13
NW	0	1	8	4	3	0	16
NNW	0	7	24	16	3	1	51
<b>Total</b>	<b>0</b>	<b>37</b>	<b>84</b>	<b>95</b>	<b>19</b>	<b>1</b>	<b>236</b>

Calm Hours not Included above for :

Total Period

1

Valid Hours for this Stability Class for:

Total Period

236

Total Hours for Period

2160

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 1/1/2018 - 3/31/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class B Delta Temperature Moderately Unstable

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	0	2	4	5	1	0	12
NNE	0	0	1	0	0	0	1
NE	0	1	0	0	0	0	1
ENE	0	1	1	1	0	0	3
E	0	1	1	2	0	0	4
ESE	0	3	0	6	2	0	11
SE	0	2	2	4	1	0	9
SSE	0	0	5	7	0	0	12
S	0	0	1	1	0	0	2
SSW	0	0	2	0	0	0	2
SW	0	0	2	3	0	0	5
WSW	0	1	3	5	1	0	10
W	0	1	2	2	0	0	5
WNW	0	0	1	1	2	0	4
NW	0	0	1	2	3	0	6
NNW	0	0	4	1	0	0	5
<b>Total</b>	<b>0</b>	<b>12</b>	<b>30</b>	<b>40</b>	<b>10</b>	<b>0</b>	<b>92</b>

<b>Calm Hours not Included above for :</b>	<b>Total Period</b>	<b>1</b>
<b>Valid Hours for this Stability Class for:</b>	<b>Total Period</b>	<b>92</b>
<b>Total Hours for Period</b>		<b>2160</b>

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 1/1/2018 - 3/31/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class C Delta Temperature Slightly Unstable

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	0	2	6	2	2	0	12
NNE	0	0	0	0	0	0	0
NE	0	1	0	0	0	0	1
ENE	0	0	0	1	0	0	1
E	0	0	4	2	2	0	8
ESE	0	0	0	4	2	0	6
SE	0	0	2	4	0	0	6
SSE	0	2	7	2	0	0	11
S	0	0	6	3	0	0	9
SSW	0	0	1	5	0	0	6
SW	0	0	2	6	1	0	9
WSW	0	2	3	2	1	0	8
W	0	0	1	3	0	0	4
WNW	0	0	0	1	1	0	2
NW	0	0	1	7	3	0	11
NNW	0	1	3	0	1	1	6
<b>Total</b>	<b>0</b>	<b>8</b>	<b>36</b>	<b>42</b>	<b>13</b>	<b>1</b>	<b>100</b>

Calm Hours not Included above for :	Total Period	1
Valid Hours for this Stability Class for:	Total Period	100
Total Hours for Period		2160

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

**Total Period**

Period of Record = 1/1/2018 - 3/31/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class D Delta Temperature Neutral

**Wind Speed (mph)**

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	4	12	39	49	9	5	118
NNE	0	7	31	22	7	2	69
NE	1	8	21	15	2	0	47
ENE	4	13	23	18	2	0	60
E	2	15	14	10	3	0	44
ESE	4	7	9	15	10	0	45
SE	3	19	9	20	6	0	57
SSE	0	8	8	18	0	0	34
S	0	9	26	30	19	0	84
SSW	0	6	35	34	15	3	93
SW	1	3	13	26	12	1	56
WSW	0	3	16	27	14	8	68
W	2	4	17	23	0	0	46
WNW	1	5	31	48	3	0	88
NW	1	3	19	58	16	0	97
NNW	0	9	25	48	13	1	96
<b>Total</b>	<b>23</b>	<b>131</b>	<b>336</b>	<b>461</b>	<b>131</b>	<b>20</b>	<b>1102</b>
<b>Calm Hours not Included above for :</b>							<b>1</b>
<b>Valid Hours for this Stability Class for:</b>							<b>1102</b>
<b>Total Hours for Period</b>							<b>2160</b>

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

**Total Period**

Period of Record = 1/1/2018 - 3/31/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class E Delta Temperature Slightly Stable

**Wind Speed (mph)**

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	0	2	10	0	0	0	12
NNE	0	7	6	0	0	0	13
NE	2	3	6	1	0	0	12
ENE	0	11	11	1	0	0	23
E	0	3	10	9	0	0	22
ESE	1	4	8	20	0	0	33
SE	0	1	13	13	0	0	27
SSE	1	3	9	21	4	0	38
S	1	2	26	34	10	2	75
SSW	1	3	24	54	17	0	99
SW	0	2	20	23	6	0	51
WSW	1	0	14	14	0	0	29
W	0	2	3	7	0	0	12
WNW	0	0	1	8	0	0	9
NW	0	2	5	3	0	0	10
NNW	0	2	12	4	0	0	18
<b>Total</b>	<b>7</b>	<b>47</b>	<b>178</b>	<b>212</b>	<b>37</b>	<b>2</b>	<b>483</b>

Calm Hours not Included above for :	Total Period	1
Valid Hours for this Stability Class for:	Total Period	483
Total Hours for Period		2160

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 1/1/2018 - 3/31/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class F Delta Temperature Moderately Stable

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	1	0	1	0	0	0	2
NNE	0	4	2	0	0	0	6
NE	0	2	2	1	0	0	5
ENE	0	2	7	2	0	0	11
E	1	1	5	2	0	0	9
ESE	0	1	2	1	0	0	4
SE	0	0	4	0	0	0	4
SSE	0	0	1	1	0	0	2
S	0	2	4	4	0	0	10
SSW	0	0	6	7	0	0	13
SW	0	0	8	0	0	0	8
WSW	0	0	5	0	0	0	5
W	0	1	1	1	0	0	3
WNW	0	7	1	0	0	0	8
NW	0	0	0	0	0	0	0
NNW	0	1	3	0	0	0	4
<b>Total</b>	<b>2</b>	<b>21</b>	<b>52</b>	<b>19</b>	<b>0</b>	<b>0</b>	<b>94</b>

Calm Hours not Included above for :	Total Period	1
Valid Hours for this Stability Class for:	Total Period	94
Total Hours for Period		2160

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 1/1/2018 - 3/31/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class G Delta Temperature Extremely Stable

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	1	0	0	0	0	0	1
NNE	1	2	1	0	0	0	4
NE	0	2	2	2	0	0	6
ENE	0	3	5	0	0	0	8
E	0	0	3	3	0	0	6
ESE	0	0	1	0	0	0	1
SE	0	0	1	0	0	0	1
SSE	1	0	0	0	0	0	1
S	0	1	0	0	0	0	1
SSW	0	3	2	1	0	0	6
SW	0	0	0	0	0	0	0
WSW	0	1	0	0	0	0	1
W	0	3	0	0	0	0	3
WNW	0	0	2	0	0	0	2
NW	0	0	0	0	0	0	0
NNW	2	0	0	0	0	0	2
<b>Total</b>	<b>5</b>	<b>15</b>	<b>17</b>	<b>6</b>	<b>0</b>	<b>0</b>	<b>43</b>

<b>Calm Hours not Included above for :</b>	<b>Total Period</b>	<b>1</b>
<b>Valid Hours for this Stability Class for:</b>	<b>Total Period</b>	<b>43</b>
<b>Total Hours for Period</b>		<b>2160</b>



## Joint Frequency Distribution

Hours at Each Wind Speed and Direction

**Summary of All Stability Classes**

**Total Period**

**Period of Record =**

1/1/2018 - 3/31/2018

**Elevation: Speed: SPD60M**

**Direction: DIR60M**

**Lapse: DT60M**

Delta Temperature

**Wind Speed (mph)**

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	6	25	78	74	18	5	206
NNE	1	22	41	23	7	2	96
NE	3	20	32	23	2	0	80
ENE	4	30	49	24	3	0	110
E	3	23	39	38	5	0	108
ESE	5	18	22	57	15	0	117
SE	3	28	31	47	7	0	116
SSE	2	13	35	51	4	0	105
S	1	15	67	74	29	2	188
SSW	1	12	72	104	32	3	224
SW	1	5	45	61	20	1	133
WSW	1	10	44	57	20	8	140
W	2	12	28	37	0	0	79
WNW	1	12	45	62	6	0	126
NW	1	6	34	74	25	0	140
NNW	2	20	71	69	17	3	182
<b>Total</b>	<b>37</b>	<b>271</b>	<b>733</b>	<b>875</b>	<b>210</b>	<b>24</b>	<b>2150</b>

**Calm Hours not Included above for :**

**Total Period** 1

**Variable Direction Hours for:**

**Total Period** 0

**Invalid Hours for:**

**Total Period** 9

**Valid Hours for this Stability Class for:**

**Total Period** 2150

**Total Hours for Period**

**2160**

## Joint Frequency Distribution

Hours at Each Wind Speed and Direction

### Total Period

Period of Record = 4/1/2018 - 6/30/2018  
 Elevation: Speed: SPD60M      Direction: DIR60M      Lapse: DT60M  
 Stability Class A      Delta Temperature      Extremely Unstable

### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	1	8	24	20	0	0	53
NNE	0	6	7	1	0	0	14
NE	1	10	4	0	0	0	15
ENE	0	2	8	7	1	1	19
E	4	3	13	13	8	6	47
ESE	1	2	7	2	0	2	14
SE	1	2	4	4	0	0	11
SSE	0	3	6	0	0	0	9
S	0	2	2	2	0	0	6
SSW	0	0	0	0	0	0	0
SW	0	1	0	5	1	0	7
WSW	0	0	10	8	1	0	19
W	2	17	28	11	3	0	61
WNW	2	11	24	14	10	1	62
NW	1	27	39	12	0	6	85
NNW	0	20	33	11	9	0	73
<b>Total</b>	<b>13</b>	<b>114</b>	<b>209</b>	<b>110</b>	<b>33</b>	<b>16</b>	<b>495</b>

Calm Hours not Included above for :	Total Period	6
Valid Hours for this Stability Class for:	Total Period	495
Total Hours for Period		2184

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

**Total Period**

Period of Record = 4/1/2018 - 6/30/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class B Delta Temperature Moderately Unstable

**Wind Speed (mph)**

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	1	5	7	5	0	0	18
NNE	1	2	0	0	0	0	3
NE	0	2	2	0	0	0	4
ENE	0	0	2	0	0	0	2
E	0	4	4	5	0	3	16
ESE	0	3	4	4	0	0	11
SE	2	2	2	1	0	0	7
SSE	1	2	0	1	0	0	4
S	0	0	4	1	0	0	5
SSW	1	0	2	0	1	0	4
SW	0	0	3	0	0	0	3
WSW	0	1	8	1	0	0	10
W	2	10	4	0	0	0	16
WNW	1	9	3	1	0	0	14
NW	0	12	3	3	2	0	20
NNW	0	7	3	1	0	0	11
<b>Total</b>	<b>9</b>	<b>59</b>	<b>51</b>	<b>23</b>	<b>3</b>	<b>3</b>	<b>148</b>

Calm Hours not Included above for :	<b>Total Period</b>	6
Valid Hours for this Stability Class for:	<b>Total Period</b>	148
<b>Total Hours for Period</b>		<b>2184</b>

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 4/1/2018 - 6/30/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class C Delta Temperature Slightly Unstable

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1-4</u>	<u>4-8</u>	<u>8-13</u>	<u>13-19</u>	<u>19-25</u>	<u>&gt; 25</u>	<u>Total</u>
N	1	2	5	3	1	0	12
NNE	1	0	2	0	0	0	3
NE	2	2	2	0	0	0	6
ENE	1	3	3	0	0	0	7
E	1	6	6	3	2	3	21
ESE	2	5	0	3	0	0	10
SE	0	3	3	1	0	0	7
SSE	0	2	1	2	0	0	5
S	1	1	6	2	1	0	11
SSW	0	2	3	2	0	0	7
SW	0	2	11	3	1	0	17
WSW	1	6	7	2	1	0	17
W	0	5	3	2	0	0	10
WNW	0	5	0	5	3	0	13
NW	1	12	1	0	0	1	15
NNW	1	6	3	2	0	0	12
<b>Total</b>	<b>12</b>	<b>62</b>	<b>56</b>	<b>30</b>	<b>9</b>	<b>4</b>	<b>173</b>

Calm Hours not Included above for :	Total Period	6
Valid Hours for this Stability Class for:	Total Period	173
<b>Total Hours for Period</b>		<b>2184</b>

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

**Total Period**

Period of Record = 4/1/2018 - 6/30/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class D Delta Temperature Neutral

**Wind Speed (mph)**

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	3	22	12	11	1	0	49
NNE	1	6	12	0	0	0	19
NE	2	7	6	1	0	0	16
ENE	1	13	18	10	0	0	42
E	3	13	30	31	3	1	81
ESE	0	6	27	20	0	0	53
SE	3	9	21	3	0	0	36
SSE	3	5	14	3	0	0	25
S	1	7	10	6	1	0	25
SSW	2	9	13	11	3	0	38
SW	2	4	15	9	4	1	35
WSW	2	6	14	4	0	0	26
W	1	13	2	9	0	0	25
WNW	6	7	4	12	8	2	39
NW	5	7	7	12	5	0	36
NNW	6	12	10	16	5	0	49
<b>Total</b>	<b>41</b>	<b>146</b>	<b>215</b>	<b>158</b>	<b>30</b>	<b>4</b>	<b>594</b>

Calm Hours not Included above for :	<b>Total Period</b>	6
Valid Hours for this Stability Class for:	<b>Total Period</b>	594
<b>Total Hours for Period</b>		2184

## Joint Frequency Distribution

Hours at Each Wind Speed and Direction

### Total Period

Period of Record = 4/1/2018 - 6/30/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class E Delta Temperature Slightly Stable

### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	4	9	10	2	0	0	25
NNE	3	9	3	1	0	0	16
NE	1	8	12	0	0	0	21
ENE	1	7	14	4	0	0	26
E	0	7	17	14	0	0	38
ESE	2	2	26	9	0	0	39
SE	0	1	12	4	0	0	17
SSE	0	1	7	2	0	0	10
S	2	2	15	7	1	0	27
SSW	0	2	20	18	1	0	41
SW	0	3	6	11	0	0	20
WSW	1	8	8	5	0	0	22
W	1	7	7	3	0	0	18
WNW	1	3	3	1	0	0	8
NW	0	2	5	1	0	0	8
NNW	0	5	6	0	0	0	11
<b>Total</b>	<b>16</b>	<b>76</b>	<b>171</b>	<b>82</b>	<b>2</b>	<b>0</b>	<b>347</b>

Calm Hours not Included above for :	Total Period	6
Valid Hours for this Stability Class for:	Total Period	347
Total Hours for Period		2184

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 4/1/2018 - 6/30/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class F Delta Temperature Moderately Stable

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	2	5	3	0	0	0	10
NNE	1	8	3	0	1	0	13
NE	2	6	11	1	0	0	20
ENE	0	6	6	0	0	0	12
E	0	2	8	2	0	0	12
ESE	0	2	14	0	0	0	16
SE	1	6	6	0	0	0	13
SSE	0	3	7	5	0	0	15
S	0	1	8	9	0	0	18
SSW	0	0	9	4	0	0	13
SW	0	1	3	2	0	0	6
WSW	1	4	5	0	0	0	10
W	4	3	0	1	0	0	8
WNW	1	2	0	0	0	0	3
NW	1	3	0	0	0	0	4
NNW	1	3	1	0	0	0	5
<b>Total</b>	<b>14</b>	<b>55</b>	<b>84</b>	<b>24</b>	<b>1</b>	<b>0</b>	<b>178</b>

Calm Hours not Included above for :	Total Period	6
Valid Hours for this Stability Class for:	Total Period	178
<b>Total Hours for Period</b>		<b>2184</b>

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 4/1/2018 - 6/30/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class G Delta Temperature Extremely Stable

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	0	2	2	0	0	0	4
NNE	1	6	6	0	0	0	13
NE	2	7	6	0	0	0	15
ENE	5	9	7	4	0	0	25
E	4	11	15	1	0	0	31
ESE	0	10	16	0	0	0	26
SE	0	5	11	3	0	0	19
SSE	0	4	24	16	0	0	44
S	2	4	4	8	0	0	18
SSW	1	2	4	4	0	0	11
SW	1	2	3	0	0	0	6
WSW	0	3	7	0	0	0	10
W	0	2	0	0	0	0	2
WNW	1	5	1	0	0	0	7
NW	1	3	0	0	0	0	4
NNW	0	6	0	0	0	0	6
<b>Total</b>	<b>18</b>	<b>81</b>	<b>106</b>	<b>36</b>	<b>0</b>	<b>0</b>	<b>241</b>

Calm Hours not Included above for :	Total Period	6
Valid Hours for this Stability Class for:	Total Period	241
<b>Total Hours for Period</b>		<b>2184</b>



## Joint Frequency Distribution

Hours at Each Wind Speed and Direction

**Summary of All Stability Classes**

**Total Period**

Period of Record =

4/1/2018 - 6/30/2018

Elevation:   Speed: SPD60M

Direction: DIR60M

Lapse: DT60M

Delta Temperature

**Wind Speed (mph)**

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	12	53	63	41	2	0	171
NNE	8	37	33	2	1	0	81
NE	10	42	43	2	0	0	97
ENE	8	40	58	25	1	1	133
E	12	46	93	69	13	13	246
ESE	5	30	94	38	0	2	169
SE	7	28	59	16	0	0	110
SSE	4	20	59	29	0	0	112
S	6	17	49	35	3	0	110
SSW	4	15	51	39	5	0	114
SW	3	13	41	30	6	1	94
WSW	5	28	59	20	2	0	114
W	10	57	44	26	3	0	140
WNW	12	42	35	33	21	3	146
NW	9	66	55	28	7	7	172
NNW	8	59	56	30	14	0	167
<b>Total</b>	<b>123</b>	<b>593</b>	<b>892</b>	<b>463</b>	<b>78</b>	<b>27</b>	<b>2176</b>

**Calm Hours not Included above for :**

**Total Period**                   6

**Variable Direction Hours for:**

**Total Period**                   0

**Invalid Hours for:**

**Total Period**                   2

**Valid Hours for this Stability Class for:**

**Total Period**                   2176

**Total Hours for Period**

**2184**

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 7/1/2018 - 9/30/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class A Delta Temperature Extremely Unstable

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	0	13	44	19	0	0	76
NNE	0	1	0	1	0	0	2
NE	0	4	1	1	0	0	6
ENE	0	2	2	4	0	0	8
E	1	4	4	0	0	0	9
ESE	0	3	6	0	0	0	9
SE	0	4	3	0	0	0	7
SSE	0	0	4	4	0	0	8
S	0	0	2	4	0	0	6
SSW	0	0	0	1	0	0	1
SW	0	0	0	0	0	0	0
WSW	0	3	5	0	0	0	8
W	0	3	2	0	0	0	5
WNW	0	20	8	5	0	0	33
NW	0	22	21	1	0	0	44
NNW	0	19	49	2	0	0	70
<b>Total</b>	<b>1</b>	<b>98</b>	<b>151</b>	<b>42</b>	<b>0</b>	<b>0</b>	<b>292</b>

Calm Hours not Included above for :	Total Period	7
Valid Hours for this Stability Class for:	Total Period	292
Total Hours for Period		2208

## Joint Frequency Distribution

Hours at Each Wind Speed and Direction

### Total Period

**Period of Record =** 7/1/2018 - 9/30/2018  
**Elevation: Speed:** SPD60M      **Direction:** DIR60M      **Lapse:** DT60M  
**Stability Class** B      **Delta Temperature**      **Moderately Unstable**

### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	0	6	10	3	0	0	19
NNE	0	0	1	0	0	0	1
NE	0	4	0	0	0	0	4
ENE	0	1	1	1	0	0	3
E	0	2	0	0	0	0	2
ESE	0	2	1	1	0	0	4
SE	0	3	3	0	0	0	6
SSE	0	1	4	4	0	0	9
S	0	1	6	4	0	0	11
SSW	0	1	1	0	1	0	3
SW	0	2	1	0	0	0	3
WSW	0	7	8	5	0	0	20
W	0	2	4	0	0	0	6
WNW	0	13	4	0	0	0	17
NW	1	4	4	1	0	0	10
NNW	0	1	3	0	0	0	4
<b>Total</b>	<b>1</b>	<b>50</b>	<b>51</b>	<b>19</b>	<b>1</b>	<b>0</b>	<b>122</b>

<b>Calm Hours not Included above for :</b>	<b>Total Period</b>	7
<b>Valid Hours for this Stability Class for:</b>	<b>Total Period</b>	122
<b>Total Hours for Period</b>		<b>2208</b>

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

**Total Period**

Period of Record =

7/1/2018 - 9/30/2018

Elevation: Speed: SPD60M

Direction: DIR60M

Lapse: DT60M

Stability Class C

Delta Temperature

Slightly Unstable

**Wind Speed (mph)**

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	0	6	5	3	1	0	15
NNE	1	1	0	0	0	0	2
NE	1	3	0	0	0	0	4
ENE	1	3	1	0	0	0	5
E	0	3	0	1	0	0	4
ESE	0	5	6	0	0	0	11
SE	0	3	2	0	0	0	5
SSE	1	6	4	0	0	0	11
S	0	3	5	4	1	0	13
SSW	0	0	4	4	0	0	8
SW	0	6	3	3	0	0	12
WSW	0	3	8	0	0	0	11
W	0	3	2	0	0	0	5
WNW	2	4	5	0	0	0	11
NW	1	6	2	1	0	0	10
NNW	0	3	3	1	0	0	7
<b>Total</b>	<b>7</b>	<b>58</b>	<b>50</b>	<b>17</b>	<b>2</b>	<b>0</b>	<b>134</b>

Calm Hours not Included above for :

Total Period

7

Valid Hours for this Stability Class for:

Total Period

134

Total Hours for Period

2208

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 7/1/2018 - 9/30/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class D Delta Temperature Neutral

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	1	23	24	4	0	0	52
NNE	4	12	9	6	0	0	31
NE	2	7	14	4	0	0	27
ENE	4	7	21	5	0	0	37
E	4	5	10	4	0	0	23
ESE	3	9	8	5	0	0	25
SE	2	9	15	2	0	0	28
SSE	3	14	12	2	0	0	31
S	3	15	23	17	3	0	61
SSW	2	9	23	11	0	0	45
SW	1	16	18	8	0	0	43
WSW	2	4	9	3	1	0	19
W	4	3	6	2	0	0	15
WNW	3	3	3	4	1	0	14
NW	4	9	11	5	7	0	36
NNW	3	7	7	2	3	0	22
<b>Total</b>	<b>45</b>	<b>152</b>	<b>213</b>	<b>84</b>	<b>15</b>	<b>0</b>	<b>509</b>

Calm Hours not Included above for :	Total Period	7
Valid Hours for this Stability Class for:	Total Period	509
<b>Total Hours for Period</b>		<b>2208</b>

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 7/1/2018 - 9/30/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class E Delta Temperature Slightly Stable

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	0	19	14	3	0	0	36
NNE	2	17	17	4	0	0	40
NE	0	8	23	2	0	0	33
ENE	2	8	25	18	0	0	53
E	1	3	5	0	0	0	9
ESE	2	9	13	5	0	0	29
SE	1	7	26	2	0	0	36
SSE	3	3	29	17	1	0	53
S	3	5	22	16	0	0	46
SSW	1	8	37	23	3	0	72
SW	1	10	13	5	1	0	30
WSW	0	4	19	4	0	1	28
W	0	1	3	0	0	0	4
WNW	1	3	10	0	1	0	15
NW	2	4	11	6	0	0	23
NNW	3	10	9	2	2	0	26
<b>Total</b>	<b>22</b>	<b>119</b>	<b>276</b>	<b>107</b>	<b>8</b>	<b>1</b>	<b>533</b>

Calm Hours not Included above for :	<b>Total Period</b>	7
Valid Hours for this Stability Class for:	<b>Total Period</b>	533
<b>Total Hours for Period</b>		<b>2208</b>

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 7/1/2018 - 9/30/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class F Delta Temperature Moderately Stable

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	3	2	4	1	0	0	10
NNE	0	10	8	0	0	0	18
NE	2	10	16	0	0	0	28
ENE	3	6	7	0	0	0	16
E	2	4	5	0	0	0	11
ESE	2	7	5	1	0	0	15
SE	2	7	15	0	0	0	24
SSE	0	1	12	8	0	0	21
S	2	4	28	13	0	0	47
SSW	1	5	20	0	0	0	26
SW	1	1	12	0	0	0	14
WSW	1	4	1	0	0	0	6
W	1	2	0	0	0	0	3
WNW	2	4	3	0	0	0	9
NW	1	4	3	1	0	0	9
NNW	0	3	3	0	0	0	6
<b>Total</b>	<b>23</b>	<b>74</b>	<b>142</b>	<b>24</b>	<b>0</b>	<b>0</b>	<b>263</b>

Calm Hours not Included above for :	Total Period	7
Valid Hours for this Stability Class for:	Total Period	263
Total Hours for Period		2208

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 7/1/2018 - 9/30/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class G Delta Temperature Extremely Stable

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	1	0	4	0	0	0	5
NNE	3	3	4	0	0	0	10
NE	1	2	8	0	0	0	11
ENE	2	8	22	0	0	0	32
E	2	12	28	4	0	0	46
ESE	3	8	24	0	0	0	35
SE	3	19	14	3	0	0	39
SSE	1	11	11	5	0	0	28
S	4	4	18	7	0	0	33
SSW	2	7	13	3	0	0	25
SW	1	10	17	0	0	0	28
WSW	1	6	10	0	0	0	17
W	3	3	0	0	0	0	6
WNW	1	10	1	0	0	0	12
NW	2	7	3	0	0	0	12
NNW	2	5	2	0	0	0	9
<b>Total</b>	<b>32</b>	<b>115</b>	<b>179</b>	<b>22</b>	<b>0</b>	<b>0</b>	<b>348</b>

Calm Hours not Included above for :	Total Period	7
Valid Hours for this Stability Class for:	Total Period	348
Total Hours for Period		2208



## Joint Frequency Distribution

Hours at Each Wind Speed and Direction

**Summary of All Stability Classes**

**Total Period**

Period of Record =

7/1/2018 - 9/30/2018

Elevation:   Speed: SPD60M

Direction: DIR60M

Lapse: DT60M

Delta Temperature

**Wind Speed (mph)**

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	5	69	105	33	1	0	213
NNE	10	44	39	11	0	0	104
NE	6	38	62	7	0	0	113
ENE	12	35	79	28	0	0	154
E	10	33	52	9	0	0	104
ESE	10	43	63	12	0	0	128
SE	8	52	78	7	0	0	145
SSE	8	36	76	40	1	0	161
S	12	32	104	65	4	0	217
SSW	6	30	98	42	4	0	180
SW	4	45	64	16	1	0	130
WSW	4	31	60	12	1	1	109
W	8	17	17	2	0	0	44
WNW	9	57	34	9	2	0	111
NW	11	56	55	15	7	0	144
NNW	8	48	76	7	5	0	144
<b>Total</b>	<b>131</b>	<b>666</b>	<b>1062</b>	<b>315</b>	<b>26</b>	<b>1</b>	<b>2201</b>

Calm Hours not Included above for:

Total Period

7

Variable Direction Hours for:

Total Period

0

Invalid Hours for:

Total Period

0

Valid Hours for this Stability Class for:

Total Period

2201

Total Hours for Period

2208

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 10/1/2018 - 12/31/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class A Delta Temperature Extremely Unstable

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	0	6	6	8	5	0	25
NNE	0	2	3	0	4	0	9
NE	0	4	4	0	0	0	8
ENE	1	2	3	0	0	0	6
E	0	0	1	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	3	0	0	0	3
SSE	0	0	5	0	0	0	5
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	1	0	2	0	3
WSW	0	0	5	1	0	0	6
W	0	0	1	0	0	0	1
WNW	0	0	1	1	0	0	2
NW	0	2	2	1	0	1	6
NNW	0	2	3	4	1	1	11
<b>Total</b>	<b>1</b>	<b>18</b>	<b>38</b>	<b>15</b>	<b>12</b>	<b>2</b>	<b>86</b>

Calm Hours not Included above for :	Total Period	1
Valid Hours for this Stability Class for:	Total Period	86
<b>Total Hours for Period</b>		<b>2208</b>

## Joint Frequency Distribution

Hours at Each Wind Speed and Direction

### Total Period

**Period of Record =** 10/1/2018 - 12/31/2018  
**Elevation:** Speed: SPD60M      **Direction:** DIR60M      **Lapse:** DT60M  
**Stability Class** B      Delta Temperature      Moderately Unstable

### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	0	4	4	3	0	0	11
NNE	0	0	1	0	0	0	1
NE	0	2	0	0	0	0	2
ENE	0	2	3	0	0	0	5
E	0	0	2	0	0	0	2
ESE	0	1	2	0	0	0	3
SE	0	0	3	1	0	0	4
SSE	0	2	9	1	0	0	12
S	0	1	1	0	0	0	2
SSW	0	0	2	0	0	0	2
SW	0	0	0	0	1	0	1
WSW	0	1	6	0	2	0	9
W	0	0	3	0	0	0	3
WNW	0	2	1	0	0	1	4
NW	0	4	5	0	0	0	9
NNW	0	1	4	1	0	0	6
<b>Total</b>	0	20	46	6	3	1	76

<b>Calm Hours not Included above for :</b>	<b>Total Period</b>	1
<b>Valid Hours for this Stability Class for:</b>	<b>Total Period</b>	76
<b>Total Hours for Period</b>		2208

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 10/1/2018 - 12/31/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class C Delta Temperature Slightly Unstable

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	0	5	2	3	2	0	12
NNE	0	0	2	0	2	0	4
NE	0	2	1	0	0	0	3
ENE	0	3	1	0	0	0	4
E	0	0	4	1	0	0	5
ESE	0	2	1	1	0	0	4
SE	0	0	2	7	0	0	9
SSE	0	0	6	3	0	0	9
S	0	1	4	5	0	0	10
SSW	0	0	1	3	0	0	4
SW	0	0	7	0	1	0	8
WSW	0	3	5	0	0	0	8
W	0	0	2	1	0	0	3
WNW	0	1	2	2	0	0	5
NW	0	1	3	2	1	0	7
NNW	0	0	6	1	0	0	7
<b>Total</b>	<b>0</b>	<b>18</b>	<b>49</b>	<b>29</b>	<b>6</b>	<b>0</b>	<b>102</b>

Calm Hours not Included above for :	Total Period	1
Valid Hours for this Stability Class for:	Total Period	102
<b>Total Hours for Period</b>		<b>2208</b>

## Joint Frequency Distribution

Hours at Each Wind Speed and Direction

### Total Period

**Period of Record =** 10/1/2018 - 12/31/2018  
**Elevation:**   **Speed:** SPD60M       **Direction:** DIR60M       **Lapse:** DT60M  
**Stability Class** D                   Delta Temperature   Neutral

### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	2	7	20	19	6	1	55
NNE	5	18	15	5	0	0	43
NE	1	12	18	4	2	0	37
ENE	1	16	13	3	2	0	35
E	3	13	11	9	6	0	42
ESE	3	15	14	20	5	2	59
SE	4	28	20	20	17	1	90
SSE	2	13	17	23	4	3	62
S	2	15	29	17	2	0	65
SSW	3	9	43	24	3	0	82
SW	2	6	27	30	6	1	72
WSW	1	7	21	29	34	5	97
W	3	7	24	36	32	7	109
WNW	1	5	43	55	25	7	136
NW	3	8	41	53	22	4	131
NNW	2	15	33	25	17	5	97
<b>Total</b>	<b>38</b>	<b>194</b>	<b>389</b>	<b>372</b>	<b>183</b>	<b>36</b>	<b>1212</b>

<b>Calm Hours not Included above for :</b>	<b>Total Period</b>	1
<b>Valid Hours for this Stability Class for:</b>	<b>Total Period</b>	1212
<b>Total Hours for Period</b>		<b>2208</b>

## Joint Frequency Distribution

Hours at Each Wind Speed and Direction

### Total Period

Period of Record = 10/1/2018 - 12/31/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class E Delta Temperature Slightly Stable

### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	1	12	2	1	0	0	16
NNE	1	7	11	3	0	0	22
NE	0	3	20	1	0	0	24
ENE	0	6	13	3	0	0	22
E	0	5	15	5	0	0	25
ESE	2	19	30	8	0	0	59
SE	1	10	22	17	1	0	51
SSE	1	6	27	28	4	0	66
S	0	4	32	23	2	0	61
SSW	1	3	22	17	2	0	45
SW	1	1	13	2	1	0	18
WSW	0	2	3	6	2	0	13
W	0	3	2	6	0	0	11
WNW	1	5	2	19	8	1	36
NW	0	4	15	26	4	0	49
NNW	1	12	13	3	1	4	34
<b>Total</b>	<b>10</b>	<b>102</b>	<b>242</b>	<b>168</b>	<b>25</b>	<b>5</b>	<b>552</b>

Calm Hours not Included above for :	Total Period	1
Valid Hours for this Stability Class for:	Total Period	552
Total Hours for Period		2208

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

#### Total Period

Period of Record = 10/1/2018 - 12/31/2018  
 Elevation: Speed: SPD60M Direction: DIR60M Lapse: DT60M  
 Stability Class F Delta Temperature Moderately Stable

#### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	0	0	4	0	0	0	4
NNE	0	1	1	0	0	0	2
NE	0	0	8	0	0	0	8
ENE	0	5	1	0	0	0	6
E	0	2	3	0	0	0	5
ESE	0	0	3	0	0	0	3
SE	0	3	6	0	0	0	9
SSE	0	1	6	1	0	0	8
S	1	0	5	6	0	0	12
SSW	1	5	12	4	0	0	22
SW	2	2	4	4	0	0	12
WSW	0	0	1	0	0	0	1
W	2	1	1	1	0	0	5
WNW	0	0	0	1	0	0	1
NW	0	1	0	0	0	0	1
NNW	0	2	1	0	0	0	3
<b>Total</b>	<b>6</b>	<b>23</b>	<b>56</b>	<b>17</b>	<b>0</b>	<b>0</b>	<b>102</b>

Calm Hours not Included above for :	Total Period	1
Valid Hours for this Stability Class for:	Total Period	102
Total Hours for Period		2208

## Joint Frequency Distribution

Hours at Each Wind Speed and Direction

### Total Period

**Period of Record =** 10/1/2018 - 12/31/2018  
**Elevation: Speed:** SPD60M      **Direction:** DIR60M      **Lapse:** DT60M  
**Stability Class** G      **Delta Temperature**      **Extremely Stable**

### Wind Speed (mph)

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>
N	0	0	0	0	0	0	0
NNE	0	1	0	0	0	0	1
NE	1	0	1	0	0	0	2
ENE	0	0	7	0	0	0	7
E	0	1	4	0	0	0	5
ESE	2	3	4	0	0	0	9
SE	0	4	5	0	0	0	9
SSE	1	3	8	0	0	0	12
S	0	2	6	1	0	0	9
SSW	0	0	3	2	0	0	5
SW	2	1	5	1	0	0	9
WSW	0	2	1	0	0	0	3
W	0	2	0	0	0	0	2
WNW	1	2	0	0	0	0	3
NW	0	0	0	0	0	0	0
NNW	0	1	0	0	0	0	1
<b>Total</b>	<b>7</b>	<b>22</b>	<b>44</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>77</b>

<b>Calm Hours not Included above for :</b>	<b>Total Period</b>	1
<b>Valid Hours for this Stability Class for:</b>	<b>Total Period</b>	77
<b>Total Hours for Period</b>		<b>2208</b>



## Joint Frequency Distribution

Hours at Each Wind Speed and Direction

**Summary of All Stability Classes**

**Total Period**

**Period of Record =**

10/1/2018 - 12/31/2018

**Elevation: Speed: SPD60M**

**Direction: DIR60M**

**Lapse: DT60M**

Delta Temperature

**Wind Speed (mph)**

<u>Wind Direction</u>	<u>1 - 4</u>	<u>4 - 8</u>	<u>8 - 13</u>	<u>13 - 19</u>	<u>19 - 25</u>	<u>&gt; 25</u>	<u>Total</u>	
N	3	34	38	34	13	1	123	
NNE	6	29	33	8	6	0	82	
NE	2	23	52	5	2	0	84	
ENE	2	34	41	6	2	0	85	
E	3	21	40	15	6	0	85	
ESE	7	40	54	29	5	2	137	
SE	5	45	61	45	18	1	175	
SSE	4	25	78	56	8	3	174	
S	3	23	77	52	4	0	159	
SSW	5	17	83	50	5	0	160	
SW	7	10	57	37	11	1	123	
WSW	1	15	42	36	38	5	137	
W	5	13	33	44	32	7	134	
WNW	3	15	49	78	33	9	187	
NW	3	20	66	82	27	5	203	
NNW	3	33	60	34	19	10	159	
<b>Total</b>	<b>62</b>	<b>397</b>	<b>864</b>	<b>611</b>	<b>229</b>	<b>44</b>	<b>2207</b>	
<b>Calm Hours not Included above for :</b>							<b>Total Period</b>	<b>1</b>
<b>Variable Direction Hours for:</b>							<b>Total Period</b>	<b>0</b>
<b>Invalid Hours for:</b>							<b>Total Period</b>	<b>0</b>
<b>Valid Hours for this Stability Class for:</b>							<b>Total Period</b>	<b>2207</b>
<b>Total Hours for Period</b>								<b>2208</b>

**OFF-SITE DOSE CALCULATION MANUAL CHANGES**

The Off-Site Dose Calculation Manual, PMP-6010-OSD-001, was not revised during this 2018 reporting period.