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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
2019 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 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, 2019, through December 31, 2019.

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

Sincerely,

A handwritten signature in black ink, appearing to read "m.k. Scarpello", written in a cursive style.

Michael K. Scarpello
Regulatory Affairs Director

SJM/ml

Enclosure: Donald C. Cook Nuclear Plant Units 1 and 2 - 2019 Annual Radioactive Effluent Release Report

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IE48
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ENCLOSURE to AEP-NRC-2020-35

DONALD C. COOK NUCLEAR PLANT UNITS 1 AND 2
2019 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 2019 | 5 |
| VIII. Conclusion | 7 |
| IX. Errata | 7 |

LIST OF APPENDICES

| Appendix | Title |
|----------|--|
| A1.1 | 2019 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 2019 |
| A1.3 | 2019 Groundwater Protection Initiative (GPI) Sample Data |
| A2.1 | Hours at Each Wind Speed and Direction: First Quarter, 2019 |
| A2.2 | Hours at Each Wind Speed and Direction: Second Quarter, 2019 |
| A2.3 | Hours at Each Wind Speed and Direction: Third Quarter, 2019 |
| A2.4 | Hours at Each Wind Speed and Direction: Fourth Quarter, 2019 |
| 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 2019. 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, 2019, to December 31, 2019. 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 2019.

| Parameter | Unit 1 | Unit 2 |
|---|-----------|-----------|
| Gross Electrical Energy Generation (Megawatt Hour (MWH)) | 7,594,318 | 9,075,948 |
| Unit Service Factor (Percent (%)) | 82.3 | 85.9 |
| Unit Capacity Factor (Maximum Dependable Capacity (MDC)) Net (%) | 81.4 | 86.2 |

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 normal downpower and was manually tripped on March 6, 2019, entering refueling outage U1C29. The unit attained criticality on May 8, 2019, and returned to NFP on May 20, 2019. 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 rapid downpower and was manually tripped on July 21, 2019, to perform repairs on NESW Strainers. The unit attained criticality on July 24, 2019, and attained NFP on July 26, 2019. The unit performed a normal downpower and was manually tripped on October 2, 2019, entering refueling outage U2C25. The unit attained criticality on November 18, 2019, and attained NFP on November 22, 2019. 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 2019. 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 2019 there were 131 liquid batch releases performed. The number of liquid batch releases for the 1st, 2nd, 3rd, and 4th quarters in 2019 were 35, 35, 26, and 35, 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 2019 there was one batch release from Gas Decay Tanks (GDT), one containment purge, one system tank vent, one header piping vent, and 61 Containment Pressure Reliefs (CPR). During the second quarter there were five batch releases from GDTs and 58 CPR. During the third quarter there were two batch releases from GDTs, and 101 CPR. During the fourth quarter there were no batch releases from GDTs, one system tank vent, one containment purge, and 127 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 eight GDT releases, two containment purge, two system tank vents, one header vent, and 347 CPR gaseous batch releases made during 2019.

In calculating the dose consequences for continuous and batch gaseous releases during 2019, 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 25 shipments of radioactive waste made during 2019. 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 2019. 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 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 2019 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 2019 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 | 1.82E-02 | 2.75E-02 | 4.30E-02 | 3.96E-02 |
| Total Body Air | 1.90E-04 | 2.00E-04 | 7.30E-04 | 2.10E-04 |
| Skin | 3.00E-04 | 3.20E-04 | 1.20E-03 | 3.30E-04 |
| Liquid TB | 4.07E-02 | 1.38E-02 | 1.87E-02 | 1.18E-02 |
| Liquid Organ | 4.07E-02 | 1.38E-02 | 1.87E-02 | 1.21E-02 |
| Direct Radiation | 0 | 0 | 0 | 0 |
| Quarterly Dose Total | 1.00E-01 | 5.56E-02 | 8.23E-02 | 6.40E-02 |
| Sum of Quarter Doses | | | | 3.02E-01 |
| C14 (Annual) Dose | | | | 2.07E+00 |
| Grand Total Dose (Total Body or any other Organ) mrem | | | | 2.37E+00 |
| Annual Dose Limit (mrem) | | | | 25 |
| Percent of limit | | | | 9.49E+00 |

The following data reflects a comparison with 2009 annual dose data (the last year without calculating C-14 dose), 2019 annual dose data, and 2019 annual dose data with C-14 added. This indicates that 2019 annual dose was 'typical' for a dual 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 |
| 2019 | 3.02E-01 | 1.21 |
| 2019 with C-14 | 2.37E+00 | 9.49 |

VI. RADIATION MONITORS INOPERABLE GREATER THAN 30 DAYS

The Radiation Monitor System (RMS) has undergone an extensive replacement project to upgrade and modernize the equipment to support the expected operational lives of the two Cook Plant units. Steam Generator Blowdown Monitor R-19 (1-DRA-300/1-DRA-353) entered 2019 being out of service, being removed from service as part of the planned Radiation Monitor System (RMS) Replacement Project on October 15, 2018. It was returned to service on September 11, 2019. The appropriate compensatory sampling actions were taken throughout the year as releases on this pathway continued. The monitor was 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 RMS replacement project did significant work in 2019, with the table below providing the details on when work was started (starting the 30 day clock) and when it was returned to service. All were greater than 30 days and all had appropriate compensatory sampling actions or surveys performed throughout the duration. All effluent releases complied with ODCM requirements. The list includes some area radiation monitors which are not involved with effluent pathways, but are included for completeness. Additionally, work continued into 2020 and those affected monitors are also listed since that work was completed prior to this writing on April 14, 2020 and also concludes the RMS Replacement Project. Specifics for the 2020 work will be included in that year's annual report. There were no other release pathways with inoperable monitors for greater than 30 days.

| | | | |
|-------------|--|-------------|-------------|
| 1-WRA-713 | East Essential Service Water Header Effluent | S: 1/15/19 | F: 9/11/19 |
| 1-WRA-717 | West Essential Service Water Header Effluent | S: 1/15/19 | F: 9/11/19 |
| 12-RRC-330 | Spent Fuel Pit Area | S: 12/18/18 | F: 9/11/19 |
| 1-CRA-415 | East Component Cooling Loop | S: 3/14/19 | F: 9/11/19 |
| 1-CRA-425 | West Component Cooling Loop | S: 3/12/19 | F: 9/11/19 |
| 12-ERA-7000 | Nuclear Sampling Room Area | S: 12/3/18 | F: 9/19/19 |
| 1-ERA- 7300 | Aux Building Equipment Room | S: 1/28/19 | F: 9/19/19 |
| 1-ERS-7400 | Control Room, Instrument Room, and Aux building Area | S: 3/12/19 | F: 9/19/19 |
| 12-ERA-7500 | Aux Building Elevation 573' and 587' Area | S: 1/2/19 | F: 9/19/19 |
| 12-RRS-1000 | Waste Disposal Liquid Effluent | S: 7/8/19 | F: 11/7/19 |
| 1-MRA-1600 | SG 1 and 4 PORVs | S: 7/8/19 | F: 11/21/19 |
| 1-MRA-1700 | SG 2 and 3 PORVs | S: 7/8/19 | F: 11/21/19 |
| 1-VRS-1200 | Upper Containment Area | S: 7/8/19 | F: 11/21/19 |
| 1-ERS-1400 | Lower Containment Area | S: 7/8/19 | F: 11/21/19 |
| 2-DRA-300 | SG Blow-down Pre-treatment Effluent | S: 6/11/19 | F: 12/4/19 |
| 2-DRA-353 | SG Blow-down Post-treatment Effluent | S: 6/11/19 | F: 12/4/19 |
| 2-CRA-415 | East Component Cooling Loop | S: 6/11/19 | F: 12/4/19 |
| 1-VRS-1500 | Unit Vent Effluent | S: 8/19/19 | F: 1/17/20 |
| 1-SRA-1800 | Gland Steam Leak off Vent | S: 8/19/19 | F: 12/18/19 |
| 1- SRA-1900 | Steam Jet Air Ejector Vent | S: 9/30/19 | F: 12/18/19 |
| 12-ERA-7600 | Aux Building Elevation 633' and 650' Area | S: 8/19/19 | F: 12/18/19 |
| 2-WRA-714 | East Essential Service Water Header Effluent | S: 6/11/19 | F: 1/23/20 |
| 2-WRA-718 | West Essential Service Water Header Effluent | S: 6/11/19 | F: 1/23/20 |
| 2-CRA-425 | West Component Cooling Loop | S: 6/11/19 | F: 1/23/20 |
| 1-VRS-1100 | Upper Containment Area | S: 12/3/19 | F: 4/7/20 |
| 1-ERS-1300 | Lower Containment Area | S: 12/3/19 | F: 4/7/20 |
| 2-VRS-2200 | Upper Containment Area | S: 11/25/19 | F: 2/7/20 |
| 2-ERS-2400 | Lower Containment Area | S: 11/25/19 | F: 2/7/20 |
| 2-ERA-8300 | Aux Building Equipment Room | S: 10/8/19 | F: 2/13/20 |
| 2-ERS-8400 | Control Room, Instrument Room, and Aux Building Area | S: 12/2/19 | F: 2/13/20 |
| 2-VRS-2500 | Unit Vent Effluent | S: 2/11/20 | F: 4/14/20 |
| 2-SRA-2800 | Gland Steam Leak off Vent | S: 2/20/20 | F: 4/14/20 |
| 2- SRA-2900 | Steam Jet Air Ejector Vent | S: 2/20/20 | F: 4/14/20 |
| 2-MRA-2700 | SG 2 and 3 PORVs | S: 1/23/20 | F: 4/14/20 |
| 2-VRS-2100 | Upper Containment Area | S: 2/20/20 | F: 4/14/20 |
| 2-MRA-2600 | SG 1 and 4 PORVs | S: 1/21/20 | F: 4/14/20 |
| 2-ERS-2300 | Lower Containment Area | S: 2/12/20 | F: 4/14/20 |
| | | | |

VII. NOTEWORTHY CONDITIONS IDENTIFIED IN 2019

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 2020 reflecting the completion of the project.

The usage of compensatory actions and sampling during the time periods for which a pathway's monitor is out of service does create some conservatism in the calculations for dose to ensure compliance with all regulations. This may take the form of using maximum design flow rates when a flow instrument is out of service, for example. Another example would be the inability to utilize fans during containment pressure reliefs, resulting in longer times of release to lower the observed pressure as well as more actual relief activities since pressure drops are limited. These conservative assumptions increase the calculated dose, and can be observed in the reporting this year. The increases are relatively small when compared to Carbon-14 dose, which was not affected. It is anticipated that the 2020 results will return to the expected range for our units and scheduled work activities.

Carbon-14 Supplemental Information for the 2019 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 2019 results in a site total of 17.9 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 2.50 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 pathway. A 'p' factor of 0.33 is determined utilizing the time of batch gaseous releases performed during 2019 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 1.725 mrem to the bone and a whole body dose of 0.343 mrem, for a combined total C-14 dose of 2.07 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 (≤ 75 mrem for thyroid).

This is planned to be the last year where this detailed C-14 section will be added to the report, since 10 years have now passed with the doses expected to be observed from power plants now incorporating C-14 created dose as the new "normal". These 10 years have demonstrated that the dose as compared to pre-2010 has remained consistent or improved when not accounting for C-14 dose. The C-14 dose is now the major contributor, and will consistently be about 8-10 times higher than the pre-2010 calculations. This dose will only change with online power generation, so it will not alter significantly unless the plant is shutdown for an extended period.

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 2019.

2019 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 ≤ 5 mrad/unit for gamma radiation and ≤ 10 mrad/unit for beta radiation.

1.1.2 During any calendar year, to ≤ 10 mrad/unit for gamma radiation and ≤ 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 ≤ 7.5 mrem/unit to any organ.

1.2.2 During any calendar year to ≤ 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 ≤ 1.5 mrem/unit to the total body and to ≤ 5 mrem/unit to any organ.

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

2019 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 ≤ 25 mrem to the total body or any organ (except the thyroid, which is limited to ≤ 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: ≤ 500 mrem/yr to the total body and ≤ 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: ≤ 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 2×10^{-4} $\mu\text{Ci/ml}$ total activity.

2019 Effluent and Waste Disposal Annual Report

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.

2019 Effluent and Waste Disposal Annual Report

5 BATCH RELEASES

5.1 Liquid

5.1.1 Number of batch releases:

35 releases in the 1st quarter, 2019

35 releases in the 2nd quarter, 2019

26 releases in the 3rd quarter, 2019

35 releases in the 4th quarter, 2019

5.1.2 Total time period for batch releases:

52,892 minutes

5.1.3 Maximum time for a batch release:

1,698 minutes

5.1.4 Average time period for batch release:

404 minutes

5.1.5 Minimum time period for a batch release:

104 minutes

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

6.45E+5 gpm circulating water

2019 Effluent and Waste Disposal Annual Report

5.2 Gaseous

5.2.1 Number of batch releases:

65 releases in the 1st quarter, 2019
63 releases in the 2nd quarter, 2019
103 releases in the 3rd quarter, 2019
129 releases in the 4th quarter, 2019

5.2.2 Total time period for batch releases:

25,120 minutes

5.2.3 Maximum time for a batch release:

354 minutes

5.2.4 Average time period for batch release:

69.8 minutes

5.2.5 Minimum time period for a batch release:

5 minutes

2019 Effluent and Waste Disposal Annual Report

6 ABNORMAL RELEASES

6.1 Liquid

6.1.1 Number of Releases:

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

6.1.2 Total activity released (Ci):

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

6.2 Gaseous

6.2.1 Number of Releases:

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

6.2.2 Total activity released (Ci):

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

2019 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 | 2.47E+01 | 2.20E+01 | 2.12E+01 | 3.84E+01 |
| AR41 | Ci | ----- | ----- | ----- | ----- |
| KR85 | Ci | ----- | ----- | ----- | ----- |
| XE133 | Ci | ----- | ----- | ----- | 4.74E-02 |
| XE135 | Ci | ----- | ----- | ----- | ----- |
| XE131m | Ci | ----- | ----- | ----- | ----- |
| XE133m | Ci | ----- | ----- | ----- | ----- |
| XE135m | Ci | ----- | ----- | ----- | ----- |
| Total for Period | Ci | 2.47E+01 | 2.20E+01 | 2.12E+01 | 3.84E+01 |

| | | | | | |
|------------------|----|-------|-------|-------|----------|
| 2. IODINES | | | | | |
| I131 | Ci | ----- | ----- | ----- | 5.07E-06 |
| I132 | Ci | ----- | ----- | ----- | ----- |
| I133 | Ci | ----- | ----- | ----- | ----- |
| Total for Period | Ci | ----- | ----- | ----- | 5.07E-06 |

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

* DENOTES SUPPLEMENTAL ISOTOPES

2019 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 | 1.19E-01 | 4.00E-02 | 9.80E-02 | 1.43E-01 |
| AR41 | Ci | 2.38E-01 | 1.50E-01 | 2.62E-01 | 1.55E-01 |
| KR85 | Ci | 3.75E-02 | 9.16E-02 | 3.99E-02 | ----- |
| XE131M | Ci | ----- | ----- | ----- | ----- |
| XE133M | Ci | ----- | ----- | ----- | ----- |
| XE133 | Ci | 4.68E-02 | 3.97E-02 | 1.74E-01 | 3.89E-02 |
| XE135m | Ci | ----- | ----- | ----- | ----- |
| XE135 | Ci | 1.37E-03 | 1.46E-03 | 3.44E-03 | 1.50E-03 |
| Total for Period | Ci | 4.43E-01 | 3.23E-01 | 5.77E-01 | 3.38E-01 |
| 2. IODINES | | | | | |
| I131 | Ci | ----- | ----- | ----- | ----- |
| I133 | Ci | ----- | ----- | ----- | ----- |
| Total for Period | Ci | ----- | ----- | ----- | ----- |
| 3. PARTICULATES | | | | | |
| CS137 | Ci | ----- | ----- | ----- | ----- |
| CO60 | Ci | ----- | ----- | ----- | ----- |
| Total for Period | Ci | ----- | ----- | ----- | ----- |

* DENOTES SUPPLEMENTAL ISOTOPES

2019 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 | 3.24E-01 | 2.83E-01 | 4.77E-01 | 2.25E-01 | 11.8 |
| 2. | Average release rate for period | uCi/sec | 4.16E-02 | 3.60E-02 | 6.00E-02 | 2.84E-02 | |
| 3. | Percent of applicable limit* | % Gamma Beta | 4.53E-03 8.55E-04 | 7.10E-03 1.94E-03 | 1.27E-02 6.85E-03 | 3.43E-03 6.60E-04 | |

| | | | | | | | |
|----|------------------------------------|---------|----------|----------|----------|----------|------|
| B. | IODINES | | | | | | |
| 1. | Total I-131 | Ci | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.07E-06 | 17.1 |
| 2. | Average release rate for period | uCi/sec | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.38E-07 | |
| 3. | Percent of applicable limit* | % | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.82E-06 | |

| | | | | | | | |
|----|--|---------|-----------|-----------|-----------|-----------|-----|
| C. | PARTICULATES | | | | | | |
| 1. | Particulates with half lives > 8 days | Ci | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | N/A |
| 2. | Average release rate for period | uCi/sec | 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 | |
| 4. | Gross alpha radioactivity | Ci | <1.03E-06 | <8.16E-07 | <9.05E-07 | <8.96E-07 | |

| | | | | | | | |
|----|------------------------------------|---------|----------|----------|----------|----------|------|
| D. | TRITIUM | | | | | | |
| 1. | Total Release | Ci | 2.48E+01 | 2.21E+01 | 2.13E+01 | 3.86E+01 | 17.4 |
| 2. | Average release rate for period | uCi/sec | 3.19E+00 | 2.81E+00 | 2.67E+00 | 4.85E+00 | |
| 3. | Percent of applicable limit* | % | 1.82E-02 | 1.60E-02 | 1.52E-02 | 2.76E-02 | |

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

2019 EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
LIQUID EFFLUENTS
CONTINUOUS MODE

| Nuclides Released | Unit | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter |
|-------------------|------|-------------|-------------|-------------|-------------|
| H3 | Ci | 2.51E-02 | ----- | ----- | ----- |
| CS137 | Ci | ----- | ----- | ----- | ----- |

BATCH MODE

| Nuclides Released | Unit | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter |
|-------------------|------|-------------|-------------|-------------|-------------|
| H3 | Ci | 1.18E+03 | 5.04E+02 | 6.92E+02 | 3.14E+02 |
| CR51 | Ci | ----- | ----- | ----- | ----- |
| MN54 | Ci | ----- | ----- | ----- | ----- |
| FE55 | Ci | ----- | ----- | ----- | ----- |
| CO58 | Ci | 6.51E-05 | 9.32E-05 | 2.79E-05 | 1.14E-04 |
| CO60 | Ci | 5.77E-05 | 1.38E-05 | 2.09E-05 | 4.32E-05 |
| NI63 | Ci | ----- | ----- | ----- | ----- |
| *KR85 | Ci | ----- | ----- | ----- | ----- |
| ZR95 | Ci | ----- | ----- | ----- | ----- |
| NB95 | Ci | ----- | ----- | ----- | ----- |
| MO99 | Ci | ----- | 3.27E-05 | 5.15E-06 | ----- |
| TC99m | Ci | 2.71E-06 | 3.08E-05 | 7.93E-06 | 2.75E-06 |
| AG110m | Ci | 2.45E-06 | ----- | 1.79E-05 | 5.62E-07 |
| SB124 | Ci | ----- | 1.49E-05 | ----- | 4.67E-05 |
| SB125 | Ci | ----- | 4.34E-05 | 1.51E-05 | 1.78E-04 |
| CS134 | Ci | ----- | ----- | ----- | 4.69E-06 |
| CS137 | Ci | 3.20E-06 | 6.06E-07 | ----- | 8.21E-05 |
| I131 | Ci | ----- | ----- | ----- | ----- |
| *XE133 | Ci | 2.35E-04 | 6.96E-05 | 4.23E-04 | 1.01E-04 |
| *XE133m | Ci | ----- | ----- | 7.03E-06 | ----- |
| *XE135 | Ci | ----- | 3.21E-06 | 2.42E-05 | ----- |

* DENOTES SUPPLEMENTAL ISOTOPES

2019 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 | 1.31E-04 | 2.70E-04 | 1.04E-04 | 4.72E-04 | 13.0 |
| 2. | Average diluted concentration during period | uCi/ml | 2.11E-12 | 5.82E-12 | 5.63E-12 | 2.99E-11 | |
| 3. | Percent of applicable limit | % | 4.19E-05 | 3.42E-05 | 6.63E-05 | 7.60E-04 | |
| B. | TRITIUM | | | | | | |
| 1. | Total Release | Ci | 1.18E+03 | 5.04E+02 | 6.92E+02 | 3.14E+02 | 10.1 |
| 2. | Average diluted concentration during period | uCi/ml | 1.89E-05 | 1.08E-05 | 3.73E-05 | 1.99E-05 | |
| 3. | Percent of applicable limit | % | 1.89E+00 | 1.08E+00 | 3.73E+00 | 1.99E+00 | |
| C. | DISSOLVED AND ENTRAINED GASES | | | | | | |
| 1. | Total Release | Ci | 2.35E-04 | 7.28E-05 | 4.48E-04 | 1.01E-04 | 12.0 |
| 2. | Average diluted concentration during period | uCi/ml | 3.77E-12 | 1.57E-12 | 2.41E-11 | 6.39E-12 | |
| 3. | Percent of applicable limit | % | 1.89E-06 | 7.83E-07 | 1.21E-05 | 3.20E-06 | |
| D. | GROSS ALPHA RADIOACTIVITY TOTAL RELEASE | Ci | <1.97E-04 | <1.95E-04 | <1.40E-04 | <2.01E-04 | N/A |
| E. | VOLUME OF WASTE RELEASED | Liters | 2.12E+06 | 2.10E+06 | 1.51E+06 | 2.17E+06 | 2.00 |
| F. | VOLUME OF DILUTION WATER USED DURING PERIOD | Liters | 5.95E+10 | 4.66E+10 | 1.86E+10 | 1.58E+10 | 3.48 |

2019 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 | 2.51E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 36.5 |
| 2. | Average diluted concentration during period | uCi/ml | 6.50E-11 | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| 3. | Percent of applicable limit | % | 6.50E-06 | 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 | 1.72E+07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.00 |
| F. | VOLUME OF DILUTION WATER USED DURING PERIOD | Liters | 3.86E+11 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.48 |

2019 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 ³ Curies | 9.15E+00 1.13E+01 | 1.00E+00 3.75E+00 |
| b) Dry compressible waste, contaminated equipment, etc. | m ³ Curies | 8.52E+02 1.67E+01 | 1.00E+00 6.48E+00 |
| c) Irradiated components, control rods, etc. | m ³ Curies | | |
| d) Other (contaminated soil) | m ³ Curies | | |

2) Estimate of Principle Radionuclide Composition

| | | | | | | | | |
|----|-------|------|-------|------|----------|------|--------|------|
| a) | H-3 | 34 % | Co-58 | 7% | Sb-125 | 1 % | Cs-137 | 1 % |
| | Mn-54 | 2 % | Co-60 | 18 % | Nb/Zr-95 | 6 % | | |
| | Fe-55 | 15 % | Ni-63 | 10 % | C-14 | 6 % | | |
| b) | Ni-59 | 1 % | Co-58 | 11 % | Sb-125 | 2 % | | |
| | Mn-54 | 3 % | Co-60 | 28 % | Zr/Nb-95 | 10 % | | |
| | Fe-55 | 24 % | Ni-63 | 9 % | Cs-137 | 2 % | C-14 | 10 % |
| | | | | | | | | |
| | | | | | | | | |

3) Solid Waste Disposition

| No. of Shipments | Mode of Transportation | Destination |
|------------------|------------------------|---------------|
| 22 | Truck | Oak Ridge, TN |
| 3 | Truck | Andrews, TX |
| | | |
| | | |

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.

| |
|--|
| <p align="center">2019 Effluent and Waste Disposal Annual Report Yearly Release Rates</p> |
|--|

| | | |
|--------------|--|--|
| GASES | | |
|--------------|--|--|

| | | |
|------------------------------|-------------------------|---|
| Fission and Activation Gases | Total Release | 1.31E+00 Curies |
| | Average Release Rate | 4.02E-02 μ Ci/sec |
| | % of Applicable Limits* | γ 2.50E-02 % β 9.40E-03 % |
| Iodines | Total I-131 Release | 0.00 Curies |
| | Average Release Rate | 0.00 μ Ci/sec |
| | % of Applicable Limit* | 0.00 % |
| Particulates | Total Release | 0.00 Curies |
| | Average Release Rate | 0.00 μ Ci/sec |
| | % of Applicable Limit* | 0.00 % |

| | | |
|----------------|--|--|
| LIQUIDS | | |
|----------------|--|--|

| | | |
|---------------------------------|-------------------------------|---|
| Fission and Activation Products | Total Release | 9.80E-04 Curies |
| | Average Diluted Concentration | 2.00E-12 μ Ci/ml |
| | % of Applicable Limits* | Total Body 1.42E+00 % Organ 4.28E-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 2019

| EFFLUENT | APPLICABLE ORGAN | ESTIMATED DOSE (mrem) | AGE GROUP | LOCATION DIST DIR (M) (Toward) | % OF APPLICABLE LIMIT | LIMIT (mrem) QTR |
|--------------------------|-----------------------|-----------------------|-----------|--------------------------------|-----------------------|------------------|
| Liquid | Total Body | 4.07E-02 | Child | Receptor 1 | 1.36E+00 | 1.5E+0 |
| Liquid | Liver | 4.07E-02 | Child | Receptor 1 | 4.07E-01 | 5.0E+0 |
| Noble Gas | Air Dose (Gamma-mrad) | 4.53E-04 | Any Age | 629 (SE) | 4.53E-03 | 5.0E+0 |
| Noble Gas | Air dose (Beta-mrad) | 1.71E-04 | Any Age | 629 (SE) | 8.55E-04 | 1.0E+1 |
| Iodines and Particulates | Total Body | 1.82E-02 | Child | 659 (N) | 1.21E-01 | 7.5E+0 |

Summary of Maximum Individual Doses

Second Quarter 2019

| EFFLUENT | APPLICABLE ORGAN | ESTIMATED DOSE (mrem) | AGE GROUP | LOCATION DIST DIR (M) (Toward) | % OF APPLICABLE LIMIT | LIMIT (mrem) QTR |
|--------------------------|-----------------------|-----------------------|-----------|--------------------------------|-----------------------|------------------|
| Liquid | Total Body | 1.38E-02 | Child | Receptor 1 | 4.59E-01 | 1.5E+0 |
| Liquid | Liver | 1.38E-02 | Child | Receptor 1 | 1.38E-01 | 5.0E+0 |
| Noble Gas | Air Dose (Gamma-mrad) | 7.10E-04 | Any Age | 594 (S) | 7.10E-03 | 5.0E+0 |
| Noble Gas | Air dose (Beta-mrad) | 3.88E-04 | Any Age | 629 (SSW) | 1.94E-03 | 1.0E+1 |
| Iodines and Particulates | Total Body | 2.75E-02 | Child | 659 (N) | 1.84E-01 | 7.5E+0 |

Summary of Maximum Individual Doses

Third Quarter 2019

| EFFLUENT | APPLICABLE ORGAN | ESTIMATED DOSE (mrem) | AGE GROUP | LOCATION DIST DIR (M) (Toward) | % OF APPLICABLE LIMIT | LIMIT (mrem) QTR |
|--------------------------|-------------------------|------------------------------|------------------|---------------------------------------|------------------------------|-------------------------|
| Liquid | Total Body | 1.87E-02 | Child | Receptor 1 | 6.20E-01 | 1.5E+0 |
| Liquid | GI-LLI | 1.87E-02 | Child | Receptor 1 | 1.87E-01 | 5.0E+0 |
| Noble Gas | Air Dose (Gamma-mrad) | 1.27E-03 | Any Age | 651 (N) | 1.27E-02 | 5.0E+0 |
| Noble Gas | Air dose (Beta-mrad) | 1.37E-03 | Any Age | 594 (S) | 6.85E-03 | 1.0E+1 |
| Iodines and Particulates | Total Body | 4.30E-02 | Child | 659 (N) | 2.87E-01 | 7.5E+0 |

Summary of Maximum Individual Doses

Fourth Quarter 2019

| EFFLUENT | APPLICABLE ORGAN | ESTIMATED DOSE (mrem) | AGE GROUP | LOCATION DIST DIR (M) (Toward) | % OF APPLICABLE LIMIT | LIMIT (mrem) QTR |
|--------------------------|-----------------------|-----------------------|-----------|--------------------------------|-----------------------|------------------|
| Liquid | Total Body | 1.18E-02 | Child | Receptor 1 | 3.94E-01 | 1.5E+0 |
| Liquid | GI_LLI | 1.21E-02 | Child | Receptor 1 | 1.21E-01 | 5.0E+0 |
| Noble Gas | Air Dose (Gamma-mrad) | 3.43E-04 | Any Age | 651 (N) | 3.43E-03 | 5.0E+0 |
| Noble Gas | Air dose (Beta-mrad) | 1.32E-04 | Any Age | 651 (N) | 6.60E-04 | 1.0E+1 |
| Iodines and Particulates | Total Body | 3.96E-02 | Child | 660 (NNE) | 2.64E-01 | 7.5E+0 |

2019 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 |
|------------|--------|--------|--------|--------|--------|--------|--------|--------|
| 02/28/2019 | | | | | | | <LLD | <LLD |
| 03/18/2019 | <LLD | <LLD | <LLD | <LLD | <LLD | <LLD | | |
| 04/26/2019 | | | | | | | <LLD | <LLD |
| 05/17/2019 | <LLD | <LLD | <LLD | <LLD | <LLD | <LLD | | |
| 08/28/2019 | <LLD | <LLD | <LLD | <LLD | <LLD * | <LLD | <LLD | <LLD |
| 11/19/2019 | <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.)

2019 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 | |
|------------|--------|--------|--------|--------|--------|--------|--------|--|
| 02/28/2019 | <LLD | <LLD | <LLD | <LLD | <LLD | <LLD | <LLD | |
| 04/26/2019 | <LLD | <LLD | <LLD | <LLD | <LLD | <LLD | <LLD | |
| 08/28/2019 | <LLD | <LLD | <LLD | <LLD | <LLD | <LLD | <LLD | |
| 11/19/2019 | <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.)

2019 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 |
|------------|------|------|------|------|------|------|------|------|
| 01/08/2019 | <LLD | <LLD | <LLD | | | | | <LLD |
| 01/09/2019 | | | | | | | <LLD | |
| 01/15/2019 | | | | <LLD | <LLD | <LLD | | |
| 04/03/2019 | <LLD | <LLD | <LLD | | | | | <LLD |
| 04/08/2019 | | | | <LLD | <LLD | <LLD | <LLD | |
| 06/12/2019 | | | | <LLD | | | | |
| 07/16/2019 | | <LLD | <LLD | | | | <LLD | |
| 07/17/2019 | | | | | | | | <LLD |
| 07/25/2019 | | | | <LLD | <LLD | <LLD | | |
| 10/08/2019 | | | | | | | <LLD | |
| 10/09/2019 | | <LLD | <LLD | | | | | |
| 11/04/2019 | <LLD | | | <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.)

2019 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 | | |
|------------|---------|--------|------|-----------|--------|--------|--|--|
| 01/15/2019 | | <LLD | | | | | | |
| 02/28/2019 | <LLD | <LLD | <LLD | 1.20e-6 | <LLD | | | |
| 03/27/2019 | | | | 1.34e-6 * | <LLD | | | |
| 03/31/2019 | 2.66e-6 | <LLD | <LLD | | | | | |
| 04/06/2019 | <LLD * | | | | | | | |
| 04/08/2019 | | <LLD | | | | | | |
| 04/27/2019 | | | <LLD | 1.05e-6 | <LLD | | | |
| 05/16/2019 | <LLD | | <LLD | 1.08e-6 | <LLD | | | |
| 06/28/2019 | | | <LLD | 1.08e-6 | <LLD * | | | |
| 07/25/2019 | | <LLD * | | | | | | |
| 08/23/2019 | <LLD | <LLD | | <LLD | <LLD | | | |
| 09/17/2019 | <LLD | <LLD | <LLD | 1.02e-6 | <LLD | | | |
| 11/01/2019 | <LLD | | <LLD | 1.25e-6 | <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.)

2019 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 |
|------------|------|------|------|------|-------|-------|-------|-------|
| 01/07/2019 | | | | | <LLD | | | |
| 01/09/2019 | | | | | | <LLD | <LLD | |
| 01/15/2019 | <LLD | <LLD | <LLD | <LLD | | | | |
| 04/01/2019 | | | | | <LLD | | | |
| 04/04/2019 | | | | | | <LLD | <LLD | |
| 04/08/2019 | <LLD | <LLD | <LLD | <LLD | | | | |
| 07/09/2019 | | | | | <LLD | | | |
| 07/16/2019 | | | | | | <LLD | <LLD | |
| 07/17/2019 | <LLD | <LLD | <LLD | <LLD | | | | |
| 10/07/2019 | | | | | <LLD | | | |
| 10/08/2019 | | | | | | <LLD | | |
| 10/09/2019 | <LLD | <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.)

2019 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 | |
|------------|------|------|------|------|------|------|------|--|
| 01/08/2019 | <LLD | | | | | | | |
| 01/09/2019 | | <LLD | <LLD | <LLD | <LLD | <LLD | <LLD | |
| 04/03/2019 | <LLD | | | | | | | |
| 04/04/2019 | | <LLD | <LLD | <LLD | | | | |
| 04/08/2019 | | | | | <LLD | <LLD | <LLD | |
| 07/16/2019 | <LLD | <LLD | <LLD | <LLD | <LLD | <LLD | <LLD | |
| 10/08/2019 | | | | | <LLD | <LLD | | |
| 10/09/2019 | <LLD | <LLD | <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.)

Analysis of the Sample Data

The Groundwater Protection Initiative (GPI) Sample Data for 2019 indicates no groundwater contamination in excess of the reporting threshold of $2.00\text{E-}5$ 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 2019 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 $9.45\text{E-}7$ and $9.98\text{E-}7$ uCi/mL, depending on which scintillation counter was used. This is well below the required maximum LLD value of $2.00\text{E-}6$ uCi/mL per the ODCM.

No tritium values were found significantly above LLD for 2019, 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 2019 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 2019 continue to reflect normal expectations and behaviors as they relate to recaptured tritium for the weather conditions observed. Wells OW-1 and MW-28 lie close to the vent stacks in the predominant wind directions, 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 2019 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 = 1/1/2019 - 3/31/2019

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>≥ 25</u> | <u>Total</u> |
|--|--------------|--------------|---------------|----------------|----------------|-------------|---------------------|
| N | 0 | 2 | 4 | 3 | 6 | 0 | 15 |
| NNE | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| NE | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| ENE | 0 | 2 | 3 | 1 | 0 | 0 | 6 |
| E | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| ESE | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| SE | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| SSE | 0 | 0 | 3 | 0 | 0 | 0 | 3 |
| S | 0 | 0 | 1 | 3 | 0 | 0 | 4 |
| SSW | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| SW | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| WSW | 0 | 0 | 4 | 7 | 0 | 0 | 11 |
| W | 0 | 3 | 4 | 4 | 0 | 0 | 11 |
| WNW | 0 | 7 | 5 | 9 | 0 | 0 | 21 |
| NW | 0 | 2 | 6 | 3 | 0 | 0 | 11 |
| NNW | 0 | 8 | 13 | 4 | 1 | 0 | 26 |
| Total | 0 | 27 | 45 | 39 | 7 | 0 | 118 |
| Calm Hours not Included above for : | | | | | | | Total Period |
| Valid Hours for this Stability Class for: | | | | | | | 0 |
| Total Hours for Period | | | | | | | Total Period |
| | | | | | | | 118 |
| | | | | | | | 2160 |

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

1/1/2019 - 3/31/2019

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>≥ 25</u> | <u>Total</u> |
|--|--------------|--------------|---------------|----------------|----------------|-------------|---------------------------|
| N | 0 | 2 | 5 | 0 | 2 | 0 | 9 |
| NNE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NE | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| ENE | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| E | 0 | 3 | 3 | 0 | 0 | 0 | 6 |
| ESE | 0 | 2 | 1 | 1 | 2 | 0 | 6 |
| SE | 0 | 1 | 3 | 0 | 0 | 0 | 4 |
| SSE | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| S | 0 | 1 | 1 | 1 | 0 | 0 | 3 |
| SSW | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| SW | 0 | 1 | 2 | 3 | 0 | 0 | 6 |
| WSW | 0 | 0 | 1 | 2 | 0 | 0 | 3 |
| W | 1 | 1 | 1 | 4 | 1 | 0 | 8 |
| WNW | 0 | 2 | 3 | 3 | 1 | 0 | 9 |
| NW | 0 | 2 | 1 | 1 | 0 | 0 | 4 |
| NNW | 0 | 2 | 7 | 0 | 0 | 0 | 9 |
| Total | 1 | 17 | 31 | 17 | 6 | 0 | 72 |
| Calm Hours not Included above for : | | | | | | | Total Period 0 |
| Valid Hours for this Stability Class for: | | | | | | | Total Period 72 |
| Total Hours for Period | | | | | | | 2160 |

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

1/1/2019 - 3/31/2019

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>> 25</u> | <u>Total</u> |
|---|--------------|--------------|---------------|----------------|----------------|----------------|--------------|
| N | 0 | 2 | 3 | 2 | 2 | 0 | 9 |
| NNE | 0 | 2 | 6 | 0 | 0 | 0 | 8 |
| NE | 0 | 2 | 1 | 0 | 0 | 0 | 3 |
| ENE | 2 | 2 | 0 | 1 | 0 | 0 | 5 |
| E | 0 | 4 | 10 | 0 | 0 | 0 | 14 |
| ESE | 0 | 0 | 1 | 0 | 0 | 1 | 2 |
| SE | 0 | 2 | 2 | 1 | 0 | 0 | 5 |
| SSE | 0 | 2 | 2 | 0 | 0 | 0 | 4 |
| S | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| SSW | 0 | 1 | 1 | 2 | 0 | 0 | 4 |
| SW | 0 | 1 | 7 | 5 | 0 | 0 | 13 |
| WSW | 0 | 4 | 5 | 5 | 0 | 0 | 14 |
| W | 0 | 2 | 1 | 10 | 5 | 0 | 18 |
| WNW | 0 | 2 | 1 | 5 | 2 | 0 | 10 |
| NW | 0 | 1 | 0 | 1 | 0 | 0 | 2 |
| NNW | 0 | 3 | 2 | 4 | 0 | 0 | 9 |
| Total | 2 | 30 | 44 | 36 | 9 | 1 | 122 |
| Calm Hours not Included above for : | | | | | | | 0 |
| Valid Hours for this Stability Class for: | | | | | | | 122 |
| Total Hours for Period | | | | | | | 2160 |

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

1/1/2019 - 3/31/2019

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>> 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|----------------|--------------|
| N | 2 | 34 | 32 | 22 | 7 | 4 | 101 |
| NNE | 1 | 13 | 15 | 6 | 1 | 0 | 36 |
| NE | 2 | 16 | 12 | 16 | 2 | 0 | 48 |
| ENE | 2 | 14 | 28 | 16 | 2 | 0 | 62 |
| E | 1 | 19 | 36 | 29 | 3 | 0 | 88 |
| ESE | 6 | 24 | 43 | 40 | 10 | 6 | 129 |
| SE | 9 | 18 | 19 | 25 | 20 | 1 | 92 |
| SSE | 2 | 8 | 19 | 11 | 7 | 2 | 49 |
| S | 2 | 7 | 29 | 26 | 1 | 0 | 65 |
| SSW | 2 | 7 | 16 | 15 | 2 | 0 | 42 |
| SW | 3 | 7 | 20 | 21 | 18 | 1 | 70 |
| WSW | 1 | 20 | 12 | 30 | 51 | 25 | 139 |
| W | 4 | 23 | 7 | 31 | 41 | 34 | 140 |
| WNW | 2 | 4 | 17 | 54 | 32 | 6 | 115 |
| NW | 3 | 9 | 26 | 34 | 19 | 2 | 93 |
| NNW | 2 | 19 | 34 | 27 | 10 | 0 | 92 |
| Total | 44 | 242 | 365 | 403 | 226 | 81 | 1361 |

Calm Hours not Included above for :

Total Period

0

Valid Hours for this Stability Class for:

Total Period

1361

Total Hours for Period

2160

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

1/1/2019 - 3/31/2019

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>> 25</u> | <u>Total</u> |
|--|--------------|--------------|---------------|----------------|----------------|----------------|---------------------|
| N | 1 | 4 | 7 | 1 | 0 | 0 | 13 |
| NNE | 0 | 7 | 7 | 2 | 0 | 0 | 16 |
| NE | 0 | 9 | 11 | 4 | 0 | 0 | 24 |
| ENE | 1 | 7 | 11 | 1 | 0 | 0 | 20 |
| E | 0 | 3 | 5 | 2 | 0 | 0 | 10 |
| ESE | 0 | 1 | 7 | 5 | 0 | 0 | 13 |
| SE | 3 | 2 | 2 | 9 | 1 | 0 | 17 |
| SSE | 2 | 4 | 13 | 14 | 7 | 0 | 40 |
| S | 0 | 1 | 14 | 45 | 3 | 0 | 63 |
| SSW | 2 | 4 | 12 | 15 | 0 | 0 | 33 |
| SW | 1 | 1 | 5 | 11 | 2 | 1 | 21 |
| WSW | 1 | 1 | 6 | 7 | 1 | 3 | 19 |
| W | 0 | 2 | 4 | 12 | 3 | 0 | 21 |
| WNW | 0 | 0 | 0 | 6 | 2 | 0 | 8 |
| NW | 2 | 1 | 0 | 2 | 0 | 0 | 5 |
| NNW | 0 | 3 | 0 | 1 | 0 | 0 | 4 |
| Total | 13 | 50 | 104 | 137 | 19 | 4 | 327 |
| Calm Hours not Included above for : | | | | | | | Total Period |
| Valid Hours for this Stability Class for: | | | | | | | 0 |
| Total Hours for Period | | | | | | | 327 |
| | | | | | | | 2160 |

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

1/1/2019 - 3/31/2019

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>> 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|----------------|--------------|
| N | 0 | 5 | 1 | 0 | 0 | 0 | 6 |
| NNE | 0 | 4 | 2 | 0 | 0 | 0 | 6 |
| NE | 0 | 2 | 5 | 0 | 0 | 0 | 7 |
| ENE | 0 | 1 | 9 | 0 | 0 | 0 | 10 |
| E | 0 | 1 | 3 | 2 | 0 | 0 | 6 |
| ESE | 0 | 0 | 9 | 2 | 0 | 0 | 11 |
| SE | 1 | 1 | 7 | 0 | 0 | 0 | 9 |
| SSE | 0 | 1 | 1 | 1 | 0 | 0 | 3 |
| S | 0 | 1 | 5 | 4 | 0 | 0 | 10 |
| SSW | 0 | 0 | 3 | 3 | 0 | 0 | 6 |
| SW | 0 | 0 | 3 | 1 | 0 | 0 | 4 |
| WSW | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| W | 0 | 2 | 3 | 0 | 0 | 0 | 5 |
| WNW | 0 | 3 | 4 | 0 | 0 | 0 | 7 |
| NW | 0 | 4 | 1 | 0 | 0 | 0 | 5 |
| NNW | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Total | 1 | 28 | 56 | 13 | 0 | 0 | 98 |

Calm Hours not Included above for :

Total Period

0

Valid Hours for this Stability Class for:

Total Period

98

Total Hours for Period

2160

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

1/1/2019 - 3/31/2019

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>> 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|----------------|--------------|
| N | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NNE | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| NE | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| ENE | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| E | 0 | 0 | 2 | 2 | 0 | 0 | 4 |
| ESE | 0 | 4 | 0 | 0 | 0 | 0 | 4 |
| SE | 0 | 2 | 2 | 0 | 0 | 0 | 4 |
| SSE | 0 | 0 | 3 | 3 | 0 | 0 | 6 |
| S | 0 | 1 | 2 | 5 | 0 | 0 | 8 |
| SSW | 0 | 2 | 3 | 0 | 0 | 0 | 5 |
| SW | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| WSW | 0 | 3 | 0 | 0 | 0 | 0 | 3 |
| W | 1 | 4 | 1 | 0 | 0 | 0 | 6 |
| WNW | 1 | 6 | 2 | 0 | 0 | 0 | 9 |
| NW | 1 | 0 | 2 | 0 | 0 | 0 | 3 |
| NNW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 3 | 25 | 19 | 10 | 0 | 0 | 57 |

Calm Hours not Included above for :

Total Period

0

Valid Hours for this Stability Class for:

Total Period

57

Total Hours for Period

2160

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Summary of All Stability Classes

Total Period

Period of Record =

1/1/2019 - 3/31/2019

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>≥ 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 3 | 49 | 52 | 28 | 17 | 4 | 153 |
| NNE | 1 | 27 | 31 | 8 | 1 | 0 | 68 |
| NE | 2 | 30 | 30 | 22 | 2 | 0 | 86 |
| ENE | 5 | 26 | 52 | 20 | 2 | 0 | 105 |
| E | 1 | 32 | 59 | 35 | 3 | 0 | 130 |
| ESE | 6 | 32 | 61 | 48 | 12 | 7 | 166 |
| SE | 13 | 26 | 36 | 35 | 21 | 1 | 132 |
| SSE | 4 | 15 | 42 | 29 | 14 | 2 | 106 |
| S | 2 | 11 | 54 | 84 | 4 | 0 | 155 |
| SSW | 4 | 14 | 36 | 37 | 2 | 0 | 93 |
| SW | 4 | 11 | 38 | 43 | 20 | 2 | 118 |
| WSW | 2 | 30 | 28 | 51 | 52 | 28 | 191 |
| W | 6 | 37 | 21 | 61 | 50 | 34 | 209 |
| WNW | 3 | 24 | 32 | 77 | 37 | 6 | 179 |
| NW | 6 | 19 | 36 | 41 | 19 | 2 | 123 |
| NNW | 2 | 36 | 56 | 36 | 11 | 0 | 141 |
| Total | 64 | 419 | 664 | 655 | 267 | 86 | 2155 |

Calm Hours not Included above for :

Total Period 0

Variable Direction Hours for:

Total Period 0

Invalid Hours for:

Total Period 5

Valid Hours for this Stability Class for:

Total Period 2155

Total Hours for Period

2160

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

4/1/2019 - 6/30/2019

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>≥ 25</u> | <u>Total</u> |
|--|--------------|--------------|---------------|----------------|----------------|-------------|-------------------------|
| N | 4 | 10 | 34 | 15 | 3 | 0 | 66 |
| NNE | 1 | 4 | 5 | 2 | 0 | 0 | 12 |
| NE | 2 | 2 | 3 | 2 | 1 | 0 | 10 |
| ENE | 2 | 6 | 5 | 3 | 0 | 0 | 16 |
| E | 0 | 6 | 1 | 0 | 0 | 0 | 7 |
| ESE | 1 | 7 | 2 | 1 | 3 | 4 | 18 |
| SE | 1 | 3 | 7 | 4 | 0 | 0 | 15 |
| SSE | 0 | 0 | 8 | 10 | 1 | 0 | 19 |
| S | 0 | 0 | 1 | 4 | 2 | 0 | 7 |
| SSW | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| SW | 1 | 0 | 4 | 1 | 2 | 0 | 8 |
| WSW | 1 | 4 | 7 | 3 | 3 | 0 | 18 |
| W | 2 | 8 | 15 | 3 | 0 | 0 | 28 |
| WNW | 1 | 13 | 19 | 0 | 0 | 0 | 33 |
| NW | 3 | 15 | 22 | 8 | 4 | 0 | 52 |
| NNW | 1 | 19 | 43 | 14 | 3 | 2 | 82 |
| Total | 20 | 97 | 177 | 71 | 22 | 6 | 393 |
| Calm Hours not Included above for : | | | | | | | Total Period 1 |
| Valid Hours for this Stability Class for: | | | | | | | Total Period 393 |
| Total Hours for Period | | | | | | | 2184 |

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

4/1/2019 - 6/30/2019

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>≥ 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 0 | 7 | 6 | 8 | 3 | 0 | 24 |
| NNE | 0 | 1 | 2 | 1 | 0 | 0 | 4 |
| NE | 1 | 4 | 0 | 0 | 0 | 0 | 5 |
| ENE | 0 | 1 | 2 | 0 | 0 | 0 | 3 |
| E | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| ESE | 0 | 1 | 1 | 0 | 2 | 1 | 5 |
| SE | 0 | 1 | 1 | 3 | 0 | 0 | 5 |
| SSE | 0 | 1 | 1 | 2 | 1 | 0 | 5 |
| S | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| SSW | 0 | 0 | 1 | 3 | 1 | 0 | 5 |
| SW | 1 | 0 | 3 | 5 | 0 | 0 | 9 |
| WSW | 0 | 4 | 5 | 4 | 0 | 0 | 13 |
| W | 1 | 6 | 4 | 2 | 0 | 0 | 13 |
| WNW | 0 | 7 | 3 | 2 | 0 | 0 | 12 |
| NW | 0 | 5 | 3 | 0 | 0 | 0 | 8 |
| NNW | 1 | 5 | 6 | 3 | 1 | 1 | 17 |
| Total | 4 | 44 | 39 | 35 | 8 | 2 | 132 |

Calm Hours not Included above for :

Total Period

1

Valid Hours for this Stability Class for:

Total Period

132

Total Hours for Period

2184

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

4/1/2019 - 6/30/2019

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>≥ 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 0 | 3 | 11 | 5 | 1 | 0 | 20 |
| NNE | 0 | 1 | 0 | 1 | 0 | 0 | 2 |
| NE | 0 | 1 | 2 | 0 | 0 | 0 | 3 |
| ENE | 2 | 3 | 2 | 2 | 0 | 0 | 9 |
| E | 0 | 6 | 5 | 3 | 0 | 0 | 14 |
| ESE | 0 | 3 | 5 | 1 | 0 | 1 | 10 |
| SE | 0 | 1 | 3 | 2 | 0 | 0 | 6 |
| SSE | 0 | 1 | 1 | 2 | 0 | 0 | 4 |
| S | 0 | 1 | 1 | 4 | 1 | 0 | 7 |
| SSW | 0 | 1 | 2 | 2 | 0 | 0 | 5 |
| SW | 0 | 0 | 3 | 3 | 0 | 0 | 6 |
| WSW | 0 | 5 | 8 | 3 | 1 | 1 | 18 |
| W | 0 | 5 | 2 | 1 | 0 | 0 | 8 |
| WNW | 0 | 4 | 1 | 0 | 1 | 0 | 6 |
| NW | 1 | 4 | 1 | 2 | 0 | 0 | 8 |
| NNW | 0 | 13 | 4 | 0 | 0 | 1 | 18 |
| Total | 3 | 52 | 51 | 31 | 4 | 3 | 144 |

Calm Hours not Included above for :

Total Period

1

Valid Hours for this Stability Class for:

Total Period

144

Total Hours for Period

2184

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

4/1/2019 - 6/30/2019

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>≥ 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 4 | 29 | 18 | 15 | 5 | 1 | 72 |
| NNE | 2 | 10 | 10 | 5 | 3 | 0 | 30 |
| NE | 2 | 9 | 13 | 3 | 0 | 0 | 27 |
| ENE | 4 | 8 | 7 | 11 | 0 | 0 | 30 |
| E | 2 | 2 | 19 | 23 | 11 | 3 | 60 |
| ESE | 2 | 10 | 14 | 29 | 26 | 2 | 83 |
| SE | 7 | 6 | 17 | 9 | 5 | 0 | 44 |
| SSE | 1 | 7 | 5 | 8 | 1 | 0 | 22 |
| S | 2 | 4 | 7 | 10 | 0 | 0 | 23 |
| SSW | 1 | 5 | 24 | 16 | 4 | 0 | 50 |
| SW | 2 | 4 | 16 | 31 | 3 | 0 | 56 |
| WSW | 1 | 19 | 10 | 14 | 5 | 0 | 49 |
| W | 2 | 9 | 8 | 7 | 4 | 0 | 30 |
| WNW | 4 | 6 | 3 | 6 | 0 | 0 | 19 |
| NW | 4 | 16 | 8 | 6 | 0 | 0 | 34 |
| NNW | 1 | 17 | 12 | 9 | 6 | 2 | 47 |
| Total | 41 | 161 | 191 | 202 | 73 | 8 | 676 |

Calm Hours not Included above for :

Total Period

1

Valid Hours for this Stability Class for:

Total Period

676

Total Hours for Period

2184

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

4/1/2019 - 6/30/2019

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>≥ 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 1 | 13 | 20 | 3 | 0 | 0 | 37 |
| NNE | 1 | 12 | 6 | 10 | 1 | 0 | 30 |
| NE | 1 | 4 | 10 | 2 | 0 | 0 | 17 |
| ENE | 0 | 2 | 10 | 2 | 0 | 0 | 14 |
| E | 1 | 1 | 16 | 8 | 0 | 0 | 26 |
| ESE | 0 | 7 | 10 | 10 | 1 | 0 | 28 |
| SE | 2 | 4 | 10 | 5 | 1 | 0 | 22 |
| SSE | 0 | 3 | 11 | 17 | 1 | 0 | 32 |
| S | 0 | 0 | 27 | 18 | 3 | 0 | 48 |
| SSW | 0 | 2 | 22 | 17 | 0 | 0 | 41 |
| SW | 0 | 4 | 10 | 20 | 3 | 0 | 37 |
| WSW | 0 | 0 | 15 | 24 | 3 | 0 | 42 |
| W | 1 | 5 | 9 | 13 | 8 | 0 | 36 |
| WNW | 1 | 5 | 4 | 2 | 1 | 0 | 13 |
| NW | 3 | 4 | 1 | 2 | 1 | 0 | 11 |
| NNW | 2 | 12 | 5 | 3 | 3 | 0 | 25 |
| Total | 13 | 78 | 186 | 156 | 26 | 0 | 459 |

Calm Hours not Included above for :

Total Period

1

Valid Hours for this Stability Class for:

Total Period

459

Total Hours for Period

2184

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

4/1/2019 - 6/30/2019

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>≥ 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 2 | 6 | 3 | 0 | 0 | 0 | 11 |
| NNE | 1 | 9 | 1 | 0 | 0 | 0 | 11 |
| NE | 0 | 5 | 4 | 0 | 0 | 0 | 9 |
| ENE | 0 | 3 | 12 | 0 | 0 | 0 | 15 |
| E | 0 | 3 | 14 | 2 | 0 | 0 | 19 |
| ESE | 2 | 2 | 4 | 3 | 0 | 0 | 11 |
| SE | 0 | 3 | 9 | 1 | 0 | 0 | 13 |
| SSE | 1 | 5 | 9 | 5 | 0 | 0 | 20 |
| S | 0 | 1 | 10 | 6 | 0 | 0 | 17 |
| SSW | 0 | 2 | 7 | 4 | 0 | 0 | 13 |
| SW | 1 | 0 | 8 | 2 | 0 | 0 | 11 |
| WSW | 1 | 1 | 5 | 0 | 0 | 0 | 7 |
| W | 0 | 4 | 4 | 0 | 0 | 0 | 8 |
| WNW | 1 | 4 | 1 | 0 | 0 | 0 | 6 |
| NW | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| NNW | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Total | 9 | 50 | 91 | 23 | 0 | 0 | 173 |

Calm Hours not Included above for :

Total Period

1

Valid Hours for this Stability Class for:

Total Period

173

Total Hours for Period

2184

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

4/1/2019 - 6/30/2019

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>≥ 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 2 | 1 | 2 | 0 | 0 | 0 | 5 |
| NNE | 5 | 6 | 1 | 0 | 0 | 0 | 12 |
| NE | 1 | 7 | 7 | 0 | 0 | 0 | 15 |
| ENE | 2 | 5 | 12 | 1 | 0 | 0 | 20 |
| E | 2 | 4 | 10 | 1 | 0 | 0 | 17 |
| ESE | 1 | 9 | 7 | 1 | 0 | 0 | 18 |
| SE | 3 | 6 | 10 | 0 | 0 | 0 | 19 |
| SSE | 2 | 4 | 7 | 7 | 0 | 0 | 20 |
| S | 1 | 2 | 9 | 2 | 0 | 0 | 14 |
| SSW | 0 | 2 | 3 | 2 | 0 | 0 | 7 |
| SW | 1 | 2 | 11 | 2 | 0 | 0 | 16 |
| WSW | 0 | 4 | 6 | 0 | 0 | 0 | 10 |
| W | 1 | 6 | 1 | 0 | 0 | 0 | 8 |
| WNW | 0 | 3 | 0 | 0 | 0 | 0 | 3 |
| NW | 0 | 2 | 1 | 0 | 0 | 0 | 3 |
| NNW | 1 | 3 | 1 | 0 | 0 | 0 | 5 |
| Total | 22 | 66 | 88 | 16 | 0 | 0 | 192 |

Calm Hours not Included above for :

Total Period

1

Valid Hours for this Stability Class for:

Total Period

192

Total Hours for Period

2184

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Summary of All Stability Classes**Total Period**

Period of Record =

4/1/2019 - 6/30/2019

Elevation: Speed: SPD60M

Direction: DIR60M

Lapse: DT60M

Delta Temperature

Wind Speed (mph)

| Wind Direction | <u>1 - 4</u> | <u>4 - 8</u> | <u>8 - 13</u> | <u>13 - 19</u> | <u>19 - 25</u> | <u>≥ 25</u> | <u>Total</u> |
|--|---------------------|---------------------|----------------------|-----------------------|-----------------------|--------------------|---------------------|
| N | 13 | 69 | 94 | 46 | 12 | 1 | 235 |
| NNE | 10 | 43 | 25 | 19 | 4 | 0 | 101 |
| NE | 7 | 32 | 39 | 7 | 1 | 0 | 86 |
| ENE | 10 | 28 | 50 | 19 | 0 | 0 | 107 |
| E | 5 | 23 | 66 | 37 | 11 | 3 | 145 |
| ESE | 6 | 39 | 43 | 45 | 32 | 8 | 173 |
| SE | 13 | 24 | 57 | 24 | 6 | 0 | 124 |
| SSE | 4 | 21 | 42 | 51 | 4 | 0 | 122 |
| S | 3 | 8 | 55 | 46 | 6 | 0 | 118 |
| SSW | 1 | 12 | 60 | 45 | 5 | 0 | 123 |
| SW | 6 | 10 | 55 | 64 | 8 | 0 | 143 |
| WSW | 3 | 37 | 56 | 48 | 12 | 1 | 157 |
| W | 7 | 43 | 43 | 26 | 12 | 0 | 131 |
| WNW | 7 | 42 | 31 | 10 | 2 | 0 | 92 |
| NW | 11 | 47 | 36 | 18 | 5 | 0 | 117 |
| NNW | 6 | 70 | 71 | 29 | 13 | 6 | 195 |
| Total | 112 | 548 | 823 | 534 | 133 | 19 | 2169 |
| Calm Hours not Included above for : | | | | | Total Period | | 1 |
| Variable Direction Hours for: | | | | | Total Period | | 0 |
| Invalid Hours for: | | | | | Total Period | | 14 |
| Valid Hours for this Stability Class for: | | | | | Total Period | | 2169 |
| Total Hours for Period | | | | | | | 2184 |

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record = 7/1/2019 - 9/30/2019

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>≥ 25</u> | <u>Total</u> |
|--|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 0 | 6 | 42 | 33 | 0 | 0 | 81 |
| NNE | 0 | 1 | 2 | 0 | 0 | 0 | 3 |
| NE | 0 | 3 | 0 | 1 | 0 | 0 | 4 |
| ENE | 1 | 1 | 3 | 0 | 0 | 0 | 5 |
| E | 0 | 4 | 7 | 3 | 0 | 0 | 14 |
| ESE | 0 | 6 | 7 | 4 | 0 | 0 | 17 |
| SE | 0 | 8 | 8 | 0 | 0 | 0 | 16 |
| SSE | 0 | 2 | 7 | 0 | 1 | 0 | 10 |
| S | 0 | 1 | 1 | 2 | 0 | 0 | 4 |
| SSW | 0 | 0 | 3 | 0 | 0 | 0 | 3 |
| SW | 0 | 1 | 5 | 9 | 0 | 0 | 15 |
| WSW | 0 | 4 | 32 | 3 | 0 | 0 | 39 |
| W | 0 | 14 | 12 | 0 | 0 | 0 | 26 |
| WNW | 0 | 19 | 14 | 5 | 0 | 0 | 38 |
| NW | 0 | 21 | 13 | 2 | 0 | 0 | 36 |
| NNW | 0 | 19 | 46 | 12 | 0 | 0 | 77 |
| Total | 1 | 110 | 202 | 74 | 1 | 0 | 388 |
| Calm Hours not Included above for : | | | | | | | 0 |
| Valid Hours for this Stability Class for: | | | | | | | 388 |
| Total Hours for Period | | | | | | | 2208 |

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

7/1/2019 - 9/30/2019

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>≥ 25</u> | <u>Total</u> |
|--|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 0 | 3 | 4 | 2 | 0 | 0 | 9 |
| NNE | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| NE | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| ENE | 1 | 0 | 2 | 0 | 0 | 0 | 3 |
| E | 1 | 6 | 2 | 0 | 0 | 0 | 9 |
| ESE | 0 | 2 | 1 | 0 | 0 | 0 | 3 |
| SE | 0 | 2 | 2 | 0 | 0 | 0 | 4 |
| SSE | 0 | 1 | 3 | 0 | 0 | 0 | 4 |
| S | 1 | 1 | 3 | 0 | 0 | 0 | 5 |
| SSW | 0 | 0 | 3 | 1 | 0 | 0 | 4 |
| SW | 0 | 4 | 4 | 7 | 0 | 0 | 15 |
| WSW | 1 | 3 | 17 | 2 | 0 | 0 | 23 |
| W | 0 | 5 | 7 | 1 | 0 | 0 | 13 |
| WNW | 0 | 6 | 3 | 0 | 0 | 0 | 9 |
| NW | 0 | 3 | 2 | 0 | 0 | 0 | 5 |
| NNW | 1 | 2 | 2 | 0 | 0 | 0 | 5 |
| Total | 6 | 39 | 56 | 14 | 0 | 0 | 115 |
| Calm Hours not Included above for : | | | | | | | 0 |
| Valid Hours for this Stability Class for: | | | | | | | 115 |
| Total Hours for Period | | | | | | | 2208 |

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

7/1/2019 - 9/30/2019

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>≥ 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 1 | 3 | 2 | 1 | 0 | 0 | 7 |
| NNE | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| NE | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| ENE | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| E | 0 | 3 | 3 | 0 | 0 | 0 | 6 |
| ESE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SE | 0 | 3 | 3 | 2 | 0 | 0 | 8 |
| SSE | 0 | 3 | 1 | 0 | 0 | 0 | 4 |
| S | 1 | 1 | 4 | 4 | 1 | 0 | 11 |
| SSW | 1 | 0 | 5 | 0 | 0 | 0 | 6 |
| SW | 3 | 2 | 9 | 2 | 0 | 0 | 16 |
| WSW | 0 | 10 | 5 | 1 | 0 | 0 | 16 |
| W | 1 | 3 | 4 | 0 | 0 | 0 | 8 |
| WNW | 0 | 5 | 0 | 0 | 0 | 0 | 5 |
| NW | 0 | 4 | 1 | 0 | 0 | 0 | 5 |
| NNW | 0 | 4 | 1 | 1 | 0 | 0 | 6 |
| Total | 7 | 44 | 40 | 11 | 1 | 0 | 103 |

Calm Hours not Included above for :

Total Period

0

Valid Hours for this Stability Class for:

Total Period

103

Total Hours for Period

2208

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

7/1/2019 - 9/30/2019

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>≥ 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 1 | 14 | 23 | 12 | 0 | 0 | 50 |
| NNE | 0 | 4 | 6 | 1 | 0 | 0 | 11 |
| NE | 0 | 5 | 2 | 0 | 0 | 0 | 7 |
| ENE | 0 | 6 | 7 | 0 | 0 | 0 | 13 |
| E | 0 | 5 | 9 | 5 | 0 | 0 | 19 |
| ESE | 3 | 5 | 20 | 9 | 0 | 0 | 37 |
| SE | 1 | 5 | 15 | 9 | 0 | 0 | 30 |
| SSE | 1 | 5 | 5 | 8 | 1 | 0 | 20 |
| S | 4 | 9 | 17 | 7 | 0 | 0 | 37 |
| SSW | 0 | 5 | 26 | 8 | 2 | 0 | 41 |
| SW | 4 | 9 | 23 | 39 | 4 | 0 | 79 |
| WSW | 1 | 8 | 17 | 6 | 2 | 0 | 34 |
| W | 2 | 5 | 9 | 6 | 0 | 0 | 22 |
| WNW | 3 | 7 | 7 | 2 | 1 | 0 | 20 |
| NW | 3 | 8 | 7 | 6 | 0 | 0 | 24 |
| NNW | 0 | 12 | 5 | 6 | 3 | 0 | 26 |
| Total | 23 | 112 | 198 | 124 | 13 | 0 | 470 |

Calm Hours not Included above for :

Total Period

0

Valid Hours for this Stability Class for:

Total Period

470

Total Hours for Period

2208

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

7/1/2019 - 9/30/2019

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>≥ 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 1 | 10 | 13 | 6 | 0 | 0 | 30 |
| NNE | 2 | 10 | 22 | 1 | 0 | 0 | 35 |
| NE | 2 | 15 | 11 | 1 | 0 | 0 | 29 |
| ENE | 0 | 11 | 11 | 1 | 0 | 0 | 23 |
| E | 0 | 7 | 23 | 0 | 0 | 0 | 30 |
| ESE | 2 | 2 | 16 | 5 | 0 | 0 | 25 |
| SE | 2 | 4 | 9 | 5 | 0 | 0 | 20 |
| SSE | 2 | 3 | 10 | 12 | 0 | 0 | 27 |
| S | 0 | 6 | 29 | 18 | 4 | 1 | 58 |
| SSW | 1 | 7 | 47 | 19 | 0 | 0 | 74 |
| SW | 0 | 14 | 27 | 16 | 3 | 0 | 60 |
| WSW | 1 | 3 | 13 | 7 | 1 | 0 | 25 |
| W | 1 | 1 | 12 | 18 | 0 | 0 | 32 |
| WNW | 1 | 2 | 13 | 5 | 2 | 0 | 23 |
| NW | 3 | 6 | 7 | 18 | 0 | 0 | 34 |
| NNW | 2 | 7 | 1 | 2 | 0 | 0 | 12 |
| Total | 20 | 108 | 264 | 134 | 10 | 1 | 537 |

Calm Hours not Included above for :

Total Period

0

Valid Hours for this Stability Class for:

Total Period

537

Total Hours for Period

2208

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

7/1/2019 - 9/30/2019

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>≥ 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 1 | 8 | 12 | 0 | 0 | 0 | 21 |
| NNE | 0 | 9 | 11 | 2 | 0 | 0 | 22 |
| NE | 0 | 10 | 12 | 0 | 0 | 0 | 22 |
| ENE | 0 | 8 | 9 | 0 | 0 | 0 | 17 |
| E | 1 | 1 | 9 | 0 | 0 | 0 | 11 |
| ESE | 1 | 4 | 12 | 0 | 0 | 0 | 17 |
| SE | 3 | 2 | 18 | 2 | 0 | 0 | 25 |
| SSE | 1 | 3 | 8 | 4 | 0 | 0 | 16 |
| S | 0 | 7 | 20 | 6 | 0 | 0 | 33 |
| SSW | 1 | 2 | 20 | 4 | 0 | 0 | 27 |
| SW | 0 | 7 | 12 | 0 | 0 | 0 | 19 |
| WSW | 2 | 1 | 4 | 0 | 0 | 0 | 7 |
| W | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| WNW | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| NW | 4 | 5 | 1 | 0 | 0 | 0 | 10 |
| NNW | 0 | 5 | 4 | 0 | 0 | 0 | 9 |
| Total | 14 | 74 | 153 | 18 | 0 | 0 | 259 |

Calm Hours not Included above for :

Total Period

0

Valid Hours for this Stability Class for:

Total Period

259

Total Hours for Period

2208

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

7/1/2019 - 9/30/2019

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>> 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|----------------|--------------|
| N | 0 | 7 | 4 | 0 | 0 | 0 | 11 |
| NNE | 3 | 2 | 11 | 0 | 0 | 0 | 16 |
| NE | 3 | 4 | 7 | 0 | 0 | 0 | 14 |
| ENE | 0 | 5 | 19 | 2 | 0 | 0 | 26 |
| E | 3 | 9 | 34 | 1 | 0 | 0 | 47 |
| ESE | 2 | 7 | 26 | 0 | 0 | 0 | 35 |
| SE | 2 | 8 | 14 | 0 | 0 | 0 | 24 |
| SSE | 0 | 8 | 21 | 5 | 0 | 0 | 34 |
| S | 1 | 9 | 20 | 2 | 0 | 0 | 32 |
| SSW | 0 | 4 | 12 | 0 | 0 | 0 | 16 |
| SW | 2 | 10 | 13 | 0 | 0 | 0 | 25 |
| WSW | 1 | 12 | 2 | 0 | 0 | 0 | 15 |
| W | 1 | 11 | 5 | 0 | 0 | 0 | 17 |
| WNW | 2 | 7 | 2 | 0 | 0 | 0 | 11 |
| NW | 1 | 5 | 0 | 0 | 0 | 0 | 6 |
| NNW | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| Total | 21 | 109 | 191 | 10 | 0 | 0 | 331 |

Calm Hours not Included above for :

Total Period

0

Valid Hours for this Stability Class for:

Total Period

331

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 =

7/1/2019 - 9/30/2019

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>> 25</u> | <u>Total</u> |
|---|--------------|--------------|---------------|----------------|----------------|----------------|-------------------|
| N | 4 | 51 | 100 | 54 | 0 | 0 | 209 |
| NNE | 5 | 27 | 54 | 5 | 0 | 0 | 91 |
| NE | 6 | 39 | 32 | 2 | 0 | 0 | 79 |
| ENE | 2 | 32 | 52 | 3 | 0 | 0 | 89 |
| E | 5 | 35 | 87 | 9 | 0 | 0 | 136 |
| ESE | 8 | 26 | 82 | 18 | 0 | 0 | 134 |
| SE | 8 | 32 | 69 | 18 | 0 | 0 | 127 |
| SSE | 4 | 25 | 55 | 29 | 2 | 0 | 115 |
| S | 7 | 34 | 94 | 39 | 5 | 1 | 180 |
| SSW | 3 | 18 | 116 | 32 | 2 | 0 | 171 |
| SW | 9 | 47 | 93 | 73 | 7 | 0 | 229 |
| WSW | 6 | 41 | 90 | 19 | 3 | 0 | 159 |
| W | 5 | 39 | 50 | 25 | 0 | 0 | 119 |
| WNW | 6 | 48 | 39 | 12 | 3 | 0 | 108 |
| NW | 11 | 52 | 31 | 26 | 0 | 0 | 120 |
| NNW | 3 | 50 | 60 | 21 | 3 | 0 | 137 |
| Total | 92 | 596 | 1104 | 385 | 25 | 1 | 2203 |
| Calm Hours not Included above for : | | | | | | | Total Period 0 |
| Variable Direction Hours for: | | | | | | | Total Period 0 |
| Invalid Hours for: | | | | | | | Total Period 5 |
| Valid Hours for this Stability Class for: | | | | | | | Total Period 2203 |
| Total Hours for Period | | | | | | | 2208 |

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

10/1/2019 - 12/31/2019

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>≥ 25</u> | <u>Total</u> |
|---|--------------|--------------|---------------|----------------|----------------|-------------|-----------------|
| N | 0 | 0 | 5 | 4 | 0 | 0 | 9 |
| NNE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NE | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| ENE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| ESE | 0 | 0 | 3 | 0 | 0 | 0 | 3 |
| SE | 0 | 2 | 9 | 1 | 0 | 0 | 12 |
| SSE | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| S | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SSW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| WSW | 0 | 0 | 3 | 0 | 1 | 0 | 4 |
| W | 0 | 0 | 3 | 6 | 0 | 0 | 9 |
| WNW | 0 | 1 | 5 | 1 | 0 | 0 | 7 |
| NW | 0 | 1 | 5 | 2 | 0 | 0 | 8 |
| NNW | 0 | 2 | 1 | 1 | 0 | 0 | 4 |
| Total | 0 | 6 | 39 | 18 | 1 | 0 | 64 |
| Calm Hours not Included above for : | | | | | | | Total Period 2 |
| Valid Hours for this Stability Class for: | | | | | | | Total Period 64 |
| Total Hours for Period | | | | | | | 2208 |

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

10/1/2019 - 12/31/2019

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>≥ 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 0 | 1 | 0 | 1 | 0 | 0 | 2 |
| NNE | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| NE | 0 | 0 | 2 | 1 | 0 | 0 | 3 |
| ENE | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| E | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| ESE | 0 | 0 | 4 | 0 | 0 | 0 | 4 |
| SE | 0 | 3 | 1 | 0 | 0 | 0 | 4 |
| SSE | 0 | 0 | 9 | 4 | 0 | 0 | 13 |
| S | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| SSW | 0 | 0 | 1 | 2 | 1 | 0 | 4 |
| SW | 0 | 0 | 2 | 5 | 0 | 0 | 7 |
| WSW | 0 | 0 | 3 | 3 | 2 | 0 | 8 |
| W | 0 | 2 | 4 | 3 | 0 | 0 | 9 |
| WNW | 0 | 1 | 1 | 0 | 1 | 0 | 3 |
| NW | 0 | 2 | 1 | 2 | 0 | 0 | 5 |
| NNW | 0 | 3 | 3 | 5 | 0 | 0 | 11 |
| Total | 0 | 12 | 35 | 27 | 4 | 0 | 78 |

Calm Hours not Included above for :

Total Period

2

Valid Hours for this Stability Class for:

Total Period

78

Total Hours for Period

2208

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

10/1/2019 - 12/31/2019

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>≥ 25</u> | <u>Total</u> |
|-----------------------|--------------|--------------|---------------|----------------|----------------|-------------|--------------|
| N | 0 | 1 | 2 | 2 | 0 | 0 | 5 |
| NNE | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| NE | 0 | 2 | 7 | 0 | 0 | 0 | 9 |
| ENE | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| E | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| ESE | 0 | 2 | 2 | 0 | 0 | 0 | 4 |
| SE | 0 | 1 | 4 | 0 | 0 | 0 | 5 |
| SSE | 0 | 2 | 5 | 3 | 0 | 0 | 10 |
| S | 0 | 1 | 8 | 2 | 2 | 0 | 13 |
| SSW | 0 | 0 | 4 | 2 | 0 | 0 | 6 |
| SW | 0 | 1 | 7 | 6 | 0 | 0 | 14 |
| WSW | 0 | 3 | 9 | 2 | 1 | 0 | 15 |
| W | 0 | 3 | 6 | 2 | 0 | 1 | 12 |
| WNW | 0 | 6 | 4 | 2 | 1 | 0 | 13 |
| NW | 0 | 0 | 2 | 7 | 0 | 0 | 9 |
| NNW | 0 | 2 | 2 | 2 | 0 | 0 | 6 |
| Total | 0 | 27 | 62 | 30 | 4 | 1 | 124 |

Calm Hours not Included above for :

Total Period

2

Valid Hours for this Stability Class for:

Total Period

124

Total Hours for Period

2208

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

10/1/2019 - 12/31/2019

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>> 25</u> | <u>Total</u> |
|--|--------------|--------------|---------------|----------------|---------------------|----------------|--------------|
| N | 1 | 13 | 16 | 19 | 6 | 1 | 56 |
| NNE | 1 | 6 | 18 | 1 | 0 | 0 | 26 |
| NE | 2 | 13 | 21 | 2 | 0 | 0 | 38 |
| ENE | 4 | 15 | 10 | 2 | 0 | 0 | 31 |
| E | 2 | 12 | 8 | 7 | 3 | 0 | 32 |
| ESE | 3 | 11 | 18 | 21 | 8 | 2 | 63 |
| SE | 4 | 10 | 18 | 11 | 3 | 0 | 46 |
| SSE | 0 | 7 | 16 | 20 | 8 | 0 | 51 |
| S | 1 | 16 | 34 | 44 | 12 | 1 | 108 |
| SSW | 0 | 12 | 49 | 30 | 5 | 0 | 96 |
| SW | 5 | 15 | 24 | 25 | 18 | 6 | 93 |
| WSW | 0 | 13 | 10 | 22 | 22 | 17 | 84 |
| W | 1 | 13 | 30 | 57 | 35 | 8 | 144 |
| WNW | 2 | 5 | 22 | 44 | 34 | 11 | 118 |
| NW | 0 | 9 | 19 | 35 | 32 | 11 | 106 |
| NNW | 0 | 17 | 22 | 26 | 12 | 5 | 82 |
| Total | 26 | 187 | 335 | 366 | 198 | 62 | 1174 |
| Calm Hours not Included above for : | | | | | Total Period | | 2 |
| Valid Hours for this Stability Class for: | | | | | Total Period | | 1174 |
| Total Hours for Period | | | | | | | 2208 |

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

10/1/2019 - 12/31/2019

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>> 25</u> | <u>Total</u> |
|--|--------------|--------------|---------------|----------------|---------------------|----------------|--------------|
| N | 0 | 9 | 4 | 1 | 0 | 0 | 14 |
| NNE | 1 | 3 | 2 | 0 | 0 | 0 | 6 |
| NE | 0 | 2 | 5 | 0 | 0 | 0 | 7 |
| ENE | 1 | 1 | 5 | 0 | 0 | 0 | 7 |
| E | 2 | 7 | 15 | 0 | 0 | 0 | 24 |
| ESE | 2 | 9 | 21 | 5 | 0 | 0 | 37 |
| SE | 1 | 9 | 22 | 15 | 3 | 0 | 50 |
| SSE | 1 | 2 | 19 | 25 | 2 | 0 | 49 |
| S | 0 | 3 | 36 | 28 | 7 | 0 | 74 |
| SSW | 0 | 7 | 41 | 33 | 3 | 0 | 84 |
| SW | 0 | 3 | 12 | 18 | 3 | 0 | 36 |
| WSW | 0 | 1 | 5 | 13 | 0 | 0 | 19 |
| W | 0 | 2 | 15 | 14 | 0 | 0 | 31 |
| WNW | 0 | 3 | 14 | 14 | 0 | 0 | 31 |
| NW | 1 | 3 | 3 | 7 | 4 | 5 | 23 |
| NNW | 0 | 2 | 4 | 4 | 2 | 0 | 12 |
| Total | 9 | 66 | 223 | 177 | 24 | 5 | 504 |
| Calm Hours not Included above for : | | | | | Total Period | | 2 |
| Valid Hours for this Stability Class for: | | | | | Total Period | | 504 |
| Total Hours for Period | | | | | | | 2208 |

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

10/1/2019 - 12/31/2019

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>> 25</u> | <u>Total</u> |
|---|--------------|--------------|---------------|----------------|----------------|----------------|------------------|
| N | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| NNE | 0 | 4 | 0 | 0 | 0 | 0 | 4 |
| NE | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| ENE | 2 | 8 | 5 | 0 | 0 | 0 | 15 |
| E | 0 | 2 | 3 | 0 | 0 | 0 | 5 |
| ESE | 0 | 4 | 6 | 2 | 0 | 0 | 12 |
| SE | 0 | 3 | 17 | 4 | 0 | 0 | 24 |
| SSE | 1 | 4 | 8 | 6 | 0 | 0 | 19 |
| S | 0 | 3 | 6 | 8 | 0 | 0 | 17 |
| SSW | 0 | 6 | 10 | 7 | 0 | 0 | 23 |
| SW | 0 | 2 | 9 | 1 | 0 | 0 | 12 |
| WSW | 0 | 5 | 0 | 1 | 0 | 0 | 6 |
| W | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| WNW | 2 | 2 | 1 | 0 | 0 | 0 | 5 |
| NW | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| NNW | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Total | 6 | 47 | 67 | 29 | 0 | 0 | 149 |
| Calm Hours not Included above for : | | | | | | | Total Period 2 |
| Valid Hours for this Stability Class for: | | | | | | | Total Period 149 |
| Total Hours for Period | | | | | | | 2208 |

Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Total Period

Period of Record =

10/1/2019 - 12/31/2019

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>> 25</u> | <u>Total</u> |
|--|--------------|--------------|---------------|----------------|----------------|----------------|---------------------|
| N | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NNE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NE | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| ENE | 1 | 0 | 1 | 0 | 0 | 0 | 2 |
| E | 2 | 1 | 2 | 0 | 0 | 0 | 5 |
| ESE | 1 | 6 | 12 | 1 | 0 | 0 | 20 |
| SE | 0 | 6 | 26 | 6 | 0 | 0 | 38 |
| SSE | 0 | 2 | 6 | 0 | 0 | 0 | 8 |
| S | 0 | 1 | 9 | 4 | 0 | 0 | 14 |
| SSW | 0 | 2 | 7 | 1 | 0 | 0 | 10 |
| SW | 1 | 0 | 2 | 0 | 0 | 0 | 3 |
| WSW | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| W | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| WNW | 0 | 2 | 1 | 0 | 0 | 0 | 3 |
| NW | 0 | 4 | 0 | 0 | 0 | 0 | 4 |
| NNW | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| Total | 7 | 27 | 67 | 12 | 0 | 0 | 113 |
| Calm Hours not Included above for : | | | | | | | Total Period |
| Valid Hours for this Stability Class for: | | | | | | | Total Period |
| 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 =

10/1/2019 - 12/31/2019

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>≥ 25</u> | <u>Total</u> |
|--|--------------|--------------|---------------|----------------|----------------|-------------|---------------------|
| N | 1 | 25 | 27 | 27 | 6 | 1 | 87 |
| NNE | 2 | 14 | 20 | 2 | 0 | 0 | 38 |
| NE | 2 | 20 | 38 | 3 | 0 | 0 | 63 |
| ENE | 8 | 25 | 22 | 2 | 0 | 0 | 57 |
| E | 6 | 23 | 30 | 7 | 3 | 0 | 69 |
| ESE | 6 | 32 | 66 | 29 | 8 | 2 | 143 |
| SE | 5 | 34 | 97 | 37 | 6 | 0 | 179 |
| SSE | 2 | 17 | 65 | 58 | 10 | 0 | 152 |
| S | 1 | 24 | 95 | 86 | 21 | 1 | 228 |
| SSW | 0 | 27 | 112 | 75 | 9 | 0 | 223 |
| SW | 6 | 21 | 56 | 58 | 21 | 6 | 168 |
| WSW | 0 | 23 | 30 | 41 | 26 | 17 | 137 |
| W | 1 | 21 | 59 | 82 | 35 | 9 | 207 |
| WNW | 4 | 20 | 48 | 61 | 36 | 11 | 180 |
| NW | 2 | 20 | 30 | 53 | 36 | 16 | 157 |
| NNW | 2 | 26 | 33 | 38 | 14 | 5 | 118 |
| Total | 48 | 372 | 828 | 659 | 231 | 68 | 2206 |
| Calm Hours not Included above for : | | | | | | | Total Period |
| | | | | | | | 2 |
| Variable Direction Hours for: | | | | | | | Total Period |
| | | | | | | | 0 |
| Invalid Hours for: | | | | | | | Total Period |
| | | | | | | | 0 |
| Valid Hours for this Stability Class for: | | | | | | | Total Period |
| | | | | | | | 2206 |
| Total Hours for Period | | | | | | | 2208 |