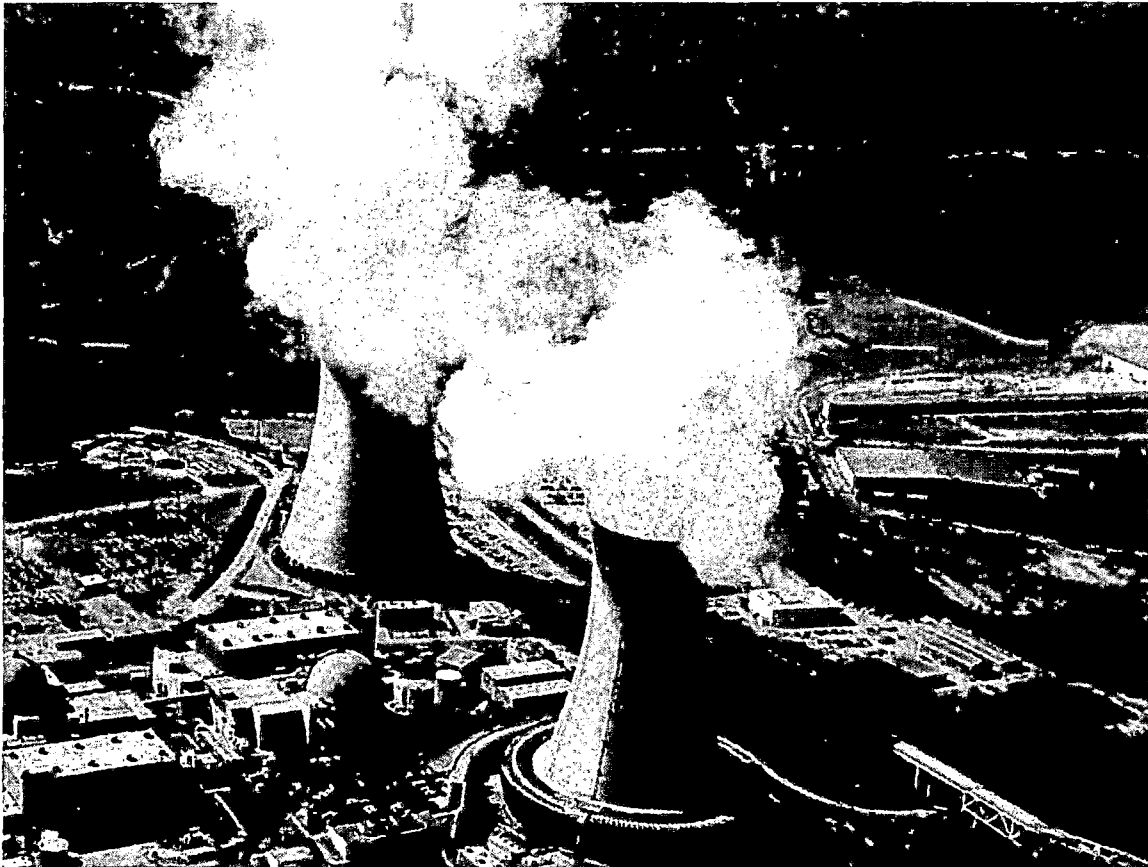


Enclosure A  
L-22-111

*2021 Annual Radioactive Effluent Release Report*  
and  
*2021 Annual Radiological Environmental Operating Report*  
(Reports follow)

**ENERGY HARBOR NUCLEAR CORP.  
BEAVER VALLEY POWER STATION**



**2021**

**ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (ARERR)**

**AND**

**ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT (AREOR)**

**UNIT NOS. 1 AND 2**

**LICENSES DPR-66 AND NPF-73**

ENCLOSURE 1

**BEAVER VALLEY POWER STATION  
ENVIRONMENTAL & CHEMISTRY SECTION**

**Technical Report Approval:**

**2021**

**ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (ARERR)**

**AND**

**ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT (AREOR)**

**UNIT NOS. 1 AND 2**

**LICENSES DPR-66 AND NPF-73**

Prepared by: Jiovanni Nunez *Jiovanni Nunez* Date: 4/21/2022

Reviewed by: Courtney F. Casto *Courtney F. Casto* Date: 4/20/2022

Reviewed by: Dr. Robert R. Winters *Robert R. Winters* Date: 4/21/2022

Approved by: Scott W. York *Scott W. York* Date: 4/21/22

Subject: **Beaver Valley Power Station, Unit Nos. 1 and 2**  
**BV-1 Docket No. 50-334, License No. DPR-66**  
**BV-2 Docket No. 50-412, License No. NPF-73**  
**Radioactive Effluent Release Report for 2021, and**  
**Annual Radiological Environmental Operating Report for 2021**

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ENCLOSURE 2



## 2021 Annual Radioactive Effluent Release Report

Energy Harbor Nuclear Corp.

Beaver Valley Power Station - Units 1 & 2  
Unit 1 License No. DPR-66  
Unit 2 License No. NPF-73

**Annual Radioactive Effluent Release Report**  
 Calendar Year - 2021  
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Attachment 3	Unit 1 and 2 Carbon-14 (C-14) Dose Estimates	

Note: The Total Error values (%) listed in this report are documented in Calculation Package No. ERS-ATL-04-002

## Annual Radioactive Effluent Release Report

### Calendar Year - 2021

### Executive Summary - Report Submittal Requirements

**Report Submittal and Requirements:** The report was prepared and submitted in accordance with the requirements contained in the following documents:

BVPS Integrated Technical Specifications, Administrative Control 5.6.2

Offsite Dose Calculation Manual (ODCM) procedure 1/2-ODC-3.03, "Controls for RETS and REMP Programs", Attachment U, Control 6.9.3

BVPS procedure 1/2-ENV-01.05, "Compliance with Regulatory Guide 1.21 and Technical Specifications"

NUREG-1301, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors, Generic Letter 89-01, Supplement No.1, April 1991"

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

BVPS Condition Report No. CR-2020-05157, Liquid Waste Line Leak In Satellite RCA

BVPS Condition Report No. CR-2020-07029, Velocity Probe BV-2HVS-VP109C Lost by FedEx

BVPS Condition Report No. CR-2020-07160, Effluent monitor will not be returned to service within 30 days

BVPS Condition Report No. CR-2021-00359, Blowdown Radiation Monitor [RM-1BD-101] is in a fault condition

BVPS Condition Report No. CR-2021-02726, U-2 Radiation monitor 2SGC-RQ100 (Liquid Waste Effluent Radiation Monitor) out of service

BVPS Condition Report No. CR-2021-04090, RM-1RW-100 Low Flow (Component Cooling/Recirc Spray Ht Ex Rad monitor)

BVPS Condition Report No. CR-2021-04482, RM-1RW-100 Sample Pump Cannot Maintain Sample Flow

BVPS Condition Report No. CR-2021-05016, WO 200817192 - RM-RW-100 moved to 2022, flagged to not be rescheduled due to plant health committee top 10 item

BVPS Condition Report No. CR-2021-09502, OOS Liquid Rad Monitor Not Returned to Service in 30 Days

BVPS Condition Report No. CR-2022-03175, MET Tower Data Recovery does not meet RG 1.23

**Condition Reporting Process:** The condition reports referenced above are documents generated electronically by plant personnel to record noncompliance issues with federal, state, local, and plant regulations and operating procedures, and to ensure that such issues are promptly addressed. If any nonconformities are identified, the Condition Reporting Process allows for corrective actions to be assigned to the proper individuals, in order to rectify adverse plant conditions and to prevent the future occurrence of similar issues.

## Annual Radioactive Effluent Release Report

### Calendar Year - 2021

### Executive Summary - Liquid and Gaseous Effluent Control (Part 1 of 2)

**Onsite Groundwater Monitoring:** H-3 Summary: In 2021, twenty three (23) on-site monitoring wells were sampled in the spring and fall sampling periods. No new wells were installed, nor were any wells retired. MW-16 was sampled eleven (11) times throughout 2021, two (2) of which were included in the yearly biannual sampling.

No adverse effect to the offsite environment has been detected at this time, because all offsite groundwater, drinking water and surface water samples were <440 pCi/L. See Enclosure 2, Page xvii for additional details.

**Onsite Spills:** There were no onsite spills >100 gallons.

**Decommissioning File Update:** There was one (1) item added to the site decommissioning files in accordance with 10CFR50.75(g). See Enclosure 2, Page xvi for additional details.

**Abnormal Liquid Releases:** There were no abnormal liquid releases.

**Abnormal Gaseous Releases:** There were no abnormal gaseous releases.

**Liquid Radwaste Treatment System:** The site operated via a shared Liquid Radwaste Treatment System, even though each Unit has its own ion-exchange vessels. Shared operation allowed either Unit to process liquid waste at the Unit of origin, or at the other Unit. Typically, when Unit 1 or 2 high level liquid waste was processed (e.g., coolant recovery waste) it was performed at Unit 1, because it has a carbon pre-conditioning filter.

**Gaseous Radwaste Treatment System:** The site operated via a shared Gaseous Radwaste Treatment System, even though each Unit has its own charcoal delay beds and storage/decay tanks. Shared operation allowed either Unit to process gaseous waste at the Unit of origin, or at the other Unit. Typically, when Unit 1 or 2 went to a shutdown condition, the gaseous waste was transferred for storage and decay at Unit 2, because Unit 2 has four (4) additional storage tanks. All doses from continuous releases of the Process Vent (elevated pathway) are assigned to Unit 1.

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Executive Summary - Liquid and Gaseous Effluent Control (Part 2 of 2)

**Lower Limits of Detectability (LLD):** All a-priori calculated LLD met the minimum requirements specified in the ODCM.

**Effluent Monitoring Channels Inoperable >30 Days:** There were five (5) Effluent Monitoring Instrumentation Channels not returned to Operable status within 30 days.

**ODCM Surveillance Deficiencies:** There were no ODCM Surveillance Deficiencies during the report period.

**ODCM Changes:** There were no changes made to the ODCM.

**Meteorological Data Recovery:** There was one (1) Meteorological Data Recovery parameter that did NOT meet the minimum requirement of at-least 90%, as specified in Section 5 of Revision 1 to Regulatory Guide 1.23, Meteorological Monitoring Programs for Nuclear Power Plants. See Attachment 1 for further details.

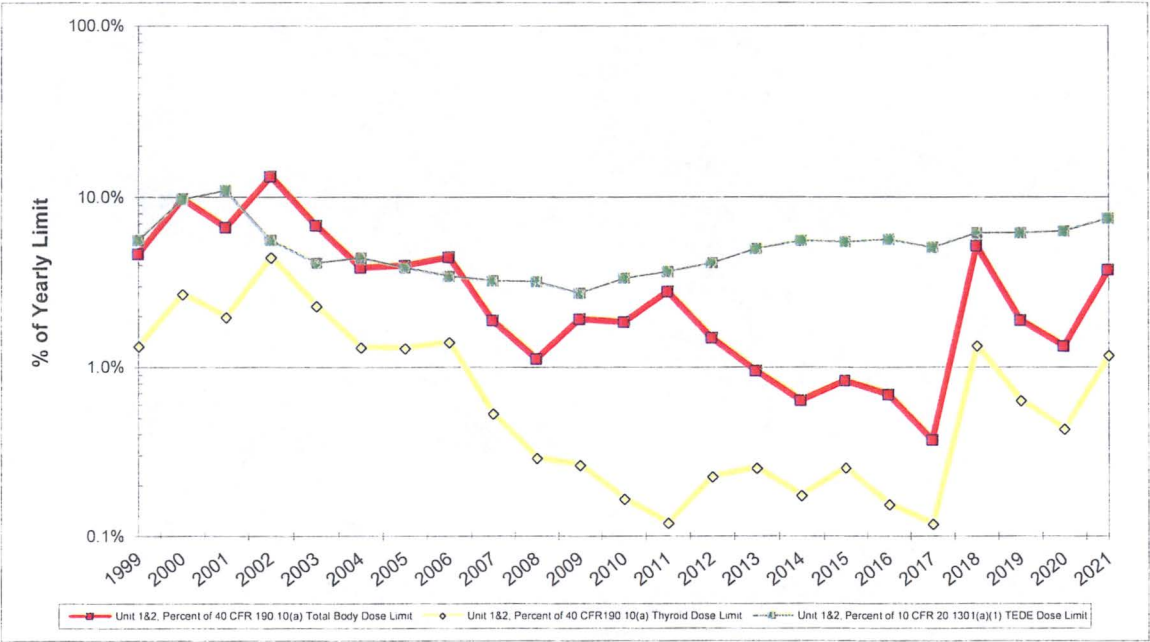
**Carbon-14 Dose Assessment:** Carbon-14 dose was calculated using EPRI & RG-1.109 calculation methods and the default ODCM receptor. The highest organ doses were to the bone (child). Details of the dose assessment due to releases of Carbon-14 in gaseous effluents are provided in Attachment 3 of this report.

# Annual Radioactive Effluent Release Report

## Calendar Year - 2021

### Executive Summary - Trends of Total Dose

**Trends of Total Dose:** The following graph provides a comparison of the ODCM dose projections from all facility releases and direct radiation exposures to show compliance with Member of the Public dose limits from 10 CFR 20.1301 and 40 CFR Part 190.

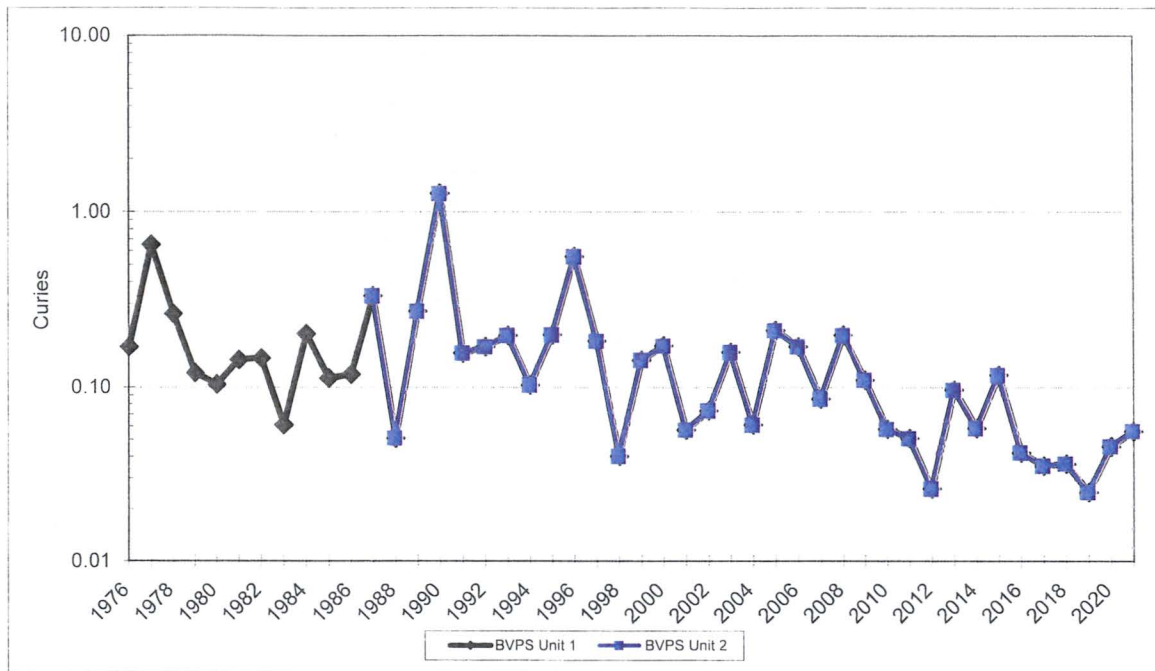


## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Executive Summary - Trends of Liquid Release Activity (Fission and Activation Products)

**Liquid Release Activity (Fission and Activation Products):** The following graph provides a comparison of total liquid mixed fission and activation product (particulate) radioactivity discharged from each unit from 1976 to present.

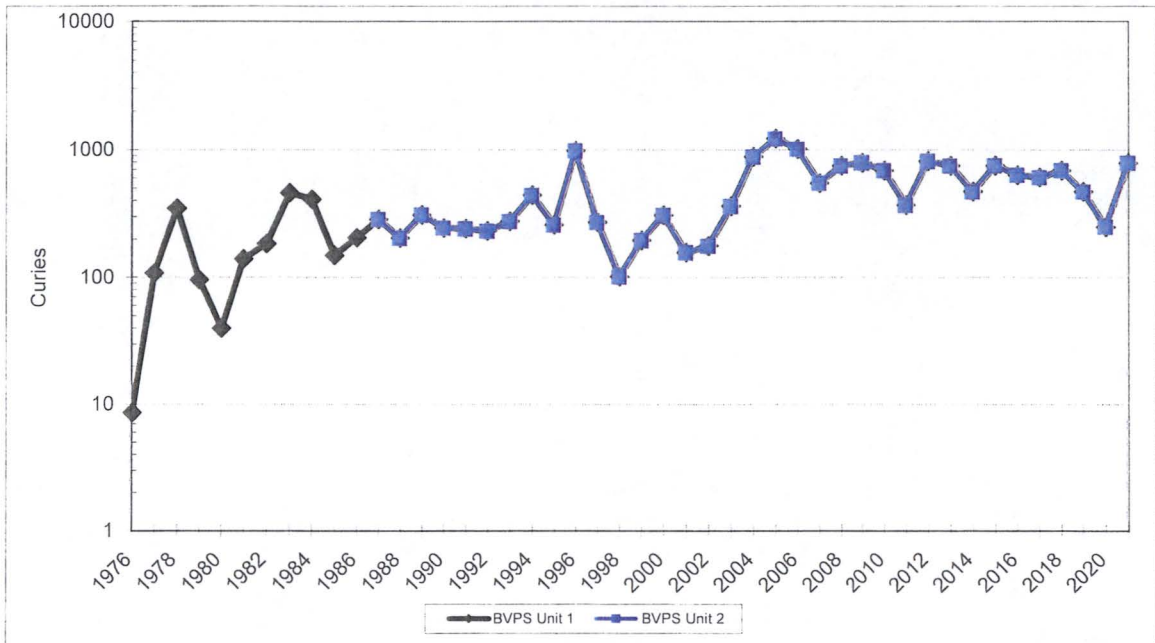


# Annual Radioactive Effluent Release Report

## Calendar Year - 2021

### Executive Summary - Trends of Liquid Release Activity (Tritium)

**Liquid Release Activity (Tritium):** The following graph provides a comparison of total liquid tritium radioactivity discharged from each unit from 1976 to present. The latest increases were due to the increase power of the reactor, or power uprate, which lead to increased tritium.



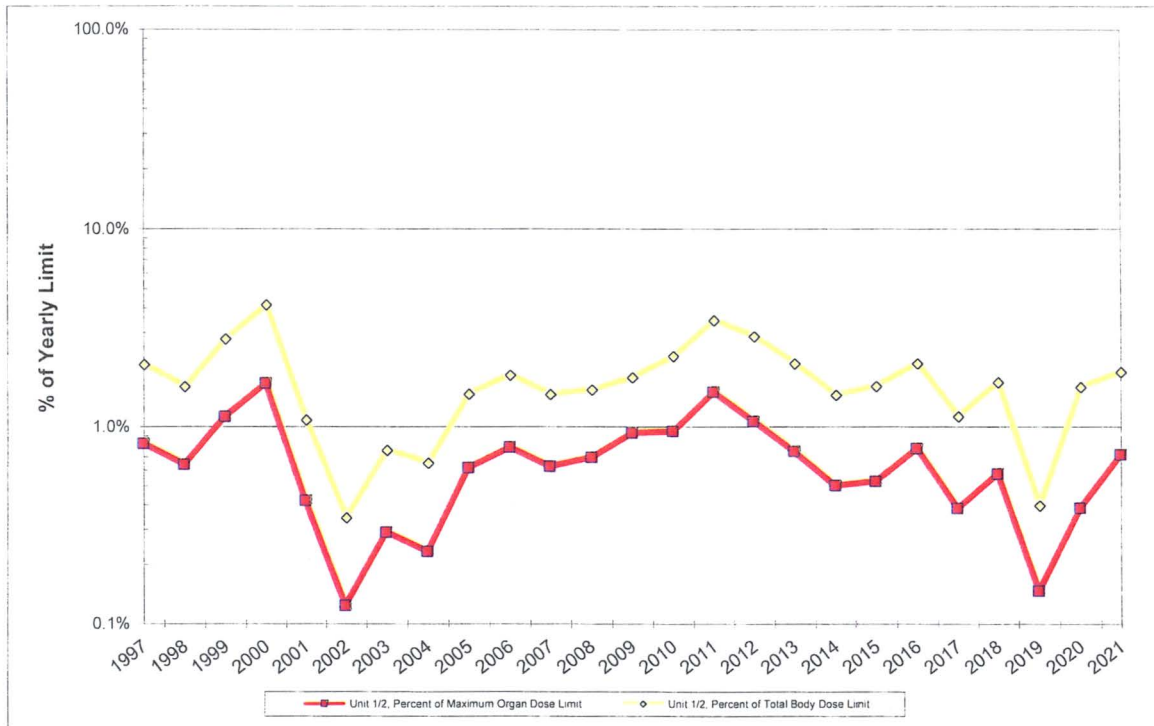


# Annual Radioactive Effluent Release Report

Calendar Year - 2021

## Executive Summary - Trends of Liquid Release Offsite Dose Projections

**Liquid Release Offsite Dose Projections:** The following graph provides a comparison of liquid offsite dose projections that were calculated to the maximum individual per 10 CFR 50, Appendix I and the ODCM. The projections use ODCM default flow rates for the receiving water (Ohio River), and were performed prior to release authorization.



## Annual Radioactive Effluent Release Report

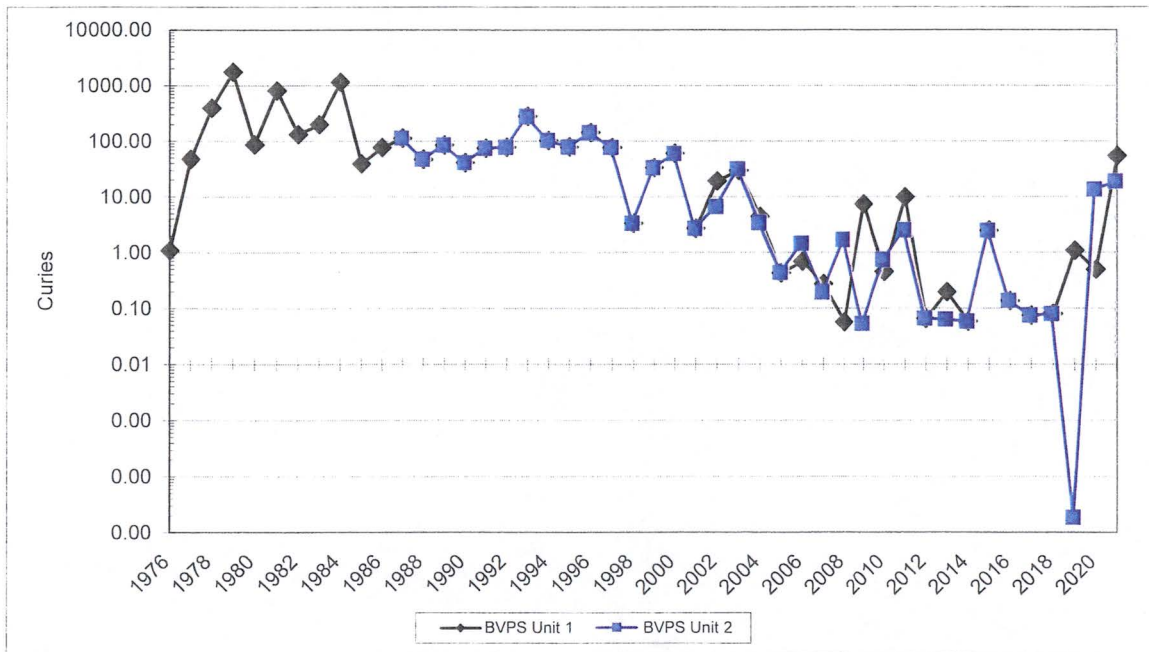
Calendar Year - 2021

Executive Summary - Trends of Gaseous Release Activity (Fission and Activation Gas)

**Gaseous Release Activity (Fission and Activation Gas):** The following graph provides a comparison of total gaseous fission and activation gas discharged from each unit from 1976 to present. The steady decreases are due to extended hold-up periods of gas space prior to release. The differences between the units are relative to the outages that occurred that year.

Note that in 2019, due to new effluent software, all continuous releases out of the elevated release Process Vent are now assigned to Unit 1, even though it is a shared pathway. This accounts for the drastic change in trend values.

The sharp increases in gaseous release activity that occurred from Unit 2 in 2020 and from Unit 1 in 2021 were determined to have been the result of the routine degassification of the reactor coolant systems that occurred as part of the refueling outages during those years. RCS degas activity is conservatively approximated by using the results of samples taken during startup from the previous outage from the same unit, and the sample used during these years contained high concentrations of Argon-41, which accounts for the increase in activity. These releases did not pose any radiation health risk to the public or plant personnel, nor did they exceed any NRC regulations or reporting criteria.

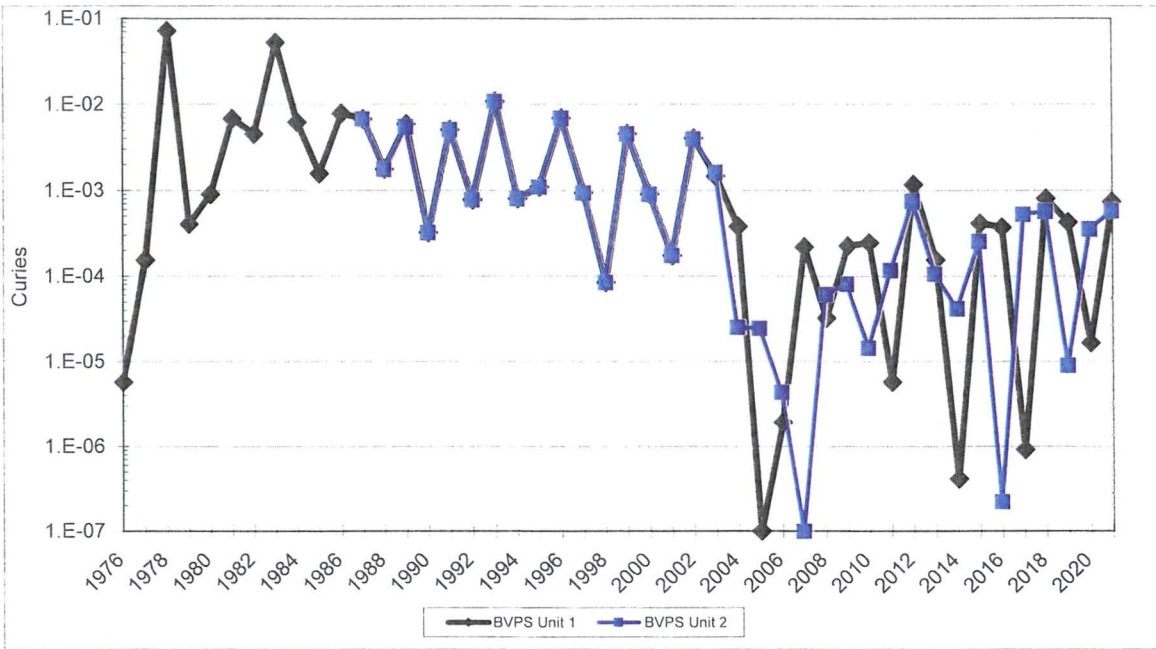


# Annual Radioactive Effluent Release Report

Calendar Year - 2021

Executive Summary - Trends of Gaseous Release Activity (Particulates and Radioiodines)

**Gaseous Release Activity (Particulates and Radioiodines):** The following graph provides a comparison of total gaseous particulates and radioiodines discharged from each unit from 1976 to present. The differences between the units are relative to the outages that occurred that year.



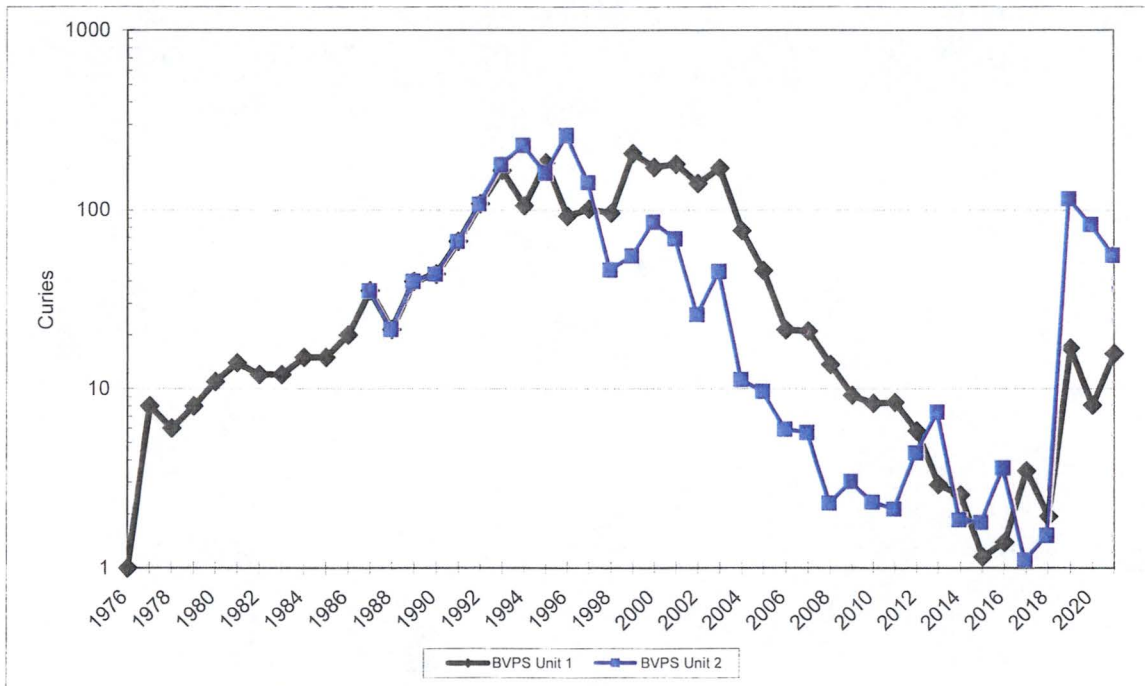
# Annual Radioactive Effluent Release Report

## Calendar Year - 2021

### Executive Summary - Trends of Gaseous Release Activity (Tritium)

**Gaseous Release Activity (Tritium):** The following graph provides a comparison of total gaseous tritium discharged from each unit from 1976 to present. The recent decreases were due to efforts to reduce overall offsite dose. Specifically, discharging liquid radioactive inventory provided the benefit of reduced total offsite dose, due to reduction in evaporative losses from the fuel pools.

Note that beginning in 2019, Beaver Valley no longer adjusts gaseous tritium effluents for background tritium and for evaporation of tritium from Fuel Pool. Excluding these adjustments provides a more conservative total for gaseous tritium released.

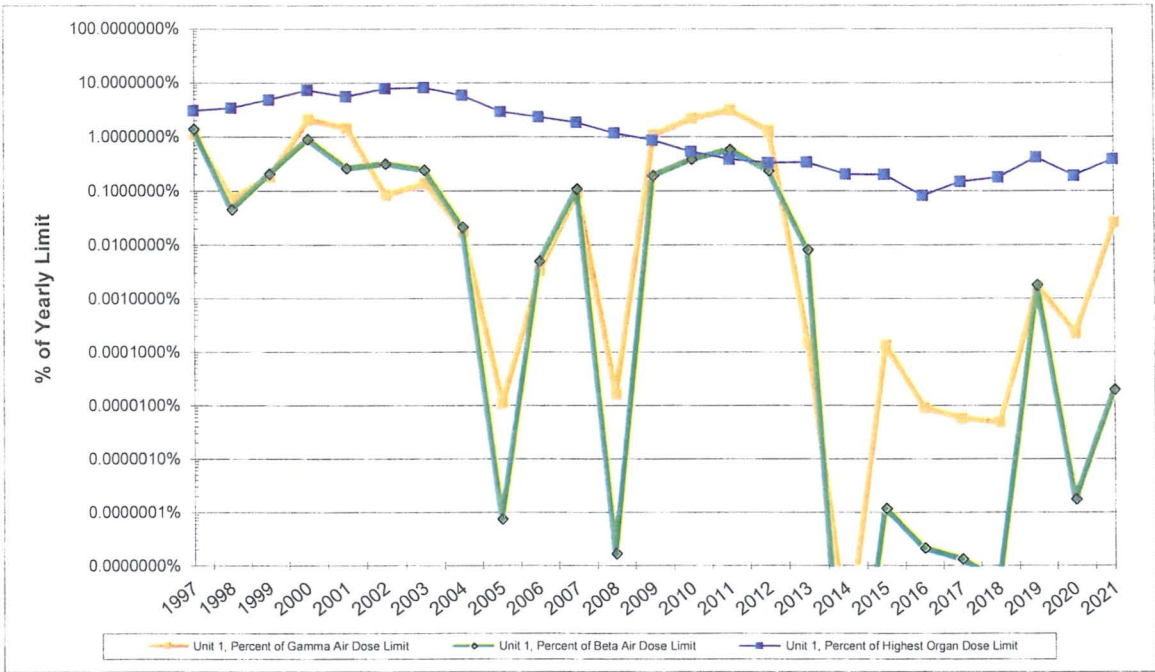


# Annual Radioactive Effluent Release Report

Calendar Year - 2021

## Executive Summary - Trends of Unit 1 Gaseous Release Offsite Dose

**Unit 1 Gaseous Release Offsite Dose:** The following graph provides a comparison of Unit 1 gaseous offsite dose projections that were calculated to the maximum individual per 10 CFR 50, Appendix I and the ODCM. The projections use ODCM default meteorological parameters for the atmospheric conditions surrounding the plant site, and were performed prior to release authorization.

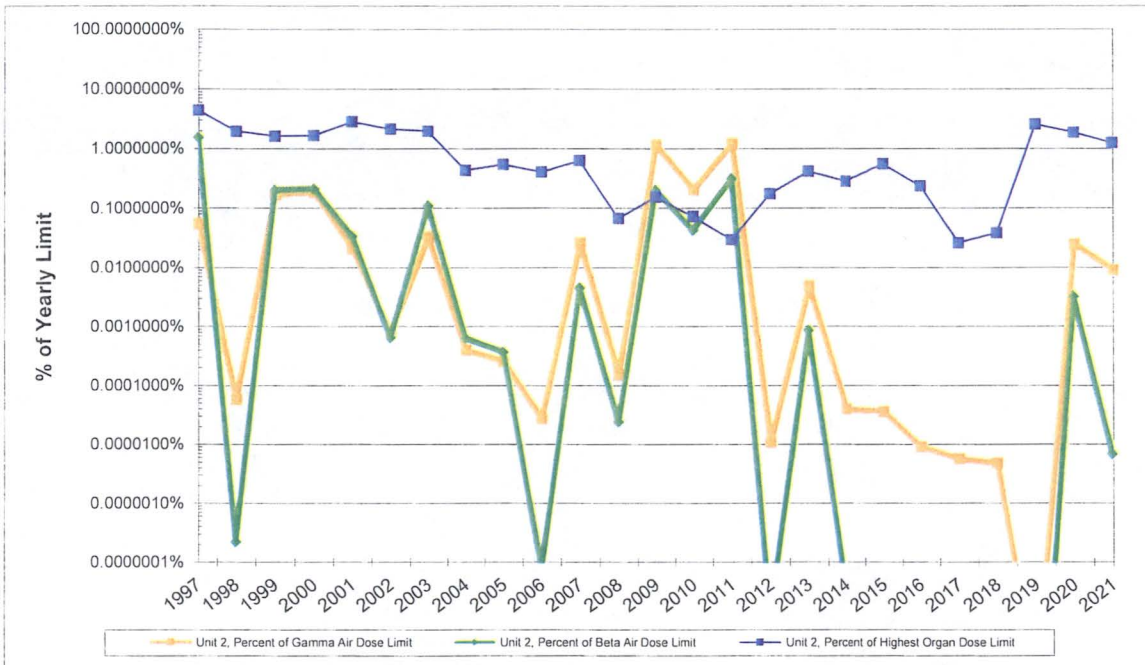


# Annual Radioactive Effluent Release Report

Calendar Year - 2021

Executive Summary - Trends of Unit 2 Gaseous Release Offsite Dose

**Unit 2 Gaseous Release Offsite Dose:** The following graph provides a comparison of Unit 2 gaseous offsite dose projections that were calculated to the maximum individual per 10 CFR 50, Appendix I and the ODCM. The projections use ODCM default meteorological parameters for the atmospheric conditions surrounding the plant site, and were performed prior to release authorization.



**Annual Radioactive Effluent Release Report**  
Calendar Year - 2021  
Results of Abnormal Releases

Description of Abnormal Release(s)
<p><u>Abnormal Liquid Releases:</u> NONE</p> <p><u>Abnormal Gaseous Releases:</u> NONE</p>

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Results of Onsite Spills and Items Added to Decommissioning Files per 10CFR50.75(g)

### Description of Spills or Items added to 10CFR50.75(g)

Summary of Onsite Spills (>100 gallons): NONE

Summary of Items added to Decommissioning Files per 10CFR50.75(g) Files:

On June 18, 2020 0500, a liquid leak was discovered on pipe 1-1/2"-LW-184-302 downstream of 1LW-513 in the satellite RCA area at elevation 735' outside of the Unit 1 Fuel Pool Leak Monitoring Room near the Decon Building. The leak rate was estimated at 1-2 drops per second with an estimated total leak volume of 3-4 gallons. Analysis of the leak indicated greater than 2000 picocuries per liter of tritium, and the presence of Mn-54, Co-58, Co-60, and Cs-137 above their lower limits of detection.

A catch containment was placed underneath the leak, and standing liquids on the concrete below were cleaned up. No smearable radioactive contamination was present after the clean up, however due to crack being present in the concrete below, it is not certain whether any liquid made contact with the soil underneath.

A voluntary communication was made to the Pennsylvania Department of Environmental Protection, Bureau of Radiation Protection, and the NRC Resident Inspector was also notified of the leak. The leakage did not pose any radiation health risk to the public or plant personnel, nor did it exceed any NRC regulations or reporting criteria. This event is captured in CR-2020-05157, and has been added to the 10CFR50.75(g) files.



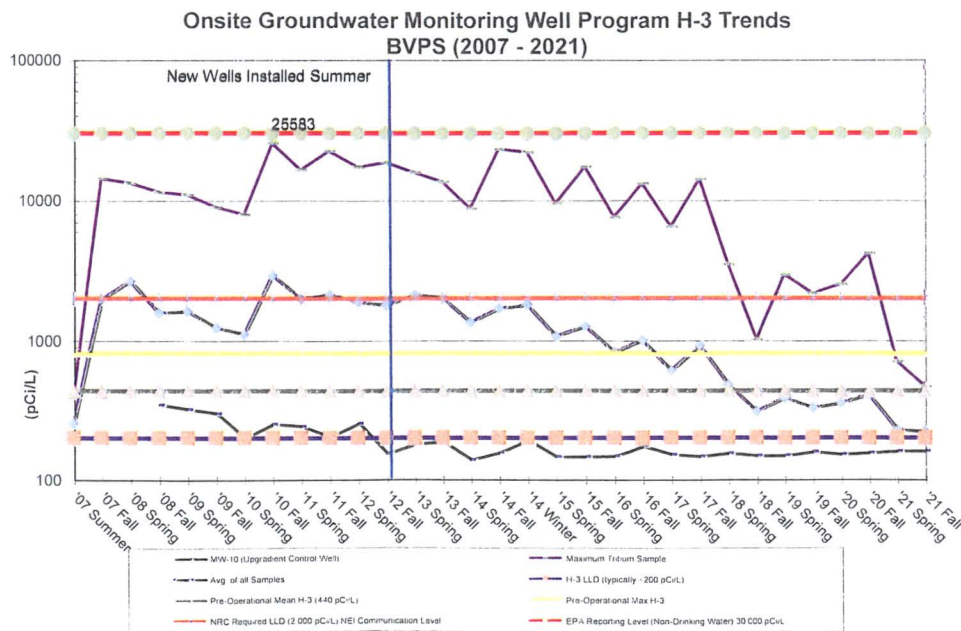
## Annual Radioactive Effluent Release Report

Calendar Year - 2021  
 Results of Onsite Groundwater Monitoring Program

Summary of Onsite Groundwater Samples									
	2021 H-3 Maximum (pCi/L)	2021 H-3 Minimum (pCi/L)	2021 H-3 Average (pCi/L)	Typical H-3 LLD (pCi/L)	Required H-3 LLD (pCi/L)	Pre Operational Mean For H-3 (pCi/L)	Are Any H-3 Analyses Greater Than The Pre Operational Mean For H-3 ?	NEI and FENOC Communication Level For H-3 (pCi/L)	EPA Reporting Level For H-3 (pCi/L)
Spring (Q2)	710	158	231	<200	<2000	440	Yes	2000	20000
Fall (Q4)	4610	162	770	<200	<2000	440	Yes	2000	20000
MW-16	4950	306	3116	<200	<2000	440	Yes	2000	20000

Tritium (H-3) Summary									
<p>In 2021, twenty three (23) on-site monitoring wells were sampled in the spring and fall sampling periods. No new wells were installed, nor were any wells retired. MW-16 was sampled eleven (11) times, two (2) of which were included in the yearly biannual sampling.</p> <p>Twenty (20) wells returned maximum results of less than the pre-operational mean (440 pCi/L) during all sample periods in 2020. Two (2) wells (MW-15, &amp; MW-20D) returned maximum results &gt;440 pCi/L, but &lt;2000 pCi/L. One (1) well (MW-16) returned maximum results &gt;2000 pCi/L, due to previously identified and communicated leakage into groundwater. No wells exceeded 20,000 pCi/L with the highest concentration recorded as 4950 pCi/L.</p> <p>The licensee communication level was reached for MW-12S &amp; MW-12D during 2007. Notification to local, state &amp; federal agencies was performed on 10/08/07. Additional communication for new well results was performed on 09/08/10 for those new wells that exceeded 2000 pCi/L. The newly installed well MW-20D exceeded 2,000 pCi/L on its first sample, but this was expected since the well was installed to monitor the previously identified plume intercepting MW-16. No adverse effect to the offsite environment has been detected at this time, because all offsite groundwater, drinking water and surface water samples were &lt;440 pCi/L. Mitigation activities (catch basin sleeving) to prevent tritiated condensate water from reaching the groundwater were completed 12/17/11.</p> <p>Extraction well, EW-1, was installed and began operation in October 2013. This equipment captures the tritium plume and it becomes a permitted discharge. Samples are taken monthly to provide the concentration of the discharge. Remediation will continue until the suspected plume is depleted and tritium levels stabilize.</p>									
Principal Gamma Emitter Summary									
<p>All onsite monitoring wells were sampled during the year, and analyzed for Principal Gamma Emitters. The results showed no positive indication of Licensed Radioactive Material (LRM) in any of the analyses.</p>									



## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Corrections to previous Annual Radioactive Effluent Release Reports

### Description of Corrections Made to RERR(s)

Correction(s) to Previous Annual Radioactive Effluent Release Reports: NONE

#### **Compliance with 10 CFR 72.44(d)(3) for Dry Fuel Storage**

While there are minimal gaseous and liquid effluents specifically from the Independent Spent Fuel Storage Installation (ISFSI), there is a contribution from Direct Radiation. The doses listed in this section include the contributions from the ISFSI.

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Supplemental Information Page

**FACILITY: B.V.P.S. Units 1 and 2**

1. Regulatory Limits	
a. Fission and activation gases:	Annual Unit 1 or 2 Dose: 10 mrad from Gamma, & 20 mrad from Beta
b. Iodines & particulates, half-lives > 8 days:	Annual Unit 1 or 2 Dose: 15 mrem to Any Organ
c. Liquid effluents:	Annual Unit 1 or 2 Dose: 3 mrem to Total Body, & 10 mrem to Any Organ

2. Maximum Permissible Concentrations Used In Determining Allowable Release Rates Or Concentrations	
a. Fission and activation gases:	Site Release Rate: 500 mrem/yr to Total Body, & 3000 mrem/yr to the Skin
b. Iodines & particulates, half-lives > 8 days:	Site Release Rate: 1500 mrem/yr to Any Organ
c. Liquid effluents:	Site Release Concentration: 10 times 10 CFR 20 Appendix B, Table 2, EC's

3. Average Energy (Not Applicable To The BVPS ODCM)

4. Measurements and Approximations of Total Radioactivity	
The methods used to measure or approximate the total radioactivity in effluents, and the methods used to determine radionuclide composition are as follows:	
a. Fission and activation gases:	Ge Gamma Spectrometry, Liquid Scintillation Counter
b. Iodines:	Ge Gamma Spectrometry
c. Particulates, half-lives > 8 days:	Ge Gamma Spectrometry
d. Liquid effluents:	Ge Gamma Spectrometry, Liquid Scintillation Counter

5. Batch & Abnormal Release Information	unit	Q1	Q2	Q3	Q4	Calendar Year
<b>a. Liquid Batch Releases</b>						
1. Number of batch releases		16	23	47	13	98
2. Total time period for batch releases	min	11687	12412	11994	15986	52079
3. Maximum time period for a batch release	min	4615	4797	4565	4920	4920
4. Average time period for batch releases	min	730	540	255	1230	531
5. Minimum time period for a batch release	min	66	13	13	13	13
6. Average river flow during release periods	cuft/sec	50167	37467	29767	35967	38342
<b>b. Gaseous Batch Releases</b>						
1. Number of batch releases		6	17	2	12	37
2. Total time period for batch releases	min	1934	22703	199	17669	42505
3. Maximum time period for a batch release	min	471	6486	129	6659	6659
4. Average time period for batch releases	min	322	1336	100	1472	1149
5. Minimum time period for a batch release	min	114	1	70	33	1
<b>c. Abnormal Liquid Releases</b>						
1. Number of releases		NONE	NONE	NONE	NONE	NONE
2. Total activity released	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
<b>d. Abnormal Gaseous Releases</b>						
1. Number of releases		NONE	NONE	NONE	NONE	NONE
2. Total activity released	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 1A

Gaseous Effluents - Summation Of All Releases

	unit	Q1	Q2	Q3	Q4	Calendar Year	Total Error %
<b>A. Fission &amp; Activation Gases</b>							
1. Site Total release	CI	2.96E-03	5.45E+01	0.00E+00	1.89E+01	7.34E+01	26.5%
1a. Unit 1 Gases	CI	2.96E-03	5.45E+01	0.00E+00	0.00E+00	5.45E+01	
1b. Unit 2 Gases	CI	0.00E+00	7.09E-05	0.00E+00	1.89E+01	1.89E+01	
2. Average release rate for period	uCi/sec	3.80E-04	6.94E+00	0.00E+00	2.38E+00	4.45E-01	
3. Percent of applicable limit	%	N/A	N/A	N/A	N/A	N/A	
<b>B. Iodines</b>							
1. Site Total iodine - 131	CI	0.00E+00	4.38E-06	0.00E+00	0.00E+00	4.38E-06	N/A
1a. Unit 1 iodine - 131	CI	0.00E+00	4.38E-06	0.00E+00	0.00E+00	4.38E-06	
1b. Unit 2 iodine - 131	CI	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
2. Average release rate for period	uCi/sec	0.00E+00	5.58E-07	0.00E+00	0.00E+00	1.39E-07	
3. Percent of applicable limit	%	N/A	N/A	N/A	N/A	N/A	
<b>C. Particulates</b>							
1. Particulates with half-lives > 8 days	CI	0.00E+00	7.40E-04	5.35E-07	5.78E-04	1.32E-03	30.0%
1a. Unit 1 Particulates	CI	0.00E+00	7.39E-04	5.35E-07	2.39E-07	7.40E-04	
1b. Unit 2 Particulates	CI	0.00E+00	2.46E-07	0.00E+00	5.78E-04	5.78E-04	
2. Average release rate for period	uCi/sec	0.00E+00	9.41E-05	6.74E-08	7.28E-05	1.19E-05	
3. Percent of applicable limit	%	N/A	N/A	N/A	N/A	N/A	
<b>D. Gross Alpha</b>							
1. Site Gross alpha radioactivity	CI	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
1a. Unit 1 Gross alpha	CI	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
1b. Unit 2 Gross alpha	CI	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
2. Average release rate for period	uCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
3. Percent of applicable limit	%	N/A	N/A	N/A	N/A	N/A	
<b>E. Tritium</b>							
1. Site Total release	CI	1.86E+01	1.35E+01	1.56E+01	2.45E+01	7.22E+01	32.9%
1a. Unit 1 Tritium	CI	2.44E+00	1.96E+00	5.22E+00	6.19E+00	1.58E+01	
1b. Unit 2 Tritium	CI	1.61E+01	1.15E+01	1.04E+01	1.83E+01	5.63E+01	
2. Average release rate for period	uCi/sec	2.39E+00	1.71E+00	1.96E+00	3.08E+00	2.90E+00	
3. Percent of applicable limit	%	N/A	N/A	N/A	N/A	N/A	
<b>F. Carbon-14</b>							
1. Site Total release	CI	4.72E+00	4.78E+00	4.85E+00	2.80E+00	1.72E+01	41.1%
1a. Unit 1 Carbon-14	CI	2.36E+00	2.39E+00	2.45E+00	1.40E+00	8.60E+00	
1b. Unit 2 Carbon-14	CI	2.36E+00	2.39E+00	2.40E+00	1.40E+00	8.55E+00	
2. Average release rate for period	uCi/sec	5.99E-01	6.07E-01	6.15E-01	3.55E-01	5.44E-01	
3. Percent of applicable limit	%	N/A	N/A	N/A	N/A	N/A	

N/A = Not Applicable

The amount of time (in seconds) used to calculate the release rates specified in A.2, B.2, C.2, D.2 and E.2 is the average amount of seconds per calendar quarter (7.88E+06 seconds).

# Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 1B-EB

Gaseous Effluents - Elevated Batch Releases (Unit 1 & 2)

Nuclides released	unit	Q1	Q2	Q3	Q4	Calendar Year
<b>A. Fission gases</b>						
argon-41	CI	LLD	5.03E+01	LLD	1.83E+01	6.86E+01
krypton-85	CI	LLD	LLD	LLD	LLD	LLD
krypton-85m	CI	LLD	9.74E-02	LLD	3.08E-02	1.28E-01
krypton-87	CI	LLD	2.38E-01	LLD	4.05E-02	2.79E-01
krypton-88	CI	LLD	2.74E-01	LLD	4.98E-02	3.24E-01
xenon-131m	CI	LLD	LLD	LLD	LLD	LLD
xenon-133	CI	2.96E-03	6.84E-01	LLD	1.26E-01	8.13E-01
xenon-133m	CI	LLD	LLD	LLD	LLD	LLD
xenon-135	CI	LLD	1.00E+00	LLD	2.63E-01	1.26E+00
xenon-135m	CI	LLD	5.99E-01	LLD	1.20E-01	7.19E-01
xenon-138	CI	LLD	1.37E+00	LLD	LLD	1.37E+00
<b>Total for period</b>	CI	2.96E-03	5.45E+01	ND	1.89E+01	7.34E+01
<b>B. Iodines</b>						
iodine-131	CI	LLD	LLD	LLD	LLD	LLD
iodine-133	CI	LLD	4.38E-06	LLD	LLD	4.38E-06
iodine-135	CI	LLD	LLD	LLD	LLD	LLD
<b>Total for period</b>	CI	ND	4.38E-06	ND	ND	4.38E-06
<b>C. Particulates</b>						
chromium-51	CI	LLD	LLD	LLD	LLD	LLD
manganese-54	CI	LLD	LLD	LLD	LLD	LLD
cobalt-57	CI	LLD	LLD	LLD	LLD	LLD
cobalt-58	CI	LLD	LLD	LLD	LLD	LLD
cobalt-60	CI	LLD	LLD	LLD	LLD	LLD
zinc-65	CI	LLD	LLD	LLD	LLD	LLD
selenium-75	CI	LLD	LLD	LLD	LLD	LLD
zirconium/niobium-95	CI	LLD	LLD	LLD	LLD	LLD
zirconium/niobium-97	CI	LLD	LLD	LLD	LLD	LLD
cesium-134	CI	LLD	LLD	LLD	LLD	LLD
cesium-137	CI	LLD	LLD	LLD	LLD	LLD
caesium-141	CI	LLD	LLD	LLD	LLD	LLD
cerium-144	CI	LLD	LLD	LLD	LLD	LLD
strontium-89	CI	LLD	LLD	LLD	LLD	LLD
strontium-90	CI	LLD	LLD	LLD	LLD	LLD
<b>Total for period</b>	CI	ND	ND	ND	ND	ND
<b>D. Tritium</b>						
hydrogen-3	CI	2.77E-05	1.16E-03	0.00E+00	4.95E-02	5.07E-02

NOTE: Unit 1/2 Process Vent

LLD = Below the Lower Limit of Detectability, in uCi/cc (Table 4).

ND = None Detected

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 1B-EC

Gaseous Effluents - Elevated Continuous Releases (Unit 1 & 2)

Nuclides released	unit	Q1	Q2	Q3	Q4	Calendar Year
<b>A. Fission gases</b>						
argon-41	Ci	LLD	LLD	LLD	LLD	LLD
krypton-85	Ci	LLD	LLD	LLD	LLD	LLD
krypton-85m	Ci	LLD	LLD	LLD	LLD	LLD
krypton-87	Ci	LLD	LLD	LLD	LLD	LLD
krypton-88	Ci	LLD	LLD	LLD	LLD	LLD
xenon-131m	Ci	LLD	LLD	LLD	LLD	LLD
xenon-133	Ci	LLD	LLD	LLD	LLD	LLD
xenon-133m	Ci	LLD	LLD	LLD	LLD	LLD
xenon-135	Ci	LLD	LLD	LLD	LLD	LLD
xenon-135m	Ci	LLD	LLD	LLD	LLD	LLD
xenon-138	Ci	LLD	LLD	LLD	LLD	LLD
Total for period	Ci	ND	ND	ND	ND	ND
<b>B. Iodines</b>						
iodine-131	Ci	LLD	LLD	LLD	LLD	LLD
iodine-133	Ci	LLD	LLD	LLD	LLD	LLD
iodine-135	Ci	LLD	LLD	LLD	LLD	LLD
Total for period	Ci	ND	ND	ND	ND	ND
<b>C. Particulates</b>						
chromium-51	Ci	LLD	LLD	LLD	LLD	LLD
manganese-54	Ci	LLD	LLD	LLD	LLD	LLD
cobalt-57	Ci	LLD	LLD	LLD	LLD	LLD
cobalt-58	Ci	LLD	LLD	LLD	1.42E-07	1.42E-07
cobalt-60	Ci	LLD	LLD	LLD	LLD	LLD
zinc-65	Ci	LLD	LLD	LLD	LLD	LLD
selenium-75	Ci	LLD	1.69E-07	5.35E-07	9.69E-08	8.01E-07
zirconium/niobium-95	Ci	LLD	LLD	LLD	LLD	LLD
zirconium/niobium-97	Ci	LLD	LLD	LLD	LLD	LLD
cesium-134	Ci	LLD	LLD	LLD	LLD	LLD
cesium-137	Ci	LLD	LLD	LLD	LLD	LLD
cerium-141	Ci	LLD	LLD	LLD	LLD	LLD
cerium-144	Ci	LLD	LLD	LLD	LLD	LLD
strontium-89	Ci	LLD	LLD	LLD	LLD	LLD
strontium-90	Ci	LLD	LLD	LLD	LLD	LLD
Total for period	Ci	ND	1.69E-07	5.35E-07	2.39E-07	9.43E-07
<b>D. Tritium</b>						
hydrogen-3	Ci	1.98E-01	1.25E-01	9.63E-02	1.31E-01	5.50E-01

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 1C-GB1

Gaseous Effluents - Ground Level Batch Releases (Unit 1)

Nuclides released	unit	Q1	Q2	Q3	Q4	Calendar Year
<b>A. Fission gases</b>						
argon-41	Ci	LLD	LLD	LLD	LLD	LLD
krypton-85	Ci	LLD	LLD	LLD	LLD	LLD
krypton-85m	Ci	LLD	LLD	LLD	LLD	LLD
krypton-87	Ci	LLD	LLD	LLD	LLD	LLD
krypton-88	Ci	LLD	LLD	LLD	LLD	LLD
xenon-131m	Ci	LLD	LLD	LLD	LLD	LLD
xenon-133	Ci	LLD	LLD	LLD	LLD	LLD
xenon-133m	Ci	LLD	LLD	LLD	LLD	LLD
xenon-135	Ci	LLD	LLD	LLD	LLD	LLD
xenon-135m	Ci	LLD	LLD	LLD	LLD	LLD
xenon-138	Ci	LLD	LLD	LLD	LLD	LLD
Total for period	Ci	ND	ND	ND	ND	ND
<b>B. Iodines</b>						
iodine-131	Ci	LLD	LLD	LLD	LLD	LLD
iodine-133	Ci	LLD	LLD	LLD	LLD	LLD
iodine-135	Ci	LLD	LLD	LLD	LLD	LLD
Total for period	Ci	ND	ND	ND	ND	ND
<b>C. Particulates</b>						
chromium-51	Ci	LLD	LLD	LLD	LLD	LLD
manganese-54	Ci	LLD	LLD	LLD	LLD	LLD
cobalt-57	Ci	LLD	LLD	LLD	LLD	LLD
cobalt-58	Ci	LLD	LLD	LLD	LLD	LLD
cobalt-60	Ci	LLD	LLD	LLD	LLD	LLD
zinc-65	Ci	LLD	LLD	LLD	LLD	LLD
selenium-75	Ci	LLD	LLD	LLD	LLD	LLD
zirconium/niobium-95	Ci	LLD	LLD	LLD	LLD	LLD
zirconium/niobium-97	Ci	LLD	LLD	LLD	LLD	LLD
cesium-134	Ci	LLD	LLD	LLD	LLD	LLD
cesium-137	Ci	LLD	LLD	LLD	LLD	LLD
cerium-141	Ci	LLD	LLD	LLD	LLD	LLD
cerium-144	Ci	LLD	LLD	LLD	LLD	LLD
strontium-89	Ci	LLD	LLD	LLD	LLD	LLD
strontium-90	Ci	LLD	LLD	LLD	LLD	LLD
Total for period	Ci	ND	ND	ND	ND	ND
<b>D. Tritium</b>						
hydrogen-3	Ci	1.79E-03	4.63E-02	2.49E-03	1.07E-03	5.17E-02

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 1C-GC1

Gaseous Effluents - Ground Level Continuous Releases (Unit 1)

Nuclides released	unit	Q1	Q2	Q3	Q4	Calendar Year
<b>A. Fission gases</b>						
argon-41	CI	LLD	LLD	LLD	LLD	LLD
krypton-85	CI	LLD	LLD	LLD	LLD	LLD
krypton-85m	CI	LLD	LLD	LLD	LLD	LLD
krypton-87	CI	LLD	LLD	LLD	LLD	LLD
krypton-88	CI	LLD	LLD	LLD	LLD	LLD
xenon-131m	CI	LLD	LLD	LLD	LLD	LLD
xenon-133	CI	LLD	LLD	LLD	LLD	LLD
xenon-133m	CI	LLD	LLD	LLD	LLD	LLD
xenon-135	CI	LLD	LLD	LLD	LLD	LLD
xenon-135m	CI	LLD	LLD	LLD	LLD	LLD
xenon-138	CI	LLD	LLD	LLD	LLD	LLD
Total for period	CI	ND	ND	ND	ND	ND
<b>B. Iodines</b>						
iodine-131	CI	LLD	LLD	LLD	LLD	LLD
iodine-133	CI	LLD	LLD	LLD	LLD	LLD
iodine-135	CI	LLD	LLD	LLD	LLD	LLD
Total for period	CI	ND	ND	ND	ND	ND
<b>C. Particulates</b>						
chromium-51	CI	LLD	3.10E-04	LLD	LLD	3.10E-04
manganese-54	CI	LLD	LLD	LLD	LLD	LLD
cobalt-57	CI	LLD	LLD	LLD	LLD	LLD
cobalt-58	CI	LLD	7.11E-05	LLD	LLD	7.11E-05
cobalt-60	CI	LLD	2.72E-05	LLD	LLD	2.72E-05
zinc-65	CI	LLD	LLD	LLD	LLD	LLD
selenium-75	CI	LLD	LLD	LLD	LLD	LLD
niobium-95	CI	LLD	1.86E-04	LLD	LLD	1.86E-04
zirconium-95	CI	LLD	1.25E-04	LLD	LLD	1.25E-04
cesium-134	CI	LLD	LLD	LLD	LLD	LLD
cesium-137	CI	LLD	1.98E-05	LLD	LLD	1.98E-05
cerium-141	CI	LLD	LLD	LLD	LLD	LLD
cerium-144	CI	LLD	LLD	LLD	LLD	LLD
strontium-89	CI	LLD	LLD	LLD	LLD	LLD
strontium-90	CI	LLD	LLD	LLD	LLD	LLD
Total for period	CI	ND	7.39E-04	ND	ND	7.39E-04
<b>D. Tritium</b>						
hydrogen-3	CI	2.24E+00	1.79E+00	5.12E+00	6.05E+00	1.52E+01



# Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 1C-GB2

Gaseous Effluents - Ground Level Batch Releases (Unit 2)

Nuclides released	unit	Q1	Q2	Q3	Q4	Calendar Year
<b>A. Fission gases</b>						
argon-41	Ci	LLD	LLD	LLD	LLD	LLD
krypton-85	Ci	LLD	LLD	LLD	LLD	LLD
krypton-85m	Ci	LLD	LLD	LLD	LLD	LLD
krypton-87	Ci	LLD	LLD	LLD	LLD	LLD
krypton-88	Ci	LLD	LLD	LLD	LLD	LLD
xenon-131m	Ci	LLD	LLD	LLD	LLD	LLD
xenon-133	Ci	LLD	LLD	LLD	LLD	LLD
xenon-133m	Ci	LLD	LLD	LLD	LLD	LLD
xenon-135	Ci	LLD	LLD	LLD	LLD	LLD
xenon-135m	Ci	LLD	LLD	LLD	LLD	LLD
xenon-138	Ci	LLD	LLD	LLD	LLD	LLD
Total for period	Ci	ND	ND	ND	ND	ND
<b>B. Iodines</b>						
iodine-131	Ci	LLD	LLD	LLD	LLD	LLD
iodine-133	Ci	LLD	LLD	LLD	LLD	LLD
iodine-135	Ci	LLD	LLD	LLD	LLD	LLD
Total for period	Ci	ND	ND	ND	ND	ND
<b>C. Particulates</b>						
chromium-51	Ci	LLD	LLD	LLD	LLD	LLD
manganese-54	Ci	LLD	LLD	LLD	LLD	LLD
cobalt-57	Ci	LLD	LLD	LLD	LLD	LLD
cobalt-58	Ci	LLD	LLD	LLD	LLD	LLD
cobalt-60	Ci	LLD	LLD	LLD	LLD	LLD
zinc-65	Ci	LLD	LLD	LLD	LLD	LLD
selenium-75	Ci	LLD	LLD	LLD	LLD	LLD
zirconium/niobium-95	Ci	LLD	LLD	LLD	LLD	LLD
zirconium/niobium-97	Ci	LLD	LLD	LLD	LLD	LLD
cesium-134	Ci	LLD	LLD	LLD	LLD	LLD
cesium-137	Ci	LLD	LLD	LLD	LLD	LLD
cerium-141	Ci	LLD	LLD	LLD	LLD	LLD
cerium-144	Ci	LLD	LLD	LLD	LLD	LLD
strontium-89	Ci	LLD	LLD	LLD	LLD	LLD
strontium-90	Ci	LLD	LLD	LLD	LLD	LLD
Total for period	Ci	ND	ND	ND	ND	ND
<b>D. Tritium</b>						
hydrogen-3	Ci	6.79E-03	5.86E-03	2.97E-03	1.57E-01	1.73E-01

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 1C-GC2

Gaseous Effluents - Ground Level Continuous Releases (Unit 2)

Nuclides released	unit	Q1	Q2	Q3	Q4	Calendar Year
<b>A. Fission gases</b>						
argon-41	Ci	LLD	LLD	LLD	LLD	LLD
krypton-85	Ci	LLD	LLD	LLD	LLD	LLD
krypton-85m	Ci	LLD	LLD	LLD	LLD	LLD
krypton-87	Ci	LLD	LLD	LLD	LLD	LLD
krypton-88	Ci	LLD	LLD	LLD	LLD	LLD
xenon-131m	Ci	LLD	LLD	LLD	LLD	LLD
xenon-133	Ci	LLD	LLD	LLD	LLD	LLD
xenon-133m	Ci	LLD	LLD	LLD	LLD	LLD
xenon-135	Ci	LLD	LLD	LLD	LLD	LLD
xenon-135m	Ci	LLD	LLD	LLD	LLD	LLD
xenon-138	Ci	LLD	LLD	LLD	LLD	LLD
Total for period	Ci	ND	ND	ND	ND	ND
<b>B. Iodines</b>						
iodine-131	Ci	LLD	LLD	LLD	LLD	LLD
iodine-133	Ci	LLD	LLD	LLD	LLD	LLD
iodine-135	Ci	LLD	LLD	LLD	LLD	LLD
Total for period	Ci	ND	ND	ND	ND	ND
<b>C. Particulates</b>						
chromium-51	Ci	LLD	LLD	LLD	9.63E-05	9.63E-05
manganese-54	Ci	LLD	LLD	LLD	4.08E-06	4.08E-06
cobalt-57	Ci	LLD	LLD	LLD	LLD	LLD
cobalt-58	Ci	LLD	LLD	LLD	2.85E-04	2.85E-04
cobalt-60	Ci	LLD	LLD	LLD	4.25E-05	4.25E-05
zinc-65	Ci	LLD	LLD	LLD	LLD	LLD
selenium-75	Ci	LLD	LLD	LLD	LLD	LLD
niobium-95	Ci	LLD	2.46E-07	LLD	9.10E-05	9.12E-05
zirconium-95	Ci	LLD	LLD	LLD	5.95E-05	5.95E-05
cesium-134	Ci	LLD	LLD	LLD	LLD	LLD
cesium-137	Ci	LLD	LLD	LLD	LLD	LLD
cerium-141	Ci	LLD	LLD	LLD	LLD	LLD
cerium-144	Ci	LLD	LLD	LLD	LLD	LLD
strontium-89	Ci	LLD	LLD	LLD	LLD	LLD
strontium-90	Ci	LLD	LLD	LLD	LLD	LLD
Total for period	Ci	ND	2.46E-07	ND	5.78E-04	5.79E-04
<b>D. Tritium</b>						
hydrogen-3	Ci	1.61E+01	1.15E+01	1.04E+01	1.81E+01	5.61E+01

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 2A

Liquid Effluents - Summation Of All Releases

	unit	Q1	Q2	Q3	Q4	Calendar Year	Total Error %
<b>A. Fission &amp; activation products</b>							
1. Total release (excl. H-3, gas & alpha)	Ci	9.87E-03	6.39E-02	1.55E-02	2.27E-02	1.12E-01	26.1%
2. Average diluted concentration	uCi/mL	2.27E-09	1.34E-08	3.32E-09	4.51E-09	5.95E-09	
3. Percent of applicable limit	%	1.97E-01	1.28E+00	3.09E-01	4.54E-01	1.12E+00	
<b>B. Tritium</b>							
1. Total release	Ci	7.28E+02	3.68E+02	3.00E+02	1.85E+02	1.58E+03	25.0%
2. Average diluted concentration	uCi/mL	1.67E-04	7.71E-05	6.43E-05	3.68E-05	8.41E-05	
3. Percent of applicable limit	%	1.67E+01	7.71E+00	6.43E+00	3.68E+00	8.41E-01	
<b>C. Dissolved and entrained gases</b>							
1. Total release	Ci	2.90E-04	0.00E+00	0.00E+00	4.47E-04	7.37E-04	27.0%
2. Average diluted concentration	uCi/mL	6.67E-11	0.00E+00	0.00E+00	8.88E-11	3.92E-11	
3. Percent of applicable limit	%	3.34E-05	0.00E+00	0.00E+00	4.44E-05	1.96E-05	
<b>D. Gross alpha radioactivity (total release)</b>							
	Ci	LLD	LLD	LLD	LLD	LLD	N/A
<b>E. Volume of waste released (prior to dilution)</b>							
	L	1.02E+07	6.83E+06	1.06E+07	1.18E+07	3.94E+07	11.2%
<b>F. Volume of dilution water used</b>							
	L	4.34E+09	4.77E+09	4.65E+09	5.01E+09	1.88E+10	22.9%

LLD = Below the Lower Limit of Detectability, in uCi/mL (Table 4)

A.3 is based on a historical PA-DEP guide of 10 Ci/yr

B.3 is based on a ODCM limit of 1.00E-2 uCi/mL

C.3 is based on a ODCM limit of 2.00E-04 uCi/mL

The values listed at F. are the volumes during actual liquid waste discharge periods. The total dilution volume for a continuous calendar quarter is approximately 1E+10 liters for BVPS-1 & 2 (ie.; ~ 22,800 gpm is the total dilution flowrate from the site)

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 2B-B

Liquid Effluents - Batch Releases

Nuclides released	unit	Q1	Q2	Q3	Q4	Calendar Year
<b>A. Fission &amp; Activation Products</b>						
beryllium-7	CI	LLD	LLD	LLD	LLD	LLD
sodium-24	CI	LLD	LLD	LLD	LLD	LLD
chromium-51	CI	LLD	2.65E-03	LLD	5.85E-04	3.24E-03
manganese-54	CI	1.56E-04	8.12E-04	2.98E-04	3.91E-04	1.66E-03
iron-59	CI	LLD	LLD	LLD	8.65E-05	8.65E-05
cobalt-57	CI	5.48E-05	1.48E-04	4.62E-05	2.58E-05	2.75E-04
cobalt-58	CI	1.52E-03	2.70E-02	1.50E-03	7.40E-03	3.74E-02
cobalt-60	CI	4.25E-03	2.03E-02	8.19E-03	7.94E-03	4.07E-02
nickel-65	CI	LLD	LLD	LLD	LLD	LLD
zinc-65	CI	LLD	1.76E-04	1.66E-05	2.51E-05	2.18E-04
selenium-75	CI	LLD	8.91E-05	LLD	LLD	8.91E-05
strontium-92	CI	LLD	2.21E-06	LLD	LLD	2.21E-06
niobium-95	CI	4.09E-05	2.09E-03	6.10E-05	1.95E-04	2.39E-03
zirconium-95	CI	LLD	1.08E-03	LLD	7.69E-05	1.16E-03
niobium-97	CI	1.49E-05	7.40E-05	7.00E-05	5.67E-05	2.16E-04
zirconium-97	CI	LLD	LLD	LLD	LLD	LLD
molybdenum-99/technetium-99m	CI	LLD	LLD	LLD	LLD	LLD
ruthenium-103	CI	LLD	LLD	LLD	LLD	LLD
ruthenium-105	CI	LLD	LLD	LLD	LLD	LLD
ruthenium-106	CI	LLD	LLD	LLD	LLD	LLD
silver-108m	CI	LLD	2.04E-06	3.73E-06	LLD	5.77E-06
silver-110m	CI	LLD	3.51E-04	2.52E-04	5.14E-04	1.12E-03
tin-113	CI	1.03E-05	LLD	LLD	LLD	1.03E-05
tin-117m	CI	LLD	LLD	LLD	LLD	LLD
antimony-122	CI	LLD	LLD	LLD	LLD	LLD
antimony-124	CI	LLD	2.15E-04	LLD	5.45E-05	2.70E-04
antimony-125	CI	2.02E-03	4.56E-03	1.54E-03	2.76E-03	1.09E-02
tin-125	CI	LLD	LLD	LLD	LLD	LLD
iodine-131	CI	LLD	LLD	LLD	LLD	LLD
iodine-133	CI	LLD	LLD	LLD	LLD	LLD
iodine-135	CI	LLD	LLD	LLD	LLD	LLD
cesium-134	CI	LLD	LLD	LLD	LLD	LLD
cesium-137	CI	1.11E-04	4.71E-04	2.37E-04	7.21E-06	8.26E-04
barium/lanthanum-140	CI	LLD	LLD	LLD	LLD	LLD
cerium-141	CI	LLD	LLD	LLD	LLD	LLD
cerium-144	CI	LLD	LLD	LLD	LLD	LLD
iron-55	CI	1.69E-03	3.94E-03	3.25E-03	2.57E-03	1.15E-02
nickel-63	CI	LLD	LLD	LLD	LLD	LLD
strontium-89	CI	LLD	LLD	LLD	LLD	LLD
strontium-90	CI	LLD	LLD	LLD	LLD	LLD
Total for period	CI	9.87E-03	6.40E-02	1.55E-02	2.27E-02	1.12E-01
<b>B. Tritium</b>						
hydrogen-3	CI	7.28E+02	3.68E+02	3.00E+02	1.85E+02	1.58E+03
Total for period	CI	7.28E+02	3.68E+02	3.00E+02	1.85E+02	1.58E+03
<b>C. Dissolved &amp; Entrained Gases</b>						
argon-41	CI	LLD	LLD	LLD	LLD	LLD
krypton-85	CI	LLD	LLD	LLD	LLD	LLD
xenon-131m	CI	LLD	LLD	LLD	LLD	LLD
xenon-133	CI	2.90E-04	LLD	LLD	4.47E-04	7.37E-04
xenon-133m	CI	LLD	LLD	LLD	LLD	LLD
xenon-135	CI	LLD	LLD	LLD	LLD	LLD
xenon-135m	CI	LLD	LLD	LLD	LLD	LLD
xenon-137	CI	LLD	LLD	LLD	LLD	LLD
Total for period	CI	2.90E-04	ND	ND	4.47E-04	7.37E-04

LLD = Below the Lower Limit of Detectability, in uCi/mL (Table 4)  
 ND = None Detected

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 2B-C

Liquid Effluents - Continuous Releases

Nuclides released	unit	Q1	Q2	Q3	Q4	Calendar Year
<b>A. Fission &amp; Activation Products</b>						
beryllium-7	Ci	LLD	LLD	LLD	LLD	LLD
sodium-24	Ci	LLD	LLD	LLD	LLD	LLD
chromium-51	Ci	LLD	LLD	LLD	LLD	LLD
manganese-54	Ci	LLD	LLD	LLD	LLD	LLD
iron-59	Ci	LLD	LLD	LLD	LLD	LLD
cobalt-57	Ci	LLD	LLD	LLD	LLD	LLD
cobalt-58	Ci	LLD	LLD	LLD	LLD	LLD
cobalt-60	Ci	LLD	LLD	LLD	LLD	LLD
zinc-65	Ci	LLD	LLD	LLD	LLD	LLD
zirconium/niobium-95	Ci	LLD	LLD	LLD	LLD	LLD
zirconium/niobium-97	Ci	LLD	LLD	LLD	LLD	LLD
molybdenum-99/technetium-99m	Ci	LLD	LLD	LLD	LLD	LLD
ruthenium-103	Ci	LLD	LLD	LLD	LLD	LLD
ruthenium-106	Ci	LLD	LLD	LLD	LLD	LLD
silver-110m	Ci	LLD	LLD	LLD	LLD	LLD
tin-113	Ci	LLD	LLD	LLD	LLD	LLD
tin-117m	Ci	LLD	LLD	LLD	LLD	LLD
antimony-122	Ci	LLD	LLD	LLD	LLD	LLD
antimony-124	Ci	LLD	LLD	LLD	LLD	LLD
antimony-125	Ci	LLD	LLD	LLD	LLD	LLD
iodine-131	Ci	LLD	LLD	LLD	LLD	LLD
iodine-133	Ci	LLD	LLD	LLD	LLD	LLD
iodine-135	Ci	LLD	LLD	LLD	LLD	LLD
cesium-134	Ci	LLD	LLD	LLD	LLD	LLD
cesium-137	Ci	LLD	LLD	LLD	LLD	LLD
barium/lanthanum-140	Ci	LLD	LLD	LLD	LLD	LLD
cerium-141	Ci	LLD	LLD	LLD	LLD	LLD
cerium-144	Ci	LLD	LLD	LLD	LLD	LLD
iron-55	Ci	LLD	LLD	LLD	LLD	LLD
strontium-89	Ci	LLD	LLD	LLD	LLD	LLD
strontium-90	Ci	LLD	LLD	LLD	LLD	LLD
<b>Total for period</b>	<b>Ci</b>	<b>ND</b>	<b>ND</b>	<b>ND</b>	<b>ND</b>	<b>ND</b>
<b>B. Tritium</b>						
hydrogen-3	Ci	2.82E-02	5.18E-03	2.97E-02	3.40E-02	9.71E-02
<b>Total for period</b>	<b>Ci</b>	<b>2.82E-02</b>	<b>5.18E-03</b>	<b>2.97E-02</b>	<b>3.40E-02</b>	<b>9.71E-02</b>
<b>C. Dissolved &amp; Entrained Gases</b>						
argon-41	Ci	LLD	LLD	LLD	LLD	LLD
krypton-85	Ci	LLD	LLD	LLD	LLD	LLD
xenon-131m	Ci	LLD	LLD	LLD	LLD	LLD
xenon-133	Ci	LLD	LLD	LLD	LLD	LLD
xenon-133m	Ci	LLD	LLD	LLD	LLD	LLD
xenon-135	Ci	LLD	LLD	LLD	LLD	LLD
xenon-135m	Ci	LLD	LLD	LLD	LLD	LLD
<b>Total for period</b>	<b>Ci</b>	<b>ND</b>	<b>ND</b>	<b>ND</b>	<b>ND</b>	<b>ND</b>

LLD = Below the Lower Limit of Detectability, in uCi/mL (Table 4)

ND = None Detected

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 3A

Solid Waste And Irradiated Fuel Shipments (Part 1 of 3)

A. Solid Waste Shipped Offsite For Burial Or Disposal (Not irradiated fuel)			
1. Type of Waste (Spent resins, Filter Sludges, Evaporator Bottoms, Oil)	Jan - Jun	Jul - Dec	Estimated Total Error
a. Volume Shipped	8.80 m <sup>3</sup>	0.00 m <sup>3</sup>	0.0% (1)
b. Volume Buried	2.92 m <sup>3</sup>	0.00 m <sup>3</sup>	0.0% (1)
c. Total Activity	13.10 Ci	0.00 Ci	30.0%
2. Estimate of Major Nuclide Composition by Type of Waste On This Table <sup>(2)</sup>	Percent (%)	Percent (%)	
H-3	0.37 %	0.00 %	
C-14	0.46 %	0.00 %	
Mn-54	0.47 %	0.00 %	
Fe-55	0.47 %	0.00 %	
Co-57	0.18 %	0.00 %	
Co-58	0.15 %	0.00 %	
Co-60	38.81 %	0.00 %	
Ni-63	0.28 %	0.00 %	
Zn-65	51.12 %	0.00 %	
Nb-95	0.12 %	0.00 %	
Cs-137	0.11 %	0.00 %	
Sb-125	6.96 %	0.00 %	
Zr-95	0.00 %	0.00 %	
3. Number of Shipments	4	0	
a. Type of Container Used	LSA	1	0
	Type A	0	0
	Type B	3	0
	Large Quantity	0	0
b. Solidification Agent Used	Cement	0	0
	UreaFormaldehyde	0	0
	None	0	0
c. Mode of Transport	Truck	4	0
	Rail	0	0
	Other	0	0
d. Final Destination	Oak Ridge, TN	1	0
	Erwin, TN	3	0
e. Waste Class per 10 CFR Part 61	Class A	1	0
	Class B	0	0
	Class C	3	0
	> Class C	0	0

(1) Since container volumes are provided by the burial site, a calculational error of zero is assumed.

(2) Percent values for any nuclide that are <0.01 % are not shown on this table. Data is available upon request.

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 3B

Solid Waste And Irradiated Fuel Shipments (Part 2 of 3)

A. Solid Waste Shipped Offsite For Burial Or Disposal (Not irradiated fuel)				
1. Type of Waste (Dry Compressible Waste, Contaminated Equipment, etc.)		Jan - Jun	Jul - Dec	Estimated Total Error
a. Volume Shipped		120.00 m <sup>3</sup>	130.00 m <sup>3</sup>	0.0% (1)
b. Volume Buried		2.24 m <sup>3</sup>	3.15 m <sup>3</sup>	0.0% (1)
c. Total Activity		0.16 Ci	0.06 Ci	30.0%
2. Estimate of Major Nuclide Composition by Type of Waste On This Table <sup>(2)</sup>		Percent (%)	Percent (%)	
H-3		1.40 %	1.60 %	
C-14		0.42 %	0.64 %	
Cr-51		0.00 %	0.00 %	
Mn-54		0.91 %	0.85 %	
Fe-55		37.90 %	24.51 %	
Co-58		10.10 %	8.58 %	
Co-60		25.55 %	22.87 %	
Ni-59		0.00 %	0.00 %	
Ni-63		20.94 %	20.48 %	
Sn-113		0.09 %	0.08 %	
Nb-95		1.89 %	14.30 %	
Zn-65		0.00 %	1.83 %	
Zr-95		8.70 %	9.14 %	
Ag-110m		0.00 %	0.74 %	
Tc-99		0.00 %	0.00 %	
Sb-125		3.01 %	2.70 %	
I-129		0.00 %	0.00 %	
Cs-134		0.00 %	0.00 %	
Cs-137		0.36 %	0.35 %	
Ce-144/Pr-144		0.00 %	0.00 %	
Pu-241		0.00 %	0.00 %	
3. Number of Shipments		4	3	
a. Type of Container Used	LSA	4	3	
	Type A	0	0	
	Type B	0	0	
	Large Quantity	0	0	
b. Solidification Agent Used	Cement	0	0	
	UreaFormaldehyde	0	0	
	None	4	3	
c. Mode of Transport	Truck	4	3	
	Rail	0	0	
	Other	0	0	
d. Final Destination	Oak Ridge, TN	4	3	
	Wampum, PA	0	0	
e. Waste Class per 10 CFR Part 61	Class A	4	3	
	Class B	0	0	
	Class C	0	0	
	> Class C	0	0	

(1) Since container volumes are provided by the burial site, a calculational error of zero is assumed.

(2) Percent values for any nuclide that are <0.01 % are not shown on this table. Data is available upon request.

## Annual Radioactive Effluent Release Report

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Table 3C

Solid Waste And Irradiated Fuel Shipments (Part 3 of 3)

A. Solid Waste Shipped Offsite For Burial Or Disposal (Not irradiated fuel)				
1. Type of Waste (Irradiated components, Control Rods, etc)		Jan - Jun	Jul - Dec	Estimated Total Error
a. Volume Shipped		0.00E+00 m <sup>3</sup>	0.00E+00 m <sup>3</sup>	0.0% (1)
b. Volume Buried		0.00E+00 m <sup>3</sup>	0.00E+00 m <sup>3</sup>	0.0% (1)
c. Total Activity		0.00E+00 Ci	0.00E+00 Ci	0.0%
2. Estimate of Major Nuclide Composition by Type of Waste On This Table <sup>(2)</sup>		Percent (%)	Percent (%)	
H-3		0 %	0 %	
Mn-54		0 %	0 %	
Fe-55		0 %	0 %	
Co-60		0 %	0 %	
Ni-59		0 %	0 %	
Ni-63		0 %	0 %	
Nb-95		0 %	0 %	
Zn-65		0 %	0 %	
Sb-125		0 %	0 %	
Cs-134		0 %	0 %	
Cs-137		0 %	0 %	
3. Number of Shipments		0	0	
a. Type of Container Used	LSA	0	0	
	Type A	0	0	
	Type B	0	0	
	Large Quantity	0	0	
b. Solidification Agent Used	Cement	0	0	
	UreaFormaldehyde	0	0	
	None	0	0	
c. Mode of Transport	Truck	0	0	
	Rail	0	0	
	Other	0	0	
d. Final Destination	Oak Ridge, TN	0	0	
	Barnwell, SC	0	0	
e. Waste Class per 10 CFR Part 61	Class A	0	0	
	Class B	0	0	
	Class C	0	0	
	> Class C	0	0	
B. No Irradiated Fuel Shipments				

(1) Since container volumes are provided by the burial site, a calculational error of zero is assumed.

(2) Percent values for any nuclide that are <0.01 % are not shown on this table. Data is available upon request.



## Annual Radioactive Effluent Release Report

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Table 4

Lower Limits Of Detectability (LLD)

Nuclide	RWDA-G 1000 cc Gas Grab Sample		RWDA-L 1000 mL Liquid Grab Sample		Filter Paper / Charcoal Continuous Effluent Sample	
	(3) Calculated LLD (uCi/cc)	ODCM Required LLD (uCi/cc)	(3) Calculated LLD (uCi/mL)	ODCM Required LLD (uCi/mL)	(3) Calculated (2) LLD (uCi/cc)	ODCM Required LLD (uCi/cc)
H-3	(4) 1.00E-06	1E-06	1.00E-06	1E-06		
Na-24	9.62E-08	1E-04	2.08E-08	5E-07	1.81E-13	1E-11
Ar-41	5.85E-08	1E-04	1.27E-08	5E-07		
Cr-51	4.51E-07	1E-04	1.04E-07	5E-07	6.31E-13	1E-11
Mn-54	6.31E-08	1E-04	1.39E-08	5E-07	2.08E-13	1E-11
Fe-55			(1) 1.00E-06	1E-06		
Fe-59	8.36E-08	1E-04	1.81E-08	5E-07	4.57E-13	1E-11
Co-57	4.55E-08	1E-04	1.13E-08	5E-07	6.76E-14	1E-11
Co-58	4.39E-08	1E-04	9.71E-09	5E-07	2.05E-13	1E-11
Co-60	8.59E-08	1E-04	1.86E-08	5E-07	2.72E-13	1E-11
Zn-65	1.65E-07	1E-04	3.58E-08	5E-07	3.69E-13	1E-11
Se-75					1.78E-13	1E-11
Kr-85	1.48E-05	1E-04	3.36E-06	1E-05		
Kr-85m	3.70E-08	1E-04	8.96E-09	1E-05		
Kr-87	1.11E-07	1E-04	2.55E-08	1E-05		
Kr-88	1.43E-07	1E-04	3.38E-08	1E-05		
Sr-89			(1) 5.00E-08	5E-08	(1) 1.00E-13	1E-11
Sr-90			(1) 5.00E-08	5E-08	(1) 1.00E-14	1E-11
Sr-92	7.59E-08	1E-04	1.64E-08	5E-07	2.36E-13	1E-11
Nb-95	4.20E-08	1E-04	9.31E-09	5E-07	1.95E-13	1E-11
Nb-97	4.92E-08	1E-04	1.10E-08	5E-07	1.52E-13	1E-11
Zr-95	9.35E-08	1E-04	2.08E-08	5E-07	2.04E-13	1E-11
Mo-99	3.54E-07	1E-04	7.87E-08	5E-07	1.16E-12	1E-11
Tc-99m	4.50E-08	1E-04	1.10E-08	5E-07	7.15E-14	1E-11
Ag-110m	4.38E-08	1E-04	9.82E-09	5E-07	1.04E-13	1E-11
Sb-124	3.11E-08	1E-04	7.00E-09	5E-07	1.16E-13	1E-11
Sb-125	1.45E-07	1E-04	3.32E-08	5E-07	3.33E-13	1E-11
I-131	5.72E-08	1E-04	1.31E-08	1E-06	1.24E-13	1E-12
I-133	6.68E-08	1E-04	1.51E-08	5E-07	1.30E-13	1E-10
I-135	3.21E-07	1E-04	6.95E-08	5E-07	6.67E-13	1E-11
Xe-131m	1.89E-06	1E-04	4.53E-07	1E-05		
Xe-133	7.16E-08	1E-04	1.98E-08	1E-05		
Xe-133m	3.93E-07	1E-04	9.20E-08	1E-05		
Xe-135	4.70E-08	1E-04	1.10E-08	1E-05		
Xe-135m	1.04E-07	1E-04	2.35E-08	1E-05		
Xe-137	8.92E-07	1E-04	2.03E-07	1E-05		
Xe-138	2.43E-07	1E-04	5.66E-08	1E-05		
Cs-134	4.42E-08	1E-04	9.94E-09	5E-07	1.16E-13	1E-11
Cs-137	5.85E-08	1E-04	1.31E-08	5E-07	2.03E-13	1E-11
Ba-139	1.70E-07	1E-04	4.07E-08	5E-07	4.53E-13	1E-11
Ba-140	1.32E-07	1E-04	3.00E-08	5E-07	4.00E-13	1E-11
La-140	1.13E-07	1E-04	2.42E-08	5E-07	2.59E-13	1E-11
Ce-141	8.10E-08	1E-04	1.97E-08	5E-07	1.38E-13	1E-11
Ce-144	2.89E-07	1E-04	7.10E-08	5E-07	4.66E-13	1E-11
Gross Alpha			(1) 1.00E-07	1E-07	(1) 3.51E-15	1E-11

(1) Sample analyses performed by a contractor laboratory.

(2) These LLD calculations contain a default weekly continuous sample volume of 1.43E+8 cc. Therefore, grab sample LLD values reflect a different volume (ie; 10 cuft or 2.83E+5 cc).

(3) The calculated LLD's are for Unit 2 Detector 7, except those denoted by (1), are from a counter/detector calibration on 3/31/20. These values are typical for other counter/detectors used for effluent counting at BVPS.

(4) Based on counting 50 mL of the water that was bubbled through a 20 liter air sample.

# Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 5A

Assessment Of Radiation Doses (Unit 1)

		Unit 1 Liquid Effluents									
		1st Quarter		2nd Quarter		3rd Quarter		4th Quarter		Calendar Year	
Batch Releases		Dose	% of ODCM Limit	Dose	% of ODCM Limit	Dose	% of ODCM Limit	Dose	% of ODCM Limit	Dose	% of ODCM Limit
	ORGANIC	Bone	2.01E-03	0.0402	6.38E-03	0.1276	2.92E-03	0.0585	1.64E-04	0.0033	1.15E-02
Liver		1.18E-02	0.2358	1.24E-02	0.2481	6.67E-03	0.1334	2.43E-03	0.0486	3.33E-02	0.3329
Total Body		9.45E-03	0.6297	5.33E-03	0.3553	2.38E-03	0.1589	2.83E-02	1.8891	4.55E-02	1.5165
Thyroid		9.32E-03	0.1864	3.23E-03	0.0647	2.20E-03	0.0440	2.08E-03	0.0416	1.68E-02	0.1683
Kidney		1.02E-02	0.2042	6.35E-03	0.1270	3.94E-03	0.0788	2.17E-03	0.0434	2.27E-02	0.2267
Lung		9.65E-03	0.1929	4.24E-03	0.0848	3.06E-03	0.0613	2.11E-03	0.0422	1.91E-02	0.1906
(1) GI-LLI		1.05E-02	0.2107	9.75E-03	0.1950	4.34E-03	0.0867	3.97E-03	0.0794	2.86E-02	0.2859

		Unit 1 Gaseous Effluents (4)									
		1st Quarter		2nd Quarter		3rd Quarter		4th Quarter		Calendar Year	
Batch & Continuous Releases		Dose	% of ODCM Limit	Dose	% of ODCM Limit	Dose	% of ODCM Limit	Dose	% of ODCM Limit	Dose	% of ODCM Limit
	(2)	Gamma Air	1.46E-08	0.0000	2.53E-03	0.0506	0.00E+00	0.0000	0.00E+00	0.0000	2.53E-03
(2)	Beta Air	6.89E-11	0.0000	3.96E-06	0.0000	0.00E+00	0.0000	0.00E+00	0.0000	3.96E-06	0.0000
ORGANIC	Bone	0.00E+00	0.0000	7.07E-04	0.0094	2.91E-09	0.0000	1.25E-09	0.0000	7.07E-04	0.0047
	Liver	8.40E-03	0.1120	7.41E-03	0.0988	1.88E-02	0.2507	2.26E-02	0.3013	5.72E-02	0.3814
	Total Body	8.40E-03	0.1120	7.22E-03	0.0963	1.88E-02	0.2507	2.26E-02	0.3013	5.70E-02	0.3801
	Thyroid	8.40E-03	0.1120	7.16E-03	0.0955	1.88E-02	0.2507	2.26E-02	0.3013	5.69E-02	0.3793
	Kidney	8.40E-03	0.1120	7.24E-03	0.0965	1.88E-02	0.2507	2.26E-02	0.3013	5.70E-02	0.3803
	Lung	8.40E-03	0.1120	7.76E-03	0.1035	1.88E-02	0.2507	2.26E-02	0.3013	5.75E-02	0.3833
(3) GI-LLI		8.40E-03	0.1120	7.30E-03	0.0973	1.88E-02	0.2507	2.26E-02	0.3013	5.70E-02	0.3800

- (1) These doses are listed in mrem; they are calculated for the maximum individual for all batch liquid effluents
- (2) These doses are listed in mrad; they are calculated at the site boundary for batch & continuous gaseous effluents (0.4 miles NW)
- (3) These doses are listed in mrem; they are calculated for the most likely exposed real individual (child) via all real pathways at 0.89 miles NW.
- (4) Unit 1 gaseous dose includes ALL continuous releases from the shared Process Vent.

Limits used for calculation of percent (%) are from ODCM procedure 1/2-ODC-3.03, Attachment H Control 3.11.1.2, Attachment L Control 3.11.2.2, and Attachment M Control 3.11.2.3 (considered to be the design objectives).

# Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 5B

Assessment Of Radiation Doses (Unit 2)

		Unit 2 Liquid Effluents									
		1st Quarter		2nd Quarter		3rd Quarter		4th Quarter		Calendar Year	
Batch Releases		Dose	% of ODCM Limit	Dose	% of ODCM Limit	Dose	% of ODCM Limit	Dose	% of ODCM Limit	Dose	% of ODCM Limit
		O R G A N (1)	Bone	2.01E-03	0.0402	6.38E-03	0.1276	2.92E-03	0.0585	1.64E-04	0.0033
Liver	1.18E-02		0.2358	1.24E-02	0.2481	6.67E-03	0.1334	2.43E-03	0.0486	3.33E-02	0.3329
Total Body	9.45E-03		0.6297	5.33E-03	0.3553	2.38E-03	0.1589	2.83E-02	1.8891	4.55E-02	1.5165
Thyroid	9.32E-03		0.1864	3.23E-03	0.0647	2.20E-03	0.0440	2.08E-03	0.0416	1.68E-02	0.1683
Kidney	1.02E-02		0.2042	6.35E-03	0.1270	3.94E-03	0.0788	2.17E-03	0.0434	2.27E-02	0.2267
Lung	9.65E-03		0.1929	4.24E-03	0.0848	3.06E-03	0.0613	2.11E-03	0.0422	1.91E-02	0.1906
GI-LLI	1.05E-02		0.2107	9.75E-03	0.1950	4.34E-03	0.0867	3.97E-03	0.0794	2.86E-02	0.2859

		Unit 2 Gaseous Effluents									
		1st Quarter		2nd Quarter		3rd Quarter		4th Quarter		Calendar Year	
Batch & Continuous Releases		Dose	% of ODCM Limit	Dose	% of ODCM Limit	Dose	% of ODCM Limit	Dose	% of ODCM Limit	Dose	% of ODCM Limit
		(2)	Gamma Air	0.00E+00	0.0000	3.51E-10	0.0000	0.00E+00	0.0000	8.95E-04	0.0179
(2)	Beta Air	0.00E+00	0.0000	1.65E-12	0.0000	0.00E+00	0.0000	1.36E-06	0.0000	1.36E-06	0.0000
O R G A N (3)	Bone	0.00E+00	0.0000	2.03E-08	0.0000	0.00E+00	0.0000	5.33E-04	0.0071	5.33E-04	0.0036
	Liver	5.38E-02	0.7173	3.84E-02	0.5120	3.43E-02	0.4573	6.13E-02	0.8173	1.88E-01	1.2520
	Total Body	5.38E-02	0.7173	3.84E-02	0.5120	3.43E-02	0.4573	6.13E-02	0.8173	1.88E-01	1.2520
	Thyroid	5.38E-02	0.7173	3.84E-02	0.5120	3.43E-02	0.4573	6.13E-02	0.8173	1.88E-01	1.2520
	Kidney	5.38E-02	0.7173	3.84E-02	0.5120	3.43E-02	0.4573	6.13E-02	0.8173	1.88E-01	1.2520
	Lung	5.38E-02	0.7173	3.84E-02	0.5120	3.43E-02	0.4573	6.20E-02	0.8267	1.89E-01	1.2567
(3)	GI-LLI	5.38E-02	0.7173	3.84E-02	0.5120	3.43E-02	0.4573	6.14E-02	0.8187	1.88E-01	1.2527

(1) These doses are listed in mrem; they are calculated for the maximum individual for all batch liquid effluents

(2) These doses are listed in mrad; they are calculated at the site boundary for batch & continuous gaseous effluents (0.4 miles NW)

(3) These doses are listed in mrem; they are calculated for the most likely exposed real individual (child) via all real pathways at 0.89 miles NW.

Limits used for calculation of percent (%) are from ODCM procedure 1/2-ODC-3.03, Attachment H Control 3.11.1.2, Attachment L Control 3.11.2.2, and Attachment M Control 3.11.2.3 (considered to be the design objectives).

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 6

### Effluent Monitoring Instrumentation Channels Not Returned To Operable Status Within 30 Days

There were five Effluent Monitoring Instrumentation Channels that were not returned to operable status within 30 days.

**1) Unit 2 effluent radiation monitors 2HVS-RQ109B/C/D (CR-2020-07160) - Carried over from 2020**

Containment ventilation gaseous effluent radiation monitors 2HVS-RQ109B/C/D remained out of service from August 17, 2020 and were not returned to service until February 10, 2021. The monitors were removed from service for performance of 2MSP-43.33-I, Elevated Release Gas Radiation Monitor 2HVS-RQ1109B, C, and D Calibration, during which the velocity probe was sent out to the vendor for calibration. The probe was lost during shipping, and a new probe was ordered from the vendor, with the monitors remaining out of service until the new part was received. Compensatory grab samples were taken in accordance with ODCM requirements.

**2) Blowdown Radiation Monitor [RM-1BD-101] is in a fault condition (CR-2021-00359)**

On January 20, 2021, blowdown radiation monitor RM-1BD-101 displayed a fault condition at the U1 Control Room PING Display Panel. An RP technician was dispatched to investigate, and the monitor was declared non-functional due to displaying multiple faults. I&C was tasked with repairing the monitor, which remained out-of-service until March 5, 2021. Compensatory grab samples were taken in accordance with ODCM requirements.

**3) U-2 Radiation monitor 2SGC-RQ100 (Liquid Waste Effluent Radiation Monitor) out of service (CR-2021-02726)**

On April 9, 2021, while attempting to purge 2SGC-RQ100 in preparation for an upcoming liquid waste discharge, a technician reported that the monitor was unable to purge for the required 2 minutes and repeatedly kept shutting off. The monitor was removed from service, and was not repaired before the 30-day mark. Compensatory grab samples were taken in accordance with ODCM requirements.

**4) RM-1RW-100 Low Flow (Component Cooling/Recirc Spray Ht Ex Rad monitor) (CR-2021-04090 & CR-2021-04482)**

On May 19, 2021, RM-RW-100 displayed a low flow alarm that would not clear despite attempts to flush out any potential blockages in the river water sample pipe. The monitor was removed from service, and further troubleshooting revealed two vent valves which were sucking air, rather than water, into the system. The monitor was quickly returned to service after further troubleshooting, however began to display another low flow alarm on June 6. An RP technician reported that the piping was again voided, and they were unable to restore water flow. The monitor was once again declared non-functional, and remained out of service beyond the 30-day mark. Compensatory grab samples were taken in accordance with ODCM requirements.

**5) OOS Liquid Rad Monitor Not Returned to Service in 30 Days (CR-2021-09502)**

During performance of WO 200817192 for performing work on RM-RW-100, issues with implementing ECP 20-0019-001 were identified. Work order 200817192 - ECP 20-0019-001 works with work order 200789895 - 1MSP-43.10. 1MSP-43.10 had a due date of 1/4/22, and therefore work on RM-RW-100 was unable to be completed until January 2022. RM-RW-100 had been taken out of service on November 17, 2021, and had to remain out of service until the work could be completed in early 2022. Compensatory grab samples were taken in accordance with ODCM requirements.

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 7

### Total Dose Commitments and Total Effective Dose Equivalents

Total Dose Commitment From All Facility Releases To Members of the Public 40 CFR 190.10(a) Environmental Doses				
Organ	Effluent Dose <sup>(1)</sup> (mrem)	Direct Radiation Dose <sup>(2)</sup> (mrem)	Total Dose (mrem)	% of ODCM or 40 CFR 190 Limit
Bone	6.24E-01	6.00E-01	1.22E+00	4.90%
Liver	9.12E-01	6.00E-01	1.51E+00	6.05%
Total Body	9.39E-01	6.00E-01	1.54E+00	6.16%
Thyroid	8.78E-01	6.00E-01	1.48E+00	1.97%
Kidney	8.90E-01	6.00E-01	1.49E+00	5.96%
Lung	8.84E-01	6.00E-01	1.48E+00	5.94%
GI-LLI	9.02E-01	6.00E-01	1.50E+00	6.01%

(1) The cumulative dose contributions from liquid and gaseous effluents were determined in accordance with the applicable CONTROLS & SURVEILLANCE REQUIREMENTS listed in ODCM procedure 1/2-ODC-3.03. The dose commitment limits for 40 CFR 190 MEMBERS OF THE PUBLIC (ODCM 1/2-ODC-3.03 Control 3.11.4.1) are as follows:  
 a) < or = 25 mrem / calendar year (for the total body, or any organ except the thyroid)  
 b) < or = 75 mrem / calendar year (for the thyroid)

(2) The dose contribution listed for the total body is for Direct Radiation. This was calculated by comparing offsite TLD exposure at the ODCM controlling location (0.8 miles NW; Midland, PA) to TLD exposure at the REMP control location (16.5 miles SSW; Weirton, WV).

#### Compliance to 100 mrem Limit of 10 CFR 20.1301 For Total Effective Dose Equivalent

Pursuant to 10 CFR 20.1301(a)(1), the Total Effective Dose Equivalent from licensed operation to the maximum individual during the report period, is 7.51 mrem. This is a summation of Direct Radiation Exposure (calculated by comparing the maximum of all perimeter TLD exposures to TLD exposure at the REMP control location) plus Effluent Doses (calculated per the ODCM).

#### Members of the Public Doses Due To Their Activities Inside The Site Boundary

The radiation doses for MEMBER(S) OF THE PUBLIC due to their activities inside the site boundary are not greater than the doses listed in this table to show compliance with 40 CFR Part 190 or 10 CFR 20.1301. Evaluations have shown that exposure time for individuals not occupationally associated with the plant site is minimal in comparison to the exposure time considered for the dose calculation at or beyond the site boundary. Therefore, a separate assessment of radiation doses from radioactive effluents to MEMBER(S) OF THE PUBLIC, due to their activities inside the site boundary, is not necessary for this report period.

#### Compliance with 10 CFR 72.44(d)(3) for Dry Fuel Storage

While there are minimal gaseous and liquid effluents specifically from the Independent Spent Fuel Storage Installation (ISFSI), there is a contribution from Direct Radiation. The doses listed in this section include the contributions from the ISFSI.

**Annual Radioactive Effluent Release Report**  
Calendar Year - 2021  
Table 8

<b>Offsite Dose Calculation Manual Surveillance Deficiencies</b>
There were no Offsite Dose Calculation Manual Surveillance Deficiencies during this report period.

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Table 9

Offsite Dose Calculation Manual Changes (Description)
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<p>There were no changes made to the ODCM during the report period. See ODCM procedure 1/2-ODC-1.01, "ODCM: Index, Matrix and History ODCM Changes" for a complete description of previous changes to the ODCM.</p>
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ENCLOSURE 2, ATTACHMENT 1



# Annual Radioactive Effluent Release Report

Calendar Year - 2021

Attachment 1

Joint Frequency Distribution Tables

## Attachment 1

As specified in the ODCM, an annual summary of hourly meteorological data (in the form of joint frequency distribution) is provided for the calendar year. In summary, the joint frequency distribution data is similar to previous years and close to long-term normals.

## Meteorological Data Recovery

The Meteorological Data Recovery for the calendar year did NOT meet the minimum requirement of at-least 90% (as specified in Section 5 of Revision 1 to Regulatory Guide 1.23, Meteorological Monitoring Programs for Nuclear Power Plants). The actual Meteorological Data Recovery is shown in the following table:

### PERCENT RECOVERY OF INDIVIDUAL METEOROLOGICAL PARAMETERS

92.4% = Wind Speed 35'

99.3% = Wind Speed 150'

99.3% = Wind Speed 500'

92.4% = Wind Direction 35'

99.3% = Wind Direction 150'

99.3% = Wind Direction 500'

96.9% = Delta Temperature (150' - 35' ) 1P

90.4% = Delta Temperature (500' - 35' ) 2P

98.3% = Temperature 35'

100.0% = Precipitation

**96.8% = Average Recovery of Individual Meteorological Parameters**

### PERCENT RECOVERY OF COMPOSITE VARIABLES

89.7% = Wind Speed 35', Wind Direction 35', Delta Temperature 1P

96.4% = Wind Speed 150', Wind Direction 150', Delta Temperature 1P

90.4% = Wind Speed 500', Wind Direction 500', Delta Temperature 2P

**92.2% = Average Recovery of Composite Variables**

## Attachment 1 Clarification

Hourly meteorological data is not provided for specific periods of Abnormal Gaseous Release during the calendar quarters (as indicated in Regulatory Guide 1.21), for the following reasons:

- 1) All routine Gaseous Releases for the calendar year were determined to be within design objectives, where as, the ODCM Dose Limits and the ODCM Dose Rate Limits are considered to be the design objectives.
- 2) There were no Abnormal Gaseous Release during the calendar year, no design objectives were exceeded.
- 3) Beaver Valley did not meet the 90% meteorological data recovery requirement for 2021. This condition is captured in CR-2022-03175, MET Tower Data Recovery does not meet RG 1.23.

For a copy of the hourly meteorological data during the calendar quarters, contact Radiological Effluents Administrator at 724-682-7667.

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP35P Direction: D135P Lapse: DT150-35

Stability Class: A Delta Temperature Extremely Unstable

#### Wind Speed (mph)

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	39	43	3	0	0	0	85
NNE	38	25	0	0	0	0	63
NE	26	7	0	0	0	0	33
ENE	36	5	0	0	0	0	41
E	14	5	0	0	0	0	19
ESE	21	9	0	0	0	0	30
SE	14	6	0	0	0	0	20
SSE	14	9	1	0	0	0	24
S	16	27	4	0	0	0	47
SSW	14	56	12	0	0	0	82
SW	29	89	18	0	0	0	136
WSW	35	96	22	0	0	0	153
W	49	115	10	0	0	0	174
WNW	46	96	3	0	0	0	145
NW	34	61	1	0	0	0	96
NNW	38	42	2	0	0	0	82
Total	463	691	76	0	0	0	1230

Calm Hours not Included above for:	Total Period	All Hours	469
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	899
Number of Valid Hours for this Table:	Total Period	All Hours	1230
Total Hours for the Period:			8759

**Joint Frequency Distribution**

Hours at Each Wind Speed and Direction

**Period of Record =** **Total Period** **All Hours**  
 01/01/2021 01:00 - 12/31/2021 23:00  
**Elevation:** **Speed:** SP35P **Direction:** DI35P **Lapse:** DT150-35

**Stability Class:** B **Delta Temperature** Moderately Unstable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	9	5	0	0	0	0	14
NNE	5	2	0	0	0	0	7
NE	8	0	0	0	0	0	8
ENE	6	0	0	0	0	0	6
E	1	0	0	0	0	0	1
ESE	2	2	0	0	0	0	4
SE	1	0	0	0	0	0	1
SSE	1	1	0	0	0	0	2
S	1	6	0	0	0	0	7
SSW	4	10	1	0	0	0	15
SW	1	17	10	0	0	0	28
WSW	5	15	1	0	0	0	21
W	3	13	2	0	0	0	18
WNW	4	14	0	0	0	0	18
NW	11	7	0	0	0	0	18
NNW	7	9	0	0	0	0	16
<b>Total</b>	<b>69</b>	<b>101</b>	<b>14</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>184</b>

<b>Calm Hours not Included above for:</b>	<b>Total Period</b>	<b>All Hours</b>	469
<b>Variable Direction Hours for:</b>	<b>Total Period</b>	<b>All Hours</b>	0
<b>Invalid Hours for:</b>	<b>Total Period</b>	<b>All Hours</b>	899
<b>Number of Valid Hours for this Table:</b>	<b>Total Period</b>	<b>All Hours</b>	184
<b>Total Hours for the Period:</b>			8759

**Joint Frequency Distribution**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP35P Direction: DI35P Lapse: DT150-35

Stability Class: C Delta Temperature Slightly Unstable

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	4	4	0	0	0	0	8
NNE	4	1	0	0	0	0	5
NE	4	2	0	0	0	0	6
ENE	1	0	0	0	0	0	1
E	5	0	0	0	0	0	5
ESE	3	0	0	0	0	0	3
SE	1	0	0	0	0	0	1
SSE	1	1	0	0	0	0	2
S	1	3	0	0	0	0	4
SSW	3	2	0	0	0	0	5
SW	3	18	1	0	0	0	22
WSW	4	15	3	1	0	0	23
W	8	10	1	0	0	0	19
WNW	7	16	1	0	0	0	24
NW	6	11	1	0	0	0	18
NNW	8	4	0	0	0	0	12
<b>Total</b>	<b>63</b>	<b>87</b>	<b>7</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>158</b>

Calm Hours not Included above for:	Total Period	All Hours	469
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	899
Number of Valid Hours for this Table:	Total Period	All Hours	158
Total Hours for the Period:			8759

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**

Elevation: Speed: SP35P Direction: DI35P Lapse: DT150-35

Stability Class: D Delta Temperature Neutral

#### Wind Speed (mph)

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	80	32	1	0	0	0	113
NNE	72	14	0	0	0	0	86
NE	74	7	0	0	0	0	81
ENE	121	14	0	0	0	0	135
E	46	9	0	0	0	0	55
ESE	24	1	0	0	0	0	25
SE	14	3	0	0	0	0	17
SSE	12	3	0	0	0	0	15
S	27	16	2	0	0	0	45
SSW	28	32	4	0	0	0	64
SW	57	103	29	0	0	0	189
WSW	70	143	39	1	0	0	253
W	74	117	23	1	0	0	215
WNW	56	85	5	0	0	0	146
NW	65	58	1	0	0	0	124
NNW	90	68	1	0	0	0	159
<b>Total</b>	<b>910</b>	<b>705</b>	<b>105</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>1722</b>

Calm Hours not included above for:	<b>Total Period</b>	<b>All Hours</b>	469
Variable Direction Hours for:	<b>Total Period</b>	<b>All Hours</b>	0
Invalid Hours for:	<b>Total Period</b>	<b>All Hours</b>	899
Number of Valid Hours for this Table:	<b>Total Period</b>	<b>All Hours</b>	1722
Total Hours for the Period:			8759

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP35P Direction: DI35P Lapse: DT150-35

Stability Class: E Delta Temperature Slightly Stable

#### Wind Speed (mph)

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	98	18	0	0	0	0	116
NNE	90	7	0	0	0	0	97
NE	110	7	0	0	0	0	117
ENE	137	4	0	0	0	0	141
E	123	4	0	0	0	0	127
ESE	82	3	0	0	0	0	85
SE	55	2	0	0	0	0	57
SSE	59	5	2	0	0	0	66
S	122	13	0	0	0	0	135
SSW	121	44	6	0	0	0	171
SW	105	124	20	3	0	0	252
WSW	99	102	21	1	0	0	223
W	87	85	9	0	0	0	181
WNW	71	36	1	0	0	0	108
NW	76	25	2	0	0	0	103
NNW	105	18	0	0	0	0	123
<b>Total</b>	<b>1540</b>	<b>497</b>	<b>61</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>2102</b>

Calm Hours not Included above for:	Total Period	All Hours	469
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	899
Number of Valid Hours for this Table:	Total Period	All Hours	2102
Total Hours for the Period:			8759

**Joint Frequency Distribution**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP35P Direction: DI35P Lapse: DT150-35

Stability Class: F Delta Temperature Moderately Stable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	20	1	0	0	0	0	21
NNE	40	0	0	0	0	0	40
NE	37	2	0	0	0	0	39
ENE	48	0	0	0	0	0	48
E	163	2	0	0	0	0	165
ESE	234	1	0	0	0	0	235
SE	177	0	0	0	0	0	177
SSE	129	0	0	0	0	0	129
S	138	7	1	0	0	0	146
SSW	85	21	4	0	0	0	110
SW	33	24	1	0	0	0	58
WSW	22	18	1	0	0	0	41
W	17	8	1	0	0	0	26
WNW	7	0	0	0	0	0	7
NW	15	3	0	0	0	0	18
NNW	27	0	0	0	0	0	27
<b>Total</b>	<b>1192</b>	<b>87</b>	<b>8</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1287</b>

Calm Hours not Included above for:	Total Period	All Hours	469
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	899
Number of Valid Hours for this Table:	Total Period	All Hours	1287
Total Hours for the Period:			8759

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP35P Direction: DI35P Lapse: DT150-35

Stability Class: G Delta Temperature Extremely Stable

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	6	0	0	0	0	0	6
NNE	12	0	0	0	0	0	12
NE	19	1	0	0	0	0	20
ENE	36	0	0	0	0	0	36
E	95	0	0	0	0	0	95
ESE	158	0	0	0	0	0	158
SE	152	0	0	0	0	0	152
SSE	83	0	0	0	0	0	83
S	60	4	0	0	0	0	64
SSW	29	5	0	0	0	0	34
SW	14	4	1	0	0	0	19
WSW	4	2	0	0	0	0	6
W	3	3	0	0	0	0	6
WNW	5	0	0	0	0	0	5
NW	7	0	0	0	0	0	7
NNW	5	0	0	0	0	0	5
<b>Total</b>	<b>688</b>	<b>19</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>708</b>

Calm Hours not Included above for:	Total Period	All Hours	469
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	899
Number of Valid Hours for this Table:	Total Period	All Hours	708
Total Hours for the Period:			8759



### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP35P Direction: DI35P Lapse: DT150-35

Stability Class: ALL Delta Temperature

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	256	103	4	0	0	0	363
NNE	261	49	0	0	0	0	310
NE	278	26	0	0	0	0	304
ENE	385	23	0	0	0	0	408
E	447	20	0	0	0	0	467
ESE	524	16	0	0	0	0	540
SE	414	11	0	0	0	0	425
SSE	299	19	3	0	0	0	321
S	365	76	7	0	0	0	448
SSW	284	170	27	0	0	0	481
SW	242	379	80	3	0	0	704
WSW	239	391	87	3	0	0	720
W	241	351	46	1	0	0	639
WNW	196	247	10	0	0	0	453
NW	214	165	5	0	0	0	384
NNW	280	141	3	0	0	0	424
<b>Total</b>	<b>4925</b>	<b>2187</b>	<b>272</b>	<b>7</b>	<b>0</b>	<b>0</b>	<b>7391</b>

Calm Hours not Included above for:	Total Period	All Hours	469
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	899
Number of Valid Hours for this Table:	Total Period	All Hours	7391
Total Hours for the Period:			8759

**Joint Frequency Distribution**

Percent

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP35P Direction: DI35P Lapse: DT150-35

Stability Class: A Delta Temperature Extremely Unstable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.53	0.58	0.04	0.00	0.00	0.00	1.15
NNE	0.51	0.34	0.00	0.00	0.00	0.00	0.85
NE	0.35	0.09	0.00	0.00	0.00	0.00	0.45
ENE	0.49	0.07	0.00	0.00	0.00	0.00	0.55
E	0.19	0.07	0.00	0.00	0.00	0.00	0.26
ESE	0.28	0.12	0.00	0.00	0.00	0.00	0.41
SE	0.19	0.08	0.00	0.00	0.00	0.00	0.27
SSE	0.19	0.12	0.01	0.00	0.00	0.00	0.32
S	0.22	0.37	0.05	0.00	0.00	0.00	0.64
SSW	0.19	0.76	0.16	0.00	0.00	0.00	1.11
SW	0.39	1.20	0.24	0.00	0.00	0.00	1.84
WSW	0.47	1.30	0.30	0.00	0.00	0.00	2.07
W	0.66	1.56	0.14	0.00	0.00	0.00	2.35
WNW	0.62	1.30	0.04	0.00	0.00	0.00	1.96
NW	0.46	0.83	0.01	0.00	0.00	0.00	1.30
NNW	0.51	0.57	0.03	0.00	0.00	0.00	1.11
<b>Total</b>	<b>6.26</b>	<b>9.35</b>	<b>1.03</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>16.64</b>

Calm Hours not Included above for:	<b>Total Period</b>	<b>All Hours</b>	469
Variable Direction Hours for:	<b>Total Period</b>	<b>All Hours</b>	0
Invalid Hours for:	<b>Total Period</b>	<b>All Hours</b>	899
Number of Valid Hours for this Table:	<b>Total Period</b>	<b>All Hours</b>	1230
Total Hours for the Period:			8759

**Joint Frequency Distribution**

**Percent**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**

Elevation: Speed: SP35P Direction: DI35P Lapse: DT150-35

Stability Class: B Delta Temperature Moderately Unstable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.12	0.07	0.00	0.00	0.00	0.00	0.19
NNE	0.07	0.03	0.00	0.00	0.00	0.00	0.09
NE	0.11	0.00	0.00	0.00	0.00	0.00	0.11
ENE	0.08	0.00	0.00	0.00	0.00	0.00	0.08
E	0.01	0.00	0.00	0.00	0.00	0.00	0.01
ESE	0.03	0.03	0.00	0.00	0.00	0.00	0.05
SE	0.01	0.00	0.00	0.00	0.00	0.00	0.01
SSE	0.01	0.01	0.00	0.00	0.00	0.00	0.03
S	0.01	0.08	0.00	0.00	0.00	0.00	0.09
SSW	0.05	0.14	0.01	0.00	0.00	0.00	0.20
SW	0.01	0.23	0.14	0.00	0.00	0.00	0.38
WSW	0.07	0.20	0.01	0.00	0.00	0.00	0.28
W	0.04	0.18	0.03	0.00	0.00	0.00	0.24
WNW	0.05	0.19	0.00	0.00	0.00	0.00	0.24
NW	0.15	0.09	0.00	0.00	0.00	0.00	0.24
NNW	0.09	0.12	0.00	0.00	0.00	0.00	0.22
<b>Total</b>	<b>0.93</b>	<b>1.37</b>	<b>0.19</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>2.49</b>

Calm Hours not Included above for:	<b>Total Period</b>	<b>All Hours</b>	469
Variable Direction Hours for:	<b>Total Period</b>	<b>All Hours</b>	0
Invalid Hours for:	<b>Total Period</b>	<b>All Hours</b>	899
Number of Valid Hours for this Table:	<b>Total Period</b>	<b>All Hours</b>	184
Total Hours for the Period:			8759

**Joint Frequency Distribution**

**Percent**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**

Elevation: Speed: SP35P Direction: D135P Lapse: DT150-35

Stability Class: C Delta Temperature Slightly Unstable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.05	0.05	0.00	0.00	0.00	0.00	0.11
NNE	0.05	0.01	0.00	0.00	0.00	0.00	0.07
NE	0.05	0.03	0.00	0.00	0.00	0.00	0.08
ENE	0.01	0.00	0.00	0.00	0.00	0.00	0.01
E	0.07	0.00	0.00	0.00	0.00	0.00	0.07
ESE	0.04	0.00	0.00	0.00	0.00	0.00	0.04
SE	0.01	0.00	0.00	0.00	0.00	0.00	0.01
SSE	0.01	0.01	0.00	0.00	0.00	0.00	0.03
S	0.01	0.04	0.00	0.00	0.00	0.00	0.05
SSW	0.04	0.03	0.00	0.00	0.00	0.00	0.07
SW	0.04	0.24	0.01	0.00	0.00	0.00	0.30
WSW	0.05	0.20	0.04	0.01	0.00	0.00	0.31
W	0.11	0.14	0.01	0.00	0.00	0.00	0.26
WNW	0.09	0.22	0.01	0.00	0.00	0.00	0.32
NW	0.08	0.15	0.01	0.00	0.00	0.00	0.24
NNW	0.11	0.05	0.00	0.00	0.00	0.00	0.16
<b>Total</b>	<b>0.85</b>	<b>1.18</b>	<b>0.09</b>	<b>0.01</b>	<b>0.00</b>	<b>0.00</b>	<b>2.14</b>

Calm Hours not included above for:	Total Period	All Hours	469
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	899
Number of Valid Hours for this Table:	Total Period	All Hours	158
Total Hours for the Period:			8759

**Joint Frequency Distribution**

**Percent**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP35P Direction: DI35P Lapse: DT150-35

Stability Class: D Delta Temperature Neutral

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	1.08	0.43	0.01	0.00	0.00	0.00	1.53
NNE	0.97	0.19	0.00	0.00	0.00	0.00	1.16
NE	1.00	0.09	0.00	0.00	0.00	0.00	1.10
ENE	1.64	0.19	0.00	0.00	0.00	0.00	1.83
E	0.62	0.12	0.00	0.00	0.00	0.00	0.74
ESE	0.32	0.01	0.00	0.00	0.00	0.00	0.34
SE	0.19	0.04	0.00	0.00	0.00	0.00	0.23
SSE	0.16	0.04	0.00	0.00	0.00	0.00	0.20
S	0.37	0.22	0.03	0.00	0.00	0.00	0.61
SSW	0.38	0.43	0.05	0.00	0.00	0.00	0.87
SW	0.77	1.39	0.39	0.00	0.00	0.00	2.56
WSW	0.95	1.93	0.53	0.01	0.00	0.00	3.42
W	1.00	1.58	0.31	0.01	0.00	0.00	2.91
WNW	0.76	1.15	0.07	0.00	0.00	0.00	1.98
NW	0.88	0.78	0.01	0.00	0.00	0.00	1.68
NNW	1.22	0.92	0.01	0.00	0.00	0.00	2.15
<b>Total</b>	<b>12.31</b>	<b>9.54</b>	<b>1.42</b>	<b>0.03</b>	<b>0.00</b>	<b>0.00</b>	<b>23.30</b>

Calm Hours not Included above for:	Total Period	All Hours	469
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	899
Number of Valid Hours for this Table:	Total Period	All Hours	1722
Total Hours for the Period:			8759

**Joint Frequency Distribution**

**Percent**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**

Elevation: Speed: SP35P Direction: DI35P Lapse: DT150-35

Stability Class: E Delta Temperature Slightly Stable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	1.33	0.24	0.00	0.00	0.00	0.00	1.57
NNE	1.22	0.09	0.00	0.00	0.00	0.00	1.31
NE	1.49	0.09	0.00	0.00	0.00	0.00	1.58
ENE	1.85	0.05	0.00	0.00	0.00	0.00	1.91
E	1.66	0.05	0.00	0.00	0.00	0.00	1.72
ESE	1.11	0.04	0.00	0.00	0.00	0.00	1.15
SE	0.74	0.03	0.00	0.00	0.00	0.00	0.77
SSE	0.80	0.07	0.03	0.00	0.00	0.00	0.89
S	1.65	0.18	0.00	0.00	0.00	0.00	1.83
SSW	1.64	0.60	0.08	0.00	0.00	0.00	2.31
SW	1.42	1.68	0.27	0.04	0.00	0.00	3.41
WSW	1.34	1.38	0.28	0.01	0.00	0.00	3.02
W	1.18	1.15	0.12	0.00	0.00	0.00	2.45
WNW	0.96	0.49	0.01	0.00	0.00	0.00	1.46
NW	1.03	0.34	0.03	0.00	0.00	0.00	1.39
NNW	1.42	0.24	0.00	0.00	0.00	0.00	1.66
Total	20.84	6.72	0.83	0.05	0.00	0.00	28.44

Calm Hours not Included above for:	Total Period	All Hours	469
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	899
Number of Valid Hours for this Table:	Total Period	All Hours	2102
Total Hours for the Period:			8759

**Joint Frequency Distribution**  
**Percent**  
 Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP35P Direction: DI35P Lapse: DT150-35

Stability Class: F Delta Temperature Moderately Stable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.27	0.01	0.00	0.00	0.00	0.00	0.28
NNE	0.54	0.00	0.00	0.00	0.00	0.00	0.54
NE	0.50	0.03	0.00	0.00	0.00	0.00	0.53
ENE	0.65	0.00	0.00	0.00	0.00	0.00	0.65
E	2.21	0.03	0.00	0.00	0.00	0.00	2.23
ESE	3.17	0.01	0.00	0.00	0.00	0.00	3.18
SE	2.39	0.00	0.00	0.00	0.00	0.00	2.39
SSE	1.75	0.00	0.00	0.00	0.00	0.00	1.75
S	1.87	0.09	0.01	0.00	0.00	0.00	1.98
SSW	1.15	0.28	0.05	0.00	0.00	0.00	1.49
SW	0.45	0.32	0.01	0.00	0.00	0.00	0.78
WSW	0.30	0.24	0.01	0.00	0.00	0.00	0.55
W	0.23	0.11	0.01	0.00	0.00	0.00	0.35
WNW	0.09	0.00	0.00	0.00	0.00	0.00	0.09
NW	0.20	0.04	0.00	0.00	0.00	0.00	0.24
NNW	0.37	0.00	0.00	0.00	0.00	0.00	0.37
<b>Total</b>	<b>16.13</b>	<b>1.18</b>	<b>0.11</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>17.41</b>

Calm Hours not Included above for:	Total Period	All Hours	469
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	899
Number of Valid Hours for this Table:	Total Period	All Hours	1287
Total Hours for the Period:			8759

**Joint Frequency Distribution**

**Percent**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** **All Hours**  
 01/01/2021 01:00 - 12/31/2021 23:00  
 Elevation:      Speed:      SP35P      Direction:      DI35P      Lapse:      DT150-35

Stability Class: G      Delta Temperature      Extremely Stable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.08	0.00	0.00	0.00	0.00	0.00	0.08
NNE	0.16	0.00	0.00	0.00	0.00	0.00	0.16
NE	0.26	0.01	0.00	0.00	0.00	0.00	0.27
ENE	0.49	0.00	0.00	0.00	0.00	0.00	0.49
E	1.29	0.00	0.00	0.00	0.00	0.00	1.29
ESE	2.14	0.00	0.00	0.00	0.00	0.00	2.14
SE	2.06	0.00	0.00	0.00	0.00	0.00	2.06
SSE	1.12	0.00	0.00	0.00	0.00	0.00	1.12
S	0.81	0.05	0.00	0.00	0.00	0.00	0.87
SSW	0.39	0.07	0.00	0.00	0.00	0.00	0.46
SW	0.19	0.05	0.01	0.00	0.00	0.00	0.26
WSW	0.05	0.03	0.00	0.00	0.00	0.00	0.08
W	0.04	0.04	0.00	0.00	0.00	0.00	0.08
WNW	0.07	0.00	0.00	0.00	0.00	0.00	0.07
NW	0.09	0.00	0.00	0.00	0.00	0.00	0.09
NNW	0.07	0.00	0.00	0.00	0.00	0.00	0.07
<b>Total</b>	<b>9.31</b>	<b>0.26</b>	<b>0.01</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>9.58</b>

Calm Hours not Included above for:	<b>Total Period</b>	<b>All Hours</b>	469
Variable Direction Hours for:	<b>Total Period</b>	<b>All Hours</b>	0
Invalid Hours for:	<b>Total Period</b>	<b>All Hours</b>	899
Number of Valid Hours for this Table:	<b>Total Period</b>	<b>All Hours</b>	708
Total Hours for the Period:			8759



**Joint Frequency Distribution**

**Percent**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP35P Direction: DI35P Lapse: DT150-35

Stability Class: ALL Delta Temperature

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	3.46	1.39	0.05	0.00	0.00	0.00	4.91
NNE	3.53	0.66	0.00	0.00	0.00	0.00	4.19
NE	3.76	0.35	0.00	0.00	0.00	0.00	4.11
ENE	5.21	0.31	0.00	0.00	0.00	0.00	5.52
E	6.05	0.27	0.00	0.00	0.00	0.00	6.32
ESE	7.09	0.22	0.00	0.00	0.00	0.00	7.31
SE	5.60	0.15	0.00	0.00	0.00	0.00	5.75
SSE	4.05	0.26	0.04	0.00	0.00	0.00	4.34
S	4.94	1.03	0.09	0.00	0.00	0.00	6.06
SSW	3.84	2.30	0.37	0.00	0.00	0.00	6.51
SW	3.27	5.13	1.08	0.04	0.00	0.00	9.53
WSW	3.23	5.29	1.18	0.04	0.00	0.00	9.74
W	3.26	4.75	0.62	0.01	0.00	0.00	8.65
WNW	2.65	3.34	0.14	0.00	0.00	0.00	6.13
NW	2.90	2.23	0.07	0.00	0.00	0.00	5.20
NNW	3.79	1.91	0.04	0.00	0.00	0.00	5.74
<b>Total</b>	<b>66.64</b>	<b>29.59</b>	<b>3.68</b>	<b>0.09</b>	<b>0.00</b>	<b>0.00</b>	<b>100.00</b>

Calm Hours not Included above for:	<b>Total Period</b>	<b>All Hours</b>	469
Variable Direction Hours for:	<b>Total Period</b>	<b>All Hours</b>	0
Invalid Hours for:	<b>Total Period</b>	<b>All Hours</b>	899
Number of Valid Hours for this Table:	<b>Total Period</b>	<b>All Hours</b>	7391
Total Hours for the Period:			8759

**Joint Frequency Distribution**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: DI150P Lapse: DT150-35

Stability Class: A Delta Temperature Extremely Unstable

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	13	43	13	0	0	0	69
NNE	19	42	24	1	0	0	86
NE	10	46	12	0	0	0	68
ENE	10	21	3	0	0	0	34
E	14	22	4	0	0	0	40
ESE	2	23	11	0	0	0	36
SE	3	15	7	1	0	0	26
SSE	0	23	22	1	0	0	46
S	1	25	33	7	1	0	67
SSW	1	20	48	4	0	0	73
SW	5	13	46	10	0	0	74
WSW	4	35	58	12	0	0	109
W	8	81	79	21	2	0	191
WNW	8	80	79	14	1	0	182
NW	10	44	39	5	0	0	98
NNW	2	36	25	1	0	0	64
<b>Total</b>	110	569	503	77	4	0	1263

Calm Hours not Included above for:	Total Period	All Hours	494
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	311
Number of Valid Hours for this Table:	Total Period	All Hours	1263
Total Hours for the Period:			8759

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: DI150P Lapse: DT150-35

Stability Class: B Delta Temperature Moderately Unstable

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	8	6	0	0	0	0	14
NNE	7	6	1	0	0	0	14
NE	1	3	0	0	0	0	4
ENE	0	4	0	0	0	0	4
E	2	0	0	0	0	0	2
ESE	1	1	3	0	0	0	5
SE	0	3	0	0	0	0	3
SSE	1	0	0	0	0	0	1
S	2	3	10	3	0	0	18
SSW	0	0	7	0	0	0	7
SW	0	3	9	4	0	0	16
WSW	3	2	7	4	0	0	16
W	0	14	18	1	0	0	33
WNW	2	5	16	1	0	0	24
NW	1	7	6	0	0	0	14
NNW	3	4	7	0	0	0	14
<b>Total</b>	<b>31</b>	<b>61</b>	<b>84</b>	<b>13</b>	<b>0</b>	<b>0</b>	<b>189</b>

Calm Hours not Included above for:	Total Period	All Hours	494
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	311
Number of Valid Hours for this Table:	Total Period	All Hours	189
Total Hours for the Period:			8759

**Joint Frequency Distribution**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: DI150P Lapse: DT150-35

Stability Class: C Delta Temperature Slightly Unstable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	2	5	2	0	0	0	9
NNE	1	6	0	0	0	0	7
NE	4	2	0	0	0	0	6
ENE	1	1	2	0	0	0	4
E	1	3	0	0	0	0	4
ESE	1	0	0	0	0	0	1
SE	0	2	0	0	0	0	2
SSE	1	3	0	0	0	0	4
S	0	5	3	0	0	0	8
SSW	0	3	3	0	0	0	6
SW	0	2	7	0	1	0	10
WSW	0	5	12	2	0	0	19
W	2	12	8	6	0	0	28
WNW	2	14	12	2	0	0	30
NW	2	7	4	2	0	0	15
NNW	1	6	4	0	0	0	11
<b>Total</b>	<b>18</b>	<b>76</b>	<b>57</b>	<b>12</b>	<b>1</b>	<b>0</b>	<b>164</b>

Calm Hours not Included above for:	<b>Total Period</b>	<b>All Hours</b>	494
Variable Direction Hours for:	<b>Total Period</b>	<b>All Hours</b>	0
Invalid Hours for:	<b>Total Period</b>	<b>All Hours</b>	311
Number of Valid Hours for this Table:	<b>Total Period</b>	<b>All Hours</b>	164
<b>Total Hours for the Period:</b>			<b>8759</b>

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: DI150P Lapse: DT150-35

Stability Class: D Delta Temperature Neutral

#### Wind Speed (mph)

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	38	46	4	0	0	0	88
NNE	58	52	9	0	0	0	119
NE	67	77	19	0	0	0	163
ENE	34	29	5	2	0	0	70
E	34	16	1	0	0	0	51
ESE	15	12	5	1	0	0	33
SE	4	16	3	1	0	0	24
SSE	8	14	7	1	0	0	30
S	4	21	24	4	0	0	53
SSW	1	28	33	5	0	0	67
SW	7	40	57	9	0	0	113
WSW	8	50	93	20	1	0	172
W	15	82	108	21	10	0	236
WNW	39	86	87	35	0	2	249
NW	19	56	52	13	3	0	143
NNW	33	45	17	1	0	0	96
<b>Total</b>	<b>384</b>	<b>670</b>	<b>524</b>	<b>113</b>	<b>14</b>	<b>2</b>	<b>1707</b>

Calm Hours not Included above for:	Total Period	All Hours	494
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	311
Number of Valid Hours for this Table:	Total Period	All Hours	1707
Total Hours for the Period:			8759

**Joint Frequency Distribution**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: D1150P Lapse: DT150-35

Stability Class: E Delta Temperature Slightly Stable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	33	39	7	0	0	0	79
NNE	55	37	12	1	0	0	105
NE	177	105	19	2	0	0	303
ENE	99	98	11	0	0	0	208
E	108	42	11	0	0	0	161
ESE	45	27	8	2	0	0	82
SE	25	34	5	0	0	0	64
SSE	15	37	8	1	0	0	61
S	14	54	15	4	0	0	87
SSW	15	65	45	4	0	0	129
SW	24	69	84	15	1	0	193
WSW	8	57	98	22	2	0	187
W	21	85	76	20	2	0	204
WNW	29	90	57	21	1	0	198
NW	29	74	40	8	3	0	154
NNW	20	50	10	0	0	0	80
<b>Total</b>	<b>717</b>	<b>963</b>	<b>506</b>	<b>100</b>	<b>9</b>	<b>0</b>	<b>2295</b>

Calm Hours not Included above for:	Total Period	All Hours	494
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	311
Number of Valid Hours for this Table:	Total Period	All Hours	2295
Total Hours for the Period:			8759

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: DI150P Lapse: DT150-35

Stability Class: F Delta Temperature Moderately Stable

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	12	12	0	0	0	0	24
NNE	58	22	1	0	0	0	81
NE	300	88	2	0	0	0	390
ENE	161	62	0	0	0	0	223
E	92	22	0	0	0	0	114
ESE	43	11	4	0	0	0	58
SE	38	16	6	0	0	0	60
SSE	23	15	1	0	0	0	39
S	31	31	9	0	0	0	71
SSW	27	53	13	3	1	0	97
SW	24	46	33	4	0	0	107
WSW	6	23	10	2	0	0	41
W	14	24	10	0	0	0	48
WNW	12	19	1	3	0	0	35
NW	14	12	2	1	0	0	29
NNW	14	14	1	1	0	0	30
<b>Total</b>	<b>869</b>	<b>470</b>	<b>93</b>	<b>14</b>	<b>1</b>	<b>0</b>	<b>1447</b>

Calm Hours not Included above for:	Total Period	All Hours	494
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	311
Number of Valid Hours for this Table:	Total Period	All Hours	1447
Total Hours for the Period:			8759

**Joint Frequency Distribution**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: DI150P Lapse: DT150-35

Stability Class: G Delta Temperature Extremely Stable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	5	5	0	0	0	0	10
NNE	43	21	3	0	0	0	67
NE	187	62	0	0	0	0	249
ENE	65	36	1	0	0	0	102
E	58	19	0	0	0	0	77
ESE	36	8	0	0	0	0	44
SE	26	9	1	0	0	0	36
SSE	19	9	0	0	0	0	28
S	31	49	5	0	0	0	85
SSW	17	41	4	0	0	0	62
SW	19	26	6	0	0	0	51
WSW	13	16	4	1	0	0	34
W	3	11	3	0	0	0	17
WNW	4	4	1	0	0	0	9
NW	6	3	1	0	0	0	10
NNW	5	3	0	0	0	0	8
<b>Total</b>	<b>537</b>	<b>322</b>	<b>29</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>889</b>

Calm Hours not Included above for:	Total Period	All Hours	494
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	311
Number of Valid Hours for this Table:	Total Period	All Hours	889
Total Hours for the Period:			8759



### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: DI150P Lapse: DT150-35

Stability Class: ALL Delta Temperature

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	111	156	26	0	0	0	293
NNE	241	186	50	2	0	0	479
NE	746	383	52	2	0	0	1183
ENE	370	251	22	2	0	0	645
E	309	124	16	0	0	0	449
ESE	143	82	31	3	0	0	259
SE	96	95	22	2	0	0	215
SSE	67	101	38	3	0	0	209
S	83	188	99	18	1	0	389
SSW	61	210	153	16	1	0	441
SW	79	199	242	42	2	0	564
WSW	42	188	282	63	3	0	578
W	63	309	302	69	14	0	757
WNW	96	298	253	76	2	2	727
NW	81	203	144	29	6	0	463
NNW	78	158	64	3	0	0	303
<b>Total</b>	<b>2666</b>	<b>3131</b>	<b>1796</b>	<b>330</b>	<b>29</b>	<b>2</b>	<b>7954</b>

Calm Hours not Included above for:	Total Period	All Hours	494
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	311
Number of Valid Hours for this Table:	Total Period	All Hours	7954
Total Hours for the Period:			8759

**Joint Frequency Distribution**

Percent

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: DI150P Lapse: DT150-35

Stability Class: A Delta Temperature Extremely Unstable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.16	0.54	0.16	0.00	0.00	0.00	0.87
NNE	0.24	0.53	0.30	0.01	0.00	0.00	1.08
NE	0.13	0.58	0.15	0.00	0.00	0.00	0.85
ENE	0.13	0.26	0.04	0.00	0.00	0.00	0.43
E	0.18	0.28	0.05	0.00	0.00	0.00	0.50
ESE	0.03	0.29	0.14	0.00	0.00	0.00	0.45
SE	0.04	0.19	0.09	0.01	0.00	0.00	0.33
SSE	0.00	0.29	0.28	0.01	0.00	0.00	0.58
S	0.01	0.31	0.41	0.09	0.01	0.00	0.84
SSW	0.01	0.25	0.60	0.05	0.00	0.00	0.92
SW	0.06	0.16	0.58	0.13	0.00	0.00	0.93
WSW	0.05	0.44	0.73	0.15	0.00	0.00	1.37
W	0.10	1.02	0.99	0.26	0.03	0.00	2.40
WNW	0.10	1.01	0.99	0.18	0.01	0.00	2.29
NW	0.13	0.55	0.49	0.06	0.00	0.00	1.23
NNW	0.03	0.45	0.31	0.01	0.00	0.00	0.80
<b>Total</b>	<b>1.38</b>	<b>7.15</b>	<b>6.32</b>	<b>0.97</b>	<b>0.05</b>	<b>0.00</b>	<b>15.88</b>

Calm Hours not Included above for:	Total Period	All Hours	494
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	311
Number of Valid Hours for this Table:	Total Period	All Hours	1263
Total Hours for the Period:			8759

**Joint Frequency Distribution**

**Percent**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: DI150P Lapse: DT150-35

Stability Class: B Delta Temperature Moderately Unstable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.10	0.08	0.00	0.00	0.00	0.00	0.18
NNE	0.09	0.08	0.01	0.00	0.00	0.00	0.18
NE	0.01	0.04	0.00	0.00	0.00	0.00	0.05
ENE	0.00	0.05	0.00	0.00	0.00	0.00	0.05
E	0.03	0.00	0.00	0.00	0.00	0.00	0.03
ESE	0.01	0.01	0.04	0.00	0.00	0.00	0.06
SE	0.00	0.04	0.00	0.00	0.00	0.00	0.04
SSE	0.01	0.00	0.00	0.00	0.00	0.00	0.01
S	0.03	0.04	0.13	0.04	0.00	0.00	0.23
SSW	0.00	0.00	0.09	0.00	0.00	0.00	0.09
SW	0.00	0.04	0.11	0.05	0.00	0.00	0.20
WSW	0.04	0.03	0.09	0.05	0.00	0.00	0.20
W	0.00	0.18	0.23	0.01	0.00	0.00	0.41
WNW	0.03	0.06	0.20	0.01	0.00	0.00	0.30
NW	0.01	0.09	0.08	0.00	0.00	0.00	0.18
NNW	0.04	0.05	0.09	0.00	0.00	0.00	0.18
<b>Total</b>	<b>0.39</b>	<b>0.77</b>	<b>1.06</b>	<b>0.16</b>	<b>0.00</b>	<b>0.00</b>	<b>2.38</b>

Calm Hours not Included above for:	Total Period	All Hours	494
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	311
Number of Valid Hours for this Table:	Total Period	All Hours	189
Total Hours for the Period:			8759

**Joint Frequency Distribution**

**Percent**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: D1150P Lapse: DT150-35

Stability Class: C Delta Temperature Slightly Unstable  
 Wind Speed (mph)

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.03	0.06	0.03	0.00	0.00	0.00	0.11
NNE	0.01	0.08	0.00	0.00	0.00	0.00	0.09
NE	0.05	0.03	0.00	0.00	0.00	0.00	0.08
ENE	0.01	0.01	0.03	0.00	0.00	0.00	0.05
E	0.01	0.04	0.00	0.00	0.00	0.00	0.05
ESE	0.01	0.00	0.00	0.00	0.00	0.00	0.01
SE	0.00	0.03	0.00	0.00	0.00	0.00	0.03
SSE	0.01	0.04	0.00	0.00	0.00	0.00	0.05
S	0.00	0.06	0.04	0.00	0.00	0.00	0.10
SSW	0.00	0.04	0.04	0.00	0.00	0.00	0.08
SW	0.00	0.03	0.09	0.00	0.01	0.00	0.13
WSW	0.00	0.06	0.15	0.03	0.00	0.00	0.24
W	0.03	0.15	0.10	0.08	0.00	0.00	0.35
WNW	0.03	0.18	0.15	0.03	0.00	0.00	0.38
NW	0.03	0.09	0.05	0.03	0.00	0.00	0.19
NNW	0.01	0.08	0.05	0.00	0.00	0.00	0.14
Total	0.23	0.96	0.72	0.15	0.01	0.00	2.06

Calm Hours not Included above for:	Total Period	All Hours	494
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	311
Number of Valid Hours for this Table:	Total Period	All Hours	164
Total Hours for the Period:			8759

**Joint Frequency Distribution**

**Percent**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: D1150P Lapse: DT150-35

Stability Class: D Delta Temperature Neutral

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.48	0.58	0.05	0.00	0.00	0.00	1.11
NNE	0.73	0.65	0.11	0.00	0.00	0.00	1.50
NE	0.84	0.97	0.24	0.00	0.00	0.00	2.05
ENE	0.43	0.36	0.06	0.03	0.00	0.00	0.88
E	0.43	0.20	0.01	0.00	0.00	0.00	0.64
ESE	0.19	0.15	0.06	0.01	0.00	0.00	0.41
SE	0.05	0.20	0.04	0.01	0.00	0.00	0.30
SSE	0.10	0.18	0.09	0.01	0.00	0.00	0.38
S	0.05	0.26	0.30	0.05	0.00	0.00	0.67
SSW	0.01	0.35	0.41	0.06	0.00	0.00	0.84
SW	0.09	0.50	0.72	0.11	0.00	0.00	1.42
WSW	0.10	0.63	1.17	0.25	0.01	0.00	2.16
W	0.19	1.03	1.36	0.26	0.13	0.00	2.97
WNW	0.49	1.08	1.09	0.44	0.00	0.03	3.13
NW	0.24	0.70	0.65	0.16	0.04	0.00	1.80
NNW	0.41	0.57	0.21	0.01	0.00	0.00	1.21
<b>Total</b>	<b>4.83</b>	<b>8.42</b>	<b>6.59</b>	<b>1.42</b>	<b>0.18</b>	<b>0.03</b>	<b>21.46</b>

Calm Hours not Included above for:	Total Period	All Hours	494
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	311
Number of Valid Hours for this Table:	Total Period	All Hours	1707
Total Hours for the Period:			8759

**Joint Frequency Distribution**  
**Percent**  
 Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: DI150P Lapse: DT150-35

Stability Class: E Delta Temperature Slightly Stable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.41	0.49	0.09	0.00	0.00	0.00	0.99
NNE	0.69	0.47	0.15	0.01	0.00	0.00	1.32
NE	2.23	1.32	0.24	0.03	0.00	0.00	3.81
ENE	1.24	1.23	0.14	0.00	0.00	0.00	2.62
E	1.36	0.53	0.14	0.00	0.00	0.00	2.02
ESE	0.57	0.34	0.10	0.03	0.00	0.00	1.03
SE	0.31	0.43	0.06	0.00	0.00	0.00	0.80
SSE	0.19	0.47	0.10	0.01	0.00	0.00	0.77
S	0.18	0.68	0.19	0.05	0.00	0.00	1.09
SSW	0.19	0.82	0.57	0.05	0.00	0.00	1.62
SW	0.30	0.87	1.06	0.19	0.01	0.00	2.43
WSW	0.10	0.72	1.23	0.28	0.03	0.00	2.35
W	0.26	1.07	0.96	0.25	0.03	0.00	2.56
WNW	0.36	1.13	0.72	0.26	0.01	0.00	2.49
NW	0.36	0.93	0.50	0.10	0.04	0.00	1.94
NNW	0.25	0.63	0.13	0.00	0.00	0.00	1.01
<b>Total</b>	<b>9.01</b>	<b>12.11</b>	<b>6.36</b>	<b>1.26</b>	<b>0.11</b>	<b>0.00</b>	<b>28.85</b>

Calm Hours not Included above for:	Total Period	All Hours	494
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	311
Number of Valid Hours for this Table:	Total Period	All Hours	2295
Total Hours for the Period:			8759

**Joint Frequency Distribution**

Percent

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: DI150P Lapse: DT150-35

Stability Class: F Delta Temperature Moderately Stable

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	0.15	0.15	0.00	0.00	0.00	0.00	0.30
NNE	0.73	0.28	0.01	0.00	0.00	0.00	1.02
NE	3.77	1.11	0.03	0.00	0.00	0.00	4.90
ENE	2.02	0.78	0.00	0.00	0.00	0.00	2.80
E	1.16	0.28	0.00	0.00	0.00	0.00	1.43
ESE	0.54	0.14	0.05	0.00	0.00	0.00	0.73
SE	0.48	0.20	0.08	0.00	0.00	0.00	0.75
SSE	0.29	0.19	0.01	0.00	0.00	0.00	0.49
S	0.39	0.39	0.11	0.00	0.00	0.00	0.89
SSW	0.34	0.67	0.16	0.04	0.01	0.00	1.22
SW	0.30	0.58	0.41	0.05	0.00	0.00	1.35
WSW	0.08	0.29	0.13	0.03	0.00	0.00	0.52
W	0.18	0.30	0.13	0.00	0.00	0.00	0.60
WNV	0.15	0.24	0.01	0.04	0.00	0.00	0.44
NW	0.18	0.15	0.03	0.01	0.00	0.00	0.36
NNW	0.18	0.18	0.01	0.01	0.00	0.00	0.38
<b>Total</b>	10.93	5.91	1.17	0.18	0.01	0.00	18.19

Calm Hours not Included above for:	Total Period	All Hours	494
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	311
Number of Valid Hours for this Table:	Total Period	All Hours	1447
Total Hours for the Period:			8759

**Joint Frequency Distribution**  
**Percent**  
 Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: DI150P Lapse: DT150-35

Stability Class: G Delta Temperature Extremely Stable

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	0.06	0.06	0.00	0.00	0.00	0.00	0.13
NNE	0.54	0.26	0.04	0.00	0.00	0.00	0.84
NE	2.35	0.78	0.00	0.00	0.00	0.00	3.13
ENE	0.82	0.45	0.01	0.00	0.00	0.00	1.28
E	0.73	0.24	0.00	0.00	0.00	0.00	0.97
ESE	0.45	0.10	0.00	0.00	0.00	0.00	0.55
SE	0.33	0.11	0.01	0.00	0.00	0.00	0.45
SSE	0.24	0.11	0.00	0.00	0.00	0.00	0.35
S	0.39	0.62	0.06	0.00	0.00	0.00	1.07
SSW	0.21	0.52	0.05	0.00	0.00	0.00	0.78
SW	0.24	0.33	0.08	0.00	0.00	0.00	0.64
WSW	0.16	0.20	0.05	0.01	0.00	0.00	0.43
W	0.04	0.14	0.04	0.00	0.00	0.00	0.21
WNW	0.05	0.05	0.01	0.00	0.00	0.00	0.11
NW	0.08	0.04	0.01	0.00	0.00	0.00	0.13
NNW	0.06	0.04	0.00	0.00	0.00	0.00	0.10
<b>Total</b>	<b>6.75</b>	<b>4.05</b>	<b>0.36</b>	<b>0.01</b>	<b>0.00</b>	<b>0.00</b>	<b>11.18</b>

Calm Hours not Included above for:	<b>Total Period</b>	<b>All Hours</b>	494
Variable Direction Hours for:	<b>Total Period</b>	<b>All Hours</b>	0
Invalid Hours for:	<b>Total Period</b>	<b>All Hours</b>	311
Number of Valid Hours for this Table:	<b>Total Period</b>	<b>All Hours</b>	889
Total Hours for the Period:			8759



**Joint Frequency Distribution**

**Percent**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP150P Direction: DI150P Lapse: DT150-35

Stability Class: ALL Delta Temperature

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	1.40	1.96	0.33	0.00	0.00	0.00	3.68
NNE	3.03	2.34	0.63	0.03	0.00	0.00	6.02
NE	9.38	4.82	0.65	0.03	0.00	0.00	14.87
ENE	4.65	3.16	0.28	0.03	0.00	0.00	8.11
E	3.88	1.56	0.20	0.00	0.00	0.00	5.64
ESE	1.80	1.03	0.39	0.04	0.00	0.00	3.26
SE	1.21	1.19	0.28	0.03	0.00	0.00	2.70
SSE	0.84	1.27	0.48	0.04	0.00	0.00	2.63
S	1.04	2.36	1.24	0.23	0.01	0.00	4.89
SSW	0.77	2.64	1.92	0.20	0.01	0.00	5.54
SW	0.99	2.50	3.04	0.53	0.03	0.00	7.09
WSW	0.53	2.36	3.55	0.79	0.04	0.00	7.27
W	0.79	3.88	3.80	0.87	0.18	0.00	9.52
WNW	1.21	3.75	3.18	0.96	0.03	0.03	9.14
NW	1.02	2.55	1.81	0.36	0.08	0.00	5.82
NNW	0.98	1.99	0.80	0.04	0.00	0.00	3.81
<b>Total</b>	<b>33.52</b>	<b>39.36</b>	<b>22.58</b>	<b>4.15</b>	<b>0.36</b>	<b>0.03</b>	<b>100.00</b>

Calm Hours not Included above for:	Total Period	All Hours	494
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	311
Number of Valid Hours for this Table:	Total Period	All Hours	7954
Total Hours for the Period:			8759

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation:      Speed: SP500P      Direction: DI500P      Lapse: DT500-35

Stability Class: A      Delta Temperature      Extremely Unstable

#### Wind Speed (mph)

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	2	16	8	3	0	0	29
NNE	0	9	11	4	0	0	24
NE	1	9	11	1	0	0	22
ENE	0	8	4	1	0	0	13
E	1	2	0	0	0	0	3
ESE	4	6	2	0	0	0	12
SE	0	5	8	5	0	0	18
SSE	0	4	9	1	0	0	14
S	0	7	17	6	0	0	30
SSW	1	7	14	6	0	0	28
SW	2	7	13	15	1	0	38
WSW	0	10	18	16	0	0	44
W	1	23	16	7	1	0	48
WNW	2	23	23	10	2	0	60
NW	6	9	9	7	0	0	31
NNW	1	4	9	3	0	0	17
<b>Total</b>	<b>21</b>	<b>149</b>	<b>172</b>	<b>85</b>	<b>4</b>	<b>0</b>	<b>431</b>

Calm Hours not Included above for:	Total Period	All Hours	26
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	843
Number of Valid Hours for this Table:	Total Period	All Hours	431
Total Hours for the Period:			8759

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP500P Direction: DI500P Lapse: DT500-35

Stability Class: B Delta Temperature Moderately Unstable

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	0	2	1	1	0	0	4
NNE	1	2	1	0	0	0	4
NE	0	5	2	1	0	0	8
ENE	0	2	1	0	0	0	3
E	0	3	1	0	0	0	4
ESE	0	4	3	0	0	0	7
SE	0	5	4	2	0	0	11
SSE	1	2	6	2	0	0	11
S	0	3	6	1	0	0	10
SSW	2	0	4	8	0	0	14
SW	3	4	8	11	0	0	26
WSW	4	3	9	5	0	0	21
W	5	2	11	6	0	0	24
WNW	2	9	11	12	3	0	37
NW	2	2	6	4	0	0	14
NNW	1	2	9	1	0	0	13
<b>Total</b>	<b>21</b>	<b>50</b>	<b>83</b>	<b>54</b>	<b>3</b>	<b>0</b>	<b>211</b>

Calm Hours not Included above for:	Total Period	All Hours	26
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	843
Number of Valid Hours for this Table:	Total Period	All Hours	211
Total Hours for the Period:			8759

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP500P Direction: DI500P Lapse: DT500-35

Stability Class: C Delta Temperature Slightly Unstable

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	1	3	7	3	0	0	14
NNE	0	2	4	0	0	0	6
NE	0	5	4	0	1	0	10
ENE	0	6	1	0	0	0	7
E	1	3	2	0	0	0	6
ESE	0	7	0	0	0	0	7
SE	0	6	1	0	0	0	7
SSE	1	5	5	3	0	0	14
S	0	3	7	3	1	0	14
SSW	0	2	15	13	0	0	30
SW	3	6	13	11	1	0	34
WSW	2	6	15	17	0	0	40
W	2	12	13	12	3	1	43
WNW	0	11	16	13	5	1	46
NW	3	6	11	14	1	0	35
NNW	1	3	6	4	0	0	14
<b>Total</b>	14	86	120	93	12	2	327

Calm Hours not Included above for:	Total Period	All Hours	26
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	843
Number of Valid Hours for this Table:	Total Period	All Hours	327
Total Hours for the Period:			8759

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP500P Direction: DI500P Lapse: DT500-35

Stability Class: D Delta Temperature Neutral

#### Wind Speed (mph)

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	12	49	78	13	0	0	152
NNE	21	58	48	12	1	0	140
NE	18	49	44	13	1	0	125
ENE	18	46	53	11	0	0	128
E	19	36	65	16	0	0	136
ESE	15	49	37	3	0	0	104
SE	14	37	40	23	7	0	121
SSE	12	19	46	10	2	1	90
S	10	28	41	23	9	2	113
SSW	11	8	83	86	11	2	201
SW	10	24	86	142	32	3	297
WSW	16	28	69	132	25	6	276
W	33	66	135	199	56	24	513
WNW	17	53	148	171	41	9	439
NW	19	44	122	80	16	0	281
NNW	11	50	71	35	2	0	169
<b>Total</b>	<b>256</b>	<b>644</b>	<b>1166</b>	<b>969</b>	<b>203</b>	<b>47</b>	<b>3285</b>

Calm Hours not Included above for:	Total Period	All Hours	26
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	843
Number of Valid Hours for this Table:	Total Period	All Hours	3285
Total Hours for the Period:			8759

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP500P Direction: DI500P Lapse: DT500-35

Stability Class: E Delta Temperature Slightly Stable

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	15	24	26	5	0	0	70
NNE	20	18	9	3	1	0	51
NE	27	32	21	6	4	0	90
ENE	25	38	14	7	3	0	87
E	37	65	29	0	0	0	131
ESE	32	71	35	7	0	0	145
SE	26	52	51	20	3	0	152
SSE	28	27	30	17	2	0	104
S	20	42	44	40	9	1	156
SSW	36	31	63	67	14	2	213
SW	40	41	73	117	67	2	340
WSW	37	65	40	24	21	2	189
W	43	79	115	63	31	7	338
WNW	36	67	56	12	4	1	176
NW	17	37	49	15	0	0	118
NNW	13	20	44	3	0	0	80
<b>Total</b>	<b>452</b>	<b>709</b>	<b>699</b>	<b>406</b>	<b>159</b>	<b>15</b>	<b>2440</b>

Calm Hours not Included above for:	<b>Total Period</b>	<b>All Hours</b>	26
Variable Direction Hours for:	<b>Total Period</b>	<b>All Hours</b>	0
Invalid Hours for:	<b>Total Period</b>	<b>All Hours</b>	843
Number of Valid Hours for this Table:	<b>Total Period</b>	<b>All Hours</b>	2440
Total Hours for the Period:			8759

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP500P Direction: D1500P Lapse: DT500-35

Stability Class: F Delta Temperature Moderately Stable

#### Wind Speed (mph)

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	9	6	12	1	0	0	28
NNE	11	10	4	0	0	0	25
NE	21	25	2	0	0	0	48
ENE	15	26	1	0	0	0	42
E	22	26	4	0	0	0	52
ESE	24	39	18	1	0	0	82
SE	22	20	13	5	0	0	60
SSE	26	23	21	1	1	0	72
S	25	26	19	12	1	0	83
SSW	29	29	25	15	0	0	98
SW	21	15	24	41	10	0	111
WSW	28	46	15	3	0	0	92
W	29	29	27	19	1	0	105
WNW	20	47	12	3	0	0	82
NW	11	17	3	0	0	0	31
NNW	13	9	6	0	0	0	28
<b>Total</b>	<b>326</b>	<b>393</b>	<b>206</b>	<b>101</b>	<b>13</b>	<b>0</b>	<b>1039</b>

Calm Hours not Included above for:	Total Period	All Hours	26
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	843
Number of Valid Hours for this Table:	Total Period	All Hours	1039
Total Hours for the Period:			8759

### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP500P Direction: DI500P Lapse: DT500-35

Stability Class: G Delta Temperature Extremely Stable

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	0	0	0	0	0	0	0
NNE	0	1	0	0	0	0	1
NE	2	0	0	0	0	0	2
ENE	3	2	0	0	0	0	5
E	4	1	0	0	0	0	5
ESE	2	15	3	0	0	0	20
SE	0	9	6	8	0	0	23
SSE	2	12	4	0	0	0	18
S	4	5	12	5	0	0	26
SSW	2	4	3	3	0	0	12
SW	2	3	1	7	2	0	15
WSW	1	12	2	1	0	0	16
W	0	1	3	0	0	0	4
WNW	0	3	0	0	0	0	3
NW	3	2	0	0	0	0	5
NNW	0	2	0	0	0	0	2
<b>Total</b>	<b>25</b>	<b>72</b>	<b>34</b>	<b>24</b>	<b>2</b>	<b>0</b>	<b>157</b>

Calm Hours not Included above for:	Total Period	All Hours	26
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	843
Number of Valid Hours for this Table:	Total Period	All Hours	157
Total Hours for the Period:			8759



### Joint Frequency Distribution

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP500P Direction: DI500P Lapsc: DT500-35

Stability Class: ALL Delta Temperature

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	39	100	132	26	0	0	297
NNE	53	100	77	19	2	0	251
NE	69	125	84	21	6	0	305
ENE	61	128	74	19	3	0	285
E	84	136	101	16	0	0	337
ESE	77	191	98	11	0	0	377
SE	62	134	123	63	10	0	392
SSE	70	92	121	34	5	1	323
S	59	114	146	90	20	3	432
SSW	81	81	207	198	25	4	596
SW	81	100	218	344	113	5	861
WSW	88	170	168	198	46	8	678
W	113	212	320	306	92	32	1075
WNW	77	213	266	221	55	11	843
NW	61	117	200	120	17	0	515
NNW	40	90	145	46	2	0	323
<b>Total</b>	<b>1115</b>	<b>2103</b>	<b>2480</b>	<b>1732</b>	<b>396</b>	<b>64</b>	<b>7890</b>

Calm Hours not Included above for:	Total Period	All Hours	26
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	843
Number of Valid Hours for this Table:	Total Period	All Hours	7890
Total Hours for the Period:			8759

**Joint Frequency Distribution**

**Percent**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP500P Direction: DI500P Lapse: DT500-35

Stability Class: A Delta Temperature Extremely Unstable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.03	0.20	0.10	0.04	0.00	0.00	0.37
NNE	0.00	0.11	0.14	0.05	0.00	0.00	0.30
NE	0.01	0.11	0.14	0.01	0.00	0.00	0.28
ENE	0.00	0.10	0.05	0.01	0.00	0.00	0.16
E	0.01	0.03	0.00	0.00	0.00	0.00	0.04
ESE	0.05	0.08	0.03	0.00	0.00	0.00	0.15
SE	0.00	0.06	0.10	0.06	0.00	0.00	0.23
SSE	0.00	0.05	0.11	0.01	0.00	0.00	0.18
S	0.00	0.09	0.22	0.08	0.00	0.00	0.38
SSW	0.01	0.09	0.18	0.08	0.00	0.00	0.35
SW	0.03	0.09	0.16	0.19	0.01	0.00	0.48
WSW	0.00	0.13	0.23	0.20	0.00	0.00	0.56
W	0.01	0.29	0.20	0.09	0.01	0.00	0.61
WNW	0.03	0.29	0.29	0.13	0.03	0.00	0.76
NW	0.08	0.11	0.11	0.09	0.00	0.00	0.39
NNW	0.01	0.05	0.11	0.04	0.00	0.00	0.22
Total	0.27	1.89	2.18	1.08	0.05	0.00	5.46

Calm Hours not Included above for:	Total Period	All Hours	26
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	843
Number of Valid Hours for this Table:	Total Period	All Hours	431
Total Hours for the Period:			8759

**Joint Frequency Distribution**

**Percent**

Hours at Each Wind Speed and Direction

**Total Period** **All Hours**  
 Period of Record = 01/01/2021 01:00 - 12/31/2021 23:00  
 Elevation: Speed: SP500P Direction: DI500P Lapse: DT500-35

Stability Class: B Delta Temperature Moderately Unstable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.00	0.03	0.01	0.01	0.00	0.00	0.05
NNE	0.01	0.03	0.01	0.00	0.00	0.00	0.05
NE	0.00	0.06	0.03	0.01	0.00	0.00	0.10
ENE	0.00	0.03	0.01	0.00	0.00	0.00	0.04
E	0.00	0.04	0.01	0.00	0.00	0.00	0.05
ESE	0.00	0.05	0.04	0.00	0.00	0.00	0.09
SE	0.00	0.06	0.05	0.03	0.00	0.00	0.14
SSE	0.01	0.03	0.08	0.03	0.00	0.00	0.14
S	0.00	0.04	0.08	0.01	0.00	0.00	0.13
SSW	0.03	0.00	0.05	0.10	0.00	0.00	0.18
SW	0.04	0.05	0.10	0.14	0.00	0.00	0.33
WSW	0.05	0.04	0.11	0.06	0.00	0.00	0.27
W	0.06	0.03	0.14	0.08	0.00	0.00	0.30
WNW	0.03	0.11	0.14	0.15	0.04	0.00	0.47
NW	0.03	0.03	0.08	0.05	0.00	0.00	0.18
NNW	0.01	0.03	0.11	0.01	0.00	0.00	0.16
<b>Total</b>	<b>0.27</b>	<b>0.63</b>	<b>1.05</b>	<b>0.68</b>	<b>0.04</b>	<b>0.00</b>	<b>2.67</b>

Calm Hours not included above for:	Total Period	All Hours	26
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	843
Number of Valid Hours for this Table:	Total Period	All Hours	211
Total Hours for the Period:			8759

**Joint Frequency Distribution**  
**Percent**  
 Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP500P Direction: DI500P Lapse: DT500-35

Stability Class: C Delta Temperature Slightly Unstable

Wind Direction	Wind Speed (mph)						Total
	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	
N	0.01	0.04	0.09	0.04	0.00	0.00	0.18
NNE	0.00	0.03	0.05	0.00	0.00	0.00	0.08
NE	0.00	0.06	0.05	0.00	0.01	0.00	0.13
ENE	0.00	0.08	0.01	0.00	0.00	0.00	0.09
E	0.01	0.04	0.03	0.00	0.00	0.00	0.08
ESE	0.00	0.09	0.00	0.00	0.00	0.00	0.09
SE	0.00	0.08	0.01	0.00	0.00	0.00	0.09
SSE	0.01	0.06	0.06	0.04	0.00	0.00	0.18
S	0.00	0.04	0.09	0.04	0.01	0.00	0.18
SSW	0.00	0.03	0.19	0.16	0.00	0.00	0.38
SW	0.04	0.08	0.16	0.14	0.01	0.00	0.43
WSW	0.03	0.08	0.19	0.22	0.00	0.00	0.51
W	0.03	0.15	0.16	0.15	0.04	0.01	0.54
WNW	0.00	0.14	0.20	0.16	0.06	0.01	0.58
NW	0.04	0.08	0.14	0.18	0.01	0.00	0.44
NNW	0.01	0.04	0.08	0.05	0.00	0.00	0.18
<b>Total</b>	<b>0.18</b>	<b>1.09</b>	<b>1.52</b>	<b>1.18</b>	<b>0.15</b>	<b>0.03</b>	<b>4.14</b>

Calm Hours not Included above for:	Total Period	All Hours	26
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	843
Number of Valid Hours for this Table:	Total Period	All Hours	327
Total Hours for the Period:			8759

**Joint Frequency Distribution**  
**Percent**  
 Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP500P Direction: DI500P Lapse: DT500-35

Stability Class: D Delta Temperature Neutral

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.15	0.62	0.99	0.16	0.00	0.00	1.93
NNE	0.27	0.74	0.61	0.15	0.01	0.00	1.77
NE	0.23	0.62	0.56	0.16	0.01	0.00	1.58
ENE	0.23	0.58	0.67	0.14	0.00	0.00	1.62
E	0.24	0.46	0.82	0.20	0.00	0.00	1.72
ESE	0.19	0.62	0.47	0.04	0.00	0.00	1.32
SE	0.18	0.47	0.51	0.29	0.09	0.00	1.53
SSE	0.15	0.24	0.58	0.13	0.03	0.01	1.14
S	0.13	0.35	0.52	0.29	0.11	0.03	1.43
SSW	0.14	0.10	1.05	1.09	0.14	0.03	2.55
SW	0.13	0.30	1.09	1.80	0.41	0.04	3.76
WSW	0.20	0.35	0.87	1.67	0.32	0.08	3.50
W	0.42	0.84	1.71	2.52	0.71	0.30	6.50
WNW	0.22	0.67	1.88	2.17	0.52	0.11	5.56
NW	0.24	0.56	1.55	1.01	0.20	0.00	3.56
NNW	0.14	0.63	0.90	0.44	0.03	0.00	2.14
<b>Total</b>	<b>3.24</b>	<b>8.16</b>	<b>14.78</b>	<b>12.28</b>	<b>2.57</b>	<b>0.60</b>	<b>41.63</b>

Calm Hours not Included above for:	Total Period	All Hours	26
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	843
Number of Valid Hours for this Table:	Total Period	All Hours	3285
Total Hours for the Period:			8759

**Joint Frequency Distribution**

**Percent**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP500P Direction: DI500P Lapse: DT500-35

Stability Class: E Delta Temperature Slightly Stable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.19	0.30	0.33	0.06	0.00	0.00	0.89
NNE	0.25	0.23	0.11	0.04	0.01	0.00	0.65
NE	0.34	0.41	0.27	0.08	0.05	0.00	1.14
ENE	0.32	0.48	0.18	0.09	0.04	0.00	1.10
E	0.47	0.82	0.37	0.00	0.00	0.00	1.66
ESE	0.41	0.90	0.44	0.09	0.00	0.00	1.84
SE	0.33	0.66	0.65	0.25	0.04	0.00	1.93
SSE	0.35	0.34	0.38	0.22	0.03	0.00	1.32
S	0.25	0.53	0.56	0.51	0.11	0.01	1.98
SSW	0.46	0.39	0.80	0.85	0.18	0.03	2.70
SW	0.51	0.52	0.93	1.48	0.85	0.03	4.31
WSW	0.47	0.82	0.51	0.30	0.27	0.03	2.40
W	0.54	1.00	1.46	0.80	0.39	0.09	4.28
WNW	0.46	0.85	0.71	0.15	0.05	0.01	2.23
NW	0.22	0.47	0.62	0.19	0.00	0.00	1.50
NNW	0.16	0.25	0.56	0.04	0.00	0.00	1.01
Total	5.73	8.99	8.86	5.15	2.02	0.19	30.93

Calm Hours not Included above for:	Total Period	All Hours	26
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	843
Number of Valid Hours for this Table:	Total Period	All Hours	2440
Total Hours for the Period:			8759

**Joint Frequency Distribution**  
**Percent**  
 Hours at Each Wind Speed and Direction

**Period of Record =** **Total Period** **All Hours**  
 01/01/2021 01:00 - 12/31/2021 23:00  
**Elevation:** **Speed:** SP500P **Direction:** DI500P **Lapse:** DT500-35

**Stability Class:** F **Delta Temperature** Moderately Stable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.11	0.08	0.15	0.01	0.00	0.00	0.35
NNE	0.14	0.13	0.05	0.00	0.00	0.00	0.32
NE	0.27	0.32	0.03	0.00	0.00	0.00	0.61
ENE	0.19	0.33	0.01	0.00	0.00	0.00	0.53
E	0.28	0.33	0.05	0.00	0.00	0.00	0.66
ESE	0.30	0.49	0.23	0.01	0.00	0.00	1.04
SE	0.28	0.25	0.16	0.06	0.00	0.00	0.76
SSE	0.33	0.29	0.27	0.01	0.01	0.00	0.91
S	0.32	0.33	0.24	0.15	0.01	0.00	1.05
SSW	0.37	0.37	0.32	0.19	0.00	0.00	1.24
SW	0.27	0.19	0.30	0.52	0.13	0.00	1.41
WSW	0.35	0.58	0.19	0.04	0.00	0.00	1.17
W	0.37	0.37	0.34	0.24	0.01	0.00	1.33
WNW	0.25	0.60	0.15	0.04	0.00	0.00	1.04
NW	0.14	0.22	0.04	0.00	0.00	0.00	0.39
NNW	0.16	0.11	0.08	0.00	0.00	0.00	0.35
<b>Total</b>	<b>4.13</b>	<b>4.98</b>	<b>2.61</b>	<b>1.28</b>	<b>0.16</b>	<b>0.00</b>	<b>13.17</b>

<b>Calm Hours not Included above for:</b>	<b>Total Period</b>	<b>All Hours</b>	26
<b>Variable Direction Hours for:</b>	<b>Total Period</b>	<b>All Hours</b>	0
<b>Invalid Hours for:</b>	<b>Total Period</b>	<b>All Hours</b>	843
<b>Number of Valid Hours for this Table:</b>	<b>Total Period</b>	<b>All Hours</b>	1039
<b>Total Hours for the Period:</b>			8759

**Joint Frequency Distribution**

**Percent**

Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**

Elevation: Speed: SP500P Direction: D1500P Lapse: DT500-35

Stability Class: G Delta Temperature Extremely Stable

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NNE	0.00	0.01	0.00	0.00	0.00	0.00	0.01
NE	0.03	0.00	0.00	0.00	0.00	0.00	0.03
ENE	0.04	0.03	0.00	0.00	0.00	0.00	0.06
E	0.05	0.01	0.00	0.00	0.00	0.00	0.06
ESE	0.03	0.19	0.04	0.00	0.00	0.00	0.25
SE	0.00	0.11	0.08	0.10	0.00	0.00	0.29
SSE	0.03	0.15	0.05	0.00	0.00	0.00	0.23
S	0.05	0.06	0.15	0.06	0.00	0.00	0.33
SSW	0.03	0.05	0.04	0.04	0.00	0.00	0.15
SW	0.03	0.04	0.01	0.09	0.03	0.00	0.19
WSW	0.01	0.15	0.03	0.01	0.00	0.00	0.20
W	0.00	0.01	0.04	0.00	0.00	0.00	0.05
WNW	0.00	0.04	0.00	0.00	0.00	0.00	0.04
NW	0.04	0.03	0.00	0.00	0.00	0.00	0.06
NNW	0.00	0.03	0.00	0.00	0.00	0.00	0.03
<b>Total</b>	<b>0.32</b>	<b>0.91</b>	<b>0.43</b>	<b>0.30</b>	<b>0.03</b>	<b>0.00</b>	<b>1.99</b>

Calm Hours not Included above for:	Total Period	All Hours	26
Variable Direction Hours for:	Total Period	All Hours	0
Invalid Hours for:	Total Period	All Hours	843
Number of Valid Hours for this Table:	Total Period	All Hours	157
Total Hours for the Period:			8759



**Joint Frequency Distribution**  
**Percent**  
 Hours at Each Wind Speed and Direction

Period of Record = **Total Period** 01/01/2021 01:00 - 12/31/2021 23:00 **All Hours**  
 Elevation: Speed: SP500P Direction: DI500P Lapse: DT500-35

Stability Class: ALL Delta Temperature

**Wind Speed (mph)**

Wind Direction	0.6-3.5	3.6-7.5	7.6-12.5	12.6-18.5	18.6-24.5	> 24.6	Total
N	0.49	1.27	1.67	0.33	0.00	0.00	3.76
NNE	0.67	1.27	0.98	0.24	0.03	0.00	3.18
NE	0.87	1.58	1.06	0.27	0.08	0.00	3.87
ENE	0.77	1.62	0.94	0.24	0.04	0.00	3.61
E	1.06	1.72	1.28	0.20	0.00	0.00	4.27
ESE	0.98	2.42	1.24	0.14	0.00	0.00	4.78
SE	0.79	1.70	1.56	0.80	0.13	0.00	4.97
SSE	0.89	1.17	1.53	0.43	0.06	0.01	4.09
S	0.75	1.44	1.85	1.14	0.25	0.04	5.48
SSW	1.03	1.03	2.62	2.51	0.32	0.05	7.55
SW	1.03	1.27	2.76	4.36	1.43	0.06	10.91
WSW	1.12	2.15	2.13	2.51	0.58	0.10	8.59
W	1.43	2.69	4.06	3.88	1.17	0.41	13.62
WNW	0.98	2.70	3.37	2.80	0.70	0.14	10.68
NW	0.77	1.48	2.53	1.52	0.22	0.00	6.53
NNW	0.51	1.14	1.84	0.58	0.03	0.00	4.09
<b>Total</b>	<b>14.13</b>	<b>26.65</b>	<b>31.43</b>	<b>21.95</b>	<b>5.02</b>	<b>0.81</b>	<b>100.00</b>

Calm Hours not Included above for:	<b>Total Period</b>	<b>All Hours</b>	26
Variable Direction Hours for:	<b>Total Period</b>	<b>All Hours</b>	0
Invalid Hours for:	<b>Total Period</b>	<b>All Hours</b>	843
Number of Valid Hours for this Table:	<b>Total Period</b>	<b>All Hours</b>	7890
Total Hours for the Period:			8759

ENCLOSURE 2, ATTACHMENT 2

Beaver Valley Power Station - Units 1 & 2

RTL # A9.690E  
Enclosure 2, Attachment 2

## Annual Radioactive Effluent Release Report

Calendar Year - 2021

Attachment 2

Unit 1 and 2 Offsite Dose Calculation Manual Changes

### Attachment 2

As no changes were made to the ODCM during the report period, submittal of a complete copy to the NRC is not required.

For a complete copy of the ODCM, contact Radiological Effluents Administrator at 724-682-7667.

ENCLOSURE 2, ATTACHMENT 3

# Annual Annual Radioactive Effluent Release Report

Calendar Year - 2021

Attachment 3

Unit 1 and 2 Carbon-14 (C-14) Dose Estimates

<b>Carbon-14 Methodology</b>	
<p>Gaseous doses from carbon-14 were calculated in accordance with EPRI and Regulatory Guide 1.109 methodology. Other considerations were made in the calculations; daylight hours and growing season.</p>	
<p>Liquid effluent release doses are considered to be insignificant and are not included in this report. This report does not address the amount of carbon-14 disposed of in shipments of solid waste and irradiated fuel. The term "other" discussed below refers to liver, total body, thyroid, kidney, lung and GI. Doses for these organs are assumed to be equal.</p>	
<p>The receptor chosen was selected based upon the default ODCM receptor - NW 1432 meters (0.89 miles). It is assumed that only vegetation and inhalation exposure pathways are available.</p>	
<p>The maximum bounding dose to a member of the public resulting from atmospheric C-14 releases from Unit 1 was determined to be less than 2.58 mrem to the bone and less than 0.52 mrem to all other organs.</p>	
<p>The maximum bounding dose to a member of the public resulting from atmospheric C-14 releases from Unit 2 was determined to be less than 2.58 mrem to the bone and less than 0.52 mrem to all other organs.</p>	

<b>Dose Calculations for Unit 1</b>								
Exposure Pathway	Infant		Child		Teen		Adult	
	Bone	Other	Bone	Other	Bone	Other	Bone	Other
Inhalation	0.06	0.01	0.09	0.02	0.06	0.01	0.04	0.01
Vegetation Ingestion	-	-	2.49	0.50	1.03	0.21	0.64	0.13
<b>TOTAL</b>	0.06	0.01	2.58	0.51	1.10	0.22	0.68	0.14

<b>Dose Calculations for Unit 2</b>								
Exposure Pathway	Infant		Child		Teen		Adult	
	Bone	Other	Bone	Other	Bone	Other	Bone	Other
Inhalation	0.06	0.01	0.09	0.02	0.06	0.01	0.04	0.01
Vegetation Ingestion	-	-	2.49	0.50	1.03	0.21	0.64	0.13
<b>TOTAL</b>	0.06	0.01	2.58	0.51	1.10	0.22	0.68	0.14

<b>Dose Calculations for Site</b>								
	Infant		Child		Teen		Adult	
	Bone	Other	Bone	Other	Bone	Other	Bone	Other
<b>TOTAL</b>	0.13	0.03	5.15	1.03	2.19	0.44	1.36	0.27

ENCLOSURE 3

RTL A9.690E  
Enclosure 3

Beaver Valley Power Station - Units 1 & 2

## 2021 Annual Radiological Environmental Operating Report

Energy Harbor Nuclear Corp.

Beaver Valley Power Station - Units 1 & 2  
Unit 1 License No. DPR-66  
Unit 2 License No. NPF-73

## EXECUTIVE SUMMARY and INDEX

**Report Preparation and Submittal Requirements:** The Beaver Valley Power Station (BVPS) Annual Radiological Environmental Operating Report (AREOR) was prepared and submitted in accordance with the requirements contained in the following documents:

- BVPS Integrated Technical Specifications, Administrative Control 5.6.1
- Offsite Dose Calculation Manual (ODCM) procedure 1/2-ODC-3.03, Attachment T, Control 6.9.2, "*Controls for RETS and REMP Programs*"
- BVPS procedure 1/2-ENV-01.05, "*Compliance with Regulatory Guide 1.21 and Technical Specifications*"
- BVPS procedure 1/2-ENV-02.01, "*Radiological Environmental Monitoring Program*"
- NUREG-1301, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors, Generic Letter 89-01, Supplement No.1, April 1991"
- BVPS form 1/2-ENV-03.01.F02, "*Environmental Field Log*". REMP sampling deviations for 2021 were tracked using the Environmental Field Log, Maintenance Tab.



## EXECUTIVE SUMMARY and INDEX

### Report Overview:

The AREOR provides a detailed summary of the BVPS Radiological Environmental Monitoring Program (REMP). During the report period, samples of air, water, shoreline sediment, milk, fish, food crops, feed crops, vegetation, and direct radiation (in the vicinity of the BVPS site) have been measured, analyzed, evaluated, and summarized. During the report period, the BVPS radioactive effluent releases (as performed in accordance with the Radiological Effluent Technical Specification (RETS) program), did not exceed the limits identified in the BVPS Operating License, Technical Specifications and/or the Offsite Dose Calculation Manual (ODCM). The results of REMP verify that the effluent releases did not impact the environment with a measurable concentration of radioactive materials and/or levels of radiation that are higher than expected.

### Description of Pre-operational REMP (1974 – 1975):

A pre-operational REMP was performed during the period 1974 through 1975. At that time, samples were collected and analyzed to determine the amount of radioactivity present in the environment prior to BVPS operation. The resulting values are considered a “baseline” to which current sample analyses can be compared. A summary of the pre-operational data is summarized in Table 2-3 of this report.

### Description of Operational REMP (1976 – Present):

The operational REMP was initiated during calendar year 1976 and continued through the report period. During the past forty (43) years, radiation and radioactivity in the environment was monitored within a 10-mile radius of the site. A description of the operational REMP is outlined in Table 2-1 of this report. In general, two (2) types of samples were collected and compared during the report period, and are described as follows:

- **Control Samples:** These samples are collected from areas that are beyond measurable influence of BVPS operation and are used as reference data. Normal background radiation levels, or radiation present due to causes other than BVPS operation, can thus be compared to the environment surrounding the BVPS site. During the report period, two hundred sixty-(260) analyses were performed on samples from the control locations. This includes eight (8) analyses that were completed for thermoluminescent dosimeters (TLDs) at the control locations. Results of the analyses from the control locations are summarized in Table 2-2 of this report.
- **Indicator Samples:** Indicator samples are collected to determine the radiological impact of BVPS operation in the environment. These samples are collected from various locations near

## EXECUTIVE SUMMARY and INDEX

the BVPS site. At a minimum, the samples are collected from areas where the BVPS contribution would indicate the most significant radiological impact. During the report period, one thousand five hundred forty (1,540) analyses were performed on samples collected from eighty-one (81) indicator locations. In addition, five hundred twenty-two (522) analyses were completed for TLDs at the indicator locations. Results of the analyses from the indicator locations are also summarized in Table 2-2 of this report.

- **Comparisons:** Current analysis results from the indicator samples were compared to both current control sample values and the pre-operational baseline to determine if changes in radioactivity levels were attributable to BVPS operation.

### Determination of Environmental Impact

- **2021 Sample Media and Analyses:** Results for drinking water, surface water, shoreline stream sediment, fish, cow milk, goat milk, feedstuff, foodcrops, air particulate and air radioiodine media remained consistent with previous data. Minor increases and decreases were noted in most sample media, and any positive results attributable to the BVPS operation were consistent with station data of authorized radioactive discharges and were within limits permitted by the operating license and the ODCM. Other radioactivity detected was attributable to naturally occurring radionuclides, previous nuclear weapons tests, other man-made sources, and to the normal statistical fluctuation for activities near the Lower Limit of Detection (LLD).
- **Airborne Exposure Pathway:** This ODCM required pathway was evaluated via sampling of airborne radioiodine and airborne particulates. The results during this report period were similar to previous years. There was no notable increase in natural products and no detectable fission products or other radionuclides in the airborne particulate media during the year attributed to effluent releases from BVPS.
- **Direct Exposure Pathway:** This ODCM required pathway was evaluated via measurement of environmental radiation doses by use of Thermo Luminescent Dosimeters (TLDs). The results of TLD processing have indicated a stable trend and compare well with previous years.
- **Ingestion Exposure Pathway:** This ODCM required pathway was evaluated via sampling of milk, fish, and foodcrops (leafy vegetables).

For milk samples, strontium-90 (attributable to past atmospheric weapons testing), was detected at levels similar to those of previous years. The gamma spectrometry analyses

## EXECUTIVE SUMMARY and INDEX

indicated positive results for naturally occurring potassium-40 at average environmental levels.

The fish samples indicated below LLD levels in each of the sample analyses.

Foodcrop (leafy vegetation) samples indicated naturally occurring potassium-40 at average environmental levels.

- **Waterborne Exposure Pathway:** This ODCM pathway was evaluated via samples of drinking water, ground (well) water, surface (river) water and river sediment.

Water samples were analyzed for tritium and gamma-emitting radionuclides. Tritium was not identified in the indicator water samples. Iodine-131 analysis of drinking water indicated positive analyses, but the values were consistent with iodine-131 at the upstream surface (river) water control location and was not due to liquid effluent releases from BVPS.

Sediment samples were collected from upstream of the site, at the discharge point of BVPS liquid effluent releases, and downstream of the site. Analysis of samples indicated naturally occurring radionuclides potassium-40, thallium-208, bismuth-214, lead-212, lead-214, radium-226, and actinium-228 in all results. The analyses also indicated cesium-137, most likely caused by previous nuclear weapons tests. Cobalt-58 and cobalt-60 were identified in some of the samples obtained at the shorelines of the BVPS Main Outfall Facility. This is not unusual because the BVPS site discharges cobalt-58 and cobalt-60 in liquid waste effluents. The activity detected at these sample locations is consistent with discharge data of authorized liquid effluent releases, and all liquid effluent releases during the report period did not exceed the release concentration limits set forth in the ODCM.

- **Other Exposure Pathways:** In addition to the samples collected from the exposure pathways described above, other media (i.e., feedstuff) were also collected. Results were consistent with previous years, with no degrading trends.
- **Offsite Groundwater Monitoring (Historical):** Since these samples are not required, they will no longer be collected as of 2017. For historical information, groundwater was collected semiannually by grab samples at locations within four (4) miles of the site, one (1) well in Hookstown, PA and one (1) well in Georgetown, PA. Each ground water sample was analyzed for tritium and is analyzed by gamma spectrometry.
- **Supplemental Sample Sites:** REMP includes supplemental sampling sites in addition to the required sites set forth in the ODCM. The supplemental sites include three (3) air sampling

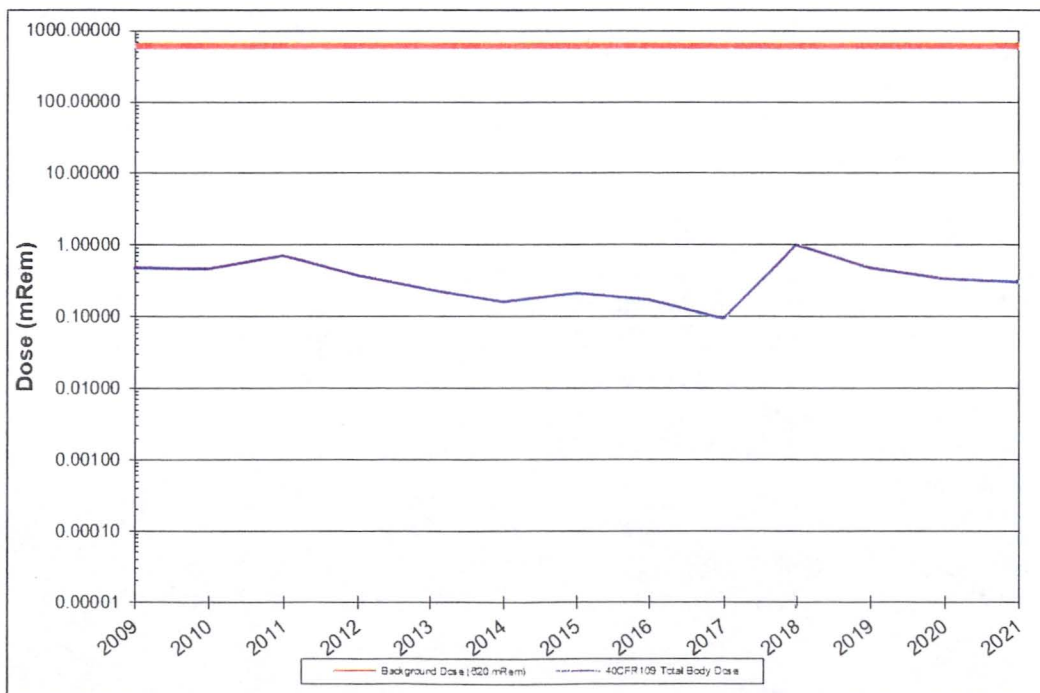
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sites, one (1) sediment site, one (1) milk animal feedstuff site, and five (5) soil sampling sites.

- **Individual Dose vs. Natural Background:** The radiation doses to man as a result of BVPS operations were calculated for both gaseous and liquid effluent pathways using computer software RADEAS which was implemented in 2019. The computer software follows Regulatory Guide 1.109 and site ODCM methodology. Dose factors listed in the ODCM are used to calculate doses from radioactive noble gases in discharge plumes. BVPS effluent data, based on sample analysis were used as the radionuclide activity input. The total doses to an individual were evaluated for all liquid and gaseous effluent pathways. The calculated dose to an individual member of the public from liquid effluent release was 0.0567 mrem whereas the gaseous effluent release was 0.245 mrem. The incremental increase in total body dose from the operation of BVPS - Unit 1 and 2, is 0.0487% of the annual radiation exposure. Figure i-1 illustrates the individual dose from BVPS effluents and natural background dose.

Figure i-1

Graph of Individual Dose from BVPS Effluents and Natural Background Dose



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- **Summary:** During the report period, radioactive effluent releases from the BVPS site did not exceed the limits identified in the BVPS Operating License, Technical Specifications and/or the ODCM. The BVPS operational REMP program was followed throughout the report period. The results demonstrate the adequacy of radioactive effluent control at BVPS, and that BVPS operation did not adversely affect the surrounding environment. Positive results were attributable to BVPS operation and were consistent with station data of authorized radioactive discharges within limits permitted by the NRC license and the ODCM. Other radioactivity detected was attributable to naturally occurring radionuclides, previous nuclear weapons tests, other man-made sources, and to the normal statistical fluctuation for activities near the LLD.

### Inter-laboratory Comparison Programs:

- **Split Sample Program:** BVPS shared split samples with the Pennsylvania Department of Environmental Protection (PADEP) in support of their nuclear power plant monitoring program. The shared media and number of locations were typically comprised of milk (2), surface water (2), river sediment (1), fish (1), foodcrops (2), co-located air particulate/air iodine (4), and TLD (24). The split sample program was coordinated by the state, and the results are not provided with this report.
- **Spike Sample Program:** Spiked samples were provided by an independent laboratory and then analyzed by the REMP contractor laboratory. The samples were provided throughout the report period and included water samples, milk samples, filter paper samples and charcoal cartridge samples. A total of one hundred eight (108) analyses were performed in 2021. All analyses met NRC acceptance criteria.

### Special Reports:

- Since no reporting levels were exceeded during 2021, no Special Reports were required. A Special Report shall be submitted to the NRC when (1) levels of radioactivity in an environmental sampling medium exceeds the limits specified in ODCM procedure 1/2-ODC-3.03, Attachment Q Table 3.12-2, and when (2) the results of the following calculation are  $\geq 1.0$  (for calculations performed when more than one radionuclide is detected in the sampling medium):

$$\frac{\text{Concentration (1)}}{\text{Limit Level (1)}} + \frac{\text{Concentration (2)}}{\text{Limit Level (2)}} + \dots \geq 1.0$$

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### Land Use Census Results:

Highlights from the most recent Land Use Census are summarized as follows:

- **Nearest Residence (0 to 5 mile radius):** The location has not changed since the previous census. The nearest inhabited residence is 209 Ferry Hill Road, Shippingport, PA (0.44 miles, east-northeast).
- **Nearest Garden >500 sqft:** The location has not changed since the previous census. The closest garden location is the Colaber Residence, 1201 Virginia Avenue, Midland, PA (1.033 miles, northwest).
- **Nearest Dairy Cow (0 to 5 mile radius):** The location has not changed since the previous census. The location remains at Brunton Dairy, 3681 Ridge Road, Aliquippa, PA (6.076 miles, southeast).
- **Nearest Doe Goat (0 to 5 mile radius):** The location has not changed since the previous census. The closest location is the Covert Residence, 930 Pine Street (Route 168), Hookstown, PA (2.131 miles, southwest).
- **Prevailing Winds:** The prevailing wind direction for ground releases was identified by showing the highest deposition parameters (D/Q) in the west (W) sector. The prevailing wind direction for elevated releases was identified by showing the highest D/Q in the east-southeast (ESE) sector. The REMP properly monitors the environment with air particulate sampling stations in some sectors and direct radiation TLDs in all sectors.
- **2021 Dairy Cow & Doe Goat Sampling Locations:** The dairy cow sampling locations have not changed in 2021. The locations remain at Brunton Dairy, 3681 Ridge Road, Aliquippa, PA (6.076 miles, southeast), and Windsheimer Dairy, 20 Windsheimer Lane, Burgettstown, PA (10.475 miles, south-southwest). The doe goat sampling location has not changed since the previous census and remains at the Covert Residence, 930 Pine Street (Route 168), Hookstown, PA (2.131 miles, southwest).
- **D/Q for Milch Animal Locations:** The 2021 milch animal sampling locations have not experienced a >20% increase in D/Q. Therefore, a Special Report per ODCM Control 3.12.2 Action "a" and/or Action "b" is not required.
- **X/Q and D/Q for Offsite Dose Determination:** A change in methodology for calculating meteorological dispersion (X/Q) and deposition (D/Q) values resulted in some significant differences (>20% change in a non-conservative direction) that will be addressed in the next ODCM revision. The change in meteorology has no bearing on

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meeting the requirements of Control 3.12.2 Action "a" and/or Action "b". Therefore, a Special Report per ODCM is not required.

- **X/Q and D/Q Historical Trend Comparison:** There is no adverse trend in D/Q when comparing 2009 to 2021 data to the ODCM default D/Q values. However, several locations had higher X/Q values that were >20% of the ODCM default values.

The Land Use Census results indicate that there were no changes in the nearest resident, milch cow, garden or doe goat. Therefore, no changes are required to be made in the current Radiological Environmental Monitoring Program (REMP).

### Deviations, Changes and Adjustments to the Normal Sampling Program

- **Deviation from Normal Air Particulate & Iodine Sampling and Analysis Schedule:**  
There were seven deviations from the required airborne particulate sampling and analysis schedule during the report period:

The REMP Air Particulate and Iodine sampling station located in Midland (Midland North Sub Station, Site No. 32, Sector 15, 0.75 miles NW) was re-located along with the Pennsylvania Department of Environmental Protection's monitor per the request of the property owner, Duquesne Light Company. The relocation of the air monitor station was the result of the demolition of a Duquesne Light control house. The station was moved from the inside of the Midland Sub Station North to outside of the Midland Sub Station South, which is approximately ¼ of a mile from the original location. The shutdown for the relocation occurred on 01/21/21 at 09:53 whereas the service was returned on 01/21/2021 at 11:25 (down time of 1 hr 32 min). Energy Harbor's responsibilities included the setting of the pole, installation of foundation/conduit, meter base, weather head, relocation of air monitoring equipment on new foundation and electrical run to equipment/weather head from meter base. Duquesne Light was responsible for setting the transformer on another pole, connection to primary source, installation of meter and electrical run from transformer to weather head. (New location has the coordinates: LAT: 40.627287, LONG: -80.443644).

During the sampling period of 02/21/2021 - 02/27/2021, REMP Air Particulate and Iodine sampling station located in Hookstown (Old Meyer Farm, Site No. 13, Sector 11, 1.49 miles SW) was found to be out of service. The cause was determined to be from shattered vanes in the rotary pump. The shattered vanes were replaced, and the station was returned to service on 03/01/2021 at 09:31. The sample station was out of service for approximately 83:04 hours, as reported by the REMP technician. (Date and time of malfunction was 02/26/2021 at 07:05 as conveyed from the calculated volume.)

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During the sampling period of 03/21/2021 - 03/27/2021, REMP Air Particulate and Iodine sampling station located in Midland South Sub Station (Site No. 32, Sector 15) was found to be out of service. The cause was determined to be from shattered vanes in the rotary pump. The shattered vanes were replaced, and the station was returned to service on 03/22/2021 at 09:32. The sample station was out of service for approximately 10 hours, 45 minutes, as reported by the REMP technician. (Date and time of malfunction was 03/21/2021 at 22:47 as conveyed from the calculated volume.)

During the sampling period of 07/18/21 - 07/24/21, REMP Air Particulate and Iodine sampling station at Brunton's Dairy in Aliquippa (Site No. 27, 6.16 miles SE) was found to be out of service due to severe thunderstorms from the prior week. The problem was quickly determined to be that the "Reset" button on the Totalizer had popped to prevent a surge overload. The button was reset, the filters changed, and the station was returned to service on 07/19/21. The sample station was out of service for approximately 139 hours as reported by the REMP technician. (Date and time of malfunction was 07/13/2021 at 15:47 as conveyed from the calculated volume.)

During the sampling period of 07/18/21 - 07/24/21, REMP Air Particulate and Iodine sampling station located in Hookstown (Old Meyer Farm, Site No. 13, Sector 11, 1.49 miles SW) was found to be out of service due to severe thunderstorms from the prior week. The cause was determined to be from a blown fuse in the pump. After replacement of the fuse, the sample unit would still not restart satisfactorily. The pump, totalizer, and Turbine were removed, and all of the components were cleaned and reassembled. A new filter was also added. The station was returned to service on 07/19/21 at 19:12. The sample station was out of service for approximately 141 hours as reported by the REMP technician. (Date and time of malfunction was 07/13/2021 at 15:26 as conveyed from the calculated volume.)

During the sampling period of 08/14/21 - 08/20/21, REMP Air Particulate and Iodine sampling station located in Shippingport (Cook's Ferry, Site No. 30, Sector 4, 0.5 miles ENE) was found to be out of service. The cause was determined to be from a shorted-out pump that burned the electrical box on the pump. The electrical box was replaced, and the station was returned to service on 08/19/21 at 10:25.

During the sampling period of 10/02/21 - 10/08/21, REMP Air Particulate and Iodine sampling station located in Shippingport (Cook's Ferry, Site No. 30, Sector 4, 0.5 miles ENE) was found to be out of service. The cause was determined to be from shattered vanes in the rotary pump. The shattered vanes were replaced, and the station was returned to service on 10/04/21 at 08:54. The sample station was out of service for approximately 95 hours 56 minutes, as reported by the REMP technician. (Date and time of malfunction was 09/30/2021 at 13:53 as conveyed from the calculated volume.)



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- **Deviation from Normal Direct Radiation Monitoring:** There were four (4) deviations from the required direct radiation monitoring schedule during the report period. During the Third Quarter TLD changeout, BV-89-Q1 and BV-90-Q2 were discovered to be missing in the field, and direct radiation data for these locations had to rely on the single remaining TLDs. During the Fourth Quarter TLD changeout, BV-7-Q1/2, and BV-92-Q1/2 were discovered to be missing in the field, and no direct radiation data could be recovered for these locations.
- **Deviation from Normal Surface and Drinking Water Sampling and Analysis Schedule:** There were no deviations from the ODCM required water sampling and analysis schedule during the report.
- **Deviation from Normal Milk Sampling & Analysis Schedule:** There was one deviation from the required milk sampling and analysis schedule occurred for the reporting period. Sufficient milk samples were not available from locations within the 5-mile radius in 2021. The unavailability of milk caused the REMP to not meet the ODCM sample requirements in 1/2-ODC-2.03 and in 1/2-ODC-3.03, Attachment Q Table 3.12-1 stating that a minimum of four (4) milk locations shall be sampled. This initiated the ODCM requirement for sampling two (2) additional garden locations based upon the highest predicted annual average D/Q when milk locations are not available.
- **Deviations from Previous Sampling and Analysis Schedule:** There were no deviations from the required sampling and analysis schedules during the report period.

The change from 2017 will remain in the report for reference. Beginning in 2017, the REMP was modified to exclude non-required samples and analyses. These changes are documented in the REMP procedure.

Two (2) Air Particulate and Radioiodine sampling points; Sherman Farm in Brighton Township (Site No. 28, 8.6 miles N) and Friendship Ridge in Beaver (Site No. 29B 7.97 miles NE).

Two (2) Groundwater sampling points; Hookstown Borough (Site No. 14A, 2.61 miles SW) and Georgetown Borough (Site No. 15B, 3.75 miles WNW).

One (1) Sediment sample point; Upstream of New Cumberland Dam (Site No. 50, 11.77 miles WSW).

Three (3) Precipitation sample points; Cook's Ferry Substation in Shippingport (Site No. 30, 0.5 miles ENE), East Liverpool Water Department (Site No. 47, 4.88 miles WNW), and Weirton Water Tower (Site No. 48, 16.4 miles SSW).

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Five (5) Soil sample points; Old Meyer Farm in Hookstown (Site No. 13A, 1.49 miles SW), South of BVPS perimeter (Site No. 22, 0.28 miles SSE), Brunton Farm (Site No. 27, 6.16 miles SE), Nicol Farm in Beaver (Site No. 29A, 8.09 miles NE) and East Liverpool Water Department (Site No. 47, 4.88 miles WNW).

The analysis schedule of I-131 for both drinking and surface was changed from weekly to biweekly.

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## SECTION 1 - INTRODUCTION

### A. Radiation Fundamentals

Radiation is the conveyance of energy through space. For example, heat emanating from a stove is a form of radiation, as are light rays, microwaves, and radio waves. All matter consists of atoms, which are comprised of positively charged particles (protons), negatively charged particles (electrons), and non-charged/neutral particles (neutrons). The relatively large particles (protons and neutrons) are packed tightly together in a cluster at the center of the atom called the nucleus, while the smaller particles (electrons) orbit around the nucleus. In an electrically neutral atom, the negative charges of the electrons are balanced by the positive charges of the protons. Due to their dissimilar charges, the protons and electrons have a strong attraction for each other. This holds the atom together. Other attractive forces between the protons and neutrons keep the densely packed protons from repelling each other and prevent the nucleus from breaking apart.

### B. Radiation and Radioactivity

The following provides an alphabetical glossary of terms associated with radiation, radioactivity, and the radioactive decay process. The terms discussed include alpha particles, beta particles, gamma rays, genetic effects, half-life, ionization, isotopes, neutrons, radiation, radioactive decay, radionuclides and somatic effects.

**Alpha Particles:** Particulate and electromagnetic radiation each travel through matter differently because of their different properties. Alpha particles contain 2 protons and 2 neutrons, are relatively large, and carry an electrical charge of +2. Alpha particles are ejected from the nucleus of a radioactive atom at speeds ranging from 2,000 to 20,000 miles per second. However, due to its comparatively large size, an alpha particle usually does not travel very far before it loses most of its energy through collisions and interactions with other atoms. As a result, a sheet of paper or a few centimeters of air can easily stop alpha particles.

**Beta Particles:** Beta particles are very small, and comparatively fast particles, traveling at speeds near the speed of light (186,000 miles per second). Beta particles have an electrical charge of either +1 or -1. Because they are so small and have a low charge, they do not collide and interact as often as alpha particles, so they can travel farther. Beta particles can usually travel through several meters in air but may be stopped by a thin piece of metal or wood.

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**Gamma Rays:** Gamma rays are pure energy and travel at the speed of light. They have no measurable charge or mass and generally travel much farther than alpha or beta particles before being absorbed. After repeated interactions, the gamma ray loses its energy and vanishes. The range of a gamma ray in air varies, depending on the ray's energy and interactions. Very high-energy gamma radiation can travel a considerable distance, where as low energy gamma radiation may travel only a few feet in air. Lead is used as shielding material for gamma radiation because of its density. Several inches of lead or concrete may be needed to effectively shield gamma rays.

**Genetic Effects:** The effects of ionizing radiation which are observed in the offspring of the exposed individual that could occur as a result of ionizing radiation interacting with the genes in the human cells.

**Half-life:** The length of time an atom remains radioactive is defined in terms of half-life, which is the amount of time required for a radioactive substance to lose half of its activity through the process of radioactive decay. Radionuclides that have infrequent emissions have a long half-life, where as, radionuclides that have more frequent emissions have a short half-life.

**Ionization:** Through interactions with atoms, alpha, beta, and gamma radiation lose their energy. When these forms of radiation interact with any form of material, the energy they impart may cause atoms in that material to become ions or charged particles. Normally, an atom has the same number of protons as electrons, thus, the number of positive and negative charges cancel, in which the atom is electrically neutral. When one or more electrons are removed, an ion is formed. Ionization is one of the processes that may result in damage to biological systems.

**Isotopes:** A group of identical atoms containing the same number of protons make up an element. In fact, the number of protons an atom contains determines its chemical identity. For instance, all atoms with one proton are hydrogen atoms, and all atoms with eight protons are oxygen atoms. However, the number of neutrons in the nucleus of an element may vary. Atoms with the same number of protons but different numbers of neutrons are called isotopes. Different isotopes of the same element have the same chemical properties, and many are stable or non-radioactive. An unstable or radioactive isotope of an element is called a radioisotope, a radioactive atom, or a radionuclide. Radionuclides usually contain an excess amount of energy in the nucleus. The excess energy is usually due to a surplus or deficit in the number of neutrons in the nucleus. Radionuclides such as uranium-238,



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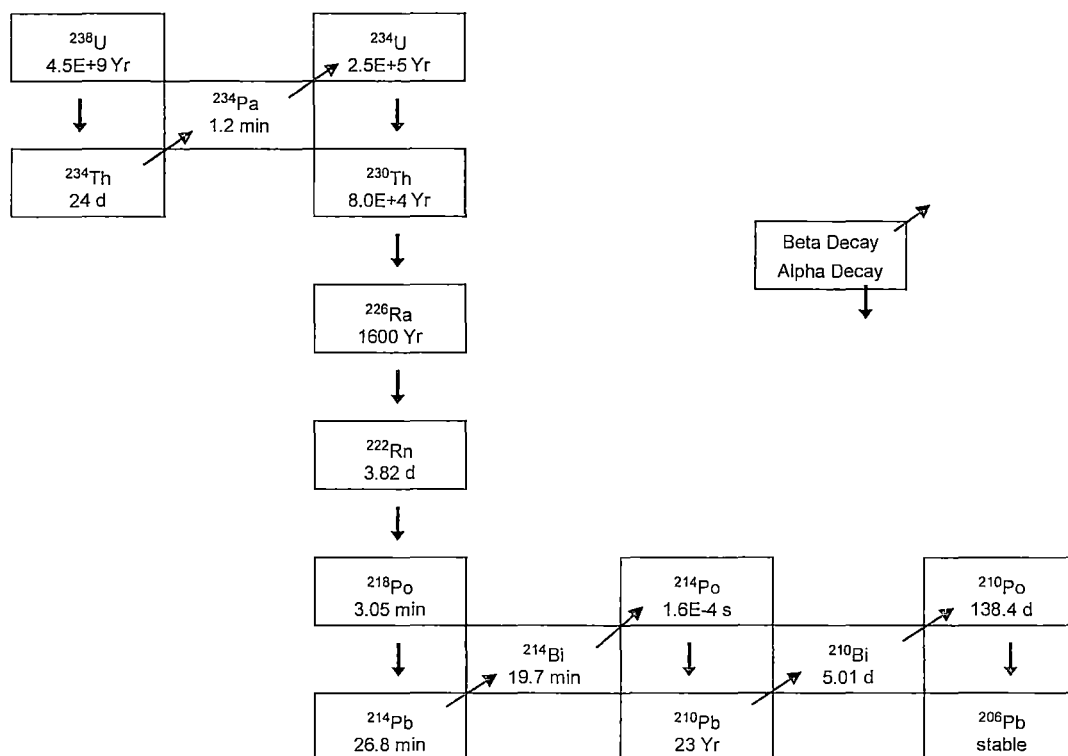
beryllium-7 and potassium-40 occur naturally. Others are man-made, such as iodine-131, cesium-137, and cobalt-60.

**Neutrons:** Neutrons come from several sources, including the interactions of cosmic radiation with the earth's atmosphere and nuclear reactions within operating nuclear power reactors. However, neutrons are not of environmental concern since the neutron source at nuclear power stations is sealed within the containment building. Because neutrons have no charge, they are able to pass very close to the nuclei of the material through which they are traveling. As a result, neutrons may be captured by one of these nuclei or they may be deflected. When deflected, the neutron loses some of its energy. After a series of these deflections, the neutron has lost most of its energy. At this point, the neutron moves about as slow as the atoms of the material through which it is traveling and is called a thermal neutron. In comparison, fast neutrons are much more energetic than thermal neutrons and have greater potential for causing damage to the material through which they travel. Fast neutrons can have from 200 thousand to 200 million times the energy of thermal neutrons. Neutron shielding is designed to slow fast neutrons and absorb thermal neutrons. Neutron shielding materials commonly used to slow neutrons down are water or polyethylene. The shield is then completed with a material such as cadmium, to absorb the now thermal neutrons. Concrete is also used to form an effective neutron shield because it contains water molecules and can be easily molded around odd shapes.

**Radiation:** This is the conveyance of energy through space. For instance, heat emanating from a stove is a form of radiation, as are light rays, microwaves, and radio waves. Ionizing radiation is another type of radiation and has similar properties to those of the examples listed above. Ionizing radiation consists of both electromagnetic radiation and particulate radiation. Electromagnetic radiation is energy with no measurable mass that travels with a wave-like motion through space. Included in this category are gamma rays and x-rays. Particulate radiation consists of tiny, fast moving particles which, if unhindered, travel in a straight line through space. The three types of particulate radiation of concern to us are alpha particles, which are made up of 2 protons and 2 neutrons; beta particles, which are essentially free electrons; and neutrons. The properties of these types of radiation will be described more fully in the Range and Shielding section.

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**Radioactive Decay:** Radioactive atoms, over time, will reach a stable, non-radioactive state through a process known as radioactive decay, which is the release of energy from an atom through the emission of ionizing radiation. Radioactive atoms may decay directly to a stable state or may go through a series of decay stages, called a radioactive decay series, and produce several daughter products that eventually result in a stable atom. The loss of energy through radioactive decay may transform the atom into a chemically different element. For example, when uranium-238 decays, it emits an alpha particle and, as a result, the atom loses 2 protons and 2 neutrons. Since the number of protons in the nucleus of an atom determines its chemical identity, then when the uranium-238 atom loses the 2 protons and 2 neutrons, it is transformed into an atom of thorium-234. Thorium-234 is one of the 14 successive daughter products of uranium-238. Radon is another daughter product, and the decay series ends with stable lead-206. The following example is part of a known radioactive decay series, called the uranium series, which begins with uranium-238 and ends with lead-206. The information provided in the upper portion of each block is the isotope name, while the information provided in the lower portion of each block is the half-life.



**Radionuclides:** See description for “isotopes”.

## SECTION 1 - INTRODUCTION

**Somatic Effects:** The effects of ionizing radiation develop in the directly exposed individual, including an unborn child. Somatic effects can be divided further into acute and chronic effects. Acute effects develop shortly after exposure to large amount of radiation. Chronic effects are a result of exposure to radiation over an extended period of time.

### C. Units of Measurement

**Activity (Curie):** This relates the number of atoms in a sample that disintegrate (decay) per unit of time. Each time an atom disintegrates, radiation is emitted. The curie (Ci) is the unit used to describe the activity of a material and indicates the rate at which the atoms of a radioactive substance are decaying. One curie indicates the disintegration of 37 billion atoms per second. A curie is a unit of activity, not a quantity of material. Thus, the amount of material required to produce one curie varies. A smaller unit of the curie is used when discussing the low concentrations of radioactivity detected in environmental samples. For instance, the picocurie (pCi) represents one trillionth of a curie.

**Absorbed Dose (rad):** This is a term used to describe the radiation energy absorbed by any material exposed to ionizing radiation and can be used for both particulate and electromagnetic radiation. The rad is the unit used to measure the absorbed dose. It is defined as the energy of ionizing radiation deposited per gram of absorbing material (1 rad = 100 erg/g). The rate of absorbed dose is usually given in rad/hr. The rad is not used to quantify biological damage caused by ionizing radiation.

**Dose Equivalent (rem):** Biological damage due to alpha, beta, gamma and neutron radiation may result from ionizing radiation. Some types of radiation, especially alpha particles, cause dense local ionization and can result in up to 20 times the amount of biological damage for the same energy imparted as do gamma or x-rays. Therefore, a quality factor must be applied to account for the different ionizing capabilities of various types of ionizing radiation. When the quality factor is multiplied by the absorbed dose (rad) the result is the dose equivalent. Dose equivalent is an estimate of the possible biological damage resulting from exposure to a particular type of ionizing radiation and is measured in rem. An example of this conversion from absorbed dose (rad) to dose equivalent (rem) uses the quality factor for alpha radiation, which is equal to 20. Thus, 1 rad of alpha radiation is equal to 20 rem. Since beta and gamma radiation each have a quality factor of 1, then 1 rad of either beta or gamma radiation is equal to 1 rem. Neutrons have a quality factor ranging from 2 to 10. In terms of radiation, the rem is a relatively large unit. Therefore, a smaller unit known as the millirem, is often used and one millirem (mrem) is equal to 1/1000 of a rem.

## SECTION 1 - INTRODUCTION

### D. Lower Limit of Detection

The Lower Limit of Detection (LLD) for environmental samples is a calculated value that represents an a-priori (before-the-fact) limit for the smallest concentration (i.e.; pCi per unit mass or volume) of radioactive material in a sample that will be detected with 95% probability, and with 5% probability of falsely concluding that a blank observation represents a real signal. A calculated LLD must consider analytical variables such as standard deviation of the background counting rate, counting efficiency, sample size, fractional radiochemical yield, radioactive decay constant, and elapsed time between sample collection and time of counting.

### E. Scope and Objectives of REMP

The environmental program consists of environmental monitoring for radioactivity in the vicinity of BVPS. Environmental sampling and analyses include air, water, milk, vegetation, river sediments, fish, and ambient radiation levels in areas surrounding the site. The results of these media are assessed to determine impacts of the plant operation on the environment. The AREOR for BVPS summarizes REMP conducted by the licensee during the report period.

### F. Description of the Beaver Valley Site

BVPS is located on the south bank of the Ohio River in the Borough of Shippingport, Beaver County, Pennsylvania, on a 453 acre tract of land. The site is approximately one mile from Midland, Pennsylvania, five miles from East Liverpool, Ohio, and twenty-five miles from Pittsburgh, Pennsylvania. Figure 1-1 shows the site location in relation to the principal population centers. Population density in the immediate vicinity of the site is relatively low. The population within a five mile radius of the plant is approximately 15,000. The only area within the radius of concentrated population is the Borough of Midland, Pennsylvania, with a population of approximately 2,435 as determined from the 2020 U.S. Census.

The site lies in a valley along the Ohio River. It extends from the river (elevation 665 feet above sea level) to a ridge along the border south of the Beaver Valley Power Station at a maximum elevation of 1160 feet. Plant grade level is approximately 735 feet above sea level.

BVPS is on the Ohio River at river mile 34.8, a location on the New Cumberland Pool that is 3.1 river miles downstream from Montgomery Lock and Dam, and 19.6 miles upstream from

## SECTION 1 - INTRODUCTION

New Cumberland Lock and Dam. The Pennsylvania-Ohio-West Virginia border is located 5.2 river miles downstream from the site. The river flow is regulated by a series of dams and reservoirs on the Beaver, Allegheny, Monongahela and Ohio Rivers and their tributaries. During the report period, the Ohio River flow (as obtained from the Corps of Engineers – Water Resources Engineering) at the New Cumberland Dam ranged from 10,571 cubic feet per second (minimum monthly average) to 221,950 cubic feet per second (maximum monthly average). The mean flow during the report period was approximately 38,326 cubic feet per second. Water temperature of the Ohio River typically varies from 32.0° Fahrenheit to 81.1° Fahrenheit. The minimum temperatures occur in January and/or February and maximum temperatures in July and/or August. Water quality in the Ohio River at the site location is affected primarily by the water quality of the Allegheny, Monongahela and Beaver rivers.

The climate of the area may be classified as humid continental. The predominant wind direction is typically from the southwest in summer and from the west in winter. The National Climatic Data Center indicates the following data for the Beaver Falls, PA area:

The total annual precipitation during the report period was 45.3 inches.

The average mean temperature during the report period was 51.6° Fahrenheit.

The basic features of the Beaver Valley Power Station Units 1 and 2 are tabulated below:

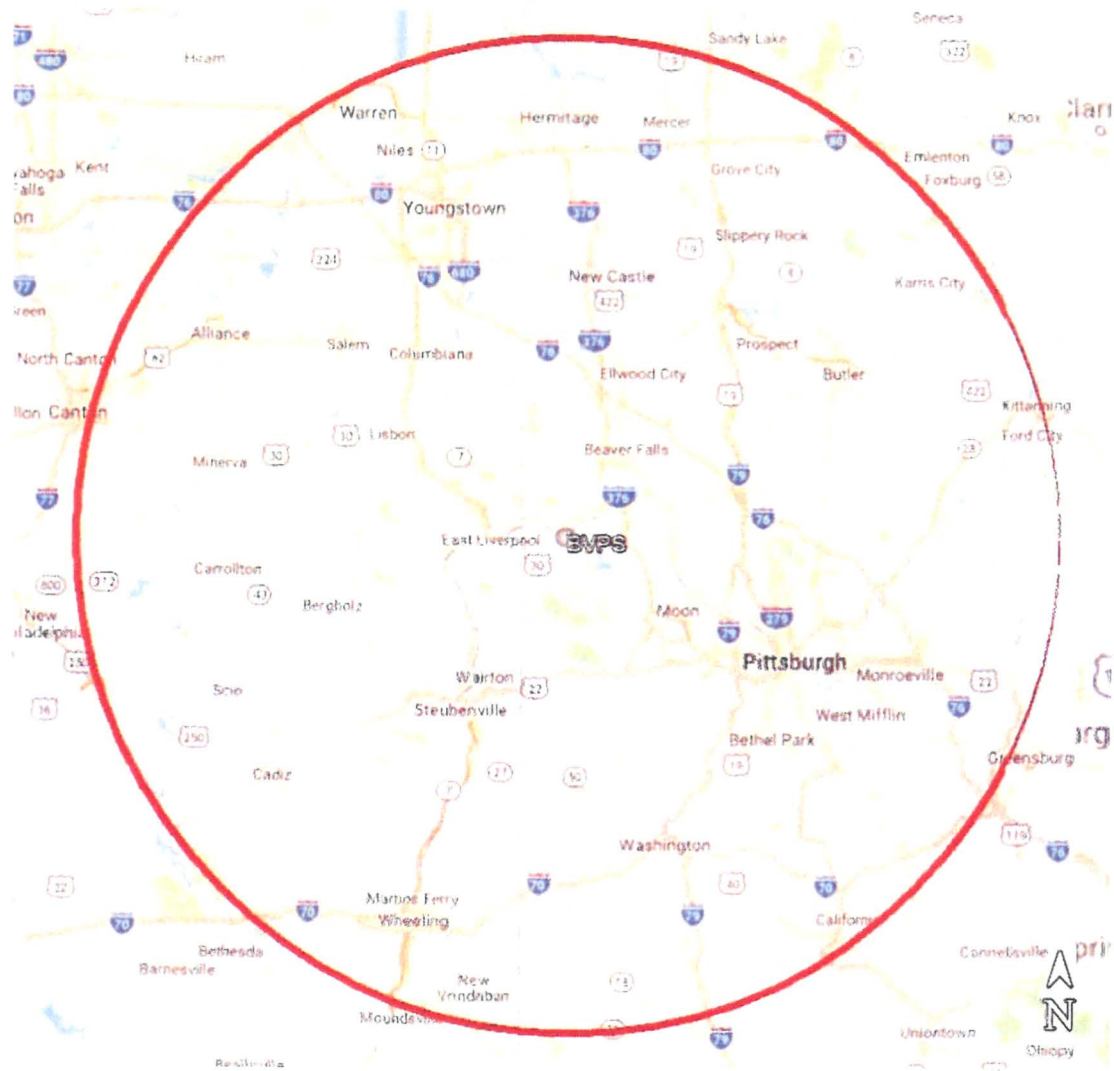
	<u>Beaver Valley Unit 1</u>	<u>Beaver Valley Unit 2</u>
Licensed Power Level	2900 – megawatts thermal	2900 – megawatts thermal
Type of Power	PWR	PWR
No. of Reactor Coolant Loops	3	3
No. of Steam Generators & Type	3 - Vertical	3 - Vertical
Steam Used by Main Turbine	Saturated	Saturated

The BVPS units utilize two separate systems (primary and secondary) for transferring heat from the source (the reactor) to the receiving component (turbine-generator). Because the two systems are isolated from each other, primary and secondary waters do not mix, and radioactivity in the primary system water is normally isolated from the secondary system. Reactor coolant in the primary system is pumped through the reactor core and steam generators by means of reactor coolant pumps. Heat is transferred from the primary system to the secondary system in the steam generators. The steam is then formed and delivered to the main unit turbine, which drives the electrical generator. The steam is condensed after passing through the turbine and returned to the steam generators to begin another steam/water cycle.

SECTION 1 - INTRODUCTION

Figure 1-1

Geographical Map and Principal Communities  
in 50-mile Radius of the Beaver Valley Power Station



## SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

### A. Radiological Environmental Monitoring Program

#### 1. Program Description

The program consists of monitoring water, air, soil, river bottoms (sediment), feedstuff, vegetation, foodcrops, cow's milk, ambient radiation levels in areas surrounding the site, and aquatic life as summarized in Table 2-1. Further description of each portion of the program (Sampling Methods, Sample Analysis, Discussion and Results) are included in Sections 2-B through 2-I of this report.

**2-B - Air Monitoring**

**2-C - Environmental Radiation Monitoring**

**2-D - Monitoring of Surface Water, Drinking Water, Groundwater and  
Precipitation**

**2-E - Monitoring of Shoreline Stream Sediment and Soil**

**2-F - Monitoring of Local Cow and Goat Milk**

**2-G - Monitoring of Fish**

**2-H - Monitoring of Feedstuff and Foodcrops**

**2-I - Estimates of Radiation Dose to Man**

SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

Table 2-1

Operational Radiological Environmental Monitoring Program

Section	Sample Type	Sample Site No.	Sample Location	Sample Frequency	Sample Preparation / Analysis Frequency	Analysis
1	Air Particulate & Radionuclide	13	Hookstown, PA (Old Meyer Farm)	Continuous Sampling with Sample Collection at least weekly	Weekly - Air Particulate  Weekly – Charcoal  Quarterly Composite (c)	Gross Beta (b)  Iodine-131  Gamma Scan
		27	Aliquippa, PA (Brunton Farm)			
		30	Shippingport, PA (Cook's Ferry Substation)			
		32B	Midland, PA (South Substation)			
		46.1	Industry, PA (McKeel's Service - Rt. 68)			
		47	East Liverpool, OH (Water Department)			
		48 (a)	Weirton, WV (Water Tower - Collier Way)			
		51	Aliquippa, PA (Sheffield Substation)			
2	Direct Radiation	7-8	BVPS Site Perimeter Locations	Continuous (TLD)	Quarterly <sup>(d)</sup>	Gamma Dose
		10	Shippingport, PA (Post Office)			
		13	Hookstown, PA (Old Meyer Farm)			
		14	Hookstown, PA			
		15	Georgetown, PA (Post Office)			
		27	Aliquippa, PA (Brunton Farm)			
		28	Sherman Farm			
		29B	Beaver, PA (Friendship Ridge)			
		30	Shippingport, PA (Cook's Ferry Substation)			
		32B	Midland, PA (South Substation)			
		33-44	BVPS Site Perimeter Locations			
		45	Raccoon Township, PA (Christian House Baptist Chapel - Rt. 18)			
		45.1	Raccoon Township, PA (Kennedy's Corner)			
		46	Industry, PA (Midway Drive)			
		46.1	Industry, PA (McKeel's Service - Rt. 68)			
		47	East Liverpool, OH (Water Department)			
		48 (a)	Weirton, WV (Water Tower - Collier Way)			
		51	Aliquippa, PA (Sheffield Substation)			
		52-56	BVPS Site Perimeter Locations			
		59	236 Green Hill Road, Aliquippa, PA			
		60	444 Hill Road, Georgetown, PA			
		70	236 Engle Road, Industry, PA			
		71	Brighton Township, PA (First Western Bank)			
		72	Ohioview, PA (Lutheran Church – Rear)			
		73	618 Squirrel Run Road, Industry, PA			
		74	37 Poplar Avenue, Monaca, PA (CCBC)			
		75	117 Holt Road, Aliquippa, PA			
		76	Raccoon Township, PA (Elementary School)			
		77	3614 Green Garden Road, Aliquippa, PA			
		78	Raccoon Township, PA (Municipal Building)			
		79	106 Rt. 151, Aliquippa, PA			
		80	Raccoon Township, PA (Park Office -Rt. 18)			
		81	Millcreek United Presbyterian, Church Hookstown, PA			
		82	2697 Rt. 18, Raccoon Twp, PA			
		83	735 Mill Creek Road, Hookstown, PA			
		84	Hancock County, WV (Senior Center)			
		85	2048 Rt. 30, West Chester, WV			
		86	1090 Ohio Avenue, East Liverpool, OH			
		87	50103 Calcutta Smith Ferry Road, Calcutta, OH			
		88A	Route 168, Midland Heights, PA			
		89	488 Smith Ferry Road, Ohioville, PA			
90	6286 Tuscarawas Road, Midland, PA					
91	Pine Grove Road & Doyle Road, Industry, PA					
92	Georgetown, PA (Georgetown Road Substation)					
93	104 Linden, Midland, PA (Sunrise Hills)					
94	Hookstown, PA (McCleary & Pole Cat Hollow Roads)					
95	832 McCleary Road, Hookstown, PA)					
111-112	BVPS Site Perimeter Locations					



SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

Table 2-1 (Continued)

Operational Radiological Environmental Monitoring Program

Section	Sample Type	Sample Site No.	Sample Location	Sample Frequency	Sample Preparation / Analysis Frequency	Analysis
3	Surface Water	49A <sup>(a)</sup>	Industry, PA (Upstream of Montgomery Dam)	Weekly Grab Sample <sup>(b)</sup>	Biweekly Sample	Iodine-131
		5	East Liverpool, OH (Water Department)	Daily Grab Sample Collected Weekly <sup>(b)</sup>	Monthly Composite of Weekly Sample <sup>(c)</sup> Quarterly Composite <sup>(c)</sup>	Gamma Scan Tritium (H-3)
4	Groundwater	No sampling performed				
5	Drinking Water	4	Midland, PA (Water Department)	Intermittent <sup>(d)</sup> Sample Collected Weekly	Biweekly Composite of Daily sample <sup>(d)</sup>	Iodine-131
		5	East Liverpool, OH (Water Department)		Monthly Composite <sup>(d)</sup>	Gamma Scan
					Quarterly Composite <sup>(d)</sup>	Tritium (H-3)
6	Shoreline Sediment	2A	BVPS Outfall Vicinity	Semi-Annual	Semi-Annual	Gamma Scan
		49A <sup>(a)</sup>	Industry, PA (Upstream of Montgomery Dam)			
7	Milk	27	Aliquippa, PA (Brunton Farm)	Biweekly <sup>(f)</sup> When animals are on pasture; monthly at other times	All other samples & analyses are Biweekly during grazing but Monthly during other times	Gamma Scan Iodine-131 Strontium-89 Strontium-90
		96 <sup>(a)</sup>	Burgettstown, PA (Windsheimer Farm)			
		114 <sup>(k)</sup>	Hookstown, PA (Covert Residence)			
8	Fish	2A	BVPS Outfall Vicinity	Semi-Annual	Composite of edible parts by species <sup>(g)</sup>	Gamma Scan on edible parts
		49A <sup>(a)</sup>	Industry, PA (Upstream of Montgomery Dam)			
9	Food Crops	10 <sup>(l)(m)</sup>	Shippingport, PA	Annual at Harvest if available	Composite of each sample species	Gamma Scan Iodine-131 on green leafy vegetables
		15 <sup>(l)(m)</sup>	Georgetown, PA			
		12 <sup>(l)(m)</sup>	Racoon Township, PA			
		46 <sup>(l)(m)</sup>	Industry, PA			
		48 <sup>(a)(l)(m)</sup>	Weirton, WV			
		* <sup>(l)(m)</sup>				
10	Feedstuff & Summer Forage	27	Aliquippa, PA (Brunton Farm)	Monthly	Monthly	Gamma Scan
11	Soil	30B	Shippingport, PA (Cook's Ferry Substation)	Every Five (5) Years (2020, 2025, 2030)	12 Core Samples 3" Deep (2" diameter at each location approx. 10' radius)	Gamma Scan
		32A	Midland, PA (North Substation)			
		46.1	Industry, PA			
		48 <sup>(a)</sup>	Weirton WV (Water Tower - Collier Way)			
		51A	Aliquippa, PA (Sheffield Substation)			
12	Precipitation	No sampling performed				

SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

Table 2-1 (Continued)

Operational Radiological Environmental Monitoring Program

Notes for Table 2-1

- (a) Control sample station: These Locations which are presumed to be outside the influence of plant effluents.
- (b) Particulate Samples are not counted within 24 hours after filter change. Perform gamma isotopic analysis on each sample when gross beta is greater than 10 times the yearly mean of control samples.
- (c) Long-term composite samples are obtained from short-term composite samples at the specified locations.
- (d) Composite samples are collected at intervals not exceeding 2 hours.
- (e) Searight Dairy is no longer operational.
- (f) Milk samples are collected biweekly when animals are grazing. The milk samples are collected monthly at other times.
- (g) The fish samples contain whatever species are available.  
IF adequate sample size is available, THEN the sample is separated according to species, and compositing will provide one sample of each species.  
IF adequate sample size is not available, THEN separation by species is not practical. Therefore, edible parts of all fish in the sample are mixed to provide one sample.
- (h) Composite samples are obtained by collecting an aliquot at intervals not exceeding 2 hours at location 2.1. In December of 2016, location 2.1 was closed. The water treatment plant operator at location 5 obtains the weekly grab sample from the daily composite grab samples. In December of 2016, location 5 was transitioned to a composite sample to replace location 2.1. For location 49A, the weekly grab sample is obtained by a field technician.
- (i) Two (2) TLDs are collected quarterly from each monitoring location.
- (k) ODCM procedure 1/2-ODC-3.03, Attachment Q, Table 3.12-1 requires three (3) dairies to be selected on basis of highest potential thyroid dose using milch census data. See Section 2-E of this report (Monitoring of Local Cow's Milk) for specific locations sampled.
- (l) Three (3) garden locations required by 1/2-ODC-2.03, Attachment A Table 3.0-1; Sites designated by 1/2-ODC-2.03 Attachment B Figure 3.0-5. Sampling locations may be altered by the REMP Administrator at any time based on availability.
- (m) When there are not enough milk sample locations available to meet the ODCM requirements, three (3) different types of broad leaf vegetation are to be sampled at each of two (2) indicator locations based on the highest predicted annual average ground D/Q (as determined from the previous year's Land Use Census results), in addition to those samples described in Note (l). Three (3) different types of broad leaf vegetation shall also be sampled at one (1) control location when in this condition.

## SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

### 2. Summary of Results

All results of this monitoring program are summarized in Table 2-2. This table is prepared in the format specified by the NRC via the Branch Technical Position in NUREG-1301, and in accordance with Beaver Valley Power Station ODCM. Summaries of results of analysis of each media are discussed in Sections 2-B through 2-H and an assessment of radiation doses are given in Section 2-I. Table 2-3 summarizes BVPS pre-operational ranges for the various sampling media during the years 1974 and 1975. Comparisons of pre-operational data with operational data indicate the ranges of values are generally in good agreement for both periods of time.

Activity detected was attributed to naturally occurring radionuclides, BVPS effluents, previous nuclear weapons tests and/or to the normal statistical fluctuation for activities near the LLD.

The conclusion from all program data is that the operation of BVPS has resulted in no significant changes to the environment.

### 3. Quality Control Program

The Quality Control Program implemented by BVPS to assure reliable performance by the contractor and the supporting QC data are presented and discussed in Section 4 of this report.

### 4. Program Changes

The REMP Air Particulate and Iodine sampling station located in Midland (Midland North Sub Station, Site No. 32, Sector 15, 0.75 miles NW) was re-located along with the Pennsylvania Department of Environmental Protection's monitor per the request of the property owner, Duquesne Light Company. The relocation of the air monitor station was the result of the demolition of a Duquesne Light control house. The station was moved from the inside of the Midland Sub Station North to outside of the Midland Sub Station South, which is approximately ¼ of a mile from the original location.

The 2017 changes will remain in the report for reference. In January 2017, REMP sampling changes were made to remove non-ODCM samples, and they are as follows; two air particulate and radioiodine locations, two groundwater locations, one sediment location, three precipitation locations, and five soil locations. Additionally, the frequency of drinking water analysis was changed to biweekly, surface water analysis #49A was changed to biweekly, and soil sample collection was changed to quinquennial.

SECTION 2 - ENVIRONMENTAL MONITORING PROGRAM

Table 2-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: Beaver Valley Power Station Unit 1 and Unit 2

Docket No.: 50-334 / 50-412

Location of Facility: Beaver County, Pennsylvania

Reporting Period: Calendar Year - 2021

Medium: Air Particulate and Radioiodine

Unit of Measurement: (picoCuries / cubic meter)

Type and Total Number of Analysis Performed	Lower Limit of Detection LLD <sup>(a)</sup>	All Indicator Locations Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Locations with Highest Annual Mean		Control Location		Number of Nonroutine Reported Measurements <sup>(c)</sup>
			Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	
Gross Beta 422	< 0.002	0.025 ( 369 / 369 ) 0.004 - 0.048	No. 13 Old Meyer Farm Hookstown, PA 1.49 miles SW	0.026 ( 52 / 52 ) 0.080 - 0.047	No. 48 Weirton Water Tower Collier Way Weirton, WV 16.4 miles SSW	0.026 ( 53 / 53 ) 0.008 - 0.043	0
I-131 422	< 0.04	LLD ( 0 / 369 )		LLD ( 0 / 369 )	No. 48 Weirton Water Tower Collier Way Weirton, WV 16.4 miles SSW	LLD ( 0 / 53 )	0
Gamma 32							
Be-7	NA	0.089 ( 28 / 28 ) 0.062 - 0.112	No. 51 Aliquippa (Sheffield S.S.) Aliquippa, PA 8.00 miles E	0.097 ( 4 / 4 ) 0.075 - 0.112	No. 48 Weirton Water Tower Collier Way Weirton, WV 16.4 miles SSW	0.095 ( 4 / 4 ) 0.073 - 0.108	0
Co-60	NA	LLD ( 0 / 28 )		LLD ( 0 / 28 )		LLD ( 0 / 4 )	0
Cs-134	< 0.0005	LLD ( 0 / 28 )		LLD ( 0 / 28 )		LLD ( 0 / 4 )	0
Cs-137	< 0.0005	LLD ( 0 / 28 )		LLD ( 0 / 28 )		LLD ( 0 / 4 )	0
Ba-La-140	NA	LLD ( 0 / 28 )		LLD ( 0 / 28 )		LLD ( 0 / 4 )	0

<sup>a</sup> Nominal Lower Limit of Detection

<sup>b</sup> Mean and range based upon detectable measurements only.

Fraction of detectable measurements at specified locations is indicated in parentheses (fraction)

<sup>c</sup> Nonroutine Reported Measurements (Reference: ODCM procedure 1/2-ODC-3.03, Attachment Q, Control 3.12.1)

NA = Not Applicable (Naturally Occurring Radionuclides Not required by ODCM)

SECTION 2 - ENVIRONMENTAL MONITORING PROGRAM

Table 2-2 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: Beaver Valley Power Station Unit 1 and Unit 2

Docket No.: 50-334 / 50-412

Location of Facility: Beaver County, Pennsylvania

Reporting Period: Calendar Year - 2021

Medium: External Radiation

Unit of Measurement: (mR / Quarter)

Type and Total Number of Analysis Performed	Lower Limit of Detection LLD <sup>(a)</sup>	All Indicator Locations Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Locations with Highest Annual Mean		Control Location		Number of Nonroutine Reported Measurements <sup>(c)</sup>
			Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	
Gamma 522	4.6	17.5 ( 514 / 514 ) 12.1 - 31.2	No. 7 BVPS Site Perimeter Location 0.25 miles SSE	27.2 ( 6 / 6 ) 25.1 - 31.2	No. 48 Weirton, WV Water Tower Collier Way 16.4 miles SSW	18.9 ( 8 / 8 ) 17.1 - 20.4	0

<sup>a</sup> Nominal Lower Limit of Detection

<sup>b</sup> Mean and range based upon detectable measurements only.  
 Fraction of detectable measurements at specified locations is indicated in parentheses (fraction)

<sup>c</sup> Nonroutine Reported Measurements (Reference: ODCM procedure 1/2-ODC-3.03, Attachment Q, Control 3.12.1)

NA = Not Applicable (Naturally Occurring Radionuclides Not required by ODCM)

SECTION 2 - ENVIRONMENTAL MONITORING PROGRAM

Table 2-2 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: Beaver Valley Power Station Unit 1 and Unit 2  
Docket No.: 50-334 / 50-412  
Location of Facility: Beaver County, Pennsylvania  
Reporting Period: Calendar Year - 2021

Medium: Surface Water  
Unit of Measurement: (picoCuries / liter)

Type and Total Number of Analysis Performed	Lower Limit of Detection LLD <sup>(a)</sup>	All Indicator Locations Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Locations with Highest Annual Mean		Control Location		Number of Nonroutine Reported Measurements <sup>(c)</sup>
			Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	
I-131 26	< 0.5				No. 49A Upstream of Montgomery Dam Industry, PA 4.93 miles NE	0.5 ( 4 / 26 ) 0.3 - 0.8	0
H-3 8	< 200	LLD ( 0 / 4 )	No. 5 East Liverpool Water Dpt. East Liverpool, OH 4.9 miles WNW	LLD ( 0 / 4 )	No. 49A Upstream of Montgomery Dam Industry, PA 4.93 miles NE	LLD ( 0 / 4 )	0
Gamma 24							
Mn-54	< 5	LLD ( 0 / 12 )		LLD ( 0 / 12 )		LLD ( 0 / 12 )	0
Fe-59	< 10	LLD ( 0 / 12 )		LLD ( 0 / 12 )		LLD ( 0 / 12 )	0
Co-58	< 5	LLD ( 0 / 12 )		LLD ( 0 / 12 )		LLD ( 0 / 12 )	0
Co-60	< 5	LLD ( 0 / 12 )		LLD ( 0 / 12 )		LLD ( 0 / 12 )	0
Zn-65	< 10	LLD ( 0 / 12 )		LLD ( 0 / 12 )		LLD ( 0 / 12 )	0
Zr-Nb-95	< 5	LLD ( 0 / 12 )		LLD ( 0 / 12 )		LLD ( 0 / 12 )	0
Cs-134	< 5	LLD ( 0 / 12 )		LLD ( 0 / 12 )		LLD ( 0 / 12 )	0
Cs-137	< 5	LLD ( 0 / 12 )		LLD ( 0 / 12 )		LLD ( 0 / 12 )	0
Ba-La-140	< 10	LLD ( 0 / 12 )		LLD ( 0 / 12 )		LLD ( 0 / 12 )	0

<sup>a</sup> Nominal Lower Limit of Detection

<sup>b</sup> Mean and range based upon detectable measurements only.  
Fraction of detectable measurements at specified locations is indicated in parentheses (fraction)

<sup>c</sup> Nonroutine Reported Measurements (Reference: ODCM procedure 1/2-ODC-3.03, Attachment Q, Control 3.12.1)

NA = Not Applicable (Naturally Occurring Radionuclides Not required by ODCM)

SECTION 2 - ENVIRONMENTAL MONITORING PROGRAM

Table 2-2 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: Beaver Valley Power Station Unit 1 and Unit 2

Docket No.: 50-334 / 50-412

Location of Facility: Beaver County, Pennsylvania

Reporting Period: Calendar Year - 2021

Medium: Drinking Water

Unit of Measurement: (picoCuries / liter)

Type and Total Number of Analysis Performed	Lower Limit of Detection LLD <sup>(a)</sup>	All Indicator Locations Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Locations with Highest Annual Mean		Control Location		Number of Nonroutine Reported Measurements <sup>(c)</sup>
			Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	
I-131 52	< 0.5	0.3 ( 1 / 26 ) 0.3 - 0.3	No. 5 East Liverpool Water Dpt. East Liverpool, OH 4.9 miles WNW	0.3 ( 1 / 26 ) 0.3 - 0.3			0
H-3 8	< 200	LLD ( 0 / 8 )		LLD ( 0 / 8 )			0
Gamma 24							
Mn-54	< 5	LLD ( 0 / 24 )		LLD ( 0 / 24 )			0
Fe-59	< 10	LLD ( 0 / 24 )		LLD ( 0 / 24 )			0
Co-58	< 5	LLD ( 0 / 24 )		LLD ( 0 / 24 )			0
Co-60	< 5	LLD ( 0 / 24 )		LLD ( 0 / 24 )			0
Zn-65	< 10	LLD ( 0 / 24 )		LLD ( 0 / 24 )			0
Zr-Nb-95	< 5	LLD ( 0 / 24 )		LLD ( 0 / 24 )			0
Cs-134	< 5	LLD ( 0 / 24 )		LLD ( 0 / 24 )			0
Cs-137	< 5	LLD ( 0 / 24 )		LLD ( 0 / 24 )			0
Ba-La-140	< 10	LLD ( 0 / 24 )		LLD ( 0 / 24 )			0

<sup>a</sup> Nominal Lower Limit of Detection

<sup>b</sup> Mean and range based upon detectable measurements only.  
 Fraction of detectable measurements at specified locations is indicated in parentheses (fraction)

<sup>c</sup> Nonroutine Reported Measurements (Reference: ODCM procedure 1/2-ODC-3.03, Attachment Q, Control 3.12.1)

NA = Not Applicable (Naturally Occurring Radionuclides Not required by ODCM)

SECTION 2 - ENVIRONMENTAL MONITORING PROGRAM

Table 2-2 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: Beaver Valley Power Station Unit 1 and Unit 2

Docket No.: 50-334 / 50-412

Location of Facility: Beaver County, Pennsylvania

Reporting Period: Calendar Year - 2021

Medium: Ground Water

Sample locations are no longer in use

Unit of Measurement: (picoCuries / liter)

Type and Total Number of Analysis Performed	Lower Limit of Detection LLD <sup>(a)</sup>	All Indicator Locations Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Locations with Highest Annual Mean		Control Location		Number of Nonroutine Reported Measurements <sup>(c)</sup>
			Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	
H-3	< 200						
Gamma							
Mn-54	< 5						
Fe-59	< 10						
Co-58	< 5						
Co-60	< 5						
Zn-65	< 10						
Zr-Nb-95	< 5						
Cs-134	< 5						
Cs-137	< 5						
Ba-La-140	< 10						

<sup>a</sup> Nominal Lower Limit of Detection

<sup>b</sup> Mean and range based upon detectable measurements only.  
 Fraction of detectable measurements at specified locations is indicated in parentheses (fraction)

<sup>c</sup> Nonroutine Reported Measurements (Reference: ODCM procedure 1/2-ODC-3.03, Attachment Q, Control 3.12.1)

NA = Not Applicable (Naturally Occurring Radionuclides Not required by ODCM)





SECTION 2 - ENVIRONMENTAL MONITORING PROGRAM

Table 2-2 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: Beaver Valley Power Station Unit 1 and Unit 2

Docket No.: 50-334 / 50-412

Location of Facility: Beaver County, Pennsylvania

Reporting Period: Calendar Year - 2021

Medium: Sediment (page 1 of 2)

Unit of Measurement: (picoCuries / gram) Dry

Type and Total Number of Analysis Performed	Lower Limit of Detection LLD <sup>(a)</sup>	All Indicator Locations Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Locations with Highest Annual Mean		Control Location		Number of Nonroutine Reported Measurements <sup>(c)</sup>
			Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	
Gamma 4							
K-40	NA	10.39 ( 2 / 2 ) 9.56 - 11.21	No. 2A BVPS Outfall Vicinity 0.31 miles WSW	10.39 ( 2 / 2 ) 9.56 - 11.21	No. 49A Upstream of Montgomery Dam Industry, PA 4.93 miles NE	11.12 ( 2 / 2 ) 10.47 - 11.76	0
Mn-54	< 0.02	LLD ( 0 / 2 )		LLD ( 0 / 2 )		LLD ( 0 / 2 )	0
Fe-59	< 0.03	LLD ( 0 / 2 )		LLD ( 0 / 2 )		LLD ( 0 / 2 )	0
Co-58	< 0.02	0.08 ( 1 / 2 ) 0.08 - 0.08	No. 2A BVPS Outfall Vicinity 0.31 miles WSW	0.08 ( 1 / 2 ) 0.08 - 0.08		LLD ( 0 / 2 )	0
Co-60	< 0.02	0.41 ( 2 / 2 ) 0.37 - 0.45	No. 2A BVPS Outfall Vicinity 0.31 miles WSW	0.41 ( 2 / 2 ) 0.37 - 0.451		LLD ( 0 / 2 )	0
Zn-65	< 0.04	LLD ( 0 / 2 )		LLD ( 0 / 2 )		LLD ( 0 / 2 )	0
Zr-95	< 0.03	LLD ( 0 / 2 )		LLD ( 0 / 2 )		LLD ( 0 / 2 )	0
Nb-95	< 0.03	LLD ( 0 / 2 )		LLD ( 0 / 2 )		LLD ( 0 / 2 )	0
Cs-134	< 0.06	LLD ( 0 / 2 )		LLD ( 0 / 2 )		LLD ( 0 / 2 )	0
Cs-137	< 0.08	0.07 ( 2 / 2 ) 0.05 - 0.10	No. 2A BVPS Outfall Vicinity 0.31 miles WSW	0.07 ( 2 / 2 ) 0.05 - 0.10		LLD ( 0 / 2 )	0
Ba-La-140	< 0.03	LLD ( 0 / 2 )		LLD ( 0 / 2 )		LLD ( 0 / 2 )	0

SECTION 2 - ENVIRONMENTAL MONITORING PROGRAM

Table 2-2 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: Beaver Valley Power Station Unit 1 and Unit 2

Docket No.: 50-334 / 50-412

Location of Facility: Beaver County, Pennsylvania

Reporting Period: Calendar Year - 2021

Medium: Sediment (page 2 of 2)

Unit of Measurement: (picoCuries / gram) Dry

Type and Total Number of Analysis Performed	Lower Limit of Detection LLD <sup>(a)</sup>	All Indicator Locations Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Locations with Highest Annual Mean		Control Location		Number of Nonroutine Reported Measurements <sup>(c)</sup>
			Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	
Tl-208	NA	0.39 ( 2 / 2 ) 0.33 - 0.46	No. 2A BVPS Outfall Vicinity 0.31 miles WSW <i>Same location for the following nuclides</i>	0.59 ( 2 / 2 ) 0.33 - 0.46	No. 49A Upstream of Montgomery Dam Industry, PA 4.93 miles NE <i>Same location for the following nuclides</i>	0.31 ( 2 / 2 ) 0.29 - 0.34	0
Bi-214	NA	0.84 ( 2 / 2 ) 0.72 - 0.97		0.84 ( 2 / 2 ) 0.72 - 0.968		0.85 ( 2 / 2 ) 0.83 - 0.87	0
Pb-212	NA	1.00 ( 2 / 2 ) 0.91 - 1.09		1.00 ( 2 / 2 ) 0.91 - 1.09		0.90 ( 2 / 2 ) 0.86 - 0.94	0
Pb-214	NA	0.98 ( 2 / 2 ) 0.83 - 1.14		0.98 ( 2 / 2 ) 0.83 - 1.14		0.93 ( 2 / 2 ) 0.87 - 0.99	0
Ra-226	NA	1.96 ( 2 / 2 ) 1.78 - 2.13		1.96 ( 2 / 2 ) 1.78 - 2.13		1.89 ( 2 / 2 ) 1.84 - 1.94	0
Ac-228	NA	1.10 ( 2 / 2 ) 0.98 - 1.22		1.10 ( 2 / 2 ) 0.98 - 1.22		0.97 ( 2 / 2 ) 0.86 - 1.09	0

<sup>a</sup> Nominal Lower Limit of Detection

<sup>b</sup> Mean and range based upon detectable measurements only.

Fraction of detectable measurements at specified locations is indicated in parentheses (fraction)

<sup>c</sup> Nonroutine Reported Measurements (Reference: ODCM procedure 1/2-ODC-3.03, Attachment Q, Control 3.12.1)

NA = Not Applicable (Naturally Occurring Radionuclides Not required by ODCM)

SECTION 2 - ENVIRONMENTAL MONITORING PROGRAM

Table 2-2 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: Beaver Valley Power Station Unit 1 and Unit 2

Docket No.: 50-334 / 50-412

Location of Facility: Beaver County, Pennsylvania

Reporting Period: Calendar Year - 2021

Medium: Soil (page 1 of 2)

Soil Sampling is performed every five (5) years. Next sampling is 2025.

Unit of Measurement: (picoCuries / gram) Dry

Type and Total Number of Analysis Performed	Lower Limit of Detection LLD <sup>(a)</sup>	All Indicator Locations Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Locations with Highest Annual Mean		Control Location		Number of Nonroutine Reported Measurements <sup>(c)</sup>
			Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	
Gamma							
0							
K-40	NA						
Mn-54	NA						
Fe-59	NA						
Co-58	NA						
Co-60	NA						
Zn-65	NA						
Zr-95	NA						
Nb-95	NA						
Cs-134	NA						
Cs-137	NA						
Ba-1.a-140	NA						

SECTION 2 - ENVIRONMENTAL MONITORING PROGRAM

Table 2-2 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: Beaver Valley Power Station Unit 1 and Unit 2

Docket No.: 50-334 / 50-412

Location of Facility: Beaver County, Pennsylvania

Reporting Period: Calendar Year - 2021

Medium: Soil (page 2 of 2)

Soil Sampling is performed every five (5) years. Next sampling is 2025.

Unit of Measurement: (picoCuries / gram) Dry

Type and Total Number of Analysis Performed	Lower Limit of Detection LLD <sup>(a)</sup>	All Indicator Locations Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Locations with Highest Annual Mean		Control Location		Number of Nonroutine Reported Measurements <sup>(c)</sup>
			Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	
TI-208	NA						
Bi-214	NA						
Pb-212	NA						
Pb-214	NA						
Ra-226	NA						
Ac-228	NA						

<sup>a</sup> Nominal Lower Limit of Detection

<sup>b</sup> Mean and range based upon detectable measurements only.  
 Fraction of detectable measurements at specified locations is indicated in parentheses (fraction)

<sup>c</sup> Nonroutine Reported Measurements (Reference: ODCM procedure 1/2-ODC-3.03, Attachment Q, Control 3.12.1)

NA = Not Applicable (Naturally Occurring Radionuclides Not required by ODCM)

SECTION 2 - ENVIRONMENTAL MONITORING PROGRAM

Table 2-2 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: Beaver Valley Power Station Unit 1 and Unit 2

Docket No.: 50-334 / 50-412

Location of Facility: Beaver County, Pennsylvania

Reporting Period: Calendar Year - 2021

Medium: Milk

Unit of Measurement: (picoCuries / liter)

Type and Total Number of Analysis Performed	Lower Limit of Detection LLD <sup>(a)</sup>	All Indicator Locations Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Locations with Highest Annual Mean		Control Location		Number of Nonroutine Reported Measurements <sup>(c)</sup>
			Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	
I-131 54	< 0.5	LLD ( 0 / 34 )		LLD ( 0 / 34 )		LLD ( 0 / 20 )	0
Sr-89 54	< 2.0	LLD ( 1 / 34 )	No. 114 Covert Residence Hookstown, PA 1.9 miles SW	0.60 ( 1 / 14 ) 0.60 - 0.60		LLD ( 0 / 20 )	0
Sr-90 54	< 0.7	0.8 ( 16 / 34 ) 0.5 - 1.4	No. 114 Covert Residence Hookstown, PA 1.9 miles SW	0.9 ( 14 / 14 ) 0.6 - 1.4	No. 96 Windsheimer Farm Burgettstown, PA 10.48 miles SSW	0.7 ( 14 / 20 ) 0.6 - 0.9	0
Gamma 54							
K-40	< 150	1504 ( 34 / 34 ) 412 - 1903	No. 114 Covert Residence Hookstown, PA 1.9 miles SW	1604 ( 14 / 14 ) 412 - 1903	No. 96 Windsheimer Farm Burgettstown, PA 10.48 miles SSW	1366 ( 20 / 20 ) 1150 - 1667	0
Mn-54	< 5	LLD ( 0 / 34 )		LLD ( 0 / 34 )		LLD ( 0 / 20 )	0
Fe-59	< 10	LLD ( 0 / 34 )		LLD ( 0 / 34 )		LLD ( 0 / 20 )	0
Co-58	< 5	LLD ( 0 / 34 )		LLD ( 0 / 34 )		LLD ( 0 / 20 )	0
Co-60	< 5	LLD ( 0 / 34 )		LLD ( 0 / 34 )		LLD ( 0 / 20 )	0
Zn-65	< 10	LLD ( 0 / 34 )		LLD ( 0 / 34 )		LLD ( 0 / 20 )	0
Zr-Nb-95	< 5	LLD ( 0 / 34 )		LLD ( 0 / 34 )		LLD ( 0 / 20 )	0
Cs-134	< 5	LLD ( 0 / 34 )		LLD ( 0 / 34 )		LLD ( 0 / 20 )	0
Cs-137	< 5	LLD ( 0 / 34 )		LLD ( 0 / 34 )		LLD ( 0 / 20 )	0
Ba-La-140	< 10	LLD ( 0 / 34 )		LLD ( 0 / 34 )		LLD ( 0 / 20 )	0

<sup>a</sup> Nominal Lower Limit of Detection

<sup>b</sup> Mean and range based upon detectable measurements only.  
Fraction of detectable measurements at specified locations is indicated in parentheses (fraction)

<sup>c</sup> Nonroutine Reported Measurements (Reference: ODCM procedure 1/2-ODC-3.03, Attachment Q, Control 3.12.1)

NA = Not Applicable (Naturally Occurring Radionuclides Not required by ODCM)

SECTION 2 - ENVIRONMENTAL MONITORING PROGRAM

Table 2-2 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: Beaver Valley Power Station Unit 1 and Unit 2

Docket No.: 50-334 / 50-412

Location of Facility: Beaver County, Pennsylvania

Reporting Period: Calendar Year - 2021

Medium: Fish

Unit of Measurement: (picoCuries / gram) Wet

Type and Total Number of Analysis Performed	Lower Limit of Detection LLD <sup>(a)</sup>	All Indicator Locations Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Locations with Highest Annual Mean		Control Location		Number of Nonroutine Reported Measurements <sup>(c)</sup>
			Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	
Gamma 8			No. 2A BVPS Outfall Vicinity 0.31 miles WSW		No. 49A Industry, PA Upstream of Montgomery Dam 4.93 miles NE		
Mn-54	< 0.05	LLD ( 0 / 4 )		LLD ( 0 / 4 )		LLD ( 0 / 4 )	0
Fe-59	< 0.10	LLD ( 0 / 4 )		LLD ( 0 / 4 )		LLD ( 0 / 4 )	0
Co-58	< 0.05	LLD ( 0 / 4 )		LLD ( 0 / 4 )		LLD ( 0 / 4 )	0
Co-60	< 0.05	LLD ( 0 / 4 )		LLD ( 0 / 4 )		LLD ( 0 / 4 )	0
Zn-65	< 0.10	LLD ( 0 / 4 )		LLD ( 0 / 4 )		LLD ( 0 / 4 )	0
Zr-Nb-95	< 0.01	LLD ( 0 / 4 )		LLD ( 0 / 4 )		LLD ( 0 / 4 )	0
Cs-134	< 0.05	LLD ( 0 / 4 )		LLD ( 0 / 4 )		LLD ( 0 / 4 )	0
Cs-137	< 0.05	LLD ( 0 / 4 )		LLD ( 0 / 4 )		LLD ( 0 / 4 )	0
Ba-La-140	< 0.01	LLD ( 0 / 4 )		LLD ( 0 / 4 )		LLD ( 0 / 4 )	0

<sup>a</sup> Nominal Lower Limit of Detection

<sup>b</sup> Mean and range based upon detectable measurements only.  
Fraction of detectable measurements at specified locations is indicated in parentheses (fraction)

<sup>c</sup> Nonroutine Reported Measurements (Reference: ODCM procedure 1/2-ODC-3.03, Attachment Q, Control 3.12.1)

NA = Not Applicable (Naturally Occurring Radionuclides Not required by ODCM)

SECTION 2 - ENVIRONMENTAL MONITORING PROGRAM

Table 2-2 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: Beaver Valley Power Station Unit 1 and Unit 2

Docket No.: 50-334 / 50-412

Location of Facility: Beaver County, Pennsylvania

Reporting Period: Calendar Year - 2021

Medium: Feedstuff

Unit of Measurement: (picoCuries / gram) Wet

Type and Total Number of Analysis Performed	Lower Limit of Detection LLD <sup>(a)</sup>	All Indicator Locations Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Locations with Highest Annual Mean		Control Location		Number of Nonroutine Reported Measurements <sup>(c)</sup>
			Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	
Gamma 12							
Be-7	< 0.2	0.32 ( 7 / 12 ) 0.18 - 0.65	No. 27 Brunton Farm 3681 Ridge Road Aliquippa, PA 6.16 miles SE	0.32 ( 7 / 12 ) 0.18 - 0.65			0
K-40	< 0.15	8.60 ( 12 / 12 ) 6.00 - 17.62	No. 27 Brunton Farm 3681 Ridge Road Aliquippa, PA 6.16 miles SE	8.60 ( 12 / 12 ) 6.00 - 17.62			0
Mn-54	< 0.02	LLD ( 0 / 12 )		LLD ( 0 / 12 )			0
Fe-59	< 0.04	LLD ( 0 / 12 )		LLD ( 0 / 12 )			0
Co-58	< 0.02	LLD ( 0 / 12 )		LLD ( 0 / 12 )			0
Co-60	< 0.02	LLD ( 0 / 12 )		LLD ( 0 / 12 )			0
Zn-65	< 0.04	LLD ( 0 / 12 )		LLD ( 0 / 12 )			0
Zr-Nb-95	< 0.03	LLD ( 0 / 12 )		LLD ( 0 / 12 )			0
Ru-103	< 0.03	LLD ( 0 / 12 )		LLD ( 0 / 12 )			0
I-131	< 0.06	LLD ( 0 / 12 )		LLD ( 0 / 12 )			0
Cs-134	< 0.04	LLD ( 0 / 12 )		LLD ( 0 / 12 )			0
Cs-137	< 0.06	LLD ( 0 / 12 )		LLD ( 0 / 12 )			0
Ba-La-140	< 0.01	LLD ( 0 / 12 )		LLD ( 0 / 12 )			0

<sup>a</sup> Nominal Lower Limit of Detection

<sup>b</sup> Mean and range based upon detectable measurements only.  
Fraction of detectable measurements at specified locations is indicated in parentheses (fraction)

<sup>c</sup> Nonroutine Reported Measurements (Reference: ODCM procedure 1/2-ODC-3.03, Attachment Q, Control 3.12.1)

NA = Not Applicable (Naturally Occurring Radionuclides Not required by ODCM)



SECTION 2 - ENVIRONMENTAL MONITORING PROGRAM

Table 2-2 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: Beaver Valley Power Station Unit 1 and Unit 2

Docket No.: 50-334 / 50-412

Location of Facility: Beaver County, Pennsylvania

Reporting Period: Calendar Year - 2021

Medium: Foodcrops

Unit of Measurement: (picoCuries / gram) Wet

Type and Total Number of Analysis Performed	Lower Limit of Detection LLD <sup>(a)</sup>	All Indicator Locations Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Locations with Highest Annual Mean		Control Location		Number of Nonroutine Reported Measurements <sup>(c)</sup>
			Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	Name Distance and Direction	Mean (fraction) <sup>(b)</sup> Range <sup>(b)</sup>	
I-131 10	< 0.06	LLD ( 0 / 9 )		LLD ( 0 / 9 )	No. 48B Weirton, WV 16.52 miles SSW	LLD ( 0 / 1 )	0
Gamma 10							
K-40	NA	3.82 ( 9 / 9 ) 1.93 - 5.26	No. 15 Georgetown, PA 3.76 miles WNW	5.26 ( 1 / 1 ) 5.26 - 5.26	No. 48B Weirton, WV 16.52 miles SSW	2.61 ( 1 / 1 ) 2.61 - 2.61	0
Mn-54	NA	LLD ( 0 / 9 )		LLD ( 0 / 9 )		LLD ( 0 / 1 )	0
Fe-59	NA	LLD ( 0 / 9 )		LLD ( 0 / 9 )		LLD ( 0 / 1 )	0
Co-58	NA	LLD ( 0 / 9 )		LLD ( 0 / 9 )		LLD ( 0 / 1 )	0
Co-60	NA	LLD ( 0 / 9 )		LLD ( 0 / 9 )		LLD ( 0 / 1 )	0
Zn-65	NA	LLD ( 0 / 9 )		LLD ( 0 / 9 )		LLD ( 0 / 1 )	0
Zr-Nb-95	NA	LLD ( 0 / 9 )		LLD ( 0 / 9 )		LLD ( 0 / 1 )	0
Cs-134	0.04	LLD ( 0 / 9 )		LLD ( 0 / 9 )		LLD ( 0 / 1 )	0
Cs-137	0.06	LLD ( 0 / 9 )		LLD ( 0 / 9 )		LLD ( 0 / 1 )	0
Ba-La-140	NA	LLD ( 0 / 9 )		LLD ( 0 / 9 )		LLD ( 0 / 1 )	0

<sup>a</sup> Nominal Lower Limit of Detection

<sup>b</sup> Mean and range based upon detectable measurements only.  
Fraction of detectable measurements at specified locations is indicated in parentheses (fraction)

<sup>c</sup> Nonroutine Reported Measurements (Reference: ODCM procedure 1/2-ODC-3.03, Attachment Q, Control 3.12.1)

NA = Not Applicable (Naturally Occurring Radionuclides Not required by ODCM)

SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

Table 2-3  
 Pre-Operational Environmental Radiological Monitoring Program Summary

Name of Facility: Beaver Valley Power Station Docket No.: 50-334  
 Location of Facility: Beaver County, Pennsylvania Reporting Period: Calendar years 1974 - 1975

Medium or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean, Fraction (c), Range
Sediments (dry) [picocurie /gram]	Gross Alpha (0)	--	--
	Gross Beta (33)	1	18 (33/33) 5 - 30
	Sr-90 (0)	--	--
	U-234, 235, 238 (0)	--	--
	Gamma (33)	--	13 (33/33) 2 - 30
	K-40	1.5	13 (33/33) 2 - 30
	Cs-137	0.1	0.4 (21/33) 0.1 - 0.6
	Zr/Nb-95	0.05	0.8 (12/33) 0.2 - 3.2
	Ce-144	0.3	0.5 (3/33) 0.4 - 0.7
	Ru-106(a)	0.3	1.5 (3/33) 1.3 - 1.8
Others	--	< LLD	
Foodcrops (dry) [picocurie /gram]	Gamma (8)	--	--
	K-40	1	33 (8/8) 10 - 53
	Cs-137	0.1	0.2 (1/8) --
	Zr/Nb-95	0.05	0.2 (1/8) --
	Ru-106(a)	0.3	0.8 (1/8) --
	Others	--	< LLD
Feedstuff (dry) [picocurie /gram]	Gross Beta (80)	0.05	19 (80/80) 8 - 50
	Sr-89 (81)	0.025	0.2 (33/81) 0.04 - 0.93
	Sr-90 (81)	0.005	0.4 (78/81) 0.02 - 0.81
	Gamma (81)	--	--
	K-40	1	19 (75/81) 5 - 46
	Cs-137	0.1	0.5 (6/81) 0.2 - 1.6
	Ce-144	0.3	1.5 (5/81) 0.9 - 2.6
	Zr/Nb-95	0.05	0.8 (13/81) 0.2 - 1.8
	Ru-106(a)	0.3	1.4 (12/81) 0.6 - 2.3
	Others	--	< LLD
Soil (dry) - Template Samples - [picocurie /gram]	Gross Alpha (0)	--	--
	Gross Beta (64)	1	22 (64/64) 14 - 32
	Sr-89 (64)	0.25	0.4 (1/64) --
	Sr-90 (64)	0.05	0.3 (48/64) 0.1 - 1.3
	U-234, 235, 238 (0)	--	--
	Gamma (64)	--	--
	K-40	1.5	13 (63/64) 5 - 24
	Cs-137	0.1	1.5 (56/64) 0.1 - 6.8
	Ce-144	0.3	1.1 (7/64) 0.2 - 3
	Zr/Nb-95	0.05	0.3 (13/64) 0.1 - 2
	Ru-106(a)	0.3	1.1 (3/64) 0.5 - 2
	Others	--	< LLD

SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

Table 2-3 (Continued)

Pre-Operational Environmental Radiological Monitoring Program Summary

Name of Facility: Beaver Valley Power Station Docket No.: 50-334

Location of Facility: Beaver County, Pennsylvania Reporting Period: Calendar years 1974 - 1975

Medium or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean, Fraction (c), Range
Soil (dry) - Core Samples - [picocurie /gram]	Gross Alpha (0)	--	--
	Gross Beta (8)	1	21 (8/8) 16 - 28
	Sr-89 (8)	0.25	< LLD
	Sr-90 (8)	0.05	0.2 (5/8) 0.08 - 0.5
	Gamma (8)	--	--
	K-40	1.5	13 (8/8) 7 - 20
	Cs-137	0.1	1.2 (7/8) 0.2 - 2.4
	Co-60	0.1	0.2 (1/8) --
	Others	--	< LLD
Surface Water [picocurie / liter]	Gross Alpha (40)	0.3	0.75 (5/40) 0.6 - 1.1
	Gross Beta (120)	0.6	4.4 (120/120) 2.5 - 11.4
	Gamma (1)	10 - 60	< LLD
	Tritium (121)	100	300 (120/121) 180 - 800
	Sr-89 (0)	--	--
	Sr-90 (0)	--	--
	C-14 (0)	--	--
Drinking Water [picocurie / liter]	I-131 (0)	--	--
	Gross Alpha (50)	0.3	0.6 (4/50) 0.4 - 0.8
	Gross Beta (208)	0.6	3.8 (208/208) 2.3 - 6.4
	Gamma (0)	--	--
	Tritium (211)	100	310 (211/211) 130 - 1000
	C-14 (0)	--	--
	Sr-89 (0)	--	--
Sr-90 (0)	--	--	
Ground Water [picocurie / liter]	Gross Alpha (19)	0.3	< LLD
	Gross Beta (76)	0.6	2.9 (73/75)(b) 1.3 - 8.0
	Tritium (81)	100	440 (77/81) 80 - 800
	Gamma (1)	10 - 60	< LLD
Air Particulates and Gaseous [picocurie /cubic meter]	Gross Alpha (188)	0.001	0.003 (35/188) 0.002 - 0.004
	Gross Beta (927)	0.006	0.07 (927/927) 0.02 - 0.32
	Sr-89 (0)	--	--
	Sr-90 (0)	--	--
	I-131 (816)	0.04	0.08 (2/816) 0.07 - 0.08
	Gamma (197)	--	--
	Zr/Nb-95	0.005	0.04 (122/197) 0.01 - 0.16
	Ru-106	0.010	0.04 (50/197) 0.02 - 0.09
	Ce-141	0.010	0.02 (3/197) 0.01 - 0.04
	Ce-144	0.010	0.02 (44/197) 0.01 - 0.04
Others	--	< LLD	

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Table 2-3 (Continued)

Pre-Operational Environmental Radiological Monitoring Program Summary

Name of Facility: Beaver Valley Power Station Docket No.: 50-334

Location of Facility: Beaver County, Pennsylvania Reporting Period: Calendar years 1974 - 1975

Medium or Pathway Sampled (Unit of Measurement)	Analysis and Total Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean, Fraction (c), Range
Milk [picocurie / liter]	I-131 (91)	0.25	0.6 (4/91) 0.3 - 0.8
	Sr-89 (134)	5	7 (4/134) 6 - 11
	Sr-90 (134)	1	5.3 (132/134) 1.5 - 12.8
	Gamma (134)	--	--
	Cs-137	10	13 (19/134) 11 - 16
	Others		< LLD
External Radiation [milliRoentgen / day]	γ - Monthly (599)	0.5 mR*	0.20 (599/599) 0.08 - 0.51
	γ - Quarterly (195)	0.5 mR*	0.20 (195/195) 0.11 - 0.38
	γ - Annual (48)	0.5 mR*	0.19 (48/48) 0.11 - 0.30
Fish (wet) [picocurie / gram]	Gross Beta (17)	0.01	1.9 (15/17) 1.0 - 3.2
	Sr-90 (17)	0.005	0.14 (17/17) 0.02 - 0.50
	Gamma (17)	0.5	
	K-40	--	2.4 (17/17) 1.0 - 3.7
	Others	--	< LLD
<p>* LLD in units of mR - Lower end of useful integrated exposure detectability range for a passive radiation detector (TLD).</p> <p>(a) May include Ru-106, Ru-103, Be-7.</p> <p>(b) One outlier not included in mean. (Water taken from dried-up spring with high sediment and potassium content. Not considered typical groundwater sample).</p> <p>(c) Fraction of detectable measurements at specified location, indicated in parentheses.</p>			

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### B. Air Monitoring

#### 1. Characterization of Air and Meteorology

The air near the site contains pollutants typical for an industrial area. Air flow is generally from the southwest in summer and from the northwest in the winter.

#### 2. Air Sampling Program and Analytical Techniques

##### a. Program

The air is sampled for gaseous radioiodine and radioactive particulates at each of eight (8) offsite air sampling stations. The locations of these stations are listed in Table 2-1 and shown on a map in Figure 2-1.

Samples are collected at each of these stations by continuously drawing two cubic feet per minute of atmosphere air through a glass fiber filter paper and a charcoal cartridge. The glass fiber filter paper is used for collection of airborne particulates, while the charcoal cartridge is used for collection of radioiodine. Samples are collected on a weekly basis.

The charcoal cartridge is used in the weekly analysis of airborne iodine-131. The glass fiber filter papers are analyzed each week for gross beta, then composited by the station each quarter for gamma spectrometry analysis. In order to reduce interference from short-lived naturally occurring radioactivity (e.g. radon and thorium), the glass fiber filter papers are allowed to decay prior to performing beta analysis in a low background counting system.

##### b. Procedures

Gross Beta Analysis of Filter Paper: Analysis is performed by placing the glass fiber filter paper from the weekly air sample in a 2-inch planchet followed by analysis in a low background, gas flow proportional counter.

Gamma Emitter Analysis of Filter Paper: Analysis is performed by stacking all of the glass fiber filter papers collected from each monitoring station during the quarter and scanning the composite on a high-resolution germanium gamma spectrometer.

## SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

Iodine-131 Analysis of Charcoal Cartridge: Analysis is performed by a gamma scan of each charcoal cartridge.

### 3. Results and Conclusions

A summary of data is presented in Table 2-2.

#### a. Airborne Radioactive Particulates

Gross Beta: A total of four hundred twenty-two (422) weekly samples from eight (8) locations were analyzed for gross beta. The results were comparable to that of previous years. Figure 2-2 indicates the weekly average concentration of gross beta in air particulates.

Gamma Spectrometry: A total of thirty-two (32) quarterly samples were composited from eight (8) locations and analyzed for gamma spectrometry. Naturally occurring beryllium-7 was identified in twenty-eight of twenty-eight (28 of 28) indicator samples, and four of four (4 of 4) control samples. No other gammas were identified. A summary of the analysis results during the report period are listed in Table 2-2. A trend graph of analyses (including the pre-operational period through the report period) is shown on Figure 2-2.

Deviations from Required Sampling and Analysis Schedule: There were seven deviations from the required airborne particulate sampling and analysis schedule during the report period.

The REMP Air Particulate and Iodine sampling station located in Midland (Midland North Sub Station, Site No. 32, Sector 15, 0.75 miles NW) was re-located along with the Pennsylvania Department of Environmental Protection's monitor per the request of the property owner, Duquesne Light Company. The relocation of the air monitor station was the result of the demolition of a Duquesne Light control house. The station was moved from the inside of the Midland Sub Station North to outside of the Midland Sub Station South, which is approximately ¼ of a mile from the original location. The shutdown for the relocation occurred on 01/21/21 at 09:53 whereas the service was returned on 01/21/2021 at 11:25 (down time of 1 hr 32 min). Energy Harbor's responsibilities included the setting of the pole, installation of foundation/conduit, meter base, weather head, relocation of air monitoring equipment on new foundation and electrical run to equipment/weather head from meter base. Duquesne Light was responsible for setting the transformer on another pole,

## SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

connection to primary source, installation of meter and electrical run from transformer to weather head. (New location has the coordinates: LAT: 40.627287, LONG: -80.443644).

During the sampling period of 02/21/2021 - 02/27/2021, REMP Air Particulate and Iodine sampling station located in Hookstown (Old Meyer Farm, Site No. 13, Sector 11, 1.49 miles SW) was found to be out of service. The cause was determined to be from shattered vanes in the rotary pump. The shattered vanes were replaced, and the station was returned to service on 03/01/2021 at 09:31. The sample station was out of service for approximately 83:04 hours, as reported by the REMP technician. (Date and time of malfunction was 02/26/2021 at 07:05 as conveyed from the calculated volume.)

During the sampling period of 03/21/2021 - 03/27/2021, REMP Air Particulate and Iodine sampling station located in Midland South Sub Station (Site No. 32B, Sector 15) was found to be out of service. The cause was determined to be from shattered vanes in the rotary pump. The shattered vanes were replaced, and the station was returned to service on 03/22/2021 at 09:32. The sample station was out of service for approximately 10 hours, 45 minutes, as reported by the REMP technician. (Date and time of malfunction was 03/21/2021 at 22:47 as conveyed from the calculated volume.)

During the sampling period of 07/18/21 - 07/24/21, REMP Air Particulate and Iodine sampling station at Brunton's Dairy in Aliquippa (Site No. 27, 6.16 miles SE) was found to be out of service due to severe thunderstorms from the prior week. The problem was quickly determined to be that the "Reset" button on the Totalizer had popped to prevent a surge overload. The button was reset, the filters changed, and the station was returned to service on 07/19/21. The sample station was out of service for approximately 139 hours as reported by the REMP technician. (Date and time of malfunction was 07/13/2021 at 15:47 as conveyed from the calculated volume.)

During the sampling period of 07/18/21 - 07/24/21, REMP Air Particulate and Iodine sampling station located in Hookstown (Old Meyer Farm, Site No. 13, Sector 11, 1.49 miles SW) was found to be out of service due to severe thunderstorms from the prior week. The cause was determined to be from a blown fuse in the pump. After replacement of the fuse, the sample unit would still not restart satisfactorily. The pump, totalizer, and turbine were removed, and all of the components were cleaned and reassembled. A new filter was also added. The station was returned to service on 07/19/21 at 19:12. The sample station was out of service for approximately 141 hours

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as reported by the REMP technician. (Date and time of malfunction was 07/13/2021 at 15:26 as conveyed from the calculated volume.)

During the sampling period of 08/14/21 - 08/20/21, REMP Air Particulate and Iodine sampling station located in Shippingport (Cook's Ferry, Site No. 30, Sector 4, 0.5 miles ENE) was found to be out of service. The cause was determined to be from a shorted-out pump that burned the electrical box on the pump. The electrical box was replaced, and the station was returned to service on 08/19/21 at 10:25.

During the sampling period of 10/02/21 - 10/08/21, REMP Air Particulate and Iodine sampling station located in Shippingport (Cook's Ferry, Site No. 30, Sector 4, 0.5 miles ENE) was found to be out of service. The cause was determined to be from shattered vanes in the rotary pump. The shattered vanes were replaced, and the station was returned to service on 10/04/21 at 08:54. The sample station was out of service for approximately 95 hours 56 minutes, as reported by the REMP technician. (Date and time of malfunction was 09/30/2021 at 13:53 as conveyed from the calculated volume.)

Summary: Based on the analytical results, the operation of BVPS did not contribute any measurable increase in air particulate radioactivity during the report period.

### b. Airborne Radioiodine

Iodine-131: A total of four hundred twenty-four (424) weekly charcoal filter samples were analyzed for iodine-131. Iodine-131 was not identified in any of the three hundred seventy-one (371) indicator samples, nor was it identified in any of the fifty-three (53) control samples.

Deviations from Required Sampling and Analysis Schedule: The deviations are the same as described above for airborne particulates.

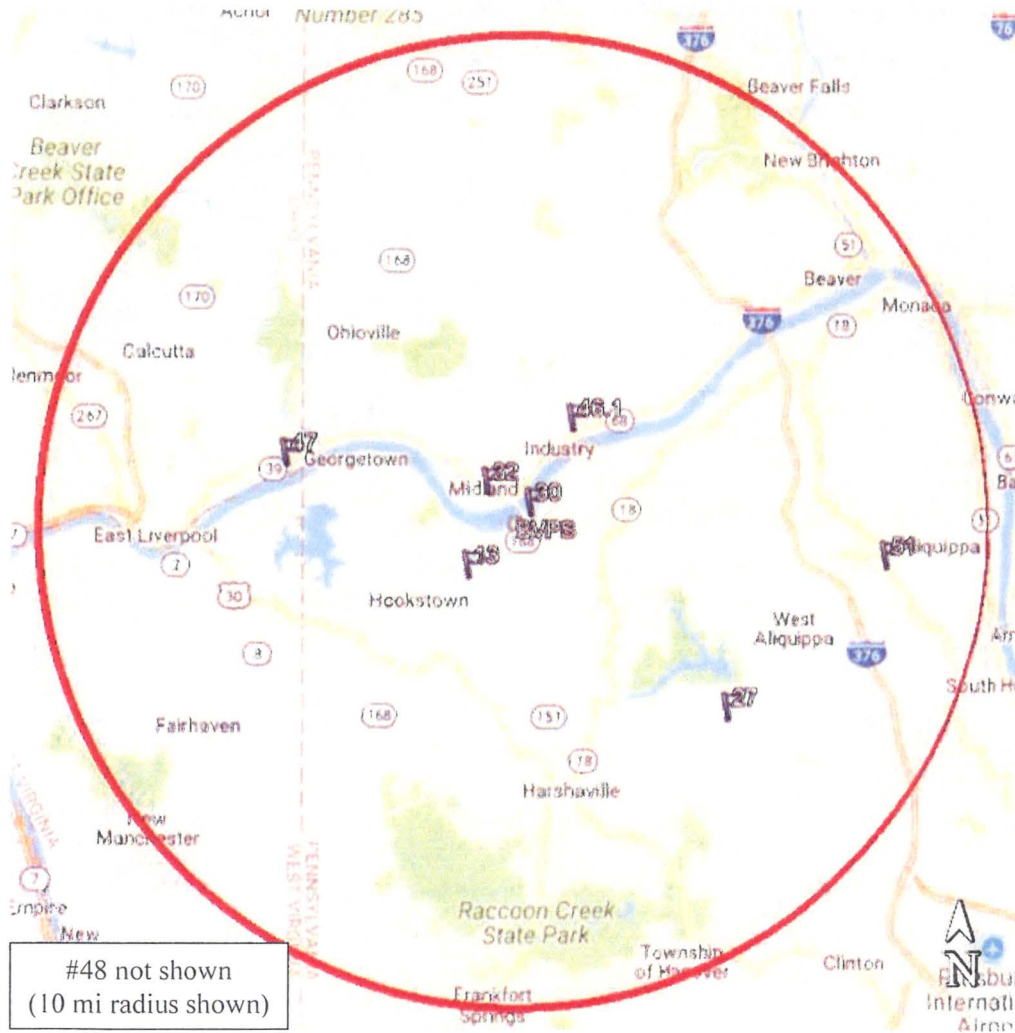
Summary: Based on analytical results, the operation of BVPS did not contribute any measurable increase in airborne radioiodine during the report period.



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Figure 2-1

Environmental Monitoring Locations - Air Sampling Stations



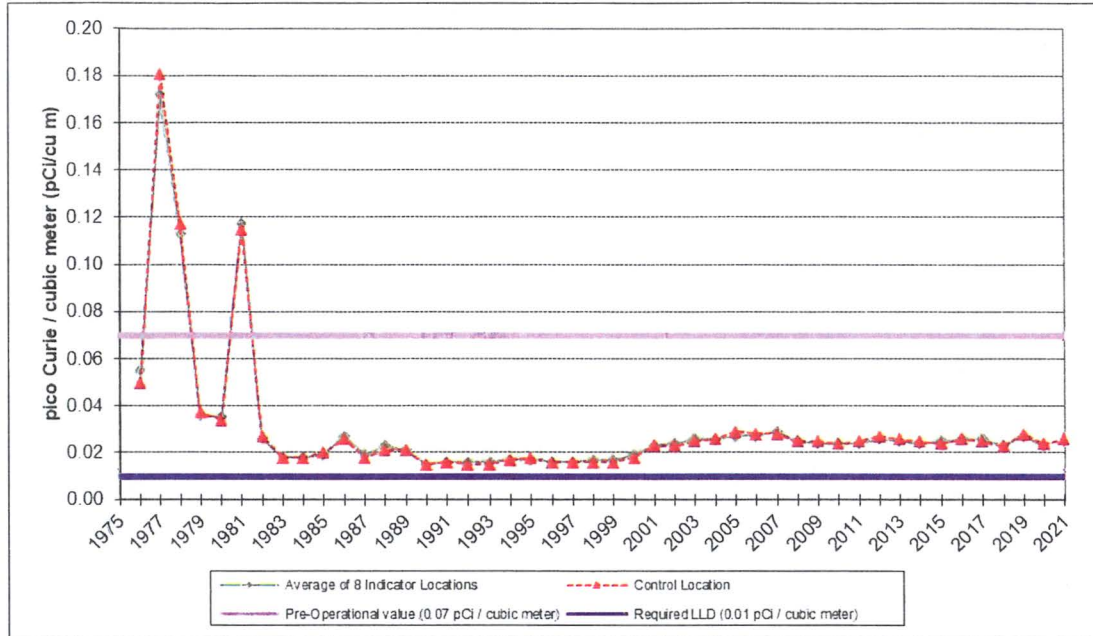
#48 not shown  
 (10 mi radius shown)

Sample Type	Site No.	Sector	Distance (miles)	Sample Point Description
Air Particulate & Radioiodine	13	11-SW	1.49	Hookstown, PA (Old Meyer Farm)
	27	7-SE	6.14	Aliquippa, Pa (Brunton Farm)
	30	4-ENE	0.43	Shippingport, PA (Cook's Ferry Substation)
	32B	15-NW	0.50	Midland, PA (South Substation - Rt. 68)
	46.1	2-NNE/ 3-NE	2.28	Industry, PA (McKeels Service - Rt. 68)
	47	14-WNW	4.88	East Liverpool, OH ( Water Department)
	48	10-SSW	16.40	Weirton, WV ( Water Tower, Collier Way)
	51	5-E	8.00	Aliquippa, PA (Sheffield Substation)

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Figure 2-2

Graph of Annual Average Concentration: Gross Beta in Air Particulates



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### C. Environmental Radiation Monitoring

#### 1. Description of Regional Background Radiation and Sources

Historical information for regional background was obtained from Reuter-Stokes instruments that were previously located within a five (5) mile radius of the BVPS site. Data is no longer available from these instruments, but historical data indicated that the background exposure rates ranged from 6  $\mu\text{R/hr}$  to 12  $\mu\text{R/hr}$ .

The sources of background radiation are affected by the terrain in the vicinity of BVPS, whereas, the local hills (i.e. altitude variations of 300-400 feet) and densely wooded areas contribute to variations in background radiation. Other sources (e.g. radon) are affected by the geological features of the region, which are characterized by nearly flat-laying sedimentary beds of the Pennsylvania age. For information, the local sedimentary beds of limestone alternate with sandstone and shale with abundant interbedded coal layers. Pleistocene glacial deposits partially cover the older sedimentary deposits in the northwest. Most of the region is underlain by shale, sandstone, and some coal beds of the Conemaugh Formation. Outcrops of sandstone, shale, and limestone of the Allegheny Formation exist within the Ohio River Valley and along major tributary streams.

#### 2. Locations and Analytical Procedures

Ambient external radiation levels around the site were measured using TLDs.

During the report period, there were a total of sixty-five (65) environmental TLD locations. This is comprised of forty-four (44) offsite locations, along with twenty-one (21) fence perimeter locations. The offsite TLD locations are plotted on Figure 2-3, but the fence perimeter locations are not plotted due to the large scale of the figure.

The TLDs were annealed at the Contractor Central Laboratory shortly before placing the TLDs in their field locations. The radiation dose accumulated in-transit between the Central Laboratory, the field location, and the Central Laboratory was corrected by transit controls maintained in lead shields at both the Central Laboratory and the field office. All dosimeters were exposed in the field for a calendar quarter, in a specific holder that contains two (2) TLDs at each location.

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### 3. Results and Conclusions

A summary of the TLD results during the report period are listed in Table 2-2. A trend graph of analyses (including the pre-operational period through the report period) is shown on Figure 2-4.

TLD Analysis: During the report period, the average quarterly external exposure rate (as measured from TLD) was 17.5 mR at the sixty-five (65) indicator locations, and 18.9 mR at the control location. This external exposure rate is comparable to previous years. As expected, there was some variation in external exposure rate among locations and seasons.

Deviations from Required Sampling and Analysis Schedule: There were four (4) deviations from the required direct radiation monitoring schedule during the report period.

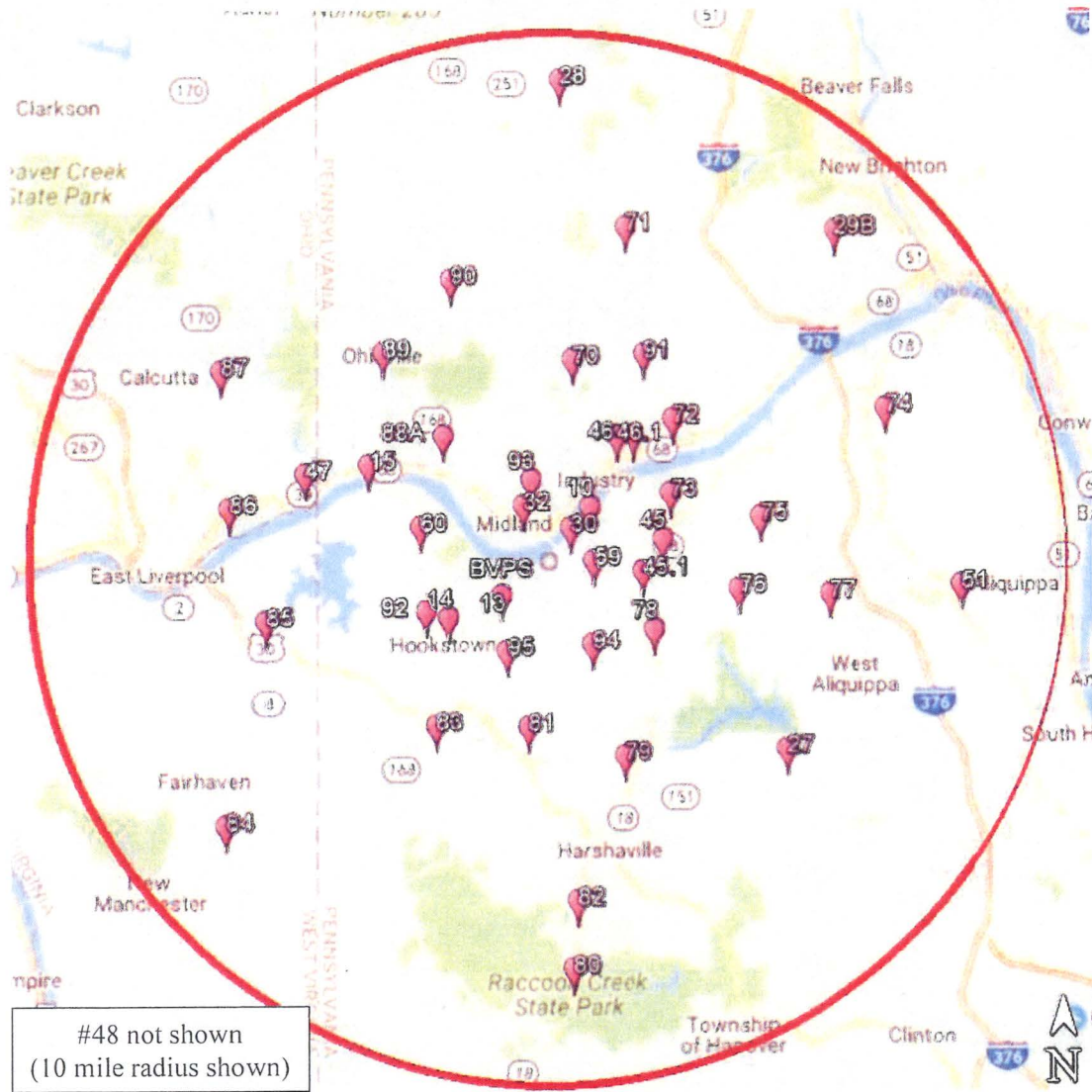
During the Third Quarter TLD changeout, BV-89-Q1 and BV-90-Q2 were discovered to be missing in the field, and direct radiation data for these locations had to rely on the single remaining TLDs. During the Fourth Quarter TLD changeout, BV-7-Q1/2, and BV-92-Q1/2 were discovered to be missing in the field, and no direct radiation data could be recovered for these locations.

Summary: The quarterly TLD external exposure rates are comparable to that of the previous decade. There was no evidence of anomalies that could be attributed to the operation of BVPS. It should also be noted that the average external exposure rate at the indicator locations was less than average external exposure rate at the control location. Based on all the analytical results and the comparison to pre-operational levels, the operation of BVPS did not contribute any measurable increase in external exposure in the vicinity of the site during the report period. The TLD exposure rates also confirm that changes from natural radiation levels, if any, are negligible.

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Figure 2-3

Environmental Monitoring Locations - TLDS



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Figure 2-3 (Continued)

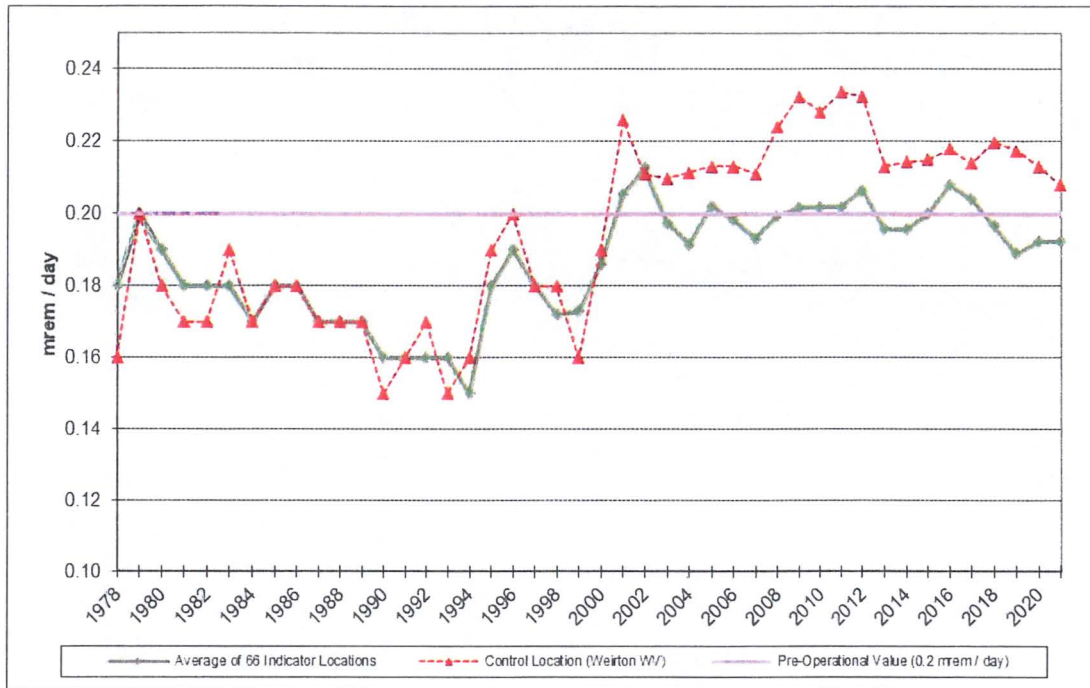
TLD Locations

NORTHEAST QUADRANT							
Site No.	Sector	Distance (miles)	Location	Site No.	Sector	Distance (miles)	Location
10	3-NE 4-ENE	0.94	Post Office Shippingport, PA	70	1-N	3.36	236 Engle Road Industry, PA
28	1-N	8.60	Sherman Farm Brighton Twp, PA	71	2-NNE	6.01	First Western Bank Brighton Township, PA
29B	3-NE	7.97	Friendship Ridge Beaver, PA	72	3-NE	3.25	Ohioview Lutheran Church – Rear Raccoon Twp, PA
30	4-ENE	0.43	Cook’s Ferry Substation Shippingport, PA	73	4-ENE	2.48	618 Squirrel Run Road Monaca, PA
45	5-E	2.19	Christian House Baptist Chapel, State Rte 18 Raccoon Township, PA	74	4-ENE	6.92	137 Poplar Avenue (CCBC) Monaca, PA
46	3-NE	2.49	Midway Drive Industry, PA	75	5-E	4.08	117 Holt Road Aliquippa, PA
46.1	2-NNE 3-NE	2.28	McKeel’s Service, State Route 68 Industry, PA	91	2-NNE	3.89	Pine Grove Road & Doyle Road Industry, PA
SOUTHEAST QUADRANT							
Site No.	Sector	Distance (miles)	Location	Site No.	Sector	Distance (miles)	Location
27	7-SE	6.14	Brunton Dairy Farm Aliquippa, PA	78	7-SE	2.72	Raccoon Twp Municipal Building Raccoon Township, PA
45.1	6-ESE	1.92	Kennedy’s Corners Raccoon Township, PA	79	8-SSE	4.46	106 State Route 151 Green Twp. Aliquippa, PA
51	5-E	8.00	Sheffield Substation Aliquippa, PA	80	9-S	8.27	Park Office, State Route 18 Raccoon Township, PA
59	6-ESE	0.99	236 Green Hill Road Aliquippa, PA	82	9-S	6.99	2697 State Route 18 Raccoon Twp, PA
76	6-ESE	3.80	Raccoon Elementary School Raccoon Township, PA	94	8-SSE	2.25	McCleary & Pole Cat Hollow Road Hookstown, PA
77	6-ESE	5.52	3614 Green Garden Road Aliquippa, PA				
SOUTHWEST QUADRANT							
Site No.	Sector	Distance (miles)	Location	Site No.	Sector	Distance (miles)	Location
13	11-SW	1.49	Old Meyer Farm Hookstown, PA	84	11-SW	8.35	Senior Center Hancock County, WV
14	11-SW	2.53	Hookstown, PA	85	12- WSW	5.73	2048 State Route 30 West Chester, WV
48	10-SSW	16.40	Collier Way Water Tower Weirton, WV	92	12- WSW	2.81	Georgetown Road Substation Georgetown, PA
81	9-S	3.69	Millcreek United Presbyterian Church Hookstown, PA	95	10-SSW	2.37	832 McCleary Road Hookstown, PA
83	10-SSW	4.26	735 Mill Creek Road, Hookstown, PA				
NORTHWEST QUADRANT							
Site No.	Sector	Distance (miles)	Location	Site No.	Sector	Distance (miles)	Location
15	14-WNW	3.75	Post Office Georgetown, PA	87	14- WNW	7.04	50103 Calcutta Smith Ferry Road Calcutta, OH
32	15-NW	0.75	North Substation Midland, PA	88A	15-NW	2.8	Route 168 Midland Heights PA
47	14-WNW	4.88	Water Department East Liverpool, OH	89	15-NW	4.72	488 Smith’s Ferry Road Ohioville, PA
60	13-W	2.51	444 Hill Road Georgetown, PA	90	16-NNW	5.20	6286 Tuscarawas Road Midland, PA
86	13-W	6.18	1090 Ohio Avenue East Liverpool, OH	93	16-NNW	1.10	104 Linden - Sunrise Hills Midland, PA

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Figure 2-4

Graph of Annual Average Exposure: Direct Radiation in Environment



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### D. Monitoring of Surface Water, Drinking Water, Groundwater, and Precipitation

#### 1. Description of Water Sources

The Ohio River is the main body of water in the area and is the main surface water supply for drinking water in the area. The Beaver Valley Power Station obtains water from the Ohio River for plant make-up water and discharges water to the Ohio River via National Pollutant Discharge Elimination System (NPDES) discharge points (e.g. cooling tower blowdown, liquid effluent releases, etc.).

The Ohio River is the main surface water supply source for towns, municipalities, and industries both upstream and downstream of the BVPS site. The nearest user of the Ohio River as a potable water source is Midland Borough Municipal Water Authority. The intake of the treatment plant is approximately 1.5 miles downstream of the Midland Borough Municipal Water Authority and is located on the opposite side of the river. The next downstream user is East Liverpool, Ohio and is approximately 6 miles downstream. The heavy industries in Midland, as well as other users downstream, also use river water for cooling purposes.

Groundwater occurs in large volumes in the gravel terraces which lie along the river and diminishes considerably in the bedrock underlying the site. Normal well yields in the bedrock are less than ten (10) gallons per minute (gpm) with occasional wells yielding up to 60 gpm.

In general, the BVPS site experiences cool winters and moderately warm summers with ample annual precipitation evenly distributed throughout the year. The National Climate Data Center indicated the total annual precipitation during the report period for the Beaver Falls, PA area was 45.3 inches.

#### 2. Sampling and Analytical Techniques

##### a. Surface (Raw River) Water

The sampling program of river water included three (3) sampling points along the Ohio River for most of 2016. In December 2016, one of the locations closed in which the program now includes two (2) sampling points.

Furthermore, Site No. 2.1, Sector 14, Midland - ATI Allegheny Ludlum, the downstream sample, is no longer a viable sample location. ATI permanently closed



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the Midland facility in 2016. As of December 2016, surface water samples were no longer available. Site No. 5, Sector 14, East Liverpool Water Department was an additional downstream sample location in which grab samples were taken. The East Liverpool site was transitioned to a composite sample location thus replacing ATI Allegheny Ludlum.

Raw water samples were collected daily at the Water Treatment Plant in East Liverpool, OH, sample location 5, [River Mile 41.2], and then made into a weekly composite sample. Now the water sample is collected with a composite water sampler. The automatic sampler takes a 20-40 mL sample every 15 minutes and samples are collected on a weekly basis. The weekly samples are then combined for a monthly composite sample for each location. The monthly composite samples are analyzed for gamma emitters. In addition, a quarterly composite sample is prepared from the monthly composites for each sample point. Quarterly composites are analyzed for hydrogen-3 (tritium). One automatic river water sampler, located at the ATI-Allegheny Ludlum (formerly J&L Steel) river water intake, sample location 2.1, [River Mile 36.2], was transitioned to East Liverpool due to the closing of the facility.

A weekly grab sample is taken upstream of the Montgomery Dam, sample location 49 [River Mile 29.6]. This upstream sample at the Montgomery Dam is the control sample. The weekly grab samples upstream of the Montgomery Dam are analyzed for iodine-131. Weekly grab samples are then made into monthly composites and are analyzed for gamma emitters. Quarterly composites are prepared from each of the monthly composites. The quarterly composites are analyzed for tritium. Locations of each sample point are shown in Figure 2-5.

### b. Drinking Water (Public Supplies)

Drinking water (i.e. treated water) is collected at both the Water Treatment Plant in Midland, PA, sample location 4, and the Water Treatment Plant in East Liverpool, OH, sample location 5. An automatic sampler at each location collects 20-40 mL every 20 minutes, which is then combined for a weekly composite sample. The weekly composite sample from each location is analyzed for iodine-131. Monthly composites are prepared from the weekly samples and are analyzed by gamma spectrometry. In addition, a quarterly composite sample is prepared for each sample point from the monthly composites. Quarterly composites are analyzed for tritium.

A weekly grab sample is taken upstream of the Montgomery Dam, sample location 49A [River Mile 29.6]. This upstream sample at the Montgomery Dam is the control sample. The weekly grab samples upstream of the Montgomery Dam are analyzed for

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iodine-131. Weekly grab samples are then made into monthly composites and are analyzed by gamma spectrometry. Quarterly composites are prepared from each of the monthly composites. The quarterly composites are analyzed for tritium. Locations of each sample point are shown in Figure 2-5.

c. Groundwater

Since these samples are not required, they will no longer be collected as of 2017. For historical information, groundwater was collected semiannually by grab samples at locations within four (4) miles of the site, one (1) well in Hookstown, PA and one (1) well in Georgetown, PA. Each ground water sample was analyzed for tritium and is analyzed by gamma spectrometry.

d. Precipitation

Since these samples are not required, they will no longer be collected as of 2017. For historical information, precipitation was collected in Shippingport, PA, East Liverpool, OH, and Weirton, WV. Precipitation, when available, was collected each week and combined for quarterly composite samples from the weekly samples. The quarterly composites were analyzed for tritium and gamma emitters.

e. Procedures

Gamma Analysis of Drinking Water and Surface Water: The analysis is performed by placing one liter of the sample into a Marinelli container and analyzing on a high-resolution germanium gamma spectrometry system. Although not required by the ODCM, this analysis is also performed on groundwater and precipitation samples.

Tritium Analysis of Drinking Water and Surface Water: The tritium is determined in water samples by liquid scintillation analysis. Although not required by the ODCM, this analysis is also performed on surface water, groundwater and precipitation samples.

Iodine-131 Analysis of Drinking Water: The sample is chemically prepared and analyzed with a low-level beta counting system. Although not required by the ODCM, this analysis is also performed on surface water samples.

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### 3. Results and Conclusions

A summary of the analysis results of water samples (surface water, drinking water, ground water, and precipitation) during the report period are listed in Table 2-2. A trend graph of analyses (including the pre-operational period through the report period) is shown in Figures 2-6 through 2-9.

#### a. Surface Water

Tritium: A total of eight (8) surface water samples were analyzed for tritium during the report period. Tritium was not detected in the four (4) indicator samples nor the four (4) control samples.

Gamma Spectrometry: A total of twenty-four (24) surface water samples were analyzed by gamma spectrometry during the report period. Gamma emitting radionuclides were not detected in the twelve (12) indicator samples, nor were they detected in the twelve (12) control samples.

Iodine-131: Although not required by the ODCM, a total of twenty-six (26) surface water control samples were analyzed for iodine-131 using radiochemical methods during the report period. Iodine-131 was detected in four of twenty-six (4 of 26) weekly control samples, of which zero (0) analysis exceeded the reporting level of 2 picocurie / liter. The results were similar to previous years, (current annual range = LLD to 0.50 picocurie / liter). The positive results were detected at the control location, which is five (5) miles upstream (not influenced by BVPS operation). Identification of iodine-131 during the report period was most likely due to medical diagnostic and treatment procedures performed at upstream facilities.

#### b. Drinking Water

Tritium: A total of eight (8) drinking water samples were analyzed for tritium during the report period in which tritium was not detected.

Gamma Spectrometry: A total of twenty-four (24) drinking water samples were analyzed by gamma spectrometry during the report period. Gamma emitting radionuclides were not detected in any of the twenty-four (24) indicator samples.

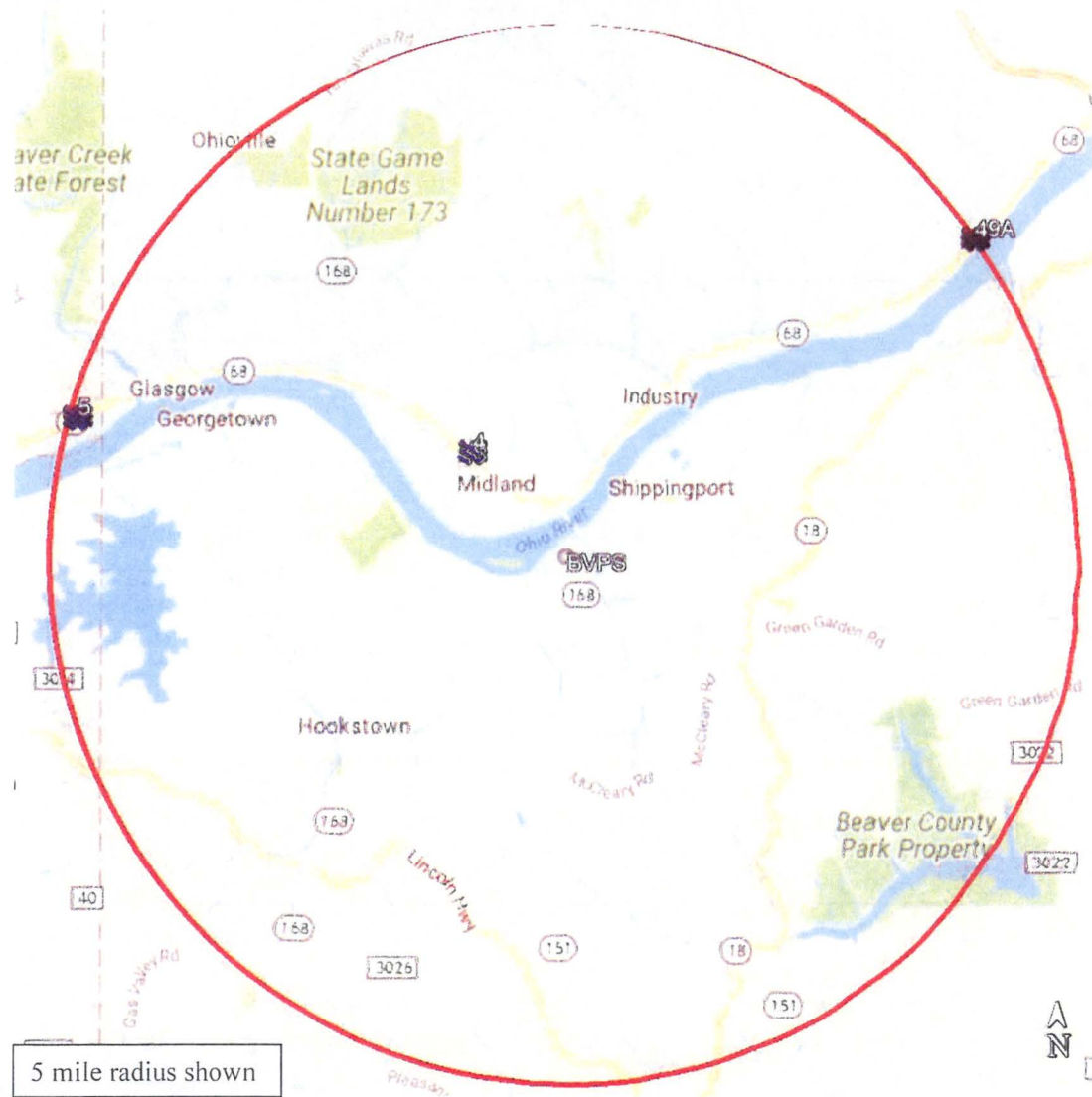
## SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

Iodine-131: A total of fifty-two (52) drinking water samples were analyzed for iodine-131 (using radiochemical methods) during the report period. Iodine-131 was detected in one of fifty-two (1 of 52) weekly indicator samples, of which zero (0) analysis exceeded the reporting level of 2 picocurie / liter. The results were similar to previous years, (current annual range = LLD to 0.30 picocurie / liter).

- c. Groundwater  
Since these samples are not required, they will no longer be collected as of 2017.
- d. Precipitation  
Since these samples are not required, they will no longer be collected as of 2017.
- e. Deviations from Required Sampling and Analysis Schedule: There were no deviations from the ODCM required water sampling and analysis schedule during the report.
- f. Summary: Data from the water sample analyses demonstrate that BVPS did not contribute a significant increase of radioactivity in the local river and drinking water. The analytical results confirm that the station assessments, prior to authorizing radioactive discharges, are adequate and that the environmental monitoring program is sufficiently sensitive.

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Figure 2-5  
 Environmental Monitoring Locations -  
 Surface Water and Drinking Water



5 mile radius shown

Sample Type	Site No.	Sector	Distance (miles)	Sample Point Description
Drinking Water	4	15-NW	1.26	Midland, PA (Water Department)
	5	14-WNW	4.90	East Liverpool, OH (Water Department)
Surface Water	5	14-WNW	4.90	East Liverpool, OH (Water Department)
	49A	3-NE	4.93	Industry, PA (Upstream Montgomery Dam)

SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

Figure 2-6

Graph of Annual Average Concentration: Iodine-131 in Surface Water & Drinking Water

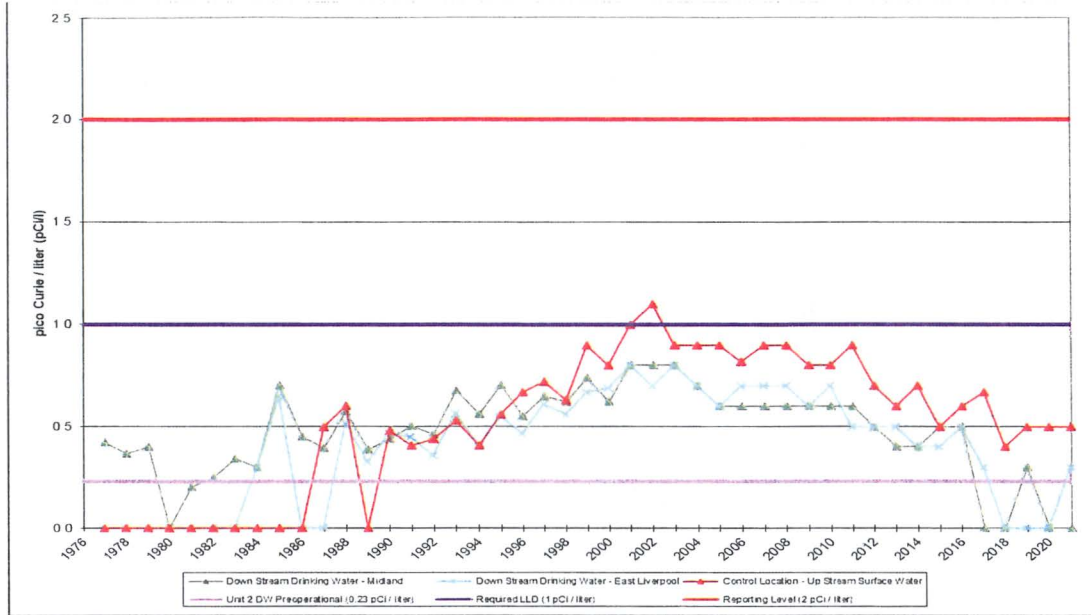
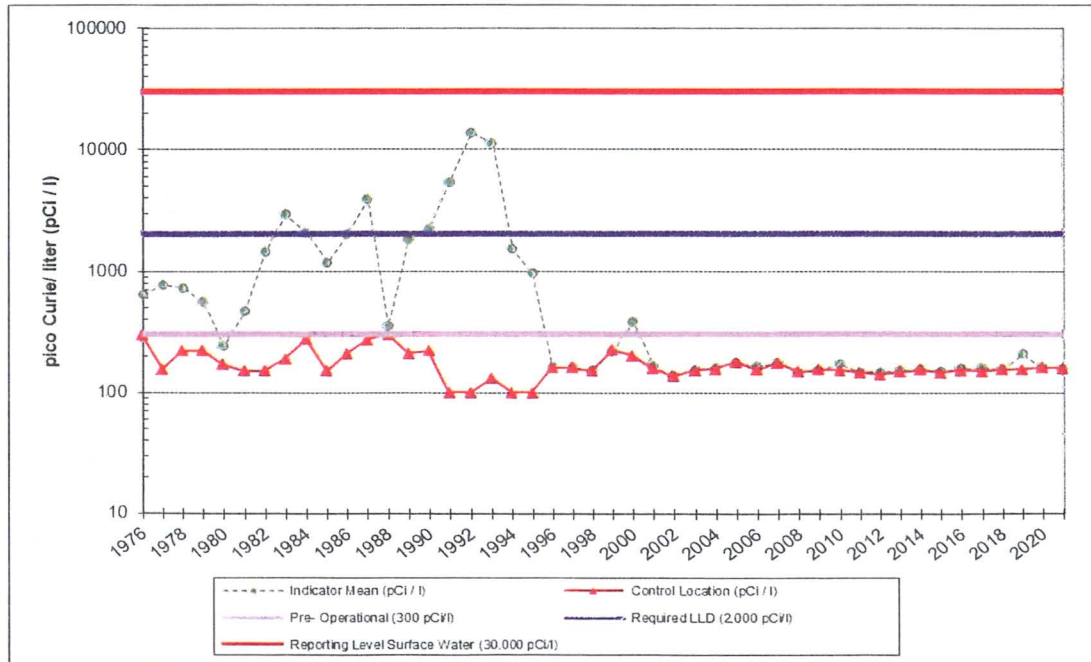


Figure 2-7

Graph of Annual Average Concentration: Tritium in Surface Water



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Figure 2-8

Graph of Annual Average Concentration: Tritium in Drinking Water

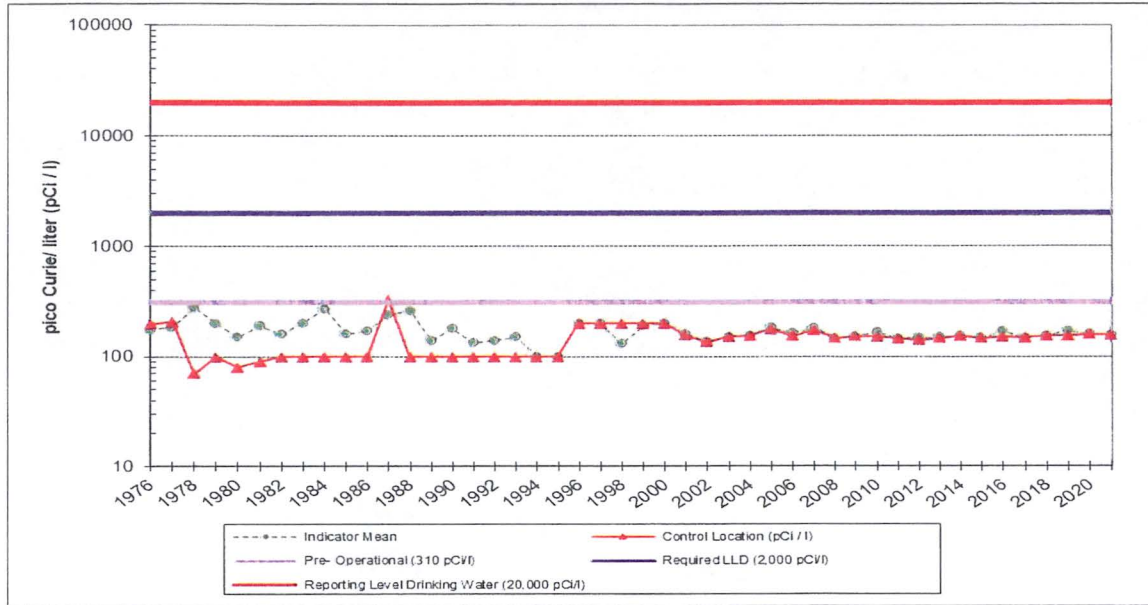
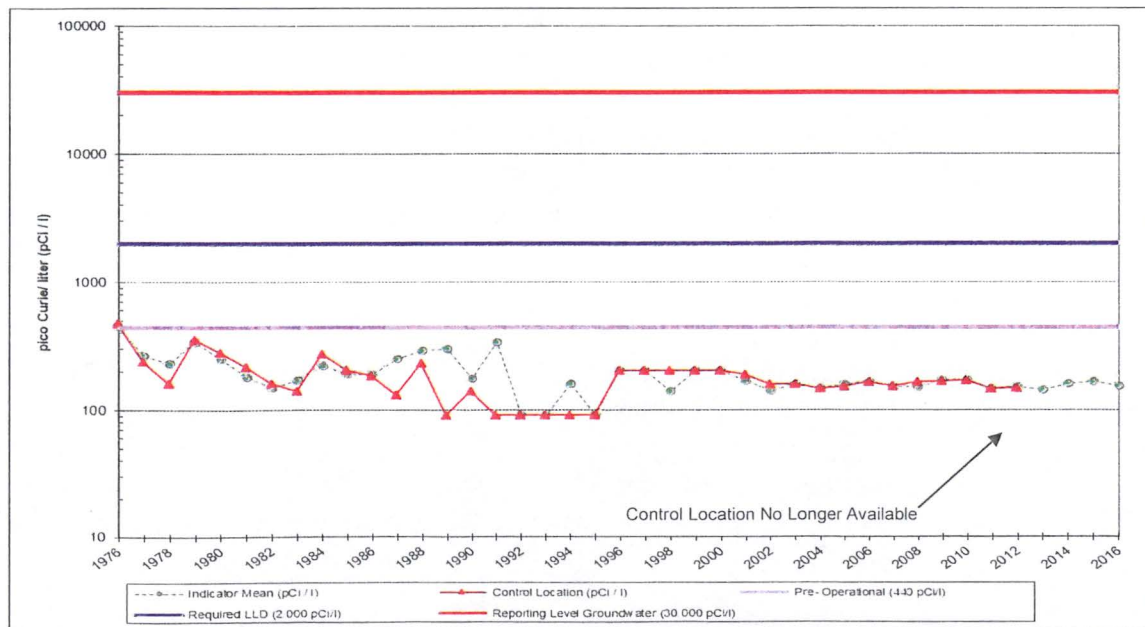


Figure 2-9

Graph of Annual Average Concentration: Tritium in Groundwater



## SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

### E. Monitoring of Shoreline Stream Sediment and Soil

#### 1. Characterization of Shoreline Stream Sediment and Soil

The stream sediment (river bottoms) consists largely of sand and silt. Soil samples may vary from sand and silt to a heavy clay with variable amounts of organic material.

#### 2. Sampling Program and Analytical Techniques

##### a. Program

Shoreline stream sediment was collected semi-annually above the Montgomery Dam, and near the BVPS outfall structure. A Ponar or Eckman dredge is used to collect the sample. The sampling locations are also listed in Table 2-1 and are shown in Figure 2-10.

Although not required by the ODCM, soil samples were collected at each of the nine (9) locations in 2015. In 2017, the locations were reduced from ten (10) to five (5), as well as the sample frequency was revised from once per three years to once every five years. Soil was last sampled in 2015 and was recently performed in 2020. At each location, twelve (12) core samples (3" diameter by 2" deep) are gathered at prescribed points on a 10-foot radius circle. Each location is permanently marked with reference pins. Each set of samples is systematically selected by moving along the radius in such a manner as to assure representative undisturbed samples. Sampling locations are listed in Table 2-1 and are shown in Figure 2-10.

Shoreline stream sediment and soil are analyzed for gamma-emitting radionuclides.

##### b. Analytical Procedures

Gamma Emitter Analysis of Stream Sediment: Analysis is performed in a 300 mL plastic bottle and analyzed by gamma spectrometry.

Gamma Emitter Analysis of Soil: Although not required by the ODCM, analysis is performed in a 300 mL plastic bottle and analyzed by gamma spectrometry.



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### 3. Results and Conclusions

A summary of the analysis results during the report period are listed in Table 2-2. A trend graph of analyses (including the pre-operational period through the report period) is shown on Figure 2-11 and Figure 2-12.

#### a. Shoreline Stream Sediment

Gamma Spectrometry: A total of four (4) sediment samples were analyzed by gamma spectrometry during the report period. Naturally occurring potassium-40, cesium-137, thallium-208, bismuth-214, lead-212, lead-214, radium-226 and actinium-228, were detected in two of two (2 of 2) indicator samples and two of two (2 of 2) control samples.

Cesium-137: Radionuclide cesium-137 was identified in two of two (2 of 2) indicator samples and zero of two (0 of 2) control samples. The results were comparable to that of previous years (current annual range = 0.05 to 0.10 picocurie / gram) and less than the pre-operational level of 0.4 picocurie / gram.

Cobalt-58: Radionuclide cobalt-58 was identified in one of two (1 of 2) indicator samples and zero of two (0 of 2) control samples. The samples, which indicated cobalt-58, were obtained at the shore line of the BVPS Main Outfall Facility. The results were comparable to previous years (current annual range = 0.08 to 0.08 picocurie / gram), and the data is less than than the BVPS Main Outfall Facility pre-operational level of 0.098 picocurie / gram.

Cobalt-60: Radionuclide cobalt-60 was identified in two of two (2 of 2) indicator samples and zero of two (0 of 2) control samples. The samples, which indicated cobalt-60, were obtained at the shore line of the BVPS Main Outfall Facility. The results were comparable to previous years (current annual range = 0.37 to 0.45 picocurie / gram), and the data is slightly higher than the BVPS Main Outfall Facility pre-operational level of 0.4 picocurie / gram.

Deviations from Required Sampling and Analysis Schedule: There were no deviations from the required sediment sampling and analysis schedule during the report period.

Summary: The identification of cobalt-58 and cobalt-60 in the shoreline stream sediment near the main outfall facility is not unusual because the plant discharges these radionuclides in liquid effluent releases. The analyses are consistent with

**SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM**

discharge data of authorized liquid effluent releases, and all liquid effluent releases during the report period did not exceed the release limits set forth in the ODCM.

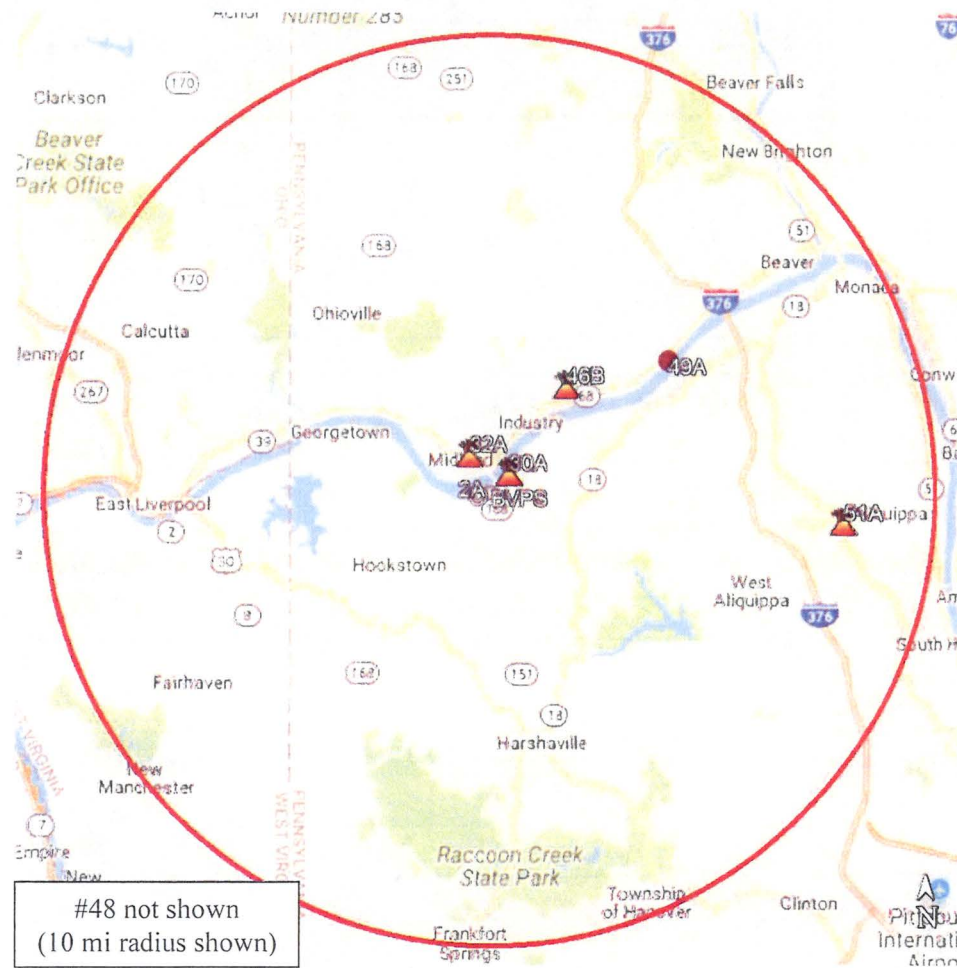
b. Soil

Soil sampling is not an ODCM requirement. Soil was last sampled in 2020 and will be performed in 2025.

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Figure 2-10

Environmental Monitoring Locations - Shoreline Sediments and Soil

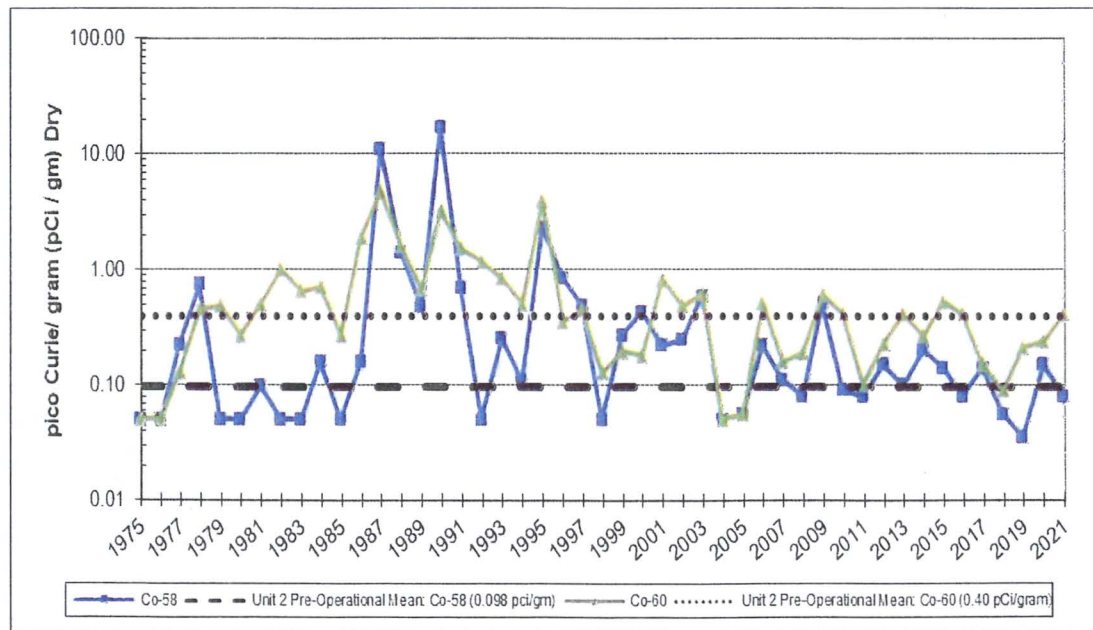
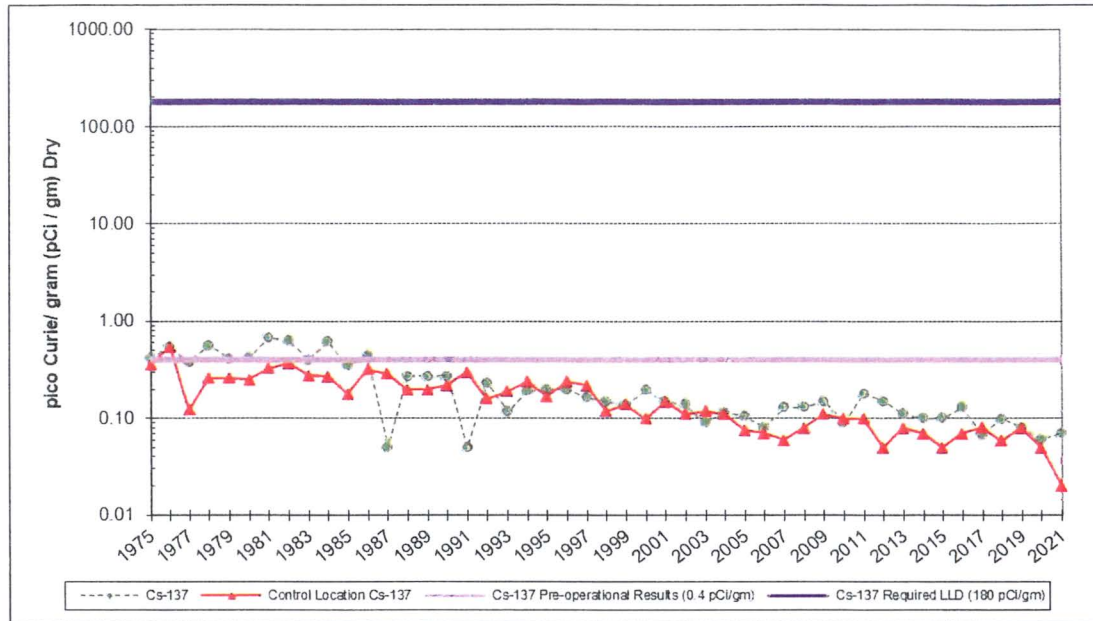


Sample Type	Site No.	Sector	Distance (miles)	Sample Point Description
Soil	30B	4-ENE	0.43	Shippingport, PA (Cooks Ferry Substation)
	32A	15-NW	0.74	Midland, PA (North Substation)
	46.1	3-NE	2.66	Industry, PA
	48	10-SSW	16.40	Weirton, WV (Collier Way Water Tower)
	51A	5-E	7.99	Aliquippa, PA (Sheffield Substation)
Sediment	2A	12-WSW	0.31	Shippingport, PA (BVPS Outfall Vicinity)
	49A	3-NE	4.93	Industry, PA (Upstream Montgomery Dam)

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Figure 2-11

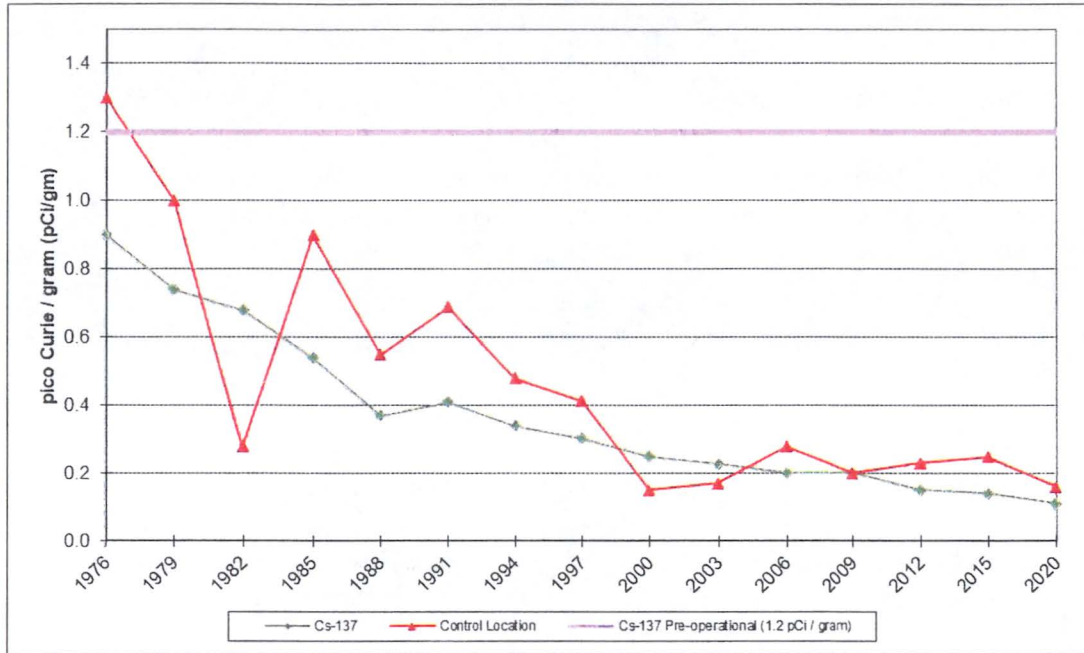
Graph of Annual Average Concentration: Cesium-137, Cobalt-58 & Cobalt-60 in Sediment



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Figure 2-12

Graph of Annual Average Concentration: Cesium-137 in Soil



## SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

### F. Monitoring of Local Cow and Goat Milk

#### 1. Description - Milch Animal Locations

Samples of fresh milk are obtained from milch animals at locations and frequencies noted in Table 2-1. The milk is analyzed for its radioiodine content, gamma emitters, strontium-89 and strontium-90.

Detailed field surveys are performed during the grazing season to locate and enumerate milch animals within a five (5) mile radius of the site. Survey data for the most recent survey conducted is shown in Section 3, Land Use Census.

#### 2. Sampling Program and Analytical Techniques

##### a. Program

Cow milk was collected from the one (1) reference dairy farm within a 10-mile radius of the BVPS, Brunton Dairy Farm (6.076 miles southeast) and one (1) control location dairy farm outside of the 10-mile radius, Windsheimer Dairy Farm (10.475 miles south-southwest).

Dairy cow sampling has been performed at Brunton Dairy since 2016, due to the closure of Halstead Dairy and Searight Dairy in 2014. Additionally, one goat location was available for sampling and samples were obtained at the Covert Residence (2.131 miles southwest).

The dairies are subject to change based upon availability of milk or when more recent data (milch animal census, and/or change in meteorological conditions) indicate other locations are more appropriate.

The milk samples are collected and analyzed biweekly when the animals are on pasture and monthly at other times. The monthly and/or biweekly sample is analyzed for principle gamma emitters (including cesium-137 by high resolution germanium gamma spectrometry), and iodine-131 high sensitivity analysis. Although not required by the ODCM, the monthly and/or biweekly sample is also analyzed for strontium-89, strontium-90.

The location of each is shown in Figure 2-8 and described below.

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Table 2-4

Local Cow and Goat Locations

Site	Dairy	Approximate Number of Animals being Milked	Distance and Direction from Midpoint between Unit 1 and Unit 2 Reactor	Collection Period
25*	Searight Dairy 948 McCleary Road Hookstown, PA	Dairy Closed end of 2013	2.107 miles SSW	January thru December
27	Brunton Dairy 3681 Ridge Road Aliquippa, PA	105 Cows	6.076 miles SE	January thru December
96	Windsheimer Dairy 20 Windsheimer Lane Burgettstown, PA	80 Cows	10.475 miles SSW	January thru December
113*	Halstead Dairy 104 Tellish Drive Hookstown, PA	Dairy Closed beginning of 2014	5.184 miles SSW	January thru December
114	Covert Residence 930 Pine Street (Route 168) Hookstown, PA	12 Goats	2.131 miles SW	January thru December

\* Highest potential pathway dairies based on evaluation of deposition parameters

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### b. Procedure

Iodine-131 Analysis of Milk: The milk samples are chemically prepared, and then analyzed with a low-level beta counting system.

Gamma Emitter Analysis of Milk: This is determined by gamma spectrometry analysis of a 1-liter Marinelli container of milk.

Strontium-90 Analysis of Milk: Although not required by the ODCM, the milk samples are prepared by adding a stable strontium carrier and evaporating to dryness, then ashing in a muffle furnace, followed by precipitating phosphates. Strontium is purified in all samples by the Argonne method using 3 grams of extraction material in a chromatographic column. Stable yttrium carrier is added, and the sample is allowed to stand for a minimum of 5 days for the in-growth of yttrium-90 (Y-90). Yttrium is then precipitated as hydroxide dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and is counted in a low-level beta counter to infer strontium-90 activity.

Strontium-89 Analysis of Milk: Although not required by the ODCM, the strontium-89 activity is determined by precipitating strontium carbonate ( $\text{SrCO}_3$ ) from the sample after yttrium separation. This precipitate is mounted on a nylon planchet and is covered with an  $80 \text{ mg/cm}^2$  aluminum absorber for low level beta counting. Chemical yields of strontium and yttrium are determined by gravimetric means.

### 3. Results and Conclusions

A summary of the analysis results during the report period are listed in Table 2-2. A trend graph of iodine-131 and strontium-90 analyses (including the pre-operational period through the report period) is shown on Figure 2-13.

- a. Strontium-89: Although not required by the ODCM, a total of fifty-four (54) milk samples were analyzed for strontium-89 during the report period. Strontium-89 was detected in one of the thirty-four (34) indicator samples.
- b. Strontium-90: Although not required by the ODCM, a total of fifty-four (54) milk samples were analyzed for strontium-90 during the report period. Strontium-90 was detected in sixteen of thirty-four (16 of 34) indicator samples and fourteen of twenty



## SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

(14 of 20) control samples. The levels detected were attributed to previous nuclear weapons tests and are within the expected range.

- c. Gamma Spectrometry: A total of fifty-four (54) milk samples were analyzed by gamma spectrometry during the report period. Naturally occurring potassium-40 was present in thirty-four of thirty-four (34 of 34) indicator samples and twenty of twenty (20 of 20) control samples. No other gamma-emitting radionuclides were identified during analysis.
- d. Iodine-131: A total of fifty-four (54) milk samples were analyzed for iodine-131 during the report period. Iodine-131 was not detected in any of the thirty-four (34) indicator samples, nor was it detected in of the twenty (20) control samples.
- e. Deviations from Required Sampling and Analysis: There was one deviation from the required milk sampling and analysis schedule occurred for the reporting period.

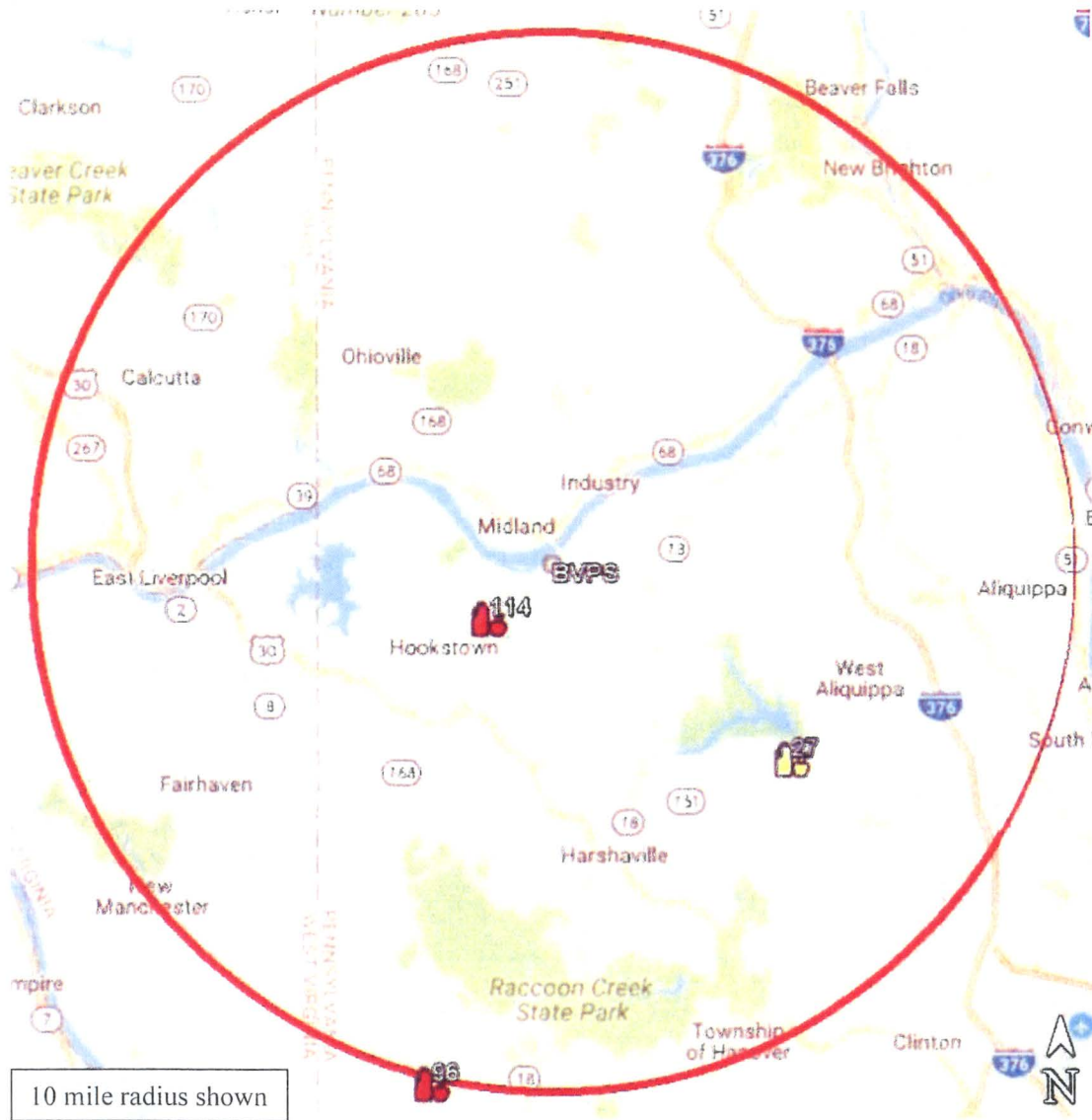
Sufficient milk samples were not available from locations within the 5-mile radius in 2021. The unavailability of milk caused the REMP to not meet the ODCM sample requirements in 1/2-ODC-2.03 and in 1/2-ODC-3.03, Attachment Q Table 3.12-1 stating that a minimum of four (4) milk locations shall be sampled. This initiated the ODCM requirement for sampling two (2) additional garden locations based upon the highest predicted annual average D/Q when milk locations are not available.

- f. Summary: Based on all the analytical results and the comparison to pre-operational levels, the operation of BVPS did not contribute any measurable increase in radioactivity in the milk during the report period compared to previous years.

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Figure 2-13

Environmental Monitoring Locations – Milk

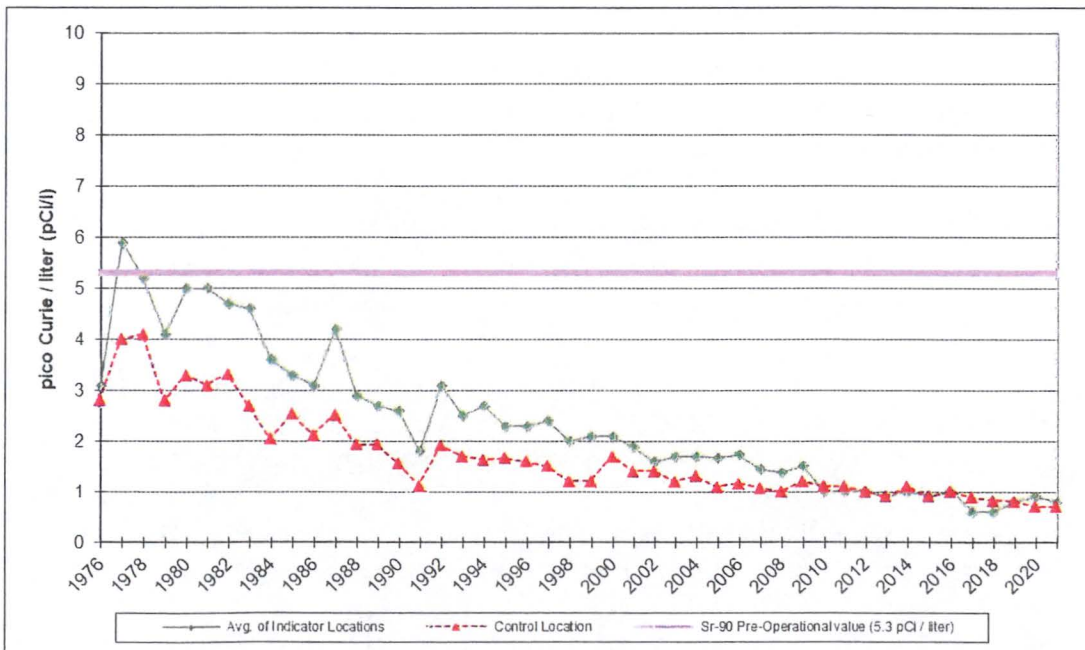
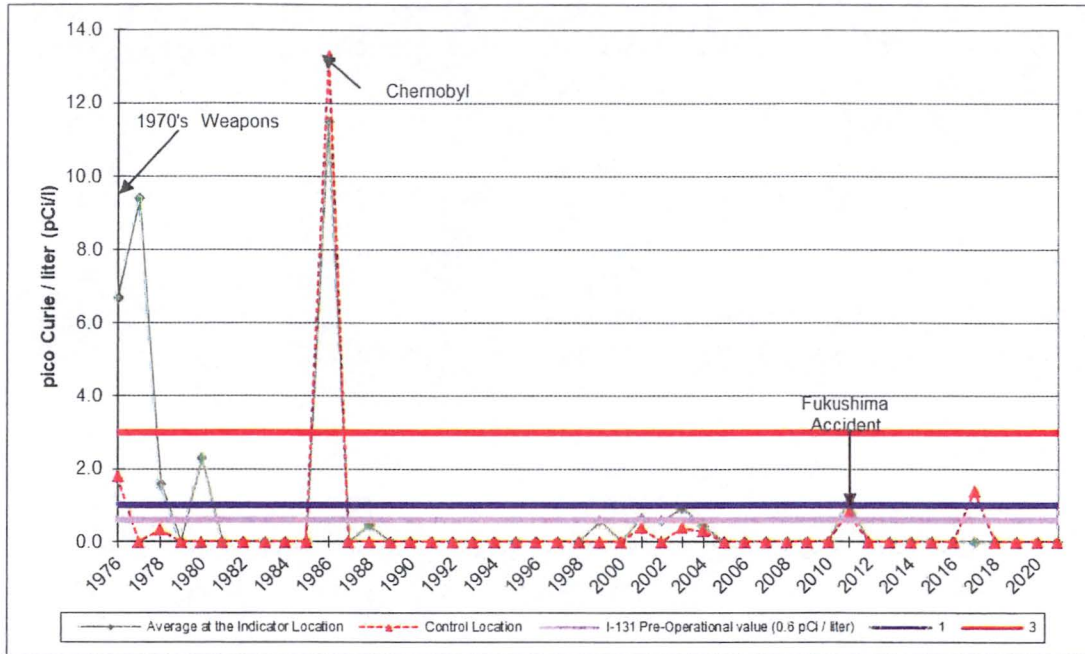


Sample Type	Site No.	Sector	Distance (miles)	Sample Point Description
Milk	27	7-SE	6.1	Aliquippa, PA (Brunton Farm)
	96	10-SSW	10.4	Burgettstown, PA (Windsheimer Farm)
	114	11-SW	1.9	Hookstown, PA (Covert Residence)

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Figure 2-14

Graph of Annual Average Concentration: Iodine-131 & Sr-90 in Milk



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### G. Monitoring of Fish

#### 1. Description

During the report period, fish species collected for the radiological monitoring program included channel catfish, brown catfish, and carp.

#### 2. Sampling Program and Analytical Techniques

##### a. Program

Fish samples are collected semi-annually in the New Cumberland pool of the Ohio River at the Beaver Valley effluent discharge point and upstream of the Montgomery Dam. The edible portion of each species caught is analyzed by gamma spectroscopy. Fish sampling locations are shown in Figure 2-15.

##### b. Procedure

A sample is prepared in a standard tare weight 300 mL plastic bottle and scanned for gamma emitting nuclides with gamma spectrometry system which utilizes a high-resolution germanium detector.

#### 3. Results and Conclusions

A summary of the analysis results during the report period are listed in Table 2-2. A trend graph of analyses (including the pre-operational period through the report period) is shown on Figure 2-16.

Gamma Spectrometry: A total of eight (8) fish samples were analyzed by gamma spectrometry during the report period. Gamma emitting radionuclides were not detected in any of the four (4) indicator samples, nor were they detected in any of the four (4) control samples.

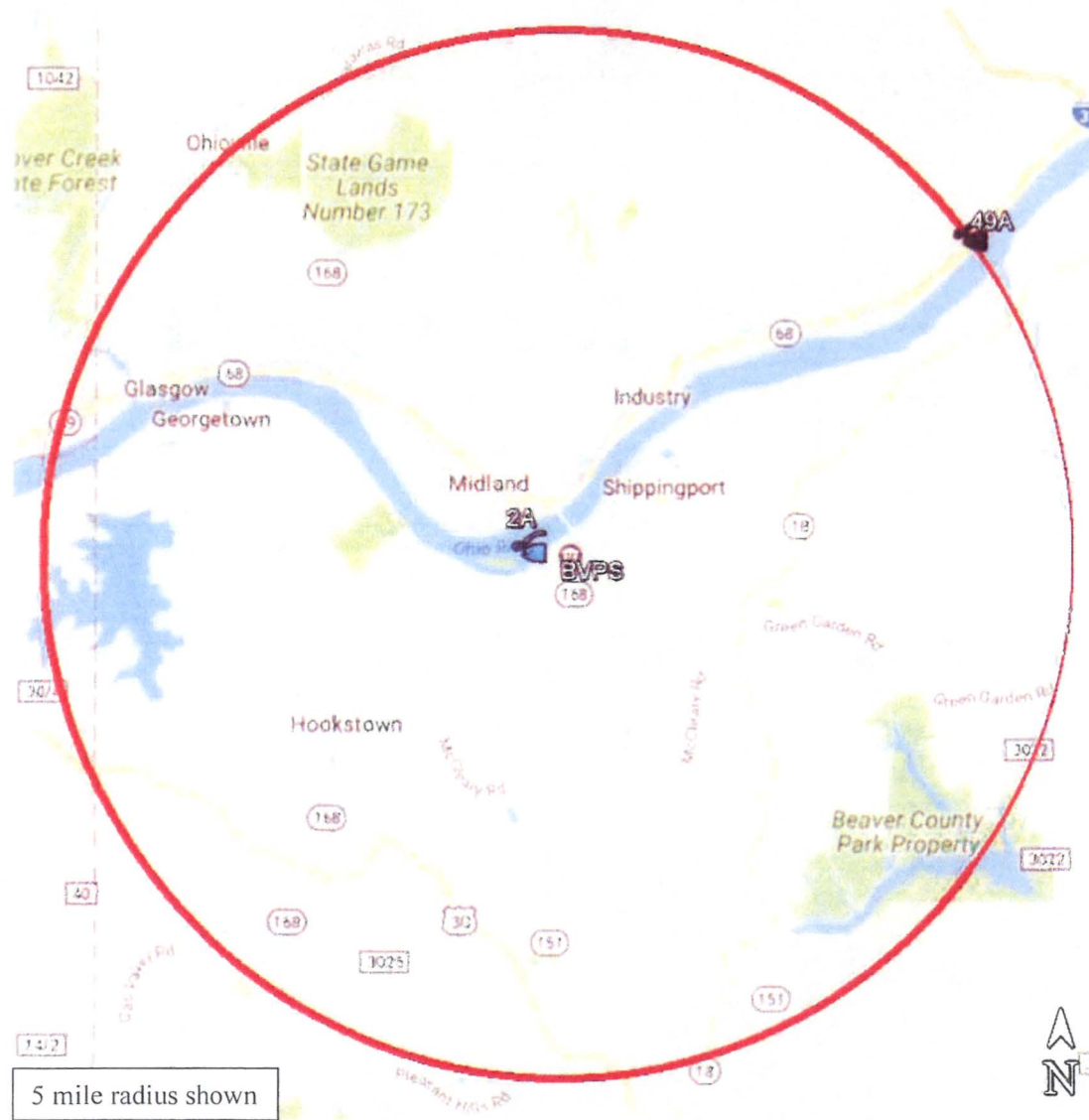
Deviations from Required Sampling and Analysis Schedule: There were no deviations from the required fish sampling and analysis schedule during the report period.

Summary: Based on the analytical results, the operation of BVPS did not contribute any measurable increase in radioactivity in the Ohio River fish population during the report period.

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Figure 2-15

Environmental Monitoring Locations - Fish



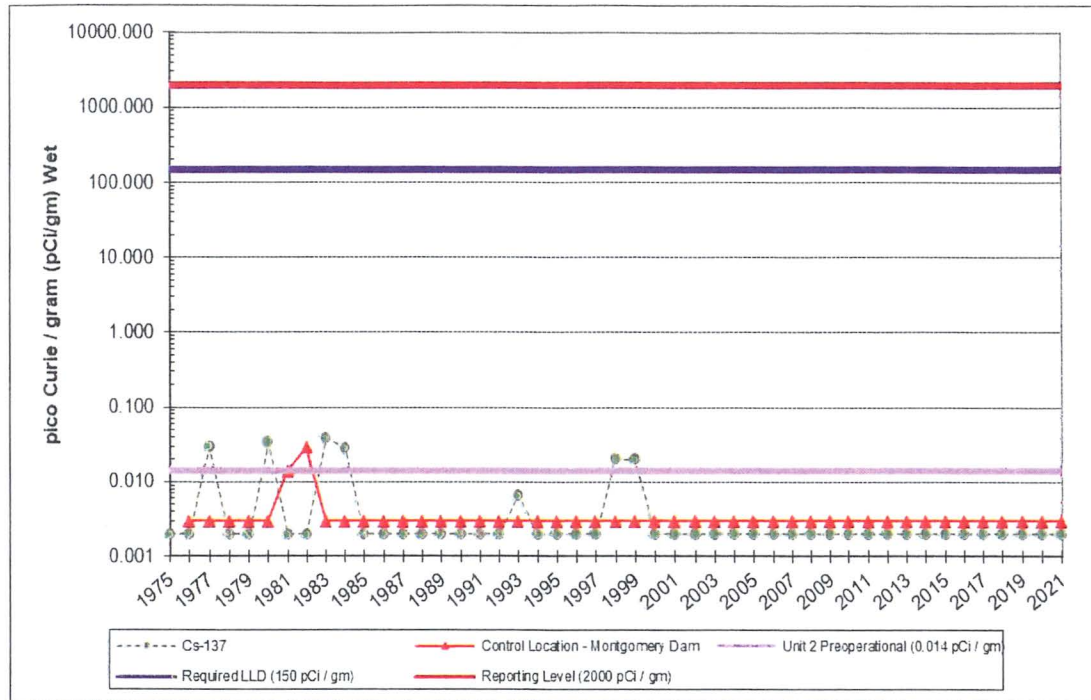
5 mile radius shown

Sample Type	Site No.	Sector	Distance (miles)	Sample Point Description
Fish	2A	12-WSW	0.31	BVPS Outfall Vicinity
	49A	3-NE	4.93	Industry, PA (Upstream Montgomery Dam)

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Figure 2-16

Graph of Annual Average Concentration: Cesium-137 in Fish



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H. Monitoring of Feedstuff and Foodcrops

1. Characterization of Farm Products

According to the 2017 Census of Agriculture <sup>(1)</sup>, there were six hundred and thirteen (613) farms in Beaver County. Total market value of production was \$23,653,000.00 and of the total market value, \$14,486,000.00 from crops and \$9,167,000.00 from livestock. Some of the principal sources of revenue (>\$25,000.00) are as follows:

Milk and Other Dairy Products from Cows	\$5,597,000.00
Other Crops and Hay	\$4,849,000.00
Nursery, Greenhouse, Floriculture and Sod	\$4,127,000.00
Grains, Oil Seeds, Dry Beans and Dry Peas	\$2,799,000.00
Cattle and Calves	\$1,859,000.00
Vegetables, Melons, Potatoes and Sweet Potatoes	\$1,507,000.00
Cut Christmas Trees, and Short Rotation Woody Crops	\$739,000.00
Fruits, Tree Nuts and Berries	\$466,000.00
Sheep, Goats and their Products	\$95,000.00
Other Animals and Other Animal Products	\$86,000.00
Horses, Ponies, Mules, Burros, and Donkeys	\$61,000.00
Poultry and Eggs	Undisclosed Amount
Hogs & Pigs	Undisclosed Amount

(1) [https://www.nass.usda.gov/Publications/AgCensus/2017/Online\\_Resources/County\\_Profiles/Pennsylvania/index.php](https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/Pennsylvania/index.php)

## SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

### 2. Sampling Program and Analytical Techniques

#### a. Program

Feedstuff: Although not required by the ODCM, representative samples of feedstuff (cattle feed) are collected monthly from the nearest dairy farm (Brunton Dairy) and analyzed by gamma spectrometry. See Figure 2-17.

Foodcrops (leafy vegetables): Foodcrops are collected at garden locations during the growing season. Leafy vegetables (e.g. cabbage) are obtained from Shippingport, Raccoon, Georgetown, and Industry, Pennsylvania. Samples are obtained from two (2) additional locations based upon the highest predicted annual average ground D/Q when milk locations are unavailable. Samples are also obtained from the control location in Weirton, West Virginia. All samples are analyzed for gamma emitters by gamma spectrometry. Samples are also analyzed by radiochemical analysis for iodine-131.

#### b. Procedures

Gamma Emitter Analysis of Foodcrops: Analysis is performed by scanning a dried, homogenized sample with a gamma spectrometry system. A high-resolution germanium detector is utilized with this system. Samples of feedstuff and foodcrops are loaded into tare weight 150 or 300 mL plastic bottles or 1-liter Marinelli containers, weighed and the net weight of the sample is determined prior to scanning for gamma emitters.

Gamma Emitter Analysis of Feedstuff: Although not required by the ODCM, analysis is performed by scanning a dried, homogenized sample with a gamma spectrometry system. A high-resolution germanium detector is utilized with this system. Samples of feedstuff and foodcrops are loaded into tare weight 150 or 300 mL plastic bottles or 1-liter Marinelli containers, weighed and the net weight of the sample is determined prior to scanning for gamma emitters.

Iodine-131 Analysis of Foodcrops: Analysis is performed by radiochemistry. A stable iodide carrier is added to a chopped sample, which is then leached with a sodium hydroxide solution, evaporated to dryness and fused in a muffle furnace. The melt is dissolved in water, filtered and then treated with sodium hypochlorite. The iodate is then reduced to iodine with hydroxylamine hydrochloride and is extracted with toluene. It is then back-extracted as iodide into sodium bisulfite solution and



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precipitated as palladium iodide. The precipitate is weighed for chemical yield and is mounted on a nylon planchet for low level beta counting.

### 3. Results and Conclusions

A summary of the analysis results during the report period are listed in Table 2-2. A trend graph of analyses (including the pre-operational period through the report period) is shown on Figure 2-18.

#### a. Feedstuff

Gamma Spectrometry: Although not required by the ODCM, a total of twelve (12) samples were analyzed by gamma spectrometry. Naturally occurring potassium-40 was identified in twelve of twelve (12 of 12) samples. Naturally occurring beryllium-7 was found in seven of twelve (7 of 12) samples.

Deviations from Required Sampling and Analysis Schedule: There were no deviations from the required feedstuff sampling and analysis schedule during the report period.

Summary: The data from the feedstuff analyses was consistent with previous data. Based on the analytical results, the operation of BVPS did not contribute any measurable increase in radioactivity in the feedstuff during the report period.

#### b. Foodcrops

Iodine-131: A total of ten (10) samples were analyzed for iodine-131. No detectable concentrations were present in the nine (9) indicator samples or the one (1) control sample.

Gamma Spectrometry: A total of ten (10) samples were analyzed by gamma spectrometry. Naturally occurring potassium-40 was identified in nine of nine (9 of 9) samples indicator samples and the one (1) control sample.

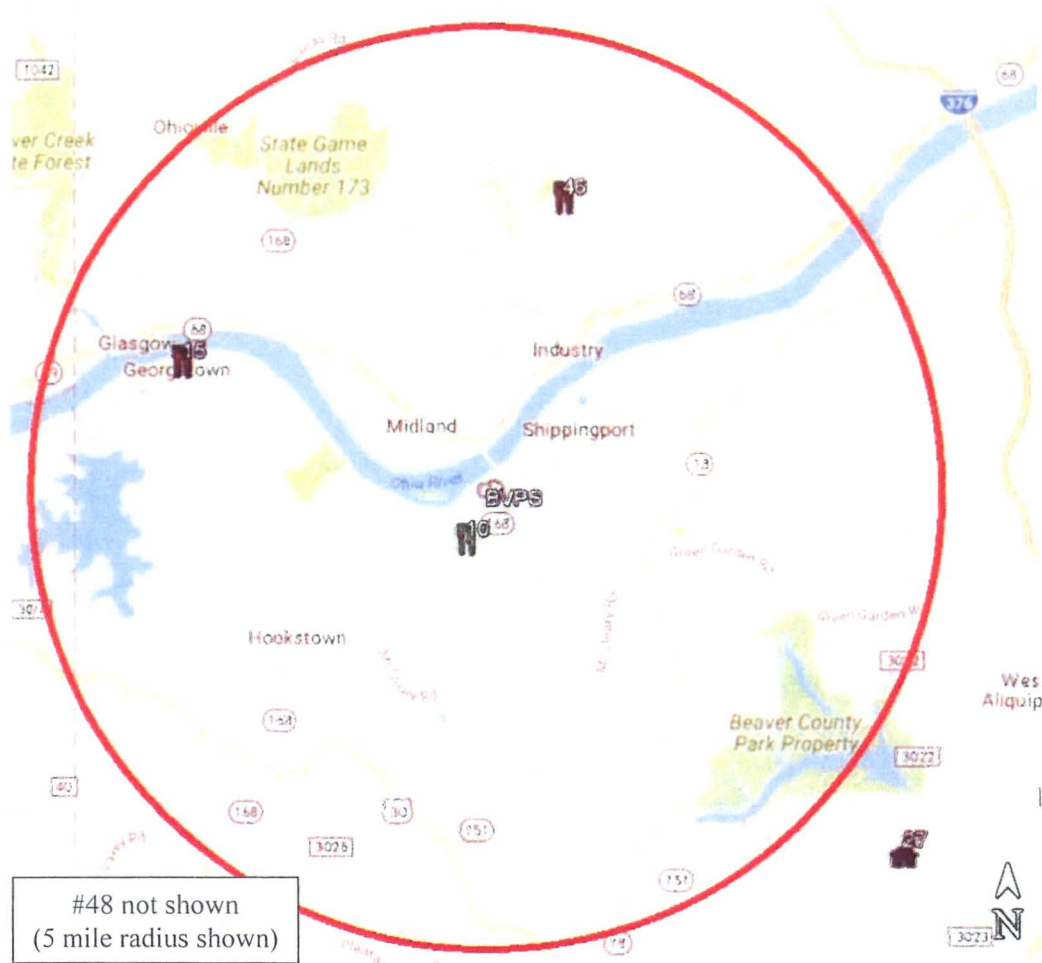
Deviations from Required Sampling and Analysis Schedule: There were no deviations from the required foodstuff sampling and analysis schedule during the report period.

Summary: The data from the foodcrops analyses was consistent with previous data. Based on the analytical results, the operation of BVPS did not contribute any measurable increase in radioactivity in the foodcrops during the report period.

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Figure 2-17

Environmental Monitoring Locations – Feedstuff and Foodcrops



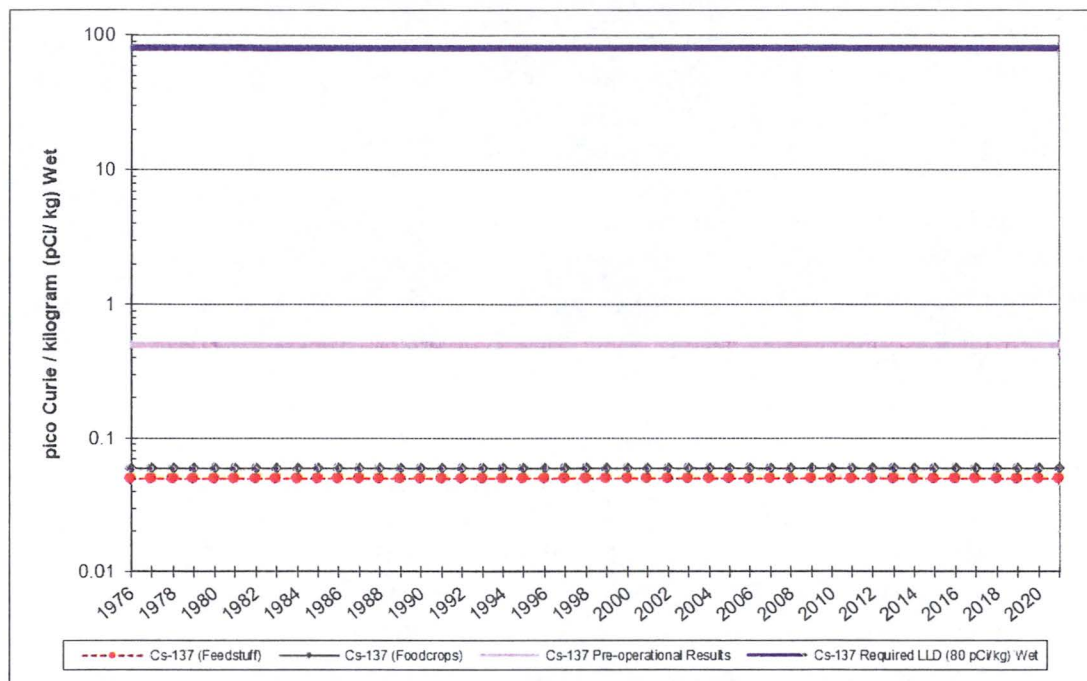
Sample Type	Site No.	Sector	Distance (miles)	Sample Point Description
Feed	27	7-SE	6.16	Aliquippa, PA (Brunton Farm)
Food	10*	*	*	Shippingport, PA
	15*	*	*	Georgetown, PA
	46*	*	*	Industry, PA
	48*	*	*	Weirton, WV
	*	*	*	2 locations based on highest predicted D/Q

Individual garden locations may change based upon availability. The requirements are met as long as one garden is sampled from each of these communities.

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Figure 2-18

Graph of Annual Average Concentration: Cesium-137 in Feedstuff and Foodcrops



## SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

### I. Estimates of Radiation Dose to Man

#### 1. Pathways to Man - Calculation Models

The radiation doses to man as a result of BVPS operations were calculated for both gaseous and liquid effluent pathways using computer software RADEAS which was implemented in 2019. The computer software follows Regulatory Guide 1.109 and site ODCM methodology. Dose factors listed in the ODCM are used to calculate doses from radioactive noble gases in discharge plumes. BVPS effluent data, based on sample analysis were used as the radionuclide activity input.

All batch and continuous gaseous effluent releases were included in the dose assessment calculations. The release activities are based on laboratory analysis. Meteorological data collected by the BVPS Meteorology System was also used as input to the dose assessment. The usage factors were obtained from the BVPS Final Environmental Statements or Regulatory Guide 1.109, except when more recent or specific data was available.

All radioactive liquid effluents are released by batch mode after analysis by gamma spectrometry. Each batch is diluted by cooling tower blowdown water prior to discharge into the Ohio River via the main outfall [River Mile 35.0]. The actual data from these analyses are tabulated and used as the radionuclide source term input to the computer software. The usage factors were obtained from the BVPS Final Environmental Statements or Regulatory Guide 1.109, except when more recent or specific data was available.

The total doses to an individual were evaluated for all liquid and gaseous effluent pathways.

#### 2. Results of Calculated Dose to Man - Liquid Effluent Releases

During the report period, the calculated dose to an individual member of the public from liquid effluent releases is presented in Table 2-5. Also shown in the Table 2-7 is a comparison to natural radiation exposure.

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3. Results of Calculated Dose to Man – Gaseous Effluent Releases

During the report period, the calculated dose to an individual member of the public from airborne effluent releases. Also shown in the Table 2-7 is a comparison to natural radiation exposure. The doses include the contribution of all pathways.

4. Conclusions

Based upon the estimated dose to individuals from the natural background radiation exposure in Tables 2-5 and 2-6, the incremental increase in total body dose from the operation of BVPS - Unit 1 and 2, is 0.0487% of the annual radiation exposure.

The calculated doses to the public from the operation of BVPS - Unit 1 and 2, are below ODCM annual limits and resulted in only a small incremental dose to that which area residents already received as a result of natural background. The doses constituted no meaningful risk to the public.

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Table 2-5: Calculated Dose to Man  
Liquid Effluent Releases

<b>Comparison of Individual Dose BVPS Liquid Effluent Releases Versus Natural and Medical Radiation Exposure</b>	
	<b>millirem</b>
<b>BVPS Liquid Effluent Release Dose to the Total Body</b>	<b>0.0567</b>
<b>United States Annual Average Radiation Exposure</b>	<b>620</b>

Table 2-6: Calculated Dose to Man  
Gaseous Effluent Releases

<b>Comparison of Individual Dose BVPS Gaseous Effluent Releases Versus Natural and Medical Radiation Exposure</b>	
	<b>millirem</b>
<b>BVPS Gaseous Effluent Release Dose</b>	<b>0.245</b>
<b>United States Annual Average Radiation Exposure</b>	<b>620</b>

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Table 2-7: Natural and Medical Radiation Exposures

<u>TYPICAL DOSE TO INDIVIDUALS</u>	
<u>FROM RADIATION EXPOSURE</u> <sup>(a)</sup>	
Ubiquitous background	= 311 millirem / year
Internal, inhalation	228 millirem / year
Internal, ingestion	29 millirem / year
External, space	33 millirem / year
External, terrestrial	21 millirem / year
Medical	= 300 millirem / year
CT	147 millirem / year
Nuclear medicine	77 millirem / year
Interventional fluoroscopy	43 millirem / year
Conventional radiography	33 millirem / year
Consumer	= 13 millirem / year
Industrial, security, educational, research	= 0.3 millirem / year
Occupational	= 0.5 millirem / year
<b>Average Individual</b>	<b>= 620 millirem / year</b>
<b>(Total from all sources shown above)</b>	
<sup>(a)</sup> NCRP Report No. 160: Ionizing Radiation Exposure of the Population of the United States." <i>Journal of Radiological Protection J. Radiol. Prot.</i> 29.3 (2009)	

### SECTION 3 – LAND USE CENSUS

A. **Land Use Census Overview:** A Land Use Census was conducted June 1 through August 31, 2021 to comply with:

- Offsite Dose Calculation Manual procedure 1/2-ODC-3.03, “*Controls for RETS and REMP Programs*”, Attachment R, Control 3.12.2, and Surveillance Requirement 4.12.2.1
- BVPS REMP procedure 1/2-ENV-04.02, “*Milch Animal Sampling Location Determination & ODCM Procedure 1/2-ODC-3.03, Control 3.12.2 Action Statements a and b Compliance Determination*”

The Land Use Census results indicate that there were no changes in the nearest resident, milch cow, garden or doe goat. Therefore, no changes are required to be made in the current Radiological Environmental Monitoring Program (REMP). Table 3-1 summarizes the location of nearest residences, gardens, milch cows and doe goats. Changes in the methodology for determining meteorological dispersion (X/Q) and deposition (D/Q) resulted in recommended changes to the Offsite Dose Calculation Manual (ODCM) and to the X/Q and D/Q values used in the effluent tracking software. A comparison of the annual D/Q to ODCM default D/Q is provided in Table 3-2. The Land Use Census is summarized as follows:

- B. **Nearest Residence:** The location has not changed since the previous census. The nearest inhabited residence is 209 Ferry Hill Road, Shippingport, PA (0.44 miles, east-northeast). The ODCM default D/Q values for the four release points remained conservative when compared to the new XOQDOQ output. However, several release points (CV 1/2, VV 1/2 and TV 1/2) had higher calculated X/Q values that were > 20% of the default ODCM.
- C. **Nearest Garden >500 sq. ft:** The location has not changed since the previous census. The closest garden location remains the Colaber Residence, 1201 Virginia Avenue, Midland, PA (1.03 miles, northwest). ODCM default X/Q and D/Q values were compared to the XOQDOQ output X/Q and D/Q values in which the ODCM values remain conservative.
- D. **Nearest Dairy Cow:** The location has not changed since the previous census. The location is not within a five-mile radius; however, the closest milking cow location is Brunton Dairy, 3681 Ridge Road, Aliquippa, PA (6.076 miles, southeast). There are no changes in the default ODCM D/Q for the nearest dairy cow milked for ground and elevated releases; however, two of the ground level release points (VV-1/2 and TV-2) had increased X/Q values that were >20% of the default ODCM values.
- E. **Nearest Doe Goat:** The location has not changed since the previous census. The location is at the Covert Residence, 930 Pine Street (Route 168), Hookstown, PA (2.131 miles, southwest). The default ODCM X/Q values remained conservative. However, two of the



### SECTION 3 – LAND USE CENSUS

ground release points (VV-1/2 and TV-2) D/Q values were >20% of the default ODCM values.

- F. **Prevailing Winds:** The prevailing wind direction for ground releases was identified by showing the highest D/Q in the **west sector**. The prevailing wind direction for elevated releases was identified by showing the highest D/Q in the **east-southeast sector**. The REMP properly monitors the environment with air particulate sampling stations in some sectors and direct radiation TLDs in all sectors.
- G. **2021 Dairy Cow & Doe Goat Sampling Locations:** The dairy cow sampling locations will remain at **Brunton Dairy**, 3681 Ridge Road, Aliquippa, PA (6.076 miles, southeast), and **Windsheimer Dairy**, 20 Windsheimer Lane, Burgettstown, PA (10.475 miles, south-southwest). The doe goat sampling location will remain at the **Covert Residence**, 930 Pine Street (Route 168), Hookstown, PA (2.131 miles, southwest).
- H. **D/Q for Milch Animal Locations:** None of the 2021 milch animal sampling locations experienced a >20% increase in D/Q. Therefore, a Special Report per ODCM procedure 1/2-ODC-3.03, Attachment R, Control 3.12.2 Action “a” and/or Action “b” is not required.
- I. **X/Q and D/Q for Offsite Dose Determination:** A change in methodology for calculating meteorological dispersion (X/Q) and deposition (D/Q) values resulted in some significant differences (>20% change in a non-conservative direction) that will be addressed in the next ODCM revision. The change in meteorology has no bearing on meeting the requirements of Control 3.12.2 Action “a” and/or Action “b”. Therefore, a Special Report per ODCM is not required.
- J. **X/Q and D/Q Comparison:** There is no adverse trend in D/Q when comparing 2009 to 2021 data to the ODCM default D/Q values. However, several locations had higher X/Q values that were >20% of the ODCM default values. A comparison of the annual D/Q to ODCM default D/Q is provided in Table 3-2.

**SECTION 3 – LAND USE CENSUS**

**Table 3-1**

**Location of Nearest Residences, Gardens, Milch Cows and Doe Goats**

SECTOR	RESIDENCES	GARDENS	DAIRY COWS	DOE GOATS
	0 to 5 miles (miles)	0 to 5 miles (miles)	0 to 5 miles (miles)	0 to 5 miles (miles)
N	1.60	1.31	None	None
NNE	1.64	3.08	None	None
NE	0.474	2.39	None	None
ENE	0.438 <sup>b</sup>	1.05	None	None
E	1.20	1.92	None	3.41
ESE	0.852	1.24	None	None
SE	1.50	1.91	None <sup>a</sup>	None
SSE	2.11	3.08	None	None
S	1.37	1.48	None	None
SSW	0.760	1.71	None	None
SW	1.46	1.46	None	2.13
WSW	1.42	2.31	None	None
W	2.22	None	None	None
WNW	2.30	3.77	None	None
NW	0.892	1.03	None	None
NNW	0.910	1.27	2.44	None

<sup>a</sup> Although there are no Dairy Cows within 5 miles in this sector, a large local dairy located at 6.076 miles is included in the milk sampling program.

<sup>b</sup> Distance is the nearest location for that receptor.

SECTION 3 – LAND USE CENSUS

Table 3-2

Comparison of Annual D/Q to ODCM Default D/Q

Receptor	Sector	Mode	Release Point	ODCM		XOQDOQ		Percent Difference	
				X/Q	D/Q	X/Q	D/Q	X/Q	D/Q
Residence	ENE	Elevated	PV 1/2	5.25E-08	1.76E-09	1.50E-09	8.90E-10	-97%	-49%
		Ground	CV 1/2	4.20E-06	3.22E-08	6.10E-09	2.80E-08	-100%	-13%
		Ground	VV 1/2	5.04E-06	3.22E-08	1.10E-05	2.00E-08	118%	-38%
		Ground	TV 1/2	4.63E-06	3.22E-08	9.80E-06	2.00E-08	112%	-38%
Garden	NW	Elevated	PV 1/2	7.40E-09	4.25E-10	4.00E-09	5.40E-10	-46%	27%
		Ground	CV 1/2	1.94E-05	1.50E-08	1.10E-06	4.20E-09	-94%	-72%
		Ground	VV 1/2	2.62E-05	1.50E-08	2.60E-06	7.50E-09	-90%	-50%
		Ground	TV 1/2	2.16E-05	1.49E-08	2.50E-06	7.50E-09	-88%	-50%
Dairy Cow	SE	Elevated	PV 1/2	1.23E-07	4.66E-10	8.10E-09	7.60E-11	-93%	-84%
		Ground	CV 1/2	9.94E-08	3.50E-10	5.20E-08	1.40E-10	-48%	-60%
		Ground	VV 1/2	1.03E-07	3.50E-10	3.60E-07	1.90E-10	250%	-46%
		Ground	TV 1/2	1.02E-07	3.51E-10	3.40E-07	1.90E-10	233%	-46%
Doe Goat	SW	Elevated	PV 1/2	2.56E-07	6.93E-10	6.60E-09	1.20E-10	-97%	-83%
		Ground	CV 1/2	9.05E-07	1.32E-09	8.80E-07	1.30E-09	-3%	-2%
		Ground	VV 1/2	9.98E-07	1.32E-09	7.50E-07	2.00E-09	-25%	52%
		Ground	TV 1/2	9.55E-07	1.32E-09	7.20E-07	2.00E-09	-25%	52%

## SECTION 4 - SPLIT SAMPLE PROGRAM and SPIKE SAMPLE INTER-LABORATORY COMPARISON PROGRAM

A. **Split Sample Program (Inter-Laboratory Comparison, Part 1 of 2):** BVPS participates in a split sample program with the Pennsylvania Department of Environmental Protection (PADEP) in support of their nuclear power plant monitoring program.

- BVPS provided split samples to PADEP throughout the report period. The shared media and number of locations were typically comprised of milk (1), surface water (2), sediment (1), fish (1), and food crops (2).
- PADEP has co-located continuous air particulate & air iodine sample stations with four (4) of the BVPS locations.
- PADEP has co-located TLDs with twenty-four (24) of the BVPS TLDs.

B. **Spike Sample Program (Inter-Laboratory Comparison, Part 2 of 2):** BVPS participates in a spike sample program with an Independent Laboratory. This program is used to independently verify sample analyses performed by the BVPS Contractor Laboratory.

- **Acceptance Criteria:** The NRC criteria listed in NRC Inspection Procedure 84750, 11/14/19, Inspection Guidance 84750-03 is used as acceptance criteria for comparisons of results of spiked samples between the Contractor Lab and the Independent Lab. These comparisons are performed by dividing the comparison standard (Independent Lab result) by its associated uncertainty to obtain the resolution. The comparison standard value is multiplied by the ratio values obtained from the following table to find the acceptance band for the result to be compared. However, in such cases in which the counting precision of the standard yields a resolution of less than 4, a valid comparison is not practical, and therefore, not performed.

NRC Criteria	
Resolution	Ratio
< 4	--
4 - 7	0.50 - 2.00
8 - 15	0.60 - 1.66
16 - 50	0.75 - 1.33
<b>51 - 200</b>	<b>0.80 - 1.25</b>
> 200	0.85 - 1.18

## SECTION 4 - SPLIT SAMPLE PROGRAM and SPIKE SAMPLE INTER-LABORATORY COMPARISON PROGRAM

Participation in an Inter-Laboratory Comparison Program is required by BVPS Unit 1 and 2 ODCM procedure 1/2-ODC-3.03 Attachment S Control 3.12.3. For the report period, the requirement was met by the Contractor Lab analyzing NIST traceable spiked samples supplied by an Independent Lab.

During the report period, BVPS used (Environmental, Inc., Midwest Laboratory – Northbrook, IL) as the Contractor Laboratory, and (Eckert & Ziegler Analytics – Atlanta, GA) as the Independent Laboratory.

The spiked samples included air particulate filter papers, charcoal cartridges, water samples, and milk samples. The samples were submitted by the Independent Laboratory to the Contractor Laboratory for analysis. The “spiked to” values were used for calculating comparison Acceptance Criteria.

- **Spiked Milk & Water Samples:** The spiked sample results (i.e. the BVPS criteria) for each calendar quarter are reported in Table 4-1 through Table 4-4, respectively. The following summary is provided:
  - A total of forty-eight (48) gamma spectrometry radionuclide analyses were performed by the Contractor Laboratory on four (4) milk samples.
  - A total of forty-eight (48) gamma spectrometry radionuclide analyses were performed by the Contractor Laboratory on four (4) water samples.
  - A total of four (4) chemical analyses for I-131(chemical) were performed by the Contractor Laboratory on four (4) milk samples.
  - A total of four (4) I-131 analyses were performed by the Contractor Laboratory on four (4) water samples.
  - A total of four (4) tritium analyses were performed by the Contractor Laboratory on four (4) water samples.
  - Comparison of results of the spiked milk and water samples showed acceptable agreement with the NRC acceptance criteria. A total of one hundred eight (108) analyses were performed in 2021. All one hundred eight (108) analyses met the NRC acceptance criteria.

## SECTION 4 - SPLIT SAMPLE PROGRAM and SPIKE SAMPLE INTER-LABORATORY COMPARISON PROGRAM

- **Spiked Filter Paper and Charcoal Cartridge Samples:** The spiked sample results for each calendar quarter are reported in Table 4-1 through Table 4-4, respectively. The following summary is provided:
  - Gross Beta (cesium-137) analyses were performed by the Contractor Laboratory on two (2) filter paper samples.
  - Iodine-131 analyses were performed by the Contractor Laboratory on two (2) charcoal cartridge samples.
  - Comparison of results of the spiked filter paper and charcoal cartridge samples showed acceptable agreement with the NRC acceptance criteria. All four (4) analyses performed by the Contractor Laboratory met the NRC acceptance criteria.

### C. Conclusions

- **Results of Split Sample Program:** The split sample program is coordinated by the state, and the results are not included in this report.

**Results of Spike Sample Program:** Based on the Inter-Laboratory comparison data, BVPS considers all analyses provided throughout the report period by the Contractor Laboratory to be acceptable with respect to both accuracy and measurement. A comparison of the data is provided in the following tables. A total of one hundred twelve (112) analyses were performed in which one hundred twelve (112) analyses met the NRC acceptance criteria

**SECTION 4 - SPLIT SAMPLE PROGRAM and SPIKE SAMPLE  
 INTER-LABORATORY COMPARISON PROGRAM**

Table 4-1

Inter-Laboratory Comparison Program Spiked Samples – 1<sup>st</sup> Quarter

Sample Date, Type and Identification No.	Resolution	Resolution	Required Ratio Band	Ratio Env Inc: Analytics	Comparison
<b>03/11/21</b> <b>Water</b> Ind. Lab: E13375 Con. Lab: SPW-635	Sr-89	60	0.80 - 1.25	0.95	AGREEMENT
	Sr-90	60	0.80 - 1.25	1.14	AGREEMENT
	I-131 (CHM)	60	0.80 - 1.25	1.03	AGREEMENT
	I-131	60	0.80 - 1.25	1.12	AGREEMENT
	Ce-141	60	0.80 - 1.25	0.98	AGREEMENT
	Cr-51	60	0.80 - 1.25	0.88	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.92	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.04	AGREEMENT
	Co-58	60	0.80 - 1.25	0.95	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.06	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.16	AGREEMENT
	Zn-65	60	0.80 - 1.25	1.05	AGREEMENT
Co-60	60	0.80 - 1.25	0.98	AGREEMENT	
<b>03/11/21</b> <b>Water</b> Ind. Lab: E13374 Con. Lab: SPW-633	H-3	60	0.80 - 1.25	0.99	AGREEMENT
<b>03/11/21</b> <b>Milk</b> Ind. Lab: E13376 Con. Lab: SPMI-637	Sr-89	60	0.80 - 1.25	0.91	AGREEMENT
	Sr-90	60	0.80 - 1.25	0.83	AGREEMENT
	I-131 (CHM)	60	0.80 - 1.25	1.03	AGREEMENT
	I-131	60	0.80 - 1.25	1.13	AGREEMENT
	Ce-141	60	0.80 - 1.25	0.92	AGREEMENT
	Cr-51	60	0.80 - 1.25	0.96	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.91	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.00	AGREEMENT
	Co-58	60	0.80 - 1.25	1.00	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.08	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.12	AGREEMENT
	Zn-65	60	0.80 - 1.25	1.04	AGREEMENT
Co-60	60	0.80 - 1.25	0.96	AGREEMENT	
<b>03/11/21</b> <b>Filter Paper</b> Ind. Lab: E13377 Con. Lab: SPAP-639	Cs-137 (Gross Beta)	60	0.80 - 1.25	1.15	AGREEMENT
<b>03/11/21</b> <b>Charcoal Cartridge</b> Ind. Lab: E13378 Con. Lab: SPCH-640	I-131	60	0.80 - 1.25	1.05	AGREEMENT

**SECTION 4 - SPLIT SAMPLE PROGRAM and SPIKE SAMPLE  
INTER-LABORATORY COMPARISON PROGRAM**

Table 4-2

Inter-Laboratory Comparison Program Spiked Samples – 2<sup>nd</sup> Quarter

Sample Date, Type and Identification No.	Resolution	Resolution	Required Ratio Band	Ratio Env Inc: Analytics	Comparison
<b>06/03/21</b> <b>Water</b> Ind Lab: E13380 Con. Lab: SPW-1637	Sr-89	60	0.80 - 1.25	0.97	AGREEMENT
	Sr-90	60	0.80 - 1.25	0.98	AGREEMENT
	I-131 (CHM)	60	0.80 - 1.25	1.08	AGREEMENT
	I-131	60	0.80 - 1.25	1.05	AGREEMENT
	Ce-141	60	0.80 - 1.25	0.97	AGREEMENT
	Cr-51	60	0.80 - 1.25	1.00	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.91	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.04	AGREEMENT
	Co-58	60	0.80 - 1.25	0.96	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.07	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.05	AGREEMENT
	Zn-65	60	0.80 - 1.25	1.14	AGREEMENT
Co-60	60	0.80 - 1.25	1.01	AGREEMENT	
<b>06/03/21</b> <b>Water</b> Ind. Lab: E13379 Con. Lab: SPW-1635	H-3	60	0.80 - 1.25	1.01	AGREEMENT
<b>06/03/21</b> <b>Milk</b> Ind. Lab: E13381 Con. Lab: SPMI-1639	Sr-89	60	0.80 - 1.25	0.93	AGREEMENT
	Sr-90	60	0.80 - 1.25	0.90	AGREEMENT
	I-131 (CHM)	60	0.80 - 1.25	1.01	AGREEMENT
	I-131	60	0.80 - 1.25	1.11	AGREEMENT
	Ce-141	60	0.80 - 1.25	1.04	AGREEMENT
	Cr-51	60	0.80 - 1.25	1.08	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.91	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.03	AGREEMENT
	Co-58	60	0.80 - 1.25	1.03	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.03	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.05	AGREEMENT
	Zn-65	60	0.80 - 1.25	1.03	AGREEMENT
Co-60	60	0.80 - 1.25	0.97	AGREEMENT	



**SECTION 4 - SPLIT SAMPLE PROGRAM and SPIKE SAMPLE  
 INTER-LABORATORY COMPARISON PROGRAM**

Table 4-3

Inter-Laboratory Comparison Program Spiked Samples – 3<sup>rd</sup> Quarter

Sample Date, Type and Identification No.	Resolution	Resolution	Required Ratio Band	Ratio Env Inc: Analytics	Comparison
<b>09/09/21</b> <b>Water</b> Ind. Lab: E13383 Con. Lab: SPW-2896	Sr-89	60	0.80 - 1.25	0.97	AGREEMENT
	Sr-90	60	0.80 - 1.25	1.05	AGREEMENT
	I-131 (CHM)	60	0.80 - 1.25	1.06	AGREEMENT
	I-131	60	0.80 - 1.25	1.00	AGREEMENT
	Ce-141	60	0.80 - 1.25	0.98	AGREEMENT
	Cr-51	60	0.80 - 1.25	0.98	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.90	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.01	AGREEMENT
	Co-58	60	0.80 - 1.25	0.99	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.03	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.05	AGREEMENT
	Zn-65	60	0.80 - 1.25	1.02	AGREEMENT
Co-60	60	0.80 - 1.25	0.98	AGREEMENT	
<b>09/09/21</b> <b>Water</b> Ind. Lab: E13382 Con. Lab: SPW-2894	H-3	60	0.80 - 1.25	1.01	AGREEMENT
<b>09/09/21</b> <b>Milk</b> Ind. Lab: E13384 Con. Lab: SPMI-2898	Sr-89	60	0.80 - 1.25	0.96	AGREEMENT
	Sr-90	60	0.80 - 1.25	0.98	AGREEMENT
	I-131 (CHM)	60	0.80 - 1.25	1.12	AGREEMENT
	I-131	60	0.80 - 1.25	1.05	AGREEMENT
	Ce-141	60	0.80 - 1.25	1.05	AGREEMENT
	Cr-51	60	0.80 - 1.25	1.07	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.96	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.05	AGREEMENT
	Co-58	60	0.80 - 1.25	1.03	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.07	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.11	AGREEMENT
	Zn-65	60	0.80 - 1.25	1.07	AGREEMENT
Co-60	60	0.80 - 1.25	1.00	AGREEMENT	
<b>09/09/21</b> <b>Filter Paper</b> Ind. Lab: E13385 Con. Lab: SPAP-2900	Cs-137 (Gross Beta)	60	0.80 - 1.25	1.08	AGREEMENT
<b>09/09/21</b> <b>Charcoal Cartridge</b> Ind. Lab: E13386 Con. Lab: SPCH-2901	I-131	60	0.80 - 1.25	0.98	AGREEMENT

**SECTION 4 - SPLIT SAMPLE PROGRAM and SPIKE SAMPLE  
 INTER-LABORATORY COMPARISON PROGRAM**

Table 4-4

Inter-Laboratory Comparison Program Spiked Samples – 4<sup>th</sup> Quarter

Sample Date, Type and Identification No.	Resolution	Resolution	Required Ratio Band	Ratio Env Inc: Analytics	Comparison
<b>12/02/21</b> <b>Water</b> Ind. Lab: E13388 Con. Lab: SPW-3955	Sr-89	60	0.80 - 1.25	1.00	AGREEMENT
	Sr-90	60	0.80 - 1.25	0.90	AGREEMENT
	I-131 (CHM)	60	0.80 - 1.25	1.00	AGREEMENT
	I-131	60	0.80 - 1.25	1.10	AGREEMENT
	Ce-141	60	0.80 - 1.25	1.03	AGREEMENT
	Cr-51	60	0.80 - 1.25	1.02	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.93	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.03	AGREEMENT
	Co-58	60	0.80 - 1.25	1.02	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.05	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.07	AGREEMENT
	Zn-65	60	0.80 - 1.25	1.04	AGREEMENT
Co-60	60	0.80 - 1.25	0.99	AGREEMENT	
<b>12/02/21</b> <b>Water</b> Ind. Lab: E13387 Con. Lab: SPW-3951	H-3	60	0.80 - 1.25	1.01	AGREEMENT
<b>12/02/21</b> <b>Milk</b> Ind. Lab: E13389 Con. Lab: SPMI-3953	Sr-89	60	0.80 - 1.25	0.95	AGREEMENT
	Sr-90	60	0.80 - 1.25	0.98	AGREEMENT
	I-131 (CHM)	60	0.80 - 1.25	1.03	AGREEMENT
	I-131	60	0.80 - 1.25	0.99	AGREEMENT
	Ce-141	60	0.80 - 1.25	0.93	AGREEMENT
	Cr-51	60	0.80 - 1.25	0.95	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.92	AGREEMENT
	Cs-137	60	0.80 - 1.25	0.98	AGREEMENT
	Co-58	60	0.80 - 1.25	0.99	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.04	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.09	AGREEMENT
	Zn-65	60	0.80 - 1.25	1.01	AGREEMENT
Co-60	60	0.80 - 1.25	0.97	AGREEMENT	

**SECTION 5 – CORRECTIONS TO PREVIOUS RADIOLOGICAL  
ENVIRONMENTAL OPERATING REPORT(S)**

- A. Corrections to Previous Radiological Environmental Operating Report(s):  
There are no corrections to be addressed for the previous report.