REFERENCES:
10 CFR 50.36a(a)(2)
10 CFR 72.44(d)(3)
CGS Technical Specification 5.6.2

Columbia Generating Station
Annual Radioactive Effluent Release Report

January through December 2017

Energy Northwest

Submitted
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1.0 Introduction

This report has been prepared in compliance with Part 50 of Title 10 of the Code of Federal Regulations (CFR), specifically 10 CFR 50.36a(a)(2), and Columbia Generating Station (CGS) Technical Specification 5.6.2. It includes a summary of the quantities of radioactive liquid and gaseous effluents and solid radioactive waste released from CGS during calendar year 2017. Effluent data is summarized on a quarterly and annual basis.

Throughout this report, units of activity and dose are as defined in 10 CFR 20.1004, 20.1005, and Nuclear Regulatory Commission (NRC) Regulatory Guide 1.109-1977.

The United States National Council on Radiation Protection published Report #160 in 2009 which can serve to put radiation dose into perspective for the reader of this report. It was determined that the average yearly dose to a person living in the United States is 620 mrem from all sources. Of this, ~50% is attributed to natural sources (radiation from gaseous radon, cosmic or space radiation, natural radioactive material in the ground, and natural radioactive materials in our bodies). About 48% is attributed to diagnostic and therapeutic medical exposure. Radiation dose from nuclear power was grouped into a category comprising <0.1% of the total.

2.0 Liquid Effluents

No planned releases of contaminated liquids from the liquid radwaste processing system were discharged to the Columbia River from CGS during calendar year 2017. The last discharge to the river from liquid processing took place in 1998.

According to ground water monitoring, spills of greater than 100 gallons, and the leak detection system of the lined evaporation ponds, there is no indication of a leak or spill of radioactive liquids to ground water in 2017.

3.0 Gaseous Effluents

Routine Releases

Gaseous effluents from CGS are released from three (3) principal release points:

Main Plant Vent -- mixed mode release
Turbine Building – mixed mode release
Radwaste Building -- ground level release

The gaseous source terms from each release point are listed in Tables 3-1, 3-2, and 3-3. The activation gas argon-41 is included in these tables under fission gases to allow a match with the fission and activation gas totals of Table 3-4. Table 3-4 provides a summation of the total activity released, the average release rate, gross alpha radioactivity, and the estimated total error associated with the measurements of radioactivity in the gaseous effluents.

Radioactivity measurements for gaseous effluent releases are performed for fission and activation gases by collecting the samples in a Marinelli beaker and analyzing them using gamma spectroscopy. Air is analyzed for tritium by collection of water vapor on a desiccant with subsequent distillation and liquid scintillation counting. Particulates and iodines are sampled continuously and the sample media (particulate filters and charcoal cartridges) are analyzed weekly using gamma spectroscopy. Each quarter a chemical separation process is used to isolate strontium from the composite particulate filters and quantification is accomplished with liquid scintillation detection. The average energy per disintegration of fission and activation gases is not included in this report as it is not required by Technical Specifications and is not used for gaseous effluent release rate limit calculations.

When a radionuclide is not positively identified at levels greater than the Minimum Detectable Activity (MDA) or Minimum Detectable Concentration (MDC), a value of zero is used for release concentrations and offsite dose assessments. The MDA is an 'a posteriori' value that is determined during analysis of a sample. Table 3-6 contains the Lower Limit of Detection (LLD – which is an 'a priori' value determined before a sample is analyzed) values corresponding to the sampling methods and analytical instruments used for each principal radionuclide. Carbon-14 (C-14 or ^{14}C) releases are calculated using an Electric Power Research Institute (EPRI) methodology that is discussed in more detail later in this chapter.

The presence of fuel defects were identified in 2015, and continued into 2017, until fuel bundles could be inspected and removed during a refueling outage. The resulting dose contribution from elevated Noble Gas concentrations remains a small fraction of the10 CFR 50 Appendix I numerical guides. These doses are reported in Table 3-0 and Section 6.0.

Dose calculations were performed for releases using the NRC XOQDOQ and NRC Regulatory Guide 1.109 methodology (manually or with the GASPAR II computer program) and parameter values as described in the Offsite Dose Calculation Manual (ODCM). This methodology was based on Publication 2 of the International Commission on Radiation Protection released in 1959.

Quarterly and annual doses to the potentially highest-exposed Member of the Public (MOP) at and beyond the site boundary were calculated. In addition, quarterly and annual doses were calculated at actual resident locations identified in the annual land use census. ODCM limits are based on 10 CFR 20 and Appendix I to 10 CFR 50. The threshold for air dose applies to fission and activation gases and is ten (10) mrad for beta and five (5) mrad for gamma quarterly and twenty (20) mrad for beta and ten (10) mrad for gamma annually. The threshold for organ dose applies to iodine, tritium, and particulates with half-lives greater than eight days and is seven and a half (7.5) mrem quarterly and fifteen (15) mrem annually.

The ODCM includes another set of release rate limits to provide operational flexibility and assurance that radioactive material discharged in gaseous effluents will not result in exposure to a MOP in excess of the design objectives of Appendix I to 10 CFR 50. For fission and activation gases the dose rate limits are less than or equal to 500 mrem per year to the whole body and less than or equal to 3000 mrem per year to the skin.

For iodines, particulates, and tritium the dose rate limit is less than or equal to 1500 mrem/year to any organ.

Dose calculations were also conducted for Members of the Public within the site boundary. The results are discussed and tabulated in Section 6.0.

There are release points around CGS that have been identified as unmonitored and evaluated for significance. Samples were taken in 2017 of the sources of these unmonitored releases.
Some of these release points include;

- Heating Steam Vents
- Cooling System Sediment Disposal Cell
- Lined Evaporation Ponds
- Condensate Storage Tanks

The radionuclides released from these four points were evaluated and determined to be less than one percent of the total Curies released from all release points for the respective type of radionuclide in 2017. The radionuclides detected were Tritium (^{3}H), Cobalt-60 and Cesium-137, and the calculated activity discharged was 1.32E-01 Ci, 1.10E-08 Ci and 2.00E-08 Ci respectively. The evaluation was completed by either verifying the assumptions of previous bounding calculations, or by evaluating activity released based on sample data. Table 3-4 below was updated to include the activity from these three radionuclides.

Abnormal Release

On December 9, 2017 at 00:30 in the morning, a relief valve on the shell side of Seal Steam Evaporator 1A lifted. This valve was reported closed at 01:30 that same morning. The steam released through this valve is exhausted through the Turbine building roof at a point that is not monitored for radiation. The make-up water to this evaporator is feedwater from the Main Condenser that has been filtered through the Condensate filter demineralizers. ^{3}H is the suspected radionuclide of concern in this water, and a sample taken from the Turbine Building Roof confirmed that ^{3}H was the only detectable radionuclide present. The flow rate through this discharge pipe is assumed to be 2.71E+05 cubic centimeters per minute; based on a previous event when the system pressure and relief valve setting were similar. The concentration of ^{3}H in the feedwater was measured to be 2.42E-03 uCi/cc on December 4, 2017. This equates to 3.94E-02 Ci of ^{3}H released while the relief valve was open.

The meteorological data before, during and after the time that the relief valve was open showed that a North Northeast wind was blowing. There are no residents within 5-miles of CGS in the South Southwest sector, and this amount of activity is less than one percent of the total ^{3}H discharged from all release points in 2017. Therefore, the activity of 3.94E-02 has been added to the Curies of ^{3}H reported in 4th quarter of Table 3-4 below and included in the dose calculations for the 4th quarter performed using the GASPAR II computer code.

Carbon-14

^{14}C, with a half-life of 5,730 years, is a naturally occurring isotope of carbon produced by cosmic ray interactions in the atmosphere. When ^{14}C decays it emits a beta particle of varying energies up to 0.156 MeV with an average energy of 0.049 MeV. As a result of this low energy, the air and inhalation doses are insignificant. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of ^{14}C in the atmosphere. ^{14}C is also produced in commercial nuclear reactors, but the amounts produced are much less than those produced naturally or from weapons testing.

Although 10 CFR 50.36a has always required reporting the principal nuclides released, ^{14}C had been exempted because of the large quantity that existed naturally in the environment. However, following release of Revision 2 of Regulatory Guide 1.21 (Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste), the NRC recommended that U.S. nuclear power plants evaluate whether ^{14}C is a "principal radionuclide", and if so, report the amount of ^{14}C released.

A radionuclide is considered a principal radionuclide if it contributes either (1) greater than 1 percent of the 10 CFR Part 50, Appendix I, design objective dose, or (2) greater than 1 percent of the activity of all radionuclides in the type of effluent being considered. This implementation of “primary radionuclides” ensures both (1) radionuclides that are present in relatively large amounts but that contribute very little to dose, and (2) radionuclides that are present in very small amounts but that have a relatively high contribution to dose are appropriately included in the annual effluent report.

At CGS, improvements over the years have resulted in a significant decrease in radioactive gaseous emissions. As a result, ^{14}C has become a "principal radionuclide" for the gaseous effluent pathway at CGS. The quantity of gaseous ^{14}C released to the environment is estimated using a ^{14}C source term scaling factor based on EPRI Technical Report 1021106 and power generation. The EPRI report estimates the production of ^{14}C at approximately 5 Ci/GW_{th} – yr for a plant like CGS. This would result in a potential release of 18.1 Ci/yr based on the rated power for CGS. The EPRI report also describes the chemical form of the ^{14}C released as being 95% Carbon Dioxide, which could be incorporated into growing plants during photosynthesis. The remainder is assumed to be methane (CH_4).

Table 3a contains estimates of ^{14}C radioactivity released in 2017. Based on 95% Carbon Dioxide, and assuming that all ^{14}C generated is released in gaseous effluent, then the total ^{14}C emission shown in Table 3a is 16.0 Ci. Estimates of public dose resulting from the ^{14}C effluent are included in the doses reported in Section 6 of this report.

Table 3a - Carbon-14 Releases

	GW_{th}-hrs	Ci of ^{14}C	Ci of $^{14}CO_2$
1st Quarter	7,390	4.32E+00	4.10E+00
2nd Quarter	5,324	3.14E+00	2.99E+00
3rd Quarter	7,511	4.43E+00	4.21E+00
4th Quarter	7,965	4.50E+00	4.27E+00
Total Year 2017	28,844	1.68E+01	1.60E+01

Out-of-Service Effluent Monitors

The noble gas detector to the Main Plant Vent (Stack Monitor) was out-of-service from May 17th, 2017 to June 27th, 2017. This out-of-service time started due to planned maintenance on electrical switchgear (SM-7) during a refueling outage. The power outage itself did not last 30 days, but the detector did not cool down appropriately once power was restored. Work began to improve the cooling system required to support operation of this noble gas detector, but this work typically takes anywhere from several days to weeks to complete because of the nature of the cooling system. The detector was restored to functional status on 6/27/17.

Gaseous Effluent Tables

Table 3-0 10 CFR Part 50 Appendix I Dose Compliance

Report Period: January -- December 2017

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year*
Noble Gas					
Gamma Air Dose (mrad)	9.47E-03	5.29E-03	4.46E-03	3.77E-03	2.07E-02
ODCM Limit	5	5	5	5	10
% of Limit	1.89E-01	1.06E-01	8.92E-02	7.54E-02	2.07E-01
Beta Air Dose (mrad)	4.80E-03	4.41E-03	1.57E-03	1.33E-03	1.06E-02
ODCM Limit	10	10	10	10	20
% of Limit	4.80E-02	4.41E-02	1.57E-02	1.33E-02	5.30E-02
Iodine-131, Iodine-133, Tritium, and Particulates with half-lives greater than eight days.					
Organ Dose (mrem)	7.37E-02	3.64E-02	5.34E-02	8.19E-02	2.43E-01
ODCM Limit	7.5	7.5	7.5	7.5	15
% of Limit	9.83E-01	4.85E-01	7.13E-01	1.09E+00	1.62E+00

* Calculated quarterly doses cannot be directly compared to the annual doses. Each above listed quarterly dose is the highest calculated dose based on a number of variables. Variables that make comparison difficult include location, seasonal changes in meteorological data (quarterly joint frequency distribution (JFD) tables vs. annual JFD tables), receptor age, target organ, and characteristics of the emitted radionuclides.

This table shows the highest air dose or organ dose for either a hypothetical resident at the site boundary or an actual resident within a 5-mile radius.

The pathways of exposure considered at the site boundary are the plume exposure, ground exposure, and inhalation pathways only. The potentially highest-exposed MOP from all gaseous effluent releases (including C-14) for 2017, was for a resident (child) at 4.64 miles E. The highest organ dose for the plume exposure, ground exposure, garden produce ingestion, and inhalation pathways was 2.43E-1 mrem which is 1.62% of the 15 mrem 10 CFR 50 Appendix I guideline. This location and assumed exposure pathways were based on the 2017 Land Use Census.

Table 3-1 Main Plant Vent Releases – Mixed Mode
Fission Gases and Iodines

Report Period: January -- December 2017

Nuclides Released	1st Quarter (Ci)	2nd Quarter (Ci)	3rd Quarter (Ci)	4th Quarter (Ci)	Year (Ci)
A. Fission gases					
krypton-85	<MDA	<MDA	<MDA	<MDA	<MDA
krypton-85m	1.54E+01	5.44E+00	<MDA	<MDA	2.09E+01
krypton-87	<MDA	<MDA	<MDA	<MDA	<MDA
krypton-88	9.87E+00	3.12E+00	<MDA	<MDA	1.30E+01
xenon-133	4.56E+01	4.92E+01	<MDA	<MDA	9.49E+01
xenon-133m	<MDA	<MDA	<MDA	<MDA	<MDA
xenon-135	<MDA	2.24E+01	<MDA	<MDA	2.24E+01
xenon-135m	<MDA	3.78E+00	<MDA	<MDA	3.78E+00
xenon-138	<MDA	<MDA	<MDA	<MDA	<MDA
Others					
argon-41	9.31E+00	5.22E+00	1.99E+01	1.64E+01	5.08E+01
Total for period *	8.03E+01	8.91E+01	1.99E+01	1.64E+01	2.06E+02
B. Iodines					
iodine-131	2.82E-05	6.19E-04	9.39E-06	<MDA	6.56E-04
iodine-132	<MDA	<MDA	<MDA	<MDA	<MDA
iodine-133	<MDA	<MDA	3.57E-05	<MDA	3.57E-05
iodine-134	<MDA	<MDA	<MDA	<MDA	<MDA
iodine-135	<MDA	<MDA	<MDA	<MDA	<MDA
Total for period *	2.82E-05	6.19E-04	4.51E-05	0.00E+00	6.92E-04

* MDA values are not included in the totals. MDA = Less than the "a posteriori" minimal detectable activity (microcuries per unit mass or volume).

Table 3-1 Main Plant Vent Releases – Mixed Mode (Continued)
Particulates and Tritium

Report Period: January -- December 2017

Nuclides Released	1st Quarter (Ci)	2nd Quarter (Ci)	3rd Quarter (Ci)	4th Quarter (Ci)	Year (Ci)
C. Particulates					
strontium-89	1.55E-05	1.93E-06	<MDA	<MDA	1.74E-05
strontium-90	<MDA	<MDA	<MDA	<MDA	<MDA
cesium-134	<MDA	<MDA	<MDA	<MDA	<MDA
cesium-137	<MDA	<MDA	<MDA	<MDA	<MDA
barium-lanthanum-140	<MDA	<MDA	<MDA	<MDA	<MDA
silver-110m	<MDA	<MDA	<MDA	<MDA	<MDA
cerium-141	<MDA	<MDA	<MDA	<MDA	<MDA
cerium-144	<MDA	<MDA	<MDA	<MDA	<MDA
cobalt-58	4.38E-05	5.35E-05	4.87E-06	1.96E-06	1.04E-04
cobalt-60	5.96E-05	3.20E-04	3.38E-05	3.77E-06	4.17E-04
iron-59	<MDA	1.70E-06	<MDA	<MDA	1.70E-06
manganese-54	1.49E-05	9.68E-05	9.38E-06	<MDA	1.21E-04
zinc-65	9.89E-06	4.10E-05	<MDA	<MDA	5.09E-05
chromium-51	<MDA	4.43E-05	<MDA	<MDA	4.43E-05
antimony-125	<MDA	<MDA	<MDA	<MDA	<MDA
Total for period*	1.44E-04	5.60E-04	4.81E-05	5.72E-06	7.57E-04
Others with T 1/2 < 8 days					
arsenic-76	<MDA	<MDA	<MDA	<MDA	<MDA
bromine-82	7.72E-06	<MDA	2.47E-05	<MDA	3.25E-05
copper-64	<MDA	<MDA	<MDA	<MDA	<MDA
molybdenum-99	<MDA	<MDA	<MDA	<MDA	<MDA
rhenium-188	<MDA	<MDA	<MDA	<MDA	<MDA
sodium-24	5.83E-05	<MDA	<MDA	<MDA	5.83E-05
technetium-99m	1.33E-05	2.86E-06	<MDA	<MDA	1.62E-05
zinc-69m	3.77E-05	<MDA	<MDA	<MDA	3.77E-05
Total with T 1/2 < 8 days*	1.17E-04	2.86E-06	2.47E-05	0.00E+00	1.45E-04
D. Tritium					
tritium	2.86E-01	3.65E-01	4.73E-01	4.42E-01	1.57E+00

* MDA values are not included in the totals. MDA = Less than the "a posteriori" minimal detectable activity (microcuries per unit mass or volume).

Table 3-2 Turbine Building Releases – Mixed Mode
Fission Gases and Iodines

Report Period: January -- December 2017

Nuclides Released	1st Quarter (Ci)	2nd Quarter (Ci)	3rd Quarter (Ci)	4th Quarter (Ci)	Year (Ci)
A. Fission gases					
krypton-85	<MDA	<MDA	<MDA	<MDA	<MDA
krypton-85m	<MDA	<MDA	<MDA	<MDA	<MDA
krypton-87	<MDA	<MDA	<MDA	<MDA	<MDA
krypton-88	<MDA	<MDA	<MDA	<MDA	<MDA
xenon-133	<MDA	<MDA	<MDA	<MDA	<MDA
xenon-133m	<MDA	<MDA	<MDA	<MDA	<MDA
xenon-135	<MDA	<MDA	<MDA	<MDA	<MDA
xenon-135m	<MDA	<MDA	<MDA	<MDA	<MDA
xenon-138	<MDA	<MDA	<MDA	<MDA	<MDA
Others					
argon-41	<MDA	<MDA	<MDA	<MDA	<MDA
Total for period *	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Iodines					
iodine-131	6.33E-04	4.57E-04	<MDA	<MDA	1.09E-03
iodine-132	<MDA	<MDA	<MDA	<MDA	<MDA
iodine-133	4.20E-04	1.58E-05	<MDA	<MDA	4.35E-04
iodine-134	<MDA	<MDA	<MDA	<MDA	<MDA
iodine-135	<MDA	<MDA	<MDA	<MDA	<MDA
Total for period *	1.05E-03	4.73E-04	0.00E+00	0.00E+00	1.53E-03

* MDA values are not included in the totals. MDA = Less than the “a posteriori” minimal detectable activity (microcuries per unit mass or volume).

Table 3-2 Turbine Building Releases – Mixed Mode (Continued)
Particulates and Tritium

Report Period: January -- December 2017

Nuclides Released	1st Quarter (Ci)	2nd Quarter (Ci)	3rd Quarter (Ci)	4th Quarter (Ci)	Year (Ci)
C. Particulates					
strontium-89	4.11E-05	1.33E-05	<MDA	<MDA	5.44E-05
strontium-90	<MDA	<MDA	<MDA	<MDA	<MDA
cesium-134	<MDA	<MDA	<MDA	<MDA	<MDA
cesium-137	<MDA	<MDA	<MDA	<MDA	<MDA
barium-lanthanum-140	<MDA	<MDA	<MDA	<MDA	<MDA
cerium-141	<MDA	<MDA	<MDA	<MDA	<MDA
cerium-144	<MDA	<MDA	<MDA	<MDA	<MDA
cobalt-58	<MDA	<MDA	<MDA	<MDA	<MDA
cobalt-60	8.07E-06	8.87E-06	3.79E-05	8.53E-06	6.34E-05
iron-59	<MDA	<MDA	<MDA	<MDA	<MDA
manganese-54	<MDA	<MDA	<MDA	<MDA	<MDA
zinc-65	<MDA	<MDA	<MDA	<MDA	<MDA
chromium-51	<MDA	<MDA	<MDA	<MDA	<MDA
Total for period*	4.92E-05	2.22E-05	3.79E-05	8.53E-06	1.18E-04
Others with T 1/2 < 8 days					
molybdenum-99	<MDA	<MDA	<MDA	<MDA	<MDA
technecium-99m	<MDA	<MDA	<MDA	<MDA	<MDA
strontium-91	<MDA	<MDA	<MDA	<MDA	<MDA
Total with T 1/2 < 8 days*	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium					
tritium	4.80E+00	2.77E+00	7.87E-01	3.45E+00	1.18E+01

* MDA values are not included in the totals. MDA = Less than the “a posteriori” minimal detectable activity (microcuries per unit mass or volume).

Table 3-3 Radwaste Building Releases – Ground Mode Fission Gases and Iodines

Report Period: January -- December 2017

Nuclides Released	1st Quarter (Ci)	2nd Quarter (Ci)	3rd Quarter (Ci)	4th Quarter (Ci)	Year (Ci)
A. Fission gases					
krypton-85	<MDA	<MDA	<MDA	<MDA	<MDA
krypton-85m	<MDA	<MDA	<MDA	<MDA	<MDA
krypton-87	<MDA	<MDA	<MDA	<MDA	<MDA
krypton-88	<MDA	<MDA	<MDA	<MDA	<MDA
xenon-133	<MDA	<MDA	<MDA	<MDA	<MDA
xenon-133m	<MDA	<MDA	<MDA	<MDA	<MDA
xenon-135	<MDA	<MDA	<MDA	<MDA	<MDA
xenon-135m	<MDA	<MDA	<MDA	<MDA	<MDA
xenon-138	<MDA	<MDA	<MDA	<MDA	<MDA
Others					
argon-41	<MDA	<MDA	<MDA	<MDA	<MDA
Total for period *	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Iodines					
iodine-131	3.03E-05	1.34E-04	1.07E-06	<MDA	1.66E-04
iodine-132	<MDA	<MDA	<MDA	<MDA	<MDA
iodine-133	<MDA	<MDA	<MDA	<MDA	<MDA
iodine-134	<MDA	<MDA	<MDA	<MDA	<MDA
iodine-135	<MDA	<MDA	<MDA	<MDA	<MDA
Total for period *	3.03E-05	1.34E-04	1.07E-06	0.00E+00	1.66E-04

* MDA values are not included in the totals. MDA = Less than the “a posteriori” minimal detectable activity (microcuries per unit mass or volume).

Table 3-3 Radwaste Building Releases – Ground Mode (Continued)
Particulates and Tritium

Report Period: January -- December 2017

Nuclides Released	1st Quarter (Ci)	2nd Quarter (Ci)	3rd Quarter (Ci)	4th Quarter (Ci)	Year (Ci)
C. Particulates					
strontium-89	3.39E-06	4.53E-07	<MDA	<MDA	3.85E-06
strontium-90	9.29E-08	1.78E-08	<MDA	<MDA	1.11E-07
cesium-134	<MDA	<MDA	<MDA	<MDA	<MDA
cesium-137	<MDA	<MDA	<MDA	<MDA	<MDA
barium-lanthanum-140	<MDA	<MDA	<MDA	<MDA	<MDA
cerium-141	<MDA	<MDA	<MDA	<MDA	<MDA
cerium-144	<MDA	<MDA	<MDA	<MDA	<MDA
cobalt-58	<MDA	<MDA	<MDA	<MDA	<MDA
cobalt-60	<MDA	<MDA	8.13E-07	<MDA	8.13E-07
iron-59	<MDA	<MDA	<MDA	<MDA	<MDA
manganese-54	<MDA	<MDA	<MDA	<MDA	<MDA
zinc-65	<MDA	<MDA	<MDA	<MDA	<MDA
Total for period*	3.49E-06	4.71E-07	8.13E-07	0.00E+00	4.77E-06
Others with T 1/2 < 8 days					
molybdenum-99	<MDA	<MDA	<MDA	<MDA	<MDA
Total with T 1/2 < 8 days*	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium					
tritium	1.00E-01	9.29E-02	9.35E-02	1.05E-01	3.92E-01

* MDA values are not included in the totals. MDA = Less than the “a posteriori” minimal detectable activity (microcuries per unit mass or volume).

Table 3-4 Summation of Releases
Gaseous Effluents

Report Period: January -- December 2017

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year	Est* Total %Error
A. Fission and activation gases						
Total release (Ci)	8.03E+01	8.91E+01	1.99E+01	1.64E+01	2.06E+02	4.30E+01
Average release rate (µCi/s)	1.02E+01	1.13E+01	2.53E+00	1.94E+00	6.42E+00	
Percent of ODCM limit (%)	7.24E-03	3.99E-03	3.40E-03	2.99E-03	3.86E-03	
B. Iodines						
Total I-131 (Ci)	6.91E-04	1.21E-03	1.05E-05	<MDA	1.91E-03	4.60E+01
Average release rate (µCi/s)	8.79E-05	1.54E-04	1.33E-06	<MDA	5.96E-05	
Percent of ODCM limit (%)	8.12E-05	2.04E-04	3.27E-06	0.00E+00	7.3E-05	
C. Particulates						
Particulates with half-lives >8 days (Ci)	1.96E-04	5.82E-04	8.68E-05	1.43E-05	8.80E-04	4.50E+01
Average release rate (µCi/s)	2.50E-05	7.40E-05	1.10E-05	1.68E-06	2.74E-05	
Percent of ODCM limit (%)	5.00E-06	2.14E-05	2.99E-06	3.95E-07	6.42E-06	
Gross alpha radioactivity (Ci)	8.87E-07	1.16E-06	2.83E-06	1.47E-06	6.35E-06	7.30E+01
D. Tritium						
Total release (Ci)	5.19E+00	3.23E+00	1.35E+00	4.03E+00	1.39E+01	2.60E+01
Average release rate (µCi/s)	6.60E-01	4.11E-01	1.72E-01	4.76E-01	4.34E-01	
Percent of ODCM limit (%)	1.53E-05	9.97E-06	8.05E-06	1.10E-05	9.94E-06	

* Measurement errors are sample-specific. The values reported represent an approximate overall error. Some of the contributors of this error are measurements associated with estimating the sample volume, the exhaust duct flow rates, plateout factors, charcoal cartridge efficiencies, sample line vacuum, run time estimates, anisokinetic correction factors, and gravimetric, gamma spectroscopy, and liquid scintillation analysis errors.

ODCM release rate limits are based on dose rate, and the percent of ODCM limit shown in Table 3-4 is for the following limits. For fission and activation gases the dose rate limits are less than or equal to 500 mrem/year to the whole body and less than or equal to 3000 mrem/year to the skin. For I-131, particulates, and tritium the dose rate limit is less than or equal to 1500 mrem/year to any organ.

Table 3-5 Gaseous Purges and Vents

Report Period: January -- December 2017

Type	Number	Total Time (hr.)	Maximum Time (hr.)	Minimum Time (hr.)	Mean Time (hr.)
Purge	1.00E+00	3.46E+01	3.46E+01	3.46E+01	3.46E+01
Vent	3.30E+01	4.25E+01	6.55E+00	2.67E-01	1.29E+00

Columbia Generating Station is a continuous release plant. All purges and vents are discharged through the High-Efficiency Particulate Air (HEPA) filters and charcoal beds of the Standby Gas Treatment System and released through the reactor building release duct which is, by procedure and design, sampled and continuously monitored for radioactive gaseous waste as a continuous release point.

Table 3-6 Lower Limits of Detection
Gaseous Effluents

Report Period: January -- December 2017

Nuclide	Required LLD† (µCi/cc)	Achieved Analysis LLD (µCi/cc)
Fission Gases		
krypton-87	1.00E-04	1.05E-08
krypton-88	1.00E-04	1.29E-08
xenon-133	1.00E-04	1.00E-08
xenon-133m	1.00E-04	3.25E-08
xenon-135	1.00E-04	3.77E-09
xenon-138	1.00E-04	4.48E-08
Iodines		
iodine-131	1.00E-12	5.79E-14
iodine-133	1.00E-10	1.10E-12
Particulates		
strontium-89	1.00E-11	1.16E-14
strontium-90	1.00E-11	5.12E-15
cesium-134	1.00E-11	4.63E-14
cesium-137	1.00E-11	3.91E-14
molybdenum-99	1.00E-11	7.97E-13
cerium-141	1.00E-11	4.70E-14
cerium-144	1.00E-11	1.78E-13
cobalt-58	1.00E-11	4.27E-14
cobalt-60	1.00E-11	7.75E-14
iron-59	1.00E-11	1.01E-13
manganese-54	1.00E-11	3.68E-14
zinc-65	1.00E-11	1.10E-13
Gross Alpha	1.00E-11	9.01E-16
Tritium		
hydrogen-3	1.00E-06	5.85E-11

† From ODCM Table 6.2.2.1-1

4.0 Solid Radwaste

This section of the annual effluent report provides information required by the Columbia Generating Station Offsite Dose Calculation Manual and recommended by Nuclear Regulatory Commission Regulatory Guide 1.21, Revision 1 (1974).

Solid Radwaste Information required by the Offsite Dose Calculation Manual

January -- December 2017

Class A

1. Container Volumes (ft^3)

5 gallon pail	0.80
55 gallon drum	7.50
B-25 Steel Box	96.0
PL8-120 Polyethylene HIC (SERDS)	120
B-88 Steel Box	128
EL-142 Polyethylene HIC	132
ES-190 Steel Liner	170
PL14-170 Polyethylene HIC (SERDS)	171
14-170 Steel Liner (SERDS)	180
20 ft C-Van	1280

2. Total Curies

   4.64E+01 Curies

3. Principal Radionuclides

Nuclide	Curies	Percent
Co-60	1.07E+01	2.31E-01
C-14	3.09E+00	6.66E-02
Mn-54	2.78E+00	6.00E-02
Co-58	1.92E+00	4.13E-02
Pu-241	1.47E-02	3.17E-04
Zn-65	9.09E-01	1.96E-02
Ag-110m	1.67E-01	3.59E-03
Pu-238	1.52E-04	3.28E-06
Cs-137	1.78E-02	3.84E-04
Pu-239	1.22E-04	2.63E-06
Am-241	1.02E-04	2.20E-06
Fe-55	2.58E+01	5.57E-01
Cm-243	5.34E-05	1.15E-06
Cs-134	1.46E-03	3.16E-05
Cm-242	2.10E-04	4.52E-06
Fe-59	2.48E-01	5.35E-03
Sr-90	3.02E-03	6.50E-05
Ni-63	4.56E-01	9.84E-03
Sb-124	2.89E-02	6.24E-04
H-3	5.66E-03	1.22E-04
Tc-99	5.55E-06	1.20E-07
I-129	1.79E-07	3.85E-09
Nb-95	6.73E-03	1.45E-04
Ba-140	8.12E-04	1.75E-05
I-131	7.60E-03	1.64E-04
Cr-51	1.27E-01	2.74E-03
Co-57	5.66E-03	1.22E-04
Sb-125	1.42E-02	3.06E-04
Zr-95	4.47E-03	9.64E-05

4. Source

Resins	4.32E+01 Ci
DAW	3.16E+00 Ci
Irradiated Components	None
Other (Sealed Source, Mixed Waste, & Liquid Waste)	None

5. Type of Container

   All containers shipped as LSA, SCO or radioactive material in Excepted Packaging, Type A or Type B (including casks) as appropriate

6. Solidification Agent

   None

Class B

There were no Class B shipments made during calendar year 2017.

Class C

There were no Class C shipments made during calendar year 2017.

Solid Radwaste Information Recommended by NRC Regulatory Guide 1.21

January -- December 2017

Solid waste shipped offsite for burial or disposal (not irradiated fuel).

1. Type of Waste

Waste Stream Category	Unit	Annual Cumulative	Est. Total Error %
A. Spent resins, filter sludge, evaporator bottoms, etc.	m^3	6.02E+01	
	Ci	4.32E+01	2.50E+01%
B. Dry Active Waste	m^3	1.60E+01	
	Ci	3.16E+00	2.50E+01%
C. Irradiated Components	m^3		
	Ci	0	
D. Other Waste (Sealed Source, mixed waste, & Liquid Waste)	m^3		
	Ci	0	

2. Estimate of major nuclide composition (by type of waste)

a. Dewatered Spent Resins – All Class A

Nuclide	Curies	Percent
Co-60	9.74E+00	2.25E-01
C-14	3.09E+00	7.15E-02
Mn-54	2.51E+00	5.81E-02
Co-58	7.47E-01	1.73E-02
Pu-241	1.23E-02	2.84E-04
Zn-65	2.92E-01	6.76E-03
Ag-110m	1.67E-01	3.86E-03
Pu-238	1.27E-04	2.93E-06
Cs-137	1.78E-02	4.12E-04
Pu-239	1.01E-04	2.35E-06
Am-241	8.48E-05	1.96E-06
Fe-55	2.57E+01	5.96E-01
Cm-243	4.45E-05	1.03E-06
Cs-134	1.46E-03	3.39E-05
Cm-242	1.74E-04	4.03E-06
Fe-59	2.48E-01	5.75E-03
Sr-90	2.71E-03	6.27E-05
Ni-63	4.33E-01	1.00E-02
Sb-124	2.89E-02	6.70E-04
H-3	5.58E-03	1.29E-04
Tc-99	5.43E-06	1.26E-07
I-129	1.48E-07	3.43E-09
Nb-95	6.73E-03	1.56E-04
Ba-140	8.12E-04	1.88E-05
I-131	7.60E-03	1.76E-04
Cr-51	1.27E-01	2.94E-03
Co-57	5.66E-03	1.31E-04
Sb-125	1.42E-02	3.29E-04
Zr-95	4.47E-03	1.04E-04

b. Dry Active Waste (DAW) – All Class A

Nuclide	Curies	Percent
Co-60	9.87E-01	3.12E-01
Co-58	1.17E+00	3.71E-01
Zn-65	6.17E-01	1.95E-01
Mn-54	2.72E-01	8.62E-02
Pu-241	2.47E-03	7.82E-04
Pu-238	2.55E-05	8.08E-06
Pu-239	2.05E-05	6.48E-06
Am-241	1.71E-05	5.40E-06
Cm-243	8.98E-06	2.84E-06
Cm-242	3.58E-05	1.13E-05
Fe-55	8.41E-02	2.66E-02
Sr-90	3.05E-04	9.64E-05
Ni-63	2.33E-02	7.38E-03
C-14	4.67E-04	1.48E-04
H-3	8.28E-05	2.62E-05
Tc-99	1.20E-07	3.79E-08
I-129	3.04E-08	9.61E-09

c. Irradiated Components – All Class C

None

d. Other Waste (sealed source, mixed waste, and liquid waste) – All Class A

None

3. Solid Waste Disposition

Number of Shipments	Mode of Transportation	Destination
13	Tractor - Trailer via Public Highway	US Ecology, Inc. P.O. Box 638 Hanford Reservation Richland, WA. 99352

Irradiated Fuel Shipments (Disposition)

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

5.0 Meteorological Data

The meteorological data contained in Tables 5-1 through 5-5 was obtained from a meteorological tower located 762 meters (2500 feet) west of Columbia Generating Station. Data was recovered from two sets of redundant instruments on the tower at the 10 meter (33-foot) and 75 meter (245- foot) levels. The meteorological data is a composite file generated from the automated data recovery systems for the calendar year 2017. Data is archived on the Energy Northwest Local Area Network.

Meteorological data recovery for 2017 was 91.7% at the 10 meter (33-foot) level. Redundant wind and temperature sensors are installed at both levels of the meteorological tower. Data from the two systems can be combined to permit maximum data recovery for defined date ranges.

The data in Tables 5-1 through 5-4 provide joint frequency distributions (JFD) at the 10-meter level by quarter for 2017. These tables show the total hours at various wind speeds for each sector and stability class. The NRC stability classes A through G and eleven wind speed categories along with the 16 wind direction sectors were used to prepare each joint frequency table. Tables 5-5 provide the annual joint frequency distributions.

Wind speed is measured in miles per hour in the tables and speeds below 1.0 MPH were recorded as calms.

There are a number of atmospheric factors which affect dispersivity but which are not modeled in the CGS estimates of dispersion and deposition. Those conditions which were measured or documented at the Hanford Meteorological Station during 2017 were snow (30 inches), total precipitation (8.6 inches), dust or blowing dust (0 days), fog (79 days), thunderstorms (10 days), and smoke (17 day).

Table 5-1 1st Quarter Average, 33 Ft Above Ground Level (AGL)

		Elevation:	33			Start Date:	1/1/2017				Total number of Periods:	2159						
		Period:	1st Quarter			Stop Date:	4/1/2017				Periods of No Data Recovery:	44						
											System Percent Data Recovery:	98.0%						
Stability Class:		**A**																
Wind Speed																		
Min	**Max**	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**	**TOTAL**
1.0	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.5	6.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.7	8.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.9	11.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.2	13.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.4	17.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.4	29.1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Stability Class:		**B**																
Wind Speed																		
Min	**Max**	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**	**TOTAL**
1.0	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.5	6.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.7	8.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.9	11.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.2	13.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.4	17.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.4	29.1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Stability Class:		**C**																
Wind Speed																		
Min	**Max**	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**	**TOTAL**
1.0	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
2.2	4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
4.5	6.7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
6.7	8.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
8.9	11.2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
11.2	13.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.4	17.9	0	0	0	0	0	0	0	0	2	5	0	1	0	0	1	0	9
17.9	22.4	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4
22.4	29.1	0	0	0	0	0	0	0	0	0	3	1	1	0	0	0	0	5
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		0	1	0	0	0	0	0	0	3	12	1	2	0	0	4	1	24
Stability Class:		**D**																
Wind Speed																		
Min	**Max**	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**	**TOTAL**
1.0	2.2	10	4	2	2	0	5	4	3	1	3	4	6	3	7	18	8	80
2.2	4.5	7	4	6	1	0	4	5	13	14	6	5	2	7	11	24	21	130
4.5	6.7	8	1	3	0	0	1	9	16	16	4	1	4	2	9	24	5	103
6.7	8.9	2	2	4	0	0	0	10	14	8	5	3	5	3	5	15	9	85
8.9	11.2	3	0	0	0	0	0	3	7	14	4	2	2	2	9	6	5	57
11.2	13.4	2	0	0	0	0	0	0	4	11	3	3	0	2	4	16	9	54
13.4	17.9	10	0	0	0	0	0	0	2	8	7	4	6	1	9	12	9	68
17.9	22.4	2	0	0	0	0	0	0	0	2	8	2	2	0	1	0	1	18
22.4	29.1	0	0	0	0	0	0	0	1	1	2	1	0	0	0	0	0	5
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		44	11	15	3	0	10	31	60	75	42	25	27	20	55	115	67	600

Table 5-1 1st Quarter Average, 33 Ft AGL (Continued)

Stability Class: E

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	6	6	4	3	0	3	2	14	19	9	9	11	6	16	20	12	140
2.2	4.5	10	8	6	1	3	3	9	17	15	10	8	15	18	24	51	17	215
4.5	6.7	7	0	5	0	0	1	7	17	8	8	3	3	3	9	34	11	116
6.7	8.9	0	1	0	1	0	0	8	19	12	8	7	5	4	10	13	7	95
8.9	11.2	1	0	0	0	0	0	8	14	9	7	7	0	4	9	8	7	74
11.2	13.4	3	0	0	0	0	0	1	5	10	6	8	4	2	3	8	6	56
13.4	17.9	5	0	0	0	0	0	0	8	8	12	11	5	3	7	12	11	82
17.9	22.4	0	0	0	0	0	0	0	0	1	11	1	0	2	1	2	6	24
22.4	29.1	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	7
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		32	15	15	5	3	7	35	94	82	78	54	43	42	79	148	77	809

Stability Class: F

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	4	4	1	1	1	2	2	2	4	4	6	7	10	3	8	6	65
2.2	4.5	14	7	4	0	0	2	4	13	4	8	8	12	7	14	13	15	125
4.5	6.7	2	1	3	0	0	0	6	17	18	2	2	4	2	8	9	10	84
6.7	8.9	0	0	1	0	0	0	2	23	5	2	1	1	1	3	1	1	41
8.9	11.2	0	0	0	0	0	0	2	10	2	0	0	3	2	1	3	1	24
11.2	13.4	0	0	0	0	0	0	2	4	3	1	0	0	0	1	2	0	13
13.4	17.9	0	0	0	0	0	0	0	4	5	4	0	0	0	1	2	0	16
17.9	22.4	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		20	12	9	1	1	4	18	73	42	22	17	27	22	31	38	33	370

Stability Class: G

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	4	1	0	0	0	0	2	1	4	3	1	2	2	2	4	6	32
2.2	4.5	1	3	2	0	0	0	0	3	7	2	1	1	3	7	17	9	56
4.5	6.7	0	0	0	0	0	0	0	1	2	3	0	1	0	3	18	5	33
6.7	8.9	0	0	0	0	0	0	0	3	4	4	0	0	0	0	4	2	17
8.9	11.2	0	0	0	0	0	0	0	5	1	0	0	0	0	1	3	0	10
11.2	13.4	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	4
13.4	17.9	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	5
17.9	22.4	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	3
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		5	4	2	0	0	0	2	22	20	12	2	4	5	14	46	22	160

Stability Class: All

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	24	15	7	6	1	10	10	20	28	19	20	26	21	28	51	32	318
2.2	4.5	32	22	18	2	3	9	18	46	40	26	22	30	35	56	106	62	527
4.5	6.7	17	3	11	0	0	2	22	51	44	17	6	12	7	29	85	32	338
6.7	8.9	2	3	5	1	0	0	20	59	29	19	11	11	8	18	34	19	239
8.9	11.2	4	0	0	0	0	0	13	36	27	11	9	5	8	20	20	13	166
11.2	13.4	5	0	0	0	0	0	3	16	24	10	11	4	4	9	26	15	127
13.4	17.9	15	0	0	0	0	0	0	18	24	28	15	12	4	17	27	20	180
17.9	22.4	2	0	0	0	0	0	0	2	5	24	3	2	2	2	2	7	51
22.4	29.1	0	0	0	0	0	0	0	1	1	14	2	1	0	0	0	0	19
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		101	43	41	9	4	21	86	249	222	168	99	103	89	179	351	200	1965

Periods of Calm while in Stability Class:							
A	B	C	D	E	F	G	Total
0	0	0	36	72	28	14	150

Table 5-2 2nd Quarter Average, 33 Ft AGL

	Elevation:	33				Start Date:	4/1/2017							Total number of Periods:	2184				
	Period:	2nd Quarter				Stop Date:	7/1/2017							Periods of No Data Recovery:	634				
														System Percent Data Recovery:	71.0%				
Stability Class:		A																	
Wind Speed																			
Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	
1.0	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2.2	4.5	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
4.5	6.7	0	1	0	1	0	0	2	0	0	2	0	0	0	0	0	0	6	
6.7	8.9	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3	
8.9	11.2	0	1	1	0	0	0	0	0	0	0	0	1	1	0	1	0	5	
11.2	13.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
13.4	17.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	4	
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	3	
22.4	29.1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTALS		0	4	2	1	0	0	2	0	0	3	0	1	3	1	6	2	25	
Stability Class:		B																	
Wind Speed																			
Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	
1.0	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2.2	4.5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
4.5	6.7	1	3	0	0	0	0	1	0	0	0	0	0	0	0	0	2	7	
6.7	8.9	0	2	2	2	0	0	0	0	0	0	0	0	0	1	0	2	9	
8.9	11.2	1	0	2	0	0	0	0	1	1	0	0	0	2	1	0	1	9	
11.2	13.4	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	2	
13.4	17.9	0	0	0	0	0	0	0	0	0	4	1	0	0	0	3	1	9	
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	4	
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTALS		2	6	4	2	0	0	1	1	2	4	1	0	3	3	9	6	44	
Stability Class:		C																	
Wind Speed																			
Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	
1.0	2.2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
2.2	4.5	4	2	3	2	1	2	1	0	0	0	0	0	0	0	1	3	19	
4.5	6.7	5	6	8	0	1	0	0	0	3	1	0	0	1	0	4	3	32	
6.7	8.9	2	5	2	0	1	0	1	2	6	1	1	1	2	0	0	2	26	
8.9	11.2	1	0	2	1	0	0	0	2	4	4	0	6	3	1	1	4	29	
11.2	13.4	0	0	0	0	0	0	0	0	12	6	0	5	3	0	2	0	28	
13.4	17.9	0	0	0	0	0	0	0	0	7	8	2	2	1	2	0	1	23	
17.9	22.4	0	0	0	0	0	0	0	0	0	1	2	0	1	4	1	0	9	
22.4	29.1	0	0	0	0	0	0	0	0	0	2	1	0	0	1	1	0	5	
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTALS		14	13	15	3	3	2	2	4	32	23	6	14	11	8	10	13	173	
Stability Class:		D																	
Wind Speed																			
Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	
1.0	2.2	1	2	5	1	2	2	6	4	4	2	2	0	0	3	5	3	42	
2.2	4.5	4	10	10	4	3	7	8	19	9	9	3	5	7	2	5	7	112	
4.5	6.7	9	1	9	4	1	5	7	14	9	6	4	6	3	2	10	6	96	
6.7	8.9	5	3	2	4	1	1	7	13	10	6	3	1	3	0	4	1	64	
8.9	11.2	0	1	0	1	0	1	5	4	17	17	7	5	2	8	5	3	76	
11.2	13.4	0	0	0	0	0	0	0	2	7	13	3	3	2	3	2	0	35	
13.4	17.9	0	0	0	0	0	0	0	1	5	6	4	7	3	3	4	0	33	
17.9	22.4	0	0	0	0	0	0	0	0	1	6	3	5	1	7	7	0	30	
22.4	29.1	0	0	0	0	0	0	0	1	2	0	0	1	0	3	1	0	8	
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTALS		19	17	26	14	7	16	33	58	64	65	29	33	21	31	43	20	496	

Table 5-2 2nd Quarter Average, 33 Ft AGL (Continued)

Stability Class: E

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	2	4	1	1	0	1	1	1	2	1	5	2	4	1	0	2	28
2.2	4.5	7	5	3	2	1	4	2	7	5	10	5	12	6	3	2	4	78
4.5	6.7	2	3	5	0	1	4	4	9	4	8	6	3	6	8	8	8	79
6.7	8.9	0	0	4	0	0	0	2	9	16	6	3	5	7	5	8	3	68
8.9	11.2	0	0	1	1	0	1	3	5	15	5	2	2	12	10	7	0	64
11.2	13.4	0	1	0	0	0	0	0	2	12	6	1	2	9	10	2	0	45
13.4	17.9	0	0	0	0	0	0	0	1	4	6	1	1	5	15	3	0	36
17.9	22.4	0	0	0	0	0	0	0	0	0	0	1	0	0	6	1	0	8
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		11	13	14	4	2	10	12	34	58	42	24	27	49	58	31	17	406

Stability Class: F

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	1	2	0	1	0	1	1	5	2	6	0	0	0	1	2	4	26
2.2	4.5	1	7	3	1	0	0	1	8	5	6	2	2	5	7	8	5	61
4.5	6.7	1	5	3	0	0	1	2	9	11	5	2	3	5	4	7	6	64
6.7	8.9	0	0	1	0	0	0	1	4	5	3	2	1	5	3	8	0	33
8.9	11.2	0	0	0	0	0	0	1	5	3	5	0	1	2	2	3	0	22
11.2	13.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.4	17.9	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		3	14	7	2	0	2	6	31	27	25	6	7	17	17	28	15	207

Stability Class: G

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	4	4	2	0	1	0	0	1	1	1	1	0	1	1	2	4	23
2.2	4.5	8	8	1	0	0	1	4	4	5	4	4	0	2	1	9	3	54
4.5	6.7	1	3	1	0	0	0	0	10	4	2	2	1	0	0	7	2	33
6.7	8.9	0	0	0	0	0	0	1	4	4	5	0	0	0	0	1	0	15
8.9	11.2	0	0	0	0	0	0	0	4	0	0	0	2	0	0	0	0	6
11.2	13.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.4	17.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		13	15	4	0	1	1	5	23	14	12	7	3	3	2	19	9	131

Stability Class: All

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	10	12	8	3	3	4	8	11	9	10	8	2	5	6	9	13	121
2.2	4.5	24	34	21	9	5	14	16	38	24	29	14	19	20	13	25	22	327
4.5	6.7	19	22	26	5	3	10	16	42	31	24	14	13	15	14	36	27	317
6.7	8.9	7	11	11	6	2	1	12	32	41	21	9	8	19	9	21	8	218
8.9	11.2	2	2	6	3	0	2	9	21	40	31	9	17	22	22	17	8	211
11.2	13.4	0	1	0	0	0	0	0	4	32	25	4	10	14	14	6	1	111
13.4	17.9	0	0	0	0	0	0	0	2	17	24	8	10	9	20	13	3	106
17.9	22.4	0	0	0	0	0	0	0	0	1	7	6	5	3	18	14	0	54
22.4	29.1	0	0	0	0	0	0	0	1	2	3	1	1	0	4	5	0	17
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		62	82	72	26	13	31	61	151	197	174	73	85	107	120	146	82	1482

Periods of Calm while in Stability Class:							
A	B	C	D	E	F	G	Total
2	0	0	15	9	15	27	68

Table 5-3 3rd Quarter Average, 33 Ft AGL

	Elevation:	33				Start Date:	7/1/2017								Total number of Periods:	2208			
	Period:	3rd Quarter				Stop Date:	10/1/2017								Periods of No Data Recovery:	4			
															System Percent Data Recovery:	99.8%			
Stability Class:		A																	
Wind Speed																			
Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	
1.0	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2.2	4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4.5	6.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6.7	8.9	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
8.9	11.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.2	13.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13.4	17.9	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTALS		0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2	
Stability Class:		B																	
Wind Speed																			
Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	
1.0	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2.2	4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4.5	6.7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
6.7	8.9	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
8.9	11.2	0	2	0	0	0	0	0	0	3	0	0	0	0	0	0	0	5	
11.2	13.4	2	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	8	
13.4	17.9	0	0	0	0	0	0	0	0	1	4	0	0	0	0	1	0	6	
17.9	22.4	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2	
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTALS		3	5	0	0	0	0	0	0	8	7	1	0	0	0	1	0	25	
Stability Class:		C																	
Wind Speed																			
Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	
1.0	2.2	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2	6	
2.2	4.5	11	7	1	2	3	0	0	1	1	0	1	0	0	0	1	2	30	
4.5	6.7	4	6	10	6	3	0	0	4	8	1	0	0	0	2	0	2	46	
6.7	8.9	2	3	3	1	0	3	0	8	19	4	1	0	0	0	0	1	45	
8.9	11.2	3	0	0	2	0	0	1	6	6	5	0	0	2	1	1	0	27	
11.2	13.4	3	0	0	0	0	0	0	0	4	4	2	0	0	0	0	1	14	
13.4	17.9	1	0	0	0	0	0	0	0	1	4	2	0	1	0	0	0	9	
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTALS		26	17	14	11	7	3	1	19	39	18	6	0	3	3	2	8	177	
Stability Class:		D																	
Wind Speed																			
Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	
1.0	2.2	7	7	11	19	13	5	4	12	7	4	5	4	0	2	5	7	112	
2.2	4.5	13	13	25	31	14	17	22	31	19	10	3	3	2	2	7	12	224	
4.5	6.7	7	8	17	26	11	5	26	26	26	8	2	2	0	2	4	10	180	
6.7	8.9	6	2	6	14	4	6	18	14	18	4	3	5	8	3	2	6	119	
8.9	11.2	7	5	2	3	3	1	9	7	6	1	3	2	3	3	0	2	57	
11.2	13.4	3	0	0	0	0	0	5	1	9	4	2	1	0	0	6	1	32	
13.4	17.9	0	0	0	0	0	0	0	0	0	5	1	3	1	2	5	3	20	
17.9	22.4	0	0	0	0	0	0	0	0	0	0	1	1	0	0	10	0	12	
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTALS		43	35	61	93	45	34	84	91	85	36	20	21	14	14	39	41	756	

Table 5-3 3rd Quarter Average, 33 Ft AGL (Continued)

Stability Class: E

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	2	1	0	3	0	2	4	3	2	2	0	4	3	2	3	0	31
2.2	4.5	9	7	5	3	0	2	3	3	15	4	3	1	5	6	7	2	75
4.5	6.7	7	1	5	1	3	1	6	17	9	3	2	5	5	7	6	6	84
6.7	8.9	1	0	3	1	0	0	9	6	4	0	2	1	3	12	11	3	56
8.9	11.2	0	0	0	0	0	0	5	3	3	3	3	1	3	13	9	2	45
11.2	13.4	0	0	0	0	0	0	0	0	1	4	3	1	1	7	10	1	28
13.4	17.9	0	0	0	0	0	0	0	0	1	2	0	0	0	6	25	0	34
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	4
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		19	9	13	8	3	5	27	32	35	18	13	13	20	55	73	14	357

Stability Class: F

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	5	2	6	3	1	3	7	6	6	5	2	2	1	4	7	4	64
2.2	4.5	7	13	7	5	1	2	3	9	15	7	6	2	2	4	5	12	100
4.5	6.7	1	5	5	3	2	0	6	26	13	8	1	0	2	1	6	8	87
6.7	8.9	1	0	0	0	0	0	5	13	4	0	1	0	1	2	3	2	32
8.9	11.2	0	0	0	0	0	0	1	3	1	0	0	0	0	0	2	0	7
11.2	13.4	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4
13.4	17.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		14	20	18	11	4	5	22	57	39	20	10	4	6	15	23	26	294

Stability Class: G

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	8	15	17	10	9	3	7	7	10	6	5	3	6	2	4	5	117
2.2	4.5	29	27	42	9	0	1	14	17	14	4	2	1	4	2	8	14	188
4.5	6.7	2	4	14	4	0	0	5	19	21	5	1	0	1	0	6	7	89
6.7	8.9	0	0	2	0	0	0	0	10	9	1	1	0	1	1	6	3	34
8.9	11.2	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2
11.2	13.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.4	17.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		39	46	75	23	9	4	26	53	54	17	10	4	12	5	24	29	430

Stability Class: All

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	24	26	34	35	24	13	22	28	25	17	12	13	10	10	19	18	330
2.2	4.5	69	67	80	50	18	22	42	61	64	25	15	7	13	14	28	42	617
4.5	6.7	22	24	51	40	19	6	43	92	77	25	6	7	8	12	22	33	487
6.7	8.9	10	8	15	16	4	9	32	51	54	9	8	6	13	18	22	15	290
8.9	11.2	10	7	2	5	3	1	16	19	19	10	7	3	8	17	12	4	143
11.2	13.4	8	0	0	0	0	0	5	1	18	14	7	2	1	11	16	3	86
13.4	17.9	1	0	0	0	0	0	0	0	4	15	3	3	2	8	31	3	70
17.9	22.4	0	0	0	0	0	0	0	0	0	1	2	1	0	2	12	0	18
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		144	132	182	146	68	51	160	252	261	116	60	42	55	92	162	118	2041

Periods of Calm while in Stability Class:							
A	B	C	D	E	F	G	Total
0	0	0	33	18	33	79	163

Table 5-4 4th Quarter Average, 33 Ft AGL

	Elevation:	33			Start Date:	10/1/2017					Total number of Periods:	2209						
	Period:	4th Quarter			Stop Date:	1/1/2018					Periods of No Data Recovery:	46						
											System Percent Data Recovery:	97.9%						

Stability Class: A

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.5	6.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.7	8.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.9	11.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.2	13.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.4	17.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Stability Class: B

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.5	6.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.7	8.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.9	11.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.2	13.4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
13.4	17.9	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2

Stability Class: C

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	4.5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
4.5	6.7	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5
6.7	8.9	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6
8.9	11.2	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	5
11.2	13.4	0	0	1	0	0	0	0	0	2	1	0	0	0	0	0	0	4
13.4	17.9	0	2	1	0	0	0	0	0	5	5	1	0	3	2	0	0	19
17.9	22.4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		3	8	5	0	0	0	0	0	7	7	1	0	3	2	0	6	42

Stability Class: D

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	9	6	11	4	1	1	5	7	15	9	6	2	6	9	7	7	105
2.2	4.5	17	23	15	7	0	1	6	17	20	5	1	6	2	1	31	24	176
4.5	6.7	20	8	3	0	0	0	5	26	14	5	2	0	4	7	42	34	170
6.7	8.9	5	5	3	0	0	0	7	14	16	2	2	2	1	5	14	14	90
8.9	11.2	4	4	2	0	0	0	2	8	5	6	1	3	2	6	8	4	55
11.2	13.4	2	1	0	0	0	0	0	2	7	8	0	0	2	2	4	7	35
13.4	17.9	0	0	1	0	0	0	0	1	7	14	6	5	4	5	1	4	48
17.9	22.4	0	0	0	0	0	0	0	0	0	5	1	2	1	1	0	0	10
22.4	29.1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		57	47	35	11	1	2	25	75	84	56	19	20	22	36	107	94	691

Table 5-4 4th Quarter Average, 33 Ft AGL (Continued)

Stability Class: E

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	9	3	3	3	3	2	1	4	7	5	5	13	8	14	15	12	107
2.2	4.5	14	10	3	2	1	4	5	11	12	5	17	11	11	11	23	40	180
4.5	6.7	8	5	4	2	0	0	7	13	18	7	9	2	1	9	25	14	124
6.7	8.9	5	2	3	0	0	0	8	15	6	7	4	0	3	8	22	6	89
8.9	11.2	2	1	0	0	0	0	4	9	12	10	11	1	0	6	11	2	69
11.2	13.4	0	2	0	0	0	0	1	3	6	6	12	2	3	2	1	0	38
13.4	17.9	0	4	0	0	0	0	0	4	10	10	8	3	1	2	2	0	44
17.9	22.4	0	6	0	0	0	0	0	0	1	2	1	0	0	0	0	0	10
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		38	33	13	7	4	6	26	59	72	52	67	32	27	52	99	74	661

Stability Class: F

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	4	1	3	1	1	0	1	2	3	1	3	1	6	7	10	7	51
2.2	4.5	16	8	3	1	0	0	0	8	17	15	5	12	12	14	13	19	143
4.5	6.7	8	2	0	0	1	0	2	4	6	12	4	1	3	10	9	16	78
6.7	8.9	1	0	0	0	0	0	3	9	11	6	1	1	2	4	4	1	43
8.9	11.2	0	0	0	0	0	0	0	9	9	3	0	0	0	1	0	0	22
11.2	13.4	0	0	0	0	0	0	0	2	0	4	0	0	1	0	0	0	7
13.4	17.9	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
17.9	22.4	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		29	11	6	2	2	0	6	34	50	41	13	15	24	36	36	43	348

Stability Class: G

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	13	3	4	3	0	0	0	6	5	1	6	5	5	6	7	8	72
2.2	4.5	10	4	3	0	0	0	4	8	9	5	6	3	10	9	21	24	116
4.5	6.7	3	0	1	1	0	0	2	6	12	4	3	1	1	2	6	16	58
6.7	8.9	0	0	0	0	0	0	0	8	6	3	1	0	0	1	2	3	24
8.9	11.2	0	0	0	0	0	0	0	3	2	1	0	0	1	0	1	0	8
11.2	13.4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
13.4	17.9	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	3
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		26	7	8	4	0	0	6	32	36	15	16	9	17	18	37	51	282

Stability Class: All

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	35	13	21	11	5	3	7	19	30	16	20	21	25	36	39	34	335
2.2	4.5	58	45	24	10	1	5	15	44	58	30	29	32	35	35	88	108	617
4.5	6.7	39	18	8	3	1	0	16	49	50	28	18	4	9	28	82	82	435
6.7	8.9	12	10	6	0	0	0	18	46	39	18	8	3	6	18	42	26	252
8.9	11.2	7	5	5	0	0	0	6	29	28	20	12	4	3	13	20	7	159
11.2	13.4	2	3	1	0	0	0	1	8	16	19	12	2	6	4	5	7	86
13.4	17.9	0	6	2	0	0	0	0	5	26	31	15	8	8	9	3	4	117
17.9	22.4	0	6	0	0	0	0	0	0	3	8	2	2	1	1	0	0	23
22.4	29.1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		153	106	67	24	7	8	63	200	250	172	116	76	93	144	279	268	2026

Periods of Calm while in Stability Class:							
A	B	C	D	E	F	G	Total
0	0	0	53	35	21	28	137

Table 5-5 Year 2017, 33 Ft AGL

Elevation:	33			Start Date:	1/1/2017			Total number of Periods:	8760								
Period:	2017 Annual			Stop Date:	1/1/2018			Periods of No Data Recovery:	728								
								System Percent Data Recovery:	91.7%								

Stability Class: A

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	4.5	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
4.5	6.7	0	1	0	1	0	0	2	0	0	2	0	0	0	0	0	0	6
6.7	8.9	0	1	1	0	0	0	0	0	0	0	0	0	2	0	0	0	4
8.9	11.2	0	1	1	0	0	0	0	0	0	0	0	1	1	0	1	0	5
11.2	13.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
13.4	17.9	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	1	5
17.9	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	3
22.4	29.1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		0	4	3	1	0	0	2	0	1	4	0	1	3	1	6	2	28

Stability Class: B

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2	4.5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
4.5	6.7	2	3	0	0	0	0	1	0	0	0	0	0	0	0	0	2	8
6.7	8.9	0	5	2	2	0	0	0	0	0	0	0	0	0	1	0	2	12
8.9	11.2	1	2	2	0	0	0	0	1	4	0	0	0	2	1	0	1	14
11.2	13.4	2	0	0	0	0	0	0	0	6	2	0	0	0	1	0	0	11
13.4	17.9	0	0	0	0	0	0	0	0	1	9	1	0	0	0	4	1	16
17.9	22.4	0	0	0	0	0	0	0	0	0	1	1	0	1	0	3	0	6
22.4	29.1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	4
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		5	11	4	2	0	0	1	1	11	13	2	0	3	3	10	6	72

Stability Class: C

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	4	1	0	0	1	0	0	0	0	0	0	0	0	0	1	2	9
2.2	4.5	16	9	4	4	4	2	1	1	1	0	1	0	0	0	3	6	52
4.5	6.7	9	16	18	6	4	0	0	4	11	2	0	0	1	2	4	8	85
6.7	8.9	5	11	5	1	1	3	1	10	25	5	2	1	2	0	1	5	78
8.9	11.2	5	0	5	3	0	0	1	8	11	9	0	6	5	2	2	5	62
11.2	13.4	3	0	1	0	0	0	0	0	18	11	2	5	3	0	2	1	46
13.4	17.9	1	2	1	0	0	0	0	0	15	22	5	3	5	4	1	1	60
17.9	22.4	0	0	0	0	0	0	0	0	0	6	2	0	1	4	1	0	14
22.4	29.1	0	0	0	0	0	0	0	0	0	5	2	1	0	1	1	0	10
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		43	39	34	14	10	5	3	23	81	60	14	16	17	13	16	28	416

Stability Class: D

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	27	19	29	26	16	13	19	26	27	18	17	12	9	21	35	25	339
2.2	4.5	41	50	56	43	17	29	41	80	62	30	12	16	18	16	67	64	642
4.5	6.7	44	18	32	30	12	11	47	82	65	23	9	12	9	20	80	55	549
6.7	8.9	18	12	15	18	5	7	42	55	52	17	11	13	15	13	35	30	358
8.9	11.2	14	10	4	4	3	2	19	26	42	28	13	12	9	26	19	14	245
11.2	13.4	7	1	0	0	0	0	5	9	34	28	8	4	6	9	28	17	156
13.4	17.9	10	0	1	0	0	0	0	4	20	32	15	21	9	19	22	16	169
17.9	22.4	2	0	0	0	0	0	0	0	3	19	7	10	2	9	17	1	70
22.4	29.1	0	0	0	0	0	0	0	2	3	4	1	1	0	3	1	0	15
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		163	110	137	121	53	62	173	284	308	199	93	101	77	136	304	222	2543

Table 5-5 Year 2017, 33 Ft AGL (Continued)

Stability Class: E

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	19	14	8	10	3	8	8	22	30	17	19	30	21	33	38	26	306
2.2	4.5	40	30	17	8	5	13	19	38	47	29	33	39	40	44	83	63	548
4.5	6.7	24	9	19	3	4	6	24	56	39	26	20	13	15	33	73	39	403
6.7	8.9	6	3	10	2	0	0	27	49	38	21	16	11	17	35	54	19	308
8.9	11.2	3	1	1	1	0	1	20	31	39	25	23	4	19	38	35	11	252
11.2	13.4	3	3	0	0	0	0	2	10	29	22	24	9	15	22	21	7	167
13.4	17.9	5	4	0	0	0	0	0	13	23	30	20	9	9	30	42	11	196
17.9	22.4	0	6	0	0	0	0	0	0	2	13	3	0	2	9	5	6	46
22.4	29.1	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	7
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		100	70	55	24	12	28	100	219	247	190	158	115	138	244	351	182	2233

Stability Class: F

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	14	9	10	6	3	6	11	15	15	16	11	10	17	15	27	21	206
2.2	4.5	38	35	17	7	1	4	8	38	41	36	21	28	26	39	39	51	429
4.5	6.7	12	13	11	3	3	1	16	56	48	27	9	8	12	23	31	40	313
6.7	8.9	2	0	2	0	0	0	11	49	25	11	5	3	9	12	16	4	149
8.9	11.2	0	0	0	0	0	0	4	27	15	8	0	4	4	4	8	1	75
11.2	13.4	0	0	0	0	0	0	2	6	3	5	0	0	1	5	2	0	24
13.4	17.9	0	0	0	0	0	0	0	4	8	4	0	0	0	1	2	0	19
17.9	22.4	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	4
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		66	57	40	16	7	11	52	195	158	108	46	53	69	99	125	117	1219

Stability Class: G

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	29	23	23	13	10	3	9	15	20	11	13	10	14	11	17	23	244
2.2	4.5	48	42	48	9	0	2	22	32	35	15	13	5	19	19	55	50	414
4.5	6.7	6	7	16	5	0	0	7	36	39	14	6	3	2	5	37	30	213
6.7	8.9	0	0	2	0	0	0	1	25	23	13	2	0	1	2	13	8	90
8.9	11.2	0	0	0	0	0	0	0	12	3	2	1	2	1	1	4	0	26
11.2	13.4	0	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	5
13.4	17.9	0	0	0	0	0	0	0	4	3	1	0	0	0	0	0	0	8
17.9	22.4	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	3
22.4	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		83	72	89	27	10	5	39	130	124	56	35	20	37	39	126	111	1003

Stability Class: All

Wind Speed Min	Max	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
1.0	2.2	93	66	70	55	33	30	47	78	92	62	60	62	61	80	118	97	1104
2.2	4.5	183	168	143	71	27	50	91	189	186	110	80	88	103	118	247	234	2088
4.5	6.7	97	67	96	48	23	18	97	234	202	94	44	36	39	83	225	174	1577
6.7	8.9	31	32	37	23	6	10	82	188	163	67	36	28	46	63	119	68	999
8.9	11.2	23	14	13	8	3	3	44	105	114	72	37	29	41	72	69	32	679
11.2	13.4	15	4	1	0	0	0	9	29	90	68	34	18	25	38	53	26	410
13.4	17.9	16	6	2	0	0	0	0	25	71	98	41	33	23	54	74	30	473
17.9	22.4	2	6	0	0	0	0	0	2	9	40	13	10	6	23	28	7	146
22.4	29.1	0	0	0	0	0	0	0	2	3	19	3	2	0	4	5	0	38
29.1	40.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.3	90.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		460	363	362	205	92	111	370	852	930	630	348	306	344	535	938	668	7514

Periods of Calm while in Stability Class:							
A	B	C	D	E	F	G	Total
2	0	0	137	134	97	148	518

6.0 Dose Assessment -- IMPACT ON MAN

Liquid Effluents - There were no liquid discharges from the radwaste processing system to the Columbia River during calendar year 2017. As such, the liquid dose reporting tables (Tables 6-1 through 6-4) described in the implementing procedure have been excluded from this report.

Gaseous Effluents - The NRC GASPAR II computer code was used to calculate doses at and beyond the site boundary using quarterly and annual meteorological data and site-specific variables as required and defined in the ODCM. Table 6-5 shows the highest calculated doses at and beyond the site boundary for Beta and Gamma air dose, skin dose, total body dose, and maximum organ dose. Table 6-6 provides the population collective dose within a 50-mile radius, and was obtained from the As Low As Reasonably Achievable (ALARA) annual integrated population dose summary (in person-rem) of the GASPAR computer code output file. Table 6-6 also provides the annual average individual doses associated with each pathway based on the population within 50 miles. These values were obtained by dividing the ALARA integrated dose (person-rem) by the 2010 US Census 50-mile population (448,383) and converting to mrem.

During the growing season, Columbia Generating Station conducts a five-mile land use census to determine the locations of nearest residents, gardens, and milk animals or other livestock out to five miles in each sector. The 2017 Land Use Census identified two broad leaf vegetable gardens but no milking animals within the 5-mile radius. Cattle and horses were observed within 5-miles. As substantial commercial fruit orchards and corn crops were observed in all eastern sectors with residents, it was assumed that these crops were being consumed by the residents. The GASPAR code consumption rates were revised to reflect these differences.

Dose to Onsite Members of the Public

The term “Member of the Public” includes all persons who are not occupationally associated with the plant. This category does not include employees of the utility, its contractors or vendors. This category does include persons who use portions of the site for recreational, occupational or other purposes not associated with the plant.

Dose was evaluated to Members of the Public that were not identified per the criteria of the 2017 Land Use Census. This includes non-Energy Northwest employees that work East of the site, in building associated with sites 1 and 4. The maximum dose from gaseous effluents to these individuals was estimated assuming exposure to the plume, inhalation, and ground deposition pathways and an occupancy factor consistent with ODCM section 3 as a bounding condition.

The following table (6.0) shows estimated dose to Members of the Public from gaseous effluents within the site boundary of Columbia Generating Station for a fraction of a year spent at each location.

Table 6.0; Dose to Members of the Public within the Site Boundary

Location	Hours Spent	Total Body Dose (mrem)	Thyroid Dose (mrem)	Highest Organ Dose (mrem)	Beta Air Dose (mrad)	Gamma Air Dose (mrad)
WNP-4 Whse.2-4	2.08E+03	4.77E-03	5.13E-03	7.61E-03	3.04E-03	5.91E-03
WNP-1 Bldg 121	2.08E+03	8.17E-03	8.66E-03	1.30E-02	5.15E-03	1.00E-02
DOE Site 618-11	2.08E+03	8.62E-04	1.02E-03	1.37E-03	5.46E-04	1.06E-03
Ashe Substation	2.08E+03	2.07E-02	2.18E-02	3.32E-02	1.34E-02	2.59E-02

Dose to Offsite Members of the Public

For all routine releases (including liquid doses since no liquid discharges were made), the highest calculated annual dose at the 4.64 mile location in the E direction was 2.43E-01 mrem to the bone. The highest dose to the thyroid was 5.24E-02 mrem. The highest dose to the total body was 5.03E-02 mrem. The highest dose to the skin was 5.17E-02 mrem.

For environmental thermoluminescent dosimeter (TLD) stations at or beyond the site boundary, no significant increase in the average ambient exposure (control) was observed in 2017.

For a Boiling Water Reactor, demonstrating conformance with Appendix I of 10 CFR 50 is generally adequate for demonstrating compliance with 40 CFR 190 when the sources of direct radiation from various sources, including the ISFSI, are indistinguishable from background.

The information contained in Table 6-5 is consistent with previous effluent release reports from Columbia Generating Station. C-14 does not contribute to air dose; inhalation dose from C-14 is so small that it is not calculated by the NRC GASPAR computer code. There are no ingestion pathways for a hypothetical MOP at the site boundary. Quarterly and annual dose estimates in this table are made with joint frequency distribution and dispersion and deposition values derived from meteorological data specific to each time period.

The six sub-tables in Table 6-5 show maximum estimated exposure and dose at and beyond the site boundary. No residents were observed at the site boundary. The maximum exposure and dose beyond the site boundary is estimated for locations with actual residents.

Table 6-5 Summary of Doses from Gaseous Effluents

1. Maximum Air Dose at the Site Boundary (1.2 miles)

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Dose*
Beta air dose (mrad)	4.80E-03	4.41E-03	1.57E-03	1.33E-03	1.06E-02
Gamma air dose (mrad)	9.47E-03	5.29E-03	4.46E-03	3.77E-03	2.07E-02

2. Maximum Air Dose Beyond the Site Boundary

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Dose*
Beta air dose (mrad)	6.55E-04	3.82E-04	1.34E-04	2.39E-04	1.66E-03
Gamma air dose (mrad)	1.29E-03	3.98E-04	3.81E-04	6.77E-04	3.23E-03

3. Maximum Annual Dose at the Site Boundary

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Dose*
Total body dose (mrem)	6.74E-03	6.02E-03	3.23E-03	2.60E-03	1.61E-02
Skin dose (mrem)	1.08E-02	9.77E-03	5.05E-03	4.11E-03	2.58E-02

4. Maximum Annual Dose Beyond the Site Boundary

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Dose*
Total body dose (mrem)	1.52E-02	7.60E-03	1.08E-02	1.65E-02	5.03E-02
Skin dose (mrem)	1.54E-02	7.86E-03	1.09E-02	1.66E-02	5.17E-02

5. Maximum Organ Dose at the Site Boundary (1.2 miles)

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Cumulative*
Maximum Organ dose (mrem)	1.08E-02	9.77E-03	5.05E-03	4.11E-03	2.58E-02

6. Maximum Organ Dose Beyond the Site Boundary

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Cumulative*
Maximum Organ dose (mrem)	7.37E-02	3.64E-02	5.34E-02	8.19E-02	2.43E-01

* Rather than the sum of the quarters, the annual cumulative dose values are based on annual meteorological data and total annual effluents. For each time period, the dose

estimate uses the radionuclide mix and release rate for that period along with an estimate of the dispersion in air and deposition on ground and vegetation calculated by the NRC computer code XOQDOQ using actual meteorological conditions during the respective quarters. The dose estimate of the NRC computer code GASPAR uses, as base methodology, NRC Regulatory Guide 1.109 (1977) which includes the prospective dose component arising from retention in the body beyond the period of environmental exposure.

Table 6-6 50-Mile Population Dose from Gaseous Effluents

A. 50-mile population collective dose

Exposure Pathway	Total Body (person-rem)	Max. Organ (person-rem)
Plume	1.15E-02	1.15E-02
Ground	2.42E-03	2.42E-03
Inhalation	2.06E-03	1.84E-05
Vegetables	3.37E-01	1.67E+00
Milk	1.50E-01	7.46E-01
Meat	1.06E-01	5.29E-01
Total	6.09E-01	2.96E+00

B. Average Individual*

Exposure Pathway	Total Body (mrem)	Max. Organ (mrem)
Plume	2.56E-05	2.56E-05
Ground	5.40E-06	5.40E-06
Inhalation	4.59E-06	4.10E-08
Vegetables	7.52E-04	3.72E-03
Milk	3.35E-04	1.66E-03
Meat	2.36E-04	1.18E-03
Total	1.36E-03	6.60E-03

* These values are derived by dividing the 50-mile population collective doses by the population within 50 miles of Columbia Generating Station (448,383). The population estimate is based on the 2010 census conducted by the United States Census Bureau tabulated/compiled by the Washington State Office of Financial Management, Small Area Estimate Program. The Maximum Organ was the skin.

7.0 REVISIONS TO THE ODCM

There was one change to the ODCM approved by the Plant Operations Committee during 2017.This change was to remove the word “isokinetic” from the description of the Main Plant Vent (Reactor Building Stack) monitoring system.
In January of 2018 the new Main Plant Vent Monitoring system was placed into service and the change to the ODCM was implemented as Amendment number 57.
The ODCM is included as an enclosure to the letter transmitting this "Radioactive Effluent Release Report” in compliance with Columbia Technical Specification 5.5.1.

8.0 REVISIONS TO THE PROCESS CONTROL PROGRAM (PCP)

The PCP is maintained as a Plant Operations Committee approved procedure, SWP-RMP-02. There were no changes to the PCP in 2017.

9.0 NEW OR DELETED LOCATIONS FOR DOSE ASSESSMENTS AND/OR ENVIRONMENTAL MONITORING LOCATIONS

The 2017 5-Mile Land Use Census (LUC) did not identify any necessary changes to locations for dose assessments or environmental monitoring locations.

10.0 MAJOR CHANGES TO RADIOACTIVE LIQUID, GASEOUS, AND SOLID WASTE TREATMENT SYSTEMS

No major changes (as defined by ODCM Section 6.4.3) were made to the radioactive waste systems (liquid, gaseous, or solid) during 2017.

11.0 Errata

The Curies of Tritium reported as disposed of in the Dry Active Waste (DAW) category of the Solid Radwaste section of the Annual Radioactive Effluent Release Report for calendar year 2016 was over reported. The corrected annual cumulative Curies of DAW disposed of in 2016 is 4.77E-01. Section 4 of the 2016 Annual Radiological Effluent Release Report (ARERR) is included as an attachment to this report with revision bars indicating where the changes occurred.

Attachment 1.0 – Correction to 2016 CGS ARERR

The errata are only within section 4.0 of the 2016 CGS ARERR, so the pages of section 4.0 are included in their entirety in this attachment with revision bars.

4.0 Solid Radwaste

This section of the annual effluent report provides information required by the Columbia Generating Station Offsite Dose Calculation Manual and recommended by Nuclear Regulatory Commission Regulatory Guide 1.21, Revision 1 (1974).

Solid Radwaste Information required by the Offsite Dose Calculation Manual

January -- December 2016

Class A

1. Container Volumes (ft^3)

5 gallon pail	0.80
55 gallon drum	7.50
B-25 Steel Box	96.0
PL8-120 Polyethylene HIC (SERDS)	120
B-88 Steel Box	128
EL-142 Polyethylene HIC	132
ES-190 Steel Liner	170
PL14-170 Polyethylene HIC (SERDS)	171
14-170 Steel Liner (SERDS)	180
20 ft C-Van	1280

2. Total Curies

   1.52E+02 Curies

3. Principal Radionuclides

Nuclide	Curies	Percent
Co-60	8.19E+01	5.40E+01
Ba-140	1.40E-01	9.24E-02
Co-58	1.93E+00	1.27E+00
C-14	1.38E+00	9.13E-01
Zn-65	9.88E+00	6.52E+00
Mn-54	9.33E+00	6.15E+00
I-131	1.18E+00	7.78E-01
Ag-110m	2.84E-01	1.88E-01
Pu-241	1.00E-02	6.63E-03
Pu-238	1.04E-04	6.88E-05
Pu-239	8.37E-05	5.52E-05
Am-241	7.12E-05	4.70E-05
Fe-55	3.80E+01	2.51E+01
Cm-243	3.65E-05	2.41E-05
Ce-141	2.69E-03	1.77E-03
Sb-124	2.79E-03	1.84E-03
Cm-242	1.29E-04	8.52E-05
Cs-137	4.77E-01	3.15E-01
Sr-90	1.32E-02	8.73E-03
Ni-63	6.54E+00	4.31E+00
H-3	1.94E-01	1.28E-01
Co-57	1.46E-02	9.61E-03
Tc-99	7.57E-05	5.00E-05
Tc-99m	0.00E+00	0.00E+00
I-129	2.07E-06	1.36E-06
Nb-95	2.52E-02	1.66E-02
Sb-125	1.67E-03	1.10E-03
Cr-51	1.65E-01	1.09E-01
La-140	0.00E+00	0.00E+00
Fe-59	6.55E-02	4.32E-02
Cs-134	1.87E-02	1.23E-02

4. Source

Resins	1.51E+02 Ci
DAW	4.77E-01 Ci
Irradiated Components	None
Other (Sealed Source, Mixed Waste, & Liquid Waste)	2.10E-02 Ci

5. Type of Container

   All containers shipped as Limited Quantity, LSA, SCO or radioactive material in IP-1, IP-2, Type A, or Type B (including casks) as appropriate

6. Solidification Agent

   None

Class B

There were no Class B shipments made during calendar year 2016.

Class C

1. Container Volumes (ft^3)

   TN-RAM Liner 58.0

2. Total Curies

   6.75E+04 Curies

3. Principal Radionuclides

Nuclide	Curies	Percent
Co-60	3.28E+04	4.86E+01
Co-58	7.64E+01	1.13E-01
C-14	2.99E+00	4.43E-03
Zn-65	2.12E+01	3.14E-02
Mn-54	9.09E+02	1.35E+00
Ag-110m	5.61E-03	8.31E-06
U-235	9.16E-08	1.36E-10
U-238	2.48E-13	3.67E-16
Pu-238	1.24E-03	1.84E-06
Pu-239	8.16E-06	1.21E-08
Pu-240	3.14E-07	4.65E-10
Pu-241	6.06E-04	8.97E-07
Am-241	5.67E-06	8.40E-09
Fe-55	3.18E+04	4.71E+01
Cm-242	2.89E-06	4.28E-09
Ce-144	4.96E-02	7.35E-05
Cm-243	1.91E-06	2.83E-09
Cm-244	3.07E-08	4.55E-11
Cs-137	1.03E-01	1.53E-04
Sr-89	3.55E-03	5.26E-06
Sr-90	8.50E-02	1.26E-04
Ni-59	3.66E+01	5.42E-02
Ni-63	1.87E+03	2.77E+00
H-3	7.41E-03	1.10E-05
Tc-99	6.11E-04	9.05E-07
I-129	4.74E-05	7.02E-08
Mo-93	4.40E-06	6.52E-09
Nb-94	2.86E-02	4.24E-05
Zr-95	4.76E-10	7.05E-13
Sb-125	3.01E+00	4.46E-03
Cr-51	3.13E+00	4.64E-03
Fe-59	2.33E+00	3.45E-03

4. Source

Resins	0 Ci
DAW	0 Ci
Irradiated Components	6.75E+04 Ci
Other (Sealed Source, Mixed Waste, & Liquid Waste)	0 Ci

5. Type of Container

All containers shipped as Type B (including casks).

6. Solidification Agent

None

Solid Radwaste Information Recommended by NRC Regulatory Guide 1.21

January -- December 2016

Solid waste shipped offsite for burial or disposal (not irradiated fuel).

7. Type of Waste

Waste Stream Category	Unit	Annual Cumulative	Est. Total Error %
A. Spent resins, filter sludge, evaporator bottoms, etc.	m^3	2.17E+02	
	Ci	1.51E+02	2.50E+01%
B. Dry Active Waste	m^3	5.43E+01	
	Ci	4.77E-01	2.50E+01%
C. Irradiated Components	m^3	8.21E+00	
	Ci	6.75E+04	2.50E+01%
D. Other Waste (Sealed Source, mixed waste, & Liquid Waste)	m^3	3.63E+01	
	Ci	2.10E-02	2.50E+01%

8. Estimate of major nuclide composition (by type of waste)

a. Dewatered Spent Resins – All Class A

Nuclide	Curies	Percent
Co-60	8.17E+01	5.41E+01
Ba-140	1.40E-01	9.27E-02
Co-58	1.76E+00	1.16E+00
C-14	1.38E+00	9.16E-01
Zn-65	9.79E+00	6.48E+00
Mn-54	9.29E+00	6.15E+00
I-131	1.18E+00	7.81E-01
Ag-110m	2.84E-01	1.88E-01
Pu-241	9.67E-03	6.40E-03
Pu-238	1.00E-04	6.65E-05
Pu-239	8.06E-05	5.34E-05
Am-241	6.81E-05	4.51E-05
Fe-55	3.80E+01	2.52E+01
Cm-243	3.52E-05	2.33E-05
Ce-141	2.69E-03	1.78E-03
Sb-124	2.79E-03	1.85E-03
Cm-242	1.24E-04	8.20E-05
Cs-137	4.77E-01	3.16E-01
Sr-90	1.32E-02	8.73E-03
Ni-63	6.53E+00	4.33E+00
H-3	1.91E-01	1.27E-01
Co-57	1.46E-02	9.65E-03
Tc-99	7.56E-05	5.00E-05
Tc-99m	0.00E+00	0.00E+00
I-129	2.06E-06	1.37E-06
Nb-95	2.52E-02	1.67E-02
Sb-125	1.67E-03	1.10E-03
Cr-51	1.65E-01	1.09E-01
La-140	0.00E+00	0.00E+00
Fe-59	6.55E-02	4.33E-02
Cs-134	1.87E-02	1.24E-02

b. Dry Active Waste (DAW) – All Class A

Nuclide	Curies	Percent
Co-60	1.49E-01	3.13E+01
Co-58	1.74E-01	3.65E+01
Zn-65	9.29E-02	1.95E+01
Mn-54	4.11E-02	8.63E+00
H-3	2.64E-03	5.55E-01
Pu-241	3.75E-04	7.86E-02
Pu-238	3.88E-06	8.13E-04
Pu-239	3.10E-06	6.50E-04
Am-241	3.08E-06	6.46E-04
Cm-243	1.36E-06	2.85E-04
Cm-242	5.26E-06	1.10E-03
Fe-55	1.27E-02	2.67E+00
Sr-90	4.61E-05	9.68E-03
Ni-63	3.53E-03	7.41E-01
C-14	7.08E-05	1.49E-02
Tc-99	1.68E-07	3.52E-05
I-129	4.59E-09	9.64E-07

c. Irradiated Components – All Class C

Nuclide	Curies	Percent
Co-60	3.28E+04	4.86E+01
Co-58	7.64E+01	1.13E-01
C-14	2.99E+00	4.43E-03
Zn-65	2.12E+01	3.14E-02
Mn-54	9.09E+02	1.35E+00
Ag-110m	5.61E-03	8.31E-06
U-235	9.16E-08	1.36E-10
U-238	2.48E-13	3.67E-16
Pu-238	1.24E-03	1.84E-06
Pu-239	8.16E-06	1.21E-08
Pu-240	3.14E-07	4.65E-10
Pu-241	6.06E-04	8.97E-07
Am-241	5.67E-06	8.40E-09
Fe-55	3.18E+04	4.71E+01
Cm-242	2.89E-06	4.28E-09
Ce-144	4.96E-02	7.35E-05
Cm-243	1.91E-06	2.83E-09
Cm-244	3.07E-08	4.55E-11
Cs-137	1.03E-01	1.53E-04

Sr-89	3.55E-03	5.26E-06
Sr-90	8.50E-02	1.26E-04
Ni-59	3.66E+01	5.42E-02
Ni-63	1.87E+03	2.77E+00
H-3	7.41E-03	1.10E-05
Tc-99	6.11E-04	9.05E-07
I-129	4.74E-05	7.02E-08
Mo-93	4.40E-06	6.52E-09
Nb-94	2.86E-02	4.24E-05
Zr-95	4.76E-10	7.05E-13
Sb-125	3.01E+00	4.46E-03
Cr-51	3.13E+00	4.64E-03
Fe-59	2.33E+00	3.45E-03

d. Other Waste (sealed source, mixed waste, and liquid waste) – All Class A

Nuclide	**Curies**	**Percent**
Co-60	1.98E-03	9.46E+00
Co-58	2.46E-03	1.17E+01
Zn-65	1.25E-03	5.97E+00
Mn-54	5.52E-04	2.63E+00
H-3	1.45E-02	6.92E+01
Pu-241	4.97E-06	2.37E-02
Pu-238	5.13E-08	2.45E-04
Pu-239	4.11E-08	1.96E-04
Am-241	3.42E-08	1.63E-04
Cm-242	7.18E-08	3.43E-04
Cm-243	1.80E-08	8.59E-05
Fe-55	1.70E-04	8.08E-01
Sr-90	6.09E-07	2.91E-03
Ni-63	4.68E-05	2.23E-01
C-14	9.38E-07	4.47E-03
Fe-59	5.74E-08	2.74E-04
Cr-51	5.55E-07	2.65E-03
Sr-89	9.69E-09	4.62E-05
Tc-99	2.22E-09	1.06E-05
I-129	6.09E-11	2.91E-07

9. Solid Waste Disposition

Number of Shipments	Mode of Transportation	Destination
24	Tractor - Trailer via Public Highway	US Ecology, Inc. P.O. Box 638 Hanford Reservation Richland, WA. 99352
1*	Tractor - Trailer via Public Highway	Perma-Fix Northwest 2025 Battelle Blvd Richland, WA 99352

(* After processing, portions of these shipments will be forwarded for disposal.)

Irradiated Fuel Shipments (Disposition)

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