Serial No. 19-163
Docket Nos. 50-245
50-336
50-423
License Nos. DPR-21
DPR-65
NPF-49

ATTACHMENT 1

2018 RADIOACTIVE EFFLUENTS RELEASE REPORT
VOLUME 1

MILLSTONE POWER STATION UNITS 1, 2, AND 3
DOMINION ENERGY NUCLEAR CONNECTICUT, INC. (DENC)

Millstone Power Station
2018
Radioactive Effluents Release Report
Volume One

Dominion Energy Nuclear Connecticut, Inc.

Unit	License	Docket
1	DPR-21	50-245
2	DPR-65	50-336
3	NPF-49	50-423

Dominion Energy

Contents

List of Tables

List of Acronyms

ABD-TK-2 Auxiliary Boiler Drains Tank 2
ADV- Atmospheric Dump Valve
BOP – Balance of plant
CFR – Code of Federal Regulations
CPF – Condensate polishing facility
DENC – Dominion Energy Nuclear Connecticut
DOT – Department of Transportation
DSN – Discharge serial number
EBFS – Enclosure building filtration system
EDAN- Environmental Data Acquisition Network
EDST- Equipment Drain Sump Tank
ESF – Engineering safeguards facility
GI - Gastrointestinal
GWPP – Groundwater protection program
HPGe – High purity germanium
ISFSI – Independent spent fuel storage installation
MPS – Millstone Power Station
MPS1 – Millstone Power Station Unit 1
MPS2 – Millstone Power Station Unit 2
MPS3 – Millstone Power Station Unit 3
MDA – Minimum Detectable Activity
NCRP- National Council on Radiation Protection and Measurements
NEI- Nuclear Energy Institute
NPP – Nuclear power plant
NRC – Nuclear Regulatory Commission
RBCCW – Reactor building closed cooling water
REMODCM - Radiological Effluent Monitoring and Offsite Dose Calculation Manual
RWST – Reactor water storage tank
SFPI – Spent Fuel Pool Island
SG – Steam generator
SGBD – Steam generator blowdown
SLCRS – Secondary Leakage Collection and Recovery System
SW – Service water
TB – Turbine building
WGDT – Waste gas decay tank
WRGM – Wide range gas monitor
WTT – Waste test tank

Introduction

This report, for the period of January through December of 2018, is being submitted by DENC, Inc. for MPS1, 2, and 3, in accordance with 10 CFR 50.36a, the Radiological Effluent Monitoring and Offsite Dose Calculation Manual (REMODCM), the MPS1 Permanently Defueled Technical Specifications, and the MPS2 and 3 Technical Specifications. This report contains radiological and volumetric information on gaseous and liquid effluents, doses to the public from these effluents, shipments of solid waste & irradiated components, onsite well water results, information on effluent instrumentation which was nonfunctional for more than 30 consecutive days and operating history.

Radioactive materials may be disposed of in solid waste shipments sent to licensed disposal sites or released in liquid or gas form in effluents to the local environment. The two basic characteristics used to describe radioactive effluents are radioactivity and radiation dose. The radioactivity of any given radionuclide increases in direct proportion to the amount of the radionuclide present. This report lists the amounts of various radionuclides present in radioactive

effluents. For this report, activity can be thought of as the amount of radioactive material present in radioactive effluents. Section 2.0 of this report gives the activity released from MPS in 2018.

Although radioactivity is an important, inherent characteristic that helps to describe radioactive effluents, it is not—by itself—a good indicator of the potential health effects from exposure to radiation. Health effects are dependent on many factors, such as the radionuclide, the type of radiation emitted by the radionuclide, the energy of the radiation, the uptake of the radionuclide into the human body, and the metabolism of the radionuclide by the human body. To properly describe the potential health effects from exposure to radioactive materials, a measure that accounts for all of these differences is needed. Dose is a measure of how much radiation energy is absorbed by organs or tissues of the body. Dose is a good indicator of the potential health effects from exposure to radiation. Section 1.0 of this report gives the dose from activity released from MPS in 2018.

1.0 Off-Site Doses

This report provides a summary of the 2018 off-site radiation doses from releases of radioactive materials in gaseous and liquid effluents and from direct radiation from MPS1, 2 and 3. This includes the annual maximum dose in millirem (mrem) to any real member of the public as well the maximum gamma and beta air doses. To provide perspective, these doses are compared to the regulatory limits (in Table 1-3) and to the annual average dose that a member of the public could receive from natural background and other sources (in Table 1-4). The doses from radioactive effluents were much less than the doses from other sources of natural radiation that are commonly considered safe. This indicates radioactive effluents from MPS in 2018 had no significant impact on the health and safety of the public or the environment.

1.1 Dose Calculations

Dose from radioactive effluents are calculated to ensure compliance with NRC requirements in 10 CFR Part 50, Appendix I (Ref. 7). The dose calculations are based on the measurements and computer models listed below:

- measurements of the radioactive materials released to the environment,
- models of how radionuclides are dispersed and diluted in the environment,
- models of how radionuclides are incorporated into animals, plants, and soil, and
- models of the biokinetic of human uptake and metabolism of radioactive materials.

The models are designed to calculate the dose to a real (or hypothetical) individual closest to MPS or to an individual who may be exposed to the highest concentrations of radioactive materials from radioactive effluents. This person is often referred to as the maximum exposed individual. The parameters and assumptions used in these dose calculations include conservative assumptions that tend to overestimate the calculated exposures. Although the location of the maximum individual may vary each quarterly period, the annual dose is the sum of these quarterly doses. This conservatively assumes that the individual is at the location of maximum dose each quarter. As a result, the actual doses received by real individuals are often much less than those calculated.

The off-site dose to humans from radioactive material in liquid and gaseous effluents have been calculated using measured radioactive effluent data and the dose computation algorithm in OpenEMS, an effluent tracking program (Ref. 9). For liquid dose OpenEMS uses equations which yield the same result as the methodology given in NRC Regulatory Guide 1.109 (Ref. 3). For airborne dose OpenEMS uses an algorithm equivalent to the NRC code, GASPAR II (Ref. 1), which uses a semi-infinite cloud model to implement the NRC Regulatory Guide 1.109 (Ref. 3) dose models. The values of average relative effluent concentration (X/Q) and average relative deposition (D/Q) used in OpenEMS were generated using EDAN, a meteorological computer code. The annual summary of hourly meteorological data (in 15-minute increments), which includes wind speed, direction, atmospheric stability, and joint frequency distribution, is not provided in the report but are available. Doses are based upon exposure to radioactivity in gaseous and liquid effluents over a one-year period and an associated dose commitment over a 50-year period from initial exposure. The portion of the doses due to inhalation and ingestion take into account radioactive decay and biological elimination of the radioactive materials.

The dose calculations are based upon three types of input: radioactive source term, site-specific data, and generic factors. The radioactive source terms (Curies) are given in Section 2, Effluent Radioactivity, of this report. The site-specific data includes: meteorological data (e.g. wind speed, wind direction, atmospheric stability) to calculate the transport and dispersion of gaseous effluents, average annual milk consumption rates and dilution factors for liquid

effluents. The generic factors include the average annual consumption rates (for ingestion of vegetables, produce, meat, fish, and shellfish), shielding factor for air submersion and ground irradiation and occupancy factors for shoreline activity, swimming and boating.

1.1.1 Gaseous Effluents

The following release points are considered ground level:

- MPS1 SFPI Vent (73 foot)
- MPS1 BOP Vent (80 foot)
- MPS2 and 3 Refueling Water Storage Tank (RWST) Vents
- MPS3 Engineered Safety Features Building (ESF) Ventilation
- Auxiliary Boiler Drains Tank 2 (ABD TK-2) Vent
- MPS2 & 3 Containment Equipment Hatch
- MPS3 Containment Drawdowns

Doses for releases from these points were calculated using the 33 foot meteorology. For each unit, doses from their respective release points were summed to determine the total unit gaseous effluent ground level dose.

The following release points are considered mixed mode (partially elevated and partially ground) releases:

- MPS2 Auxiliary Building Ventilation (159 foot elevation)
- MPS3 Auxiliary Building Ventilation (133 foot elevation)
- MPS2 No. 1&2 Atmospheric Dump Valves

The doses for mixed mode releases are calculated using 142 foot meteorology for which the Pasquill stability classes are determined based upon the temperature gradient between the 33 foot and 142 foot meteorological tower levels.

The MPS Stack release point at 374 foot elevation is considered an elevated release. Doses for elevated releases are calculated using Pasquill stability classes determined based upon the temperature gradient between the 33 foot and 374 foot meteorological tower levels. Only MPS2 and MPS3 discharge to the MPS Stack. In March 2001, MPS1 was separated from the stack and two new release points were added to MPS1, the Spent Fuel Pool Island (SFPI) Vent and the Balance of Plant (BOP) Vent. The following are sources of radioactivity for releases from the stack:

- MPS2 Waste Gas Decay Tanks batch releases
- MPS2 Containment Vents batch releases
- MPS2 Containment Purge batch releases
- MPS3 Containment Vents batch releases
- MPS3 Gaseous Waste System continuous releases
- MPS3 Containment Purge batch releases (only during outage in fourth quarter)

1.1.2 Liquid Effluents

MPS discharges radioactivity in water through two release pathways – thru the MPS Quarry to the Long Island Sound and thru Discharge Point DSN-006 to Niantic Bay. Discharges to the MPS Quarry are from primary side water, primarily from liquid waste processing systems. Discharges to DSN-006 are from secondary side water, primarily turbine building sumps. MPS1 discharges only to the MPS Quarry from sumps and leakage collection systems. Discharges to both release pathways are considered either continuous or batch discharges. Sources of continuous and batch discharges are listed in Sections 2.2.1.1 and 2.2.1.2. Water containing radioactivity being discharged to the MPS Quarry is diluted mainly by circulating water and, to a minor extent, by service water. Water containing radioactivity being discharged to DSN-006 is diluted by storm drains runoff.

1.2 Dose Results

The calculated maximum off-site doses are presented in Table 1-1 for gaseous effluents and Table 1-2 for liquid effluents. The units 'mrad' and 'mrem' used in this report are units of radiation dose. The letter 'm' is for 'milli', or one-thousandth of a 'rad' or a 'rem.' The word 'rad' is an acronym for radiation absorbed dose.

One rad is equal to the absorption of 100 ergs of energy per gram of tissue. The word 'rem' is an acronym for roentgen equivalent man. One rem is equal to a rad multiplied by factors to account for type of radiation and distribution within the body.

1.2.1 Gaseous Effluents

For the dose to the maximum individual, OpenEMS calculates the dose to the whole body, gastrointestinal (GI), bone, liver, kidney, thyroid, lung, and skin from each of the following pathways: direct exposure from submersion in noble gases in the plume, direct exposure from ground deposition of radioactivity, inhalation, and ingestion of vegetation, produce, cow or goat milk, and meat. A cloud shine dose component for releases of noble gas radioactivity from the elevated MPS Stack is calculated using Reference 13. This cloud shine pathway accounts for dose to the maximum individual from the plume at the site boundary while the plume is still elevated. The values presented are a total from all pathways. Only the whole body, skin, thyroid and maximum organ (other than thyroid) doses are presented.

For the plume and inhalation pathways, the maximum individual dose is calculated at the off-site location of the highest X/Q where a potential for dose exists.

For ground deposition and ingestion pathways (vegetation, meat and milk), the maximum individual dose is calculated at the location of the highest D/Q. For the milk pathways (cow and goat), the calculated dose is included in the maximum individual's dose only at locations and times where these pathways actually exist.

To determine compliance with 10 CFR 50, Appendix I (Reference 7), the maximum individual whole body and organ doses include all applicable external pathways (i.e., plume and ground exposure) as well as the internal pathways (inhalation and ingestion).

1.2.2 Liquid Effluents

Maximum individual doses from the release of radioactive liquid effluents were calculated using OpenEMS which gives dose results equal to dose results calculated using NRC Regulatory Guide 1.109. OpenEMS performs calculations for the following pathways: fish, shellfish, shoreline activity, swimming, and boating. Doses are calculated for the whole body, skin, thyroid, and maximum organ (GI, bone, liver, kidney, and lung).

1.2.3 Analysis of Results

Table 1-3 provides a quantitative dose comparison with the limits specified in the REMODCM. Gaseous and liquid effluent doses are compared to limits required by technical specifications and contained in Appendix I of 10 CFR 50. Total offsite doses are compared to limits in 40 CFR 190 (Reference 8). The data indicates that the total whole body and organ doses to the maximum offsite individual from MPS including all sources of the fuel cycle are well within the limits. On-site radioactive waste and spent fuel storage during this year was within storage criteria and the maximum dose to a member of the public from these sources was approximately 0.13 mrem. The doses from gaseous and liquid effluents were added to the estimated dose from on-site radioactive waste storage to show compliance compared to 40 CFR 190.

The Offsite Dose Comparison, Table 1-4, provides a perspective on the maximum offsite individual dose received from MPS with the natural background radiation dose received by the average Connecticut resident (Reference 4). The total dose to the maximum individual received from MPS is small (< 0.2%) in comparison to the dose received from natural background radiation.

Table 1-1
2018 Off-Site Dose Commitments from Gaseous Effluents
MPS1, 2, 3

MPS1	*1st Quarter*	*2nd Quarter*	*3rd Quarter*	*4th Quarter*	*Annual Total*
Max Air	mrad	mrad	mrad	mrad	mrad
Beta	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gamma	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Max Individual	mrem	mrem	mrem	mrem	mrem
Whole Body	1.18E-05	2.86E-05	2.19E-05	2.01E-06	6.43E-05
Skin	1.05E-05	1.36E-05	1.02E-05	2.01E-06	3.63E-05
Thyroid	1.05E-05	2.86E-05	2.19E-05	2.01E-06	6.30E-05
Max organ[1]	1.33E-05	2.86E-05	2.19E-05	2.01E-06	6.58E-05

MPS2	*1st Quarter*	*2nd Quarter*	*3rd Quarter*	*4th Quarter*	*Annual Total*
Max Air	mrad	mrad	mrad	mrad	mrad
Beta	5.66E-06	3.18E-05	5.77E-07	3.27E-06	4.13E-05
Gamma	1.23E-05	6.04E-05	1.37E-06	8.15E-06	8.22E-05
Max Individual	mrem	mrem	mrem	mrem	mrem
Whole Body	2.49E-03	1.65E-02	1.73E-02	1.24E-03	3.76E-02
Skin	4.73E-04	3.84E-04	7.13E-04	3.14E-04	1.88E-03
Thyroid	2.60E-03	1.75E-02	1.79E-02	1.25E-03	3.93E-02
Max organ[1]	1.11E-02	9.89E-02	1.02E-01	5.39E-03	2.18E-01

MPS3	*1st Quarter*	*2nd Quarter*	*3rd Quarter*	*4th Quarter*	*Annual Total*
Max Air	mrad	mrad	mrad	mrad	mrad
Beta	1.25E-05	5.27E-07	1.87E-06	1.68E-04	1.83E-04
Gamma	1.72E-06	6.16E-08	1.35E-06	2.93E-04	2.96E-04
Max Individual	mrem	mrem	mrem	mrem	mrem
Whole Body	4.46E-03	1.74E-02	1.75E-02	2.46E-03	4.18E-02
Skin	1.60E-03	9.84E-04	5.42E-04	1.41E-03	4.53E-03
Thyroid	4.46E-03	1.74E-02	1.75E-02	2.46E-03	4.18E-02
Max organ[1]	1.63E-02	9.94E-02	1.02E-01	7.99E-03	2.26E-01

NOTES:
1- Maximum of the following organs (not including thyroid): Bone, GI-LLI, Kidney Liver Lung

Table 1-2
2018 Off-Site Commitments from Liquid Effluents MPS1, 2, 3

MPS1	*1st Quarter*	*2nd Quarter*	*3rd Quarter*	*4th Quarter*	*Annual Total*
Max Individual	(mrem)	(mrem)	(mrem)	(mrem)	(mrem)
Whole Body	1.96E-06	1.26E-05	1.14E-05	9.41E-06	3.53E-05
Thyroid	5.69E-07	3.66E-06	3.26E-06	2.70E-06	1.02E-05
Max Organ[1]	2.78E-06	1.79E-05	1.59E-05	1.32E-05	4.98E-05

MPS2	*1st Quarter*	*2nd Quarter*	*3rd Quarter*	*4th Quarter*	*Annual Total*
Max Individual	(mrem)	(mrem)	(mrem)	(mrem)	(mrem)
Whole Body	4.17E-05	5.16E-05	1.07E-04	3.54E-05	2.36E-04
Thyroid	4.17E-05	5.16E-05	1.07E-04	3.26E-05	2.33E-04
Max Organ[1]	4.17E-05	5.16E-05	1.77E-04	5.86E-04	8.56E-04

MPS3	*1st Quarter*	*2nd Quarter*	*3rd Quarter*	*4th Quarter*	*Annual Total*
Max Individual	(mrem)	(mrem)	(mrem)	(mrem)	(mrem)
Whole Body	5.71E-05	1.02E-04	2.02E-04	1.12E-04	4.73E-04
Thyroid	5.65E-05	1.02E-04	8.63E-05	7.83E-05	3.23E-04
Max Organ[1]	6.05E-05	1.02E-04	8.97E-04	2.63E-04	1.32E-03

NOTES:
1- Maximum of the following organs (not including thyroid): Bone, GI-LLI, Kidney Liver Lung

Table 1- 3
2018 Off-Site Dose Comparison to Limits MPS1, 2, 3

Gaseous Effluents Dose

	Whole Body (mrem)	Thyroid (mrem)	Max Organ* (mrem)	Skin (mrem)	Beta Air (mrad)	Gamma Air (mrad)
MPS1	6.43E-05	6.30E-05	6.58E-05	3.63E-05	0.00E+00	0.00E+00
MPS2	3.76E-02	3.93E-02	2.18E-01	1.88E-03	4.13E-05	8.22E-05
MPS3	4.18E-02	4.18E-02	2.26E-01	4.53E-03	1.83E-04	2.96E-04
MPS	**7.95E-02**	**8.12E-02**	**4.44E-01**	**6.45E-03**	**2.24E-04**	**3.78E-04**
Limits	*5*	*15*	*15*	*15*	*20*	*10*

Liquid Effluents Dose

	Whole Body (mrem)	Thyroid (mrem)	Max Organ* (mrem)
MPS1	3.53E-05	1.02E-05	4.98E-05
MPS2	2.36E-04	2.33E-04	8.56E-04
MPS3	4.73E-04	3.23E-04	1.32E-03
MPS	**7.43E-04**	**5.65E-04**	**2.23E-03**
Limits	*3*	*10*	*10*

Total Off-Site Dose from MPS

	Whole Body (mrem)	Thyroid (mrem)	Max Organ* (mrem)
Gaseous	7.95E-02	8.12E-02	4.44E-01
Liquid	7.43E-04	5.65E-04	2.23E-03
Direct Shine**	1.20E-01	1.20E-01	1.20E-01
MPS	**2.00E-01**	**2.02E-01**	**5.66E-01**
Limits	*25*	*75*	*25*

* Maximum of the following organs (not including Thyroid): Bone, GI-LLI, Kidney, Liver, Lung

** Direct shine is radiation exposure from onsite storage of radwaste and spent fuel.

Table 1- 4
2018 Off-Site Dose Comparison
Natural Background vs MPS

Average Resident	Natural Background Radiation Dose	
Cosmic	30 -100	mrem
Terrestrial (Atlantic and Gulf Coastal Plain)	30 - 60	mrem
Inhaled	20 - 1,000	mrem
In the Body	20 - 80	mrem
	100 - 1,240	mrem

Courtesy UNSCEAR Report 2000

Maximum Off-Site Individual	MPS Whole Body Dose	
Gaseous Effluents	0.079	mrem
Liquid Effluents	0.001	mrem
Direct Shine	0.120	mrem
	0.200	mrem

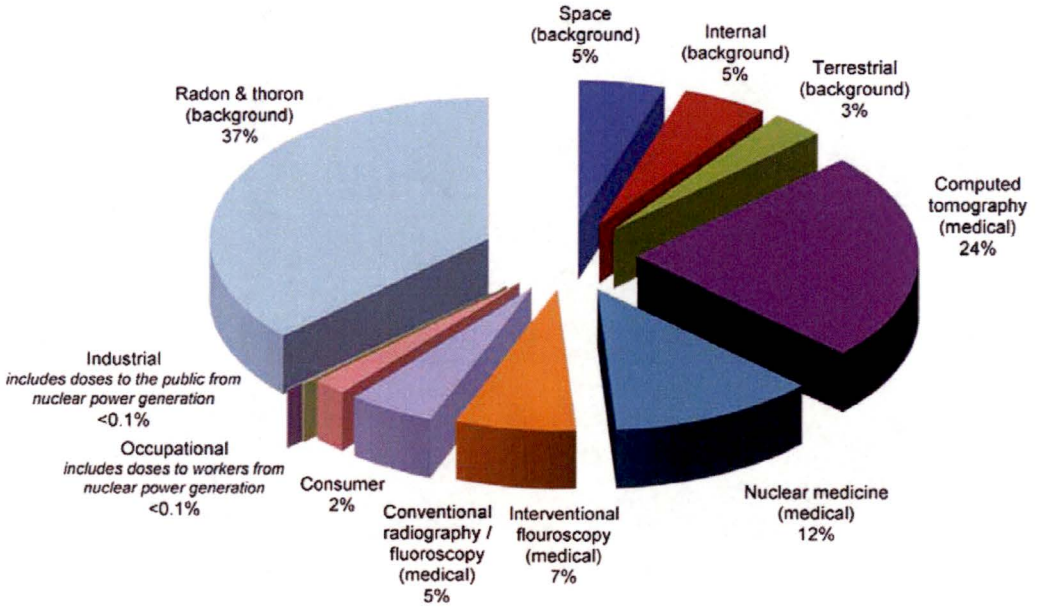
1.3 Other Sources of Radiation Dose to the Public (from Ref. 12)

This section discusses the doses that the average American typically receives each year from naturally occurring background radiation and all other sources of radiation. The reader can compare the doses received from MPS effluents with the doses received from natural, medical, and other sources of radiation. This comparison provides some context to the concept of radiation dose effects. In March 2009, the National Council on Radiation Protection and Measurements (NCRP) published Report No. 160 as an update to the 1987 NCRP Report No. 93, Ionizing Radiation Exposure of the Population of the United States. Report No. 160 describes the doses to the U.S. population from all sources of ionizing radiation for 2006, the most recent data available at the time the NCRP report was written. The NCRP report also includes information on the variability of those doses from one individual to another. The NCRP estimated that the average person in the United States receives about 620 mrem of radiation dose each year. NCRP Report No. 160 describes each of the sources of radiation that contribute to this dose, including:

- Naturally occurring sources (natural background) such as cosmic radiation from space, terrestrial radiation from radioactive materials in the earth, and naturally occurring radioactive materials in the food people eat and in the air people breathe;
- medical sources from diagnosis and treatment of health disorders using radioactive pharmaceuticals and radiation-producing equipment;
- consumer products (such as household smoke detectors);
- industrial processes, security devices, educational tools, and research activities; and
- exposures of workers that result from their occupations.

Below is a pie chart showing the relative contributions of these sources of radiation to the dose received by the average American. Larger contributors to dose are represented by proportionally larger slices of the pie. Doses to the public from nuclear power plants are included in the industrial category; doses to workers from nuclear power generation are included in the category of occupational dose. Doses to the public due to effluents from nuclear power plants are less than 0.1% (one-tenth of one percent) of what the average person receives each year from all sources of radiation. Doses to workers from occupational exposures, including those received from work at NPPs, also are less than 0.1% of the average dose to a member of the public from all sources.

Sources of Radiation Exposure to the U.S. Population



2.0 Effluent Radioactivity

2.1 Gaseous Effluents

2.1.1 Measurement of Radioactivity in Gaseous Effluents

2.1.1.1 Continuous Releases

The following pathways have continuous radiation monitors which monitor gaseous radioactivity and collect radioactive particulates on filters and radioactive halogens (iodine's, etc.) on charcoal cartridges except where noted on the list.

MPS1 SFPI Island (no charcoal cartridge)
MPS1 BOP Vent (no charcoal cartridge)
MPS2 Ventilation Vent
MPS2 Wide Range Gas Monitor (WRGM) to Site Stack
MPS2 Equipment Hatch Opening (no gaseous monitoring)
MPS3 Ventilation Vent
MPS3 SLCRS to Site Stack
MPS3 ESF Building Vent
MPS3 Containment Equipment Hatch Openings (no gaseous monitoring)
MPS2 Atmospheric Dump Valves (ADVS)

Most releases are based on results of sample analyses. Charcoal cartridges and particulate filters are replaced weekly (except every two weeks for MPS1) and analyzed for isotopic content using a gamma spectrometer. Particulate filters are also analyzed for Strontium-89 (Sr-89) (except for MPS1), Strontium-90 (Sr-90) and gross alpha. At least monthly, gaseous grab samples are taken and analyzed for noble gasses and H-3. The gas washing bottle (bubbler) method is utilized for H-3 collection. This sample is counted on a liquid scintillation detector. Isotopic concentrations at the release point are multiplied by the total flow to obtain the total activity released for each isotope.

Some releases are based on calculation. These include tritium from spent fuel pools, Carbon 14 (C-14), Equipment Hatch, and RWST vent releases.

Spent fuel pool tritium release is calculated using concentrations of tritium in the water and evaporation determined by change in pool levels. Grab samples from the MPS1 SFPI Vent and the MPS2 and MPS3 Vents are compared to the measured evaporation and both of these results are included in the amount of tritium released.

C-14 releases are calculated using the methodology in Reference 11. Based on Reference 2, it was conservatively assumed that 30% of the C-14 exists as carbon dioxide (CO_2) which may be deposited on surfaces. Thus only 30% of C-14 released yielded dose via ingestion pathways of milk, meat, produce and vegetation. C-14 has always been released from the plant but, previous to 2010, was not reported because it was not a significant release relative to other radioactive releases. Since the overall quantity of other radioactive releases has steadily decreased due to improvements in power plant operations and improved fuel integrity, C-14 now qualifies as a principle radionuclide. For each Unit, it is assumed that half of the C-14 is released from the MPS Site Stack and half from each unit's main ventilation vent.

When water is transferred to the RWST there is a potential for a release of radioactivity through the tank vent. In 2017 MP-CHEM-17-07, "Reporting of Radioactivity Released from RWST Vents" was written to establish a maximum dose threshold of 0.075 mrem/quarter for creating release permits. The organ dose threshold value of 0.075 mrem/quarter is 1% of the quarterly organ dose limit of 7.5 mrem for H-3 and particulate releases. Nuclides that do not have a partitioning or evaporation factor such as iodines and noble gases are assumed to have been released and are reported in the MPS2 & MPS3 ground release tables. Both the MPS2&3 RWSTs are sampled on a monthly basis during normal operations and prior to transfer when transferring water during outages.

Any releases from the spent fuel pool area in the reactor building at MPS1 are released through the SFPI Vent. Releases from other parts of the MPS1 reactor building and other buildings are continuously discharged to the BOP Vent.

Samples of air near the containment equipment hatch openings are analyzed for particulates and iodines, during refueling outages for the period that the equipment hatch is open. An estimated flow out of the hatch and sample results are used to determine the radioactivity released. Containment equipment hatch releases occurred only during the MPS2 outages during the fourth quarter. Condition report 1107689 was written to document two weeks of equipment hatch air samples not being counted to the requirements specified in the REMODCM Table I.D.-2 "Millstone Unit 2 Radioactive Gaseous Waste Sampling and Analysis Program." The first two weeks of equipment hatch air samples were counted and determined to be below the threshold to be counted using gamma spectroscopy. The gross instruments used to perform the screening counts on the first two weeks of air samples do not have the sensitivity to identify all the nuclides in the sample. Historical information from previous outages was used in the gaseous release permits for the first two weeks the equipment hatch was opened. Administrative communications have been established to ensure the equipment hatch air samples will be counted using gamma spectroscopy.

The MPS2 Atmospheric Dump Valves (ADVS) were opened during the refueling outage and fans were used to assist in cooling down the stream generators for personnel entry. A gooseneck air sampler (HD-29A) was set up at the suction plenum of each fan to monitor the effluent being discharge through the ADVS. The effluent being discharged was monitored for iodine, particulate, and tritium.

2.1.1.2 Batch Releases

The following sources of radioactivity releases are considered batch releases:

MPS2 Waste Gas Decay Tanks (WGDT) (via MPS2 WRGM to MPS Stack)
MPS2 Containment Purge (via MPS2 Main Exhaust Vent)
MPS2 Reactor Coolant System Venting
MPS2 Equipment Drain Sump Tank.
MPS2 and MPS3 Containment Vents (via EBFS to MPS Stack for MPS2 and via SLCRS to MPS Stack for MPS3)
MPS3 Volume control tank sampling and purging operations
MPS3 Process gas system maintenance

Waste Gases from the MPS2 Gaseous Waste Processing System are held for decay in waste gas decay tanks prior to discharge through the MPS Site Stack. Each gas decay tank is analyzed prior to discharge for noble gas and H-3. Calculated volume discharged is multiplied by the isotopic concentrations (noble gas and H-3) from the analysis of grab samples to determine the total activity released.

Containment air is sampled prior to each purge for gamma and H-3 to determine the activity released from containment purging. Similar to containment venting, the measured concentrations are multiplied by the containment purge volume to obtain the total activity released. Any iodines and particulates discharged would be detected by the continuous monitoring discussed in section 2.1.1.1. There were only two containment purges conducted in 2018 one in the beginning of MPS2 refueling outage 25 and the other during the subsequent outage in November. In both cases the discharge pathway alignment to the MPS2 Main Exhaust Vent.

The RCS is vented prior to opening piping system to the atmosphere in the beginning of the refueling outage. RCS venting operations caused an increase on MPS2 Wide Range Gaseous Monitor RM8169 and a local grab sample was taken during the release. The activity concentrations were multiplied by the flowrate of the MPS2 air entering the MPS Stack to calculate the release in this gaseous release calculation.

When the equipment drain sump tank was returned to service there was a release into the auxiliary building. A grab sample identified noble gases and this was used to document the release out of the MPS2 Main Exhaust Vent. The release did not cause an increase on the "MPS2 Stack Gaseous Radiation monitor" RM8132B, so the activity concentrations were applied to the estimated volume release from the EDST.

Containment air is sampled periodically for gamma and H-3 to determine the activity released from containment venting. The measured concentrations are multiplied by the containment vent volume to obtain the total activity released. MPS2 typically performs this process of discharging air from containment to maintain pressure approximately once per week and MPS3 vents containment about 16 times per month. Any iodines and particulates discharged would be detected by the continuous monitoring discussed in Section 2.1.1.1.

Periodically the MPS3 volume control tank needs to be purged for chemistry control of the reactor coolant system. Normally reactor coolant system gases are maintained and processed by the degasifier, but extensive maintenance required the degasifier to be tagged out of service. While the degasifier was removed from service periodic sampling was required to ensure the reactor chemistry parameters were within specification. These periodic samples would cause deflection on SLCRS gaseous low range radiation monitor HVR-19B and gaseous grab samples of the volume control tank and radiation monitor activity concentration were used to quantify VCT sampling releases. During the 2018 the MPS3 VCT did not need to be purged but was sampled 5 times to periodically to monitor parameters while the degasifier was out of service.

The MPS3 process gas water separator skid experienced a dryer problem and was required to be drained before the unit could be placed back into service. While this draining was occurring there is potential for reactor coolant system gases to be releases to both SLCRS and MPS3 Ventilation Vent. The most recent RCS noble gas sample and responses on "Ventilation Vent Noble Gas Effluent monitor" HVR-10B and "SLCRS gaseous low range radiation monitor" HVR-19B were used to quantify these releases.

2.1.2 Estimate of Errors

Estimates of errors associated with radioactivity measurements were made using the following guidelines:

Radioactivity Measurement Calibration	10%	Calibration to NIST* standards
Sampling/Data Collection	10% - 20%	Variation in sample collection
Sample Line Loss	20% - 40%	Deposition of some nuclides
Sample Counting	10% - 30%	Error for counting statistics
Flow & Level Measurements	10% - 20%	Error for release volumes

*National Institute of Standards and Technology

2.1.3 Gaseous Batch Release Statistics

MPS1 – None

MPS2	CTMT Vents	WGDT	CTMT Purge	EDST Release
Number of Batches	57	2	2	1
Total Time (min)	7921	254	3416	724
Maximum Time (min)	193	128	3250	724
Average Time (min)	139	127	1708	724
Minimum Time (min)	17	126	166	724

MPS3	CTMT Vents	VCT Sample	Process Gas
Number of Batches	196	5	4
Total Time (min)	49126	154	24
Maximum Time (min)	661	71	8
Average Time (min)	251	31	6
Minimum Time (min)	35	5	5

2.1.4 Abnormal Gaseous Releases

An abnormal gaseous release of radioactivity is defined as radioactive material released in gaseous effluents to the environment that was unplanned or uncontrolled due to an unanticipated event. These do not include normal routine effluent releases from anticipated operational and maintenance occurrences such as power level changes, reactor trip, opening primary system loops, degassing, letdown of reactor coolant or transferring spent resin and do not include non-routine events such as minor leakages from piping, valves, pump seals, tank vents, etc.

2.1.4.1 MPS1 – None

2.1.4.2 MPS2 –

Waste gas discharges are discharged through the MPS Stack to minimize the dose consequence to the public. A damper alignment problem resulted in the 'D' waste gas decay tank being aligned to the MPS2 Main Exhaust Vent (MPS2 Vent) resulting in a release of 5.5E-04 Ci Kr-85 and 7.51E-04Ci H-3. Since the waste gas decay tank had decayed greater than 90 days prior to release the dose consequence resulting from this release is 5.60E-04 mrem/year at the site boundary. The dose consequence for the 'D' WGDT if released through MPS stack would have been 9.04E-05 mrem/year at the site boundary. The impact to a member of the public at the site boundary from this release is 4.70E-04 mrem/year and is 0.005% of the annual gamma dose limit and 0.002% of the beta dose limit. Actions to address reoccurrence include additional administrative requirements to validate the damper alignment prior to release.

2.1.4.3 MPS3 - None

2.1.5 Gaseous Release Tables

The following tables provide the details of the gaseous radioactivity released from each of the MPS units. They are categorized by type of release, source(s), and by release point of discharge to the environment.

Table 2.1-A1
MPS1
Gaseous Effluents - Release Summary

	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
1. Total Activity Released	Ci	-	-	-	-	-
2. Average Period Release Rate	uCi/sec	-	-	-	-	-
B. Iodines / Halogens						
1. Total Activity Released	Ci	na	na	na	na	na
2. Average Period Release Rate	uCi/sec	na	na	na	na	na
C. Particulates						
1. Total Activity Released	Ci	9.65E-06	-	1.30E-10	-	9.64E-06
2. Average Period Release Rate	uCi/sec	1.24E-06	-	1.63E-11	-	3.06E-07
D. Gross Alpha						
1. Total Activity Released	Ci	-	-	-	-	-
E. Tritium						
1. Total Activity Released	Ci	1.40E-02	1.80E-02	1.36E-02	1.11E-02	5.66E-02
2. Average Period Release Rate	uCi/sec	1.80E-03	2.28E-03	1.71E-03	1.39E-03	1.79E-03

"-" denotes less than Minimum Detectable Activity (MDA)
"na" denotes not required to be analyzed

Table 2.1-A2

MPS1

Gaseous Effluents - Ground Continuous - BOP Vent & SFPI Vent

Nuclides Released	Units	2018				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
Kr-85	Ci	-	-	-	-	-
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
B. Iodines / Halogens						
I-131	Ci	na	na	na	na	na
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
C. Particulates						
Be-7	Ci	6.46E-06	-	1.30E-10	-	6.46E-06
Cs-137	Ci	3.17E-06	-	-	-	3.17E-06
Other γ Emitters	Ci	-	-	-	-	-
Sr-90	Ci	-	-	-	-	-
Total Activity	Ci	9.64E-06	-	1.30E-10	-	9.64E-06
D. Gross Alpha						
Gross Alpha	Ci	-	-	-	-	-
E. Tritium						
H-3	Ci	1.40E-02	1.80E-02	1.36E-02	1.11E-02	5.66E-02

"-" denotes less than Minimum Detectable Activity (MDA)
"na" denotes not required to be analyzed

Table 2.2-A1
MPS2
Gaseous Effluents - Release Summary

	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
1. Total Activity Released	Ci	4.57E-02	5.55E-02	5.08E-01	3.31E-02	6.43E-01
2. Average Period Release Rate	uCi/sec	5.88E-03	7.06E-03	6.40E-02	4.16E-03	2.04E-02
B. Iodines / Halogens						
1. Total Activity Released	Ci	6.26E-05	5.97E-05	1.46E-04	7.20E-05	3.40E-04
2. Average Period Release Rate	uCi/sec	8.05E-06	7.59E-06	1.84E-05	9.05E-06	1.08E-05
C. Particulates						
1. Total Activity Released	Ci	-	-	7.80E-06	2.60E-05	3.38E-05
2. Average Period Release Rate	uCi/sec	-	-	9.81E-07	3.27E-06	1.07E-06
D. Gross Alpha						
1. Total Activity Released	Ci	-	-	-	-	-
E. Tritium						
1. Total Activity Released	Ci	2.17E+00	1.71E+00	2.04E+00	4.39E+00	1.03E+01
2. Average Period Release Rate	uCi/sec	2.80E-01	2.18E-01	2.57E-01	5.52E-01	3.27E-01
F. C-14						
1. Total Activity Released**	Ci	2.16E+00	2.16E+00	2.10E+00	1.80E+00	8.22E+00
2. Average Period Release Rate	uCi/sec	2.78E-01	2.75E-01	2.64E-01	2.26E-01	2.61E-01

"-" denotes less than Minimum Detectable Activity (MDA)

** Calculated value per "Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents" EPRI Final Report, 12/2010.

Table 2.2-A2

MPS2

Gaseous Effluents - Ground Level Release - Batch Mode

Release Point - No Releases

Nuclides Released	Units	2018				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
Total Activity	Ci	*	*	*	*	*
B. Iodines / Halogens						
Total Activity	Ci	*	*	*	*	*
C. Particulates						
Total Activity	Ci	*	*	*	*	*
D. Gross Alpha						
Gross Alpha	Ci	*	*	*	*	*
E. Tritium						
H-3	Ci	*	*	*	*	*

* No activity released

Table 2.2-A3

MPS2

Gaseous Effluents - Ground Level Release - Continuous Mode

Release Point - Refuel Water Storage Tank Vent, Equipment Hatch

Nuclides Released	Units	2018				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
Xe-133	Ci	-	-	9.98E-03	1.35E-02	2.35E-02
Xe-135	Ci	-	-	4.24E-03	9.44E-04	5.18E-03
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	1.42E-02	1.44E-02	2.87E-02
I-131	Ci	-	-	-	7.02E-08	7.02E-08
I-132	Ci	-	-	4.76E-05	6.62E-05	1.14E-04
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	4.76E-05	6.63E-05	1.14E-04
C. Particulates						
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	2.52E-05	2.52E-05
D. Gross Alpha						
Gross Alpha	Ci	na	na	na	na	na
E. Tritium						
H-3	Ci	-	-	-	-	-

"na" denotes Not Required to be Analyzed

"-" denotes less than Minimum Detectable Activity (MDA)

Table 2.2-A4

MPS2

Gaseous Effluents - Elevated Release - Batch Mode

Release Point – MPS Stack

Nuclides Released	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
Ar-41	Ci	3.87E-02	4.64E-02	4.95E-02	1.11E-02	1.46E-01
Kr-85	Ci	-	-	7.42E-04	-	7.42E-04
Xe-133	Ci	6.56E-03	8.51E-03	9.42E-03	6.41E-03	3.09E-02
Xe-135	Ci	4.85E-04	5.74E-04	1.79E-02	5.14E-04	1.95E-02
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	4.57E-02	5.55E-02	7.76E-02	1.80E-02	1.97E-01
B. Iodines / Halogens						
	Ci	-	-	-	-	-
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
C. Particulates						
	Ci	-	-	-	-	-
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
D. Gross Alpha						
Gross Alpha	Ci	na	na	na	na	na
E. Tritium						
H-3	Ci	2.41E-01	3.04E-01	1.99E-01	1.04E-02	7.54E-01

"-" denotes less than Minimum Detectable Activity (MDA)

"na" denotes not required to be analyzed

Table 2.2-A5

MPS2

Gaseous Effluents - Elevated Release - Continuous Mode

Release Point - MPS Stack

Nuclides Released	Units	2018				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
	Ci	-	-	-	-	-
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
B. Iodines / Halogens						
Br-82	Ci	-	-	2.27E-07	4.57E-06	4.80E-06
I-131	Ci	-	-	-	-	-
I-133	Ci	-	-	-	-	-
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	2.27E-07	4.57E-06	4.80E-06
C. Particulates						
Be-7	Ci	-	-	-	5.42E-07	5.42E-07
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	5.42E-07	5.34E-06
D. Gross Alpha						
Gross Alpha	Ci	-	-	-	-	-
E. Tritium						
H-3	Ci	-	-	1.50E-01	7.13E-01	8.63E-01
F. C-14						
C-14	Ci	1.08E+00	1.08E+00	1.05E+00	9.00E-01	4.11E+00

"-" denotes less than Minimum Detectable Activity (MDA)

Table 2.2-A6

MPS2

Gaseous Effluents - Mixed Mode Release - Batch Mode

Release Point – MPS2 Main Exhaust Vent, CTMT Purge, 'D' WGDT, EDST

Nuclides Released	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
Ar-41	Ci	*	*	1.09E-01	-	1.09E-01
Kr-85	Ci	*	*	2.41E-08	5.50E-04	5.50E-04
Kr-85m	Ci	*	*	2.41E-08	-	2.41E-08
Kr-88	Ci	*	*	7.89E-09	-	7.89E-09
Xe-131m	Ci	*	*	1.46E-07	-	1.46E-07
Xe-133	Ci	*	*	2.87E-02	-	2.87E-02
Xe-133m	Ci	*	*	2.25E-07	-	2.25E-07
Xe-135	Ci	*	*	1.45E-06	-	1.45E-06
Other γ Emitters	Ci	*	*	-	-	-
Total Activity	Ci	*	*	1.38E-01	5.50E-04	1.38E-01
B. Iodines / Halogens						
Br-82	Ci	*	*	2.25E-05	-	2.25E-05
I-131	Ci	*	*	1.24E-06	-	1.24E-06
I-133	Ci	*	*	8.11E-07	-	8.11E-07
Other γ Emitters	Ci	*	*	-	-	-
Total Activity	Ci	*	*	2.46E-05	-	2.46E-05
C. Particulates						
Co-60	Ci	*	*	3.41E-07		3.41E-07
Other γ Emitters	Ci	*	*	-	-	-
Total Activity	Ci	*	*	3.41E-07	-	3.41E-07
D. Gross Alpha						
Gross Alpha	Ci	na	na	na	na	na
E. Tritium						
H-3	Ci	*	*	3.84E-01	4.90E-02	4.33E-01

* No activity released

"na" denotes not required to be analyzed

"-" denotes less than Minimum Detectable Activity (MDA)

Table 2.2-A7

MPS2

Gaseous Effluents - Mixed Mode Release - Continuous Mode

Release Point - MPS 2 Main Exhaust Vent

Nuclides Released	Units	2018				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
Xe-133	Ci	-	-	2.55E-01	-	2.55E-01
Xe-135	Ci	-	-	2.41E-02	-	2.41E-02
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	2.79E-01	-	2.79E-01
B. Iodines / Halogens						
Br-82	Ci	-	-	5.84E-06	-	5.84E-06
I-131	Ci	1.30E-05	1.54E-05	1.92E-05	1.11E-06	4.87E-05
I-133	Ci	4.96E-05	4.43E-05	4.85E-05	-	1.42E-04
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	6.26E-05	5.97E-05	7.35E-05	1.11E-06	1.97E-04
C. Particulates						
Co-58	Ci	-	-	2.76E-06	-	2.76E-06
Cs-137	Ci	-	-	4.70E-06	-	4.70E-06
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	7.46E-06	-	7.46E-06
D. Gross Alpha						
Gross Alpha	Ci	-	-	-	-	-
E. Tritium						
H-3	Ci	1.93E+00	1.41E+00	1.31E+00	3.58E+00	8.23E+00
F. C-14						
C-14	Ci	1.08E+00	1.08E+00	1.05E+00	9.00E-01	4.11E+00

"-" denotes less than Minimum Detectable Activity (MDA)

Table 2.2-A8

MPS2

Gaseous Effluents - Mixed Mode Release - Continuous Mode

Release Point – MPS2 Atmospheric Dump Valves

Nuclides Released	Units	2018				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
Other γ Emitters	Ci	*	*	*	-	-
Total Activity	Ci	*	*	*	-	-
B. Iodines / Halogens						
Other γ Emitters	Ci	*	*	*	-	-
Total Activity	Ci	*	*	*	-	-
C. Particulates						
Co-58	Ci	*	*	*	8.18E-08	8.18E-08
Co-60	Ci	*	*	*	6.56E-08	6.56E-08
Zr-95	Ci	*	*	*	5.63E-08	5.63E-08
Nb-95	Ci	*	*	*	1.03E-07	1.03E-07
Other γ Emitters	Ci	*	*	*	-	-
Total Activity	Ci	*	*	*	3.07E-07	3.07E-07
D. Gross Alpha						
Gross Alpha	Ci	na	na	na	na	na
E. Tritium						
H-3	Ci	*	*	*	3.71E-02	3.71E-02

* No activity released
"na" denotes not required to be analyzed
"-" denotes less than Minimum Detectable Activity (MDA)

Table 2.3-A1
MPS3
Gaseous Effluents - Release Summary

	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
1. Total Activity Released	Ci	2.23E-01	3.01E-01	3.21E-01	9.61E-01	1.81E+00
2. Average Period Release Rate	uCi/sec	2.87E-02	3.83E-02	4.03E-02	1.21E-01	5.73E-02
B. Iodines / Halogens						
1. Total Activity Released	Ci	3.92E-06	3.56E-06	3.79E-06	4.85E-06	1.61E-05
2. Average Period Release Rate	uCi/sec	5.04E-07	4.53E-07	4.76E-07	6.10E-07	5.11E-07
C. Particulates						
1. Total Activity Released	Ci	-	-	2.01E-07	1.34E-07	3.35E-07
2. Average Period Release Rate	uCi/sec	-	-	2.53E-08	1.68E-08	5.22E-07
D. Gross Alpha						
1. Total Activity Released	Ci	-	-	-	-	-
E. Tritium						
1. Total Activity Released	Ci	9.07E+00	5.46E+00	4.78E+00	8.88E+00	2.83E+01
2. Average Period Release Rate	uCi/sec	1.17E+00	6.95E-01	6.13E-01	1.12E+00	8.97E-01
F. C-14						
1. Total Activity Released**	Ci	3.18E+00	3.18E+00	3.18E+00	3.18E+00	1.27E+01
2. Average Period Release Rate	uCi/sec	4.09E-01	4.04E-01	4.00E-01	4.00E-01	4.03E-01

"-" denotes less than Minimum Detectable Activity (MDA)

** Calculated value per "Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents" EPRI Final Report, 12/2010.

Table 2.3-A2

MPS3

Gaseous Effluents - Ground Level Release - Batch Mode

Release Point -ESF Building Rooftop

Nuclides Released	Units	2018				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
Other γ Emitters	Ci	*	*	*	*	*
Total Activity	Ci	*	*	*	*	*
B. Iodines / Halogens						
Other γ Emitters	Ci	*	*	*	*	*
Total Activity	Ci	*	*	*	*	*
C. Particulates						
Other γ Emitters	Ci	*	*	*	*	*
Total Activity	Ci	*	*	*	*	*
D. Gross Alpha						
Gross Alpha	Ci	na	na	na	na	na
E. Tritium						
H-3	Ci	*	*	*	*	*

* No activity released

"-" denotes less than Minimum Detectable Activity (MDA)

"na" denotes Not Required to be Analyzed

Table 2.3-A3

MPS3

Gaseous Effluents - Ground Level Release - Continuous Mode

Release Point - ESF Building Vent, Auxiliary Boiler Vents

Nuclides Released	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
B. Iodines / Halogens						
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
C. Particulates						
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
D. Gross Alpha						
Gross Alpha	Ci	-	-	-	-	-
E. Tritium						
H-3	Ci	3.09E-02	7.11E-02	1.52E-02	8.09E-02	1.98E-01

"-" denotes less than Minimum Detectable Activity (MDA)

Table 2.3-A4

MPS3

Gaseous Effluents - Elevated Release - Batch Mode

Release Point - MPS Stack

Nuclides Released	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
Ar-41	Ci	6.14E-03	5.59E-03	1.50E-02	5.41E-03	3.21E-02
Kr-85m	Ci	-	-	1.68E-03	8.23E-03	9.91E-03
Kr-87	Ci	-	-	1.62E-03	5.30E-03	6.92E-03
Kr-88	Ci	-	-	3.84E-03	5.10E-03	8.94E-03
Xe-133	Ci	-	8.98E-04	1.83E-02	1.12E-03	2.03E-02
Xe-135	Ci	-	1.45E-04	2.17E-02	1.20E-02	3.38E-02
Xe-135m	Ci	-	-	3.54E-03	7.80E-03	1.13E-02
Xe-138	Ci	-	-	-	3.40E-02	3.40E-02
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	6.14E-03	6.63E-03	6.57E-02	7.90E-02	1.57E-01
B. Iodines / Halogens						
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
C. Particulates						
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
D. Gross Alpha						
Gross Alpha	Ci	na	na	na	na	na
E. Tritium						
H-3	Ci	6.14E-03	6.63E-03	6.57E-02	7.90E-02	1.57E-01

"-" denotes less than Minimum Detectable Activity (MDA)
"na" denotes Not Required to be Analyzed

Table 2.3-A5

MPS3

Gaseous Effluents - Elevated Release - Continuous Mode

Release Point - MPS Stack

Nuclides Released	Units	2018				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
Ar-41	Ci	-	3.90E-04	2.49E-03	-	2.88E-03
Kr-83m	Ci	-	-	8.45E-04	-	8.45E-04
Kr-85	Ci	2.17E-01	2.91E-01	2.17E-01	3.65E-01	1.09E+00
Kr-85m	Ci	-	1.16E-04	2.47E-04	-	3.63E-04
Kr-87	Ci	-	1.18E-04	2.69E-03	-	2.81E-03
Kr-88	Ci	-	2.57E-04	3.12E-03	-	3.37E-03
Xe-133	Ci	-	7.75E-04	3.40E-03	-	4.17E-03
Xe-135	Ci	-	1.36E-03	8.23E-03	-	9.59E-03
Xe-135m	Ci	-	3.34E-04	3.02E-03	-	3.35E-03
Xe-138	Ci	-	-	1.38E-02	-	1.38E-02
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	2.17E-01	2.94E-01	2.55E-01	3.65E-01	1.13E+00
B. Iodines / Halogens						
Br-82	Ci	3.92E-06	3.65E-06	3.79E-06	4.85E-06	1.62E-05
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	3.92E-06	3.65E-06	3.79E-06	4.85E-06	1.62E-05
C. Particulates						
Co-60	Ci	-	-	2.01E-07	1.34E-07	3.35E-07
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	2.01E-07	1.34E-07	3.35E-07
D. Gross Alpha						
Gross Alpha	Ci	-	-	-	-	-
E. Tritium						
H-3	Ci	6.91E-01	5.11E-01	4.17E-01	1.34E+00	2.96E+00
F. C-14						
C-14	Ci	1.59E+00	1.59E+00	1.59E+00	1.59E+00	6.36E+00

"-" denotes less than Minimum Detectable Activity (MDA)

Table 2.3-A6

MPS3

Gaseous Effluents - Mixed Mode Release - Batch Mode

Release Point - MPS3 Unit 3 Ventilation Vent

Nuclides Released	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
Kr-85	Ci	*	*	*	5.90E-03	5.90E-03
Kr-85m	Ci	*	*	*	1.08E-02	1.08E-02
Kr-87	Ci	*	*	*	4.85E-02	4.85E-02
Kr-88	Ci	*	*	*	4.49E-02	4.49E-02
Xe-135	Ci	*	*	*	8.22E-02	8.22E-02
Xe-135m	Ci	*	*	*	6.45E-02	6.45E-02
Xe-138	Ci	*	*	*	2.60E-01	2.60E-01
Other γ Emitters	Ci	*	*	*	-	-
Total Activity	Ci	*	*	*	5.17E-01	5.17E-01
B. Iodines / Halogens						
Other γ Emitters	Ci	*	*	*	-	-
Total Activity	Ci	*	*	*	-	-
C. Particulates						
Other γ Emitters	Ci	*	*	*	-	-
Total Activity	Ci	*	*	*	-	-
D. Gross Alpha						
Gross Alpha	Ci	na	na	na	na	na
E. Tritium						
H-3	Ci	*	*	*	-	-

* No activity released

"-" denotes less than Minimum Detectable Activity (MDA)
"na" denotes Not Required to be Analyzed

Table 2.3-A7

MPS3

Gaseous Effluents - Mixed Mode Release - Continuous Mode

Release Point - MPS3 Ventilation Vent

Nuclides Released	Units	2018				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Gases						
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
B. Iodines / Halogens						
I-131	Ci	-	-	-	-	-
I-133	Ci	-	-	-	-	-
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
C. Particulates						
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
D. Gross Alpha						
Gross Alpha	Ci	-	-	-	-	-
E. Tritium						
H-3	Ci	8.24E+00	4.65E+00	4.15E+00	7.35E+00	2.44E+01
F. C-14						
C-14	Ci	1.59E+00	1.59E+00	1.59E+00	1.59E+00	6.36E+00

"-" denotes less than Minimum Detectable Activity (MDA)

2.2 Liquid Effluents

2.2.1 Measurement of Radioactivity in Liquid Effluents

2.2.1.1 Continuous Liquid Releases

Water containing radioactivity is continuously released through one of two pathways – the MPS Quarry or DSN006. DSN006 is next to the MPS3 intake structure (DSN is acronym for Discharge Serial Number.) Grab samples are taken for continuous liquid release pathways and analyzed on the gamma spectrometer and liquid scintillation detector (for H-3) if required by the conditional action requirements of the REMODCM. Total estimated volume is multiplied by the isotopic concentrations (if any) to determine the total activity released. A proportional aliquot of each discharge is retained for composite analysis for Sr-89, Sr-90, Fe-55 and gross alpha if required by the conditional action requirements of the REMODCM. Sources for continuous liquid effluent releases via the MPS Quarry include Steam Generator Blowdown for MPS2 & MPS3, Service Water Effluent for MPS2 & MPS3 and Reactor Building Closed Cooling Water (RBCCW) Sump for MPS2. Sources for continuous liquid effluent releases via DSN006 include Turbine Building Sump discharge from MPS2 & MPS3, CPF TK2 from MPS3 and SRW Sump 3 from MPS3.

2.2.1.2 Batch Liquid Releases from Tanks and Sumps

Batch liquid releases are made via both the MPS Quarry and DSN006. There are numerous sources from which batches of liquids containing radioactivity are discharged to the environs. Except for two sources from MPS3 to DSN006 they are discharged via the MPS Quarry. The sources are:

MPS1 Radwaste Processing System – Includes sources from:

1. Reactor Building Sumps
2. Underground Ventilation Duct
3. Site Stack Sump

MPS2 Radwaste Processing System:

1. Clean Waste Monitor Tanks (2)
2. Aerated Waste Monitor Tanks

Other Radwaste Sources:

1. CPF Waste Neutralization Sump
2. Steam Generator Bulk
3. Other Systems' Bulk Discharges

MPS3 Radwaste Processing

1. Waste Test Tanks (2)
2. Low Level Waste Test Tanks (2)
3. Boron Test Tanks (2)

Other Radwaste Sources:

1. CPF Waste Neutralization Sump
2. Steam Generator Bulk
3. Other systems' Bulk Discharges (via Quarry or DSN006)
4. Boron and Waste Test Tanks Berm (via DSN006)

Prior to release, a tank is re-circulated for two equivalent tank volumes, a sample is drawn and then analyzed on the HPGe gamma spectrometer and liquid scintillation detector (H-3) for individual radionuclide composition. Isotopic concentrations are multiplied by the volume released to obtain the total activity released. For bulk releases, several samples are taken during the discharge to verify the amount of radioactivity released. A proportional aliquot of each discharge is retained for composite analysis for Sr-89, Sr-90, Fe-55, and gross alpha.

2.2.2 Estimate of Errors

Estimates of errors associated with radioactivity measurements were made using the following guidelines:

Radioactivity Measurement Calibration	10%	Calibration to NIST* standards
Sampling/Data Collection	10% - 20%	Variation in sample collection
Sample Counting	10% - 30%	Error for counting statistics
Flow & Level Measurements	10% - 20%	Error for release volumes

* National Institute of Standards and Technology

2.2.3 Liquid Batch Release Statistics

	MPS1	MPS2	MPS3
Radwaste Processing System:			
Number of Batches	12	20	56
Total Time (min)	511	4061	6021
Maximum Time (min)	46	245	135
Average Time (min)	43	203	108
Minimum Time (min)	40	130	94
	MPS1	**MPS2**	**MPS3**
Other Radwaste Sources:			
Number of Batches	NA	18	127
Total Time (min)	NA	5511	17914
Maximum Time (min)	NA	747	519
Average Time (min)	NA	306	141
Minimum Time (min)	NA	16	10

2.2.4 Abnormal Liquid Releases

An abnormal release of radioactivity is the discharge of a volume of liquid radioactive material to the environment that was unplanned or uncontrolled. In 2018, the following abnormal liquid releases occurred:

2.2.4.1 MPS1 - None
2.2.4.2 MPS2 - None
2.2.4.3 MPS3 - None

2.2.5 Liquid Release Tables

The following tables provide the details of the liquid radioactivity released from each of the MPS units. They are categorized by type of release, source(s), and by release point of discharge to the environment.

Table 2.1-L1
MPS1
Liquid Effluents - Release Summary

	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission and Activation Products						
1. Total Activity Released	Ci	1.41E-04	6.32E-04	8.84E-04	6.94E-04	2.35E-03
2. Average Period Diluted Activity+	uCi/ml	5.39E-13	2.84E-12	3.17E-12	4.39E-12	2.55E-12
B. Tritium						
1. Total Activity Released	Ci	1.85E-03	1.18E-02	7.87E-03	4.65E-03	2.61E-02
2. Average Period Diluted Activity+	uCi/ml	7.08E-12	5.27E-11	2.82E-11	2.94E-11	2.83E-11
C. Dissolved and Entrained Gases						
1. Total Activity Released	Ci	-	-	-	-	-
2. Average Period Diluted Activity+	uCi/ml	-	-	-	-	-
D. Gross Alpha						
1. Total Activity Released	Ci	-	-	-	-	-
E. Volume						
1. Released Waste Volume	Liters	1.38E+05	1.00E+05	7.19E+04	9.86E+04	4.09E+05
2. Dilution Volume During Releases	Liters	8.45E+08	4.18E+08	4.08E+08	5.99E+08	2.27E+09
3. Dilution Volume During Period++	Liters	2.62E+11	2.23E+11	2.79E+11	1.58E+11	9.22E+11

* No activity released
"-" denotes less than Minimum Detectable Activity (MDA)
\+ "Total Activity Released" ÷ ("Released Waste Volume" + "Dilution Volume During Period")
++ MPS2 Dilution Volume During Period used because there is no MPS1 dilution

Table 2.1-L2

MPS1

Liquid Effluents - Batch

Release to Quarry: Liquid Radwaste Processing System

Nuclides Released	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Products						
Cs-137	Ci	1.41E-04	6.32E-04	8.80E-04	6.91E-04	2.34E-03
Fe-55	Ci	-	-	-	-	-
Sr-89	Ci	-	-	-	-	-
Sr-90	Ci	-	-	4.06E-06	2.91E-06	6.97E-06
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	1.41E-04	6.32E-04	8.84E-04	6.94E-04	2.35E-03
B. Tritium						
H-3	Ci	1.85E-03	1.18E-02	7.87E-03	4.65E-03	2.61E-02
C. Dissolved & Entrained Gases						
Kr-85	Ci	-	-	-	-	-
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
D. Gross Alpha						
Gross Alpha	Ci	-	-	-	-	-

"-" denotes less than Minimum Detectable Activity (MDA)

Table 2.2-L1

MPS2

Liquid Effluents - Release Summary

	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission and Activation Products						
1. Total Activity Released	Ci	-	-	1.95E-05	9.64E-04	9.83E-04
2. Average Period Diluted Activity *	uCi/ml	-	-	6.98E-14	6.10E-12	6.17E-12
B. Tritium						
1. Total Activity Released	Ci	1.07E+02	1.25E+02	3.25E+02	6.07E+01	6.18E+02
2. Average Period Diluted Activity *	uCi/ml	4.08E-07	5.60E-07	1.16E-06	3.84E-07	6.70E-07
C. Dissolved and Entrained Gases						
1. Total Activity Released	Ci	-	-	7.18E-03	6.76E-04	7.86E-03
2. Average Period Diluted Activity *	uCi/ml	-	-	2.57E-11	4.28E-12	3.00E-11
D. Gross Alpha						
1. Total Activity Released	Ci	-	-	-	-	-
E. Volume						
1. Released Waste Volume						
Primary	Liters	2.67E+05	2.03E+05	7.27E+05	6.26E+05	1.82E+06
Secondary	Liters	2.52E+06	9.66E+05	4.46E+05	2.63E+06	6.56E+06
2. Dilution Volume During Releases						
Primary	Liters	2.55E+09	1.72E+09	8.72E+09	5.10E+09	1.81E+10
Secondary (DSN006)	Liters	6.35E+07	1.82E+07	Note	5.04E+07	1.32E+08
Secondary (Quarry)	Liters	Note	5.13E+08	3.32E+09	8.69E+09	1.25E+10
3. Dilution Volume During Period						
Quarry	Liters	2.62E+11	2.23E+11	2.79E+11	1.58E+11	9.22E+11
DSN006	Liters	5.89E+07	4.81E+07	4.06E+07	4.31E+07	1.91E+08

* "Total Activity Released" ÷ ("Released Waste Volume" + "Dilution Volume During Period")
"-" denotes less than Minimum Detectable Activity (MDA)
Note: No secondary releases to the Quarry 1st quarter and DSN006 in the 3rd quarter.

Table 2.2-L2

MPS2

Liquid Effluents - Continuous

1. **Release to Quarry: Steam Generator Blowdown, Service Water and Reactor Building Closed Cooling Water**
2. **Release to DSN006: Turbine Building Sumps and Tendon Gallery**

Nuclides Released	Units	2018				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Products						
Ni-63	Ci	-	-	-	-	-
Sr-89	Ci	-	-	-	-	-
Sr-90	Ci	-	-	-	-	-
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
B. Tritium						
H-3	Ci	1.00E-02	4.08E-03	3.95E-05	2.36E-02	3.77E-02
C. Dissolved & Entrained Gases						
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
D. Gross Alpha						
Gross Alpha	Ci	-	-	-	-	-

"-" denotes less than Minimum Detectable Activity (MDA)

Table 2.2-L3
MPS2
Liquid Effluents - Batch
Release to Quarry: Liquid Radwaste Processing System

Nuclides Released	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Products						
Co-58	Ci	-	-	-	6.55E-04	6.55E-04
Co-60	Ci	-	-	-	1.20E-04	1.20E-04
Nb-97	Ci	-	-	-	6.29E-05	6.29E-05
Ag-110m	Ci	-	-	1.95E-05	1.26E-04	1.46E-04
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	1.95E-05	9.64E-04	9.83E-04
B. Tritium						
H-3	Ci	1.07E+02	1.25E+02	3.25E+02	6.07E+01	6.18E+02
C. Dissolved & Entrained Gases						
Xe-133	Ci	-	-	7.01E-03	6.76E-04	7.69E-03
Xe-135	Ci	-	-	1.71E-04	-	1.71E-04
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	7.18E-03	6.76E-04	7.86E-03
D. Gross Alpha						
Gross Alpha	Ci	-	-	-	-	-

"-" denotes less than Minimum Detectable Activity (MDA)

Table 2.3-L1

MPS3

Liquid Effluents - Release Summary

	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission and Activation Products						
1. Total Activity Released	Ci	3.67E-04	8.35E-05	1.11E-02	2.74E-03	1.43E-02
2. Average Period Diluted Activity *	uCi/ml	9.26E-13	2.20E-13	2.34E-11	5.81E-12	8.28E-12
B. Tritium						
1. Total Activity Released	Ci	1.40E+02	2.17E+02	1.27E+02	1.60E+02	6.44E+02
2. Average Period Diluted Activity *	uCi/ml	3.54E-07	5.70E-07	2.69E-07	3.40E-07	3.74E-07
C. Dissolved and Entrained Gases						
1. Total Activity Released	Ci	-	-	-	-	-
2. Average Period Diluted Activity *	uCi/ml	-	-	-	-	-
D. Gross Alpha						
1. Total Activity Released	Ci	-	-	-	-	-
E. Volume						
1. Released Waste Volume						
Primary	Liters	7.58E+05	7.97E+05	1.01E+06	7.08E+05	3.27E+06
Secondary	Liters	1.18E+07	1.25E+07	1.42E+07	1.43E+07	5.27E+07
2. Dilution Volume During Releases						
Primary	Liters	6.27E+09	5.66E+09	9.34E+09	5.24E+09	2.65E+10
Secondary (DSN006)	Liters	5.88E+07	4.60E+07	4.00E+07	4.37E+07	1.89E+08
Secondary (Quarry)	Liters	7.37E+11	6.44E+11	3.96E+11	6.07E+11	2.38E+12
3. Dilution Volume During Period						
Quarry	Liters	3.96E+11	3.80E+11	4.72E+11	4.72E+11	1.72E+12
DSN006	Liters	5.89E+07	4.81E+07	4.06E+07	4.31E+07	1.91E+08

"-" denotes less than Minimum Detectable Activity (MDA)

* "Total Activity Released" ÷ (Primary "Released Waste Volume" + "Dilution Volume During Period")

Table 2.3-L2

MPS3

Liquid Effluents - Continuous

1. **Release to Quarry: Steam Generator Blowdown, Service Water, ABD TK-2**
2. **Release to DSN006: Turbine Building Sump and SRW Sump 3**

Nuclides Released	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Products						
Sr-89	Ci	-	-	-	-	-
Sr-90	Ci	-	-	-	-	-
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
B. Tritium						
H-3	Ci	3.12E-01	5.23E-01	9.00E-01	4.96E-01	2.23E+00
C. Dissolved & Entrained Gases						
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
D. Gross Alpha						
Gross Alpha	Ci	-	-	-	-	-

"-" denotes less than Minimum Detectable Activity (MDA)

Table 2.3-L3

MPS3

Liquid Effluents - Batch

1. **Release to Quarry: Liquid Radwaste Processing System, CPF Waste Neutralization Sumps, Hotwell and Steam Generator Bulk, ABD TK-2**
2. **Release to DSN006: Waste Test Tank Berm**

Nuclides Released	Units	2018 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Products						
Fe-55	Ci	-	-	1.08E-02	2.30E-03	1.31E-02
Co-58	Ci	2.31E-04	-	-	-	2.31E-04
Co-60	Ci	-	-	-	3.02E-05	3.02E-05
Sb-125	Ci	1.13E-04	8.35E-05	2.36E-04	7.81E-05	5.11E-04
Cs-137	Ci	2.26E-05	-	2.54E-05	3.32E-04	3.80E-04
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	3.67E-04	8.35E-05	1.11E-02	2.74E-03	1.43E-02
B. Tritium						
H-3	Ci	1.40E+02	2.16E+02	1.26E+02	1.60E+02	6.42E+02
C. Dissolved & Entrained Gases						
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-
D. Gross Alpha						
Gross Alpha	Ci	-	-	-	-	-

"-" denotes less than Minimum Detectable Activity (MDA)

2.3 Solid Waste

Solid waste shipment summaries for each unit are given in the following tables:

Table 2.1-S MPS1 Solid Waste and Irradiated Component Shipments
Table 2.2-S MPS2 Solid Waste and Irradiated Component Shipments
Table 2.3-S MPS3 Solid Waste and Irradiated Component Shipments

The principal radionuclides in these tables were from shipping manifests.

Solidification Agent(s): No solidification on site

Containers routinely used for radioactive waste shipment include:

55-gal Steel Drum DOT* 17-H container	7.5 ft^3
Steel Boxes	45 ft^3
	87 ft^3
	95 ft^3
Steel Container	202.1 ft^3
Steel "Sea Van"	1280 ft^3
Polyethylene High Integrity Containers	120.3 ft^3
	132.4 ft^3
	173.4 ft^3
	202.1 ft^3

* United States Department of Transportation

Table 2.1-S
Solid Waste and Irradiated Component Shipments
MPS1

January 1, 2018 through December 31, 2018

Resins, Filters, and Evaporator Bottoms	Volume		Curies Shipped
Waste Class	**ft^3**	**m^3**	**Curies**
	7.20E+01	2.04E+00	1.45E-03
B	N/A	N/A	N/A
C	N/A	N/A	N/A
ALL	**7.20E+01**	**2.04E+00**	**1.45E-03**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
Co-60	0.14%	2.01E-06
Ni-63	1.32%	1.91E-05
Sr-90	0.74%	1.08E-05
Cs-137	97.80%	1.42E-03
CURIES (TOTAL)		**1.45E-03**

Table 2.1-S (continued)
Solid Waste and Irradiated Component Shipments
MPS1

January 1, 2018 through December 31, 2018

Dry Active Waste	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	5.85E+02	1.66E+01	2.17E-02
B	N/A	N/A	N/A
C	N/A	N/A	N/A
ALL	**5.85E+02**	**1.66E+01**	**2.17E-02**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	0.74%	1.60E-04
C-14	0.03%	7.17E-06
Cr-51	3.61%	7.85E-04
Mn-54	1.19%	2.59E-04
Fe-55	4.69%	1.02E-03
Fe-59	0.41%	8.88E-05
Co-57	0.25%	5.35E-05
Co-58	2.21%	4.81E-04
Co-60	34.59%	7.52E-03
Ni-59	0.38%	8.24E-05
Ni-63	21.50%	4.67E-03
Sr-90	0.11%	2.42E-05
Zr-95	1.11%	2.42E-04
Nb-94	0.46%	9.97E-05
Nb-95	2.40%	5.21E-04
Tc-99	0.15%	3.29E-05
Ag-110m	0.65%	1.41E-04
Sn-113	0.51%	1.10E-04
Sb-125	2.72%	5.92E-04
Cs-137	22.16%	4.82E-03
Pu-238	< 0.01%	2.10E-06
Pu-239	< 0.01%	1.14E-06
Pu-241	0.10%	2.11E-05
Am-241	0.02%	3.81E-06
Cm-242	< 0.01%	7.50E-08
Cm-244	< 0.01%	1.77E-06
CURIES (TOTAL)		**2.17E-02**

Table 2.1-S (continued)
Solid Waste and Irradiated Component Shipments
MPS1

January 1, 2018 through December 31, 2018

Irradiated Components	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	N/A	N/A	N/A
B	N/A	N/A	N/A
C	N/A	N/A	N/A
ALL	**N/A**	**N/A**	**N/A**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
CURIES (TOTAL)		0

Other Waste	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	N/A	N/A	N/A
B	N/A	N/A	N/A
C	N/A	N/A	N/A
ALL	**N/A**	**N/A**	**N/A**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
CURIES (TOTAL)		0

Table 2.1-S (continued)
Solid Waste and Irradiated Component Shipments
MPS1

January 1, 2018 through December 31, 2018

Sum of All Low-Level Waste Shipped from Site	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	6.57E+02	1.86E+01	2.32E-02
B	N/A	N/A	N/A
C	N/A	N/A	N/A
ALL	**6.57E+02**	**1.86E+01**	**2.32E-02**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	0.69%	1.60E-04
C-14	0.03%	7.17E-06
Cr-51	3.39%	7.85E-04
Mn-54	1.12%	2.59E-04
Fe-55	4.39%	1.02E-03
Fe-59	0.38%	8.88E-05
Co-57	0.23%	5.35E-05
Co-58	2.07%	4.81E-04
Co-60	32.43%	7.52E-03
Ni-59	0.36%	8.24E-05
Ni-63	20.23%	4.69E-03
Sr-90	0.15%	3.50E-05
Zr-95	1.04%	2.42E-04
Nb-94	0.43%	9.97E-05
Nb-95	2.25%	5.21E-04
Tc-99	0.14%	3.29E-05
Ag-110m	0.61%	1.41E-04
Sn-113	0.48%	1.10E-04
Sb-125	2.55%	5.92E-04
Cs-137	26.90%	6.24E-03
Pu-238	< 0.01%	2.10E-06
Pu-239	< 0.01%	1.14E-06
Pu-241	0.09%	2.11E-05
Am-241	0.02%	3.81E-06
Cm-242	< 0.01%	7.50E-08
Cm-244	< 0.01%	1.77E-06
CURIES (TOTAL)		**2.32E-02**

Table 2.2-S
Solid Waste and Irradiated Component Shipments
MPS2

January 1, 2018 through December 31, 2018

Resins, Filters, and Evaporator Bottoms	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	1.12E+02	3.17E+00	3.19E+00
B	N/A	N/A	N/A
C	3.29E+01	9.33E-01	1.29E+00
ALL	**1.45E+02**	**4.11E+00**	**4.48E+00**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	8.34%	3.74E-01
C-14	0.57%	2.57E-02
Cr-51	< 0.01%	1.81E-25
Mn-54	3.41%	1.53E-01
Fe-55	14.37%	6.44E-01
Fe-59	< 0.01%	1.29E-15
Co-57	0.04%	1.74E-03
Co-58	0.03%	1.56E-03
Co-60	35.36%	1.58E+00
Ni-59	0.41%	1.85E-02
Ni-63	29.00%	1.30E+00
Zn-65	< 0.01%	1.45E-05
Sr-89	< 0.01%	6.75E-16
Sr-90	0.10%	4.68E-03
Zr-95	< 0.01%	4.88E-10
Nb-94	< 0.01%	2.48E-04
Nb-95	< 0.01%	1.08E-09
Tc-99	0.05%	2.28E-03
Ag-110m	0.24%	1.08E-02
Sn-113	< 0.01%	2.86E-07
Sb-124	< 0.01%	1.72E-11
Sb-125	2.39%	1.07E-01
I-129	< 0.01%	1.07E-06
Cs-134	0.17%	7.58E-03
Cs-137	5.39%	2.41E-01
Ce-144	< 0.01%	3.27E-06
Pu-238	< 0.01%	5.98E-05
Pu-239	< 0.01%	2.87E-05
Pu-241	0.10%	4.31E-03
Am-241	< 0.01%	9.82E-05
Cm-242	< 0.01%	6.25E-09
Cm-244	< 0.01%	7.64E-05
CURIES (TOTAL)		**4.48E+00**

Table 2.2-S (continued)
Solid Waste and Irradiated Component Shipments
MPS2
January 1, 2018 through December 31, 2018

Dry Active Waste	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	9.32E+03	2.64E+02	2.88E-01
B	N/A	N/A	N/A
C	N/A	N/A	N/A
ALL	**9.32E+03**	**2.64E+02**	**2.88E-01**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	0.71%	2.05E-03
C-14	< 0.01%	7.53E-06
Cr-51	0.31%	8.78E-04
Mn-54	0.31%	8.82E-04
Fe-55	6.54%	1.88E-02
Co-57	0.02%	5.76E-05
Co-58	0.51%	1.48E-03
Co-60	33.82%	9.74E-02
Ni-59	0.55%	1.58E-03
Ni-63	49.11%	1.41E-01
Sr-89	< 0.01%	2.25E-07
Sr-90	< 0.01%	1.15E-05
Zr-95	0.42%	1.22E-03
Nb-94	0.04%	1.07E-04
Nb-95	0.94%	2.71E-03
Tc-99	0.17%	4.92E-04
Ag-110m	0.71%	2.04E-03
Sn-113	0.05%	1.32E-04
Sb-125	2.29%	6.58E-03
Cs-137	3.34%	9.61E-03
Ce-144	< 0.01%	3.80E-06
Pu-238	< 0.01%	1.75E-05
Pu-239	< 0.01%	5.21E-06
Pu-241	0.11%	3.15E-04
Am-241	< 0.01%	1.56E-05
Cm-242	< 0.01%	3.93E-06
Cm-244	< 0.01%	9.31E-06
CURIES (TOTAL)		**2.88E-01**

Table 2.2-S (continued)
Solid Waste and Irradiated Component Shipments
MPS2
January 1, 2018 through December 31, 2018

Irradiated Components	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	N/A	N/A	N/A
B	N/A	N/A	N/A
C	N/A	N/A	N/A
ALL	**N/A**	**N/A**	**N/A**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
CURIES (TOTAL)		0

Table 2.2-S (continued)
Solid Waste and Irradiated Component Shipments
MPS2
January 1, 2018 through December 31, 2018

Other Waste	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	2.60E+02	7.35E+00	2.69E-02
B	N/A	N/A	N/A
C	N/A	N/A	N/A
ALL	**2.60E+02**	**7.35E+00**	**2.69E-02**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	98.05%	2.64E-02
C-14	< 0.01%	4.57E-08
Cr-51	< 0.01%	1.29E-07
Mn-54	0.04%	1.19E-05
Fe-55	0.48%	1.30E-04
Co-57	< 0.01%	2.92E-07
Co-58	0.02%	5.10E-06
Co-60	0.46%	1.24E-04
Ni-59	< 0.01%	1.51E-06
Ni-63	0.70%	1.89E-04
Sr-90	< 0.01%	6.84E-08
Zr-95	< 0.01%	1.65E-06
Nb-94	< 0.01%	3.16E-07
Nb-95	0.01%	3.68E-06
Tc-99	< 0.01%	2.05E-06
Ag-110m	0.02%	6.05E-06
Sn-113	< 0.01%	3.38E-07
Sb-125	0.07%	1.85E-05
Cs-134	< 0.01%	1.09E-06
Cs-137	0.10%	2.75E-05
Pu-238	< 0.01%	1.64E-08
Pu-239	< 0.01%	5.80E-09
Pu-241	< 0.01%	6.23E-07
Am-241	< 0.01%	1.81E-08
Cm-242	< 0.01%	2.98E-10
Cm-244	< 0.01%	1.02E-08
CURIES (TOTAL)		**2.69E-02**

Table 2.2-S (continued)
Solid Waste and Irradiated Component Shipments
MPS2
January 1, 2018 through December 31, 2018

Sum of All Low-Level Waste Shipped from Site	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	9.69E+03	2.74E+02	3.50E+00
B	N/A	N/A	N/A
C	3.29E+01	9.33E-01	1.29E+00
ALL	**9.73E+03**	**2.75E+02**	**4.79E+00**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	8.39%	4.02E-01
C-14	0.54%	2.57E-02
Cr-51	0.02%	8.79E-04
Mn-54	3.21%	1.54E-01
Fe-55	13.82%	6.63E-01
Fe-59	< 0.01%	9.15E-05
Co-57	0.04%	1.80E-03
Co-58	0.06%	3.04E-03
Co-60	35.07%	1.68E+00
Ni-59	0.42%	2.01E-02
Ni-63	30.05%	1.44E+00
Zn-65	< 0.01%	1.48E-05
Sr-89	< 0.01%	2.25E-07
Sr-90	0.10%	4.69E-03
Zr-95	0.03%	1.22E-03
Nb-94	< 0.01%	3.55E-04
Nb-95	0.06%	2.71E-03
Tc-99	0.06%	2.77E-03
Ag-108m	< 0.01%	1.28E-05
Ag-110m	0.27%	1.28E-02
Sn-113	< 0.01%	1.33E-04
Sn-117m	< 0.01%	1.41E-13
Sb-124	< 0.01%	1.26E-07
Sb-125	2.37%	1.13E-01
I-129	< 0.01%	1.07E-06
Cs-134	0.16%	7.58E-03
Cs-137	5.24%	2.51E-01
Ce-144	< 0.01%	7.07E-06
Hf-181	< 0.01%	5.86E-09
Pu-238	< 0.01%	7.73E-05
Pu-239	< 0.01%	3.39E-05
Pu-241	0.10%	4.62E-03
Am-241	< 0.01%	1.14E-04
Cm-242	< 0.01%	3.94E-06
Cm-244	< 0.01%	8.57E-05
CURIES (TOTAL)		**4.79E+00**

Table 2.3-S
Solid Waste and Irradiated Component Shipments
MPS3

January 1, 2018 through December 31, 2018

Resins, Filters, and Evaporator Bottoms	Volume		Curies Shipped
Waste Class	**ft^3**	**m^3**	**Curies**
A	1.85E+02	5.24E+00	1.17E+01
B	1.72E+02	4.87E+00	4.82E+01
C	3.29E+01	9.33E-01	1.29E+00
ALL	**3.90E+02**	**1.10E+01**	**6.12E+01**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	0.78%	4.75E-01
C-14	0.25%	1.53E-01
Cr-51	0.06%	3.56E-02
Mn-54	4.53%	2.78E+00
Fe-55	8.37%	5.12E+00
Fe-59	< 0.01%	1.29E-15
Co-57	0.14%	8.30E-02
Co-58	0.60%	3.65E-01
Co-60	9.27%	5.67E+00
Ni-59	0.64%	3.92E-01
Ni-63	59.39%	3.63E+01
Zn-65	< 0.01%	3.16E-03
Sr-89	< 0.01%	6.75E-16
Sr-90	0.01%	7.97E-03
Zr-95	< 0.01%	1.23E-03
Nb-94	< 0.01%	2.84E-03
Nb-95	< 0.01%	2.66E-03
Tc-99	0.17%	1.01E-01
Ag-110m	< 0.01%	7.45E-04
Sn-113	< 0.01%	2.25E-03
Sb-124	< 0.01%	1.72E-11
Sb-125	14.66%	8.97E+00
Cs-134	0.04%	2.52E-02
Cs-137	1.07%	6.58E-01
Ce-144	< 0.01%	3.27E-06
Pu-238	< 0.01%	5.59E-05
Pu-239	< 0.01%	2.63E-05
Pu-241	< 0.01%	3.96E-03
Am-241	< 0.01%	9.71E-05
Cm-242	< 0.01%	6.25E-09
Cm-244	< 0.01%	7.56E-05
CURIES (TOTAL)		**6.12E+01**

Table 2.3-S (continued)
Solid Waste and Irradiated Component Shipments
MPS3
January 1, 2018 through December 31, 2018

Dry Active Waste	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	5.96E+03	1.69E+02	1.02E+00
B	N/A	N/A	N/A
C	N/A	N/A	N/A
ALL	**5.96E+03**	**1.69E+02**	**1.02E+00**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	0.47%	4.83E-03
C-14	< 0.01%	7.61E-06
Cr-51	0.15%	1.50E-03
Mn-54	1.76%	1.80E-02
Fe-55	44.52%	4.54E-01
Fe-59	0.02%	2.25E-04
Co-57	0.04%	4.36E-04
Co-58	1.62%	1.65E-02
Co-60	37.77%	3.85E-01
Ni-59	0.09%	9.38E-04
Ni-63	9.48%	9.67E-02
Sr-90	< 0.01%	4.63E-05
Zr-95	0.44%	4.49E-03
Nb-94	0.12%	1.25E-03
Nb-95	0.93%	9.52E-03
Tc-99	< 0.01%	4.67E-05
Ag-110m	0.12%	1.23E-03
Sn-113	0.05%	4.90E-04
Sb-125	0.99%	1.01E-02
Cs-137	1.36%	1.38E-02
Pu-238	< 0.01%	2.34E-06
Pu-239	< 0.01%	1.05E-06
Pu-241	0.04%	4.32E-04
Am-241	< 0.01%	4.14E-06
Cm-242	< 0.01%	2.30E-07
Cm-244	< 0.01%	2.62E-06
CURIES (TOTAL)		**1.02E+00**

Table 2.3-S (continued)
Solid Waste and Irradiated Component Shipments
MPS3
January 1, 2018 through December 31, 2018

Irradiated Components	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	N/A	N/A	N/A
B	N/A	N/A	N/A
C	N/A	N/A	N/A
ALL	**N/A**	**N/A**	**N/A**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
CURIES (TOTAL)		0

Table 2.3-S (continued)
Solid Waste and Irradiated Component Shipments
MPS3
January 1, 2018 through December 31, 2018

Other Waste	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	3.96E+02	1.12E+01	4.18E-02
B	N/A	N/A	N/A
C	N/A	N/A	N/A
ALL	**3.96E+02**	**1.12E+01**	**4.18E-02**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	98.73%	4.13E-02
C-14	< 0.01%	4.59E-08
Cr-51	< 0.01%	1.29E-07
Mn-54	0.03%	1.19E-05
Fe-55	0.31%	1.31E-04
Co-57	< 0.01%	2.92E-07
Co-58	0.01%	5.10E-06
Co-60	0.30%	1.25E-04
Ni-59	< 0.01%	1.51E-06
Ni-63	0.45%	1.90E-04
Sr-90	< 0.01%	7.26E-08
Zr-95	< 0.01%	1.65E-06
Nb-94	< 0.01%	3.16E-07
Nb-95	< 0.01%	3.68E-06
Tc-99	< 0.01%	2.15E-06
Ag-110m	0.02%	6.47E-06
Sn-113	< 0.01%	3.38E-07
Sb-125	0.05%	2.18E-05
Cs-134	< 0.01%	1.09E-06
Cs-137	0.07%	2.95E-05
Pu-238	< 0.01%	1.65E-08
Pu-239	< 0.01%	5.83E-09
Pu-241	< 0.01%	6.25E-07
Am-241	< 0.01%	1.82E-08
Cm-242	< 0.01%	3.26E-10
Cm-244	< 0.01%	1.03E-08
CURIES (TOTAL)		**4.18E-02**

Table 2.3-S (continued)
Solid Waste and Irradiated Component Shipments
MPS3
January 1, 2018 through December 31, 2018

Sum of All Low-Level Waste Shipped from Site	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	6.54E+03	1.85E+02	1.27E+01
B	1.72E+02	4.87E+00	4.82E+01
C	3.29E+01	9.33E-01	1.29E+00
ALL	**6.75E+03**	**1.91E+02**	**6.23E+01**

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	0.84%	5.21E-01
C-14	0.25%	1.53E-01
Cr-51	0.06%	3.71E-02
Mn-54	4.49%	2.79E+00
Fe-55	8.96%	5.58E+00
Fe-59	< 0.01%	2.25E-04
Co-57	0.13%	8.35E-02
Co-58	0.61%	3.82E-01
Co-60	9.73%	6.06E+00
Ni-59	0.63%	3.93E-01
Ni-63	58.53%	3.64E+01
Zn-65	< 0.01%	3.16E-03
Sr-89	< 0.01%	6.75E-16
Sr-90	0.01%	8.01E-03
Zr-95	< 0.01%	5.72E-03
Nb-94	< 0.01%	4.09E-03
Nb-95	0.02%	1.22E-02
Tc-99	0.16%	1.01E-01
Ag-110m	< 0.01%	1.98E-03
Sn-113	< 0.01%	2.74E-03
Sb-124	< 0.01%	1.72E-11
Sb-125	14.43%	8.98E+00
Cs-134	0.04%	2.52E-02
Cs-137	1.08%	6.72E-01
Ce-144	< 0.01%	3.27E-06
Pu-238	< 0.01%	5.82E-05
Pu-239	< 0.01%	2.73E-05
Pu-241	< 0.01%	4.39E-03
Am-241	< 0.01%	1.01E-04
Cm-242	< 0.01%	2.36E-07
Cm-244	< 0.01%	7.83E-05
CURIES (TOTAL)		**6.23E+01**

2.4 Groundwater Monitoring

The Groundwater Protection Program (GWPP) MPS implements the actions cited in the Nuclear Energy's Institute's (NEI) Groundwater Protection Initiative, NEI 07-07 (Reference 10). The purpose of the GWPP is to establish a program to assure timely and effective management of situations involving potential releases of radioactive material to ground. A key element in the GWPP is on-site groundwater monitoring. The results of the GWPP are documented in Table 2.4-GW.

Another key element in the GWPP is site hydrological characterization. The general trend of groundwater flow at the station is toward the Long Island Sound. The underdrain system effectively captures groundwater in the area around MPS3 and channels this water via the storm drain system to Long Island Sound

On 07/31/2018, during a planned underground pipe inspection of the Unit 3 condensate surge tank, a water leak was identified from one of the return lines to the tank. The leak was stopped and leaked standing water was captured. Following the event, local and state government stakeholders and the NRC were notified.

The level of tritium in the groundwater wells inside the Plant Protected Area does not present an exposure pathway to onsite personnel or members of the public, as there are no drinking water wells onsite. In addition to ground water samples taken within the Protected Area, ground water samples were also taken outside the Protected Area on owner controlled property. The absence of tritium in wells outside the Protected Area indicates that tritium is confined to the specified locations identified in Table 2.4.

Table 2.4-GW (p. 1 of 2) Well Sample Results

Name	Date	H-3[1,2] (pCi/L)	Name	Date	H-3[1,2] (pCi/L)
MW-7C[3]	01/24/2018	7130	MW-7D[3]	01/16/2018	5530
	02/08/2018	5890		01/24/2018	6410
	02/21/2018	3500		02/08/2018	4790
	03/10/2018	4540		02/22/2018	4140
	06/22/2018	6150		03/10/2018	3920
	07/25/2018	6580		04/13/2018	2660
	08/02/2018	6180		06/22/2018	4980
	08/08/2018	5000		07/25/2018	7270
	08/14/2018	6150		08/02/2018	7760
	08/21/2018	6120		08/08/2018	7000
	08/29/2018	5320		08/14/2018	5670
	09/11/2018	5700		08/21/2018	6990
	09/27/2018	2710		08/29/2018	5450
	10/30/2018	2920		09/10/2018	6840
	11/21/2018	1860		09/27/2018	3250
	12/18/2018	2,100		10/30/2018	<mda
				11/21/2018	4310
				12/18/2018	2,900

Notes:

1. There was no gamma radioactivity detected in these samples.
2. MDA is approximately 1,760 pCi/L.
3. MW-7C/7D have been subjected to tritium from atmospheric deposition as well as residual water leakage of the buried condensate piping that was replaced in 2018. Also, these wells are located near the Unit 3 RWST which is downwind direction from the Unit 3 Ventilation Vent. Tritium detected is attributed from releases out of the RWST vent and Ventilation Vent. Gaseous releases from the Ventilation Vent are reported in Table 2.3-A7 and from the RWST vent in Table 2.3-A3. Any releases from RWST vent or Ventilation Vent which reach the groundwater are captured in sumps and underground vaults, and periodically monitored before release to the environment and reported in Table 2.3-L2. There has been no hydraulic communication with offsite groundwater.

Table 2.4-GW (p. 2 of 2)
Well Sample Results

Name	Date	H-3[1,2] (pCi/L)	Name	Date	H-3[1,2] (pCi/L)
DP-102[3]	02/23/2018	7600	MW-GPI-09[4]	03/16/2018	<mda
	03/12/2018	2210		05/24/2018	<mda
	06/19/2018	<mda		09/12/2018	<mda
	09/19/2018	<mda		11/29/2018	2470
	12/05/2018	2370	MW-GPI-10	03/15/2018	<mda
ME-2	12/07/2018	<mda		05/24/2018	<mda
ME-5	12/03/2018	<mda		09/12/2018	<mda
MW-6A	02/28/2018	<mda		11/29/2018	<mda
	05/30/2018	<mda	MW-GPI-11	03/15/2018	<mda
	09/06/2018	<mda		04/13/2018	<mda
	11/18/2018	<mda		09/06/2018	<mda
MW-6B	02/28/2018	<mda	S11-MW-1	12/14/2018	<mda
	05/30/2018	<mda	S12-MW-1	03/16/2018	<mda
	09/06/2018	<mda		06/20/2018	<mda
	11/07/2018	<mda		09/06/2018	<mda
MW-GPI-02[4]	03/19/2018	<mda		11/07/2018	<mda
	05/30/2018	<mda	S12-MW-3	03/19/2018	<mda
	09/12/2018	3290			
	09/20/2018	2780		05/24/2018	<mda
	09/27/2018	<mda		09/21/2018	<mda
MW-GPI-03	12/07/2018	<mda		11/07/2018	<mda
MW-GPI-04	11/29/2018	<mda	S13-MW-1	11/18/2018	<mda
MW-GPI-06	03/12/2018	<mda	S1-MW-1	11/29/2018	<mda
	06/22/2018	<mda	S3-MW-2	11/07/2018	<mda
	09/19/2018	<mda	T10-MW-5E	11/18/2018	<mda
	12/05/2018	<mda	T10-MW-6A	12/11/2018	<mda
MW-GPI-08	03/16/2018	<mda	T10-MW-6B	12/07/2018	<mda
	06/20/2018	<mda			
	09/12/2018	<mda			
	11/29/2018	<mda			

Notes:

1. There was no gamma radioactivity detected in these samples.
2. MDA is approximately 1,760 pCi/L.
3. DP-102 is located near the Unit 3 RWST which is downwind direction from the Unit 3 Ventilation Vent. All or some of the H-3 detected in these wells is from releases out of the RWST vent and Ventilation Vent. Gaseous releases from the Ventilation Vent are reported in Table 2.3-A7 and from the RWST vent in Table 2.3-A3. Any releases from RWST vent or Ventilation Vent which reach the groundwater are captured in sumps and underground vaults, and periodically monitored before release to the environment and reported in Table 2.3-L2. There has been no hydraulic communication with offsite groundwater.
4. Some results from MW-GPI-09 and MW-GPI-02 were positive. The source of tritium appears to be from the tritium being released via underground discharge tunnels.

3.0 NONFUNCTIONAL Effluent Monitors

During the period January 1 through December 31, 2018, the following effluent instrumentation were NONFUNCTIONAL for more than 30 consecutive days:

3.1. **MPS1** - None

3.2. **MPS2** –
The aerated waste radiation monitor RM 9116 was out of service for greater than 30 days (Condition Report 1103527). The radiation monitor was tagged out of service to support the Unit 2 Equipment Drain sump tank pump replacement. Compensatory actions for when the aerated waste radiation monitor is removed from service includes two independent samples prior to release. This release pathway was not used while the radiation monitor was tagged out of service.

3.3. **MPS3** - None

4.0 Operating History

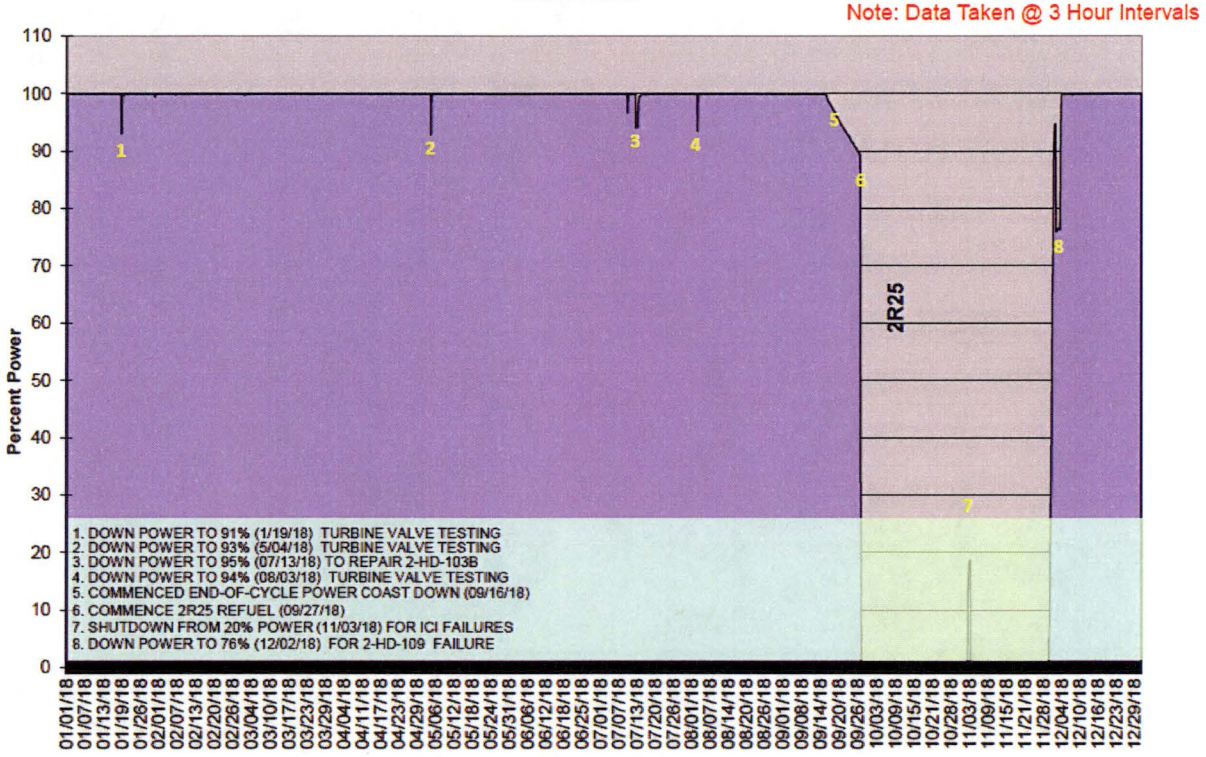
The operating history of the MPS Units during this reporting period was as follows:
MPS1 was shut down November 11, 1995 with a cessation of operation declared in July 1998.
MPS2 operated with a capacity factor of **80.7%**

MPS3 operated with a capacity factor of **101.3%**

The power histograms for 2018 are on the following pages.

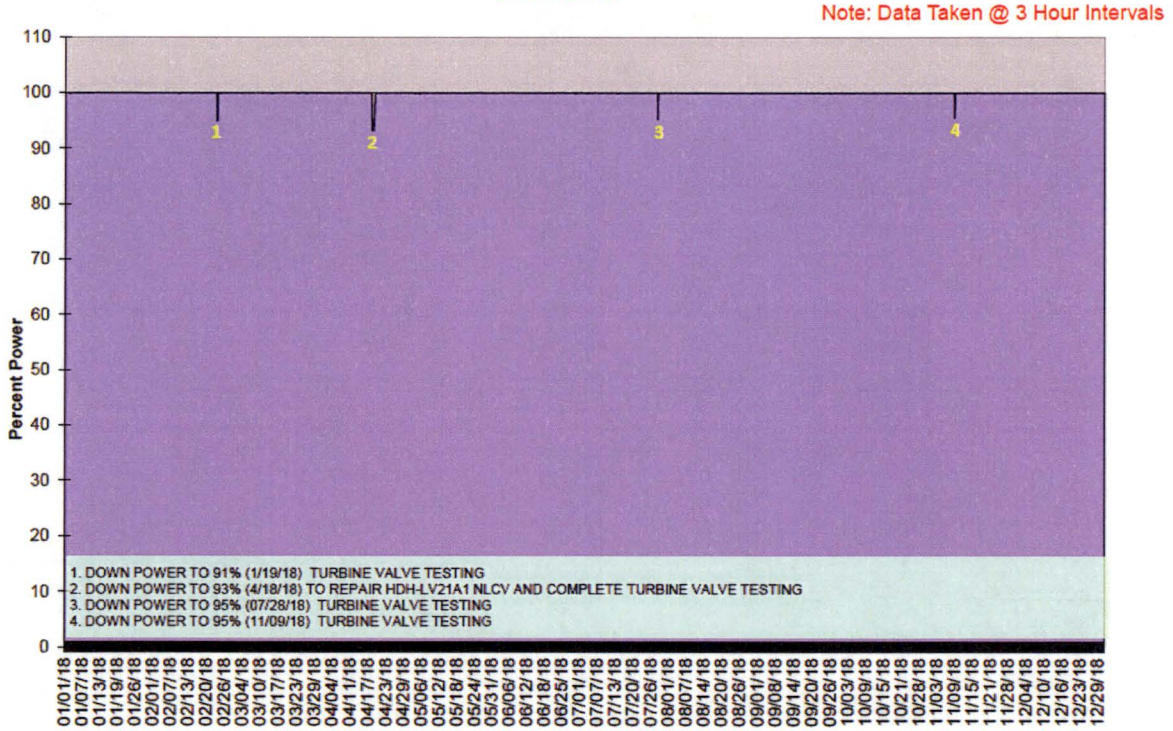
MP2 - CYCLE 25/26 POWER HISTORY
YEAR 2018

Note: Data Taken @ 3 Hour Intervals



MP3 - CYCLE 19 POWER HISTORY
YEAR 2018

Note: Data Taken @ 3 Hour Intervals



5.0 ERRATA

The follow items have been updated for the 2017 RERR.
The revisions to following tables were the result of spreadsheet errors carried forward and were not identified in the review process. These were identified in the preparation for the 2018 RERR.

Table 2.1-L1
MPS1
Liquid Effluents - Release Summary

	Units	2017 1st Qtr	2017 2nd Qtr	2017 3rd Qtr	2017 4th Qtr	2017 Total
A. Fission and Activation Products						
1. Total Activity Released	Ci	9.71E-04	1.87E-03	*	2.62E-04	3.11E-03
2. Average Period Diluted Activity+	uCi/ml	3.98E-12	1.06E-11	*	9.16E-13	4.40E-12
B. Tritium						
1. Total Activity Released	Ci	1.53E-03	2.56E-03	*	1.79E-04	4.27E-03
2. Average Period Diluted Activity+	uCi/ml	6.25E-12	1.45E-11	*	6.26E-13	6.04E-12
C. Dissolved and Entrained Gases						
1. Total Activity Released	Ci	-	-	*	-	-
2. Average Period Diluted Activity+	uCi/ml	-	-	*	-	-
D. Gross Alpha						
1. Total Activity Released	Ci	-	-	*	-	-
E. Volume						
1. Released Waste Volume	Liters	6.11E+04	6.40E+04	*	6.26E+04	1.88E+05
2. Dilution Volume During Releases	Liters	4.62E+08	3.24E+08	*	3.83E+08	1.17E+09
3. Dilution Volume During Period++	Liters	2.44E+11	1.77E+11	*	2.86E+11	7.07E+11

* No activity released
"-" denotes less than Minimum Detectable Activity (MDA)
\+ "Total Activity Released" ÷ ("Released Waste Volume" + "Dilution Volume During Period")
++ MPS2 Dilution Volume During Period used because there is no MPS1 dilution
Updates to the 2017 RERR are highlighted.

Table 2.1-L2
MPS1
Liquid Effluents - Batch
Release to Quarry: Liquid Radwaste Processing System

Nuclides Released	Units	2017 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission & Activation Products						
Fe-55	Ci	6.11E-05	9.03E-05	*	-	1.51E-04
Sr-89	Ci	4.33E-06	-	*	-	4.33E-06
Sr-90	Ci	-	3.90E-06	*	-	3.90E-06
Cs-137	Ci	9.06E-04	1.78E-03	*	2.62E-04	2.95E-03
Other γ Emitters	Ci	-	-	*	-	-
Total Activity	Ci	9.71E-04	1.87E-03	*	2.62E-04	3.11E-03
B. Tritium						
H-3	Ci	1.53E-03	2.56E-03	*	1.79E-04	4.27E-03
C. Dissolved & Entrained Gases						
Kr-85	Ci	-	-	*	-	-
Other γ Emitters	Ci	-	-	*	-	-
Total Activity	Ci	-	-	*	-	-
D. Gross Alpha						
Gross Alpha	Ci	-	-	*	-	-

"-" denotes less than Minimum Detectable Activity (MDA)
Updates to the 2017 RERR are highlighted.

Table 2.2-L1

MPS2

Liquid Effluents - Release Summary

	Units	2017 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission and Activation Products						
1. Total Activity Released	Ci	1.06E-02	6.36E-04	-	9.39E-05	1.13E-02
2. Average Period Diluted Activity *	uCi/ml	4.34E-11	3.59E-12	-	3.28E-13	4.74E-11
B. Tritium						
1. Total Activity Released	Ci	3.09E+02	3.17E+01	6.98E+00	3.28E+01	3.80E+02
2. Average Period Diluted Activity *	uCi/ml	1.27E-06	1.79E-07	2.44E-08	1.15E-07	3.83E-07
C. Dissolved and Entrained Gases						
1. Total Activity Released	Ci	1.74E-02	7.19E-04	-	-	1.81E-02
2. Average Period Diluted Activity *	uCi/ml	7.13E-11	4.06E-12	-	-	7.54E-11
D. Gross Alpha						
1. Total Activity Released	Ci	-	-	-	-	-
E. Volume						
1. Released Waste Volume						
Primary	Liters	8.62E+05	4.77E+05	8.66E+04	1.59E+05	1.58E+06
Secondary	Liters	2.40E+06	1.61E+05	1.08E+04	3.46E+05	2.92E+06
2. Dilution Volume During Releases						
Primary	Liters	9.80E+09	1.13E+10	9.35E+08	3.46E+09	2.55E+10
Secondary (DSN006)	Liters	6.53E+07	2.42E+05	4.61E+05	8.46E+06	7.45E+07
Secondary (Quarry)	Liters	2.41E+09	3.16E+09	Note	8.88E+08	6.46E+09
3. Dilution Volume During Period						
Quarry	Liters	2.44E+11	1.77E+11	2.86E+11	2.86E+11	9.93E+11
DSN006	Liters	6.38E+07	4.76E+07	6.17E+07	5.72E+07	2.30E+08

* "Total Activity Released" ÷ ("Released Waste Volume" + "Dilution Volume During Period")
"-" denotes less than Minimum Detectable Activity (MDA)
Note: No secondary releases to DSN006 in the 2nd and 3rd quarters.
Updates to the 2017 RERR are highlighted.

Table 2.3-L1

MPS3

Liquid Effluents - Release Summary

	Units	2017 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
A. Fission and Activation Products						
1. Total Activity Released	Ci	-	1.91E-03	-	3.02E-04	2.21E-03
2. Average Period Diluted Activity *	uCi/ml	-	4.76E-12	-	9.59E-13	1.36E-12
B. Tritium						
1. Total Activity Released	Ci	1.51E+02	6.86E+01	6.26E+02	5.30E+02	1.38E+03
2. Average Period Diluted Activity *	uCi/ml	3.49E-07	1.71E-07	1.32E-06	1.68E-06	8.49E-07
C. Dissolved and Entrained Gases						
1. Total Activity Released	Ci	-	-	-	-	-
2. Average Period Diluted Activity *	uCi/ml	-	-	-	-	-
D. Gross Alpha						
1. Total Activity Released	Ci	-	-	-	-	-
E. Volume						
1. Released Waste Volume						
Primary	Liters	5.35E+05	1.31E+06	1.15E+06	1.07E+06	4.07E+06
Secondary	Liters	2.60E+07	2.16E+07	1.84E+07	1.47E+07	8.07E+07
2. Dilution Volume During Releases						
Primary	Liters	4.51E+09	1.19E+10	1.07E+10	8.09E+09	3.52E+10
Secondary (DSN006)	Liters	1.25E+08	4.71E+07	1.20E+08	3.37E+04	2.92E+08
Secondary (Quarry)	Liters	1.08E+12	9.00E+11	1.10E+12	7.43E+11	3.82E+12
3. Dilution Volume During Period						
Quarry	Liters	4.31E+11	4.01E+11	4.73E+11	3.15E+11	1.62E+12
DSN006	Liters	6.38E+07	4.76E+07	6.17E+07	5.72E+07	2.30E+08

"-" denotes less than Minimum Detectable Activity (MDA)

* "Total Activity Released" ÷ (Primary "Released Waste Volume" + "Dilution Volume During Period")

Updates to the 2017 RERR are highlighted.

6.0 REMODCM Changes

The description and the bases of the change(s) for REMODCM Revision 30 (effective September, 19 2018) are included here in Volume II of the Radioactive Effluent Release Report. In addition, a complete copy of the REMODCM revision is provided to the Nuclear Regulatory Commission as Volume 2 of the Radioactive Effluent Release Report.

6.1 Summary of Changes

No programmatic or technical changes were included in this revision.
Editorial changes include:

- Updating the Unit 1 Liquid Waste Effluent Discharge Radiation Monitor to RE-M6-110.
- Removing an extra 'S' from the word ISFSI on page 63.
- Revised the foot note label in III.C-3 to identify the instruments that have a required Alarm Setpoint.

REMODCM Summary of Changes in Revision 30	
Table II.E. Table III.C. Pg. 1,64, 86-87	"Liquid Discharge Flow Rates and Monitor Setpoints" "Radioactive Effluent Monitoring Instrumentation" Both revisions 028 and 029 of MP-22REC-BAP01 (REMODCM) identify the "Unit 1 Liquid Waste Effluent Discharge" radiation monitor with the wrong equipment identifier RE-MG-110. The correct equipment identifier was validated on P&ID 25202-26010 SH.29, locally, and PAMS, which all use the equipment identifier "RE-M6-110."
Table II.D.5. Pg. 63	"Gaseous Dose Calculations" Remove the extra 'S' from "ISSFSI"
Table III.C.	"Radioactive Effluent Monitoring Instrumentation" Administration correction to Table III.C-3 Radioactive Gaseous Effluent Monitoring Instrumentation Note. 2.

7.0 References

1. NUREG-0597, User Guide to GASPAR Code, KF Eckerman, FJ Congel, AK Roecklien, WJ Pasciak, Division of Site Safety and Environmental Analysis, Office of Nuclear Reactor Regulation, US Nuclear Regulatory Commission, Washington, DC 20555, manuscript completed January 1980, published June 1980.

2. EPRI Report 1021106, Estimation of Carbon-14 in Nuclear Power Plants Gaseous Effluents, December, 2010.

3. NRC Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Revision 1, October 1977.

4. UNSCEAR 2000 Report Vol. I, Sources and Effects of Ionizing Radiation, United Nations Scientific Committee on the Effects of Atomic Radiation

5. NRC Regulatory Guide 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, Revision 1, July 1977.

6. NUREG/CR-1276, ORNL/NUREG/TDMC-1, User's Manual for LADTAP II - A Computer Program for Calculating Radiation Exposure to Man from Routine Release of Nuclear Reactor Liquid Effluents, DB Simpson, BL McGill, prepared by Oak Ridge National Laboratory, Oak Ridge, TN 37830, for Office of Administration, US Nuclear Regulatory Commission, manuscript completed 17 March 1980.

7. 10 CFR Part 50, Domestic Licensing of Production and Utilization Facilities, Appendix I, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low As Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents.

8. 40 CFR Part 190, Environmental Radiation Protection Standard for Nuclear Power Operation.

9. OpenEMS Software Documentation, SQA-OpenEMS-20140130, SQA Level 3

10. NEI 07-07, Nuclear Energy Institute, Industry Ground Water Protection Initiative – Final Guidance Document, August 2007.

11. NRC Regulatory Guide 1.21, Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste, Revision 2, October 2008.

12. EPRI Report 1024827, Carbon-14 Dose Calculation Methods at Nuclear Power Plants, April, 2012.

13. NUREG/CR-2907, Vol. 15, Radioactive Effluents from Nuclear Power Plants Annual Report 2009, R. Conatser, US Nuclear Regulatory Commission and N. Daugherty, Oak Ridge Associated Universities, Aug., 2013.

14. Radiation Protection Calculation #16-18, "Isotopic Cloud Shine Doses for MPS Releases," Jan. 24, 2017.

15. MP-CHEM-17-07, "Reporting of Radioactivity Released from RWST Vents," May 26, 2016.