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U.S. Nuclear Regulatory Commission  
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License Nos.	DPR-21 DPR-65 NPF-49

**DOMINION NUCLEAR CONNECTICUT, INC.**  
**MILLSTONE POWER STATION UNITS 1, 2, AND 3**  
**2016 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT**

In accordance with 10 CFR 50.36a, this letter transmits the annual Radioactive Effluent Release Report (RERR) for the period January 2016 through December 2016. This report meets the provisions of Section 5.7.3 of the Millstone Power Station Unit 1 Permanently Defueled Technical Specifications (PDTS), and Sections 6.9.1.6b and 6.9.1.4 of the Millstone Power Station Units 2 and 3 Technical Specifications, respectively.

Attachment 1 transmits Volume 1 of the 2014 RERR, in accordance with Regulatory Guide 1.21. The RERR contains information regarding airborne, liquid, and solid radioactivity released from Millstone Power Station, including the off-site dose from airborne and liquid effluents.

Attachment 2 transmits Volume 2 of the report, which consists of a complete copy of the Radiological Effluent Monitoring and Off-Site Dose Calculation Manual (REMDCM) as of December 31, 2016. This satisfies the requirements of Sections 5.6.1c of the Millstone Power Station Unit 1 PDTS, and Sections 6.15c and 6.9.13c of the Millstone Power Station Units 2 and 3 Technical Specifications, respectively.

If you have any questions or require additional information, please contact Mr. Jeffrey A. Langan at (860) 444-5544.

Sincerely,

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**ATTACHMENT 1**

**2016 RADIOACTIVE EFFLUENTS RELEASE REPORT**  
**VOLUME 1**

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

# Millstone Power Station 2016

## Radioactive Effluents Release Report

### Volume One



Dominion Nuclear Connecticut, Inc.

Unit	License	Docket
1	DPR-21	50-245
2	DPR-65	50-336
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## List of Acronyms

BOP – Balance of plant  
CFR – Code of Federal Regulations  
CPF – Condensate polishing facility  
DOT – Department of Transportation  
DSN – Discharge serial number  
EBFS – Enclosure building filtration system  
ESF – Engineering safeguards facility  
GI - Gastrointestinal  
GWPP – Groundwater protection program  
HPGe – High purity germanium  
ISFSI – Independent spent fuel storage installation  
NPP – Nuclear power plant  
NRC – Nuclear Regulatory Commission  
RBCCW – Reactor building closed cooling water  
REMOCM - 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 2016, is being submitted by Dominion Nuclear Connecticut, Inc. for Millstone Power Station Units 1, 2, and 3, in accordance with 10 CFR 50.36a, the Radiological Effluent Monitoring and Offsite Dose Calculation Manual (REMODOCM), and the Station's 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 Millstone in 2016.

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 Millstone in 2016.

## 1.0 Off-Site Doses

This report provides a summary of the 2016 off-site radiation doses from releases of radioactive materials in gaseous and liquid effluents and from direct radiation from Units 1, 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 Millstone in 2016 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 Millstone 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:

- Unit 1 SFPI Vent (73 foot)
- Unit 1 BOP Vent (80 foot)
- Units 2 and 3 Reactor Water Storage Tank (RWST) Vents
- Unit 3 Engineered Safety Features Building (ESF) Ventilation
- Unit 3 Containment Equipment Hatch
- Unit 3 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:

- Unit 2 Auxiliary Building Ventilation (159 foot elevation)
- Unit 3 Auxiliary Building Ventilation (133 foot elevation)

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 Millstone Station 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 Unit 2 and Unit 3 discharge to the Millstone Station Stack. In March 2001, Unit 1 was separated from the stack and two new release points were added to Unit 1, 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:

- Unit 2 Waste Gas Decay Tanks batch releases
- Unit 2 Containment Vents batch releases
- Unit 3 Containment Vents batch releases
- Unit 3 Gaseous Waste System continuous releases
- Unit 3 Containment Purge batch releases (only during outage in second quarter)

### **1.1.2 Liquid Effluents**

Millstone Power Station discharges radioactivity in water through two release pathways – thru the Millstone Quarry to the Long Island Sound and thru Discharge Point DSN-006 to Niantic Bay. Discharges to the Millstone 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. Unit 1 discharges only to the Millstone 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 Millstone 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 Millstone 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  $\chi/Q$  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 Millstone Power Station 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 Millstone Power Station with the natural background radiation dose received by the average Connecticut resident (Reference 4). The total dose to the maximum individual received from Millstone Power Station is small (< 0.3%) in comparison to the dose received from natural background radiation.

**Table 1-1  
2016 Off-Site Dose Commitments from Gaseous Effluents  
Millstone Units 1, 2, 3**

<b>Unit 1</b>	<b>1st Quarter</b>	<b>2nd Quarter</b>	<b>3rd Quarter</b>	<b>4th Quarter</b>	<b>Annual Total</b>
<b>Max Air</b>	mrad	mrad	mrad	mrad	mrad
<i>Beta</i>	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
<i>Gamma</i>	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
<b>Max Individual</b>	mrem	mrem	mrem	mrem	mrem
<i>Whole Body</i>	2.10E-06	1.48E-05	1.17E-05	4.18E-05	7.04E-05
<i>Skin</i>	2.10E-06	4.95E-06	5.47E-06	4.85E-05	6.10E-05
<i>Thyroid</i>	2.10E-06	1.48E-05	1.17E-05	4.17E-05	7.03E-05
<i>Max organ1</i>	2.10E-06	1.48E-05	1.17E-05	4.20E-05	5.45E-05

<b>Unit 2</b>	<b>1st Quarter</b>	<b>2nd Quarter</b>	<b>3rd Quarter</b>	<b>4th Quarter</b>	<b>Annual Total</b>
<b>Max Air</b>	mrad	mrad	mrad	mrad	mrad
<i>Beta</i>	5.37E-06	3.60E-07	9.15E-05	1.73E-07	9.74E-05
<i>Gamma</i>	8.81E-06	7.85E-07	1.15E-05	3.70E-07	2.15E-05
<b>Max Individual</b>	mrem	mrem	mrem	mrem	mrem
<i>Whole Body</i>	1.84E-03	1.95E-02	2.37E-02	4.72E-03	4.98E-02
<i>Skin</i>	4.68E-04	4.46E-04	5.87E-04	2.59E-04	1.76E-03
<i>Thyroid</i>	1.87E-03	2.05E-02	2.41E-02	4.72E-03	5.12E-02
<i>Max organ1</i>	7.64E-03	1.16E-01	1.38E-01	2.80E-02	2.90E-01

<b>Unit 3</b>	<b>1st Quarter</b>	<b>2nd Quarter</b>	<b>3rd Quarter</b>	<b>4th Quarter</b>	<b>Annual Total</b>
<b>Max Air</b>	mrad	mrad	mrad	mrad	mrad
<i>Beta</i>	7.49E-07	4.50E-07	4.27E-07	5.47E-07	2.17E-06
<i>Gamma</i>	3.81E-07	2.05E-07	3.86E-07	4.10E-07	1.38E-06
<b>Max Individual</b>	mrem	mrem	mrem	mrem	mrem
<i>Whole Body</i>	1.64E-03	1.90E-02	1.78E-02	1.64E-03	4.01E-02
<i>Skin</i>	5.10E-04	7.01E-03	1.45E-03	5.63E-04	9.53E-03
<i>Thyroid</i>	1.64E-03	1.88E-02	1.78E-02	1.64E-03	3.99E-02
<i>Max organ1</i>	6.38E-03	6.65E-02	9.28E-02	2.37E-03	1.68E-01

**NOTES:**

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

**Table 1-2**  
**2016 Off-Site Dose Commitments from Liquid Effluents**  
**Millstone Units 1, 2, 3**

<b>Unit 1</b>	<i>1st Quarter</i>	<i>2nd Quarter</i>	<i>3rd Quarter</i>	<i>4th Quarter</i>	<i>Annual Total</i>
<b>Max Individual</b>	(mrem)	(mrem)	(mrem)	(mrem)	(mrem)
<i>Whole Body</i>	9.00E-06	6.12E-06	0.00E+00	1.26E-05	2.77E-05
<i>Thyroid</i>	2.61E-06	1.77E-06	0.00E+00	3.66E-06	8.04E-06
<i>Max Organ</i> <sup>1</sup>	1.28E-05	8.68E-06	0.00E+00	1.79E-05	3.94E-05

<b>Unit 2</b>	<i>1st Quarter</i>	<i>2nd Quarter</i>	<i>3rd Quarter</i>	<i>4th Quarter</i>	<i>Annual Total</i>
<b>Max Individual</b>	(mrem)	(mrem)	(mrem)	(mrem)	(mrem)
<i>Whole Body</i>	7.96E-06	2.24E-05	2.19E-05	5.22E-05	1.04E-04
<i>Thyroid</i>	8.71E-06	2.15E-05	3.92E-05	6.11E-05	1.31E-04
<i>Max Organ</i> <sup>1</sup>	9.20E-05	1.80E-04	1.46E-04	1.56E-04	5.74E-04

<b>Unit 3</b>	<i>1st Quarter</i>	<i>2nd Quarter</i>	<i>3rd Quarter</i>	<i>4th Quarter</i>	<i>Annual Total</i>
<b>Max Individual</b>	(mrem)	(mrem)	(mrem)	(mrem)	(mrem)
<i>Whole Body</i>	2.65E-04	5.26E-04	3.17E-04	2.46E-04	1.35E-03
<i>Thyroid</i>	2.12E-04	4.77E-04	6.40E-05	2.46E-04	9.99E-04
<i>Max Organ</i> <sup>1</sup>	4.73E-04	6.11E-04	1.68E-03	2.46E-04	2.37E-03

**NOTES:**

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

**Table 1-3  
2016 Off-Site Dose Comparison to Limits  
Millstone Units 1, 2, 3**

**Gaseous Effluents Dose**

	Whole Body (mrem)	Thyroid (mrem)	Max Organ* (mrem)	Skin (mrem)	Beta Air (mrad)	Gamma Air (mrad)
Unit 1	7.04E-05	7.03E-05	5.45E-05	6.10E-05	0.00E+00	0.00E+00
Unit 2	4.98E-02	5.12E-02	2.90E-01	1.76E-03	9.74E-05	2.15E-05
Unit 3	4.01E-02	3.99E-02	1.68E-01	9.53E-03	2.17E-06	1.38E-06
<b>Millstone Station</b>	<b>8.99E-02</b>	<b>9.12E-02</b>	<b>4.58E-01</b>	<b>1.14E-02</b>	<b>9.96E-05</b>	<b>2.28E-05</b>
<b>Limits</b>	<b>5</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>20</b>	<b>10</b>

**Liquid Effluents Dose**

	Whole Body (mrem)	Thyroid (mrem)	Max Organ* (mrem)
Unit 1	2.77E-05	8.04E-06	3.94E-05
Unit 2	1.04E-04	1.31E-04	5.74E-04
Unit 3	1.35E-03	9.99E-04	2.37E-03
<b>Millstone Station</b>	<b>1.49E-03</b>	<b>1.14E-03</b>	<b>2.98E-03</b>
<b>Limits</b>	<b>3</b>	<b>10</b>	<b>10</b>

**Total Off-Site Dose from Millstone Station**

	Whole Body (mrem)	Thyroid (mrem)	Max Organ* (mrem)
Gaseous	8.99E-02	9.12E-02	4.58E-01
Liquid	1.49E-03	1.14E-03	2.98E-03
Direct Shine**	1.30E-01	1.30E-01	1.30E-01
<b>Millstone Station</b>	<b>2.21E-01</b>	<b>2.22E-01</b>	<b>5.91E-01</b>
<b>Limits</b>	<b>25</b>	<b>75</b>	<b>25</b>

\* 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**  
**2016 Offsite Dose Comparison**  
**Natural Background vs Millstone Station**

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

Courtesy UNSCEAR Report 2000

<b>Maximum Off-Site Individual</b>	<b>Millstone Station Whole Body Dose</b>
Gaseous Effluents	0.090 mrem
Liquid Effluents	0.001 mrem
Direct Shine	0.130 mrem
	<b>0.221</b> mrem

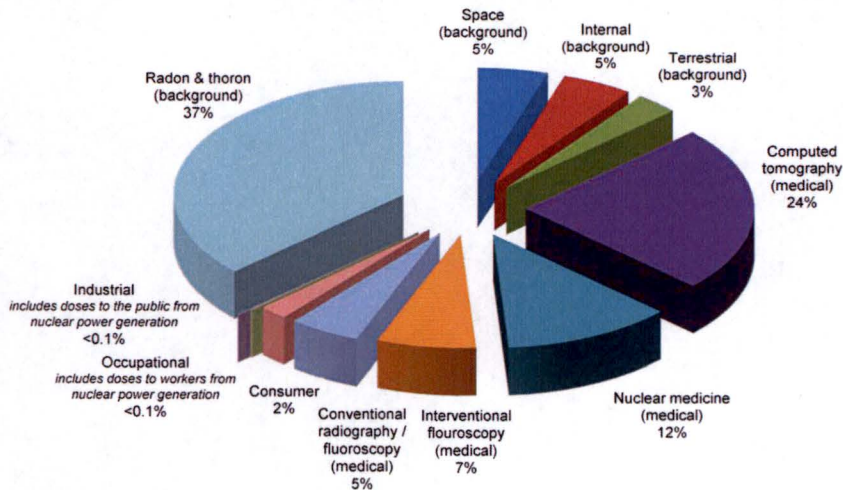
### 1.3 Other Sources of Radiation Dose to the Public (from Ref. 12)

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 Millstone 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 (iodines, etc.) on charcoal cartridges except where noted on the list.

- Unit 1 SFPI Island (no charcoal cartridge)
- Unit 1 BOP Vent (no charcoal cartridge)
- Unit 2 Ventilation Vent
- Unit 2 Wide Range Gas Monitor (WRGM) to Site Stack
- Unit 3 Ventilation Vent
- Unit 3 SLCRS to Site Stack
- Unit 3 ESF Building Vent
- Unit 3 Containment Equipment Hatch Openings (no gaseous monitoring)

Most releases are based on results of sample analyses. Charcoal cartridges and particulate filters are replaced weekly (except every two weeks for Unit 1) and analyzed for isotopic content using a gamma spectrometer. Particulate filters are also analyzed for Strontium-89 (Sr-89) (except for Unit 1), 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) 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 Unit 1 SFPI Vent and the Unit 2 and Unit 3 Vents are compared to the measured evaporation technique and the higher amount from either the vent or the measured evaporation technique is used to determine the amount of H-3 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<sub>2</sub>) 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. This nuclide is not monitored because it is too difficult to measure and analyze. Because the overall quantity of other radioactive releases has steadily decreased due to improvements in power plant operations, C-14 now qualifies as a principle radionuclide. According to the regulatory guidance, releases of C-14 are reported in gaseous effluents but not in liquid effluents and the amount released is calculated based on a normalized source term. The calculation is for an annual source term which is then divided evenly between quarters in the year except that Unit 3 C-14 release was reduced in the second quarter because of its outage. For each Unit, it is assumed that half of the C-14 is released from the Millstone 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. Releases of particulates and H-3 from the Units 2 and 3 RWSTs were estimated using factors for release from water to air. For H-3 the release factor is based on the ratio of mass of water vapor to mass of dry air and adjusted for difference between water and air densities. For particulates the release factor is based on an assumed partitioning factor of 10,000. RWST vent releases are calculated using concentration of tritium in water, particulate radioactivity added to the RWST during outages and volumes of air exhaled based on observed changes in water level and on thermal fluctuations of the water.

Any releases from the spent fuel pool area in the reactor building at Unit 1 are released through the SFPI Vent. Releases from other parts of the Unit 1 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 and containment drawdown releases at Unit 3 occurred only during the Unit 3 outage during the second quarter.

#### **2.1.1.2 Batch Releases**

The following sources of radioactivity releases are considered batch releases:

- Unit 2 Waste Gas Decay Tanks (WGDT) (via Unit 2 WRGM to Millstone Station Stack)
- Unit 3 Containment Purges (via Ventilation Vents)
- Unit 2 and Unit 3 Containment Vents (via EBFS to Millstone Station Stack for Unit 2 and via SLCRS to Millstone Station Stack for Unit 3)
- Unit 3 Containment Drawdown (ground level release at containment)

Waste Gases from the Unit 2 Gaseous Waste Processing System are held for decay in waste gas decay tanks prior to discharge through the Millstone Station 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 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. Unit 2 typically performs this process of discharging air from containment to maintain pressure approximately once per week and Unit 3 vents containment about 15 times per month. Any iodines and particulates discharged would be detected by the continuous monitoring discussed in Section 2.1.1.1.

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.

Unit 3 containment is initially drawn down prior to startup. This is accomplished by using the containment vacuum steam jet ejector which releases through an unmonitored vent on the roof of the Auxiliary Building. Grab samples are performed prior to drawdown to document the amount of radioactivity released during these evolutions.

### 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

#### Unit 1 – None

Unit 2	Ctmt Vents	WGDT
Number of Batches	51	4
Total Time (min)	7800	965
Maximum Time (min)	209	361
Average Time (min)	153	241
Minimum Time (min)	77	128

Unit 3	Ctmt Vents	Ctmt Purges	Ctmt Drawdown
Number of Batches	196	2	1
Total Time (min)	37963	463	837
Maximum Time (min)	491	243	837
Average Time (min)	196	232	837
Minimum Time (min)	23	220	837

### 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 Unit 1 – None

#### 2.1.4.2 Unit 2 – None

#### 2.1.4.3 Unit 3 - None

### 2.1.5 Gaseous Release Tables

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

**Table 2.1-A1**  
 Millstone Unit 1  
**Gaseous Effluents - Release Summary**

Units	2016				
	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	-	5.68E-06	-	3.95E-06	9.63E-06
2. Average Period Release Rate	uCi/sec	-	7.23E-07	-	4.97E-07	3.05E-07

**D. Gross Alpha**

1. Total Activity Released	Ci	-	-	-	-	-
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**E. Tritium**

1. Total Activity Released	Ci	1.23E-02	1.15E-02	1.39E-02	1.08E-02	4.85E-02
2. Average Period Release Rate	uCi/sec	1.57E-03	1.46E-03	1.75E-03	1.36E-03	1.54E-03

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

"na" denotes not required to be analyzed

**Table 2.1-A2**  
 Millstone Unit 1  
 Gaseous Effluents - Ground Continuous - BOP Vent & SFPI Vent

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Gases**

Kr-85	Ci	-	-	-	-	-
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

**B. Iodines / Halogens**

I-131	Ci	na	na	na	na	na
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

**C. Particulates**

Be-7	Ci	-	5.68E-06	-	-	5.68E-06
Cs-137	Ci	-	-	-	3.95E-06	3.95E-06
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Sr-90	Ci	-	-	-	-	-
Total Activity	Ci	-	5.68E-06	-	3.95E-06	9.63E-06

**D. Gross Alpha**

Gross Alpha	Ci	-	-	-	-	-
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**E. Tritium**

H-3	Ci	1.23E-02	1.15E-02	1.39E-02	1.08E-02	4.85E-02
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"-" denotes less than Minimum Detectable Activity (MDA)

"na" denotes not required to be analyzed

**Table 2.2-A1**  
**Millstone Unit 2**  
**Gaseous Effluents - Release Summary**

Units	2016				
	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Gases**

1. Total Activity Released	Ci	9.53E-02	8.24E-02	2.16E-01	7.29E-02	4.66E-01
2. Average Period Release Rate	uCi/sec	1.21E-02	1.05E-02	2.71E-02	9.17E-03	1.47E-02

**B. Iodines / Halogens**

1. Total Activity Released	Ci	1.94E-05	9.08E-05	1.94E-05	5.14E-05	1.81E-04
2. Average Period Release Rate	uCi/sec	2.46E-06	1.15E-05	2.44E-06	6.47E-06	5.72E-06

**C. Particulates**

1. Total Activity Released	Ci	-	-	-	-	-
2. Average Period Release Rate	uCi/sec	-	-	-	-	-

**D. Gross Alpha**

1. Total Activity Released	Ci	-	-	-	-	-
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**E. Tritium**

1. Total Activity Released	Ci	3.13E+00	2.43E+00	1.93E+00	2.43E+00	9.92E+00
2. Average Period Release Rate	uCi/sec	3.98E-01	3.09E-01	2.43E-01	3.05E-01	3.14E-01

**F. C-14**

1. Total Activity Released**	Ci	2.45E+00	2.45E+00	2.45E+00	2.45E+00	9.80E+00
2. Average Period Release Rate	uCi/sec	3.12E-01	3.12E-01	3.08E-01	3.08E-01	3.10E-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**  
**Millstone Unit 2**  
**Gaseous Effluents - Ground Level Release - Batch Mode**  
**Release Point - No releases**

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
<b>A. Fission &amp; Activation Gases</b>						
Total Activity	Ci	*	*	*	*	*
<b>B. Iodines / Halogens</b>						
Total Activity	Ci	*	*	*	*	*
<b>C. Particulates</b>						
Total Activity	Ci	*	*	*	*	*
<b>D. Gross Alpha</b>						
Gross Alpha	Ci	*	*	*	*	*
<b>E. Tritium</b>						
H-3	Ci	*	*	*	*	*

\* No activity released

**Table 2.2-A3**  
**Millstone Unit 2**  
**Gaseous Effluents - Ground Level Release - Continuous Mode**  
**Release Point - Reactor Water Storage Tank Vent**

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Gases**

γ Emitters	Ci	*	*	*	*	*
Total Activity	Ci	*	*	*	*	*

**B. Iodines / Halogens**

I-131	Ci	*	*	*	*	*
Other γ Emitters	Ci	*	*	*	*	*
Total Activity	Ci	*	*	*	*	*

**C. Particulates**

γ Emitters	Ci	*	*	*	*	*
Total Activity	Ci	*	*	*	*	*

**D. Gross Alpha**

Gross Alpha	Ci	na	na	na	na	na
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**E. Tritium**

H-3	Ci	6.81E-04	2.36E-04	8.45E-05	2.30E-04	1.23E-03
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"na" denotes Not Required to be Analyzed

\* No activity released

**Table 2.2-A4**  
**Millstone Unit 2**  
**Gaseous Effluents - Elevated Release - Batch Mode**  
**Release Point - Millstone Site Stack**

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Gases**

Ar-41	Ci	3.16E-02	3.82E-02	3.92E-02	3.70E-02	1.46E-01
Kr-85	Ci	1.95E-02	2.55E-03	-	-	2.21E-02
Xe-133	Ci	4.28E-02	4.00E-02	3.38E-02	3.43E-02	1.51E-01
Xe-135	Ci	1.36E-03	1.54E-03	1.54E-03	1.15E-03	5.59E-03
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	9.53E-02	8.23E-02	7.45E-02	7.25E-02	3.25E-01

**B. Iodines / Halogens**

Total Activity	Ci	na	na	na	na	na
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**C. Particulates**

Total Activity	Ci	na	na	na	na	na
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**D. Gross Alpha**

Gross Alpha	Ci	na	na	na	na	na
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**E. Tritium**

H-3	Ci	1.07E-01	2.49E-01	2.30E-01	6.97E-01	1.28E+00
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"-" denotes less than Minimum Detectable Activity (MDA)

"na" denotes not required to be analyzed

**Table 2.2-A5**  
**Millstone Unit 2**  
**Gaseous Effluents - Elevated Release - Continuous Mode**  
**Release Point - Millstone Site Stack**

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Gases**

Ar-41	Ci	-	5.50E-05	-	-	5.50E-05
Kr-85	Ci	-	2.00E-07	-	-	2.00E-07
Kr-85m	Ci	-	2.20E-06	-	-	2.20E-06
Kr-87	Ci	-	4.00E-06	-	-	4.00E-06
Kr-88	Ci	-	5.90E-06	-	-	5.90E-06
Xe-133	Ci	-	2.00E-05	-	-	2.00E-05
Xe-133m	Ci	-	2.70E-06	-	-	2.70E-06
Xe-135	Ci	-	2.30E-05	-	-	2.30E-05
Xe-135m	Ci	-	5.50E-06	-	-	5.50E-06
Xe-138	Ci	-	1.60E-06	-	-	1.60E-06
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	1.20E-04	-	-	1.20E-04

**B. Iodines / Halogens**

I-131	Ci	-	-	-	-	-
I-133	Ci	-	-	-	-	-
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

**C. Particulates**

Sr-89	Ci	-	-	-	-	-
Sr-90	Ci	-	-	-	-	-
$\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

**D. Gross Alpha**

Gross Alpha	Ci	-	-	-	-	-
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**E. Tritium**

H-3	Ci	-	-	-	-	-
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**F. C-14**

C-14	Ci	1.23E+00	1.23E+00	1.23E+00	1.23E+00	4.90E+00
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"-" denotes less than Minimum Detectable Activity (MDA)

**Table 2.2-A6  
Millstone Unit 2  
Gaseous Effluents - Mixed Mode Release - Batch Mode  
Release Point - Unit 2 Ventilation Vent**

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Gases**

γ Emitters	Ci	*	*	*	*	*
Total Activity	Ci	*	*	*	*	*

**B. Iodines / Halogens**

γ Emitters	Ci	*	*	*	*	*
Total Activity	Ci	*	*	*	*	*

**C. Particulates**

γ Emitters	Ci	*	*	*	*	*
Total Activity	Ci	*	*	*	*	*

**D. Gross Alpha**

Gross Alpha	Ci	na	na	na	na	na
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**E. Tritium**

H-3	Ci	*	*	*	*	*
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\* No activity released

"na" denotes not required to be analyzed

**Table 2.2-A7**  
**Millstone Unit 2**  
**Gaseous Effluents - Mixed Mode Release - Continuous Mode**  
**Release Point - Unit 2 Ventilation Vent**

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Gases**

Kr-85	Ci	-	-	1.41E-01	1.76E-04	1.41E-01
Xe-131m	Ci	-	-	-	2.88E-05	2.88E-05
Xe-133	Ci	-	-	-	2.37E-04	2.37E-04
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	1.41E-01	4.42E-04	1.41E-01

**B. Iodines / Halogens**

I-131	Ci	4.28E-06	2.03E-05	5.57E-06	1.42E-05	4.44E-05
I-133	Ci	1.51E-05	7.05E-05	1.38E-05	3.72E-05	1.37E-04
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	1.94E-05	9.08E-05	1.94E-05	5.14E-05	1.81E-04

**C. Particulates**

$\gamma$ Emitters	Ci	-	-	-	-	-
Sr-89	Ci	-	-	-	-	-
Sr-90	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

**D. Gross Alpha**

Gross Alpha	Ci	-	-	-	-	-
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**E. Tritium**

H-3	Ci	3.02E+00	2.18E+00	1.70E+00	1.73E+00	8.63E+00
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**F. C-14**

C-14	Ci	1.23E+00	1.23E+00	1.23E+00	1.23E+00	4.90E+00
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"-" denotes less than Minimum Detectable Activity (MDA)

**Table 2.3-A1**  
 Millstone Unit 3  
**Gaseous Effluents - Release Summary**

Units	2016				
	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Gases**

1. Total Activity Released	Ci	3.55E-01	1.62E-01	2.76E-01	2.13E-01	1.01E+00
2. Average Period Release Rate	uCi/sec	4.52E-02	2.06E-02	3.47E-02	2.68E-02	3.18E-02

**B. Iodines / Halogens**

1. Total Activity Released	Ci	4.15E-06	8.47E-07	7.88E-06	1.67E-06	1.45E-05
2. Average Period Release Rate	uCi/sec	5.28E-07	1.08E-07	9.91E-07	2.10E-07	4.60E-07

**C. Particulates**

1. Total Activity Released	Ci	-	5.07E-04	9.13E-08	-	5.07E-04
2. Average Period Release Rate	uCi/sec	-	6.44E-05	1.15E-08	-	1.60E-05

**D. Gross Alpha**

1. Total Activity Released	Ci	-	-	-	-	-
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**E. Tritium**

1. Total Activity Released	Ci	5.58E+00	2.40E+01	9.42E+00	1.77E+01	5.66E+01
2. Average Period Release Rate	uCi/sec	7.09E-01	3.05E+00	1.19E+00	2.22E+00	1.79E+00

**F. C-14**

1. Total Activity Released**	Ci	2.92E+00	2.48E+00	2.59E+00	2.81E+00	1.08E+01
2. Average Period Release Rate	uCi/sec	3.71E-01	3.15E-01	3.26E-01	3.54E-01	3.42E-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**  
**Millstone Unit 3**  
**Gaseous Effluents - Ground Level Release - Batch Mode**  
**Release Point -ESF Building Rooftop**

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Gases**

γ Emitters	Ci	*	-	*	*	-
Total Activity	Ci	*	-	*	*	-

**B. Iodines / Halogens**

I-131	Ci	*	-	*	*	-
I-133	Ci	*	-	*	*	-
Other γ Emitters	Ci	*	-	*	*	-
Total Activity	Ci	*	-	*	*	-

**C. Particulates**

γ Emitters	Ci	*	-	*	*	-
Total Activity	Ci	*	-	*	*	-

**D. Gross Alpha**

Gross Alpha	Ci	na	na	na	na	na
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**E. Tritium**

H-3	Ci	*	-	*	*	-
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\* No activity released

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

"na" denotes Not Required to be Analyzed



**Table 2.3-A3**  
**Millstone Unit 3**  
**Gaseous Effluents - Ground Level Release - Continuous Mode**  
**Release Point - ESF Building Vent, Containment Equipment Hatch, RWST Vent**

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Gases**

Ar-41	Ci	-	-	3.32E-06	-	3.32E-06
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	3.32E-06	-	3.32E-06

**B. Iodines / Halogens**

I-131	Ci	-	-	-	-	-
I-133	Ci	-	-	-	-	-
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

**C. Particulates**

Cr-51	Ci	-	2.40E-04	-	-	2.40E-04
Mn-54	Ci	-	1.53E-05	-	-	1.53E-05
Fe-59	Ci	-	4.68E-06	-	-	4.68E-06
Co-57	Ci	-	6.54E-07	-	-	6.54E-07
Co-58	Ci	-	1.14E-04	-	-	1.14E-04
Co-60	Ci	-	4.93E-05	-	-	4.93E-05
Zr-95	Ci	-	2.51E-06	-	-	2.51E-06
Nb-95	Ci	-	5.42E-06	-	-	5.42E-06
Ag-110m	Ci	-	1.98E-08	-	-	1.98E-08
Sb-124	Ci	-	5.44E-08	-	-	5.44E-08
Cs-134	Ci	-	4.39E-08	-	-	4.39E-08
Cs-137	Ci	-	6.18E-07	-	-	6.18E-07
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	4.33E-04	-	-	4.33E-04

**D. Gross Alpha**

Gross Alpha	Ci	-	-	-	-	-
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**E. Tritium**

H-3	Ci	3.93E-03	9.83E-03	3.32E-04	1.39E-04	1.42E-02
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"-" denotes less than Minimum Detectable Activity (MDA)

**Table 2.3-A4**  
**Millstone Unit 3**  
**Gaseous Effluents - Elevated Release - Batch Mode**  
**Release Point - Millstone Site Stack**

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Gases**

Ar-41	Ci	1.01E-02	2.18E-03	5.74E-03	6.61E-03	2.46E-02
Xe-133	Ci	2.27E-04	-	1.91E-03	1.58E-04	2.30E-03
Xe-135	Ci	-	-	1.37E-04	8.78E-05	2.25E-04
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	1.03E-02	2.18E-03	7.79E-03	6.86E-03	2.71E-02

**B. Iodines / Halogens**

I-131	Ci	-	-	-	-	-
I-133	Ci	-	-	-	-	-
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

**C. Particulates**

$\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

**D. Gross Alpha**

Gross Alpha	Ci	na	na	ma	ma	ma
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**E. Tritium**

H-3	Ci	1.59E-02	1.01E-02	1.43E-01	2.50E-01	4.19E-01
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"-" denotes less than Minimum Detectable Activity (MDA)

"na" denotes Not Required to be Analyzed

**Table 2.3-A5**  
**Millstone Unit 3**  
**Gaseous Effluents - Elevated Release - Continuous Mode**  
**Release Point - Millstone Site Stack**

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Gases**

Ar-41	Ci	1.74E-02	1.73E-03	4.62E-02	2.87E-03	6.82E-02
Kr-85	Ci	2.91E-01	1.38E-01	2.14E-01	1.92E-01	8.35E-01
Kr-85m	Ci	1.54E-03	5.30E-04	2.91E-04	3.60E-04	2.72E-03
Kr-87	Ci	8.40E-04	3.90E-04	6.90E-04	1.09E-03	3.01E-03
Kr-88	Ci	2.50E-03	6.14E-04	2.40E-04	1.44E-03	4.79E-03
Xe-133	Ci	6.50E-03	5.45E-03	1.25E-03	1.17E-03	1.44E-02
Xe-135	Ci	2.11E-02	9.00E-03	1.77E-03	1.49E-03	3.34E-02
Xe-135m	Ci	6.30E-04	5.00E-04	6.90E-04	9.10E-04	2.73E-03
Xe-138	Ci	3.50E-03	1.70E-03	2.71E-03	5.06E-03	1.30E-02
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	3.45E-01	1.58E-01	2.68E-01	2.06E-01	9.77E-01

**B. Iodines / Halogens**

B-82	Ci	4.15E-06	1.63E-07	8.91E-07	1.67E-06	6.87E-06
I-131	Ci	-	-	-	-	-
I-133	Ci	-	-	-	-	-
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	4.15E-06	1.63E-07	8.91E-07	1.67E-06	6.87E-06

**C. Particulates**

Sr-89	Ci	-	-	-	-	-
Sr-90	Ci	-	-	-	-	-
Co-58	Ci	-	-	9.13E-08	-	9.13E-08
Ta-182	Ci	-	2.35E-07	-	-	2.35E-07
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	2.35E-07	9.13E-08	-	3.26E-07

**D. Gross Alpha**

Gross Alpha	Ci	-	-	-	-	-
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**E. Tritium**

H-3	Ci	7.06E-01	2.45E-01	2.29E-01	1.08E+00	2.26E+00
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**F. C-14**

C-14	Ci	1.46E+00	1.24E+00	1.30E+00	1.41E+00	5.41E+00
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"-" denotes less than Minimum Detectable Activity (MDA)

**Table 2.3-A6**  
**Millstone Unit 3**  
**Gaseous Effluents - Mixed Mode Release - Batch Mode**  
**Release Point - Unit 3 Ventilation Vent**

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Gases**

Xe-133	Ci	*	1.03E-03	*	*	1.03E-03
Xe-135	Ci	*	3.99E-04	*	*	3.99E-04
Other $\gamma$ Emitters	Ci	*	-	*	*	-
Total Activity	Ci	*	1.43E-03	*	*	1.43E-03

**B. Iodines / Halogens**

Br-82	Ci	*	3.51E-07	*	*	3.51E-07
I-132	Ci	*	3.33E-07	*	*	3.33E-07
Other $\gamma$ Emitters	Ci	*	-	*	*	-
Total Activity	Ci	*	6.84E-07	*	*	6.84E-07

**C. Particulates**

Ba-133	Ci	*	7.48E-08	*	*	7.48E-08
Other $\gamma$ Emitters	Ci	*	-	*	*	-
Total Activity	Ci	*	7.48E-08	*	*	7.48E-08

**D. Gross Alpha**

Gross Alpha	Ci	na	na	na	na	na
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**E. Tritium**

H-3	Ci	*	4.66E-01	*	*	4.66E-01
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\* No activity released

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

"na" denotes Not Required to be Analyzed

**Table 2.3-A7**  
**Millstone Unit 3**  
**Gaseous Effluents - Mixed Mode Release - Continuous Mode**  
**Release Point - Unit 3 Ventilation Vent**

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Gases**

γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

**B. Iodines / Halogens**

I-131	Ci	-	-	-	-	-
I-133	Ci	-	-	-	-	-
Br-82	Ci	-	-	6.99E-06	-	6.99E-06
Other γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	6.99E-06	-	6.99E-06

**C. Particulates**

Cr-51	Ci	-	4.89E-05	-	-	4.89E-05
Mn-54	Ci	-	2.22E-06	-	-	2.22E-06
Co-58	Ci	-	1.83E-05	-	-	1.83E-05
Co-60	Ci	-	4.36E-06	-	-	4.36E-06
Other γ Emitters	Ci	-	-	-	-	-
Sr-89	Ci	-	-	-	-	-
Sr-90	Ci	-	-	-	-	-
Total Activity	Ci	-	7.38E-05	-	-	7.38E-05

**D. Gross Alpha**

Gross Alpha	Ci	-	-	-	-	-
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**E. Tritium**

H-3	Ci	4.85E+00	2.33E+01	9.05E+00	1.51E+01	5.23E+01
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**F. C-14**

C-14	Ci	1.46E+00	1.24E+00	1.30E+00	1.41E+00	5.40E+00
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"-" 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 Millstone Quarry or DSN006. DSN006 is next to the Unit 3 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 Millstone Quarry include Steam Generator Blowdown for Units 2&3, Service Water Effluent for Units 2&3 and Reactor Building Closed Cooling Water (RBCCW) Sump for Unit 2. Sources for continuous liquid effluent releases via DSN006 include Turbine Building Sump discharge from Units 2&3, CPF TK2 from Unit 3 and SRW Sump 3 from Unit 3.

#### 2.2.1.2 Batch Liquid Releases from Tanks and Sumps

Batch liquid releases are made via both the Millstone Quarry and DSN006. There are numerous sources from which batches of liquids containing radioactivity are discharged to the environs. Except for two sources from Unit 3 to DSN006 they are discharged via the Millstone Quarry. The sources are:

- Unit 1** Radwaste Processing System – Includes sources from:
  1. Reactor Building Sumps
  2. Underground Ventilation Duct
  3. Site Stack Sump
- Unit 2** Radwaste Processing System:
  1. Clean Waste Monitor Tanks (2)
  2. Aerated Waste Monitor TanksOther Radwaste Sources:
  1. CPF Waste Neutralization Sump
  2. Steam Generator Bulk
  3. Other Systems' Bulk Discharges
- Unit 3** 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

	Unit 1	Unit 2	Unit 3
Radwaste Processing System:			
Number of Batches	5	40	122
Total Time (min)	203	3,851	13,801
Maximum Time (min)	43	248	307
Average Time (min)	41	96	113
Minimum Time (min)	37	9	17
	Unit 1	Unit 2	Unit 3
Other Radwaste Sources:			
Number of Batches	NA	11	168
Total Time (min)	NA	3,498	20,055
Maximum Time (min)	NA	630	375
Average Time (min)	NA	318	119
Minimum Time (min)	NA	15	7

### 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 2016, the following abnormal liquid releases occurred:

2.2.4.1 Unit 1 – None

2.2.4.2 Unit 2 – None

2.2.4.3 Unit 3 - None

### 2.2.5 Liquid Release Tables

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

**Table 2.1-L1  
Millstone Unit 1**

**Liquid Effluents - Release Summary**

Units	2016				
	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission and Activation Products**

1. Total Activity Released	Ci	6.43E-04	4.73E-04	*	8.88E-04	2.00E-03
2. Average Period Diluted Activity+	uCi/ml	2.77E-12	1.94E-12	*	3.10E-12	2.63E-12

**B. Tritium**

1. Total Activity Released	Ci	7.96E-03	5.79E-04	*	2.15E-03	1.07E-02
2. Average Period Diluted Activity+	uCi/ml	3.43E-11	2.37E-12	*	7.52E-12	1.40E-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	-	-	*	-	-
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**E. Volume**

1. Released Waste Volume	Liters	6.11E+04	3.18E+04	*	6.62E+04	1.59E+05
2. Dilution Volume During Releases	Liters	3.59E+08	2.06E+08	*	3.89E+08	9.54E+08
3. Dilution Volume During Period++	Liters	2.32E+11	2.44E+11	*	2.86E+11	7.62E+11

\* No activity released

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

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

++ Unit 2 Dilution Volume During Period used because there is no Unit 1 dilution



**Table 2.1-L2  
Millstone Unit 1**

**Liquid Effluents - Batch  
Release to Quarry: Liquid Radwaste Processing System**

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Products**

Cs-137	Ci	6.43E-04	4.73E-04	*	8.88E-04	2.00E-03
Other $\gamma$ Emitters	Ci	-	-	*	-	-
Sr-90	Ci	-	-	*	-	-
Fe-55	Ci	-	-	*	-	-
Total Activity	Ci	6.43E-04	4.73E-04	*	8.88E-04	2.00E-03

**B. Tritium**

H-3	Ci	7.96E-03	5.79E-04	*	2.15E-03	1.07E-02
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**C. Dissolved & Entrained Gases**

Kr-85	Ci	-	-	*	-	-
Other $\gamma$ Emitters	Ci	-	-	*	-	-
Total Activity	Ci	-	-	*	-	-

**D. Gross Alpha**

Gross Alpha	Ci	-	-	*	-	-
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\* No activity released

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

**Table 2.2-L1**

**Millstone Unit No. 2  
Liquid Effluents - Release Summary**

Units	2016				
	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission and Activation Products**

1. Total Activity Released	Ci	2.38E-04	1.64E-04	4.69E-04	2.75E-04	1.15E-03
2. Average Period Diluted Activity *	uCi/ml	1.03E-12	6.70E-13	1.64E-12	9.60E-13	1.09E-12

**B. Tritium**

1. Total Activity Released	Ci	1.81E+01	3.45E+01	5.96E+01	1.51E+02	2.63E+02
2. Average Period Diluted Activity *	uCi/ml	7.80E-08	1.41E-07	2.08E-07	5.28E-07	2.51E-07

**C. Dissolved and Entrained Gases**

1. Total Activity Released	Ci	-	-	-	6.83E-05	6.83E-05
2. Average Period Diluted Activity *	uCi/ml	-	-	-	2.39E-13	6.52E-14

**D. Gross Alpha**

1. Total Activity Released	Ci	-	-	-	-	-
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**E. Volume**

1. Released Waste Volume	Primary	Liters	2.43E+05	8.58E+04	2.80E+05	3.21E+05	9.30E+05
	Secondary	Liters	1.31E+06	2.61E+04	1.74E+04	1.24E+06	2.59E+06
2. Dilution Volume During Releases	Primary	Liters	4.71E+09	2.44E+09	5.16E+09	5.88E+09	1.82E+10
	Secondary (DSN006)	Liters	3.46E+07	Note	Note	2.80E+07	6.26E+07
	Secondary (Quarry)	Liters	6.72E+08	6.63E+08	2.25E+10	7.98E+09	3.18E+10
3. Dilution Volume During Period	Quarry	Liters	2.32E+11	2.44E+11	2.86E+11	2.86E+11	1.05E+12
	DSN006	Liters	5.60E+07	6.25E+07	5.11E+07	6.02E+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 2nd and 3rd quarters.

**Table 2.2-L2**

**Millstone Unit 2  
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	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Products**

γ Emitters	Ci	-	-	-	-	-
Sr-89	Ci	-	-	-	-	-
Sr-90	Ci	-	-	-	-	-
Ni-63	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

**B. Tritium**

H-3	Ci	3.87E-03	3.58E-04	5.04E-05	8.90E-03	1.32E-02
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**C. Dissolved & Entrained Gases**

γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

**D. Gross Alpha**

Gross Alpha	Ci	-	-	-	-	-
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"-" denotes less than Minimum Detectable Activity (MDA)

**Table 2.2-L3**

**Millstone Unit 2  
Liquid Effluents - Batch**

**Release to Quarry: Liquid Radwaste Processing System**

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Products**

Be-7	Ci	-	-	5.47E-06	-	5.47E-06
Mn-54	Ci	-	-	9.49E-07	-	9.49E-07
Co-58	Ci	2.64E-05	3.77E-06	8.67E-06	3.26E-06	4.21E-05
Co-60	Ci	1.14E-05	2.41E-05	1.16E-04	8.82E-05	2.40E-04
Nb-97	Ci	9.07E-06	-	1.12E-05	4.77E-06	2.50E-05
Ag-110m	Ci	2.39E-05	2.08E-05	3.79E-05	3.03E-05	1.13E-04
Sb-125	Ci	1.37E-04	8.54E-05	4.06E-05	-	2.63E-04
I-131	Ci	1.00E-05	-	1.74E-04	9.26E-05	2.77E-04
Cs-137	Ci	2.05E-05	2.95E-05	1.93E-05	5.54E-05	1.25E-04
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Fe-55	Ci	-	-	5.52E-05	-	5.52E-05
Ni-63	Ci	-	-	-	-	-
Sr-89	Ci	-	-	-	-	-
Sr-90	Ci	-	-	-	-	-
Total Activity	Ci	2.38E-04	1.64E-04	4.69E-04	2.75E-04	1.15E-03

**B. Tritium**

H-3	Ci	1.81E+01	3.45E+01	5.96E+01	1.51E+02	2.63E+02
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**C. Dissolved & Entrained Gases**

Xe-133	Ci	-	-	-	6.83E-05	6.83E-05
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	6.83E-05	6.83E-05

**D. Gross Alpha**

Gross Alpha	Ci	-	-	-	-	-
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"-" denotes less than Minimum Detectable Activity (MDA)

**Table 2.3-L1  
Millstone Unit 3**

**Liquid Effluents - Release Summary**

Units	2016				
	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission and Activation Products**

1. Total Activity Released	Ci	4.82E-02	6.54E-03	2.08E-02	5.16E-05	7.55E-02
2. Average Period Diluted Activity *	uCi/ml	1.07E-10	2.30E-11	4.39E-11	1.14E-13	4.55E-11

**B. Tritium**

1. Total Activity Released	Ci	3.84E+02	6.73E+02	1.82E+02	1.24E+02	1.36E+03
2. Average Period Diluted Activity *	uCi/ml	8.53E-07	2.37E-06	3.85E-07	2.73E-07	8.21E-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	-	-	-	-	-
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**E. Volume**

1. Released Waste Volume						
Primary	Liters	1.24E+06	3.05E+06	1.39E+06	5.78E+05	6.26E+06
Secondary	Liters	1.92E+07	1.15E+07	1.21E+07	1.67E+07	5.95E+07
2. Dilution Volume During Releases						
Primary	Liters	1.13E+10	2.60E+10	1.52E+10	5.10E+09	5.76E+10
Secondary (DSN006)	Liters	1.22E+08	4.73E+07	5.14E+07	1.12E+08	3.33E+08
Secondary (Quarry)	Liters	7.11E+11	4.92E+11	8.54E+11	7.36E+11	2.79E+12
3. Dilution Volume During Period						
Quarry	Liters	4.50E+11	2.84E+11	4.73E+11	4.53E+11	1.66E+12
DSN006	Liters	5.60E+07	6.25E+07	5.11E+07	6.02E+07	2.30E+08

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

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

**Table 2.3-L2**

**Millstone Unit 3  
Liquid Effluents - Continuous**

1. Release to Quarry: Steam Generator Blowdown & Service Water
2. Release to DSN006: Turbine Building Sump and SRW Sump 3

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Products**

γ Emitters	Ci	-	-	-	-	-
Sr-89	Ci	-	-	-	-	-
Sr-90	Ci	-	-	-	-	-
Fe-55	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

**B. Tritium**

H-3	Ci	1.29E-01	2.56E-02	2.69E-01	5.11E-01	9.35E-01
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**C. Dissolved & Entrained Gases**

γ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

**D. Gross Alpha**

Gross Alpha	Ci	-	-	-	-	-
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"-" denotes less than Minimum Detectable Activity (MDA)

**Table 2.3-L3**

**Millstone Unit 3  
Liquid Effluents - Batch**

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

Nuclides Released	Units	2016				
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total

**A. Fission & Activation Products**

Mn-54	Ci	9.11E-04	3.55E-05	7.06E-06	-	9.54E-04
Co-58	Ci	2.17E-04	4.15E-05	2.66E-05	-	2.85E-04
Co-60	Ci	1.85E-03	3.98E-04	4.22E-05	-	2.29E-03
Zr-95	Ci	1.37E-05	-	1.87E-06	-	1.56E-05
Nb-95	Ci	1.21E-05	-	3.63E-06	-	1.57E-05
Sb-125	Ci	4.04E-02	3.13E-03	3.73E-04	5.16E-05	4.40E-02
Cs-134	Ci	2.23E-04	1.95E-05	-	-	2.43E-04
Cs-137	Ci	2.00E-03	2.83E-04	-	-	2.28E-03
Other $\gamma$ Emitters	Ci	-	-	-	-	-
Fe-55	Ci	1.35E-03	2.63E-03	2.03E-02	-	2.43E-02
Ni-63	Ci	1.19E-03	-	9.72E-06	-	1.20E-03
Sr-89	Ci	-	-	-	-	-
Sr-90	Ci	-	-	-	-	-
Total Activity	Ci	4.82E-02	6.54E-03	2.08E-02	5.16E-05	7.55E-02

**B. Tritium**

H-3	Ci	3.84E+02	6.73E+02	1.82E+02	1.23E+02	1.36E+03
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**C. Dissolved & Entrained Gases**

$\gamma$ Emitters	Ci	-	-	-	-	-
Total Activity	Ci	-	-	-	-	-

**D. Gross Alpha**

Gross Alpha	Ci	-	-	-	-	-
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"-" 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 Unit 1 Solid Waste and Irradiated Component Shipments

Table 2.2-S Unit 2 Solid Waste and Irradiated Component Shipments

Table 2.3-S Unit 3 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 <sup>3</sup>
Steel Boxes	45 ft <sup>3</sup> 87 ft <sup>3</sup> 95 ft <sup>3</sup>
Steel Container	202.1 ft <sup>3</sup>
Steel "Sea Van"	1280 ft <sup>3</sup>
Polyethylene High Integrity Containers	120.3 ft <sup>3</sup> 132.4 ft <sup>3</sup> 173.4 ft <sup>3</sup> 202.1 ft <sup>3</sup>

\* United States Department of Transportation



**Table 2.1-S  
Solid Waste and Irradiated Component Shipments  
Millstone Unit 1**

January 1, 2016 through December 31, 2016

Resins, Filters, and Evaporator Bottoms	Volume		Curies Shipped
Waste Class	ft <sup>3</sup>	m <sup>3</sup>	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

Dry Active Waste	Volume		Curies Shipped
Waste Class	ft <sup>3</sup>	m <sup>3</sup>	Curies
A	2.44E+03	6.91E+01	3.13E-02
B	N/A	N/A	N/A
C	N/A	N/A	N/A
ALL	2.44E+03	6.91E+01	3.13E-02

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
C-14	0.02%	6.46E-06
Fe-55	0.28%	8.88E-05
Co-60	7.08%	2.22E-03
Ni-63	2.32%	7.27E-04
Sr-90	0.41%	1.29E-04
Cs-137	89.77%	2.81E-02
Pu-238	< 0.01%	2.93E-06
Pu-239	< 0.01%	2.68E-06
Pu-241	0.05%	1.65E-05
Am-241	0.03%	9.86E-06
Cm-242	< 0.01%	2.86E-08
Cm-244	0.01%	4.06E-06
<b>CURIES (TOTAL)</b>		<b>3.13E-02</b>

Table 2.1-S (continued)  
Solid Waste and Irradiated Component Shipments  
Millstone Unit 1  
January 1, 2016 through December 31, 2016

Irradiated Components	Volume		Curies Shipped
Waste Class	ft <sup>3</sup>	m <sup>3</sup>	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

Other Waste	Volume		Curies Shipped
Waste Class	ft <sup>3</sup>	m <sup>3</sup>	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

**Table 2.1-S (continued)**  
**Solid Waste and Irradiated Component Shipments**  
**Millstone Unit 1**

January 1, 2016 through December 31, 2016

Sum of All Low-Level Waste Shipped from Site	Volume		Curies Shipped
	ft <sup>3</sup>	m <sup>3</sup>	
Waste Class	ft <sup>3</sup>	m <sup>3</sup>	Curies
A	2.44E+03	6.91E+01	3.13E-02
B	N/A	N/A	N/A
C	N/A	N/A	N/A
<b>ALL</b>	<b>2.44E+03</b>	<b>6.91E+01</b>	<b>3.13E-02</b>

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
C-14	0.02%	6.46E-06
Fe-55	0.28%	8.88E-05
Co-60	7.06%	2.22E-03
Ni-63	2.32%	7.27E-04
Sr-90	0.41%	1.29E-04
Cs-137	89.77%	2.81E-02
Pu-238	< 0.01%	2.93E-06
Pu-239	< 0.01%	2.68E-06
Pu-241	0.05%	1.65E-05
Am-241	0.03%	9.86E-06
Cm-242	< 0.01%	2.86E-08
Cm-244	0.01%	4.06E-06
<b>CURIES (TOTAL)</b>		<b>3.13E-02</b>

**Table 2.2-S**  
**Solid Waste and Irradiated Component Shipments**  
**Millstone Unit 2**

January 1, 2016 through December 31, 2016

Resins, Filters, and Evaporator Bottoms	Volume		Curies Shipped
Waste Class	ft <sup>3</sup>	m <sup>3</sup>	Curies
A	3.71E+01	1.05E+00	9.11E-02
B	2.41E+02	6.81E+00	3.99E+01
C	5.29E+01	1.50E+00	3.36E+00
<b>ALL</b>	<b>3.31E+02</b>	<b>9.36E+00</b>	<b>4.33E+01</b>

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	0.51%	2.23E-01
C-14	0.90%	3.88E-01
Cr-51	< 0.01%	3.03E-12
Mn-54	3.42%	1.48E+00
Fe-55	16.04%	6.95E+00
Fe-59	< 0.01%	4.11E-10
Co-57	0.13%	5.70E-02
Co-58	0.64%	2.76E-01
Co-60	19.59%	8.49E+00
Ni-59	0.54%	2.32E-01
Ni-63	49.15%	2.13E+01
Zn-65	< 0.01%	1.12E-04
Sr-89	< 0.01%	8.48E-04
Sr-90	0.05%	1.96E-02
Nb-94	< 0.01%	4.80E-04
Zr-95	< 0.01%	6.07E-06
Nb-95	< 0.01%	5.81E-06
Tc-99	0.02%	7.07E-03
Ag-108m	< 0.01%	1.86E-04
Ag-110m	0.40%	1.72E-01
Sn-113	< 0.01%	5.73E-05
Sn-117m	< 0.01%	4.58E-24
Sb-124	< 0.01%	6.29E-09
Sb-125	4.25%	1.84E+00
Cs-134	0.88%	3.80E-01
Cs-137	3.41%	1.48E+00
Ce-144	< 0.01%	9.28E-04
Hf-181	< 0.01%	2.01E-10
Np-237	< 0.01%	2.16E-09
Pu-238	< 0.01%	4.82E-04
Pu-239	< 0.01%	1.36E-04
Pu-241	0.08%	3.68E-02
Am-241	< 0.01%	1.73E-04
Cm-242	< 0.01%	1.43E-05
Cm-244	< 0.01%	4.36E-04
<b>CURIES (TOTAL)</b>		<b>4.33E+01</b>

**Table 2.2-S (continued)**  
**Solid Waste and Irradiated Component Shipments**  
**Millstone Unit 2**

January 1, 2016 through December 31, 2016

Dry Active Waste	Volume		Curies Shipped
	ft <sup>3</sup>	m <sup>3</sup>	Curies
A	6.21E+03	1.76E+02	7.74E-01
B	N/A	N/A	N/A
C	N/A	N/A	N/A
ALL	6.21E+03	1.76E+02	7.74E-01

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	0.05%	3.89E-04
C-14	0.01%	1.08E-04
Cr-51	0.15%	1.14E-03
Mn-54	1.61%	1.24E-02
Fe-55	15.60%	1.21E-01
Co-57	0.03%	2.57E-04
Co-58	0.34%	2.65E-03
Co-60	28.21%	2.18E-01
Ni-59	0.37%	2.84E-03
Ni-63	47.24%	3.66E-01
Sr-89	< 0.01%	9.18E-07
Sr-90	0.02%	1.21E-04
Nb-94	< 0.01%	3.97E-05
Zr-95	0.39%	3.03E-03
Nb-95	0.60%	4.65E-03
Tc-99	0.03%	1.96E-04
Ag-110m	0.21%	1.59E-03
Sn-113	0.05%	3.71E-04
Sb-125	2.84%	2.20E-02
Cs-137	2.06%	1.61E-02
Ce-144	< 0.01%	1.84E-06
Pu-238	< 0.01%	2.65E-05
Pu-239	< 0.01%	8.28E-06
Pu-241	0.16%	1.28E-03
Am-241	< 0.01%	2.14E-05
Cm-242	< 0.01%	3.87E-07
Cm-244	< 0.01%	1.55E-05
<b>CURIES (TOTAL)</b>		<b>7.74E-01</b>

**Table 2.2-S (continued)**  
**Solid Waste and Irradiated Component Shipments**  
**Millstone Unit 2**  
 January 1, 2016 through December 31, 2016

Irradiated Components	Volume		Curies Shipped
	ft <sup>3</sup>	m <sup>3</sup>	
<b>Waste Class</b>	<b>ft<sup>3</sup></b>	<b>m<sup>3</sup></b>	<b>Curies</b>
A	N/A	N/A	N/A
B	N/A	N/A	N/A
C	N/A	N/A	N/A
<b>ALL</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>

Other Waste	Volume		Curies Shipped
	ft <sup>3</sup>	m <sup>3</sup>	
<b>Waste Class</b>	<b>ft<sup>3</sup></b>	<b>m<sup>3</sup></b>	<b>Curies</b>
A	3.27E+02	9.26E+00	8.17E-03
B	N/A	N/A	N/A
C	N/A	N/A	N/A
<b>ALL</b>	<b>3.27E+02</b>	<b>9.26E+00</b>	<b>8.17E-03</b>

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	98.34%	8.04E-03
C-14	< 0.01%	2.83E-09
Mn-54	0.03%	2.07E-06
Fe-55	0.08%	6.91E-06
Co-58	0.18%	1.49E-05
Co-60	0.19%	1.58E-05
Ni-63	0.06%	4.79E-06
Tc-99	< 0.01%	6.02E-07
Ag-110m	0.29%	2.41E-05
Sb-125	0.54%	4.43E-05
Cs-137	0.27%	2.19E-05
<b>CURIES (TOTAL)</b>		<b>8.17E-03</b>

**Table 2.2-S (continued)**  
**Solid Waste and Irradiated Component Shipments**  
**Millstone Unit 2**  
 January 1, 2016 through December 31, 2016

Sum of All Low-Level Waste Shipped from Site	Volume		Curies Shipped
Waste Class	ft <sup>3</sup>	m <sup>3</sup>	Curies
A	6.57E+03	1.86E+02	8.73E-01
B	2.41E+02	6.81E+00	3.99E+01
C	5.29E+01	1.50E+00	3.36E+00
<b>ALL</b>	<b>6.87E+03</b>	<b>1.94E+02</b>	<b>4.41E+01</b>

Nuclides for the Above Table:

Radionuclide	% of Total	Curies	Radionuclide	% of Total	Curies
H-3	0.52%	2.31E-01	Ag-108m	< 0.01%	1.86E-04
C-14	0.88%	3.88E-01	Ag-110m	0.39%	1.73E-01
Cr-51	< 0.01%	1.14E-03	Sn-113	< 0.01%	4.28E-04
Mn-54	3.38%	1.49E+00	Sn-117m	< 0.01%	4.58E-24
Fe-55	16.03%	7.07E+00	Sb-124	< 0.01%	6.29E-09
Fe-59	< 0.01%	4.11E-10	Sb-125	4.22%	1.86E+00
Co-57	0.13%	5.73E-02	Cs-134	0.86%	3.80E-01
Co-58	0.63%	2.79E-01	Cs-137	3.38%	1.49E+00
Co-60	19.74%	8.70E+00	Ce-144	< 0.01%	9.30E-04
Ni-59	0.53%	2.35E-01	Hf-181	< 0.01%	2.01E-10
Ni-63	49.10%	2.16E+01	Np-237	< 0.01%	2.16E-09
Zn-65	< 0.01%	1.12E-04	Pu-238	< 0.01%	5.09E-04
Sr-89	< 0.01%	8.49E-04	Pu-239	< 0.01%	1.45E-04
Sr-90	0.04%	1.97E-02	Pu-241	0.09%	3.80E-02
Nb-94	< 0.01%	5.19E-04	Am-241	< 0.01%	1.94E-04
Zr-95	< 0.01%	3.04E-03	Cm-242	< 0.01%	1.47E-05
Nb-95	0.01%	4.66E-03	Cm-244	< 0.01%	4.52E-04
Tc-99	0.02%	7.27E-03	<b>CURIES (TOTAL)</b>		<b>4.41E+01</b>

**Table 2.3-S**  
**Solid Waste and Irradiated Component Shipments**  
**Millstone Unit 3**

January 1, 2016 through December 31, 2016

Resins, Filters, and Evaporator Bottoms	Volume		Curies Shipped
Waste Class	ft <sup>3</sup>	m <sup>3</sup>	Curies
A	8.15E+02	2.31E+01	6.79E-02
B	1.32E+02	3.75E+00	4.29E+01
C	6.74E+01	1.91E+00	4.28E+00
<b>ALL</b>	<b>1.02E+03</b>	<b>2.87E+01</b>	<b>4.72E+01</b>

Nuclides for the Above Table:

Radionuclide	% of Total	Curies	Radionuclide	% of Total	Curies
H-3	0.45%	2.11E-01	Tc-99	0.01%	6.55E-03
C-14	< 0.01%	3.20E-03	Ag-110m	< 0.01%	4.50E-03
Cr-51	< 0.01%	3.86E-12	Sn-113	< 0.01%	4.70E-05
Mn-54	11.65%	5.50E+00	Sn-117m	< 0.01%	5.82E-24
Fe-55	21.68%	1.02E+01	Sb-124	< 0.01%	8.01E-09
Fe-59	< 0.01%	5.23E-10	Sb-125	0.68%	3.20E-01
Co-57	0.42%	2.00E-01	Cs-134	0.03%	1.25E-02
Co-58	6.44%	3.04E+00	Cs-137	0.30%	1.42E-01
Co-60	14.70%	6.94E+00	Ce-144	< 0.01%	3.61E-04
Ni-59	0.50%	2.38E-01	Hf-181	< 0.01%	2.56E-10
Ni-63	43.08%	2.03E+01	Np-237	< 0.01%	2.76E-09
Zn-65	< 0.01%	1.42E-04	Pu-238	< 0.01%	3.47E-04
Sr-89	< 0.01%	4.66E-04	Pu-239	< 0.01%	1.04E-04
Sr-90	< 0.01%	1.29E-03	Pu-241	0.03%	1.33E-02
Nb-94	< 0.01%	6.22E-04	Am-241	< 0.01%	9.41E-05
Zr-95	< 0.01%	6.47E-05	Cm-242	< 0.01%	8.72E-06
Nb-95	< 0.01%	8.44E-05	Cm-244	< 0.01%	4.83E-04
<b>CURIES (TOTAL)</b>					<b>4.72E+01</b>



**Table 2.3-S (continued)**  
**Solid Waste and Irradiated Component Shipments**  
**Millstone Unit 3**

January 1, 2016 through December 31, 2016

Dry Active Waste	Volume		Curies Shipped
	ft <sup>3</sup>	m <sup>3</sup>	
<b>Waste Class</b>	<b>ft<sup>3</sup></b>	<b>m<sup>3</sup></b>	<b>Curies</b>
A	1.34E+04	3.79E+02	1.37E+00
B	N/A	N/A	N/A
C	N/A	N/A	N/A
<b>ALL</b>	<b>1.34E+04</b>	<b>3.79E+02</b>	<b>1.37E+00</b>

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	1.65%	2.27E-02
Cr-51	0.37%	5.13E-03
Mn-54	2.14%	2.95E-02
Fe-55	53.77%	7.39E-01
Fe-59	0.05%	6.47E-04
Co-57	0.03%	4.75E-04
Co-58	0.88%	1.20E-02
Co-60	18.18%	2.50E-01
Ni-59	0.16%	2.22E-03
Ni-63	11.79%	1.62E-01
Sr-90	< 0.01%	1.07E-05
Nb-94	0.31%	4.31E-03
Zr-95	0.39%	5.35E-03
Nb-95	0.66%	9.00E-03
Tc-99	1.80%	2.47E-02
Sn-113	0.02%	2.67E-04
Sb-125	0.72%	9.95E-03
Cs-134	0.65%	8.92E-03
Cs-137	6.42%	8.82E-02
Pu-241	0.01%	1.90E-04
Am-241	< 0.01%	3.20E-07
Cm-242	< 0.01%	2.07E-07
Cm-244	< 0.01%	4.27E-07
<b>CURIES (TOTAL)</b>		<b>1.37E+00</b>

**Table 2.3-S (continued)**  
**Solid Waste and Irradiated Component Shipments**  
**Millstone Unit 3**  
 January 1, 2016 through December 31, 2016

Irradiated Components	Volume		Curies Shipped
	ft <sup>3</sup>	m <sup>3</sup>	
<b>Waste Class</b>	<b>ft<sup>3</sup></b>	<b>m<sup>3</sup></b>	<b>Curies</b>
A	N/A	N/A	N/A
B	N/A	N/A	N/A
C	N/A	N/A	N/A
<b>ALL</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>

Other Waste	Volume		Curies Shipped
	ft <sup>3</sup>	m <sup>3</sup>	
<b>Waste Class</b>	<b>ft<sup>3</sup></b>	<b>m<sup>3</sup></b>	<b>Curies</b>
A	3.69E+02	1.04E+01	9.22E-03
B	N/A	N/A	N/A
C	N/A	N/A	N/A
<b>ALL</b>	<b>3.69E+02</b>	<b>1.04E+01</b>	<b>9.22E-03</b>

Nuclides for the Above Table:

Radionuclide	% of Total	Curies
H-3	98.34%	9.06E-03
C-14	< 0.01%	3.20E-09
Mn-54	0.03%	2.34E-06
Fe-55	0.08%	7.79E-06
Co-58	0.18%	1.68E-05
Co-60	0.19%	1.78E-05
Ni-63	0.06%	5.41E-06
Tc-99	< 0.01%	6.78E-07
Ag-110m	0.29%	2.71E-05
Sb-125	0.54%	5.00E-05
Cs-137	0.27%	2.46E-05
<b>CURIES (TOTAL)</b>		<b>9.22E-03</b>

**Table 2.3-S (continued)**  
**Solid Waste and Irradiated Component Shipments**  
**Millstone Unit 3**

January 1, 2016 through December 31, 2016

Sum of All Low-Level Waste Shipped from Site	Volume		Curies Shipped
Waste Class	ft <sup>3</sup>	m <sup>3</sup>	Curies
A	1.46E+04	4.13E+02	1.45E+00
B	1.32E+02	3.75E+00	4.29E+01
C	6.74E+01	1.91E+00	4.28E+00
<b>ALL</b>	<b>1.48E+04</b>	<b>4.19E+02</b>	<b>4.86E+01</b>

Nuclides for the Above Table:

Radionuclide	% of Total	Curies	Radionuclide	% of Total	Curies
H-3	0.50%	2.42E-01	Tc-99	0.06%	3.12E-02
C-14	< 0.01%	3.20E-03	Ag-110m	< 0.01%	4.52E-03
Cr-51	0.01%	5.13E-03	Sn-113	< 0.01%	3.14E-04
Mn-54	11.38%	5.53E+00	Sn-117m	< 0.01%	5.82E-24
Fe-55	22.58%	1.10E+01	Sb-124	< 0.01%	8.01E-09
Fe-59	< 0.01%	6.47E-04	Sb-125	0.68%	3.30E-01
Co-57	0.41%	2.01E-01	Cs-134	0.04%	2.14E-02
Co-58	6.28%	3.05E+00	Cs-137	0.47%	2.30E-01
Co-60	14.80%	7.19E+00	Ce-144	< 0.01%	3.61E-04
Ni-59	0.49%	2.40E-01	Hf-181	< 0.01%	2.56E-10
Ni-63	42.19%	2.05E+01	Np-237	< 0.01%	2.76E-09
Zn-65	< 0.01%	1.42E-04	Pu-238	< 0.01%	3.47E-04
Sr-89	< 0.01%	4.66E-04	Pu-239	< 0.01%	1.04E-04
Sr-90	< 0.01%	1.30E-03	Pu-241	0.03%	1.35E-02
Nb-94	0.01%	4.93E-03	Am-241	< 0.01%	9.44E-05
Zr-95	0.01%	5.41E-03	Cm-242	< 0.01%	8.93E-06
Nb-95	0.02%	9.09E-03	Cm-244	< 0.01%	4.83E-04
<b>CURIES (TOTAL)</b>					<b>4.86e+01</b>

## 2.4 Groundwater Monitoring

With the Groundwater Protection Program (GWPP) Millstone Power Station implements the actions cited in the Nuclear Energy's Institute's (NEI) Groundwater Protection Initiative (Reference 9). 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 groundwater. A key element in the GWPP is on-site groundwater monitoring. The results of the GWPP are documented in the Annual Radiological Environmental Operating Report (AREOR). Additional wells were sampled and the results are documented in tables below.

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 Unit 3 and channels this water via the storm drain system to Long Island Sound.

**Table 2.4-GW (p. 1 of 3)  
Additional Well Samples**

Name	Date	H-3 <sup>1,3</sup> (pCi/L)	Name	Date	H-3 <sup>1,3</sup> (pCi/L)
MW-7C <sup>2</sup>	1/11/16	2250	MW-7D <sup>2</sup> (cont)	4/6/16	3410
	1/21/16	<mda		4/18/16	3310
	2/22/16	4880		5/2/16	<mda
	3/9/16	3020		5/17/16	<mda
	3/22/16	2200		6/15/16	3660
	4/6/16	<mda		7/6/16	4410
	5/4/16	4390		7/18/16	4890
	5/17/16	3520		8/2/16	4940
	6/20/16	3370		8/17/16	4300
	7/6/16	<mda		8/29/16	4,940
	7/18/16	4280		9/12/16	4140
	8/17/16	2430		9/26/16	5800
	8/29/16	2370		10/3/16	7740
	9/27/16	<mda		10/6/16	6430
10/6/16	4170	10/11/16	5560		
11/18/16	4320	10/17/16	7310		
12/6/16	5800	10/24/16	7070		
MW-7D <sup>2</sup>	1/11/16	6280	11/1/16	5950	
	1/21/16	7540	11/8/16	6060	
	2/9/16	7070	11/17/16	4500	
	2/22/16	5320	11/28/16	7950	
	2/29/16	4550	12/6/16	8110	
	3/9/16	3640	12/13/16	7690	
	3/22/16	3850			

- Notes: 1 - There was no gamma radioactivity detected in these samples.  
 2 - These wells are 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.  
 3 - MDA is approximately 1,760 pCi/L.

**Table 2.4-GW (p. 2 of 3)  
Additional Well Samples**

Name	Date	H-3 <sup>1,3</sup> (pCi/L)	Name	Date	H-3 <sup>1,3</sup> (pCi/L)
DP-102 <sup>2</sup>	2/22/16	12600	MW-GPI-6 (continued)	9/13/16	<mda
	6/1/16	4500		11/14/16	<mda
	9/13/16	2200	MW-GPI-8	1/6/16	<mda
	11/14/16	2400		1/21/16	<mda
M3-MW-1	1/6/16	<mda		4/30/16	<mda
ME-2	1/6/16	<mda		7/19/16	<mda
	8/26/16	<mda		10/12/16	<mda
ME-5	1/6/16	<mda		MW-GPI-9 <sup>4</sup>	1/6/16
	8/23/16	<mda	1/11/16		<mda
MW-6A	1/15/16	<mda	2/1/16		<mda
	6/16/16	<mda	2/9/16		2470
	8/22/16	<mda	2/15/16		1750
	11/10/16	<mda	2/22/16		<mda
MW-6B	1/15/16	<mda	2/29/16		<mda
	6/15/16	<mda	3/7/16		<mda
	8/22/16	<mda	3/30/16		3510
	11/10/16	<mda	4/5/16		2970
MW-GPI-1	8/24/16	<mda	4/18/16		2700
	9/8/16	<mda	5/2/16		3620
	9/20/16	<mda	5/17/16		2240
	10/3/16	<mda	6/6/16		2430
	10/17/16	<mda	6/20/16		1860
	10/31/16	<mda	7/6/16		<mda
MW-GPI-2	1/6/16	<mda	7/18/16	<mda	
	2/1/16	<mda	8/2/16	<mda	
	4/20/16	<mda	8/17/16	<mda	
	7/19/16	<mda	8/29/16	<mda	
	11/18/16	<mda	9/12/16	<mda	
MW-GPI-3	1/6/16	<mda	9/26/16	<mda	
	8/23/16	<mda	10/11/16	<mda	
MW-GPI-4	3/7/16	<mda	10/24/16	1840	
	7/12/16	<mda	11/8/16	2090	
MW-GPI-6	1/25/16	2130	11/17/16	2060	
	2/22/16	<mda	11/28/16	2260	
	6/2/16	<mda			

- Notes: 1 - There was no gamma radioactivity from licensed radioactive material detected in these samples.  
2 - These wells are 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. During 2012, an investigation was initiated to determine if there are additional sources of H-3 to onsite groundwater at these wells.  
3 - MDA is approximately 1,760 pCi/L.  
4 - Some results from MW-GPI-9 are positive. The source of tritium appears to be from the tritium being released via underground discharge tunnels. This tritium has been documented and the releases reported in another part of this report. No other leakage source has been identified.

**Table 2.4-GW (p. 3 of 3)  
Additional Well Samples**

Name	Date	H-3 <sup>1,2</sup> (pCi/L)	Name	Date	H-3 <sup>1,2</sup> (pCi/L)
MW-GPI-10	11/14/16	<mda	S3-MW-2	2/2/16	<mda
MW-GPI-11	11/14/16	<mda		5/10/16	<mda
S11-MW-1	1/21/16	<mda		8/30/16	<mda
	6/6/16	<mda		10/19/16	<mda
	8/31/16	<mda	T10-MW-5e	1/27/16	<mda
	11/1/16	<mda		6/13/16	<mda
S12-MW-1	1/21/16	<mda		8/15/16	<mda
	5/16/16	<mda		11/4/16	<mda
	7/25/16	<mda	T10-MW-6a	1/28/16	<mda
	10/5/16	<mda		6/6/16	<mda
S12-MW-2	2/1/16	<mda		8/12/16	<mda
S12-MW-3	2/1/16	<mda	T10-MW-6b	1/28/16	<mda
	5/16/16	<mda		5/12/16	<mda
	7/25/16	<mda		8/12/16	<mda
	10/5/16	<mda	T1-MW-3	2/17/16	<mda
S13-MW-1	2/2/16	<mda		5/9/16	<mda
	5/10/16	<mda		7/14/16	<mda
	8/30/16	<mda	T3-MW-1	8/9/16	<mda
	10/19/16	<mda		8/24/16	<mda
S1-MW-1	2/17/16	<mda		9/8/16	<mda
	5/9/16	<mda		9/20/16	<mda
	7/14/16	<mda		10/3/16	<mda
	10/12/16	<mda		10/17/16	<mda
				10/31/16	<mda

Notes: 1 - There was no gamma radioactivity from licensed radioactive material detected in these samples.  
2 - MDA is approximately 1,760 pCi/L.

### **3.0 Inoperable Effluent Monitors**

During the period January 1 through December 31, 2016, the following effluent instrumentation were inoperable for more than 30 consecutive days:

3.1. **Unit 1** - None

3.2. **Unit 2** -

The Waste Gas Discharge Radiation Monitor (RM-9095) was out of service for greater than 30 days from July 27 to August 26. It was out of service due to a time extension of required surveillance work. A functional test for RM-9095 was performed on July 27 and completed satisfactorily. The calibration of the monitor which is normally scheduled after a functional test had to be rescheduled due to resources. Surveillances require the decay tank outlet stop valves to be tagged shut to prevent discharge during functional and calibration testing. Per operational practice the REMODCM surveillance requirement is only exited after tags are removed. The monitor was not declared functional until the calibration was performed. During the time that the monitor was not available (non-functional) there were no discharges of waste gas and compensatory extra sampling of waste gas was not needed.

3.3. **Unit 3** - None

### **4.0 Operating History**

The operating history of the Millstone Power Station Units during this reporting period was as follows:

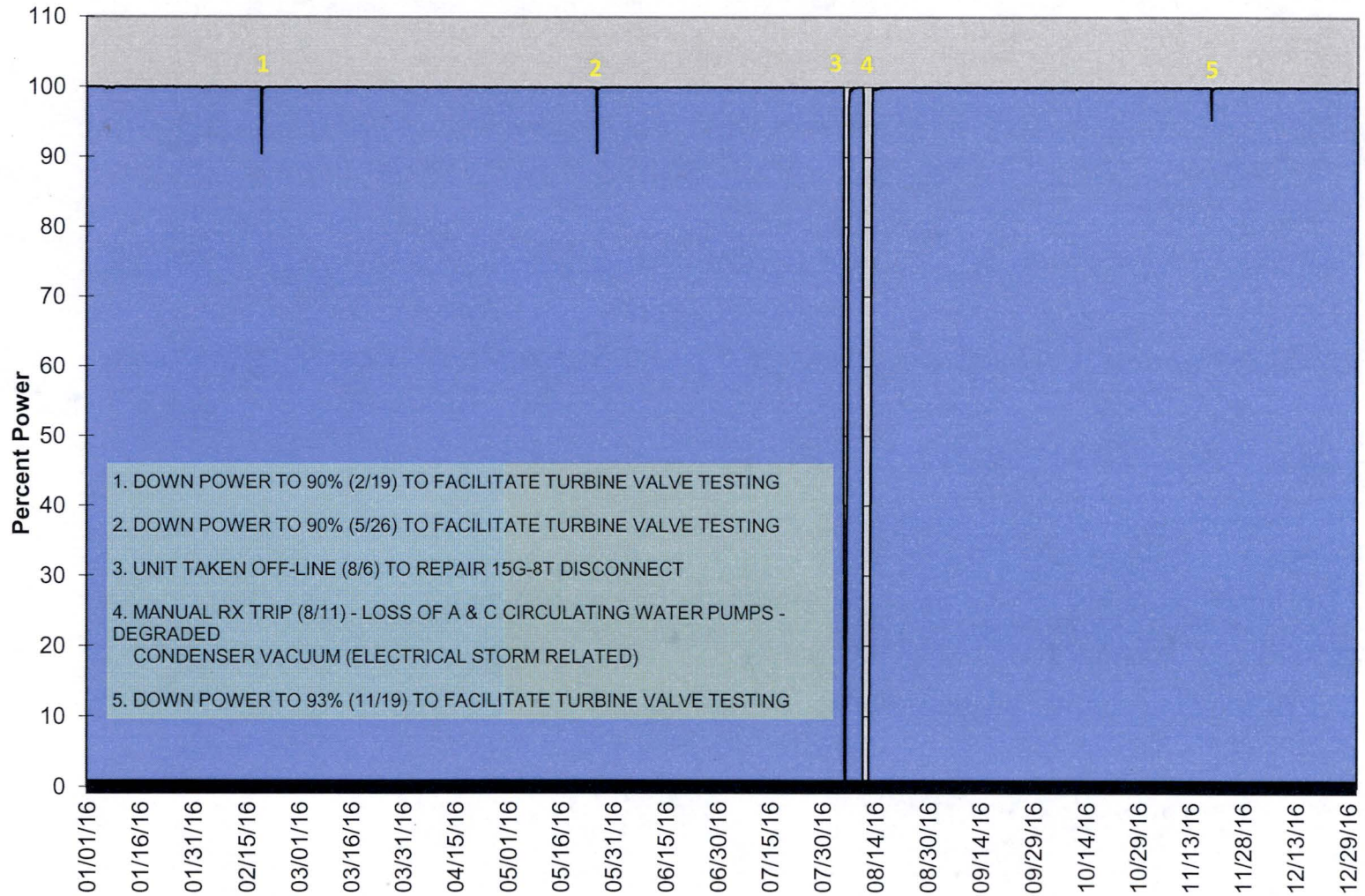
Unit 1 was shut down November 11, 1995 with a cessation of operation declared in July 1998.

Unit 2 operated with a capacity factor of 97.5%

Unit 3 operated with a capacity factor of 85.8%

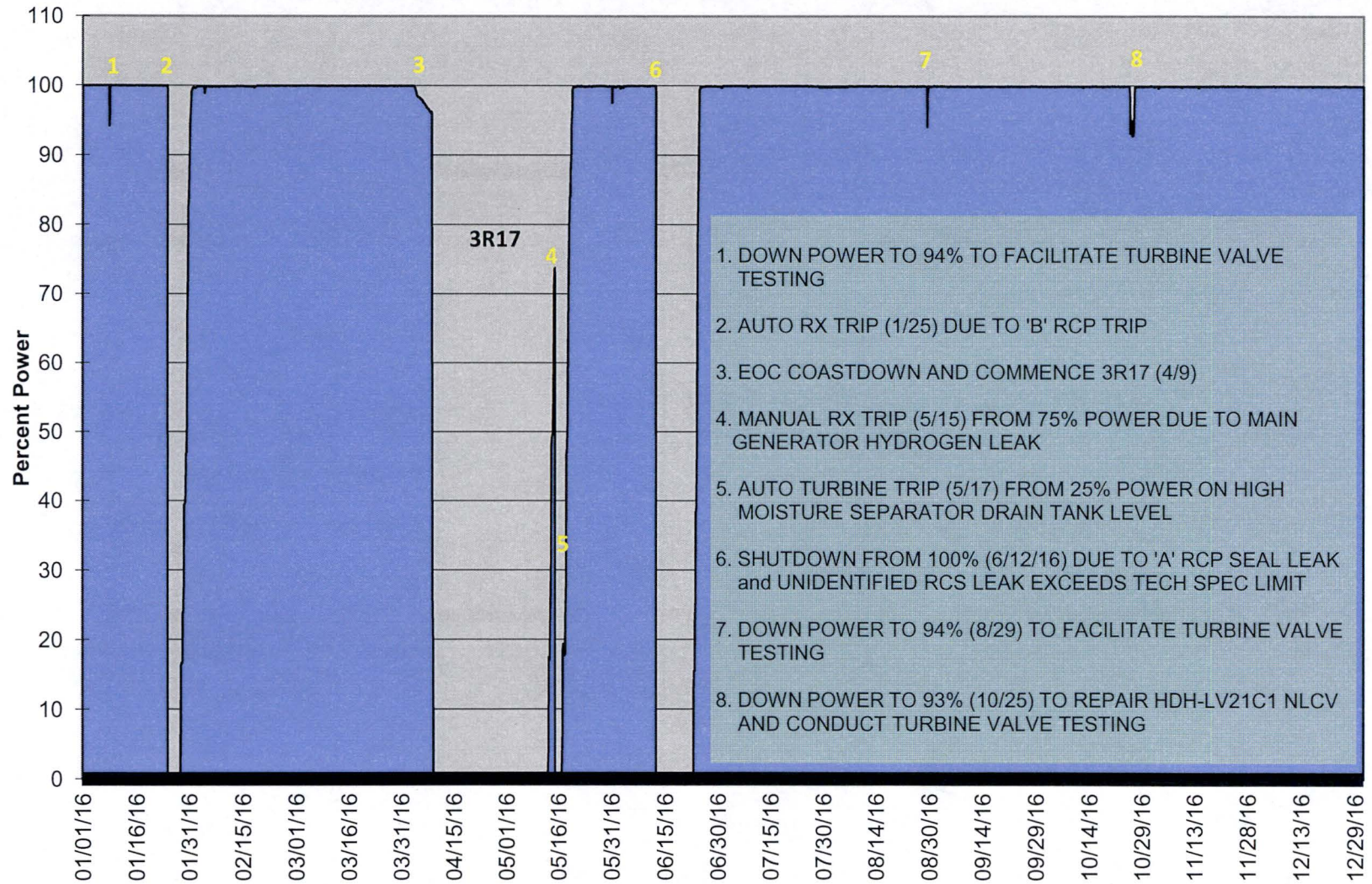
The power histograms for 2016 are on the following pages.

## MP2 - CYCLE 24 POWER HISTORY YEAR 2016





## MP3 - CYCLE 17 / 18 POWER HISTORY YEAR 2016



## 5.0 Errata

There is no errata of corrections to previous reports.

## 6.0 REMODCM Changes

The description and the bases of the change(s) for REMODCM Revision 28 (effective October 1, 2016) are included here in Volume 1 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

Programmatic and technical changes include:

- For samples of liquid batch releases at Unit 1 (Tables I.C-1), Unit 2 (Table I.C-2) and Unit 3 (Table I.C-3) the monthly analyses for tritium (H-3) on composite samples were changed to analyses of each sample for tritium.
- The ALPS processing system was added to processing equipment in Unit 3 high level waste stream.
- The Unit 2 liquid effluent flow diagram (Figure I.C-2) was revised by deleting the line shown bypassing the Temp Filters between the Coolant Waste Receiver Tanks and the Coolant Waste Monitor Tanks.
- The Unit 3 liquid effluent flow diagram (Figure I.C-3) was revised by adding the ALPS system as an alternative pathway to high level processing and adding Service Water discharge.
- In Section I.D.1, requirement was changed so that gaseous effluents analyses results are applied to all dose categories, not just dose rates.
- For Unit 1 gaseous effluent sampling (Table I.D-1) added an exemption to gaseous sampling for release points not in use.
- For Unit 1 gaseous effluent sampling (Table I.D-1) deleted requirement that ratio of sample flow rate to stream flow rate be known.
- In the gaseous effluent sampling requirements for Unit 2 (Table I.D-2) and Unit 3 (Table I.D-3), reworded Footnote F for additional particulate and iodine sampling. Part of the change is non-technical making the requirement of the footnote easier to read. Technical changes included
  - a) defined "startup" as "reactor criticality after shutdown,"
  - b) specified that Dose Equivalent I-131 and radiation monitor reading increases be compared to values during steady state, full power operation prior to the power transient and
  - c) added that additional sampling may stop when both conditions are satisfied.
- For Unit 3, changed requirement for sampling particulates at open equipment hatch to sampling particulates for open equipment hatch (Table I.D-3).
- Changed sampling requirements for the Radiological Environmental Monitoring Program (REMP) in Tables I.E-1 and I.E-2. These changes include:
  - a) changed frequency of fish, clams and lobster samples from quarterly to semi-annually,

- b) added a new sample type, aquatic flora (seaweed), to Locations 29, 32 and 35 and to new Location 36, "Black Point,"
- c) deleted Location 38 at Waterford Shellfish Bed for clams and moved clam sample requirement to Location 31 at Niantic Shoals,
- d) deleted all oyster samples including Locations 31, 32 and 37 and 88 and
- e) deleted Location 88 at DEEP Dock.
- In Section II.D.1.b, the following instantaneous iodine, tritium and particulate release rate limits were changed:
  - a) Unit 1 tritium vent releases ( $Q_{H1V}$ ) from  $9.36 \times 10^{-6}$  to  $2.78E-5$  ( $2.78 \times 10^{-5}$ ), Units 2&3 I-131 vent releases ( ${}_{131}Q_{I2V}$  &  ${}_{131}Q_{I3V}$ ) from  $5.1 \times 10^{-2}$  to  $8.80E-2$  ( $8.80 \times 10^{-2}$ ),
  - b) Units 2&3 I-131 Millstone Stack releases ( ${}_{131}Q_{I2S}$  &  ${}_{131}Q_{I3S}$ ) from  $2.38 \times 10^{-3}$  to  $9.67E-3$  ( $9.67 \times 10^{-3}$ ),
  - c) Units 2&3 I-133 vent releases ( ${}_{133I}Q_{I2V}$  &  ${}_{133I}Q_{I3V}$ ) from  $1.25 \times 10^{-2}$  to  $2.08E-2$  ( $2.08 \times 10^{-2}$ ),
  - d) Units 2&3 I-133 Millstone Stack releases ( ${}_{133I}Q_{I2S}$  &  ${}_{133I}Q_{I3S}$ ) from  $5.75 \times 10^{-4}$  to  $2.29E-3$  ( $2.29 \times 10^{-3}$ ),
  - e) Units 2&3 tritium vent releases ( $Q_{H2V}$  &  $Q_{H3V}$ ) from  $4.2 \times 10^{-6}$  and  $4.1 \times 10^{-6}$  to  $6.87E-6$  ( $6.87 \times 10^{-6}$ ),
  - f) Units 2&3 tritium Millstone Stack releases ( $Q_{H2S}$  &  $Q_{H3S}$ ) from  $1.9 \times 10^{-7}$  to  $7.53E-7$  ( $7.53 \times 10^{-7}$ ),
  - g) Unit 1 particulate vent releases ( $Q_{P1V} + Q_{P1B}$ ) from  $1.05 \times 10^{-1}$  to  $3.52E-1$  ( $3.52 \times 10^{-1}$ ),
  - h) Units 2&3 particulate vent releases ( $Q_{P2V}$  &  $Q_{P3V}$ ) from  $5.1 \times 10^{-2}$  to  $8.67E-2$  ( $8.67 \times 10^{-2}$ ) and
  - i) Units 2&3 particulate Millstone Stack releases ( $Q_{P2S}$  &  $Q_{P3S}$ ) from  $2.38 \times 10^{-3}$  to  $9.53E-3$  ( $9.53 \times 10^{-3}$ ).
- In Section II.D.4, the dose factors for monthly air dose projections were changed from  $1.81 \times 10^{-4}$  to  $5E-4$  ( $5 \times 10^{-4}$ ) for gamma air dose and from  $1.81 \times 10^{-6}$  to  $3E-4$  ( $3 \times 10^{-4}$ ) for beta air dose.
- In Section II.D.4, organ dose was added to the monthly dose projections for the Units 2&3 gaseous waste systems.
- In the Unit 2 gaseous effluent monitoring instrumentation surveillance requirements (Table IV.C-4), deleted requirement on the Millstone Stack flow rate monitor channel functional test to demonstrate control room annunciation.
- Deleted the exception on functionality of Unit 3 CPF waste neutralization sump radiation monitor and flow measurement device when there is no detectable radioactivity in the steam generators or when sump is being directed to radwaste.
- A note was added to the Unit 3 gaseous effluent monitoring instrumentation (Table V.C-3) that upon loss of the process flow rate monitors the iodine and particulate channel would continue to be functional given adequate indicated process flow.

Changes which are editorial in nature include:

- Liquid batch release sources for Unit 2 (Table I.C-2) and Unit 3 (Table I.C-3) were listed separately.
- In list of liquid processing equipment which would require dose projection if not functional:
- For Unit 3 High Level Waste Stream changed order of Demineralizer Filter and Demineralizer to be consistent between the two trains and Relabeled Unit 3 equipment to be consistent with plant labeling and added a note was added to explain use of qualifier “OR.”
- In Sections I.C, I.D, I.E, II.C, II.D, II.E, II.F, III.F, IV.F and V.F, the bases information for each section were transferred to MP-22-REC-REF03, "REMODCM Technical Information Document."
- Replaced Unit 2 gaseous effluent flow figure (Figure I.D-2) with a better drawn figure.
- In Footnote H of Table I.D-2 changed “activity” to “radioactivity” to be consistent with use of same word throughout the REMODCM.
- Revised names of several TLD locations in Table I.E-2.
- Several changes were made to the REMP land use census requirements in Section I.E.2. The wording in the first three sentences was revised and the second paragraph on the time of the year and the methods for the land use census was deleted. Requirements were not changed with this rewording and deletion.
- In the liquid dose projection formulae in Section II.C.2, deleted the superscripted comma in the designations for whole body and maximum organ doses.
- Bases information for dose conversion factors for the monthly dose projection for Units 2&3 was transferred to MP-22-REC-REF03, "REMODCM Technical Information Document."
- Changed name of Unit 1 Spent Fuel Pool Water Discharge to Unit 1 Liquid Waste Effluent Discharge (RE-MG-110).
- Restructured the tables for instrument functionality (Tables III.C-1, III.C-3, IV.C-1, IV.C-3, V.C-1 and V.C-3). Changes made include transferring information in table columns into table notes, adding additional words in column headings and footnotes for clarification and relabeling aster ices as numbers. No requirements in the tables were changed or added.
- In tables for liquid effluent instrument functionality (Tables III.C-1, IV.C-1 and V.C-1) reworded part (1) in Action A. For Unit 2 table (Table IV.C-1) reworded part (1) in Action E and for Unit 3 table (Table V.C-1) reworded part (1) in Action D. Change requires same actions but refers directly to sampling tables I.C-1, I.C-2 and I.C-3 instead of indirectly thru the surveillance requirements.
- In Unit 2 table for liquid effluent instrument functionality (Table IV.C-2), deleted the footnote on the Reactor Building Closed Cooling Water Monitor. This footnote was moved to MP-22-REC-REF03, "REMODCM Technical Information Document" as basis information.
- Made several changes in controls for radioactive gaseous effluents dose rate (Sections III.D.2.a, IV.D.2.a and V.D.2.a). These included:
  - a) changed “radioactive materials” to “radioactivity,”

- b) changed the words “instantaneous release rate” in Section III.D.2.a to “release rate, at any time” in the Surveillance Requirements. The change is equivalent and is consistent with wording in the same requirement for Units 2 and 3,
- c) changed the word “rate” in Section III.D.2.a to “rates” in the first surveillance requirement and
- d) changed the words “radioactive materials” in Sections IV.D.2.a and V.D.2.a in the third surveillance requirement to “Iodine-131, Iodine-133, tritium and all radioactive materials in particulate form with half lives greater than 8 days.”
- Deleted brackets in controls in Unit 1 dose from radionuclides other than noble gas (Section III.D.2.c).
- Moved basis information at bottom of Table IV.C-1 giving reason for not monitoring service water to MP-22-REC-REF03, "REMODOCM Technical Information Document."
- Changed name of Table IV.C-3 from “Radioactive Gaseous Effluent Instrumentation” to “Radioactive Gaseous Effluent Monitoring Instrumentation.”

## 6.2 Discussion of Changes

- The requirement for frequency of tritium analyses on samples of batch releases of liquid radwaste was increased from monthly to each discharge. This includes discharges of Unit 2 Clean Liquid Waste, Unit 2 Aerated Liquid Waste, Unit 2 Steam Generator Bulk, and Unit 2 CPF Waste Neutralization Sump. It also includes discharges of Unit 3 Waste Test Tanks, Unit 3 Low Level Waste Tank, Unit 3 Boron Test Tank, Unit 3 Steam Generator Bulk and Unit 3 CPF Waste Neutralization Sump. Tritium analyses are already being performed on every discharge except that tritium analysis is not performed on Units 2 & 3 CPF Waste Neutralization Sump when there is no detectable tritium in the steam generators.
- The Advanced Liquid Processing System (ALPS) will be installed as the primary liquid radwaste processing equipment for Unit 3 high level waste. In preparation for this installation ALPS has been added as processing equipment for which a dose projection would be required if it were out of service. ALPS will provide higher cleanup of liquid radwaste than the pairs of filters and demineralizers presently listed as radwaste processing equipment for which a dose projections would be required if both pairs of filters and demineralizers were out of service. The present set of filters and demineralizers will be retained in the requirement for dose projection. ALPS will add a third option, albeit the primary option for processing.
- For Unit 2 (Figure I.C-2), the line shown bypassing the Temp Filters between the Coolant Waste Receiver Tanks and the Coolant Waste Monitor Tanks was deleted. This was a correction to the diagram as there was never a bypass. There is no impact on plant operations because the flow diagrams are only in the REMODOCM for information purposes.

- For Unit 3 (Figure I.C-3), the diagram was revised by adding the ALPS system as an alternative pathway to high level processing and adding Service Water discharge. See discussion #2 above concerning addition of ALPS. Service water pathway was added because it is one of the required sampling points in the REMODCM.
- The requirement that sampling and analyses in Tables I.D-1, I.D-2 and I.D-3 be used to assure dose rates limits in Radiological Controls III.D.2.a, IV.D.2.a and V.D.2.a are maintained has been changed to apply to all dose limits (not just dose rate limits) of Sections III.D.2, IV.D.2 and V.D.2. Although the surveillance requirements in Radiological Controls III.D.2, IV.D.2 and V.D.2 require that this be done only for dose rates, the sampling and analyses are also used to determine other doses such as noble gas gamma and beta air doses and doses from radionuclides other than noble gases. This is currently being done as part of the radiological effluent control program.
- An exemption to gaseous sampling at Unit 1 (Table I.D-1) for release points not in use was added. Sampling would not be needed at times when ventilation for the Spent Fuel Pool Island or Balance of Plant is secured.
- The requirement that ratio of sample flow rate to stream flow rate be known was deleted. This is not needed. The methodology used to determine radioactivity release is taking calculated radioactivity concentration in the sample air stream and multiply by volume of air released via the effluent stream. Showing the ratio of the two flows is not needed.
- The rewording of Footnote F in Tables I.D-2 and I.D-3 provides a clearer description of the exceptions to the requirement for taking additional filter samples after power changes. Rationale for technical changes:
  - a) "Startup" was defined to identify when sampling would be needed when returning from a shutdown.
  - b) Exceptions were modified by adding specifying that the RCS dose equivalent I-131 and noble gas radiation monitor reading be compared to conditions at full power. The intent of the exceptions is to exempt the additional sampling if there is not a potential for increased release of radioactivity in effluents due to degraded fuel conditions. Such would be the case if there is a significant increase in RCS dose equivalent I-131 or in radioactive noble gas being released. At reduced power both of these indicators go down. With increase in power operation both indicators are expected to increase and would not be an indication of degraded fuel.
  - c) Footnote F was also revised to allow termination of additional sampling of both RCS dose equivalent I-131 and noble gas radiation readings return to less than a factor of three full power indication. This provides relief from daily sampling when indicators show conditions are returning to normal. Sampling would return to the normal weekly sample.
- For Unit 3, changed requirement for sampling particulates at open equipment hatch to sampling particulates for open equipment hatch (Table I.D-3). This makes the requirement consistent with similar Unit 2 requirement in Table I.D-2. It provides

for more flexibility of sampling airborne radioactivity released from the open equipment hatch. The sample could be taken anywhere at the open equipment hatch where the airborne radioactivity is representative of the air being released.

- Sampling requirements for the Radiological Environmental Monitoring Program (REMP) in Tables I.E-1 and I.E-2 were changed. These changes include:
  - a) The frequency of fish, clams and lobster samples were changed from quarterly to semi-annually. These types of sample would measure long term accumulation of radioactivity. Reducing the number of samples from four to two in a year would not reduce their effectiveness for detecting any plant related radioactivity. Because of unavailability in the winter months (1<sup>st</sup> quarter) these samples were obtained only three times in a year during many years. NRC guidance for REMF sampling in NUREG-1301 gives a frequency of seasonally, or semiannual if fish and invertebrates are not seasonal. The addition of seaweed as a sample will compensate (see next discussion).
  - b) A new sample type, aquatic flora (seaweed), was added to Locations 29, 32 and 35 and to new Location 36, "Black Point." This sample type would compensate for the reduction in fish and invertebrate sampling. Although not a food source, seaweed can be a good indicator sample. Plant related radioactivity has been found at times in seaweed.
  - c) Location 38 at Waterford Shellfish Bed for clams was deleted and moved to Location 31 at Niantic Shoals. The Niantic Shoals location is a more readily available source of clams. This maintains the number of required clam locations at two.
  - d) Oyster samples were deleted. This sample type has become increasingly difficult to sample in sufficient volume. The addition of seaweed as a sample will compensate (see discussion in b above).
  
- In Section II.D.1.b, the instantaneous iodine, tritium and particulate release rate limits were changed. This change was based on using a more conservative meteorology than that used to determine the previous release rate limits. Previous meteorology was the average meteorology over the years 1980 to 1987. This was revised to use the highest meteorology from all calendar quarters in those years. The meteorological parameter used was the X/Q value. For rooftop (Units 2&3 vents) releases the highest X/Q of 8.1E-6 was used. For elevated (Millstone Stack) and ground (Unit 1 vents) releases the highest X/Qs of 8.92E-7 and 3.28E-5, respectively, were used. The release rate limits were changed as follows:
  - a) Unit 1 tritium vent releases ( $Q_{H1V}$ ) from  $9.36 \times 10^{-6}$  to  $2.78E-5$  ( $2.78 \times 10^{-5}$ ),
  - b) Units 2&3 I-131 vent releases ( ${}_{131}Q_{I2V}$  &  ${}_{131}Q_{I3V}$ ) from  $5.1 \times 10^{-2}$  to  $8.80E-2$  ( $8.80 \times 10^{-2}$ ),
  - c) Units 2&3 I-131 Millstone Stack releases ( ${}_{131}Q_{I2S}$  &  ${}_{131}Q_{I3S}$ ) from  $2.38 \times 10^{-3}$  to  $9.67E-3$  ( $9.67 \times 10^{-3}$ ),
  - d) Units 2&3 I-133 vent releases ( ${}_{133}Q_{I2V}$  &  ${}_{133}Q_{I3V}$ ) from  $1.25 \times 10^{-2}$  to  $2.08E-2$  ( $2.08 \times 10^{-2}$ ),
  - e) Units 2&3 I-133 Millstone Stack releases ( ${}_{133}Q_{I2S}$  &  ${}_{133}Q_{I3S}$ ) from  $5.75 \times 10^{-4}$  to  $2.29E-3$  ( $2.29 \times 10^{-3}$ ),

- f) Units 2&3 tritium vent releases ( $Q_{H2V}$  &  $Q_{H3V}$ ) from  $4.2 \times 10^{-6}$  and  $4.1 \times 10^{-6}$  to  $6.87E-6$  ( $6.87 \times 10^{-6}$ ),
- g) Units 2&3 tritium Millstone Stack releases ( $Q_{H2S}$  &  $Q_{H3S}$ ) from  $1.9 \times 10^{-7}$  to  $7.53E-7$  ( $7.53 \times 10^{-7}$ ),
- h) Unit 1 particulate vent releases ( $Q_{P1V} + Q_{P1B}$ ) from  $1.05 \times 10^{-1}$  to  $3.52E-1$  ( $3.52 \times 10^{-1}$ ),
- i) Units 2&3 particulate vent releases ( $Q_{P2V}$  &  $Q_{P3V}$ ) from  $5.1 \times 10^{-2}$  to  $8.67E-2$  ( $8.67 \times 10^{-2}$ ), and
- j) Units 2&3 particulate Millstone Stack releases ( $Q_{P2S}$  &  $Q_{P3S}$ ) from  $2.38 \times 10^{-3}$  to  $9.53E-3$  ( $9.53 \times 10^{-3}$ ).
- In Section II.D.4, the dose factors for monthly air dose projections were changed from  $1.81 \times 10^{-4}$  to  $5E-4$  ( $5 \times 10^{-4}$ ) for gamma air dose and from  $1.81 \times 10^{-6}$  to  $3E-4$  ( $3 \times 10^{-4}$ ) for beta air dose. A different, more conservative methodology was used to determine the dose factors. The new dose factors are more conservative because they result in higher dose results.
  - In Section II.D.4, organ dose was added to the monthly dose projections for the Units 2&3 gaseous waste systems. This addition was needed because Section I.D.2 has a criterion for organ dose projection when processing equipment is not functional. The methodology for determining organ dose was not in the REMODCM as specified in Section I.D.2. The dose factor for organ dose was determined using the highest dose factors for noble gas isotopes. Details are contained in the REMODCM Technical Information document, MP-22-REC-REF03.
  - In the Unit 2 gaseous effluent monitoring instrumentation surveillance requirements (Table IV.C-4), deleted requirement on the Millstone Stack flow rate monitor channel functional test to demonstrate control room annunciation. Footnote (2) which stipulates demonstration of control room annunciation was erroneously added in a previous revision to the REMODCM. Plant design does not include a control annunciation for high reading on or failure of the stack flow rate monitor.
  - Deleted the exception on functionality of Unit 3 CPF waste neutralization sump radiation monitor and flow measurement device when there is no detectable radioactivity in the steam generators or when sump is being directed to radwaste. The functionality requirement should remain in place in case of a failure to detect actual radioactivity in the steam generators or errors in valve lineups when there is an intent to divert to radwaste.
  - A note is added to the Unit 3 gaseous effluent monitoring instrumentation (Table V.C-3) that upon loss of the process flow rate monitors the iodine and particulate channel would continue to be functional given adequate indicated process flow. When functionality of the process flow rate monitor is lost the functionality of the other components may or may not be impacted. As part of the isokinetic design the sampler flow rate is adjusted with change in process flow. Sampler flow is adjusted



in the same direction as any change in process flow. With a large or total loss of indication on the process flow rate monitor the sampler flow rate monitor would eventually reach a fail low state and also become non-functional. This, in turn, would cause loss of functionality of the radioactivity monitor and two samplers because of loss of sufficient sample flow. However, there may be an abnormal decrease in process flow indication which renders the process flow nonfunctional but sufficient to maintain enough sample flow to allow continued functioning of the gas, iodine and particulate channels. Although there would be a loss of isokinetic sample flow, the other components (other than the process flow rate monitor) need not be declared non-functional for the following reasons:

- a) Loss of isokinetic sample flow affects representativeness of the sample collected on the iodine and particulate filters, but not the gas radioactivity monitor.
- b) Sample flow which is too low for isokinetic sampling causes a conservative error in sampling in that a higher percentage of radioactive iodine and particulates are collected on the filters than is present in the process flow.
- c) Compensatory sampling as required by Action Statement B in Table V.C-3 for the iodine and particulate samplers does not compensate for loss of isokinetic flow.
- d) Compensatory sampling of the iodine and particulate sampling will cause the noble gas radioactivity monitor to also become non-functional. However, the gas monitor is still capable of performing its function of continuous monitoring of radioactive gases in the process stream even with degraded flow from the process stream. Declaring the gas monitor nonfunctional is not desirable because it is used in the Emergency Action Levels of the emergency response plan.

For these reasons, the noble gas radioactivity monitor, iodine sampler, particulate sampler and sampler flow rate monitor may remain in service whenever the process flow rate monitor is degraded but continues to read a minimum acceptable process flow.

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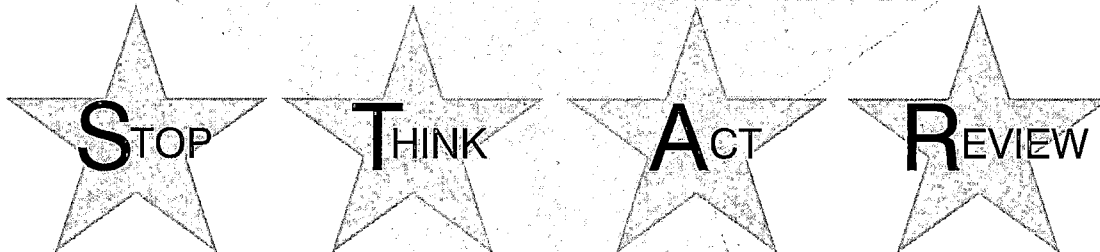
Serial No. 17-156  
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50-336  
50-423  
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DPR-65  
NPF-49

**ATTACHMENT 2**

**2016 RADIOACTIVE EFFLUENT RELEASE REPORT**  
**VOLUME 2**

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

MILLSTONE POWER STATION  
STATION PROCEDURE



**Radiological Effluent Monitoring and Offsite  
Dose Calculation Manual (REMDCM)**

**MP-22-REC-BAP01**

**Rev. 028**

Approval Date: 08/18/16

Effective Date: 10/01/16

**Millstone All Units  
Station Procedure**

**Radiological Effluent Monitoring and Offsite Dose Calculation Manual  
(REMODCM)**

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# SECTION I.

## Radiological Effluent Monitoring Manual (REMM)

For the  
Millstone Nuclear Power Station  
Nos. 1, 2, & 3

Docket Nos. 50-245, 50-336, 50-423

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## SECTION I. RADIOLOGICAL EFFLUENT MONITORING MANUAL (REMM)

### I.A. Introduction

The purpose of Section I of this manual is to provide the sampling and analysis programs which provide input to Section II for calculating liquid and gaseous effluent concentrations and offsite doses. Guidelines are provided for operating radioactive waste treatment systems in order that offsite doses are kept As-Low-As-Reasonably-Achievable (ALARA).

The Radiological Environmental Monitoring Program outlined within this manual provides confirmation that the measurable concentrations of radioactive material in the environment as a result of operations at the Millstone Site are not higher than expected.

In addition, this manual outlines the information required to be submitted to the NRC in both the Annual Radiological Environmental Operating Report and the Radioactive Effluent Release Report.

MP-22-REC-REF03, "REMDCM Technical Information Document (TID)," has additional bases and technical information. It also contains a list of exceptions to Regulatory Guide 1.21 (see Section 2 of the TID).

### I.B. Responsibilities

All changes to the Radiological Effluent Monitoring Manual (REMM) shall be reviewed and approved by the Facility Safety Review Committee prior to implementation.

All changes and their rationale shall be documented in the Radioactive Effluent Release Report.

It shall be the responsibility of the Site Vice President Millstone to ensure that this manual is used as required by the administrative controls of the Technical Specifications. The delegation of implementation responsibilities is delineated in MP-22-REC-PRG, "Radiological Effluent Program."

### I.C. Liquid Effluents

#### 1. Liquid Effluent Sampling and Analysis Program

Radioactive liquid wastes shall be sampled and analyzed in accordance with the program specified in Table I.C.-1 for Millstone Unit No. 1, Table I.C.-2 for Millstone Unit No. 2, and Table I.C.-3 for Millstone Unit No. 3. The results of the radioactive analyses shall be input to the methodology of Section II to assure that the concentrations at the point of release are maintained within the limits of Radiological Effluent Controls (Section III.D.1.a. for Millstone Unit No. 1, Section IV.D.1.a. for Millstone Unit No. 2, and Section V.D.1.a. for Millstone Unit No. 3).



**Table I.C.-1  
Millstone Unit 1 Radioactive Liquid Waste Sampling and Analysis Program**

Liquid Release Source	Sample Type and Frequency	Minimum Analysis Frequency	Type of Radioactivity Analysis	Lower Limit of Detection (LLD) <sub>A</sub> (μCi/ml)
Any Batch Release from any source	Grab sample prior to each batch release <sup>B</sup>	Prior to each batch release	Principal Gamma Emitters	5 x 10 <sup>-7</sup>
			Kr-85	1 x 10 <sup>-5</sup>
			H-3	1 x 10 <sup>-5</sup>
	Grab sample prior to initial batch release from any one source and quarterly composite thereafter	Prior to initial batch release from each source. Quarterly for each source. <sup>D</sup>	Gross alpha	1 x 10 <sup>-7</sup>
			Sr-90	5 x 10 <sup>-8</sup>
			Fe-55	1 x 10 <sup>-6</sup>

**Table I.C.-1  
TABLE NOTATIONS**

A. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66 S_b}{(E)(V)(2.22 \times 10^6)(Ye^{-\lambda \Delta t})}$$

Where:

- **LLD** is the lower limit of detection as defined above (as μCi per unit mass or volume)
- **S<sub>b</sub>** is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)
- **E** is the counting efficiency (as counts per transformation)
- **V** is the sample size (in units of mass or volume)
- **2.22 x 10<sup>6</sup>** is the number of transformations per minute per μCi
- **Y** is the fractional radiochemical yield (when applicable)
- **λ** is the radioactive decay constant for the particular radionuclide
- **Δt** is the elapsed time between midpoint of sample collection and midpoint of counting time

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors will be identified and recorded on the analysis sheet for the particular sample.

- B. Prior to the sampling, each batch shall be isolated and at least two tank/sump volumes shall be recirculated or equivalent mixing provided.
- C. A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released. Prior to analysis, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluents released.
- D. For sources with no release during previous quarter, a quarterly sample is not required.

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Table I.C.-2 Millstone Unit 2 Radioactive Liquid Waste Sampling and Analysis Program				
Liquid Release Source	Sample Type and Frequency	Minimum Analysis Frequency	Type of Radioactivity Analysis	Lower Limit of Detection (LLD) <sub>A</sub> (μCi/ml)
<b>A. Batch Release<sup>B</sup></b>				
1. Clean Waste Monitor Tank. 2. Aerated Waste Monitor Tank. 3. Steam Generator Bulk <sup>D</sup> . 4. Condensate Polishing Facility - Waste Neutralization Sump <sup>E</sup> .	Grab sample prior to each batch release	Prior to each batch release	Principal Gamma Emitters <sup>C</sup>	5 x 10 <sup>-7</sup>
			I-131	1 x 10 <sup>-6</sup>
			Ce-144	5 x 10 <sup>-6</sup>
			Dissolved & Entrained Gases <sup>K</sup>	1 x 10 <sup>-5</sup>
		Quarterly Composite <sup>F,G</sup>	Gross alpha	1 x 10 <sup>-7</sup>
			Sr-89, Sr-90	5 x 10 <sup>-8</sup>
			Fe-55	1 x 10 <sup>-6</sup>
<b>B. Continuous Release</b>				
1. Steam Generator Blowdown <sup>H</sup> . 2. Service Water Effluent <sup>J</sup> .	Daily Grab Sample <sup>L</sup> & prior to aligning to Long Island Sound for RBCCW sump	Weekly Composite <sup>F,G</sup>	Principal Gamma Emitters <sup>C</sup>	5 x 10 <sup>-7</sup>
			I-131	1 x 10 <sup>-6</sup>
			Ce-144	5 x 10 <sup>-6</sup>
3. Turbine Sumps <sup>L</sup> .	Monthly Grab Sample	Monthly	Dissolved & Entrained Gases <sup>K</sup>	1 x 10 <sup>-5</sup>
4. RBCCW Sump <sup>M</sup> .	Weekly Grab or Composite	Monthly Composite <sup>F,G</sup>	H-3 <sup>N</sup>	1 x 10 <sup>-5</sup>
			Quarterly Composite <sup>F,G</sup>	Gross alpha
				Sr-89, Sr-90
			Fe-55	1 x 10 <sup>-6</sup>

**TABLE I.C.-2  
TABLE NOTATIONS**

A. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66 S_b}{(E)(V)(2.22 \times 10^6)(Ye^{-\lambda t})}$$



Where:

- **LLD** is the lower limit of detection as defined above (as  $\mu\text{Ci}$  per unit mass or volume)
- **$S_b$**  is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)
- **E** is the counting efficiency (as counts per transformation)
- **V** is the sample size (in units of mass or volume)
- **$2.22 \times 10^6$**  is the number of transformations per minute per  $\mu\text{Ci}$
- **Y** is the fractional radiochemical yield (when applicable)
- **$\lambda$**  is the radioactive decay constant for the particular radionuclide
- **$\Delta t$**  is the elapsed time between midpoint of sample collection and midpoint of counting time

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors will be identified and recorded on the analysis sheet for the particular sample.

- B. A batch release is the discharge of liquid wastes of a discrete volume from the tanks listed in this table. Prior to the sampling, each batch shall be isolated and at least two tank/sump volumes shall be recirculated or equivalent mixing provided. If the steam generator bulk can not be recirculated prior to batch discharge, a sample will be obtained by representative compositing during discharge.
- C. The LLD will be  $5 \times 10^{-7} \mu\text{Ci/ml}$ . The principal gamma emitters for which this LLD applies are exclusively the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141. Ce-144 shall also be measured, but with an LLD of  $5 \times 10^{-6} \mu\text{Ci/ml}$ . This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level. When unusual circumstances result in a priori LLDs higher than required, the reasons shall be documented in the Radioactive Effluent Release Report.
- D. For the Steam Generator Bulk:  
**IF** the applicable batch gamma radioactivity is not greater than  $5 \times 10^{-7} \mu\text{Ci/ml}$ , **THEN** the sampling and analysis schedule for gross alpha, Sr-89, Sr-90, Fe-55 are not required.

- E. For the Condensate Polishing Facility (CPF) waste neutralization sump:  
**IF** there is no detectable tritium in the steam generators, **THEN** tritium sampling and analyses is not required.  
**IF** the gross gamma radioactivity in the grab sample taken prior to release does not exceed  $5 \times 10^{-7}$   $\mu\text{Ci/ml}$ , **THEN** the sampling and analysis schedule for gross alpha, Sr-89, Sr-90 and Fe-55 are not required.
- F. For Batch Releases and Steam Generator Blowdown only, a composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released.
- G. Prior to analysis, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluents released.
- H. For the Steam Generator Blowdown:  
**IF** the steam generator gross gamma radioactivity does not exceed  $5 \times 10^{-7}$   $\mu\text{Ci/ml}$ , **THEN** the sampling and analysis schedule for all principal gamma, I-131, Ce-144, noble gases, gross alpha, Sr-89, Sr-90 and Fe-55 are not required.
- I. Daily grab samples shall be taken at least five days per week. For service water, daily grabs shall include each train that is in-service.
- J. For the Service Water:  
**IF** a weekly gamma analysis does not indicate a gamma radioactivity greater than  $5 \times 10^{-7}$   $\mu\text{Ci/ml}$ , **THEN** the sampling and analysis schedule for gross alpha, Sr-89, Sr-90, Fe-55 are not required.
- K. LLD applies exclusively to the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level. When unusual circumstances result in a priori LLDs higher than required, the reasons shall be documented in the "Radioactive Effluent Release Report."
- L. For the Turbine Building Sump:  
**IF** there is no detectable tritium in the secondary side before an outage, **THEN** tritium sampling and analyses is not required during an outage.  
**IF** the steam generator gross gamma radioactivity does not exceed  $5 \times 10^{-7}$   $\mu\text{Ci/ml}$ , **OR** sump is directed to radwaste treatment, **THEN** the sampling and analysis schedule for all principal gamma, I-131, Ce-144, noble gases, gross alpha, Sr-89, Sr-90 and Fe-55 are not required.  
**IF** the release pathway is directed to yard drains, **THEN** the LLD for I-131 shall be  $1.5 \times 10^{-7}$   $\mu\text{Ci/ml}$  and for gross alpha  $1 \times 10^{-8}$   $\mu\text{Ci/ml}$ .
- M. For the RBCCW Sump:  
**IF** the RBCCW Sump is directed to radwaste treatment or is not aligned to Long Island Sound, **THEN** sampling is not required.  
**IF** the applicable batch gamma radioactivity is not greater than  $5 \times 10^{-7}$   $\mu\text{Ci/ml}$ , **THEN** sampling and analysis schedule for gross alpha, Sr-89, Sr-90, Fe-55 are not required.
- N. Detectable tritium shall be used to estimate tritium releases to the atmosphere via the blowdown tank vent.





Table I.C.-3 Millstone Unit 3 Radioactive Liquid Waste Sampling and Analysis Program				
Liquid Release Source	Sample Type and Frequency	Minimum Analysis Frequency	Type of Radioactivity Analysis	Lower Limit of Detection (LLD) <sup>A</sup> (µCi/ml)
<b>A. Batch Release<sup>B</sup></b>				
1. Condensate Polishing Facility Waste Neutralization Sump <sup>E</sup> 2. Waste Test Tanks 3. Low Level Waste Tank 4. Boron Test Tanks 5. Steam Generator Bulk <sup>D</sup>	Grab sample prior to each batch release	Prior to each batch release	Principal Gamma Emitters <sup>C</sup>	5 x 10 <sup>-7</sup>
			I-131	1 x 10 <sup>-6</sup>
			Ce-144	5 x 10 <sup>-6</sup>
			Dissolved & Entrained Gases <sup>K</sup>	1 x 10 <sup>-5</sup>
			H-3	1 x 10 <sup>-5</sup>
		Quarterly Composite <sup>F,G</sup>	Gross alpha	1 x 10 <sup>-7</sup>
			Sr-89, Sr-90	5 x 10 <sup>-8</sup>
			Fe-55	1 x 10 <sup>-6</sup>
<b>B. Continuous Release</b>				
1. Steam Generator Blowdown <sup>H</sup> 2. Service Water Effluent <sup>J</sup>	Daily Grab Sample <sup>I</sup>	Weekly Composite <sup>F,G</sup>	Principal Gamma Emitters <sup>C</sup>	5 x 10 <sup>-7</sup>
			I-131	1 x 10 <sup>-6</sup>
			Ce-144	5 x 10 <sup>-6</sup>
3. Turbine Building Sumps <sup>L</sup>	Monthly Grab Sample	Monthly	Dissolved & Entrained Gases <sup>K</sup>	1 x 10 <sup>-5</sup>
	Weekly Grab or Composite	Monthly Composite <sup>F,G</sup>	H-3 <sup>M</sup>	1 x 10 <sup>-5</sup>
	Weekly Composite	Quarterly Composite <sup>F,G</sup>	Gross alpha	1 x 10 <sup>-7</sup>
			Sr-89, Sr-90	5 x 10 <sup>-8</sup>
Fe-55			1 x 10 <sup>-6</sup>	

**TABLE I.C.-3  
TABLE NOTATIONS**

A. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66 S_b}{(E)(V)(2.22 \times 10^6)(Ye^{-\lambda \Delta t})}$$

Where:

- **LLD** is the lower limit of detection as defined above (as  $\mu\text{Ci}$  per unit mass or volume)
- **$S_b$**  is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)
- **E** is the counting efficiency (as counts per transformation)
- **V** is the sample size (in units of mass or volume)
- **$2.22 \times 10^6$**  is the number of transformations per minute per  $\mu\text{Ci}$
- **Y** is the fractional radiochemical yield (when applicable)
- **$\lambda$**  is the radioactive decay constant for the particular radionuclide
- **$\Delta t$**  is the elapsed time between midpoint of sample collection and midpoint of counting time

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors will be identified and recorded on the analysis sheet for the particular sample.

- B. A batch release is the discharge of liquid wastes of a discrete volume from the tanks listed in this table. Prior to the sampling, each batch shall be isolated and at least two tank/sump volumes shall be recirculated or equivalent mixing provided. If the steam generator bulk can not be recirculated prior to batch discharge, a sample will be obtained by representative compositing during discharge.
- C. The LLD will be  $5 \times 10^{-7} \mu\text{Ci/ml}$ . The principal gamma emitters for which this LLD applies are exclusively the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141. Ce-144 shall also be measured, but with an LLD of  $5 \times 10^{-6} \mu\text{Ci/ml}$ . This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level. When unusual circumstances result in a priori LLDs higher than required, the reasons shall be documented in the Radioactive Effluent Release Report.
- D. For the Steam Generator Bulk:  
**IF** the applicable batch gamma radioactivity is not greater than  $5 \times 10^{-7} \mu\text{Ci/ml}$ , **THEN** the sampling and analysis schedule for gross alpha, Sr-89, Sr-90, Fe-55 are not required.



- E. For the Condensate Polishing Facility (CPF) waste neutralization sump:  
 IF there is no detectable tritium in the steam generators, **THEN** tritium sampling and analyses is not required.  
 IF the gross gamma radioactivity in the grab sample taken prior to release does not exceed  $5 \times 10^{-7}$   $\mu\text{Ci/ml}$ , **THEN** the sampling and analysis schedule for gross alpha, Sr-89, Sr-90 and Fe-55 are not required.
- F. For Batch Releases and Steam Generator Blowdown only, a composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released.
- G. Prior to analysis, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluents released.
- H. For the Steam Generator Blowdown:  
 IF the steam generator gross gamma radioactivity does not exceed  $5 \times 10^{-7}$   $\mu\text{Ci/ml}$ , **THEN** the sampling and analysis schedule for all principal gamma, I-131, Ce-144, noble gases, gross alpha, Sr-89, Sr-90 and Fe-55 are not required.
- Steam Generator Blowdown samples are not required when blowdown is being recovered.
- I. Daily grab samples shall be taken at least five days per week. For service water, daily grabs shall include each train that is in-service.
- J. For the Service Water:  
 IF a weekly gamma analysis does not indicate a gamma radioactivity greater than  $5 \times 10^{-7}$   $\mu\text{Ci/ml}$ , **THEN** the sampling and analysis schedule for gross alpha, Sr-89, Sr-90, Fe-55 are not required.
- K. LLD applies exclusively to the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level. When unusual circumstances result in a priori LLDs higher than required, the reasons shall be documented in the "Radioactive Effluent Release Report."
- L. For the Turbine Building Sump:  
 IF the steam generator gross gamma radioactivity does not exceed  $5 \times 10^{-7}$   $\mu\text{Ci/ml}$ , **OR** sump is directed to radwaste treatment, **THEN** the sampling and analysis schedule for all principal gamma, I-131, Ce-144, noble gases, gross alpha, Sr-89, Sr-90 and Fe-55 are not required.  
 IF the release pathway is directed to yard drains, **THEN** the LLD for I-131 shall be  $1.5 \times 10^{-7}$   $\mu\text{Ci/ml}$  and for gross alpha  $1 \times 10^{-8}$   $\mu\text{Ci/ml}$ .
- M. Detectable tritium shall be used to estimate tritium releases to the atmosphere via the blowdown tank vent.

## 2. Liquid Radioactive Waste Treatment

### a. Dose Criteria for Equipment Functionality Applicable to All Millstone Units

The following dose criteria shall be applied separately to each Millstone unit.

- 1) **IF** the radioactivity concentration criteria for the Unit 3 steam generator blowdown is exceeded with blowdown recovery not available to maintain releases to as low as reasonably achievable; or, **IF** any of the other radioactive waste processing equipment listed in Section b. are not functional, **THEN** doses due to liquid effluents from the applicable waste stream to unrestricted areas shall be projected at least once per 31 days in accordance with the methodology and parameters in Section II.C.2.
- 2) **IF** any of these dose projections exceeds 0.006 mrem to the total body or 0.02 mrem to any organ, **THEN** best efforts shall be made to return the processing equipment to service, or to limit discharges via the applicable waste stream.
- 3) **IF** an actual dose due to liquid effluents exceeds 0.06 mrem to the total body or 0.2 mrem to any organ **AND** the dose from the waste stream with processing equipment not functional exceeds 10% of one of these limits, **THEN** prepare and submit to the Commission a Special Report within 30 days as specified in Section 2.c.

### b. Required Equipment for Each Millstone Unit

Best efforts shall be made to return the applicable liquid radioactive waste treatment system equipment specified below for each unit to service or to limit discharge via the applicable waste stream if the projected doses exceed any of the doses specified above.

1. Millstone Unit No. 1	
Waste Stream	Processing Equipment
Spent Fuel Pool water	One filter and one demineralizer
2. Millstone Unit No. 2	
Waste Stream	Processing Equipment
Clean liquid	Deborating ion exchanger (T11) <b>OR</b> Purification ion exchanger (T10A or T10B) <b>OR</b> Equivalent ion exchanger
	Primary demineralizer (T22 A or B) <b>OR</b> Equivalent demineralizer
	Secondary demineralizer (T23 A or B) <b>OR</b> Equivalent demineralizer//Aerated liquid
Aerated liquid	Demineralizer (T24) <b>OR</b> Equivalent demineralizer
3. Millstone Unit No. 3	
Waste Stream	Processing Equipment or Radioactivity Concentration
High level	ALPS processing (3LWS-SKD1) <b>OR</b> Demineralizer (3LWS-DEMN2) and Demineralizer filter (3LWS-FLT3) <b>OR</b> Demineralizer (LWS-DEMN1) and Demineralizer filter (LWS-FLT1)
Boron recovery	Cesium ion exchanger (3BRS-DEMN1A or B)
	Boron evaporator (3BRS-EV1)
Low level	High level processing equipment
Steam generator blowdown	Blowdown recovery when total gamma radioactivity exceeds $5E-7$ $\mu\text{Ci/ml}$ or tritium exceeds $0.02 \mu\text{Ci/ml}$ .

NOTE: The qualifier **OR** indicates that any of the equipment listed within the block would satisfy the processing requirement if functional.



c. Report Requirement For All Three Millstone Units

If required by Section 2.a.3), prepare and submit to the Commission a Special Report within 30 days with the following content:

- Explanation of why liquid radwaste was being discharged without treatment, identification of any equipment not in service, and the reason for the equipment being out of service,
- Action(s) taken to restore the equipment to service, and
- Summary description of action(s) taken to prevent a recurrence.

Figure I.C.-1, "Reserved

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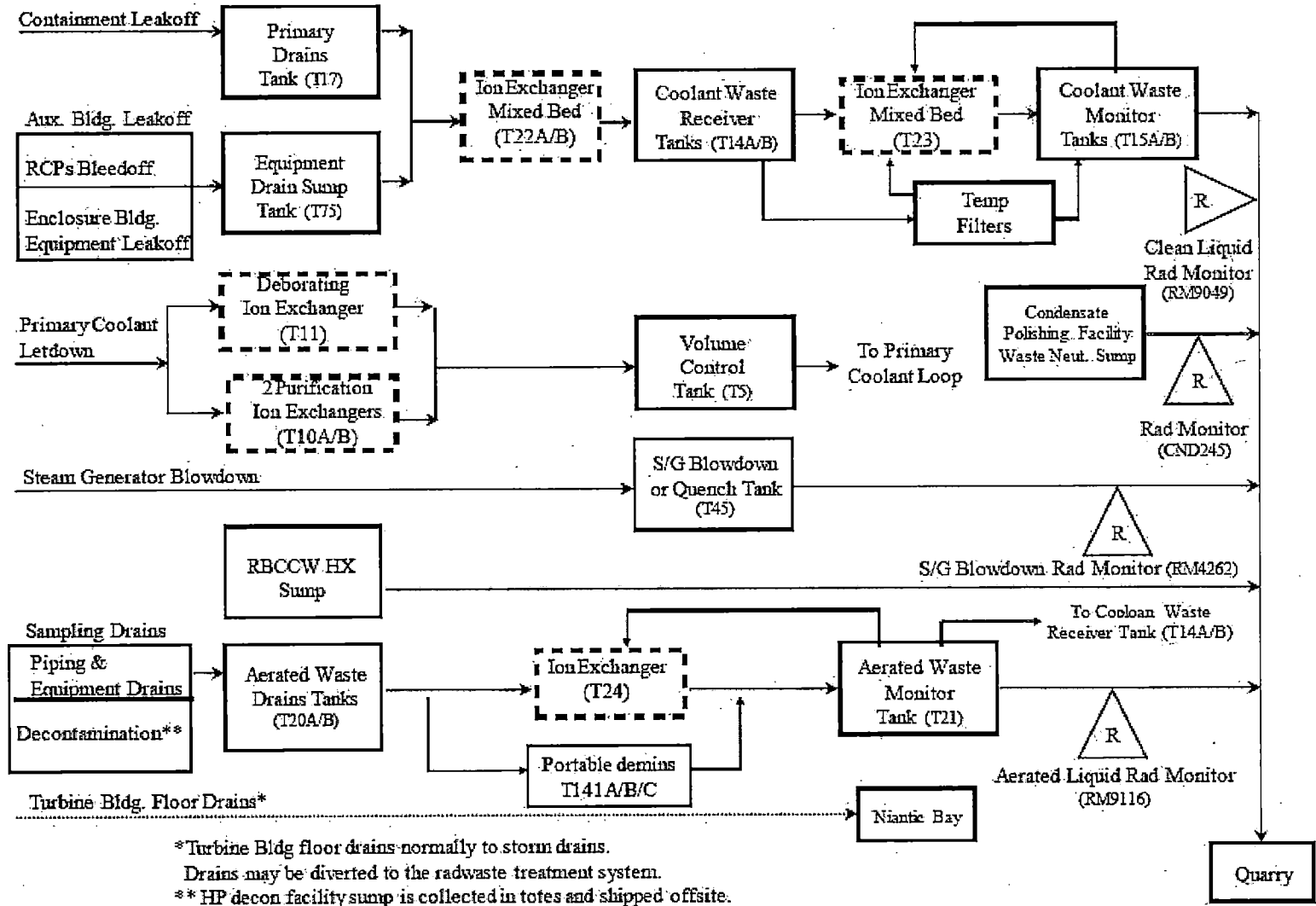



Figure I.C.-2, "Simplified Liquid Effluent Flow Diagram Millstone Unit 2"

\*Turbine Bldg floor drains normally to storm drains.  
 Drains may be diverted to the radwaste treatment system.  
 \*\* HP decon facility sump is collected in totes and shipped offsite.

 = Component included in radwaste treatment equipment requirement

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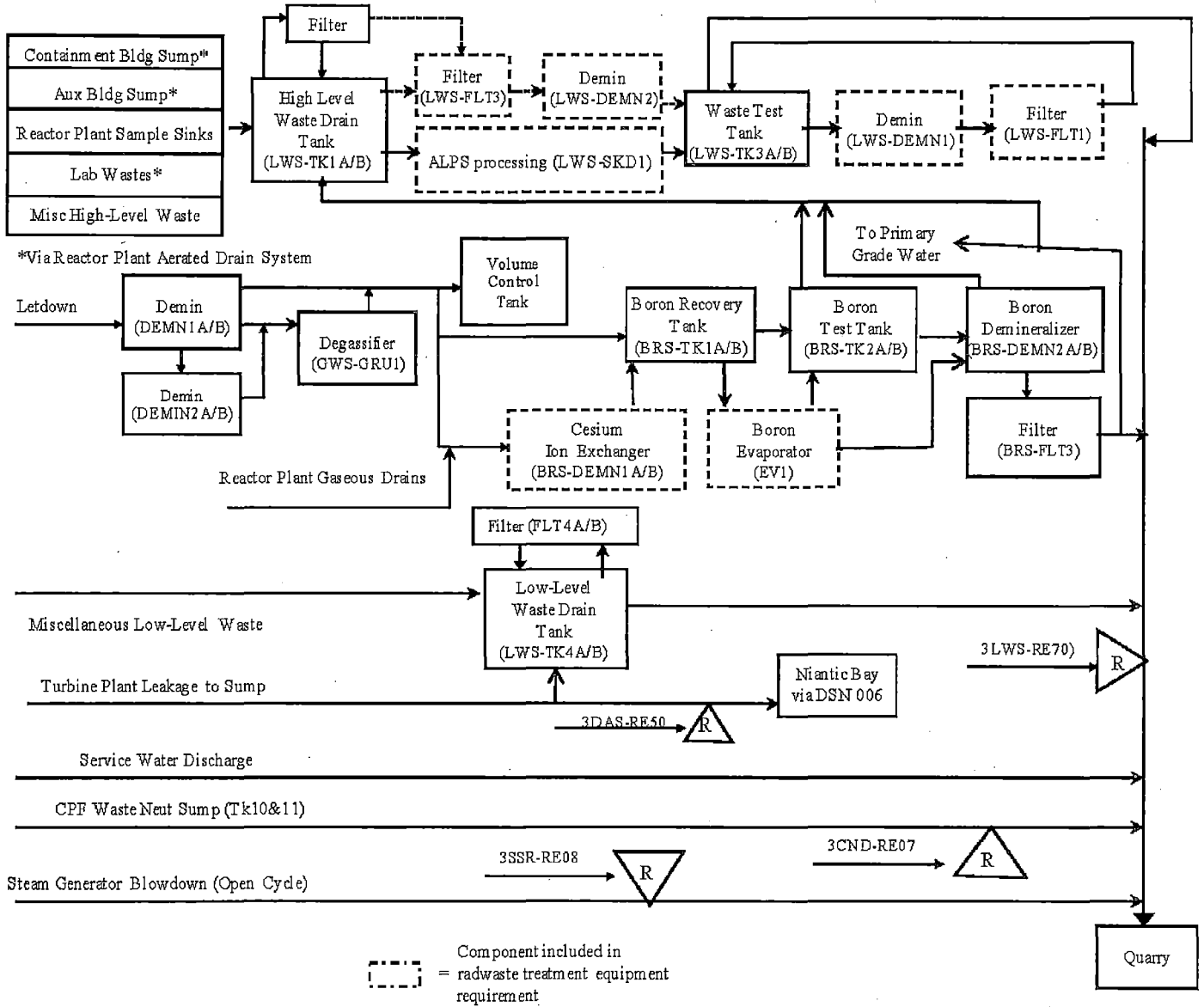


Figure I.C.-3, "Simplified Liquid Effluent Flow Diagram Millstone Unit 3"

Component included in  
= radwaste treatment equipment  
requirement

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## I.D. Gaseous Effluents

### 1. Gaseous Effluent Sampling and Analysis Program

Radioactive gaseous wastes shall be sampled and analyzed in accordance with the program specified in Table I.D.-1 for Millstone Unit No. 1, Table I.D.-2 for Millstone Unit No. 2, and Table I.D.-3 for Millstone Unit No. 3. The results of the radioactive analyses shall be input to the methodology of Section II to assure that offsite doses are maintained within the limits of Radiological Effluent Controls (Section III.D.2. for Millstone Unit No. 1, Section IV.D.2. for Millstone Unit No. 2, and Section V.D.2. for Millstone Unit No. 3).

Table I.D.-1 Millstone Unit 1 Radioactive Gaseous Waste Sampling and Analysis Program				
Gaseous Release Point or Source	Sample Type and Frequency <sup>B</sup>	Minimum Analysis Frequency	Type of Radioactivity Analysis	Lower Limit of Detection (LLD) <sup>A</sup> (μCi/ml)
A. Spent Fuel Pool Island Vent	Monthly <sup>D</sup> - Gaseous Grab Sample	Monthly	Kr-85	1 x 10 <sup>-4</sup>
			H-3	1 x 10 <sup>-6</sup>
	Continuous <sup>E</sup> Particulate Sample	Twice per month	Principal Gamma Emitters <sup>C</sup> - (with half lives greater than 8 days)	1 x 10 <sup>-11</sup>
	Continuous <sup>E</sup> Particulate Sample	Quarterly Composite	Sr-90, Gross alpha	1 x 10 <sup>-11</sup>
	Continuous <sup>E</sup> Noble Gas	Continuous Monitor	Kr-85	1 x 10 <sup>-6</sup>
B. Balance of Plant Vent	Continuous <sup>E</sup> Particulate Sample	Twice per month	Principal Gamma Emitters <sup>C</sup> - (with half lives greater than 8 days)	1 x 10 <sup>-11</sup>
		Quarterly Composite	Sr-90, Gross alpha	1 x 10 <sup>-11</sup>
	Grab sample of Reactor Bldg evaporator staging tank prior to processing	Prior to processing of each batch	H-3	1 x 10 <sup>-5</sup>

Table I.D.-1  
TABLE NOTATIONS

A. The lower limit of detection (LLD) is defined in Table Notations, Item a, of Tables I.C.-1, I.C.-2, or I.C.-3.

B. Samples not required when Release Point is not in use.

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- C. For particulate samples, the LLD will be  $1 \times 10^{-11}$   $\mu\text{Ci/cc}$ . The principal gamma emitters for which this LLD applies are exclusively the following radionuclides: Mn-54, Co-60, Zn-65, Cs-134, Cs-137, and Ce-144. The list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level for that nuclide. When unusual circumstances result in a priori LLDs higher than required, the reasons shall be documented in the Radioactive Effluent Release Report.
- D. IF there is an unexplained increase of the SFPI Vent noble gas monitor of greater than a factor of ten, OR the monitor reads  $8.8\text{E}-5$   $\mu\text{Ci/cc}$  or greater, THEN sampling and analysis shall also be performed within 24 hours.
- E. Continuous when exhaust fans are in operation.

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Table I.D.-2 Millstone Unit 2 Radioactive Gaseous Waste Sampling and Analysis Program				
Gaseous Release Point or Source	Sample Type and Frequency	Minimum Analysis Frequency	Type of Radioactivity Analysis	Lower Limit of Detection (LLD) <sub>A</sub> (μCi/ml)
A. Batch Release 1. Waste Gas Storage Tank <sup>H</sup>	Gaseous Grab Prior to each Waste Gas Tank Discharge	Each Tank Discharge	Principal Gamma Emitters <sup>B</sup>	1 x 10 <sup>-4</sup>
			H-3	1 x 10 <sup>-6</sup>
<b>B. Containment &amp; Aux Building Releases</b>				
1. Containment	Gaseous Grab of purges and vents 1. Prior to Each Purge <sup>J</sup> 2. Every two weeks for Venting <sup>I</sup>	1. Prior to Each Purge 2. Every two weeks for Venting	Principal Gamma Emitters <sup>B</sup>	1 x 10 <sup>-4</sup>
		Monthly	H-3	1 x 10 <sup>-6</sup>
2. Spent Fuel Pool	Continuous Particulate for Open Containment Equipment Hatch during Outage	Weekly	Gamma emitters for 1/2 hr count (I-131, others with half-life greater than 8 days)	NA
		Weekly	I-131 and I-133 for one hour count	NA
<b>C. Continuous Release</b>				
1. Vent (RM8132B)	Monthly - Gaseous Grab Sample <sup>C,G</sup>	Monthly <sup>C,G</sup>	Principal Gamma Emitters <sup>B</sup>	1 x 10 <sup>-4</sup>
			H-3 <sup>G</sup>	1 x 10 <sup>-6</sup>
2. Millstone Stack (RM8169-1)	Continuous Charcoal Sample <sup>D,F</sup>	Weekly	I-131 I-133	1 x 10 <sup>-12</sup> 1 x 10 <sup>-10</sup>
			Weekly	Principal Gamma Emitters <sup>B</sup> - (I-131, others with half lives greater than 8 days)
	Continuous Particulate Sample <sup>D</sup>	Quarterly Composite		Sr-89, Sr-90 - Gross alpha
	Continuous Noble Gas <sup>D</sup>	Continuous Monitor	Noble Gases - Gross Radioactivity	1 x 10 <sup>-6</sup>

TABLE I.D.-2  
TABLE NOTATIONS

A. The lower limit of detection (LLD) is defined in Table Notations, Item a, of Tables I.C.-1, I.C.-2, or I.C.-3.



- B. For gaseous samples, the LLD will be  $1 \times 10^{-4}$   $\mu\text{Ci/cc}$  and for particulate samples, the LLD will be  $1 \times 10^{-11}$   $\mu\text{Ci/cc}$ . The principal gamma emitters for which these LLDs apply are exclusively the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for gaseous emission and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, Ce-141, and Ce-144 for particulate emissions. The list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level for that nuclide. When unusual circumstances result in a priori LLDs higher than required, the reasons shall be documented in the "Radioactive Effluent Release Report."
- C. **IF** there is an unexplained increase of the Millstone Stack or Unit 2 Vent noble gas monitor of greater than 50%, **THEN** sampling and analysis for principal gamma emitters shall be performed within 72 hours. Sampling and analysis is not required if the monitor reading has returned to within 20% of the average reading prior to the increase.
- IF** the Millstone Stack or Unit 2 Vent noble gas monitor increased greater than 50% and then has decreased to within 20% of the average reading prior to collecting a sample representative of the elevated reading, **THEN** an estimate of radioactivity released during the period of elevated reading shall be made.
- D. The ratio of the sample flow rate to the sampled stream flow rate shall be known.
- E. RESERVED
- F. Samples shall be changed at least once per seven days and analyses shall be completed within 48 hours after changing.

For Unit 2 vent only

The sampling frequency shall be increased to daily following each reactor shutdown, reactor criticality after shutdown, or thermal power change exceeding 15% of rated thermal power as defined in Technical Specification within a one hour period, if one or both of the following has occurred:

- 1) The Dose Equivalent I-131 concentration in the reactor coolant has increased by more than a factor of three above the concentration that existed during steady state, full power operation prior to the power transient.
- 2) The noble gas monitor, RM8132B, has increased more than a factor of three relative to the radiation monitor reading that existed during steady state, full power operation prior to the power transient.

Analyses shall be completed within 48 hours of changing. For daily samples, the LLDs may be increased by a factor of 10.

Daily sampling shall be maintained for seven days or until such time when both conditions (1) and (2) are not satisfied, whichever is shorter.

- G. **IF** the refueling cavity is flooded, **THEN** grab samples for tritium shall be taken weekly. The grab sample shall be taken from the Millstone Stack or vent where the containment ventilation is being discharged at the time of sampling.

H. Waste Gas Storage Tanks are normally released on a batch basis via the Millstone Stack. However, for the purpose of tank maintenance, inspection, or reduction of oxygen concentration, a waste gas tank may be vented or purged with nitrogen and released to the environment via the normal or alternate pathway using one of the following methods:

Method A: Without a permit provided the following conditions are met:

- (1) The tank has been previously discharged with a permit.
- (2) The current tank pressure is less than 5 PSIG.
- (3) No radioactive gases have been added to the tank since the previous discharge from the tank.
- (4) Valve lineups are verified to ensure that no radioactive waste gases will be added to the tank.
- (5) Prior to initiation of the vent or purge, a sample of the gas in the tank will be taken and analyzed for any residual gamma emitters and tritium. The tank may be released if:
  - a) Tank radioactivity is less than 1% of the radioactivity released in the previous batch release from the tank, or less than 1% of the radioactivity released to date for the calendar year, and
  - b) the radioactivity of Kr-85 and Xe-133 is less than 0.01 Ci and the radioactivity of all other gases is less than 0.001 Ci.

Method B: With a permit provided valve lineups are verified to ensure that no radioactive waste gases will be added to the tank.

- I. **IF**, compared to the radioactivity at the time of the air sample, a Radiation Monitor RM8123 or RM8262 gas channel increases by a factor of two, **THEN** a new containment air sample shall be taken.  
**IF**, containment noble gas radioactivity exceeds  $1E-6$   $\mu\text{Ci/cc}$  as indicated by the last grab sample, **THEN** sampling frequency shall be increased to weekly until such time that the radioactivity is less than  $1E-6$   $\mu\text{Ci/cc}$ .
- J. During an outage a sample is only required prior to the initial purge.



**Table I.D.-3  
Millstone Unit 3 Radioactive Gaseous Waste Sampling and Analysis Program**

<b>Gaseous Release Point or Source</b>	<b>Sample Type and Frequency</b>	<b>Minimum Analysis Frequency</b>	<b>Type of Radioactivity Analysis</b>	<b>Lower Limit of Detection (LLD)<sup>A</sup> (<math>\mu\text{Ci/ml}</math>)</b>
<b>A. Containment and Fuel Building Release</b>				
1. Containment	Gaseous, particulate and charcoal grab prior to each drawdown (via air ejector)	Same as sample frequency.	Principal gamma emitters <sup>B</sup> .	$1 \times 10^{-4}$
2. Fuel Building	Gaseous grab prior to each purge <sup>H</sup> .	Same as sample frequency.	On charcoal sample: I-131 I-133	$1 \times 10^{-12}$ $1 \times 10^{-10}$
	Gaseous Grab every two weeks for vents (i.e., releases to maintain sub-atmospheric pressure via containment vacuum pump) <sup>I</sup> .		On particulate sample: Principal gamma emitters <sup>B</sup> - (I-131, others with half lives greater than 8 days)	$1 \times 10^{-11}$
		Monthly for purge, vents, and drawdowns	H-3	$1 \times 10^{-6}$
	Continuous particulate for open containment equipment hatch during outages.	Weekly	Gamma emitters for 1/2 hour count (I-131, others with half-life greater than 8 days)	NA
	Continuous charcoal for open containment equipment hatch during outages.	Weekly	I-131 and I-133 for one hour count	NA
<b>B. Continuous Release</b>				
1. Unit 3 Ventilation Vent (HVR-RE10B)	Monthly - Gaseous Grab Sample <sup>C, G</sup> .	Monthly <sup>C, G</sup> .	Principal gamma emitters <sup>B</sup>	$1 \times 10^{-4}$
			H-3 <sup>G</sup>	$1 \times 10^{-6}$
2. Engineered Safeguards Building (HVQ-RE49)	Continuous charcoal sample <sup>D, F</sup>	Weekly	I-131 I-133	$1 \times 10^{-12}$ $1 \times 10^{-10}$
	Continuous particulate sample <sup>D, F</sup>	Weekly	Principal gamma emitters <sup>B</sup> - (I-131, others with half lives greater than 8 days)	$1 \times 10^{-11}$
3. Millstone Stack via SLCRS (HVR-RE19B)	Continuous particulate sample <sup>D</sup> .	Quarterly composite	Sr-89, Sr-90 Gross alpha	$1 \times 10^{-11}$ $1 \times 10^{-11}$
	Continuous noble gas <sup>D</sup> .	Continuous monitor	Noble gases - gross radioactivity	$1 \times 10^{-6}$

**TABLE I.D.-3  
TABLE NOTATIONS**

A. The lower limit of detection (LLD) is defined in Table Notations, Item a, of Tables I.C.-1, I.C.-2, or I.C.-3.

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B. For gaseous samples, the LLD will be  $1 \times 10^{-4}$   $\mu\text{Ci}/\text{cc}$  and for particulate samples, the LLD will be  $1 \times 10^{-11}$   $\mu\text{Ci}/\text{cc}$ . The principal gamma emitters for which these LLDs apply are exclusively the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for gaseous emission and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, Ce-141, and Ce-144 for particulate emissions. The list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level for that nuclide. When unusual circumstances result in a priori LLDs higher than required, the reasons shall be documented in the Radioactive Effluent Release Report.

C. **IF** there is an unexplained increase of the Unit 3 ventilation vent or SLCRS noble gas monitor of greater than 50%, **THEN** sampling and analysis for principal gamma emitters shall be performed within 72 hours. Sampling and analysis is not required if the monitor reading has returned to within 20% of the average reading prior to the increase.

**IF** the SLCRS or Unit 3 Vent noble gas monitor increased greater than 50% and then has decreased to within 20% of the reading prior to collecting a sample representative of the elevated reading, **THEN** an estimate of radioactivity released during the period of elevated reading shall be made.

D. The ratio of the sample flow rate to the sampled stream flow rate shall be known.

E. RESERVED

F. Samples shall be changed at least once per seven days and analyses shall be completed within 48 hours after changing.

For Unit 3 Vent only:

The sampling frequency shall be increased to daily following each reactor shutdown, reactor criticality after shutdown, or thermal power change exceeding 15% of rated thermal power as defined in Technical Specification within a one hour period, if one or both of the following has occurred:

- 3) The Dose Equivalent I-131 concentration in the reactor coolant has increased by more than a factor of three above the concentration that existed during steady state, full power operation prior to the power transient.
- 4) The noble gas monitor, HVR-RE10B, has increased more than a factor of three relative to the radiation monitor reading that existed during steady state, full power operation prior to the power transient.

Analyses shall be completed within 48 hours of changing. For daily samples, the LLDs may be increased by a factor of 10.

Daily sampling shall be maintained for seven days or until such time when both conditions (1) and (2) are not satisfied, whichever is shorter.

G. **IF** the refueling cavity is flooded, **THEN** grab samples for tritium shall be taken weekly from the ventilation vent.

H. During an outage a sample is only required prior to the initial purge.



1. **IF** compared to the radioactivity at the time of the air sample, Radiation Monitor CMS22 gas channel increases by a factor of two, **THEN** a new containment air sample shall be taken.

**IF** containment noble gas radioactivity exceeds  $1E-6 \mu\text{Ci/cc}$  as indicated by the last grab sample, **THEN** sampling frequency shall be increased to weekly until such time that the radioactivity is less than  $1E-6 \mu\text{Ci/cc}$ .

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2. Gaseous Radioactive Waste Treatment

a. Dose Criteria for Equipment Functionality Applicable to All Millstone Units

The following dose criteria shall be applied separately to each Millstone unit.

- 1) **IF** any of the radioactive waste processing equipment listed in Section 2.b. are not functional or are being bypassed, **THEN** doses due to gaseous effluents from the untreated waste stream to unrestricted areas shall be projected at least once per 31 days in accordance with the methodology and parameters in Section II.D.4. For each waste stream, only those doses specified in Section II.D.4. need to be determined for compliance with this section.
- 2) **IF** any of these dose projections exceed 0.02 mrad for gamma radiation, 0.04 mrad for beta radiation or 0.03 mrem to any organ due to gaseous effluents, **THEN** best efforts shall be made to return the processing equipment to service.
- 3) **IF** actual doses exceed 0.2 mrad for gamma radiation, 0.4 mrad for beta radiation or 0.3 mrem to any organ **AND** the dose from a waste stream with equipment not functional exceed 10% any of these limits, **THEN** prepare and submit to the Commission a report as specified in Section I.D.2.c.

b. Required Equipment for Each Millstone Unit

Best efforts shall be made to return the gaseous radioactive waste treatment system equipment specified below for each unit to service if the projected doses exceed any of doses specified above. For the Unit 2 gas decay tanks, the tanks shall be operated to allow enough decay time of radioactive gases to ensure that the Radiological Effluent Control dose limits are not exceeded.

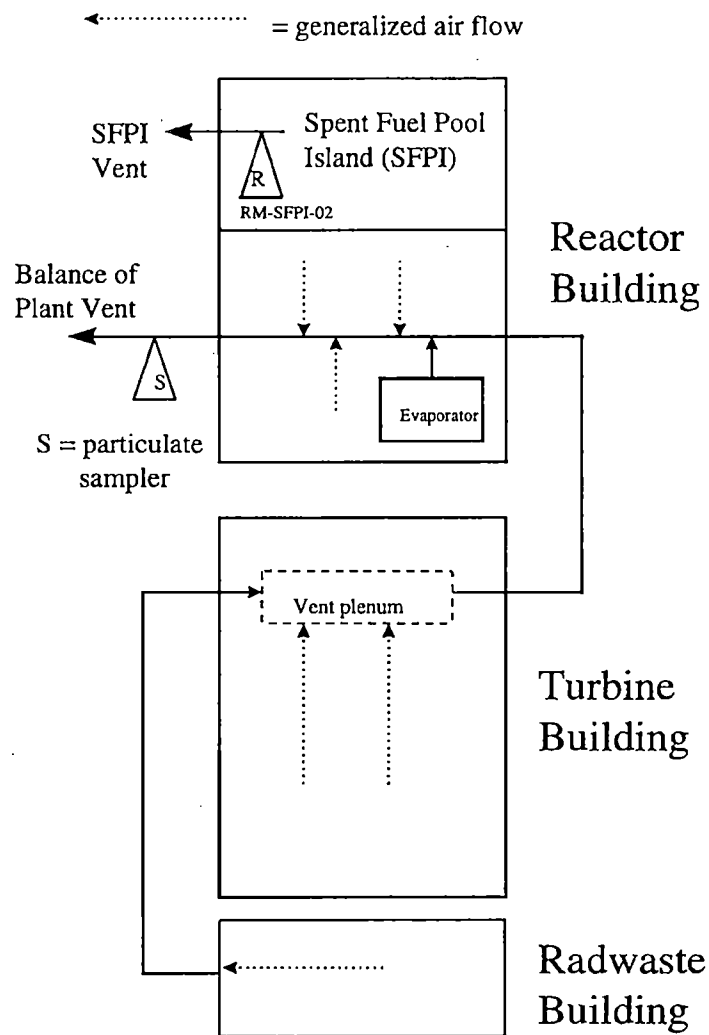
1. Millstone Unit No. 1	
<b>Waste Stream</b>	<b>Processing Equipment</b>
None Specified	None required
2. Millstone Unit No. 2	
<b>Waste Stream</b>	<b>Processing Equipment</b>
Gaseous Radwaste Treatment System	Five (5) gas decay tanks
	One waste gas compressor
Ventilation Exhaust Treatment System	Auxiliary building ventilation HEPA filter (L26 or L27)
	Containment purge HEPA filter (L25)
	Containment vent HEPA/charcoal filter (L29 A or B)
3. Millstone Unit No. 3	
<b>Waste Stream</b>	<b>Processing Equipment or Radioactivity Concentration</b>
Gaseous Radwaste Treatment System	Charcoal bed adsorbers
	One HEPA filter

c. Report Requirement For All Three Millstone Units

If required by Section I.D.2.a.3), prepare and submit to the Commission a Special Report within 30 days with the following content:

- Explanation of why gaseous radwaste was being discharged without treatment, identification of any equipment out of service, and the reason for being out of service,
- Actions taken to restore the nonfunctional equipment to service, and
- Summary description of actions taken to prevent a recurrence.

Figure I.D.-1, "Simplified Gaseous Effluent Flow Diagram Millstone Unit One"



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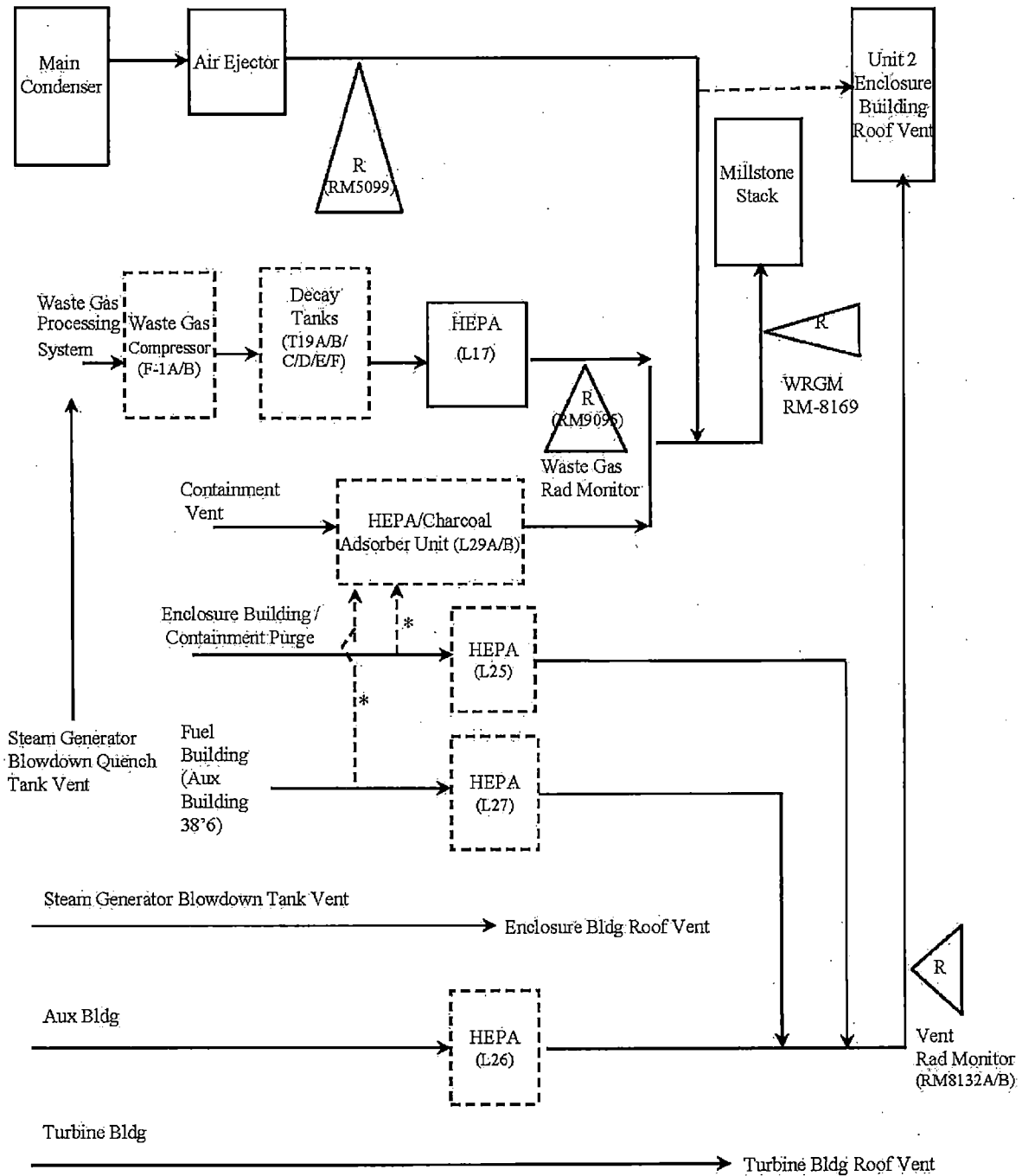
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Figure I.D.-2, "Simplified Gaseous Effluent Flow Diagram Millstone Unit Two"



\* These flow paths used during an accident.



= Component included in treatment equipment requirement

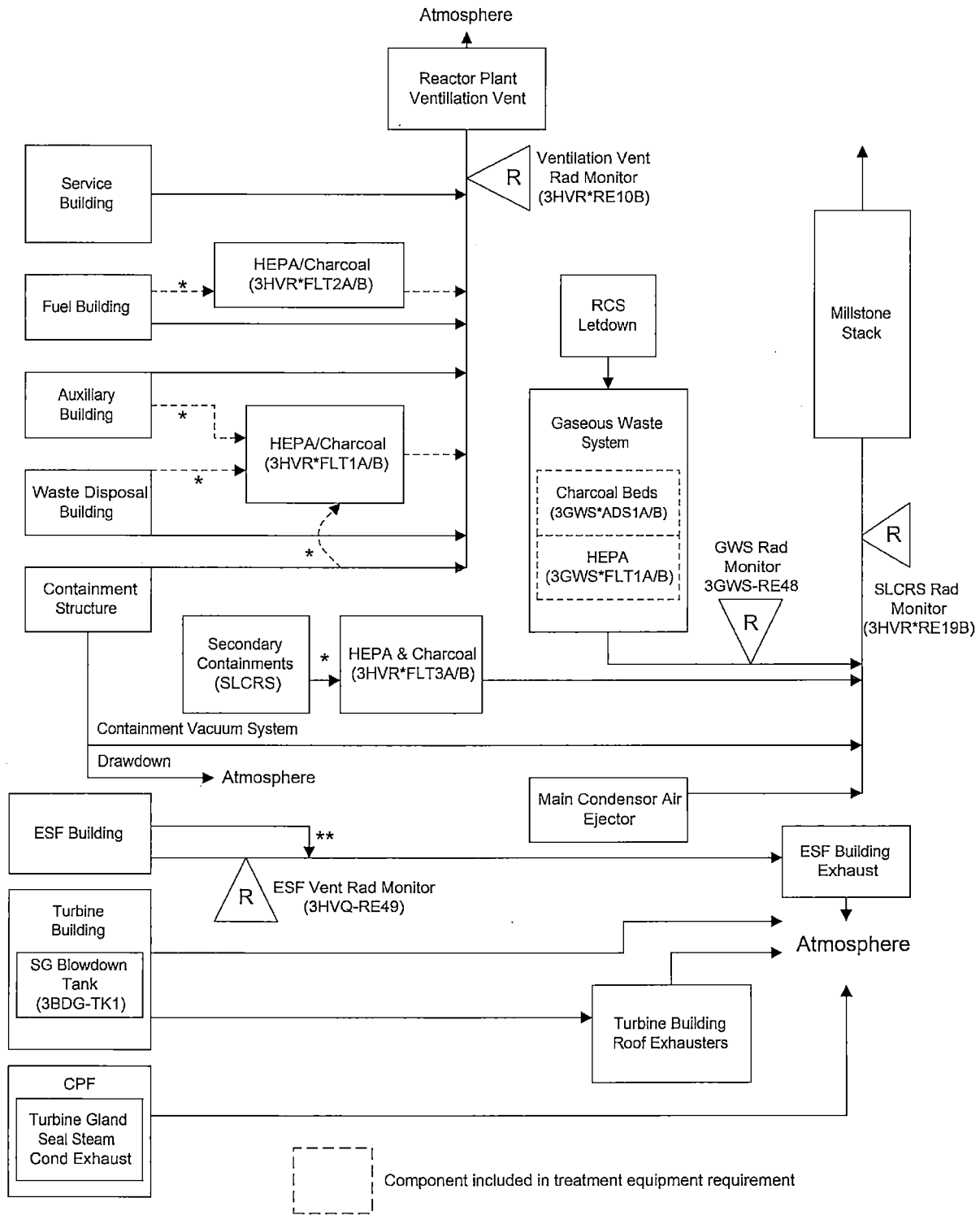
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Figure I.D.-3, "Simplified Gaseous Effluent Flow Diagram Millstone Unit Three"



\* These flow paths used during an accident

\*\* Releases from Mechanical Rooms A-D not monitored

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## I.E. Radiological Environmental Monitoring

### 1. Sampling and Analysis

The radiological sampling and analyses provide measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides which lead to the highest potential radiation exposures of individuals resulting from plant operation. This monitoring program thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways. Program changes may be made based on operational experience.

The sampling and analyses shall be conducted as specified in Table I.E.-1 for the locations shown Table I.E.-2. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment or other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, every effort shall be made to complete corrective action prior to the end of the next sampling period.

All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report pursuant to Section I.F.1. It is recognized that, at times, it may not be possible or practicable to obtain samples of the media of choice at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the radiological environmental monitoring program. Any of the above occurrences shall be documented in the Annual Radiological Environmental Operating Report, which is submitted to the U. S. Nuclear Regulatory Commission prior to May 1 of each year.

If the level of radioactivity in an environmental sampling medium at one or more of the locations specified in Table I.E.-2 exceeds the report levels of Table I.E.-3 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days from receipt of sample results, a Special Report which includes an evaluation of any release conditions, environmental factors or other aspects which caused the limits of Table I.E.-3 to be exceeded. When more than one of the radionuclides in Table I.E.-3 are detected in the sampling medium, this report shall be submitted if:

$$\frac{\text{concentration (1)}}{\text{reporting level (1)}} + \frac{\text{concentration (2)}}{\text{reporting level (2)}} + \dots \geq 1.0$$

When radionuclides other than those in Table I.E.-3 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose to an individual is equal to or greater than the appropriate calendar year limit of the Radiological Effluent Controls (Sections III.D.1.b., III.D.2.b., or III.D.2.c. for Unit 1; Sections IV.D.1.b., IV.D.2.b., or IV.D.2.c. for Unit 2; and Sections V.D.1.b., V.D.2.b., or V.D.2.c. for Unit 3). This report is not required if the measured level of radioactivity was not the result of plant effluents, however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report.

The detection capabilities required by Table I.E.-4 are state-of-the-art for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement. All analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors will be identified and described in the Annual Radiological Environmental Operating Report.



**Table I.E. – 1  
Millstone Radiological Environmental Monitoring Program**

<b>Exposure Pathway and/or Sample</b>	<b>No. of Locations</b>	<b>Sampling and Collection Frequency</b>	<b>Type and Frequency of Analysis</b>
1. Gamma Dose – Environmental TLD	39 <sup>(a)</sup>	Quarterly	Gamma Dose – Quarterly
2. Airborne Particulate	8	Continuous sampler – filter change every two weeks	Gross Beta – Every two weeks Gamma Spectrum – Quarterly on composite (by location), and on individual sample if gross beta is greater than 10x the mean of the control station's gross beta results
3. Airborne Iodine	8	Continuous sampler – canister change every two weeks	I-131 – Every two weeks
4. Vegetation	5	One sample near middle and one near end of growing season	Gamma Isotopic on each sample
5. Reserved			
6. Sea Water	2	Continuous sampler with a monthly collection at indicator location. Quarterly at control location – Composite of 6 weekly grab samples	Gamma Isotopic & Tritium on each sample
7. Well Water	6	Semiannual	Gamma Isotopic & Tritium on each sample
8. Bottom Sediment	5	Semiannual	Gamma Isotopic on each sample
9. Soil	3	Annually	Gamma Isotopic on each sample
10. Fin Fish-(edible portion)	2	Semi-annual	Gamma Isotopic on each sample
11. Aquatic flora	4	Quarterly	Gamma Isotopic on each sample
13. Clams (edible portion)	2	Semi-annual	Gamma Isotopic on each sample
14. Lobsters (edible portion)	2	Semi-annual	Gamma Isotopic on each sample

(a) Two or more TLDs or TLD with two or more elements per location.

(b) Not required during 1<sup>st</sup> quarter.

**Table I.E.-2  
Environmental Monitoring Program Sampling Locations**

The following lists the environmental sampling locations and the types of samples obtained at each location. Sampling locations are also shown on Figures I.E.-1 and I.E.-2:

Location		Direction & Distance from Release Point**	Sample Types
No*	Name		
1-I	Onsite - NAP Parking Lot North	0.6 Mi, NNW	TLD, Air Particulate, Iodine, Vegetation
2-I	Onsite - Weather Shack	0.3 Mi, S	TLD, Air Particulate, Iodine
3-I	Onsite - Bird Sanctuary	0.3 Mi, NE	TLD, Air Particulate, Iodine, Soil
4-I	Onsite - Albacore Drive	1.0 Mi, N	TLD, Air Particulate, Iodine, Soil
5-I	Onsite - Quarry East	0.1 Mi, SSE	TLD
6-I	Onsite - Quarry Discharge	0.3 Mi, SSE	TLD
7-I	Onsite - Environmental Lab Dock	0.3 Mi, SE	TLD
8-I	Onsite - Environmental Lab	0.3 Mi, SE	TLD
9-I	Onsite - Bay Point Beach	0.4 Mi, W	TLD
10-I	Waterford - Goshen Fire Dept.	1.2 Mi, E	TLD, Air Particulate, Iodine, Vegetation
11-I	Great Neck Country Club	1.6 Mi, ENE	TLD, Air Particulate, Iodine
13-C	Mystic, CT	11.5 Mi, ENE	TLD
14-C	Ledyard, CT	12.0 Mi, NE	TLD, Soil
15-C	Norwich, CT	14.0 Mi, N	TLD, Air Particulate, Iodine
16-C	Old Lyme, Halls Rd.	8.8 Mi, W	TLD
17-I	Site Boundary	0.5 Mi, NE	Vegetation
25-I	Fruits & Vegetables	Within 10 Miles	Vegetation
26-C	Fruits & Vegetables	Beyond 10 Mi	Vegetation
27-I	East Lyme - Police Station	1.7 Mi, WNW	TLD, Air Particulate, Iodine
28-I	Two Tree Island	0.8 Mi, SSE	Fish <sup>1</sup>
29-I	West Jordan Cove	≤0.5 Mi, ENE to ESE	Clams, Fish <sup>1</sup> , Aquatic Flora
31-I	Niantic Shoals	1.8 Mi, NW	Bottom Sediment, Clams
32-I	Vicinity of Discharge <sup>2</sup>		Bottom Sediment, Fish <sup>1</sup> , Seawater, Aquatic Flora
33-I	Seaside Point	1.8 Mi, ESE	Bottom Sediment
34-I	Thames River Yacht Club	4.0 Mi, ENE	Bottom Sediment
35-I	Niantic Bay	≤0.5 Mi, SSW to W	Lobster, Fish, Aquatic Flora
36-C	Black Point	2.7 Mi, SW	Aquatic Flora
37-C	Giant's Neck	3.5 Mi, WSW	Bottom Sediment, Seawater
41-I	Waterford - Myrock Avenue	3.2 Mi, ENE	TLD
42-I	East Lyme - Billow Road	2.4 Mi, WSW	TLD



**Table I.E.-2, Cont.**

Location		Direction & Distance from Release Point**	Sample Types
No*	Name		
43-I	East Lyme - Old Black Point Rd.	2.6 Mi, SW	TLD
44-I	Onsite - Schoolhouse	0.1 Mi, NNE	TLD
45-I	Onsite Access Road #1	0.5 Mi, NNW	TLD
46-I	Old Lyme - Hillcrest Rd.	4.6 Mi, WSW	TLD
47-I	East Lyme - W. Main St.	4.5 Mi, W	TLD
48-I	East Lyme - Corey & Roxbury Rd.	3.4 Mi, WNW	TLD
49-I	East Lyme - Society Rd.	3.6 Mi, NW	TLD
50-I	East Lyme - Manwaring Rd & Terrace Ave.	2.1 Mi, W	TLD
51-I	East Lyme - Smith Ave.	1.5 Mi, NW	TLD
52-I	Waterford - River Rd.	1.1 Mi, NNW	TLD
53-I	Waterford - Gardiners Wood Rd.	1.4 Mi, NNE	TLD
55-I	Waterford - Magonk Point	1.8 Mi, ESE	TLD
56-I	New London - Ocean & Mott Ave.	3.7 Mi, E	TLD
57-I	New London - Ocean Ave.	3.6 Mi, ENE	TLD
59-I	Waterford - Miner Ave.	3.4 Mi, NNE	TLD
60-I	Waterford - Parkway South & Cross Rd.	4.0 Mi, N	TLD
61-I	Waterford - Oil Mill & Boston Post Rd.	4.3 Mi, NNW	TLD
62-I	East Lyme - Columbus Ave.	1.9 Mi, WNW	TLD
63-I	Waterford - Gradiners Wood & Jordon Cove Rd.	0.8 Mi, NE	TLD
64-I	Waterford - Shore Rd.	1.1 Mi, ENE	TLD
65-I	Waterford - Boston Post Rd.	3.2 Mi, NE	TLD
71-I	Onsite well	Onsite	Well water
72-I	Onsite well	Onsite	Well water
79-I	Onsite well	Onsite	Well water
80-I	Onsite well	Onsite	Well water
81-I	Onsite well	Onsite	Well water
82-I	Onsite well	Onsite	Well water
89-C	Aquatic Background	Beyond 4 Mi. Of discharge	Lobster

<sup>1</sup> Fish to be sampled from one of three locations -28, 29, or 32.

<sup>2</sup> Vicinity of discharge includes the Quarry and shoreline area from Fox Island to western point of Red Barn Recreation Area and offshore out to 500 feet.

\* I = Indicator; C = Control.

\*\* = The release points are the Millstone Stack for terrestrial locations and the end of the quarry for aquatic location.

NOTE: Environmental TLDs also function as accident TLDs in support of the Millstone Emergency Plan.

Figure I.E.-1, "Inner TLD, Air, Grass, Soil, and Aquatic Locations"

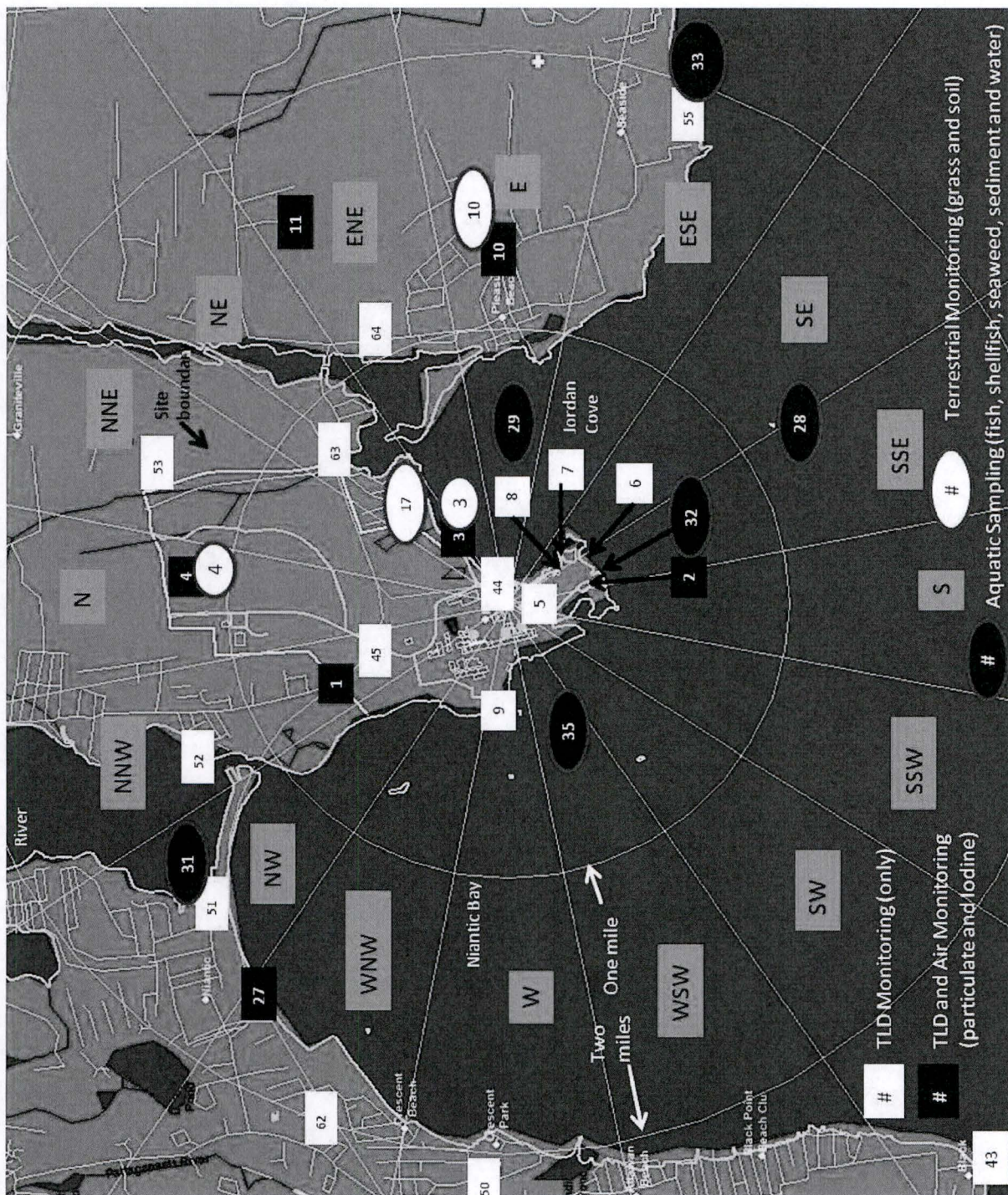


Figure I.E.-2, "Outer TLD and Aquatic Locations"



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**Table I.E.-3  
Reporting Levels For Radioactivity Concentrations In Environmental Samples**

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m <sup>3</sup> )	Fish (pCi/g, wet)	Shellfish <sup>C.</sup> (pCi/g, wet)	Milk (pCi/l)	Vegetables (pCi/g, wet)
H-3	20,000 <sup>A.</sup>					
Mn-54	1,000		30	140		
Fe-59	400		10	60		
Co-58	1,000		30	130		
Co-60	300		10	50		
Zn-65	300		20	80		
Zr-95	400					
Nb-95	400					
Ag-110m			8	30		
I-131	20 <sup>B.</sup>	0.9	0.2	1	3	0.1
Cs-134	30	10	1	5	60	1
Cs-137	50	20	2	8	70	2
Ba-140	200				300	
La-140	200				300	

- A. 20,000 pCi/l for drinking water samples. (This is 40 CFR Part 141 value.) For non-drinking water pathways, a value of 30,000 pCi/l may be used.
- B. Reporting level for I-131 applies to non-drinking water pathways (i.e., seawater). If drinking water pathways are sampled, a value of 2 pCi/l is used.
- C. For on-site samples, these values can be multiplied by 3 to account for the near field dilution factor

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**Table I.E. -4**  
**Maximum Values For Lower Limits Of Detection (LLD)<sup>A</sup>**

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m <sup>3</sup> )	Fish Shellfish (pCi/g, wet)	Milk (pCi/l)	Food Products (pCi/g, wet)	Sediment (pCi/g, dry)
gross beta		1 x 10 <sup>-2</sup>				
H-3	2000 <sup>D</sup> .					
Mn-54	15		0.130			
Fe-59	30		0.260			
Co-58, 60	15		0.130			
Zn-65	30		0.260			
Zr-95	30					
Nb-95	15					
I-131	15 <sup>C</sup> .	7 x 10 <sup>-2</sup>		1	0.06 <sup>B</sup> .	
Cs-134	15	5 x 10 <sup>-2</sup>	0.130	15	0.060	0.150
Cs-137	18	6 x 10 <sup>-2</sup>	0.150	18	0.080	0.180
Ba-140	60 <sup>C</sup> .			70		
La-140	15 <sup>C</sup> .			25		

**TABLE NOTATIONS**  
**Table I.E. -4**

A. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66 S_b}{(E)(V)(2.22)(Ye^{-\lambda t})}$$

Where:

- **LLD** is the lower limit of detection as defined above (as pCi per unit mass or volume)
- **S<sub>b</sub>** is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)
- **E** is the counting efficiency (as counts per transformation)
- **V** is the sample size (in units of mass or volume)
- **2.22** is the number of transformations per minute per pCi
- **Y** is the fractional radiochemical yield (when applicable)

- $\lambda$  is the radioactive decay constant for the particular radionuclide
- $\Delta t$  is the elapsed time between midpoint of sample collection and midpoint of counting time (or end of the sample collection period) and time of counting.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors will be identified in the Annual Radiological Environmental Operating Report.

- B. LLD for leafy vegetables.
- C. From end of sample period.
- D. If no drinking water pathway exists (i.e., seawater), a value of 3,000 pCi/l may be used.



## 2. Land Use Census

A land use census shall be conducted annually during the growing season to identify; (1) changes in the use of unrestricted areas, (2) receptor locations, and (3) new exposure pathways to permit modifications in monitoring programs for evaluating doses to individuals from principal pathways of exposure. The land use census shall identify the location of the nearest resident, nearest garden, and any other land-based food sources in each of the meteorological land sectors within a distance of five miles. Sectors SE, SSE, S, and SSW, are not land sectors because they are over water.

When a land use census identifies a food source location other than the nearest garden in a sector which yields a calculated dose greater than the dose currently being calculated in the off-site dose models, make the appropriate changes in the sample location used.

For each type of food source (milk, fruits, etc.) other than the nearest garden in a sector, when a land use census identifies a location which has a D/Q 20% or greater than the D/Q for a current indicator location begin sampling from the new location within 30 days.

Sample location changes for food sources other than nearest garden shall be noted in the Annual Radiological Environmental Operating Report.

## 3. Interlaboratory Comparison Program

The Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of a quality assurance program for environmental monitoring in order to demonstrate that the results are reasonably valid.

Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program. A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report.

With analyses not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report.

## I.F. Report Content

### 1. Annual Radiological Environmental Operating Report

The Annual Radiological Environmental Operating Report shall include summaries, interpretations, and statistical evaluation of the results of the radiological environmental surveillance activities for the report period, including a comparison with previous environmental surveillance reports and an assessment of radioactivity from plant operation in the environment. Any radioactivity from plant operation detected in the environment shall be compared to levels of radioactivity expected based on the effluent monitoring program and modelling of environment exposure pathways for the purpose of verifying the accuracy of the program and modelling. If levels of radioactivity are detected that result in calculated doses greater than 10CFR50 Appendix I Guidelines, the report shall provide an analysis of the cause and a planned course of action to alleviate the cause.

The report shall include a summary table of all radiological environmental samples which shall include the following information for each pathway sampled and each type of analysis:

- 1) Total number of analyses performed at indicator locations.
- 2) Total number of analyses performed at control locations.
- 3) Lower limit of detection (LLD).
- 4) Mean and range of all indicator locations together.
- 5) Mean and range of all control locations together.
- 6) Name, distance and direction from discharge, mean and range for the location with the highest annual mean (indicator or control).
- 7) Number of non-routine reported measurements as defined in these specifications.

In the event that some results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted in the next annual report.

The report shall also include a map of sampling locations keyed to a table giving distances and directions from the discharge; the report shall also include a summary of the Interlaboratory Comparison Data required by Section I.E.3. of this manual.

The report shall include the results of the land use census required by Section I.E.2. of this manual.

## 2. Radioactive Effluent Release Report

The Radioactive Effluent Release Report (RERR) shall include quarterly quantities of and an annual summary of radioactive liquid and gaseous effluents released from the unit in the Regulatory Guide 1.21 (Rev. 1, June 1974) format. Radiation dose assessments for these effluents shall be provided in accordance with 10 CFR 50.36a and the Radiological Effluent Controls. An annual assessment of the radiation doses from the site to the most likely exposed REAL MEMBER OF THE PUBLIC shall be included to demonstrate conformance with 40 CFR 190. Gaseous pathway doses shall use meteorological conditions concurrent with the quarter of radioactive gaseous effluent releases. Doses shall be calculated in accordance with the Offsite Dose Calculation Manual. The licensee shall maintain an annual summary of the hourly meteorological data (i.e., wind speed, wind direction and atmospheric stability) either in the form of a listing or in the form of a joint frequency distribution. The licensee has the option of submitting this annual meteorological summary with the RERR or retaining it and providing it to the NRC upon request. The RERR shall be submitted prior to May 1 of each year for the period covering the previous calendar year.

The RERR shall include a summary of each type of solid radioactive waste shipped offsite for burial or final disposal during the report period and shall include the following information for each type:

- type of waste (e.g., spent resin, compacted dry waste, irradiated components, etc.)
- solidification agent (e.g., cement)
- total curies
- total volume and typical container volumes
- principal radionuclides (those greater than 10% of total radioactivity)
- types of containers used (e.g., LSA, Type A, etc.)

The RERR shall include a list of all abnormal releases of radioactive gaseous and liquid effluents (i.e., all unplanned or uncontrolled radioactivity releases, including reportable quantities) from the site to unrestricted areas. Refer To MP-22-REC-REF03, "REMODOCM Technical Information Document (TID)," for guidance on classifying releases as normal or

abnormal. The following information shall be included for each abnormal release:

- total number of and curie content of releases (liquid and gas)
- a description of the event and equipment involved
- cause(s) for the abnormal release
- actions taken to prevent recurrence
- consequences of the abnormal release

Changes to the MP-22-REC-BAP01, "Radiological Effluent Monitoring And Offsite Dose Calculation Manual (REMODOCM)," shall be submitted to the NRC as appropriate, as a part of or concurrent with the RERR for the period in which the changes were made.

## SECTION II.

# Offsite Dose Calculation Manual (ODCM)

For the  
Millstone Nuclear Power Station  
Nos. 1, 2, & 3

Docket Nos. 50-245, 50-336, 50-423

## SECTION II. OFFSITE DOSE CALCULATION MANUAL (ODCM)

### II.A. Introduction

The purpose of the Offsite Dose Calculation Manual (Section II of the REMODCM) is to provide the parameters and methods to be used in calculating offsite doses and effluent monitor setpoints at the Millstone Nuclear Power Station. Included are methods for determining maximum individual whole body and organ doses due to liquid and gaseous effluents to assure compliance with the regulatory dose limitations in 10 CFR 50, Appendix I. Also included are methods for performing dose projections to assure compliance with the liquid and gaseous treatment system functionality sections of the Radiological Effluent Monitoring Manual (REMM – Section I of the REMODCM). The manual also includes the methods used for determining quarterly and annual doses for inclusion in the Radioactive Effluent Release Report.

The bases for selected site-specific factors used in the dose calculation methodology are provided in MP-22-REC-REF03, "REMODCM Technical Information."

Another section of this manual discusses the methods to be used in determining effluent monitor alarm/trip setpoints to be used to ensure compliance with the instantaneous release rate limits in Sections III.D.2.a., IV.D.2.a., and V.D.2.a.

This manual includes the methods to be used in performance of the surveillance requirements in the Radiological Effluent Controls of Sections III, IV, and V. Appendix A, Tables App.A-1 provide a cross-reference of effluent requirements and applicable methodologies contained in the REMODCM.

Most of the calculations in this manual have several methods given for the calculation of the same parameter. These methods are arranged in order of simplicity and conservatism, Method 1 being the easiest and most conservative. As long as releases remain low, one should be able to use Method 1 as a simple estimate of the dose. If release calculations approach the limit, however, more detailed yet less conservative calculations may be used. At any time a more detailed calculation may be used in lieu of a simple calculation.

This manual is written common to all three units since some release pathways are shared and there are also site release limits involved. These facts make it impossible to completely separate the three units.

### II.B. Responsibilities

All changes to the Offsite Dose Calculation Manual (ODCM) shall be reviewed and approved by the Facilities Safety Review Committee prior to implementation.

All changes and their rationale shall be documented in the Radioactive Effluent Release Report.

It shall be the responsibility of the Site Vice President Millstone to ensure that this manual is used as required by the administrative controls of the Technical Specifications. The delegation of implementation responsibilities is delineated in the MP-22-REC-PRG, "Radiological Effluent Control."

## II.C. Liquid Dose Calculations

Radiological Effluent Controls (Sections III, IV, and V) limit whole body and maximum organ doses to an individual member of the public to 1.5 mrem whole body and 5 mrem maximum organ per calendar quarter and 3 mrem whole body and 10 mrem maximum organ per year from liquid effluents released from each unit. (See Appendix A, Table App.A-1 for cross-reference effluent control requirements and applicable sections in the REMODCM which are used to determine compliance). In addition, installed portions of liquid radwaste treatment system are required to be operated to reduce radioactive materials in liquid effluents when the projected dose over 31 days from applicable waste streams exceeds 0.006 mrem whole body or 0.02 mrem maximum organ. This part of the REMODCM provides the calculation methodology for determining the doses from radioactive materials released into liquid pathways of exposure associated with routine discharges.

### 1. Monthly, Quarterly, and Annual Dose Calculation (Applicable to All Units)

For each Unit, whole body and maximum organ doses from liquid effluents shall be calculated at least once per 31 days (or monthly) using the methodology of Regulatory Guide 1.109, Rev. 1. The calculation shall include contributions from all analyses required by Table I.C-1 for Unit 1, Table I.C-2 for Unit 2, and Table I.C-3 for Unit 3 recorded to date. If any required analyses have not yet been completed for the dose period, an estimate of dose from unanalyzed isotopes shall be included in the dose total. Results of these dose calculations shall be summed to determine compliance with quarterly and annual dose limits for each Unit.

### 2. Monthly Dose Projections

Section I.C.2.a. of the REMM requires that certain portions of the liquid radwaste treatment equipment be used to reduce radioactive liquid effluents when the projected doses for each Unit (made at least once per 31 days) exceeds 0.006 mrem whole body or 0.02 mrem to any organ. The following methods are applied in the estimation of monthly dose projections:

- a. Whole Body and Maximum Organ when Steam Generator Total Gamma Radioactivity is less than  $5E-7$   $\mu\text{Ci/ml}$  and Steam Generator Tritium is less than  $0.02$   $\mu\text{Ci/ml}$  (Applicable to Units 2 and 3)

The projected monthly whole body dose (Units 2 or 3) is determined from:

$$D_{MW}^E = D_{MW} [R_1 R_4 F_2]$$

The monthly projected maximum organ dose (Units 2 or 3) is determined from:

$$D_{MO}^E = D_{MO} [R_1 R_4 F_2]$$

Where:

$D_{MW}$  = the whole body dose from the last typical previously completed month as calculated per the methods in Section II.C.1.

$D_{MO}$  = the maximum organ dose from the last typical previously completed month as calculated per the methods in Section II.C.1.

$R_1$  = the ratio of the total estimated volume of liquid batches to be released in the present month to the volume released in the past month.

$R_4$  = the ratio of estimated primary coolant radioactivity for the present month to that for the past month.

$F_2$  = the factor to be applied to the estimated ratio of final curies released if there are expected differences in treatment of liquid waste for the present month as opposed to the past month (e.g., bypass of filters or demineralizers). NUREG-0017 or past experience shall be used to determine the effect of each form of treatment which will vary.  $F_2 = 1$  if there are no expected differences.

The last month should be typical without significant operational differences from the projected month. If there were no releases during last month, do not use that month as the base month if it is estimated that there will be releases for the coming month.

- b. Whole Body and Maximum Organ when Steam Generator Total Gamma radioactivity Exceeds  $5E-7$   $\mu\text{Ci/ml}$  or Steam Generator Tritium Exceeds  $0.02$   $\mu\text{Ci/ml}$  (Applicable to Units 2 and 3)

The projected monthly whole body dose (Units 2 or 3) is determined



from:

$$D_{MW}^E = D_{MW} [(1 - F_1) R_1 R_4 F_2 + F_1 R_2 R_3]$$

The monthly projected maximum organ dose (Units 2 or 3) is determined from:

$$D_{MO}^E = D_{MO} [(1 - F_1) R_1 R_4 F_2 + F_1 R_2 R_3]$$

Where:

$D_{MW}$  = the whole body dose from the last typical previously completed month as calculated per the methods in Section II.C.1.

$D_{MO}$  = the maximum organ dose from the last typical previously completed month as calculated per the methods in Section II.C.1.

$R_1$  = the ratio of the total estimated volume of liquid batches to be released in the present month to the volume released in the past month.

$R_2$  = the ratio of estimated volume of steam generator blowdown to be released in present month to the volume released in the past month.

$F_1$  = the fraction of curies released last month coming from steam generator blowdown calculated as:

$$\frac{\text{curies from blowdown}}{\text{curies from blowdown} + \text{curies from batch tanks}}$$

$R_3$  = the ratio of estimated secondary coolant radioactivity for the present month to that for the past month.

$R_4$  = the ratio of estimated primary coolant radioactivity for the present month to that for the past month.

$F_2$  = the factor to be applied to the estimated ratio of final curies released if there are expected differences in treatment of liquid waste for the present month as opposed to the past month (e.g., bypass of filters or demineralizers). NUREG-0017 or past experience shall be used to determine the effect of each form of treatment which will vary.  $F_2 = 1$  if there are no expected differences.

## II.D. Gaseous Dose Calculations

### 1. Site Release Rate Limits ("Instantaneous")

Radiological Effluent Controls (Sections III, IV, and V) for each unit require that the instantaneous off-site dose rates from noble gases released to the atmosphere be limited such that they do not exceed 500 mrem/year at any time to the whole body or 3000 mrem/year to the skin at any time from the external cloud. For iodine-131, 133, tritium, and particulates (half-lives > 8 days), the inhalation pathway critical organ dose rate from all units shall not exceed 1500 mrem/year at any time. These limits apply to the combination of releases from all three Units on the site, and are directly related to the radioactivity release rates measured for each Unit. By limiting gaseous release rates for both classes of radionuclides (i.e., noble gases; and iodines, tritium, and particulates) to within values which correlate to the above dose rate limits, assurance is provided that the Radiological Effluent Controls dose rate limits are not exceeded.

#### a. Method 1 for Noble Gas Release Rate Limits

Instantaneous noble gas release rate for the site:

$$Q_{1V}/90,000 + Q_{2S}/560,000 + Q_{2V}/290,000 + Q_{3S}/560,000 + Q_{3V}/290,000 \leq 1$$

Where:

$Q_{1V}$  = Noble gas release rate from Spent Fuel Pool Island Vent ( $\mu\text{Ci}/\text{sec}$ )

$Q_{2S}$  = Noble gas release rate from MP2 to Millstone Stack ( $\mu\text{Ci}/\text{sec}$ )

$Q_{2V}$  = Noble gas release rate from MP2 Vent ( $\mu\text{Ci}/\text{sec}$ )

$Q_{3V}$  = Noble gas release rate from MP3 Vent ( $\mu\text{Ci}/\text{sec}$ )

$Q_{3S}$  = Noble gas release rate from MP3 to Millstone Stack ( $\mu\text{Ci}/\text{sec}$ )

As long as the above is less than or equal to 1, the doses will be less than or equal to 500 mrem to the total body and less than 3000 mrem to the skin. The limiting factor for the Unit 1 SFPI vent of 90,000 is based on the skin dose limit of 3,000 mrem/year, while all the other factors are based on the whole body dose limit of 500 mrem/year.

#### b. Method 1 Release Rate Limit – I-131, I-133, H-3 and Particulates Half Lives Greater Than 8 Days

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With releases satisfying the following limit conditions, the dose rate to the maximum organ will be less than 1500 mrem/year from the inhalation pathway:

- 1) Site release rate of I-131, I-133, and tritium (where the thyroid is the critical organ for these radionuclides):

$$DR_{thy1} + DR_{thy2} + DR_{thy3} \leq 1$$

Where the contribution from each Unit is calculated from:

$$\text{Unit 1: } DR_{thy1} = 2.78E-5 Q_{H1V}$$

$$\begin{aligned} \text{Unit 2: } DR_{thy2} = & 8.80E-2 \text{}^{131}Q_{I2V} + 9.67E-3 \text{}^{131}Q_{I2S} + \\ & 2.08E-2 \text{}^{133}Q_{I2V} + 2.29E-3 \text{}^{133}Q_{I2S} + \\ & 6.87E-6 Q_{H2V} + 7.53E-7 Q_{H2S} \end{aligned}$$

$$\begin{aligned} \text{Unit 3: } DR_{thy3} = & 8.80E-2 \text{}^{131}Q_{I3V} + 9.67E-3 \text{}^{131}Q_{I3S} + \\ & 2.08E-2 \text{}^{133}Q_{I3V} + 2.29E-3 \text{}^{133}Q_{I3S} + \\ & 6.87E-6 Q_{H3V} + 7.53E-7 Q_{H3S} \end{aligned}$$

- 2) Site release rate of particulates with half-lives greater than 8 days and tritium (where the critical organ is a composite of target organs for a mix of radionuclides):

$$DR_{org1} + DR_{org2} + DR_{org3} \leq 1$$

Where the contribution from each Unit is calculated from:

$$\text{Unit 1: } DR_{org1} = 3.52E-1 [Q_{P1V} + Q_{P1B}] + 2.78E-5 Q_{H1V}$$

$$\begin{aligned} \text{Unit 2: } DR_{org2} = & 9.53E-3 Q_{P2S} + 8.67E-2 Q_{P2V} + \\ & 7.53E-7 Q_{H2S} + 6.87E-6 Q_{H2V} \end{aligned}$$

$$\begin{aligned} \text{Unit 3: } DR_{org3} = & 9.53E-3 Q_{P3S} + 8.67E-2 Q_{P3V} + \\ & 7.53E-7 Q_{H3S} + 6.87E-6 Q_{H3V} \end{aligned}$$

Each of the release rate quantities in the above equations are defined as:

$\text{}^{131}Q_{I2V}$  = Release rate of I-131 from MP2 Vent ( $\mu\text{Ci/sec}$ )\*

$\text{}^{131}Q_{I2S}$  = Release rate of I-131 from MP2 to Millstone Stack ( $\mu\text{Ci/sec}$ )

$\text{}^{133}Q_{I2V}$  = Release rate of I-133 from MP2 Vent ( $\mu\text{Ci/sec}$ )\*

$\text{}^{133}Q_{I2S}$  = Release rate of I-133 from MP2 to Millstone Stack ( $\mu\text{Ci/sec}$ )

$^{131}Q_{I3V}$  = Release rate of I-131 from MP3 Vents (Normal and ESF) ( $\mu\text{Ci}/\text{sec}$ )\*

$^{131}Q_{I3S}$  = Release rate of I-131 from MP3 to Millstone Stack ( $\mu\text{Ci}/\text{sec}$ )

$^{133}Q_{I3V}$  = Release rate of I-133 from MP3 Vents (Normal and ESF) ( $\mu\text{Ci}/\text{sec}$ )\*

$^{133}Q_{I3S}$  = Release rate of I-133 from MP3 to Millstone Stack ( $\mu\text{Ci}/\text{sec}$ )

$Q_{H1V}$  = Release rate of tritium from the Spent Fuel Pool Island and Balance of Plant Vents ( $\mu\text{Ci}/\text{sec}$ )

$Q_{H2V}$  = Release rate of tritium from MP2 Vent ( $\mu\text{Ci}/\text{sec}$ )\*

$Q_{H2S}$  = Release rate of tritium from MP2 to Millstone Stack ( $\mu\text{Ci}/\text{sec}$ )

$Q_{H3V}$  = Release rate of tritium from MP3 Vents (Normal and ESF) ( $\mu\text{Ci}/\text{sec}$ )\*

$Q_{H3S}$  = Release rate of tritium from MP3 to Millstone Stack ( $\mu\text{Ci}/\text{sec}$ )

$Q_{P1V}$  = Release rate of total particulates with half-lives greater than 8 days from the Spent Fuel Pool Island Vent ( $\mu\text{Ci}/\text{sec}$ )

$Q_{P1B}$  = Release rate of total particulates with half-lives greater than 8 days from the Balance of Plant Vent ( $\mu\text{Ci}/\text{sec}$ )

$Q_{P2V}$  = Release rate of total particulates with half-lives greater than 8 days from the MP2 Vent ( $\mu\text{Ci}/\text{sec}$ )

$Q_{P2S}$  = Release rate of total particulates with half-lives greater than 8 days from MP2 to Millstone Stack ( $\mu\text{Ci}/\text{sec}$ )

$Q_{P3V}$  = Release rate of total particulates with half-lives greater than 8 days from MP3 Vents (Normal and ESF) ( $\mu\text{Ci}/\text{sec}$ )

$Q_{P3S}$  = Release rate of total particulates with half-lives greater than 8 days from MP3 to Millstone Stack ( $\mu\text{Ci}/\text{sec}$ )

\* includes releases via the steam generator blowdown tank vent.

c. Method 2

The above Method 1 equations assume a conservative nuclide mix. If necessary, use the methodology given in Regulatory Guide 1.109 to estimate the dose rate from either noble gases or iodines, tritium, and particulates with half-lives greater than 8 days.

2. 10 CFR50 Appendix I – Noble Gas Limits

Use the methodology of Regulatory Guide 1.109 Rev.1, to calculate the critical site boundary gamma air and beta air doses at least once per 31 days (monthly).

For calculations performed once every 31 days, enter the following meteorology:

Release Point	$\chi/Q$	D/Q
Site Stack	8.92E-7	8.84E-9
Mixed-mode or rooftop (e.g., vents)	8.1E-6	1.5E-7
Ground	3.28E-5	1.68E-7

If the calculated air dose exceeds one half the quarterly Radiological Effluent Control limit, use meteorology concurrent with quarter of release.

Results of these dose calculations shall be summed to determine compliance with quarterly and annual dose limits for each Unit.

For calculations of quarterly doses for the Radioactive Effluent Release Report, use average quarterly or real-time meteorology.

3. 10 CFR50 Appendix I – Iodine, Tritium, C-14, and Particulate Doses

For each Unit, whole body and maximum organ doses from I-131, I-133, tritium, C-14 and particulates with half-lives greater than 8 days in gaseous effluents shall be calculated at least once per 31 days (or monthly) using the methodology of Regulatory Guide 1.109, Rev.1.

For calculations performed once every 31 days, enter the following meteorology:

Release Point	$\chi/Q$	D/Q
Site Stack	8.92E-7	8.84E-9
Mixed-mode or rooftop (e.g., vents)	8.1E-6	1.5E-7
Ground	3.28E-5	1.68E-7

The calculation shall include contributions from all analyses required by Table I.D-1 for Unit 1, Table I.D-2 for Unit 2, and Table I.D-3 for Unit 3 recorded to date. If any required analyses have not yet been completed for the dose period, an estimate of dose from unanalyzed isotopes shall be included in the dose total. If the calculated dose exceeds one-half the quarterly Radiological Effluent Control limit, use meteorology concurrent with the dose period.

Results of these dose calculations shall be summed to determine compliance with quarterly and annual dose limits for each Unit.

For calculations of quarterly doses for the Radioactive Effluent Release Report, use average quarterly or real-time meteorology.

#### 4. Gaseous Effluent Monthly Dose Projections

Section I.D.2.a. of the REMM requires that certain portions of the gaseous radwaste treatment equipment be returned to service to reduce radioactive gaseous effluents when the projected doses for each Unit (made at least once per 31 days) exceed 0.02 mrad gamma air, 0.04 mrad beta air, or 0.03 mrem to any organ from gaseous effluents. The following methods are applied in the estimation of monthly dose projections.

##### a. Unit 1 Projection Method

None required.

##### b. Unit 2 Projection Method

###### 1) Due to Gaseous Radwaste Treatment System (Unit 2)

Determine the beta and gamma monthly air dose projection from noble gases from the following:

$$D_{MG}^E \text{ (mrad)} = 5E-4 C_N^E$$

$$D_{MB}^E \text{ (mrad)} = 3E-4 C_N^E$$

$$D_{MO}^E \text{ (mrem)} = 3E-4 C_N^E$$

Where:

$C_N^E$  = the number of curies of noble gas estimated to be released from the waste gas storage tanks during the next month.

$D_{MG}^E$  = the estimated monthly gamma air dose.

$D_{MB}^E$  = the estimated monthly beta air dose.

$D_{MO}^E$  = the estimated monthly organ dose.

###### 2) (Reserved)

###### 3) Due to Ventilation Releases (Unit 2)

If portions of the ventilation treatment system are expected to be out of service during the month, determine the monthly maximum organ dose projection ( $D_{MO}^E$ ) from the following:

##### i. Method 1

Determine  $D_{MO}^E$  which is the estimated monthly dose to the maximum organ from the following:

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$$D_{MO}^E = 1/3 R_1 (1.01 - R_2) (R_3 + 0.01) D_O$$

For the last quarter of operation, determine  $D_O$  as determined per Section II.D.3.

$R_1$  = the expected reduction factor for the HEPA filter. Typically this should be 100 (see NUREG-0016 or 0017 for additional guidance).

$R_2$  = the fraction of the time which the equipment was nonfunctional during the last quarter.

$R_3$  = the fraction of the time which the equipment is expected to be nonfunctional during the next month.

$D_O$  = maximum organ dose from the previous month.

ii. Method 2

If necessary, estimate the curies expected to be released for the next month and applicable method for dose calculation from Section II.D.3.



c. Unit 3 Projection Method

1) Due to Radioactive Gaseous Waste System (Unit 3)

Determine the beta and gamma monthly air dose projection from noble gases from the following:

$$D_{MG}^E \text{ (mrad)} = 5E-4 C_N^E$$

$$D_{MB}^E \text{ (mrad)} = 3E-4 C_N^E$$

$$D_{MO}^E \text{ (mrem)} = 3E-4 C_N^E$$

Where:

$C_N^E$  = the number of additional curies of noble gas estimated to be released from Unit 3 during the next month due to the nonfunctional processing equipment.

$D_{MG}^E$  = the estimated monthly gamma air dose.

$D_{MB}^E$  = the estimated monthly beta air dose.

$D_{MO}^E$  = the estimated monthly organ dose.

5. Compliance with 40CFR190

The following sources shall be considered in determining the total dose to any real member of the public, at or beyond the site boundary, from uranium fuel cycle sources:

- a. Gaseous Releases from Units 1, 2, and 3.
- b. Liquid Releases from Units 1, 2, and 3.
- c. Direct and Scattered Radiation from Radioactive Material on Site.
- d. Direct and Scattered Radiation from the Independent Spent Fuel Storage Installation (ISSFSI).

Doses shall be obtained per the requirements of Section II.C.1 for liquid releases and Section II.D.2 and II.D.3 for gaseous releases.

Direct and scattered radiation doses shall be calculated. Doses from all sources shall be added to determine compliance with 40CFR190.

## II.E. Liquid Discharge Flow Rates And Monitor Setpoints

### 1. Unit 1 Liquid Waste Effluent Discharge (RE-MG-110)

The limit on discharge flow rate and setpoint on the Unit 1 liquid waste monitor depend on dilution water flow, radwaste discharge flow, the isotopic composition of the liquid, the background count rate of the monitor and the efficiency of the monitor. Due to the variability of these parameters, the alert and alarm setpoints will be determined prior to the release of each batch. The following method will be used:

#### STEP 1:

From the isotopic analysis and the Effluent Concentration (EC) values for each identified nuclide determine the required reduction factor, i.e.:

$$R = \text{Required Reduction Factor} = \frac{1}{\sum \frac{\mu\text{Ci of nuclide } i}{10 \times \text{EC of nuclide } i}}$$

#### STEP 2:

Determine the allowable discharge flow (F)

$$F = 0.1 \times R \times D$$

Where:

D = The existing dilution flow which is the any dilution flow from Millstone Unit 2 and/or Unit 3 not being credited for any other radioactivity discharge during discharge of Unit 1 water.

0.1 = safety factor to limit discharge concentration to 10% of the Radiological Effluent Control Limit.

#### STEP 3:

Calculate the monitor setpoint as follows:

$$R_{\text{set}} = 2 \times AC \times RCF + \text{Background}$$

Where:

Rset = The setpoint of the monitor.

AC = The total radwaste effluent concentration ( $\mu\text{Ci/ml}$ ) in the tank.

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RCF = The response correction factor for the effluent line monitor using the current calibration factor or isotopic-specific responses.

2 = Tolerance limit which brings the setpoint at twice the expected response of the monitor based on sample analysis. With the safety factor of 0.1 the setpoint would be at 20% of the Radiological Effluent Control Limit.

Option setpoint:

A setpoint based upon worst case conditions may be used. Assume the maximum possible discharge flow, a minimum dilution flow not to exceed 100,000 gpm, and a limit of  $1 \times 10^{-7}$   $\mu\text{Ci/ml}$  which is lower than any 10CFR20 EC limit except for transuranics. This will assure that low level releases are not terminated due to small fluctuations in radioactivity. When using this option setpoint independent verification of discharge lineup shall be performed. The optional setpoint may be adjusted (increased or decreased) by factors to account for the actual discharge flow and actual dilution flow; however, controls shall be established to ensure that the allowable discharge flow is not exceeded and the dilution flow is maintained.

2. Reserved
3. Unit 2 Clean Liquid Radwaste Effluent Line – RM9049 and Aerated Liquid Radwaste Effluent Line – RM9116

The setpoint on the Unit 2 clean and aerated liquid waste effluent lines depend on dilution water flow, radwaste discharge flow, the isotopic composition of the liquid, the background count rate of the monitor and the efficiency of the monitor. Due to the variability of these parameters, an alarm/trip setpoint will be determined prior to the release of each batch. The following method will be used:

STEP 1:

From the tank isotopic analysis and the Effluent Concentrations (EC) in 10CFR20, App. B, Table 2, Col. 2 for each identified nuclide determine the required reduction factor, i.e.:

For Nuclides Other Than Noble Gases:

$$R_1 = \text{Required Reduction Factor} = \frac{1}{\sum \frac{\frac{\mu\text{Ci}}{\text{ml}} \text{ of nuclide } i}{10 \times \text{EC of nuclide } i}}$$

For Noble Gases: If the noble gas concentration is less than  $1.1 \times 10^{-2} \mu\text{Ci/ml}$  or the calculated diluted concentration is less than  $2 \times 10^{-5} \mu\text{Ci/ml}$ , the reduction factor need not be determined. The concentration of  $1.1 \times 10^{-2} \mu\text{Ci/ml}$  is based on 175 gpm discharge flow, 100,000 gpm dilution flow, and a safety factor of 0.1 (See Note below.) If dilution flow is less than 100,000 gpm, the noble gas concentration limit shall be decreased by the ratio of actual dilution flow to 100,000gpm. For example, if dilution flow is 50,000 gpm, the limit would be reduced by a factor of 0.5 (50,000/100,000).

$$R_2 = \text{Required Reduction Factor} = \frac{1}{\sum \frac{\frac{\mu\text{Ci}}{\text{ml}} \text{ of noble gases}}{2 \times 10^{-4} \frac{\mu\text{Ci}}{\text{ml}}}} = \frac{2 \times 10^{-4} \frac{\mu\text{Ci}}{\text{ml}}}{\sum \frac{\mu\text{Ci}}{\text{ml}} \text{ noble gases}}$$

R = the smaller of  $R_1$  or  $R_2$

STEP 2:

Determine the allowable discharge flow (F) in gpm:

$$F = 0.1 \times R \times D$$

Where:

D = the existing dilution flow (D) from circulating and service water pumps. It may include any Unit 3 flow, or portion of Unit 3 flow, not being credited for dilution of a Unit 3 radioactivity discharge during the time of the Unit 2 discharge.

## NOTE

Note that discharging at this flow rate would yield a discharge concentration corresponding to 10% of the Radiological Effluent Control Limit due to the safety factor of 0.1.

With this condition on discharge flow rate met, the monitor setpoint can be calculated:

$$R_{\text{set}} = 2 \times AC \times RF \text{ (See Note 1 below.)}$$

Where:

$R_{\text{set}}$  = the setpoint of the monitor (cpm).

AC = the total radwaste effluent concentration ( $\mu\text{Ci/ml}$ ) in the tank.

RF = the response factor for the effluent line monitor using the current calibration factor or isotopic-specific responses.

2 = the multiple of expected count rate on the monitor based on the radioactivity concentration in the tank.

This value or that corresponding to  $5.6 \times 10^{-5} \mu\text{Ci/ml}$  (Note 2 below), whichever is greater, plus background is the trip setpoint. For the latter setpoint, independent valve verification shall be performed and minimum dilution flow in Note 2 shall be verified and if necessary, appropriately adjusted.

Note 1: If discharging at the allowable discharge rate (F) as determined in above, this setpoint would correspond to 20% of the Radiological Effluent Control limit.

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Note 2: This value is based upon assuming maximum discharge flow (175 gpm), dilution water flow of 100,000 gpm and a limit of  $1 \times 10^{-7}$  which is lower than any Technical Specification limit (ten times 10CFR20 EC values) except for transuranics. This will assure that low level releases are not terminated due to small fluctuations in radioactivity activity. However, to verify that the correct tank is being discharged when using this value, independent valve verification shall be performed. This value may be adjusted (increased or decreased) by factors to account for the actual discharge flow and actual dilution flow; however, controls shall be established to ensure that the allowable discharge flow is not exceeded and the dilution flow is maintained. Dilution flow may include any Unit 3 flow, or a portion of Unit 3 flow, not being credited for dilution of a Unit 3 radioactive discharge during the time of the Unit 2 discharge.

4. Condensate Polishing Facility Waste Neutralization Sump Effluent Line – CND245

The setpoint shall be determined as for the Clean and Aerated Liquid Monitors in Section II.E.3.

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5. Unit 2 Steam Generator Blowdown – RM4262 and Unit 2 Steam Generator Blowdown Effluent Concentration Limitation

5a. Unit 2 Steam Generator Blowdown – RM4262

Alarm  $\leq$  800 CPM + background

This setpoint may be adjusted (increased or decreased) through proper administrative controls.

$$\text{Adjusted alarm} \leq 6 \text{ CPM} \times \frac{\text{circulating \& service water flow (gpm)}}{\text{total SG blowdown (gpm)}} + \text{Background}$$

When using the adjusted alarm, ensure that any other simultaneous discharge does not cause an exceedance of regulatory limits.

5b. Unit 2 Steam Generator Blowdown Effluent Concentration Limitation

The results of analysis of blowdown samples required by Table I.C.–2 of Section I of the REMODCM shall be used to ensure that blowdown effluent releases do not exceed ten times the concentration limits in 10CFR20, Appendix B.

6. Unit 2 Condenser Air Ejector – RM5099

N/A since this monitor is no longer a final liquid effluent monitor.

7. Unit 2 Reactor Building Closed Cooling Water RM6038 and Unit 2 Service Water, and RBCCW Sump and Turbine Building Sump Effluent Concentration Limitation

7a. Unit 2 Reactor Building Closed Cooling Water RM6038

The purpose of the Reactor Building Closed Cooling Water (RBCCW) radiation monitor is to give warning of abnormal radioactivity in the RBCCW system and to prevent releases to the Service Water system which, upon release to the environment, would exceed ten times the concentration values in 10CFR20. According to Calculation RERM–02665–R2, radioactivity in RBCCW water which causes a monitor response of greater than the setpoint prescribed below could exceed ten times the 10CFR20 concentrations upon release to the Service Water system.



#### SETPOINT DURING POWER OPERATIONS:

To give adequate warning of abnormal radioactivity, the setpoint shall be two times the radiation monitor background reading, provided that the background reading does not exceed 2,000 cpm. The monitor background reading shall be the normal monitor reading. If the monitor background reading exceeds 2,000 cpm, the setpoint shall be set at the background reading plus 2,000 cpm and provisions shall be made to adjust the setpoint if the background decreases.

#### SETPOINT DURING SHUTDOWN:

- 1) During outages not exceeding three months the setpoint shall be two times the radiation monitor background reading, provided that the background reading does not exceed 415 cpm. If the monitor background reading exceeds 415 cpm, the setpoint shall be set at the background reading plus 415 cpm and provisions shall be made to adjust the setpoint if the background decreases.
- 2) During extended outages exceeding three months, but not exceeding three years, the setpoint shall be two times the radiation monitor background reading, provided that the background reading does not exceed 80 cpm. If the monitor background reading exceeds 80 cpm, the setpoint shall be set at the background reading plus 80 cpm and provisions shall be made to adjust the setpoint if the background decreases.

#### PROVISIONS FOR ALTERNATE DILUTION FLOWS:

These setpoints are based on a dilution flow of 4,000 gpm from one service water train. If additional dilution flow is credited, the setpoint may be adjusted proportionately. For example, the addition of a circulating water pump dilution flow of 100,000 gpm would allow the setpoint to be increased by a factor of 25.

#### 7b. Unit 2 Service Water, and RBCCW Sump and Turbine Building Sump Effluent Concentration Limitation

Results of analyses of service water, RBCCW sump and turbine building sump samples taken in accordance with Table I.C.-2 of Section I of the REMODCM shall be used to limit radioactivity concentrations in the service water, RBCCW sump and turbine building sump effluents to less than ten times the limits in 10CFR20, Appendix B.

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8. Unit 3 Liquid Waste Monitor – LWS–RE70

The setpoints on the Unit 3 liquid waste monitor depend on dilution water flow, radwaste discharge flow, the isotopic composition of the liquid, the background count rate of the monitor and the efficiency of the monitor. Due to the variability of these parameters, the alert and alarm setpoints will be determined prior to the release of each batch. The following method will be used:

Step 1:

From the tank isotopic analysis and the Effluent Concentration (EC) values for each identified nuclide determine the required reduction factor, i.e.:

For Nuclides Other Than Noble Gases:

$$R_1 = \text{Required Reduction Factor} = \frac{1}{\sum \frac{\frac{\mu\text{Ci}}{\text{ml}} \text{ of nuclide } i}{10 \times \text{EC of nuclide } i}}$$

For Noble Gases: If the noble gas concentration is less than 0.013  $\mu\text{Ci/ml}$  or the calculated diluted concentration is less than  $2 \times 10^{-5} \mu\text{Ci/ml}$ , the reduction factor need not be determined. The concentration of 0.013  $\mu\text{Ci/ml}$  is based on 100,000 gpm dilution flow and a safety factor of 0.1 (See Note Below.) If dilution flow is less than 100,000 gpm, the noble gas concentration limit shall be decreased by the ratio of actual dilution flow to 100,000gpm. For example, if dilution flow is 50,000 gpm, the limit would be reduced by a factor of 0.5 (50,000/100,000).

$$R_2 = \text{Required Reduction Factor} = \frac{1}{\sum \frac{\frac{\mu\text{Ci}}{\text{ml}} \text{ of noble gases}}{2 \times 10^{-4} \frac{\mu\text{Ci}}{\text{ml}}}} = \frac{2 \times 10^{-4} \frac{\mu\text{Ci}}{\text{ml}}}{\sum \frac{\mu\text{Ci}}{\text{ml}} \text{ noble gases}}$$

R = the smaller of R1 or R2

Step 2:

Determine the allowable discharge flow (F)

$$F = 0.1 \times R \times D$$

Where:

D = The existing dilution flow (D) from circulating and service water pumps. It may include any Unit 2 flow, or portion of Unit 2 flow, not being credited for dilution of a Unit 2 radioactivity discharge during the time of the Unit 3 discharge.

## NOTE

Note that discharging at this flow rate would yield a discharge concentration corresponding to 10% of the Radiological Effluent Control Limit due to the safety factor of 0.1.

With this condition on discharge flow rate met, the monitor setpoint can be calculated:

$$R_{set} = 2 \times AC \times RCF \text{ (see Note 1)}$$

Where:

$R_{set}$  = The setpoint of the monitor.

AC = The total radwaste effluent concentration ( $\mu\text{Ci/ml}$ ) in the tank.

RCF = The response correction factor for the effluent line monitor using the current calibration factor or isotopic-specific responses.

2 = The multiple of expected count rate on the monitor based on the radioactivity concentration in the tank.

This value, or that corresponding to  $6.6 \times 10^{-5} \mu\text{Ci/ml}$  (Note 2 below), whichever is greater, plus background is the trip setpoint. For the latter setpoint, independent valve verification shall be performed and minimum dilution flow in Note 2 shall be verified and if necessary, appropriately adjusted.

## NOTE

1. If discharging at the allowable discharge rate (F) as determined above, this Alarm setpoint would yield a discharge concentration corresponding to 20% of the Radiological Effluent Control limit.
2. This value is based upon assuming maximum discharge flow (150 gpm), dilution water flow of 100,000 gpm, and a limit of  $1 \times 10^{-7}$   $\mu\text{Ci/ml}$  which is lower than any Technical Specification limit (ten times 10CFR20 EC values) except for transuranics. This will assure that low level releases are not terminated due to small fluctuations in radioactivity. However, to verify that the correct tank is being discharged when using this value, independent valve verification shall be performed. This value may be adjusted (increased or decreased) by factors to account for the actual discharge flow and actual dilution flow; however, controls shall be established to ensure that the allowable discharge flow is not exceeded and the dilution flow is maintained. Dilution flow may include Unit 2 flow, or portion of Unit 2 flow, not being credited for dilution of a Unit 2 discharge during the time of the Unit 3 discharge.

### 9. Unit 3 Regenerant Evaporator Effluent Line – LWC–RE65

The MP3 Regenerant Evaporator has been removed from service with DCR M3–97–041. Therefore a radiation monitor alarm is not needed.

### 10. Unit 3 Waste Neutralization Sump Effluent Line – CND–RE07

Same as Section II.E.8.

### 11. Unit 3 Steam Generator Blowdown – SSR–RE08 and Unit 3 Steam Generator Blowdown Effluent Concentration Limitation

#### 11a. Unit 3 Steam Generator Blowdown – SSR–RE08

The alarm setpoint for this monitor assumes:

- a. Steam generator blowdown rate of 400 gpm (maximum blowdown total including weekly cleaning of generators – per ERC 25212–ER–99–0133).
- b. The release rate limit is conservatively set at  $3 \times 10^{-8}$   $\mu\text{Ci/ml}$  which is well below any 10CFR20 Effluent Concentration except for transuranics\*.
- c. Circulating and service water dilution flow during periods of blowdown = 100,000 gpm.

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d. Background can be added after above calculations are performed.

Therefore, the alarm setpoint corresponds to a concentration of:

$$\text{Alarm } (\mu\text{Ci/ml}) = \frac{100,000}{400} \times 3 \times 10^{-8} + \text{background} = 7.5 \times 10^{-6} \mu\text{Ci/ml} + \text{background}$$

This setpoint may be increased through proper administrative controls if the steam generator blowdown rate is maintained less than 400 gpm and/or more than 100,000 gpm dilution flow are available. The amount of the increase would correspond to the ratio of flows to those assumed above or:

$$\text{Alarm } (\mu\text{Ci/ml}) = 7.5 \times 10^{-6} \mu\text{Ci/ml} \times \frac{\text{circulating \& service water flow (gpm)}}{100,000} \times \frac{400}{\text{S/ G blowdown (gpm)}}$$

$$\text{Background} = 3 \times 10^{-8} \mu\text{Ci/ml} \times \frac{\text{circulating \& service water flow (gpm)}}{\text{total S/ G blowdown (gpm)}} + \text{Background}$$

When using the adjusted alarm, ensure that any other simultaneous discharge does not cause an exceedance of regulatory limits.

#### NOTE

The Steam Generator Blowdown alarm criteria is in practice based on setpoints required to detect allowable levels of primary to secondary leakage. This alarm criteria is typically more restrictive than that required to meet discharge limits. This fact shall be verified, however, whenever the alarm setpoint is recalculated.

\* In lieu of using  $3 \times 10^{-8} \mu\text{Ci/ml}$ , ten times the identified 10CFR20 EC values may be used.

#### 11b. Unit 3 Steam Generator Blowdown Effluent Concentration Limitation

The results of analysis of blowdown samples required by Table I.C.-3 of Section I of the REMODCM shall be used to ensure that blowdown effluent releases do not exceed ten times the concentration limits in 10CFR20, Appendix B.

12. Unit 3 Turbine Building Floor Drains Effluent Line – DAS–RE50 and Unit 3 Service Water and Turbine Building Sump Effluent Concentration Limitation

12a. Unit 3 Turbine Building Floor Drains Effluent Line – DAS–RE50

The alarm setpoint for this monitor shall be set to four times (4X) the reading of the monitor when there is no gamma radioactivity present in the turbine building sumps. As determined in Calculation RERM–04101R3, the setpoint shall not exceed  $1.4 \times 10^{-5}$   $\mu\text{Ci/ml}$ .

12b. Unit 3 Service Water and Turbine Building Sump Effluent Concentration Limitation

Results of analyses of service water and turbine building sump samples taken in accordance with Table I.C.–3 of Section I of the REMODCM shall be used to limit radioactivity concentrations in the service water and turbine building sump effluents to less than ten times the limits in 10CFR20, Appendix B.

## II.F. Gaseous Monitor Setpoints

### 1. Unit 1 Spent Fuel Pool Island Monitor – RM-SFPI-02

The instantaneous release rate limit from the site shall be set in accordance with the conditions given in Section II.D.1.a. in order to satisfy Unit 1 Radiological Effluent Controls III.C.2. and III.D.2.a.

The Unit 1 allocated portion of the site instantaneous release rate limit is 30,000  $\mu\text{Ci}/\text{sec}$ . This assumes that 7% of the site limit for skin dose of 3000 mrem per year is assigned to the Unit 1 Spent Fuel Pool Island vent. If effluent conditions from the Unit 1 Spent Fuel Pool Island vent reach 30,000  $\mu\text{Ci}/\text{sec}$ , releases from Units 2 and 3 vents and from the Millstone Stack shall be determined to ensure that the sum of the individual noble gas release rates do not cause the site skin dose limit to be exceeded. Use Section II.D.1.a. and Section 4.2 of MP-22-REC-REF03, "REMODOCM Technical Information Document," in making this determination.

The alarm setpoint shall be set at or below the monitor reading in  $\mu\text{Ci}/\text{cc}$  corresponding to the Unit 1 portion of the limit. The setpoint shall be set at or below  $1.71\text{E}-3$   $\mu\text{Ci}/\text{cc}$ . NOTE: This setpoint is the basis for emergency classification in Unit 1 EAL Table (OA-1 and OU-1). A change to this setpoint would require a concurrent change to the EAL.

### 2. Unit 2 Wide Range Gas Monitor (WRGM) – RM8169

The instantaneous release rate limit from the site shall be set in accordance with the conditions given in Section II.D.1.a. in order to satisfy Units 2 Radiological Effluent Controls IV.C.2. and IV.D.2.a.

For releases from Unit 2 to the Millstone Stack, the allocated portion of the site instantaneous release rate limit is 72,000  $\mu\text{Ci}/\text{sec}$ . This assumes that 13% of the site limit is assigned to Unit 2 releases to the Millstone Stack. If effluent conditions from Unit 2 releases to the Millstone Stack reach 72,000  $\mu\text{Ci}/\text{sec}$ , releases from Units 1, 2, and 3 vents and from Unit 3 releases to the Millstone Stack shall be determined to ensure that the sum of the individual noble gas release rates do not cause the site limit to be exceeded. Use Section II.D.1.a. and Section 4.2 of MP-22-REC-REF03, "REMODOCM Technical Information Document," in making this determination.

The alarm setpoint shall be set at or below the monitor reading in  $\mu\text{Ci}/\text{cc}$  corresponding to the Unit 2 release to the stack portion of the limit. The setpoint shall be set at or below  $1.3\text{E}-2$   $\mu\text{Ci}/\text{cc}$ .

### 3. Reserved

4. Unit 3 SLCRS – HVR–RE19B

The instantaneous release rate limit from the site shall be set in accordance with the conditions given in Section II.D.1.a. in order to satisfy Unit 3 Radiological Effluent Controls V.C.2. and V.D.2.a.

For releases from Unit 3 to the Millstone Stack, the allocated portion of the site instantaneous release rate limit is 72,000  $\mu\text{Ci}/\text{sec}$ . This assumes that 13% of the site limit is assigned to Unit 3 releases to the Millstone Stack. If effluent conditions from Unit 3 releases to the Millstone Stack reach 72,000  $\mu\text{Ci}/\text{sec}$ , releases from Units 1 and 2 vents, Unit 3 ESF vent and from Unit 2 releases to the Millstone Stack shall be determined to ensure that the sum of the individual noble gas release rates do not cause the site dose limit to be exceeded. Use Section II.D.1.a. and Section 4.2 of MP–22–REC–REF03, “REMODOCM Technical Information Document,” in making this determination.

The alarm setpoint shall be set at or below the monitor reading in  $\mu\text{Ci}/\text{cc}$  corresponding to the Unit 3 release to the stack portion of the limit. The setpoint shall be set at or below  $1.16 \text{ E}^{-2} \mu\text{Ci}/\text{cc}$ .

5. Unit 2 Vent – Noble Gas Monitor – RM8132B

The instantaneous release rate limit from the site shall be set in accordance with the conditions given in Section II.D.1.a. in order to satisfy the Unit 2 Radiological Effluent Controls in Sections IV.C.2. and IV.D.2.a.

For releases from Unit 2 vent, the allocated portion of the site instantaneous release rate limit is 95,000  $\mu\text{Ci}/\text{sec}$ . This assumes that 33% of the site limit is assigned to Unit 2 vent releases. If effluent conditions from Unit 2 vent releases reach 95,000  $\mu\text{Ci}/\text{sec}$ , releases from Units 1 and 3 vents and from Units 2 and 3 releases to the Millstone Stack shall be determined to ensure that the sum of the individual noble gas release rates do not cause the site limit to be exceeded. Use Section II.D.1.a. and Section 4.2 of MP–22–REC–REF03, “REMODOCM Technical Information Document,” in making this determination.

The alarm setpoint shall be set at or below the monitor reading in cpm corresponding to the Unit 2 vent portion of the limit. The setpoint shall be set at or below 42,000 CPM.

6. Unit 2 Waste Gas Decay Tank Monitor RM9095

Administratively all waste gas decay tank releases are via the Millstone Stack. Unit 2 has a release rate limit to the Millstone Stack of 72,000  $\mu\text{Ci}/\text{sec}$  (see the MP–22–REC–REF03, “REMODOCM Technical Information Document,” Section 4.2 for bases).



Batch releases of waste gas shall be limited to less than 10% of the Unit 2 releases to the Millstone Stack release rate limits. Therefore, the waste gas decay tank monitor setpoint should be set not to exceed 7,200  $\mu\text{Ci}/\text{sec}$ . If the setpoint exceeds 7,200  $\mu\text{Ci}/\text{sec}$ , the release shall be automatically terminated.

The MP2 waste gas decay tank monitor (given  $\mu\text{Ci}/\text{cc}$  per cpm) calibration curve and the tank discharge rate is used to assure that the concentration of gaseous radioactivity being released from a waste gas decay tank does not cause the setpoint of 7,200  $\mu\text{Ci}/\text{sec}$  to be exceeded.

7. Unit 3 Vent Noble Gas Monitor – HVR–RE10B

The instantaneous release rate limit from the site shall be set in accordance with the conditions given in Section II.D.1.a. in order to satisfy Unit 3 Radiological Effluent Controls in Sections V.C.2. and V.D.2.a.

For releases from Unit 3 vent, the allocated portion of the site instantaneous release rate limit is 95,000  $\mu\text{Ci}/\text{sec}$ . This assumes that 33% of the site limit is assigned to Unit 3 vent releases. If effluent conditions from Unit 3 vent releases reach 95,000  $\mu\text{Ci}/\text{sec}$ , releases from Units 1 and 2 vents, Unit 3 ESF vent and from Units 2 and 3 releases to the Millstone Stack shall be determined to ensure that the sum of the individual noble gas release rates do not cause the site limit to be exceeded. Use Section II.D.1.a. and Section 4.2 of MP–22–REC–REF03, “REMODOCM Technical Information Document,” in making this determination.

The alarm setpoint shall be set at or below the monitor reading corresponding to the Unit 3 vent portion of the limit. The setpoint shall be set at or below  $8.4 \times 10^{-4}$   $\mu\text{Ci}/\text{cc}$ .

8. Unit 3 Engineering Safeguards Building Monitor – HVQ–RE49

For releases from Unit 3 ESF vent, the allocated portion of the site instantaneous release rate limit is 2,900  $\mu\text{Ci}/\text{sec}$ . This applies 1% of the Unit 3 Vent release rate limit (see Section II.D.1.a.) to Unit 3 ESF vent releases. If effluent conditions from Unit 3 ESF vent releases reach 2,900  $\mu\text{Ci}/\text{sec}$ , releases from Units 1 and 2 vents, Unit 3 vent and from Units 2 and 3 releases to the Millstone Stack shall be determined to ensure that the sum of the individual noble gas release rates do not cause the site limit to be exceeded. Use Section II.D.1.a. and Section 4.2 of MP–22–REC–REF03, “REMODOCM Technical Information Document,” in making this determination.

The Alarm setpoint shall be set at or below the value of  $5.9\text{E}-4$   $\mu\text{Ci}/\text{cc}$ . This setpoint assumes a monitor flow rate of 10,500 cfm. However, only 6,000 cfm is monitored. By assuming 10,500 cfm the setpoint is conservatively low.

**APPENDIX II.A**  
**REMODOCM METHODOLOGY CROSS-REFERENCES**

Radiological effluent controls (Sections III, IV, and V) identify the requirements for monitoring and limiting liquid and gaseous effluents releases from the site such the resulting dose impacts to members of the public are kept to "As Low As Reasonably Achievable" (ALARA). The demonstration of compliance with the dose limits is by calculational models that are implemented by Section II of the REMODOCM.

Table App. II.A-1 provides a cross-reference guide between liquid and gaseous effluent release limits and those sections of the REMODOCM, which are used to determine compliance. It also shows the administrative Technical Specifications which reference the REMODOCM for operation of radioactive waste processing equipment. This table also provides a quick outline of the applicable limits or dose objectives and the required actions if those limits are exceeded. Details of the effluent control requirements and the implementing sections of the REMODOCM should be reviewed directly for a full explanation of the requirements.

**Table II.A. - 1  
Millstone Effluent Requirements and Methodology Cross Reference**

Radiological Effluent Controls & Technical Specifications	REMOCM Methodology Section	Applicable Limit or Objective	Exposure Period	Required Action
IV/VE.1.a Liquid Effluent Concentration	Tables I.C.-2 and I.C.-3	Ten times 10CFR20App.B, Table 2, Column 2, & $2 \times 10^{-4}$ $\mu\text{Ci}/\text{mL}$ for dissolved noble gases*	Instantaneous	Restore concentration to within limits within 15 mins.
IV/VE.1.b Dose - Liquids	II.C.1.	$\leq 1.5$ mrem T.B. $\leq 5$ mrem Organ	Calendar Quarter**	30-day report if exceeded. Relative accuracy or conservatism of the calculations shall be confirmed by performance of the REMC in Section I.
	II.C.1.	$\leq 3$ mrem T.B. $\leq 10$ mrem Organ	Calendar Year	
T.S. 6.16 & 6.20 (Unit 2) T.S. 6.14 & 6.15 (Unit 3) Liquid Radwaste Treatment	I.C.2. II.C.2.	$\leq 0.06$ mrem T.B. $\leq 0.2$ mrem Organ	Projected for 31 days (if system not in use)	Return to operation Liquid Waste Treatment System
III.D.2.a IV/VD.2.a T.S. 6.20 (Unit 2) T.S. 6.15 (Unit 3) Gaseous Effluents Dose Rate	Tables I.D.-1, I.D.-2, & I.D.-3	$\leq 500$ mrem/yr T.B. from noble gases*	Instantaneous	Restore release rates to within specifications within 15 minutes
	II.D.1.a.	$\leq 3000$ mrem/yr skin from noble gases*		
	II.D.1.b.	$\leq 1500$ mrem/yr organ from particulates with $T_{1/2} > 8\text{d.}$ , I-131, I-133 & tritium*		
III.D.2.b IV/VD.2.b Dose Noble Gases	II.D.2.	$\leq 5$ mrad gamma air $\leq 10$ mrad beta air	Calendar Quarter**	30-day report if exceeded
		$\leq 10$ mrad gamma air $\leq 20$ mrad beta air	Calendar Year	
III.D.2.c IV/VD.2.c Dose I-131, I-133, Particulates, H-3	II.D.3.	$\leq 7.5$ mrem organ	Calendar Quarter**	30-day report if exceeded. Relative accuracy or conservatism of the calculations shall be confirmed by performance of the REMC in Section I.
		$\leq 15$ mrem organ	Calendar Year	
T.S. 5.6.4 (Unit 1) T.S. 6.14 (Unit 2) T.S. 6.14 & T.S. 6.15 (U3) Gaseous Radwaste Treatment	II.D.2. II.D.4.	$> 0.02$ mrad gamma air $> 0.04$ mrad beta air $> 0.03$ mrem organ	Projected for 31 Days (if system not in use)	Return to operation Gaseous Radwaste Treatment System
II.E IVI/VF Total Dose	II.D.5.	$\leq 25$ mrem T.B.* $\leq 25$ mrem organ* $\leq 75$ mrem thyroid*	12 Consecutive Months**	30-day report if Unit 1 Effluent Control III.D.1.2, III.D.2.2, or III.D.2.3 or Units 2/3 Effluent Control IV/VE.1.2, IV/VE.2.2, or IV/VE.2.3 are exceeded by a factor of 2. Restore dose to public to within the applicable EPA limit(s) or obtain a variance

NOTE: T.B. means total or whole body.

\* Applies to the entire site (Units 1, 2, and 3) discharges combined.

\*\*Cumulative dose contributions calculated once per 31 days.

# SECTION III.

## Millstone Unit 1

### Radiological Effluent Controls

Docket Nos. 50–245

## SECTION III. REMODCM UNIT ONE CONTROLS

### III.A. Introduction

The purpose of this section is to provide the following for Millstone Unit One:

- a. the effluent radiation monitor controls and surveillance requirements,
- b. the effluent radioactivity concentration and dose controls and surveillance requirements, and
- c. the bases for the controls and surveillance requirements.

Definitions of certain terms are provided as an aid for implementation of the controls and requirements.

Some surveillance requirements refer to specific sub-sections in Sections I and II as part of their required actions

### III.B. Definitions and Surveillance Requirement (SR) Applicability

#### III.B.1 – Definitions

The defined terms of this sub-section appear in capitalized type and are applicable throughout Section III.

1. **ACTION** – that part of a Control that prescribes remedial measures required under designated conditions.
2. **INSTRUMENT CALIBRATION** – the adjustment, as necessary, of the instrument output such that it responds within the necessary range and accuracy to known values of the parameter that the instrument monitors. The **INSTRUMENT CALIBRATION** shall encompass those components, such as sensors, displays, and trip functions, required to perform the specified safety function(s). The **INSTRUMENT CALIBRATION** shall include the **INSTRUMENT FUNCTIONAL TEST** and may be performed by means of any series of sequential, overlapping, or total channel steps so that the entire channel is calibrated.

3. INSTRUMENT FUNCTIONAL TEST – the injection of a simulated or actual signal into the channel as close to the sensor as practicable to verify that the instrument is FUNCTIONAL, including all components in the channel, such as alarms, interlocks, displays, and trip functions, required to perform the specified safety function(s). For digital instruments, the computer database may be manipulated, in lieu of a signal injection, to verify operability of alarm and/or trip functions. The INSTRUMENT FUNCTIONAL TEST may be performed by means of any series of sequential, overlapping, or total channel steps so that the entire channel is tested.
4. CHANNEL CHECK – the qualitative determination of functionality by observation of behavior during operation. This determination shall include, where possible, comparison of the instrument with other independent instruments measuring the same variable.
5. FUNCTIONAL – An instrument shall be FUNCTIONAL when it is capable of performing its specified functions(s). Implicit in this definition shall be the assumption that all necessary attendant instrumentation, controls, normal and emergency electrical power sources, cooling or seal water, lubrication or other auxiliary equipment that are required for the instrument to perform its functions(s) are also capable of performing their related support function(s).
6. REAL MEMBER OF THE PUBLIC – an individual, not occupationally associated with the Millstone site, who is exposed to existing dose pathways at one particular location. This does not include employees of the utility or utilities which own a Millstone plant and utility contractors and vendors. Also excluded are persons who enter the Millstone site to service equipment or to make deliveries. This does include persons who use portions of the Millstone site for recreational, occupational, or other purposes not associated with any of the Millstone plants.
7. SITE BOUNDARY – that line beyond which the land is not owned, leased, or otherwise controlled by the licensee.
8. SOURCE CHECK – the qualitative assessment of channel response when the channel is exposed to radiation.
9. RADIOACTIVE WASTE TREATMENT SYSTEMS – Radioactive Waste Treatment Systems are those liquid, gaseous, and solid waste systems which are required to maintain control over radioactive materials in order to meet the controls set forth in this section.

### **III.B.2 – Surveillance Requirement (SR) Applicability**

1. SRs shall be met during specific conditions in the Applicability for individual LCOs unless otherwise stated in the SR. Failure to meet a Surveillance, whether such failure is experienced during the performance of the Surveillance or between performances of the Surveillance, shall be failure to meet the LCO. Failure to perform a Surveillance within the specified Frequency shall be failure to meet the LCO except as provided in III.B.2 3. Surveillances do not have to be performed on nonfunctional equipment or variables outside specified limits.
2. The specified Frequency for each SR is met if the Surveillance is performed within 1.25 times the interval specified in the Frequency, as measured from the previous performance or as measured from the time a specified condition of the frequency is met.
3. If it is discovered that a Surveillance was not performed within its specified frequency, then compliance with the requirement to declare the LCO not met may be delayed from the time of discovery up to 24 hours or up to the limit of the specified frequency, whichever is less. This delay period is permitted to allow performance of the surveillance. If the Surveillance is not performed within the delay period, the LCO must immediately be declared not met and the applicable Condition(s) must be entered. The Completion Times of the Required Actions begin immediately upon expiration of the delay period. When the Surveillance is performed within the delay period and the Surveillance is not met, the LCO must immediately be declared not met and the applicable Condition(s) must be entered. The Completion Times of the Required Actions begin immediately upon failure to meet the Surveillance.

### III.C. Radioactive Effluent Monitoring Instrumentation

#### 1. Radioactive Liquid Effluent Monitoring Instrumentation

##### CONTROLS

The radioactive liquid effluent monitoring instrumentation channels shown in Table III.C.-1 shall be FUNCTIONAL with applicable alarm/trip setpoints set to ensure that the limits of Specification III.D.1.a. are not exceeded. The setpoints shall be determined in accordance with methods and parameters described in Section II.

APPLICABILITY: As shown in Table III.C.-1

##### ACTION:

- a. With a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above Specification, without delay suspend the release of radioactive liquid effluents monitored by the affected channel, or declare the channel nonfunctional, or change the setpoint so it is acceptably conservative.
- b. With the number of channels less than the minimum channels FUNCTIONAL requirement, take the action shown in Table III.C.-1. Exert best efforts to restore the nonfunctional monitor to FUNCTIONAL status within 30 days and, if unsuccessful, explain in the next Radioactive Effluent Release Report why the nonfunctionality was not corrected in a timely manner. Releases need not be terminated after 30 days provided the specified actions are continued.

##### SURVEILLANCE REQUIREMENTS

Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated FUNCTIONAL by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table III.C.-2.





**TABLE III.C.-1  
Radioactive Liquid Effluent Monitoring Instrumentation**

Instrument	Action when not functional	Notes
1. Liquid Waste Effluent Monitor (RE-MG-110)	A	1, 2

1. Whenever the pathway is being used except that outages are permitted, for a maximum of 12 hours, for the purpose of maintenance and performance of required test, checks, calibrations, or sampling.
2. Alarm setpoint required.

Action A

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirements, effluent releases may continue provided that best efforts are made to repair the instrument and that prior to initiating a release:

- (1) At least two independent samples are analyzed for gamma radioactivity as specified in Table I.C-1 and;
- (2) The original release rate calculations and discharge valving are independently verified by a second individual.

TABLE III.C.-2 Radioactive Liquid Effluent Monitoring Instrumentation Surveillance Requirements				
Instrument	Channel Check	Source Check	Channel Calibration	Channel Functional Test
1. Liquid Waste Effluent Monitor (RE-MG-110)	D*	P	T(1)	Q

- D = Daily
- P = Prior to each batch release
- T = Once every two years
- Q = Once every 3 months

\* During releases via this pathway and when the monitor is required FUNCTIONAL per Table III.C.-1. The CHANNEL CHECK should be done when the discharge is in progress.

(1) Calibration shall include the use of a radioactive liquid or solid source which is traceable to an NIST source.

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## 2. Radioactive Gaseous Effluent Monitoring Instrumentation

### CONTROLS

The radioactive gaseous effluent monitoring instrumentation channels shown in Table III.C.-3 shall be FUNCTIONAL with applicable alarm setpoints set to ensure that the limits of Control III.D.2.a. are not exceeded. The setpoints shall be determined in accordance with methods and parameters described in Section II.F.1.

APPLICABILITY: As shown in Table III.C.-3

### ACTION:

- a. With a radioactive gaseous effluent monitoring instrumentation channel alarm setpoint less conservative than required by the above Control, without delay suspend the release of radioactive gaseous effluents monitored by the affected channel, or declare the channel nonfunctional, or change the setpoint so it is acceptably conservative.
- b. With the number of channels less than the minimum channels functional requirements, take the action shown in Table III.C.-3. Exert best efforts to restore the nonfunctional monitor to FUNCTIONAL status within 30 days and, if unsuccessful, explain in the next Radiological Effluent Release Report why the nonfunctionality was not corrected in a timely manner. Release need not be terminated after 30 days provided the specified actions are continued.

### SURVEILLANCE REQUIREMENT

Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated FUNCTIONAL by performance of the INSTRUMENT CHECK, INSTRUMENT CALIBRATION, INSTRUMENT FUNCTIONAL TEST, and SOURCE CHECK operations at the frequencies shown in Table III.C.-4.

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**TABLE III.C.-3  
Radioactive Gaseous Effluent Monitoring Instrumentation**

Instrument	Action when not functional	Notes
<b>1.Spent Fuel Pool Island Vent</b>		
(a) Noble Gas Radioactivity Monitor	A	1, 2
(b) Particulate Sampler	B	1
(c) Vent Flow Rate Monitor	C	1
(d) Sampler Flow Rate Monitor	D	1, 2
<b>2.Balance of Plant Vent</b>		
(a) Particulate Sampler	B	1
(b) Sampler Flow Monitor	D	1

- Channels are FUNCTIONAL and in service on a continuous, uninterrupted basis when exhaust fans are operating, except that outages are permitted, for a maximum of 12 hours, for the purpose of maintenance and performance of required tests, checks, calibrations, and sampling associated with the instrument or any system or component which affects functioning of the instrument.
- Alarm setpoint required.

**ACTION STATEMENTS**

Action A

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument and that grab samples are taken daily when fuel is being moved, or during any evolution or event which would threaten fuel integrity, and these samples are analyzed for gamma radioactivity within 24 hours.

Action B

With the number of samplers FUNCTIONAL less than required by the Minimum number FUNCTIONAL requirement, effluent releases via this pathway may continue provided that the best efforts are made to repair the instrument and that a 24 hour sample is collected with auxiliary sampling equipment once every seven (7) days, or anytime significant generation of airborne radioactivity is expected, and analyzed for principal gamma emitters with half lives greater than 8 days within 24 hours after the end of the sampling period. Operation of the auxiliary sampling equipment shall be verified every twelve (12) hours.

Action C

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument.

Action D

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument and that the flow rate is estimated once during the Chemistry compensatory sampling time period as specified in Action A or Action B. Sample flow rate need not be estimated if the auxiliary sampling equipment of Action B is in use.

**TABLE III.C.-4  
Radioactive Gaseous Effluent Monitoring Instrumentation Surveillance Requirements**

Instrument	Channel Check	Instrument Calibration	Functional Test	Source Check
1.Spent Fuel Pool Island Vent				
(a) Noble Gas Radioactivity Monitor	D <sup>(3)</sup>	T <sup>(6)</sup>	Q <sup>(7)</sup>	M
(b) Particulate Sampler	TM	NA	NA	NA
(c) Vent Flow Rate Monitor	D	T	NA	NA
(d) Sampler Flow Rate Monitor	D	T	NA	NA
2.Balance of Plant Vent				
(a) Particulate Sampler	TM	NA	NA	NA
(b) Sampler Flow Monitor	D	T	NA	NA

D = Daily  
W = Weekly  
TM = Twice per month  
M = Monthly  
Q = Once every 3 months  
T = Once every two years  
NA = Not Applicable

**Table III.C.-4  
TABLE NOTATION**

- (1) RESERVED
- (2) RESERVED
- (3) Instrument check daily only when there exist releases via this pathway.
- (4) RESERVED
- (5) RESERVED
- (6) Calibration shall include the use of a known source whose strength is determined by a detector which has been calibrated to a source which is traceable to the NIST. These sources shall be in a known reproducible geometry.
- (7) The INSTRUMENT FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exist:
  - 1. Instrument indicates measured levels above the alarm/trip setpoint.
  - 2. Instrument indicates a downscale failure.

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### III.D. Radioactive Effluents Concentrations And Dose Limitations

#### 1. Radioactive Liquid Effluents

##### a. Radioactive Liquid Effluents Concentrations

#### LIMITING CONDITIONS OF OPERATIONS

The concentration of radioactive material released from the site (see Figure III.D.-1) shall not exceed ten times the concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall not exceed  $2 \times 10^{-4}$   $\mu\text{Ci/ml}$  total radioactivity.

APPLICABILITY: At all times.

#### ACTION:

With the concentration of radioactive material released from the site exceeding the above limits, restore the concentration to within the above limits within 15 minutes.

#### SURVEILLANCE REQUIREMENT

Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program specified in Section I. The results of the radioactive analysis shall be used in accordance with the methods of Section II to assure that the concentrations at the point of release are maintained within the limits of Specification III.D.1.a.

b. Radioactive Liquid Effluents Doses

LIMITING CONDITIONS OF OPERATIONS

The dose or dose commitment to any REAL MEMBER OF THE PUBLIC from radioactive materials in liquid effluents from Unit 1 released from the site (see Figure III.D.-1) shall be limited:

- a. During any calendar quarter to less than or equal to 1.5 mrem to the total body and to less than or equal to 5 mrem to any organ; and,
- b. During any calendar year to less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ.

APPLICABILITY: At all times

ACTION:

- a. With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits prepare and submit to the Commission within 30 days a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce the releases of radioactive materials in liquid effluents and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

SURVEILLANCE REQUIREMENTS

- 1) Dose Calculations – Cumulative dose contributions for the current calendar quarter and current calendar year shall be determined in accordance with Section II once every 31 days.
- 2) Relative accuracy or conservatism of the calculations shall be confirmed by performance of the Radiological Environmental Monitoring Program as detailed in Section I.

## 2. Radioactive Gaseous Effluents

### a. Radioactive Gaseous Effluents Dose Rate

#### CONTROLS

---

The dose rate, at any time, offsite (See Figure III.D. -1) due to radioactivity released in gaseous effluents from the site shall be limited to the following values:

- a. The dose rate limit for noble gases shall be less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin; and,
- b. The dose rate limit for Tritium and for all radioactive materials in particulate form with half lives greater than 8 days shall be less than or equal to 1500 mrem/yr to any organ.

APPLICABILITY: At all times.

#### ACTION:

With the dose rate(s) exceeding the above limits, decrease the release rate to comply with the limit(s) given in Control III.D.2.a. within 15 minutes.

#### SURVEILLANCE REQUIREMENT

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- 1) The release rate, at any time, corresponding to the above dose rates shall be determined in accordance with the methodology of Section II.
- 2) The release rate, at any time shall be monitored in accordance with the requirements of Section III.C.2.
- 3) Sampling and analysis shall be performed in accordance with Section I to assure that the limits of Control III.D.2.a. are met.

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b. Radioactive Gaseous Effluents Noble Gas Dose

CONTROLS

The air dose offsite (see Figure III.D.-1) due to noble gases released in gaseous effluents from Unit 1 shall be limited to the following:

- a. During any calendar quarter, to less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation;
- b. During any calendar year to less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

APPLICABILITY: At all times.

ACTION:

With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits prepare and submit to the Commission within 30 days a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce the releases of radioactive noble gases in gaseous effluents and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

SURVEILLANCE REQUIREMENTS

- 1) Dose Calculations – Cumulative dose contributions for the current calendar quarter and current calendar year shall be determined in accordance with Section II once every 31 days.
- 2) Relative accuracy or conservatism of the calculations shall be confirmed by performance of the Radiological Environmental Monitoring Program as detailed in Section I.

- c. Gaseous Effluents – Dose from Radionuclides Other than Noble Gas

### CONTROLS

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The dose to any REAL MEMBER OF THE PUBLIC from Tritium and radioactive materials in particulate form with half lives greater than 8 days in gaseous effluents released offsite from Unit 1 (see Figure III.D.–1) shall be limited to the following:

- a. During any calendar quarter to less than or equal to 7.5 mrem to any organ;
- b. During any calendar year to less than or equal to 15 mrem to any organ.

APPLICABILITY: At all times.

### ACTION:

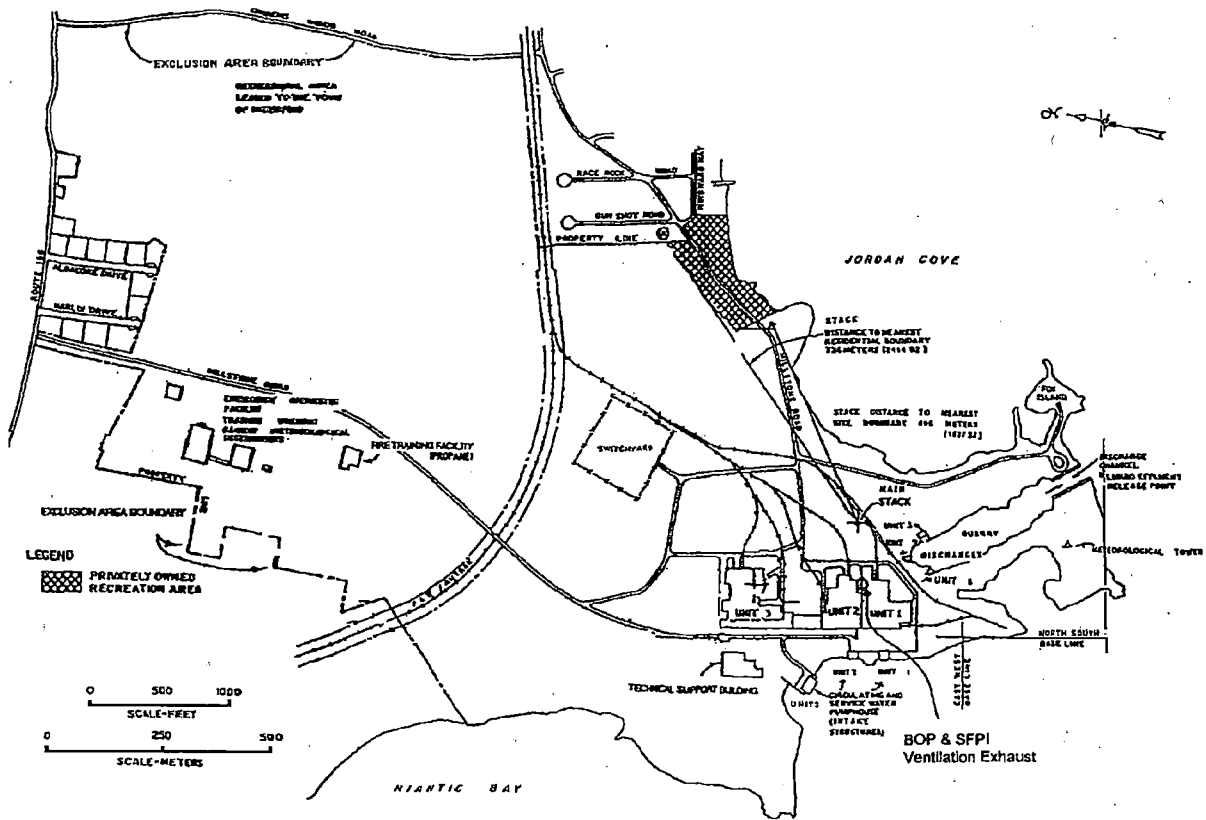
With the calculated dose from the release of Tritium and radioactive materials in particulate form exceeding any of the above limits prepare and submit to the Commission within 30 days a Special Report which identifies the cause(s) for exceeding the limit and defines the corrective actions to be taken to reduce the releases of radioactive materials in gaseous effluents and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

### SURVEILLANCE REQUIREMENTS

---

- 1) Dose Calculations – Cumulative dose contributions for the current calendar quarter and current calendar year shall be determined in accordance with Section II once every 31 days.
- 2) Relative accuracy or conservatism of the calculations shall be confirmed by performance of the Radiological Environmental Monitoring Program as detailed in Section I.

Figure III.D.-1, "Site Boundary for Liquid and Gaseous Effluents"



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### III.E. Total Radiological Dose From Station Operations Controls

#### CONTROLS

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The annual dose or dose commitment to any REAL MEMBER OF THE PUBLIC, beyond the site boundary, from the Millstone Site is limited to less than or equal to 25 mrem to the total body or any organ (except the thyroid, which is limited to less than or equal to 75 mrem).

APPLICABILITY: At all times.

#### ACTION:

With the calculated dose from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Controls III.D.1.b., III.D.2.b. or III.D.2.c. prepare and submit a Special Report to the Commission within 30 days and limit the subsequent releases such that the dose commitment from the site to any REAL MEMBER OF THE PUBLIC from the Millstone Site is limited to less than or equal to 25 mrem to the total body or any organ (except thyroid, which is limited to less than or equal to 75 mrem) over 12 consecutive months. This Special Report shall include an analysis which demonstrates that radiation exposures from the site to any REAL MEMBER OF THE PUBLIC from the Millstone Site (including all effluent pathways and direct radiation) are less than the 40 CFR 190 Standard.

If the estimated doses exceed the above limits, the Special Report shall include a request for a variance in accordance with the provisions of 40 CFR 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

#### SURVEILLANCE REQUIREMENTS

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Cumulative dose contributions from liquid and gaseous effluents and direct radiation from the Millstone Site shall be determined in accordance with Section II once per 31 days.



# SECTION IV.

## Millstone Unit 2

### Radiological Effluent Controls

Docket Nos. 50-336

## SECTION IV. REMODCM UNIT TWO CONTROLS

### IV.A. Introduction

The purpose of this section is to provide the following for Millstone Unit Two:

- a. the effluent radiation monitor controls and surveillance requirements,
- b. the effluent radioactivity concentration and dose controls and surveillance requirements, and
- c. the bases for the controls and surveillance requirements.

Definitions of certain terms are provided as an aid for implementation of the controls and requirements.

Some surveillance requirements refer to specific sub-sections in Sections I and II as part of their required actions.

### IV.B. Definitions, Applicability and Surveillance Requirements

#### IV.B.1 – Definitions

The defined terms of this sub-section appear in capitalized type and are applicable throughout Section IV.

1. **ACTION** – Those additional requirements specified as corollary statements to each principal control and shall be part of the control.
2. **FUNCTIONAL / FUNCTIONALITY** – An instrument shall be **FUNCTIONAL** or have **FUNCTIONALITY** when it is capable of performing its specified functions(s) and when all necessary attendant instrumentation, controls, normal and emergency electrical power sources, or other auxiliary equipment that are required for the instrument to perform its functions are also capable of performing their related support functions.
3. **CHANNEL CALIBRATION** – A **CHANNEL CALIBRATION** shall be the adjustment, as necessary, of the channel output such that it responds within the necessary range and accuracy to know values of the parameter which the channel monitors. The **CHANNEL CALIBRATION** shall encompass the entire channel including the sensors and alarm and/or trip functions, and shall include the **CHANNEL FUNCTIONAL TEST**. The **CHANNEL CALIBRATION** may be performed by any series of sequential, overlapping, or total channel steps such that the entire channel is calibrated.

4. CHANNEL CHECK – A CHANNEL CHECK shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter.
5. CHANNEL FUNCTIONAL TEST – A CHANNEL FUNCTIONAL TEST shall be the injection of a simulated signal into the channel as close to the primary sensor as practicable to verify FUNCTIONALITY including alarm and/or trip functions. For digital instruments, the computer database may be manipulated, in lieu of a signal injection, to verify functionality of alarm and/or trip functions.
6. SOURCE CHECK – A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to radiation.
7. MEMBER(S) OF THE PUBLIC – MEMBER(S) OF THE PUBLIC shall include all persons who are not occupationally associated with the plant. This category does not include employees of the utility, its contractors or its vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational, or other purposes not associated with the plant.

The term “REAL MEMBER OF THE PUBLIC” means an individual who is exposed to existing dose pathways at one particular location.

8. MODE – Refers to Mode of Operation as defined in Safety Technical Specifications.
9. SITE BOUNDARY – The SITE BOUNDARY shall be that line beyond which the land is not owned, leased, or otherwise controlled by the licensee.
10. UNRESTRICTED AREA – Any area at or beyond the site boundary to which access is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials or any area within the site boundary used for residential quarters or industrial, commercial, institutional and/or recreational purposes.

11. DOSE EQUIVALENT I-131 – DOSE EQUIVALENT I-131 shall be that concentration of I-131 ( $\mu\text{Ci}/\text{gram}$ ) which alone would produce the same CDE-thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134, and I-135 actually present. The thyroid dose conversion factors used for this calculation shall be those listed under Inhalation in Federal Guidance Report No. 11 (FGR 11), "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion."

#### **IV.B.2 – Applicability**

##### **IV.B.2a – LIMITING CONDITIONS FOR OPERATION**

1. Compliance with the Limiting Conditions for Operation contained in the succeeding specifications is required during the OPERATIONAL MODES or other conditions specified therein; except that upon failure to meet the Limiting Conditions for Operation, the associated ACTION requirements shall be met.
2. Noncompliance with a specification shall exist when the requirements of the Limiting Condition for Operation and associated ACTION requirements are not met within the specified time intervals, except as provided in Condition IV.B.2.a(6). If the Limiting Condition for Operation is restored prior to expiration of the specified time intervals, completion of the ACTION requirements is not required.
3. NOT USED.
4. NOT USED.
5. When a system, subsystem, train, component or device is determined to be nonfunctional solely because its emergency power source is nonfunctional, or solely because its normal power source is nonfunctional, it may be considered FUNCTIONAL for the purpose of satisfying the requirements of its applicable Limiting Condition for Operation, provided: (1) its corresponding normal or emergency power source is FUNCTIONAL; and (2) all of its redundant system(s), subsystem(s), train(s), component(s) and device(s) are FUNCTIONAL, or likewise satisfy the requirements of this specification.
6. Equipment removed from service or declared nonfunctional to comply with ACTIONS may be returned to service under administrative control solely to perform testing required to demonstrate its FUNCTIONALITY or the FUNCTIONALITY of other equipment. This is an exception to Condition IV.B.2.a(2) for the system returned to service under administrative control to perform the testing required to demonstrate FUNCTIONALITY.

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#### IV.B2.b – SURVEILLANCE REQUIREMENTS

1. Surveillance Requirements shall be applicable during any condition specified for individual Limiting Conditions for Operation unless otherwise stated in an individual Surveillance Requirement.
2. Each Surveillance Requirement shall be performed within the specified time interval with a maximum allowable extension not to exceed 25% of the surveillance time interval.
3. Failure to perform a Surveillance Requirement within the allowed surveillance interval, defined by Condition IV.B2.b(2), shall constitute a failure to meet the FUNCTIONALITY requirements for a Limiting Condition for Operation. The time limits of the ACTION requirements are applicable at the time it is identified that a Surveillance Requirement has not been performed. The ACTION requirements may be delayed for up to 24 hours to permit the completion of the surveillance when the allowable outage time limits of the ACTION requirements are less than 24 hours. Surveillance Requirements do not have to be performed on nonfunctional equipment.
4. Entry into any specified condition shall not be made unless the Surveillance Requirement(s) associated with the Limiting Condition for Operation have been performed within the stated surveillance interval or as otherwise specified.

## IV.C. Radioactive Effluent Monitoring Instrumentation

### 1. Radioactive Liquid Effluent Monitoring Instrumentation

#### LIMITING CONDITIONS OF OPERATIONS

The radioactive liquid effluent monitoring instrumentation channels shown in Table IV.C.-1 shall be FUNCTIONAL with applicable alarm/trip setpoints set to ensure that the limits of Specification IV.D.1.a. are not exceeded. The setpoints shall be determined in accordance with methods and parameters described in Section II.

APPLICABILITY: As shown in Table IV.C.-1

#### ACTION:

- a. With a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above Specification, without delay suspend the release of radioactive liquid effluents monitored by the affected channel, or declare the channel nonfunctional, or change the setpoint so it is acceptably conservative.
- b. With the number of channels less than the minimum channels FUNCTIONAL requirement, take the action shown in Table IV.C.-1. Exert best efforts to restore the nonfunctional monitor to FUNCTIONAL status within 30 days and, if unsuccessful, explain in the next Radioactive Effluent Release Report why the nonfunctionality was not corrected in a timely manner. Releases need not be terminated after 30 days provided the specified actions are continued.

#### SURVEILLANCE REQUIREMENTS

Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated FUNCTIONAL by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table IV.C.-2.

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**TABLE IV.C. -1  
Radioactive Liquid Effluent Monitoring Instrumentation**

Instrument	Action when not functional	Notes
<b>1. Gross Radioactivity Monitors Providing Alarm and Automatic Termination Of Release</b>		
(a) Clean Liquid Radwaste Effluent Line	A	1
(b) Aerated Liquid Radwaste Effluent Line	A	2
(c) Steam Generator Blowdown Monitor	B	3
(d) Condensate Polishing Facility Waste Neut Sump	E	2
<b>2. Gross Radioactivity Monitors Providing Alarm and Not Providing Automatic Termination Of Release</b>		
(a) Reactor Building Closed Cooling Water Monitor	C	1
<b>3. Flow Rate Measurements – No Alarm Setpoint Requirements</b>		
(a) Clean Liquid Radwaste Effluent Line	D	1
(b) Aerated Liquid Radwaste Effluent Line	D	1
(c) Condensate Polishing Facility	D	1

1. Required to be functional at all times – which means that channels shall be FUNCTIONAL and in service on a continuous, uninterrupted basis, except that outages are permitted, for a maximum of 12 hours, for the purpose of maintenance and performance of required test, checks, calibrations, or sampling associated with the instrument or any system or component which affects functioning of the instrument.
2. Required to be functional whenever the discharge pathway is being used except that outages are permitted, for a maximum of 12 hours, for the purpose of maintenance and performance of required test, checks, calibrations, or sampling associated with the instrument or any system or component which affects functioning of the instrument.
3. Required to be functional in MODEs 1–4, except that outages are permitted, for a maximum of 12 hours, for the purpose of maintenance and performance of required test, checks, calibrations, or sampling associated with the instrument or any system or component which affects functioning of the instrument.

**ACTION STATEMENTS**

**Action A**

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirements, effluent releases may continue provided that best efforts are made to repair the instrument and that prior to initiating a release:

- (1) At least two independent samples are analyzed for gamma radioactivity as specified in Table I.C.-2, and;
- (2) The original release rate calculations and discharge valving are independently verified by a second individual.

### Action B

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, either:

- (1) Suspend all effluent releases via this pathway, or
- (2) Make best efforts to repair the instrument and obtain grab samples and analyze for gamma radioactivity as specified in Table I.C.-2;
  - a) Once per 12 hours when the specific activity of the secondary coolant is greater than 0.01  $\mu\text{Ci/gm}$  DOSE EQUIVALENT I-131.
  - b) Once per 24 hours when the specific activity of the secondary coolant is less than or equal to 0.01  $\mu\text{Ci/gm}$  DOSE EQUIVALENT I-131.

### Action C

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument and that once per 12 hours grab samples of the service water effluent are collected and analyzed for gamma radioactivity at LLD as specified in Table I.C.-2;

### Action D

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument and that the flow rate is estimated once per 4 hours during actual releases. Pump performance curves may be used to estimate flow.

### Action E

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirements, effluent releases may continue provided that best efforts are made to repair the instrument and that prior to initiating a release:

- (1) At least two independent samples are analyzed for gamma radioactivity as specified in Table I.C.-2, and;
- (2) If one of the samples has gamma radioactivity greater than any of the LLDs in Table I.C.-2, the original release rate calculations and discharge valving are independently verified by a second individual.

**TABLE IV.C.-2  
Radioactive Liquid Effluent Monitoring Instrumentation Surveillance Requirements**

Instrument	Channel Check	Source Check	Channel Calibration	Channel Functional Test
<b>1. Gross Radioactivity Monitors Providing Alarm and Automatic Termination Of Release</b>				
a. Clean Liquid Radwaste Effluent Line	D*	P	R(1)	Q(2)
b. Aerated Liquid Radwaste Effluent Line	D*	P	R(1)	Q(2)
c. Steam Generator Blowdown Monitor	D*	M	R(1)	Q(2)
d. Condensate Polishing Facility Waste Neut Sump	D*	P	R(1)	Q(2)
<b>2. Gross Radioactivity Monitors Providing Alarm But Not Providing Automatic Termination Of Release</b>				
a. Reactor Building Closed Cooling Water Monitor	D*	M	R(1)	Q(2)
<b>3. Flow Rate Measurements</b>				
a. Clean Liquid Radwaste Effluent Line	D*	N/A	R	Q
b. Aerated Liquid Radwaste Effluent Line	D*	N/A	R	Q
c. Condensate Polishing Facility Waste Neut Sump	D*	N/A	R	Q

D = Daily  
M = Monthly  
P = Prior to each batch release

R = Once every 18 months  
Q = Once every 3 months  
N/A = Not Applicable

**TABLE IV.C.-2  
TABLE NOTATION**

\* During releases via this pathway and when the monitor is required FUNCTIONAL per Table IV.C.-1. The CHANNEL CHECK should be done when the discharge is in progress.

- (1) Calibration shall include the use of a radioactive liquid or solid source which is traceable to an NIST source.
- (2) The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exist:
  - a) Instrument indicates measured levels above the alarm/trip setpoint.
  - b) Instrument indicates a downscale or circuit failure.
    - Automatic isolation of the discharge stream shall also be demonstrated for this case for each monitor except the reactor building closed cooling water monitor.

2. Radioactive Gaseous Effluent Monitoring Instrumentation

LIMITING CONDITIONS OF OPERATIONS

The radioactive gaseous effluent monitoring instrumentation channels shown in Table IV.C.-3 shall be FUNCTIONAL with applicable alarm setpoints set to ensure that the limits of Specifications IV.D.2.a. are not exceeded. The setpoints shall be determined in accordance with methods and parameters described in Section II.

APPLICABILITY: As shown in Table IV.C.-3

ACTION:

- a. With a radioactive gaseous effluent monitoring instrumentation channel alarm setpoint less conservative than required by the above specification, without delay suspend the release of radioactive gaseous effluents monitored by the affected channel, or declare the channel nonfunctional, or change the setpoint so it is acceptably conservative.
- b. With the number of channels less than the minimum channels FUNCTIONAL requirement, take the action shown in Table IV.C.-3. Exert best efforts to restore the nonfunctional monitor to FUNCTIONAL status within 30 days and, if unsuccessful, explain in the next Radioactive Effluent Release Report why the nonfunctionality was not corrected in a timely manner. Release need not be terminated after 30 days provided the specified actions are continued.

SURVEILLANCE REQUIREMENTS

Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated FUNCTIONAL by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table IV.C.-4.

**TABLE IV.C.-3  
Radioactive Gaseous Effluent Monitoring Instrumentation**

Instrument	Action when not functional	Notes
1.MP2 Vent (normal range, RM-8132 only; high range monitor, RM-8168, requirements are in the TS)		
a. Noble Gas Radioactivity Monitor	A	1, 3
b. Iodine Sampler	B	1
c. Particulate Sampler	B	1
d. Vent Flow Rate Monitor	C	1
e. Sampler Flow Rate Monitor	C	1
2.Millstone Stack – applicable to the WRGM (RM-8169, normal range, channel 1, only; mid range channel 2 and high range channel 3 requirements are contained in TRM LCO 3.3.3.8)		
a. Noble Gas Radioactivity Monitor	E	1, 3
b. Iodine Sampler	B	1
c. Particulate Sampler	B	1
d. Stack Flow Rate Monitor	C	1
e. Sampler Flow Rate Monitor	C	1
3.Waste Gas Holdup System		
a. Noble Gas Monitor Providing Automatic Termination of Release	D	2, 4

- 1 Required to be functional at all times when air is being released to the environment by the pathway being monitored. The channel shall be FUNCTIONAL and in service on a continuous, uninterrupted basis. Outages are permitted for a maximum of 12 hours for the purpose of maintenance and performance of required tests, checks, calibrations, or sampling associated with the instrument or any system or component which affects functioning of the instrument.
- 2 Required to be functional during waste gas holdup system discharge.
- 3 Alarm setpoint with required. Automatic isolation feature is not required.
- 4 Alarm setpoint required. Automatic isolation feature is required.

**ACTION STATEMENTS**

Action A

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument and that grab samples are taken once per 12 hours and these samples are analyzed for gamma radioactivity within 24 hours. If the monitor flow and readout are not adversely affected by the loss of functionality, the daily CHANNEL CHECK may be performed in lieu of the grab sample.



#### Action B

With the number of samplers FUNCTIONAL less than required by the Minimum number FUNCTIONAL requirement, effluent releases via this pathway may continue provided that the best efforts are made to repair the instrument and that effluent is continuously sampled with auxiliary sampling equipment and collected at least once per seven (7) days and analyzed for principal gamma emitters with half lives greater than 8 days within 48 hours after the end of the sampling period. Auxiliary sampling must be initiated within 12 hours of initiation of this action statement. Operation of the auxiliary sampling equipment shall be verified every twelve (12) hours. Auxiliary sampling outages are permitted for a maximum of 12 hours for the purpose of maintenance and performance of required tests, checks, calibrations, or sampling.

#### Action C

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument and that the flow rate is estimated once per 5 hours. Sample flow rate need not be estimated if the auxiliary sampling equipment of Action B is in use.

#### Action D

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement:

Releases from the Millstone Unit 2 waste gas system may continue provided that best efforts are made to repair the instrument and that prior to initiating the release:

- a) At least two independent samples of the tank's contents are analyzed; and
- b) The original release rate calculations and discharge valve lineups are independently verified by a second individual. Otherwise, suspend releases from the waste gas holdup system.

#### Action E

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, Millstone Unit 2 releases via the Millstone Stack may continue provided that best efforts are made to repair the instrument and that grab samples are taken once per 12 hours and these samples are analyzed for gamma radioactivity within 24 hours. If the monitor flow and readout are not adversely affected by the loss of functionality, the daily CHANNEL CHECK may be performed in lieu of the grab sample.



**TABLE IV.C.-4  
Radioactive Gaseous Effluent Monitoring Instrumentation Surveillance Requirements**

Instrument	Channel Check	Source Check	Channel Calibration	Channel Functional Test
1.MP2 Vent (normal range, RM-8132 only; high range monitor, RM-8168, requirements are in the TS)				
a. Noble Gas Radioactivity Monitor	D	M	R <sup>(1)</sup>	Q <sup>(2)</sup>
b. Iodine Sampler	W	NA	NA	NA
c. Particulate Sampler	W	NA	NA	NA
d. Vent Flow Rate Monitor	D	NA	R	Q
e. Sampler Flow Rate Monitor	D	NA	R	NA
2.Millstone Stack – applicable to the WRGM (RM-8169, normal range, channel 1, only; mid range channel 2 and high range channel 3 requirements are contained in TRM LCO 3.3.3.8)				
a. Noble Gas Radioactivity Monitor	D	M	R <sup>(1)</sup>	Q <sup>(2)</sup>
b. Iodine Sampler	W	NA	NA	NA
c. Particulate Sampler	W	NA	NA	NA
d. Stack Flow Rate Monitor	D	NA	R	Q
e. Sampler Flow Rate Monitor	D	NA	R	NA
3.Waste Gas Holdup System				
a. Noble Gas Monitor	D*	P	R <sup>(1)</sup>	Q <sup>(2)</sup>

\*During releases via this pathway and when the monitor is required FUNCTIONAL per Table IV.C.-3. The CHANNEL CHECK should be performed when the discharge is in progress.

P = Prior to discharge  
D = Daily  
W = Weekly  
M = Monthly

R = Once every 18 months  
Q = Once every 3 months  
NA= Not Applicable

**TABLE IV.C.-4  
TABLE NOTATION**

(1) Calibration shall include the use of a known source whose strength is determined by a detector which has been calibrated to a source which is traceable to the NIST. These sources shall be in a known, reproducible geometry.

(2) The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation\* occurs if any of the following conditions exist:

- a) Instrument indicates measured levels above the alarm/trip setpoint.
- b) Instrument indicates a downscale failure.

\* – Also demonstrate automatic isolation for the waste gas system noble gas monitor.

## IV.D. Radioactive Effluents Concentrations And Dose Limitations

1. Radioactive Liquid Effluents
  - a. Radioactive Liquid Effluents Concentrations

### LIMITING CONDITIONS OF OPERATIONS

The concentration of radioactive material released from the site (see Figure IV.D. -1) shall not exceed ten times the concentrations specified in 10 CFR 20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall not exceed  $2 \times 10^{-4}$   $\mu\text{Ci/ml}$  total radioactivity.

APPLICABILITY: At all times.

### ACTION:

With the concentration of radioactive material released from the site exceeding the above limits, restore the concentration to within the above limits within 15 minutes.

### SURVEILLANCE REQUIREMENTS

- 1) Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program specified in Section I.
- 2) The results of the radioactive analysis shall be used in accordance with the methods of Section II to assure that the concentrations at the point of release are maintained within the limits of Specification IV.D.1.a.

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b. Radioactive Liquid Effluents Doses

LIMITING CONDITIONS OF OPERATIONS

The dose or dose commitment to any REAL MEMBER OF THE PUBLIC from radioactive materials in liquid effluents from Unit 2 released from the site (see Figure IV.D.-1) shall be limited:

- a. During any calendar quarter to less than or equal to 1.5 mrem to the total body and to less than or equal to 5 mrem to any organ; and,
- b. During any calendar year to less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ.

APPLICABILITY: At all times.

ACTION:

- a. With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits prepare and submit to the Commission within 30 days a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce the releases of radioactive materials in liquid effluents and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limit.

SURVEILLANCE REQUIREMENTS

- 1) Dose Calculations. Cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined in accordance with the methodology and parameters in Section II at least once per 31 days.
- 2) Relative accuracy or conservatism of the calculations shall be confirmed by performance of the Radiological Environmental Monitoring Program as detailed in Section I.

2. Radioactive Gaseous Effluents

a. Radioactive Gaseous Effluents Dose Rate

LIMITING CONDITIONS OF OPERATIONS

The dose rate, at any time, offsite (see Figure IV.D.—1) due to radioactivity released in gaseous effluents from the site shall be limited to the following values:

- a. The dose rate limit for noble gases shall be less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin; and,
- b. The dose rate limit for Iodine—131, Iodine—133, Tritium, and for all radioactive materials in particulate form with half lives greater than 8 days shall be less than or equal to 1500 mrem/yr to any organ.

APPLICABILITY: At all times.

ACTION:

With the dose rate(s) exceeding the above limits, decrease the release rate to comply with the limit(s) given in Specification IV.D.2.a. within 15 minutes.

SURVEILLANCE REQUIREMENTS

- 1) The release rate, at any time, of noble gases in gaseous effluents shall be controlled by the offsite dose rate as established above in Specification IV.D.2.a. The corresponding release rate shall be determined in accordance with the methodology of Section II.
- 2) The noble gas effluent monitors of Table IV.C.—3 shall be used to control release rates to limit offsite doses within the values established in Specification IV.D.2.a.
- 3) The release rate of Iodine—131, Iodine—133, tritium and for all radioactive materials in particulate form with half lives greater than 8 days in gaseous effluents shall be determined by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Section I. The corresponding dose rate shall be determined using the methodology given in Section II.

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b. Radioactive Gaseous Effluents Noble Gas Dose

LIMITING CONDITIONS OF OPERATIONS

The air dose offsite (see Figure IV.D.-1) due to noble gases released in gaseous effluents from Unit 2 shall be limited to the following:

- a. During any calendar quarter, to less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation;
- b. During any calendar year to less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

APPLICABILITY: At all times.

ACTION:

- a. With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits prepare and submit to the Commission within 30 days a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce the releases of radioactive noble gases in gaseous effluents and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limit.

SURVEILLANCE REQUIREMENTS

- 1) Dose Calculations – Cumulative dose contributions for the current calendar quarter and current calendar year shall be determined in accordance with Section II once every 31 days.
- 2) Relative accuracy or conservatism of the calculations shall be confirmed by performance of the Radiological Environmental Monitoring Program as detailed in Section I.

- c. Gaseous Effluents – Doses from Radionuclides Other than Noble Gas

LIMITING CONDITIONS OF OPERATIONS

The dose to any REAL MEMBER OF THE PUBLIC from Iodine-131, Iodine-133, Tritium, C-14, and radioactive materials in particulate form with half lives greater than 8 days in gaseous effluents released offsite from Unit 2 (see Figure IV.D.-1) shall be limited to the following:

- a. During any calendar quarter to less than or equal to 7.5 mrem to any organ;
- b. During any calendar year to less than or equal to 15 mrem to any organ.

APPLICABILITY: At all times.

ACTION:

- a. With the calculated dose from the release of radioiodines, radioactive materials in particulate form, or radionuclides other than noble gases in gaseous effluents exceeding any of the above limits prepare and submit to the Commission within 30 days a Special Report which identifies the cause(s) for exceeding the limit and defines the corrective actions to be taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limit.

SURVEILLANCE REQUIREMENTS

- 1) Dose Calculations – Cumulative dose contributions for the current calendar quarter and current calendar year shall be determined in accordance with Section II once every 31 days.
- 2) Relative accuracy or conservatism of the calculations shall be confirmed by performance of the Radiological Environmental Monitoring Program as detailed in Section I.



#### IV.E. Total Radiological Dose From Station Operation

##### CONTROLS

The annual dose or dose commitment to any REAL MEMBER OF THE PUBLIC, beyond the site boundary, from the Millstone Site is limited to less than or equal to 25 mrem to the total body or any organ (except the thyroid, which is limited to less than or equal to 75 mrem).

APPLICABILITY: At all times.

##### ACTION:

With the calculated dose from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Controls IV.D.2.a., IV.D.1.b., or IV.D.2.c. prepare and submit a Special Report to the Commission within 30 days and limit the subsequent releases such that the dose commitment from the site to any REAL MEMBER OF THE PUBLIC from the Millstone Site is limited to less than or equal to 25 mrem to the total body or any organ (except thyroid, which is limited to less than or equal to 75 mrem) over 12 consecutive months. This Special Report shall include an analysis which demonstrates that radiation exposures from the site to any REAL MEMBER OF THE PUBLIC from the Millstone Site (including all effluent pathways and direct radiation) are less than the 40 CFR 190.

If the estimated doses exceed the above limits, the Special Report shall include a request for a variance in accordance with the provisions of 40 CFR 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

##### SURVEILLANCE REQUIREMENTS

Cumulative dose contributions from liquid and gaseous effluents and direct radiation from the Millstone Site shall be determined in accordance with Section II once per 31 days.

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# SECTION V.

## Millstone Unit 3

### Radiological Effluent Controls

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## SECTION V. REMODCM UNIT THREE CONTROLS

### V.A. Introduction

The purpose of this section is to provide the following for Millstone Unit Three:

- a. the effluent radiation monitor controls and surveillance requirements,
- b. the effluent radioactivity concentration and dose controls and surveillance requirements, and
- c. the bases for the controls and surveillance requirements.

Definitions of certain terms are provided as an aid for implementation of the controls and requirements.

Some surveillance requirements refer to specific sub-sections in Sections I and II as part of their required actions.

### V.B. Definitions and Applicability and Surveillance Requirements

#### V.B.1 – Definitions

The defined terms of this sub-section appear in capitalized type and are applicable throughout Section V.

1. **ACTION** – **ACTION** shall be that part of the control which prescribes remedial measures required under designated conditions.
2. **CHANNEL FUNCTIONAL TEST** – A **CHANNEL FUNCTIONAL TEST** shall be the injection of a simulated signal into the channel as close to the sensor as practicable to verify **FUNCTIONALITY** of alarm, interlock and/or trip functions. For digital instruments, the computer database may be manipulated, in lieu of a signal injection, to verify functionality of alarm and/or trip functions.

The **CHANNEL FUNCTIONAL TEST** shall include adjustments, as necessary, of the alarm, interlock and/or trip setpoints such that the setpoints are within the required range and accuracy.

3. CHANNEL CALIBRATION – A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel such that it responds within the required range and accuracy to known values of input. The CHANNEL CALIBRATION shall encompass the entire channel including the sensors and alarm, interlock and/or trip functions and may be performed by any series of sequential, overlapping, or total channel steps such that the entire channel is calibrated.
4. CHANNEL CHECK – A CHANNEL CHECK shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter.
5. DOSE EQUIVALENT I-131 – DOSE EQUIVALENT I-131 shall be that concentration of I-131 ( $\mu\text{Ci}/\text{gram}$ ) which alone would produce the same CDE-thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134, and I-135 actually present. The thyroid dose conversion factors used for this calculation shall be those listed under Inhalation in Federal Guidance Report No. 11 (FGR 11), "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion."
6. MEMBER(S) OF THE PUBLIC – MEMBER(S) OF THE PUBLIC shall include all persons who are not occupationally associated with the plant. This category does not include employees of the licensee, its contractors or its vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational, or other purposes not associated with the plant.

The term "REAL MEMBER OF THE PUBLIC" means an individual who is exposed to existing dose pathways at one particular location.

7. MODE – Refers to Mode of Operation as defined in Safety Technical Specifications.
8. FUNCTIONAL – FUNCTIONALITY – An instrument shall be FUNCTIONAL or have FUNCTIONALITY when it is capable of performing its specified function(s) and when all necessary attendant instrumentation, controls, electrical power, or other auxiliary equipment that are required for the instrument to perform its function(s) are also capable of performing their related support function(s).
9. SITE BOUNDARY – The SITE BOUNDARY shall be that line beyond which the land is not owned, leased, or otherwise controlled by the licensee.

10. SOURCE CHECK – A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to radiation.
11. UNRESTRICTED AREA – Any area at or beyond the SITE BOUNDARY to which access is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials or any area within the SITE BOUNDARY used for residential quarters or industrial, commercial, institutional and/or recreational purposes.

### **V.B.2 – Applicability**

#### **V.B.2.a – LIMITING CONDITIONS FOR OPERATION**

1. Compliance with the Limiting Conditions for Operation contained in the succeeding specifications is required during the OPERATIONAL MODES or other conditions specified therein; except that upon failure to meet the Limiting Conditions for Operation, the associated ACTION requirements shall be met.
2. Noncompliance with a specification shall exist when the requirements of the Limiting Condition for Operation and associated ACTION requirements are not met within the specified time intervals. If the Limiting Condition for Operation is restored prior to expiration of the specified time intervals, completion of the ACTION requirements is not required.

#### **V.B.2.b – SURVEILLANCE REQUIREMENTS**

1. Surveillance Requirements shall be applicable during any condition specified for individual Limiting Conditions for Operation unless otherwise stated in an individual Surveillance Requirement.
2. Each Surveillance Requirement shall be performed within the specified time interval with a maximum allowable extension not to exceed 25% of the surveillance time interval.
3. Failure to perform a Surveillance Requirement within the allowed surveillance interval, defined by Condition V.B.2.b(2), shall constitute a failure to meet the FUNCTIONALITY requirements for a Limiting Condition for Operation. The time limits of the ACTION requirements are applicable at the time it is identified that a Surveillance Requirement has not been performed. The ACTION requirements may be delayed for up to 24 hours to permit the completion of the surveillance when the allowable outage time limits of the ACTION requirements are less than 24 hours. Surveillance Requirements do not have to be performed on nonfunctional equipment.

4. Entry into any specified condition shall not be made unless the Surveillance Requirement(s) associated with the Limiting Condition for Operation have been performed within the stated surveillance interval or as otherwise specified.

#### V.C. Radioactive Effluent Monitoring Instrumentation

1. Radioactive Liquid Effluent Monitoring Instrumentation

##### LIMITING CONDITIONS OF OPERATION

The radioactive liquid effluent monitoring instrumentation channels shown in Table V.C.–1 shall be FUNCTIONAL with their Alarm/Trip setpoints set to ensure that the limits of Specification V.D.1.a are not exceeded. The alarm/trip setpoints shall be determined in accordance with methodology and parameters as described in Section II.

APPLICABILITY: As shown in Table V.C.–1

##### ACTION:

- a. With a radioactive liquid effluent monitoring instrumentation channel Alarm/Trip setpoint less conservative than required by the above specification, without delay suspend the release of radioactive liquid effluents monitored by the affected channel, or declare the channel nonfunctional, or change the setpoint so it is acceptably conservative.
- b. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels FUNCTIONAL, take the action shown in Table V.C.–1. Exert best efforts to restore the nonfunctional instrumentation to FUNCTIONAL status within 30 days and, if unsuccessful, explain in the next Radioactive Effluent Release Report why the nonfunctionality was not corrected in a timely manner. Releases need not be terminated after 30 days provided the specified actions are continued.

##### SURVEILLANCE REQUIREMENTS

Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated FUNCTIONAL by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL OPERATIONAL TEST at the frequencies shown in Table V.C.–2.

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**TABLE V.C.-1  
Radioactive Liquid Effluent Monitoring Instrumentation**

Instrument	Action when not functional	Notes
<b>1. Radioactivity Monitors Providing Alarm and Automatic Termination Of Release</b>		
a. Waste Neutralization Sump Monitor Condensate Polishing Facility	D	2
b. Turbine Building Floor Drains	B	1
c. Liquid Waste Monitor	A	1
d. RESERVED		
e. Steam Generator Blowdown Monitor	B	3
<b>2. Flow Rate Measurement Devices -- No Alarm Setpoint Requirements</b>		
a. Waste Neutralization Sump Effluents	C	1
b. RESERVED		
c. Liquid Waste Effluent Line	C	1
d. RESERVED		
e. Steam Generator Blowdown Effluent Line	C	3

- 1 Required to be functional at all times – which means that channels shall be FUNCTIONAL and in service on a continuous, uninterrupted basis, except that outages are permitted, for a maximum of 12 hours, for the purpose of maintenance and performance of required test, checks, calibrations, or sampling associated with the instrument or any system or component which affects functioning of the instrument.
  
- 2 Required to be functional in MODEs 1–5, and MODE 6 when discharge pathway is being used, except that outages are permitted, for a maximum of 12 hours, for the purpose of maintenance and performance of required test, checks, calibrations, or sampling associated with the instrument or any system or component which affects functioning of the instrument. The monitor must be on-line with no unexpected alarms.
  
- 3 Required to be functional in MODEs 1–4, except that outages are permitted, for a maximum of 12 hours, for the purpose of maintenance and performance of required test, checks, calibrations, or sampling associated with the instrument or any system or component which affects functioning of the instrument. The monitor must be on-line with no unexpected alarms.

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**TABLE V.C. -1**  
**ACTION STATEMENTS**

Action A

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirements, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument and that prior to initiating a release:

1. At least two independent samples are analyzed for gamma radioactivity as specified in Table I.C-3, and;
2. The original release rate calculations and discharge line valving are independently verified by a second individual.

Action B

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided best efforts are made to repair the instrument and that grab samples are analyzed for gamma radioactivity specified in Table I.C.-3:

1. At least once per 12 hours when the specific activity of the secondary coolant is greater than 0.01  $\mu\text{Ci}/\text{gram}$  DOSE EQUIVALENT I-131, or
2. At least once per 24 hours when the specific activity of the secondary coolant is less than or equal to 0.01  $\mu\text{Ci}/\text{gram}$  DOSE EQUIVALENT I-131.

Action C

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument and that the flow rate is estimated at least once per 4 hours during actual releases. Pump performance curves may be used to estimate flow.

Action D

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirements, effluent releases may continue provided that best efforts are made to repair the instrument and that prior to initiating a release:

1. At least two independent samples are analyzed for gamma radioactivity as specified in Table I.C-3, and;
2. If one of the samples has gamma radioactivity greater than any of the lower limits of detection specified in Table I.C.-3, the original release rate calculations and discharge valving are independently verified by a second individual.

TABLE V.C. -2 Radioactive Liquid Effluent Monitoring Instrumentation Surveillance Requirements				
Instrument	Channel Check	Source Check	Channel Calibration	Channel Functional Test
1. Radioactivity Monitors Providing Alarm and Automatic Termination Of Release				
a. Waste Neutralization Sump Monitor Condensate Polishing Facility	D	P	R <sup>(2)</sup>	Q <sup>(1)</sup>
b. Turbine Building Floor Drains	D	M	R <sup>(2)</sup>	Q <sup>(1)</sup>
c. Liquid Waste Monitor	D	P	R <sup>(2)</sup>	Q <sup>(1)</sup>
d. Deleted				
e. Steam Generator Blowdown Monitor	D	M	R <sup>(2)</sup>	Q <sup>(1)</sup>
2. Flow Rate Measurements				
a. Waste Neutralization Sump Effluents	D <sup>(3)</sup>	NA	R	Q
b. RESERVED				
c. Liquid Waste Effluent Line	D <sup>(3)</sup>	N/A	R	Q
d. Deleted				
e. Steam Generator Blowdown Effluent Line	D <sup>(3)</sup>	N/A	R	Q

D = Daily  
M = Monthly  
P = Prior to each batch release

R = Once every 18 months  
Q = Once every 3 months  
N/A = Not Applicable

**TABLE V.C. -2  
TABLE NOTATION**

- (1) The CHANNEL FUNCTIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exists:
- Instrument indicates measured levels above the alarm/trip setpoint, or
  - Circuit failure (Alarm only), or Instrument indicates a downscale failure (Alarm only).
- (2) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Institute of Standards and Technology (NIST) or using standards that have been obtained from suppliers that participate in measurement assurance activities of NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used.
- (3) CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days on which continuous, periodic, or batch releases are made.

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## 2. Radioactive Gaseous Effluent Monitoring Instrumentation

### LIMITING CONDITIONS OF OPERATION

The radioactive gaseous effluent monitoring instrumentation channels shown in Table V.C.–3 shall be FUNCTIONAL with their Alarm Setpoints set to ensure that the limits of Specification V.D.2.a. are not exceeded. The Alarm Setpoints of these channels shall be determined in accordance with the methodology and parameters in Section II.

APPLICABILITY: As shown in Table V.C.–3.

### ACTION:

- a. With a radioactive gaseous effluent monitoring instrumentation channel Alarm Setpoint less conservative than required by the above specification, without delay suspend the release of radioactive gaseous effluents monitored by the affected channel, or declare the channel nonfunctional, or change the setpoint so it is acceptably conservative.
- b. With the number of FUNCTIONAL radioactive gaseous effluent monitoring instrumentation channels less than the Minimum Channels FUNCTIONAL, take the ACTION shown in Table V.C.–3. Exert best efforts to restore the nonfunctional instrumentation to FUNCTIONAL status within 30 days and, if unsuccessful, explain in the next Radioactive Effluent Release Report why the nonfunctionality was not corrected in a timely manner. Release need not be terminated after 30 days provided the specified actions are continued.

### SURVEILLANCE REQUIREMENT

Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated FUNCTIONAL by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST at the frequencies shown in Table V.C.–4.

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**TABLE V.C.-3  
Radioactive Gaseous Effluent Monitoring Instrumentation**

Instrument	Action when not functional	Notes
1. Millstone Unit 3 Ventilation Vent (Turbine Building – HVR–RE10B, normal range only; high range monitor, HVR–RE10A, requirements are in the TRM)		
a. Noble Gas Radioactivity Monitor Providing Alarm	A	1, 2
b. Iodine Sampler	B	1, 2
c. Particulate Sampler	B	1, 2
d. Vent Flow Rate Monitor	C	1, 2
e. Sampler Flow Rate Monitor	C	1
2. Millstone Stack – applicable to SLCRS (HVR–RE19B, normal range only; high range monitor, HVR–RE19A, requirements are in the TRM)		
a. Noble Gas Radioactivity Monitor Providing Alarm	A	1, 2
b. Iodine Sampler	B	1, 2
c. Particulate Sampler	B	1, 2
d. Process Flow Rate Monitor	C	1, 2
e. Sampler Flow Rate Monitor	C	1
3. Engineered Safeguards Building Monitor (HVQ–RE49)		
a. Noble Gas Radioactivity Monitor	D	1
b. Iodine Sampler	B	1
c. Particulate Sampler	B	1
d. Discharge Flow Rate Monitor	E	1
e. Sampler Flow Rate Monitor	C	1

**TABLE V.C.-3  
Table Notations**

- 1 Instrument required to be functional whenever the release path is in service. Outages are permitted for a maximum of 12 hours for the purpose of maintenance and performance of required tests, checks, calibrations, or sampling associated with the instrument or any system or component which affects functioning of the instrument.
- 2 When the Ventilation Vent Flow Rate Monitor or Millstone Stack Process Flow Rate Monitor is nonfunctional because of degraded flow indication, the Noble Gas Monitor and Iodine and Particulate Samplers for the affected pathway (Ventilation Vent or Millstone Stack) remain functional as long as there is a minimum indicated process flow.

**TABLE V.C. -3**  
**ACTION STATEMENTS**

**Action A**

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that

- a) best efforts are made to repair the instrument and that grab samples are taken at least once per 12 hours and these samples are analyzed for gamma radioactivity within 24 hours, OR
- b) if the cause of the nonfunctionality is solely due to a loss of annunciation in the control room and the Remote Indicating Controller (RIC) remains FUNCTIONAL, perform a channel check at the RIC at least once per twelve hours and verify the indication has not alarmed.

**Action B**

With the number of samplers FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that the best efforts are made to repair the instrument and that effluent is continuously sampled with auxiliary sampling equipment at least once per seven (7) days and analyzed for principal gamma emitters with half lives greater than 8 days within 48 hours after the end of the sampling period. Auxiliary sampling must be initiated within 12 hours after initiation of this ACTION statement. Operation of the auxiliary sampling equipment shall be verified every twelve (12) hours. Auxiliary sampling outages are permitted for a maximum of 12 hours for the purpose of maintenance and performance of required tests, checks, calibrations, or sampling.

**Action C**

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument and that the flow rate is estimated at least once per 5 hours. Sample flow rate need not be estimated if the auxiliary sampling equipment of Action B is in use.

**Action D**

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument and that grab samples are taken at least once per 12 hours and these samples are analyzed for gamma radioactivity within 24 hours.

**Action E**

With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that best efforts are made to repair the instrument.

**TABLE V.C.-4  
Radioactive Gaseous Effluent Monitoring Instrumentation Surveillance Requirements**

Instrument	Channel Check	Source-Check	Channel Calibration	Channel Functional Check	When Surveillance is Required
<b>1. Millstone Unit 3 Ventilation Vent (Turbine Building – HVR–RE10B, normal range only; high range monitor, HVR–RE10A, requirements are in the TRM)</b>					
a. Noble Gas Radioactivity Monitor Providing Alarm	D	M	R <sup>(1)</sup>	Q <sup>(2)</sup>	*
b. Iodine Sampler	W	NA	NA	NA	*
c. Particulate Sampler	W	NA	NA	NA	*
d. Vent Flow Rate Monitor	D	NA	R	Q	*
e. Sampler Flow Rate Monitor	D	NA	R	Q	*
<b>2. Millstone Stack – applicable to SLCRS (HVR–RE19B, normal range only; high range monitor, HVR–RE19A, requirements are in the TRM)</b>					
a. Noble Gas Radioactivity Monitor Providing Alarm	D	M	R <sup>(3)</sup>	Q <sup>(2)</sup>	*
b. Iodine Sampler	W	NA	NA	NA	*
c. Particulate Sampler	W	NA	NA	NA	*
d. Process Flow Rate Monitor	D	NA	R	Q	*
e. Sampler Flow Rate Monitor	D	NA	R	Q	*
<b>3. Engineered Safeguards Building Monitor (HVQ–RE49)</b>					
a. Noble Gas Radioactivity Monitor Providing Alarm	D	M	R <sup>(1)</sup>	Q <sup>(2)</sup>	*
b. Iodine Sampler	W	NA	NA	NA	*
c. Particulate Sampler	W	NA	NA	NA	*
d. Discharge Flow Rate Monitor	D	NA	R	Q	*
e. Sampler Flow Rate Monitor	D	NA	R	Q	*

\* At all times except when the vent path is isolated.

D = Daily  
W = Weekly  
M = Monthly

R = Once every 18 months  
Q = Once every 3 months  
N/A = Not Applicable

**TABLE V.C.-4**  
**Table Notations**

- (1) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Institute of Standards and Technology (NIST) or using standards that have been obtained from suppliers that participate in measurement assurance activities of NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used.
- (2) The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exist:
  - a) Instrument indicates measured levels above the Alarm Setpoint, or
  - b) Circuit failure, or
  - c) Instrument indicates a downscale failure.
- (3) The CHANNEL CALIBRATION shall include the use of a known source whose strength is determined by a detector which has been calibrated to an NIST source. These sources shall be in know, reproduciblè geometry.

## V.D. Radioactive Effluents Concentrations And Dose Limitations

1. Radioactive Liquid Effluents
  - a. Radioactive Liquid Effluents Concentrations

### LIMITING CONDITIONS OF OPERATION

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The concentration of radioactive material released from the site (see Figure V.D. - 1) shall be limited to ten times the concentrations specified in 10 CFR 20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall not exceed  $2 \times 10^{-4}$   $\mu\text{Ci/ml}$  total radioactivity.

APPLICABILITY: At all times.

### ACTION:

With the concentration of radioactive material released from the site exceeding the above limits, restore the concentration to within the above limits within 15 minutes.

### SURVEILLANCE REQUIREMENTS

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- 1) Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program specified in Section I.
- 2) The results of the radioactive analysis shall be used in accordance with the methods of Section II to assure that the concentrations at the point of release are maintained within the limits of Specification V.D.1.a.

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b. Radioactive Liquid Effluents Doses

LIMITING CONDITIONS OF OPERATION

The dose or dose commitment to any REAL MEMBER OF THE PUBLIC from radioactive materials in liquid effluents from Unit 3 released from the site (see Figure V.D.-1) shall be limited:

- a. During any calendar quarter to less than or equal to 1.5 mrem to the total body and to less than or equal to 5 mrem to any organ; and,
- b. During any calendar year to less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ.

APPLICABILITY: At all times.

ACTION:

- a. With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits prepare and submit to the Commission within 30 days a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce the releases of radioactive materials in liquid effluents and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limit.

SURVEILLANCE REQUIREMENTS

- 1) Dose Calculations. Cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined in accordance with the methodology and parameters in Section II at least once per 31 days.
- 2) Relative accuracy or conservatism of the calculations shall be confirmed by performance of the Radiological Environmental Monitoring Program as detailed in Section I.

## 2. Radioactive Gaseous Effluents

### a. Radioactive Gaseous Effluents Dose Rate

#### LIMITING CONDITIONS OF OPERATION

The dose rate, at any time, offsite (see Figure V.D.-1) due to radioactivity released in gaseous effluents from the site shall be limited to the following values:

- a. The dose rate limit for noble gases shall be less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin; and,
- b. The dose rate limit due to inhalation for Iodine-131, Iodine-133, Tritium, and for all radioactive materials in particulate form with half lives greater than 8 days shall be less than or equal to 1500 mrem/yr to any organ.

APPLICABILITY: At all times.

#### ACTION:

With the dose rate(s) exceeding the above limits, decrease the release rate to comply with the limit(s) given in Specification V.D.2.a. within 15 minutes.

#### SURVEILLANCE REQUIREMENTS

- 1) The release rate, at any time, of noble gases in gaseous effluents shall be controlled by the offsite dose rate as established in Specification V.D.2.a. The corresponding release rate shall be determined in accordance with the methodology of Section II.
- 2) The noble gas effluent monitors of Table V.C.-3 shall be used to control release rates to limit offsite doses within the values established in Specification V.D.2.a.
- 3) The release rate of Iodine-131, Iodine-133, tritium, and for all radioactive materials in particulate form with half lives greater than 8 days in gaseous effluents shall be determined by obtaining representative samples and performing analyses in accordance with the sampling and analysis program, specified in Section I. The corresponding dose rate shall be determined using the methodology given in Section II.



b. Radioactive Gaseous Effluents Noble Gas Dose

LIMITING CONDITIONS OF OPERATION

The air dose offsite (see Figure V.D. – 1) due to noble gases released from Unit 3 in gaseous effluents shall be limited to the following:

- a. During any calendar quarter: Less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation, and
- b. During any calendar year: Less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

APPLICABILITY: At all times.

ACTION:

- a. With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits prepare and submit to the Commission within 30 days a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce the releases of radioactive noble gases in gaseous effluents and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limit.

SURVEILLANCE REQUIREMENTS

- 1) Dose Calculations – Cumulative dose contributions for the current calendar quarter and current calendar year shall be determined in accordance with Section II once every 31 days.
- 2) Relative accuracy or conservatism of the calculations shall be confirmed by performance of the Radiological Environmental Monitoring Program as detailed in Section I.

- c. Gaseous Effluents – Doses from Radionuclides Other than Noble Gas

LIMITING CONDITIONS OF OPERATION

The dose to any REAL MEMBER OF THE PUBLIC from Iodine–131, Iodine–133, Tritium, C–14, and radioactive materials in particulate form with half lives greater than 8 days in gaseous effluents released offsite from Unit 3 released offsite (see Figure V.D.–1) shall be limited to the following:

- a. During any calendar quarter: Less than or equal to 7.5 mrem to any organ and,
- b. During any calendar year: Less than or equal to 15 mrem to any organ.

APPLICABILITY: At all times.

ACTION:

- c. With the calculated dose from the release of radioiodines, radioactive materials in particulate form, or radionuclides other than noble gases in gaseous effluents exceeding any of the above limits prepare and submit to the Commission within 30 days a Special Report which identifies the cause(s) for exceeding the limit and defines the corrective actions to be taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limit.

SURVEILLANCE REQUIREMENTS

- 1) Dose Calculations – Cumulative dose contributions for the current calendar quarter and current calendar year shall be determined in accordance with Section II once every 31 days.
- 2) Relative accuracy or conservatism of the calculations shall be confirmed by performance of the Radiological Environmental Monitoring Program as detailed in Section I.



V.E. **Total Radiological Dose From Station Operations**

CONTROLS

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The annual dose or dose commitment to any REAL MEMBER OF THE PUBLIC, beyond the site boundary, from the Millstone Site is limited to less than or equal to 25 mrem to the total body or any organ (except the thyroid, which is limited to less than or equal to 75 mrem).

APPLICABILITY: At all times.

ACTION:

With the calculated dose from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Controls V.D.1.b., V.D.2.b., or V.D.2.c. prepare and submit a Special Report to the Commission within 30 days and limit the subsequent releases such that the dose commitment from the site to any REAL MEMBER OF THE PUBLIC from the Millstone Site is limited to less than or equal to 25 mrem to the total body or any organ (except thyroid, which is limited to less than or equal to 75 mrem) over 12 consecutive months. This Special Report shall include an analysis which demonstrates that radiation exposures from the site to any REAL MEMBER OF THE PUBLIC from the Millstone Site (including all effluent pathways and direct radiation) are less than the 40 CFR 190 Standard.

If the estimated doses exceed the above limits, the Special Report shall include a request for a variance in accordance with the provisions of 40 CFR 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete.

SURVEILLANCE REQUIREMENTS

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Cumulative dose contributions from liquid and gaseous effluents and direct radiation from the Millstone Site shall be determined in accordance with Section II once per 31 days.

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