**Enclosure 1 to TXX-12061**

**2011 Radioactive Effluent Release Report**


# 2011 RADIOACTIVE EFFLUENT RELEASE REPORT

## January 1, 2011 - December 31, 2011

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| CFR | Code of Federal Regulations |
| CPNPP | Comanche Peak Nuclear Power Plant |
| ECL | Effluent Concentration Limit |
| IFSFI | Independent Spent Fuel Storage Installation |
| LDCR | Licensing Document Change Request |
| LHMT | Laundry Holdup and Monitor Tanks |
| LVW | Low Volume Waste |
| ODCM | Offsite Dose Calculation Manual |
| PET | Primary Effluent Tanks |
| pCi | Picocurie |
| REC | Radiological Effluent Control |
| SORC | Station Operations Review Committee |
| uCi | Microcurie |
| WMT | Waste Monitor Tanks |
| WWHT | Waste Water Holdup Tanks |

## 1.0 Introduction

This Radioactive Effluent Release Report, for Comanche Peak Nuclear Power Plant Unit 1 and Unit 2, is submitted as required by Technical Specification 5.6.3 and Offsite Dose Calculation Manual (ODCM) Administrative Control 6.9.1.4 for the period January 1, 2011, through December 31, 2011.

## 1.1 Executive Summary

The radioactive effluent monitoring program for the year 2011 was conducted as described in the following report. The results of the monitoring program indicate the continued effort to maintain the release of radioactive effluents to the environment as low as reasonably achievable (ALARA).

In June 2009, the NRC provided revised guidance in Regulatory Guide 1.21, *Measuring, Evaluating and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste, Revision 2*, establishing an updated approach for identifying principal radionuclides. Because the overall quantity of radioactive releases has steadily decreased due to improvements in power plant operations, carbon 14 (C-14) now qualifies as a "principal radionuclide" (anything greater than one percent of overall radioactivity in effluents) under federal regulations at many plants. In other words, C-14 has not increased and C-14 is not a new nuclear plant emission. Rather, the improvements in the mitigation of other isotopes have made C-14 more prominent.

Attachment 10.2 on page 46 provides more detail about C-14.

**Gaseous Effluents:**

A summary of all the radioactive gaseous releases to the environment during 2011:

| Gaseous Waste | 2011 | 2010 | Comments |
|---|---|---|---|
| Tritium | 48.12 Ci | 43.21 Ci | 1 |
| C-14 Activity | 23.32 Ci | 25.48 Ci | 2 |
| Total Fission and Activation Activity | 3.73 Ci | 3.89 Ci | |
| Total Particulate Activity | 0 Ci | 0 Ci | 3 |
| Gross Alpha Activity | 0 Ci | 0 Ci | 3 |
| Iodine Activity | 0 Ci | 0 Ci | 3 |
| Calculated Gamma Air Dose | 6.21E-5 mRad | 4.15E-4 mRad | |
| Calculated Beta Air Dose | 7.54E-5 mRad | 8.51E-4 mRad | |
| Total Whole body dose | 0.11mRem | 0.11 mRem | 4 |

**Comments:**

1. The major contributor to gaseous tritium activity is evaporation from the spent fuel pools. Factors contributing to the tritium activity in the pools is related to the type of fuel used (i.e., 18-month fuel) the core life and power output and number of core cycles.

2. Because the industry as a whole has minimized effluents, C-14 is now a principle isotope. The majority of the gaseous activity and dose increase is from the addition of C-14.

3. No alpha, iodine or particulate activity was released.

4. Despite the inclusion of C-14, total whole body dose is very low (0.44% of Technical Specification).

Overall the gaseous radioactivity releases from CPNPP are well controlled and maintained ALARA. CPNPP is well below all applicable limits for gaseous releases. Neither unit had significant fuel defects during 2011. There were 2 refueling outages and 3 other unplanned outages. Despite the higher than normal number of outages, most of the released activity and associated dose was significantly lower in 2011 versus 2010.

**Liquid Effluents:**

A summary of all the radioactive liquid releases to the environment during 2011:

| Liquid Waste | 2011 | 2010 | Comments |
|---|---|---|---|
| Total Activity (excluding tritium) | 6.56mCi | 16.4 mCi | 1 |
| Tritium Activity | 2790 Ci | 1340 Ci | 2 |
| Total Whole Body Dose | 0.149 mRem | 0.155 mRem | 1 |
| Total Volume Released | 1,155,673 Gal | 28,005,284 Gal | 3 |

**Comments**

1. The increased activity and dose in 2010 was due to issues with the liquid waste processing equipment from March to June. Changes in media and processing equipment repairs solved the problem and restored processing efficiency as can be seen by the decrease in 2011 totals.

2. The increased tritium activity for 2011 is attributed to waste water processing for 2 refueling outages.

3 Explanation for the larger than normal total volume released during 2010: CPNPP processes many millions of gallons of non-radioactive water each year from the secondary portion of the plant. Water plant waste, turbine building sumps and other sources all contribute to these totals. This waste water is processed through the low volume waste (LVW) system which then discharges to Squaw Creek Reservoir. A monthly composite sample from the LVW is analyzed quarterly for activity. Normally, this waste water does not contain any radionuclides.

However, in late 2009, the Unit 2 refueling water storage tank (RWST) overflowed into the turbine building sumps. Initially this water was diverted to the waste processing system. Once the cleanup was complete, the turbine building sump was directed back to the LVW system. A small amount of tritium remained in the turbine building sumps and was sent to the LVW. The first quarter LVW composite sample tested positive for tritium (a small amount above background). Consequently, the volume discharged from the LVW had to be accounted for as liquid waste.

Because the LVW sample is a quarterly composite, the volume processed as liquid waste for the first quarter (and for the year) is 20 times larger than normal. For 2011, the volume returned to normal values.

**Meteorological Data**

The CPNPP meteorological system achieved a greater than 90% recoverable data rate for the joint frequency parameters required by Regulatory Guide 1.23 for wind speed, wind direction and delta temperature. See section 7.1 for the actual recovery percentages.

**Monitors OOS > 30 Days**

During 2011 there were no Technical Specification/ODCM effluent radiation monitors out of service for >30 days.

**ODCM Changes**

There were 2 changes made to the ODCM. These changes are referenced in section 8.2

**Solid Waste**

Summary of the solid waste production

| Total Waste | 2011 | 2010 | % Error |
|---|---|---|---|
| **Shipped (m3)** | 667 | 476 | 25% |
| **Shipped (Ci)** | 0.215 | 18.9 | 25% |
| **Buried (m3)** | 70.7 | 65.6 | 25% |
| **Buried (Ci)** | 0.149 | 18.9 | 25% |

**Comments**

CPNPP disposed four containers of Class A resins in 2010 and a typical quantity of dry active waste. The impact of this resin disposal disproportionally increased the activity disposal with respect to 2011. In addition, during 2011, several containers of legacy dry activity waste were disposed of which resulted in greater volume during the year.

Over the past three years, CPNPP has only had access to a Class A radioactive waste disposal site. Class A waste represents the vast majority of volume but very little of the activity disposed of as radioactive waste resulting from operations and maintenance. Once the Texas waste disposal facility becomes available, the disposal activity is expected to spike high due to disposal of waste in storage and then return to normal.

**Groundwater Tritium**

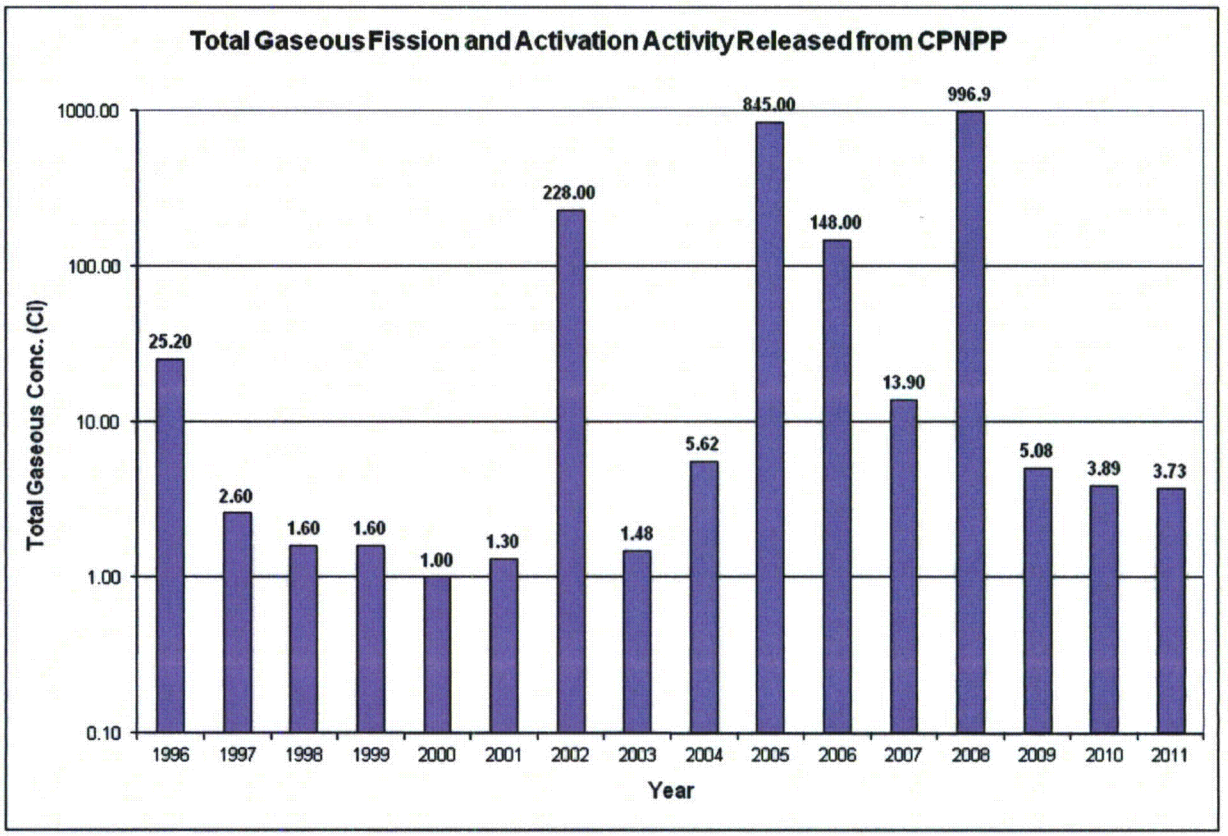
CR-2011-003303, CR 2011-010251 and CR-2011-009873 documented some positive indications of tritium in the seepage sump near the water treatment plant and in the LVW Pond A Leachate. All of these samples were well below the state reportable criteria of 20,000 pCi/L. Because Squaw Creek Reservoir (SCR) water contains a low background concentration of tritium, SCR water used in the plant will contain similar concentrations.

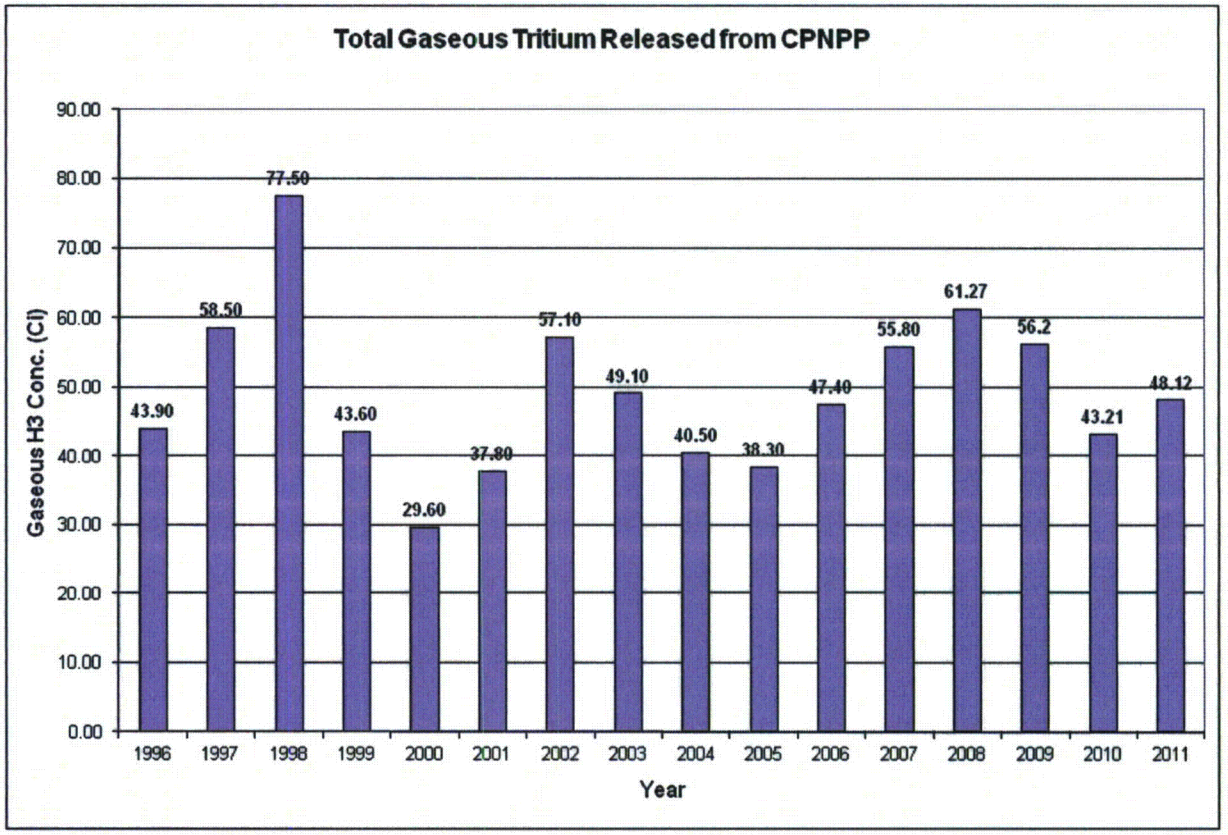
See section 8.8 for details.

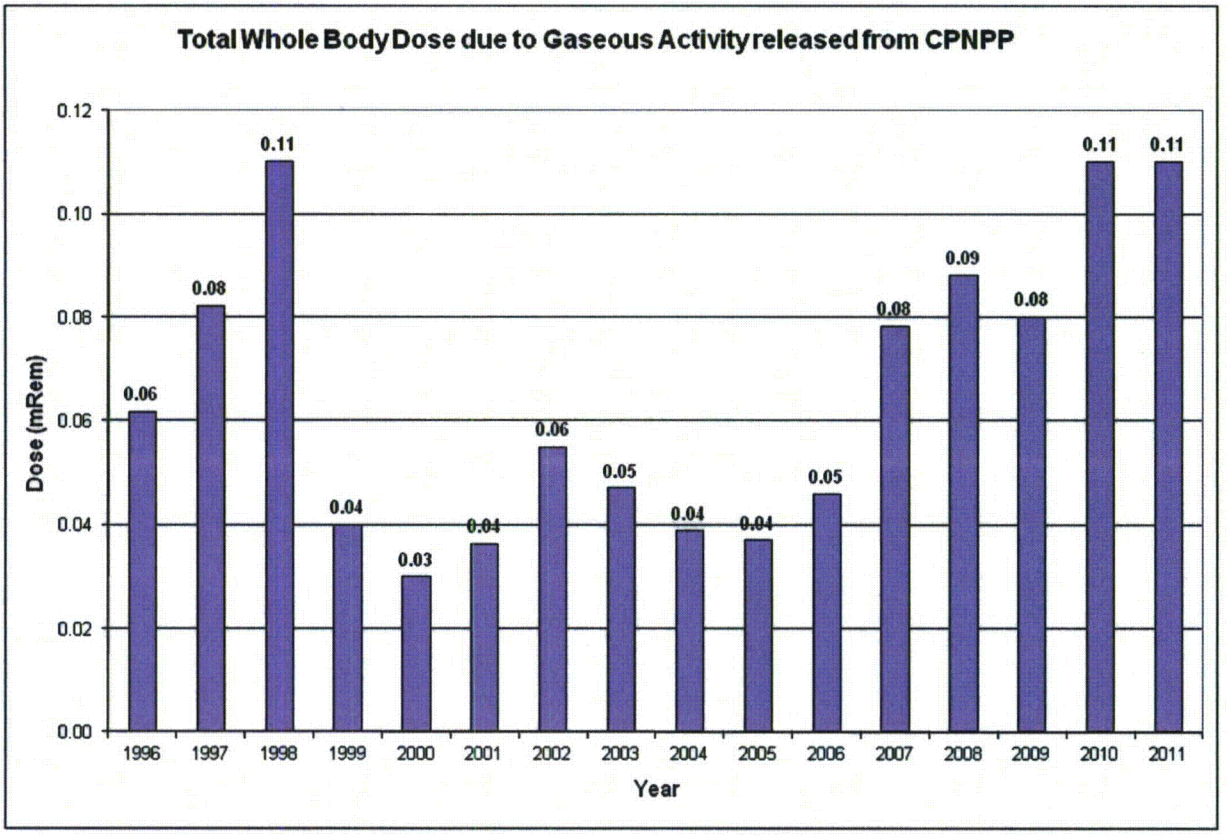
**Conclusion**

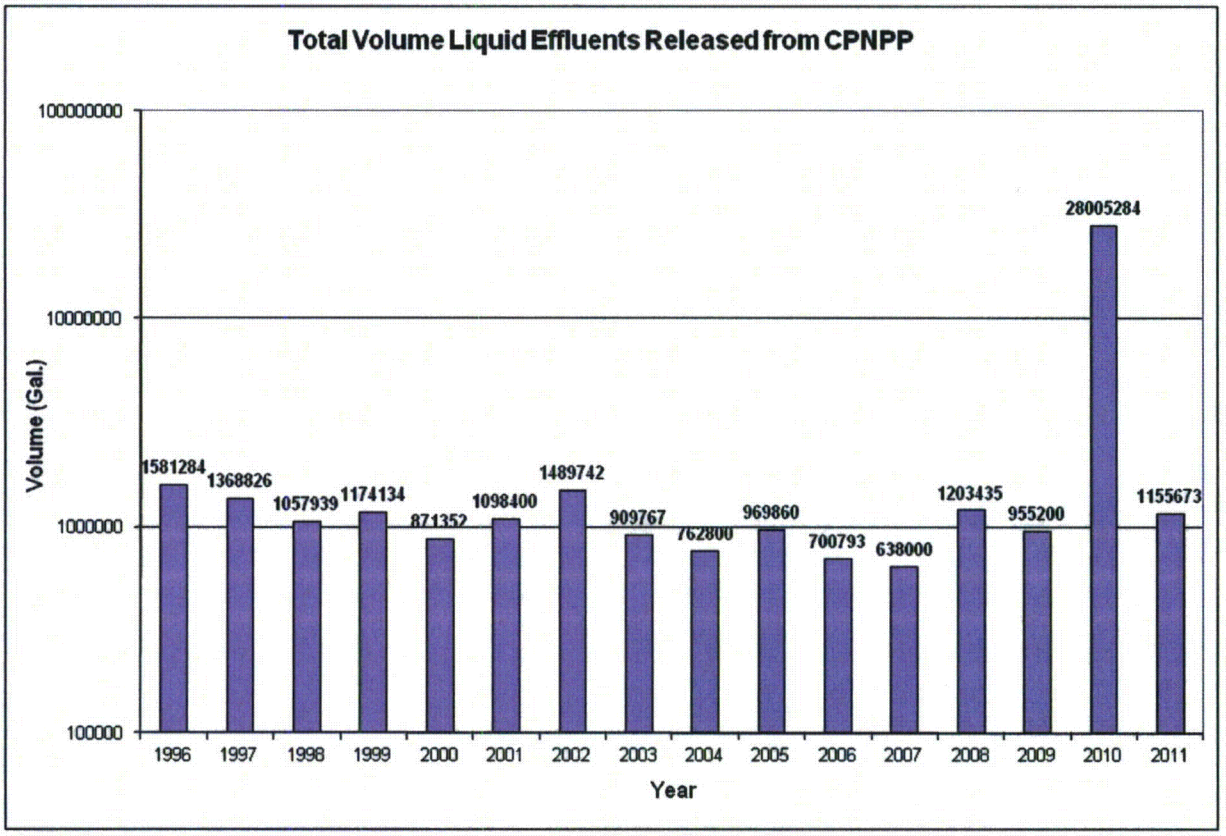
Overall, the radioactive effluent monitoring program has been conducted in an appropriate manner to ensure the activity released and associated dose to the public has been maintained as low as reasonably achievable (ALARA).

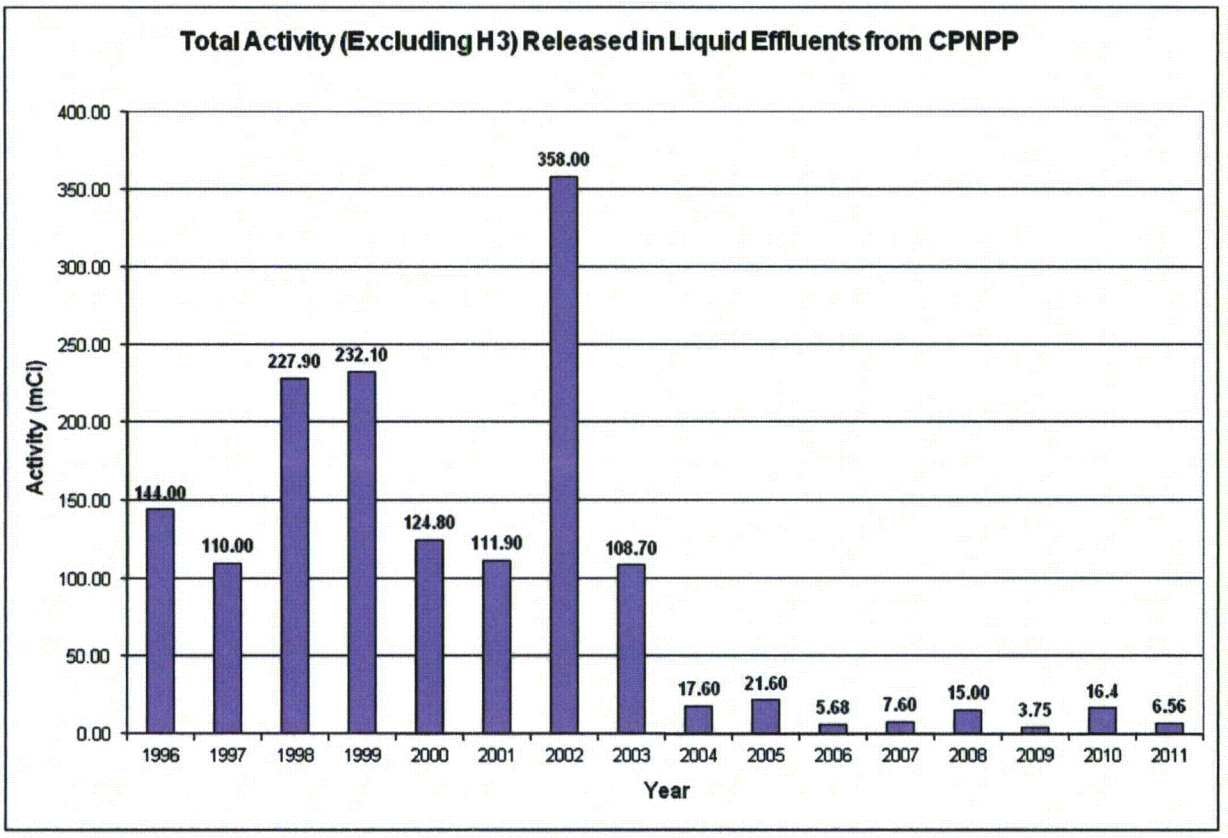
## 1.2 Historical Trend Graphs

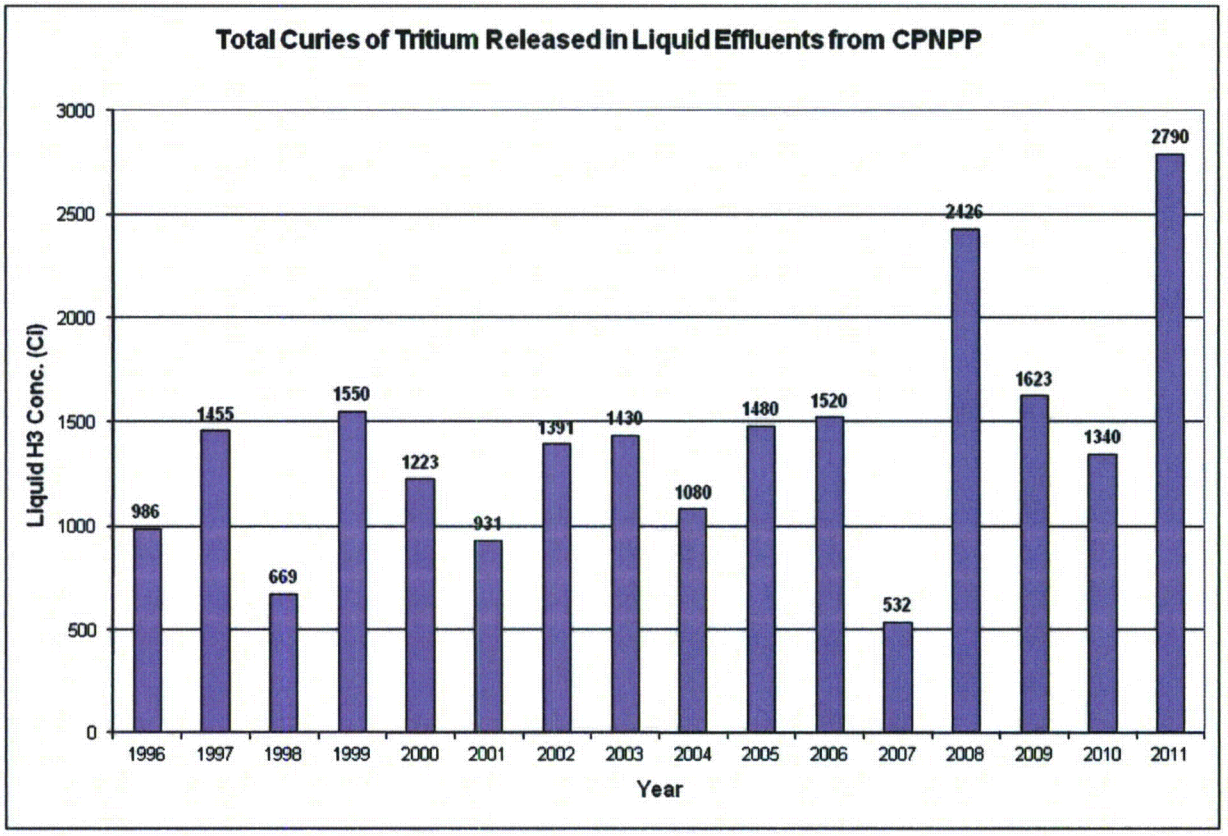



Total Whole Body Dose due to Gaseous Activity released from CPNPP
Dose (mRem)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0.06
0.08
0.11
0.04
0.03
0.04
0.06
0.05
0.04
0.04
0.05
0.08
0.09
0.08
0.11
0.11
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Year


Total Volume Liquid Effluents Released from CPNPP
Volume (Gal.)
100000000
10000000
1000000
100000
1581284
1368826
1057939
1174134
871352
1098400
1489742
909767
762800
969860
700793
638000
1203435
955200
28005284
1155673
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Year


Total Activity (Excluding H3) Released in Liquid Effluents from CPNPP
Activity (mCi)
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
144.00
110.00
227.90
232.10
124.80
111.90
358.00
108.70
17.60
21.60
5.68
7.60
15.00
3.75
16.4
6.56
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Year


Total Curies of Tritium Released in Liquid Effluents from CPNPP
Liquid H3 Conc. (Ci)
3000
2500
2000
1500
1000
500
0
986
1455
669
1550
1223
931
1391
1430
1080
1480
1520
532
2426
1623
1340
2790
1996
1997
1998
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2002
2003
2004
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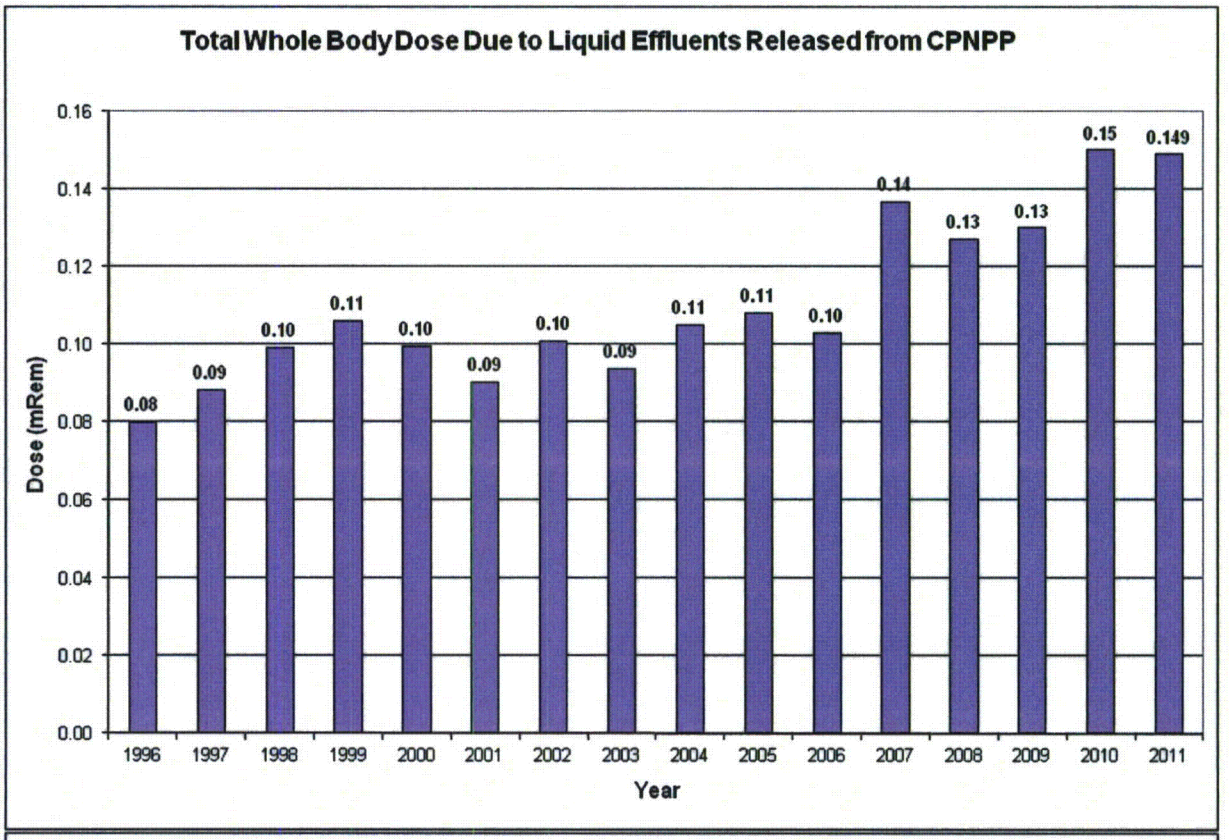
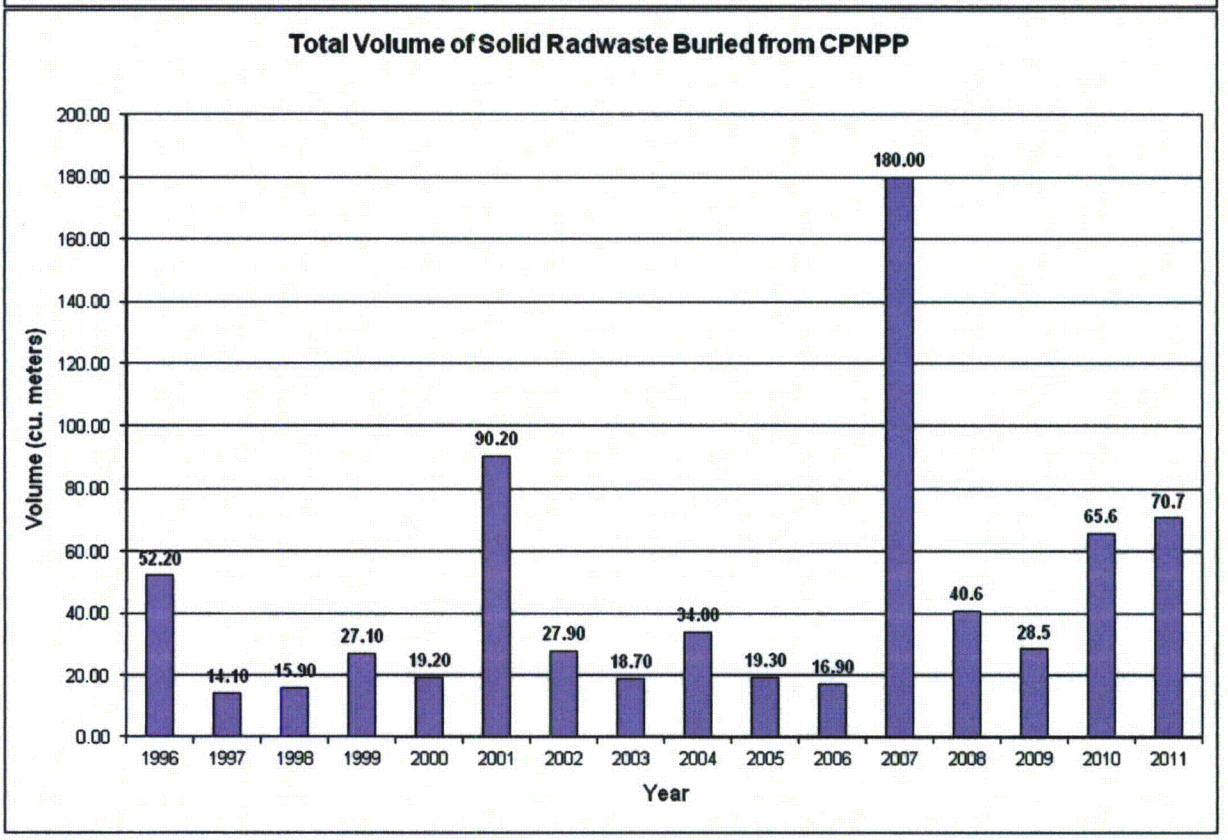
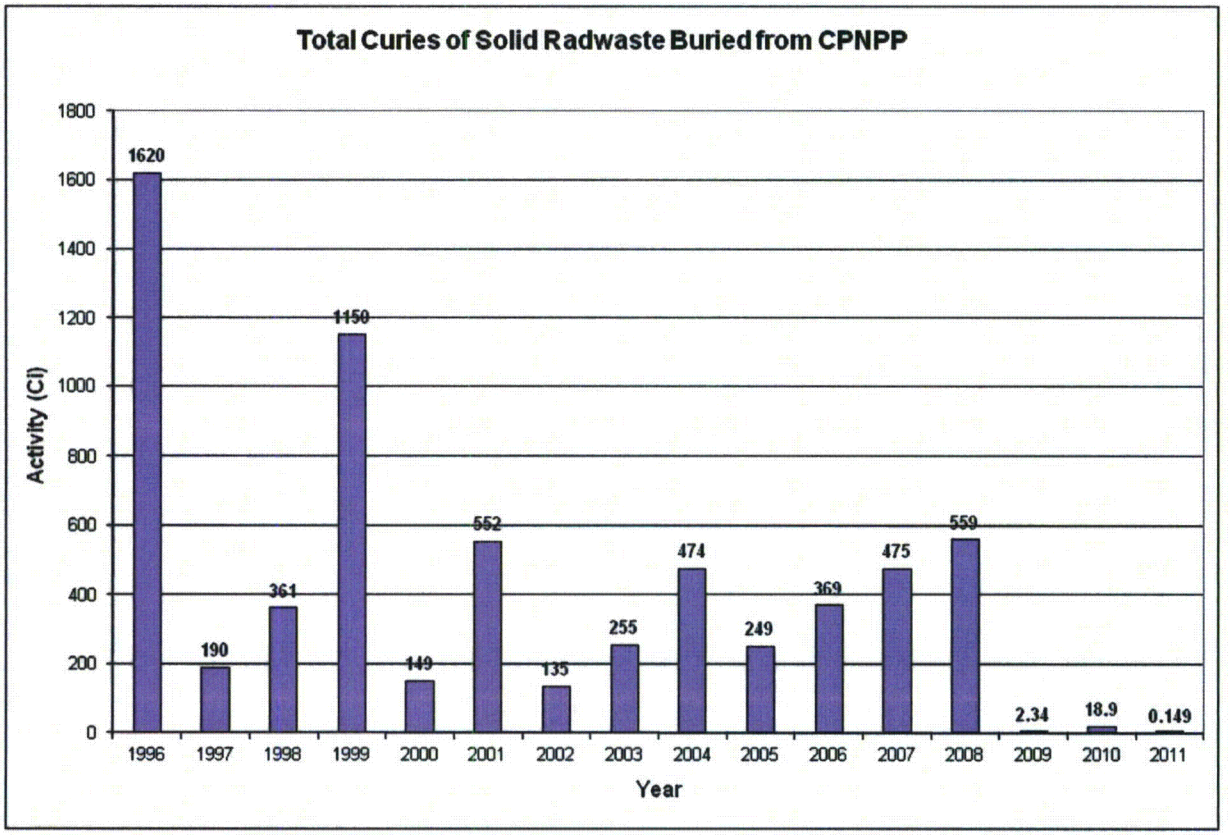
2006
2007
2008
2009
2010
2011
Year


Total Whole Body Dose Due to Liquid Effluents Released from CPNPP
Dose (mRem)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0.08
0.09
0.10
0.11
0.10
0.09
0.10
0.09
0.11
0.11
0.10
0.14
0.13
0.13
0.15
0.149
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Year


Total Volume of Solid Radwaste Buried from CPNPP
Volume (cu. meters)
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
52.20
14.10
15.90
27.10
19.20
90.20
27.90
18.70
34.00
19.30
16.90
180.00
40.6
28.5
65.6
70.7
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Year


Total Curies of Solid Radwaste Buried from CPNPP
Activity (Ci)
1800
1600
1400
1200
1000
800
600
400
200
0
1620
190
361
1150
149
552
135
255
474
249
369
475
559
2.34
18.9
0.149
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Year

## 2.0 SUPPLEMENTAL INFORMATION

### 2.1 Regulatory Limits

The ODCM Radiological Effluent Control limits applicable to the release of radioactive material in liquid and gaseous effluents are described in the following sections.

#### 2.1.1 Fission and Activation Gases (Noble Gases)

The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to less than or equal to 500 mRem/yr to the whole body and less than or equal to 3000 mRem/yr to the skin.

The air dose due to noble gases released in gaseous effluents, from each unit, to areas at and beyond the site boundary 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.

#### 2.1.2 Iodine-131, Iodine-133, Tritium and Radioactive Material in Particulate Form

The dose rate due to iodine-131, iodine-133, tritium and all radionuclides in particulate form with half lives greater than 8 days, released in gaseous effluents from the site to areas at and beyond the site boundary, shall be limited to less than or equal to 1500 mRem/yr to any organ.

The dose to a MEMBER OF THE PUBLIC from iodine-131, iodine-133, tritium and all radionuclides in particulate form with half lives greater than 8 days, in gaseous effluents released, from each unit, to areas at and beyond the site boundary, 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.

#### 2.1.3 Liquid Effluents

The concentration of radioactive material released in liquid effluents to unrestricted areas shall be limited to 10 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 be limited to 2.0E-4 μCi/ml total activity.

The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each unit, to unrestricted areas shall be limited:

**a.** During any calendar quarter to less than or equal to 1.5 mRem to the whole 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 whole body and to less than or equal to 10 mRem to any organ.

### 2.1.4 LVW Pond Resin Inventory

The quantity of radioactive material contained in resins transferred to the LVW pond shall be limited by the following expression:

$$(264/V) \bullet \Sigma_j A_j/C_j < 1.0$$

excluding tritium, dissolved or entrained noble gases and radionuclides with less than an 8 day half life, where:

$A_j$ = pond inventory limit for a single radionuclide j (Curies),

$C_j$ = 10CFR20, Appendix B, Table 2 Column 2, concentration for a single radionuclide j (μCi/ml),

V = volume of resins in the pond (gallons), and

264 = conversion factor (μCi/Ci per ml/gal)

### 2.1.5 Total Dose

The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to less than or equal to 25 mRem to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mRem.

## 2.2 Effluent Concentration Limits

### 2.2.1 Gaseous Effluents

For gaseous effluents, effluent concentration limits (ECL) values are not directly used in release rate calculations since the applicable limits are expressed in terms of dose rate at the site boundary.

### 2.2.2 Liquid Effluents

The values specified in 10 CFR Part 20, Appendix B, Table 2, Column 2 are used as the ECL for liquid radioactive effluents released to unrestricted areas. A value of 2.0E-04 μCi/ml is used as the ECL for dissolved and entrained noble gases in liquid effluents.

## 2.3 Measurements and Approximations of Total Radioactivity

Measurements of total radioactivity in liquid and gaseous radioactive effluents were accomplished in accordance with the sampling and analysis requirements of Tables 4.11-1 and 4.11-2, respectively, of the CPNPP ODCM.

### 2.3.1 Liquid Radioactive Effluents

Each batch release was sampled and analyzed for gamma emitting radionuclides using gamma spectroscopy, prior to release. Composite samples were analyzed monthly and quarterly for the Primary Effluent Tanks (PET), Waste Monitor Tanks (WMT), Laundry Holdup and Monitor Tanks (LHMT) and Waste Water Holdup Tanks (WWHT). Composite samples were analyzed monthly for tritium and gross alpha radioactivity in the onsite laboratory using liquid scintillation and gas flow proportional counting techniques, respectively. Composite samples were analyzed quarterly for Sr-89, Sr-90 and Fe-55 by a contract laboratory. The results of the composite analyses from the previous month or quarter were used to estimate the quantities of these radionuclides in liquid effluents during the current month or quarter. The total radioactivity in liquid effluent releases was determined from the measured and estimated concentrations of each radionuclide present and the total volume of the effluent released during periods of discharge.

For batch releases of powdex resin to the LVW pond, samples were analyzed for gamma emitting radionuclides, using gamma spectroscopy techniques prior to release. Composite samples were analyzed quarterly for Sr-89 and Sr-90 by a contract laboratory.

For continuous releases to the Circulating Water Discharge from the LVW pond, daily grab samples were obtained over the period of pond discharge. These samples were composited and analyzed for gamma emitting radionuclides, using gamma spectroscopy techniques. Composite samples were also analyzed for tritium and gross alpha radioactivity using liquid scintillation and gas flow proportional counting techniques, respectively. Composite samples were analyzed quarterly for Sr-89, Sr-90 and Fe-55 by a contract laboratory.

### 2.3.2 Gaseous Radioactive Effluents

Each gaseous batch release was sampled and analyzed for radioactivity prior to release using gamma spectroscopy. Waste Gas Decay Tank samples were analyzed for gamma emitting radionuclides. Containment Building charcoal (iodine), particulate, noble gas, and tritium grab samples were also analyzed for gamma emitting radionuclides prior to each release. The results of the analyses and the total volume of effluent released were used to determine the total amount of radioactivity released in the batch mode.

For continuous effluent release pathways, noble gas and tritium grab samples were collected and analyzed weekly for gamma emitting radionuclides by gamma spectroscopy and liquid scintillation counting techniques, respectively. Continuous release pathways were continuously sampled using radioiodine adsorbers and particulate filters. The radioiodine adsorbers and particulate filters were analyzed weekly for I-131 and gamma emitting radionuclides using gamma spectroscopy. Results of the noble gas and tritium grab samples, radioiodine adsorber and particulate filter analyses from the current week and the average effluent flow rate for the previous week were used to determine the total amount of radioactivity released in the continuous mode. Monthly composites of particulate filters were analyzed for gross alpha activity, in the onsite laboratory using the gas flow proportional counting technique. Quarterly composites of particulate filters were analyzed for Sr-89 and Sr-90 by a contract laboratory.

C-14 was estimated in accordance with the methodology in the EPRI report *Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents.* EPRI, Palo Alto, CA: 2010, 1021106. See attachment 10.2 on page 46 for more information on C-14.

## 2.4 Batch Releases

A summary of information for gaseous and liquid batch releases is included in Table 9.1.

## 2.5 Abnormal or Unplanned Releases

Abnormal releases are defined as the unintended discharge of a volume of liquid or airborne radioactivity to the environment. There was 1 normal (monitored) unplanned gaseous effluent releases during 2011 and is summarized in section 8.5.1. There were no abnormal unplanned liquid or gaseous releases during 2011. Table 9.2 summarizes the abnormal and unplanned releases.

## 3.0 GASEOUS EFFLUENTS

The quantities of radioactive material released in gaseous effluents are summarized in Tables 9.3 and 9.4. All releases of radioactive material in gaseous form are considered to be ground level releases.

## 4.0 LIQUID EFFLUENTS

The quantities of radioactive material released in liquid effluents are summarized in Tables 9.5 and 9.6.

## 5.0 SOLID WASTES

The quantities of radioactive material released as solid effluents are summarized in Table 9.10.

## 6.0 RADIOLOGICAL IMPACT ON MAN

### 6.1 Dose Due to Liquid Effluents

The dose to an adult from the fish and cow-meat consumption pathways from Squaw Creek Reservoir were calculated in accordance with the methodology and parameters in the ODCM. The results of the calculations are summarized on a quarterly and annual basis in table 9.7.

### 6.2 Dose Due to Gaseous Effluents

The air dose due to gamma emissions and the air dose due to beta emissions were calculated using the highest annual average atmospheric dispersion factor at the Site Boundary location, in accordance with the methodology and parameters in the ODCM. The results of the calculations are summarized on a quarterly and annual basis in Table 9.8.

### 6.3 Dose Due to Radioiodines, Tritium and Particulates

The dose to an adult, teen, child, and infant from radioiodines and particulates, for the pathways

listed in Part II, Table 2.4 of the ODCM, were calculated using the highest dispersion and deposition factors, as appropriate, in accordance with the methodology and parameters in the ODCM. The results of the calculations are summarized on a quarterly and annual basis in Table 9.9. Because of pathway similarity, C-14 dose is included in this table.

## 6.4 40CFR190 Dose Evaluation

ODCM Radiological Effluent Control 3.11.4 requires dose evaluations to demonstrate compliance with 40 CFR Part 190 only if the calculated quarterly or yearly dose exceed two times the applicable quarterly or annual dose limits. At no time during 2011 were any of these limits exceeded, therefore no evaluations are required.

## 6.5 Dose to a MEMBER OF THE PUBLIC From Activities Inside the Site Boundary

Three activities are considered in this evaluation: fishing on Squaw Creek Reservoir, recreation activities at the CPNPP employee recreational area and site tours through the CPNPP Visitors Center.

The highest dose occurred in the evaluation for fishing, resulting in a dose of 3.69E-03 mRem/yr. The dose to a MEMBER OF THE PUBLIC (fisherman) on Squaw Creek Reservoir was calculated based on fishing twice a week, five hours each day, six months per year. Pathways included in the calculation were gaseous inhalation and submersion. Liquid pathways are not considered since all dose is calculated at the point of circ water discharge into the reservoir.

The dose to a MEMBER OF THE PUBLIC engaged in recreational activities at the CPNPP employee recreational park was calculated based on one visit a week, five hours each day, six months per year. Pathways included in the calculation were gaseous inhalation, submersion and ground plane.

The dose to a MEMBER OF THE PUBLIC during site tours through the CPNPP Visitors Center was calculated based on two visits per year, thirty minutes each visit. Pathways included in the calculation were gaseous inhalation and submersion.

Due to increased security, routine fishing on Squaw Creek Reservoir and visitation by the public on-site has been significantly restricted. The calculations are still valid and included in the event security access restrictions are ever returned to previous conditions and controls.

All calculations were performed in accordance with the methodology and parameters in the ODCM.

## 7.0 METEROLOGICAL DATA

### 7.1 Meteorological Monitoring Program

In accordance with ODCM Administrative Control 6.9.1.4, a summary of hourly meteorological data, collected during 2011, is retained onsite. This data is available for review by the NRC upon request. Joint Frequency Tables are included in Attachment 10. During 2011, the goal of >90% joint data recovery was met. The individual percent recoveries are listed below:

| Meteorological Data Recovery | |
|---|---|
| **Channel** | **% Recovery** |
| Wind Speed | 99.8 |
| Wind Direction | 99.7 |
| Delta Temperature A | 98.4 |
| Delta Temperature B | 99.8 |

## 8.0 RELATED INFORMATION

### 8.1 Operability of Liquid and Gaseous Monitoring Instrumentation

ODCM Radiological Effluent Controls 3.3.3.4 and 3.3.3.5 require an explanation of why designated inoperable liquid and gaseous monitoring instrumentation was not restored to operable status within thirty days.

During the period covered by this report, there were no instances where these instruments were inoperable for more than thirty days.

### 8.2 Changes to the Offsite Dose Calculation Manual

During the period covered by this report, there were 2 revisions to the ODCM:

**REVISION 31**
LDCR-OD-2011-1 (EV-CR-2010-010410-37) (SCD):
Dose limits at the site boundary require monitoring to demonstrate compliance with the limits of 10 CFR 72 as a result of direct radiation exposure emitted by the facility. The limits for the ISFSI are the same as the existing limits specified by 10 CFR 50 and therefore there are no changes to the monitoring criteria outlined in the ODCM.

**REVISION 32**
LDCR-OD-2010-1 (EV-CR-2010-011250-1) (SCD):
Revised the ODCM to incorporate the Carbon-14 isotope dose considerations into the CPNPP Radioactive Effluent Release Report in accordance with the new revision 2 of REGULATORY GUIDE 1.21, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste" This change is applicable to Units 1 and 2.

## 8.3 New Locations for Dose Calculations or Environmental Monitoring

ODCM Administrative Control 6.9.1.4 requires any new locations for dose calculations and/or environmental monitoring, identified by the Land Use Census, to be included in the Radioactive Effluent Release Report. Based on the 2011 Land Use Census, no new receptor locations were identified which resulted in changes requiring a revision in current environmental sample locations. Values for the current nearest resident, milk animal, garden, X/Q and D/Q values in all sectors surrounding CPNPP were included in the 2011 Land Use Census.

## 8.4 Liquid Holdup and Gas Storage Tanks

ODCM Administrative Control 6.9.1.4 requires a description of the events leading to liquid holdup or gas storage tanks exceeding the limits required to be established by Technical Specification 5.5.12. Technical Requirements Manual 13.10.33 limits the quantity of radioactive material contained in each unprotected outdoor tank to less than or equal to ten curies, excluding tritium and dissolved or entrained noble gases. Technical Requirements Manual 13.10.32 limits the quantity of radioactive material contained in each gas storage tank to less than or equal to 200,000 curies of noble gases (considered as Xe-133 equivalent). These limits were not exceeded during the period covered by this report.

## 8.5 Noncompliance with Radiological Effluent Control Requirements

This section provides a listing and description of Abnormal Releases, issues that did not comply with the applicable requirements of the Radiological Effluents Controls given in Part I of the CPNPP ODCM and/or issues that did not comply with associated Administrative Controls and that failed to meet CPNPP expectations regarding Station Radioactive Effluent Controls. Detailed documentation concerning evaluations of these events and corrective actions is maintained onsite.

### 8.5.1 Normal, Unplanned Gaseous Release

There was one normal, unplanned gaseous effluent releases occurred during 2011 documented by CR-2011-001885. RCS leakage from the Unit 1 charging system degassed and caused an increasing trend on PVG-384 plant stack A radiation monitor. A plant stack A gas sample indicated the presence of Xe-135 and Ar-41. A release permit was created to account for this monitored gas release.

### 8.5.2 Abnormal, Unplanned Gaseous Effluent Release

No abnormal, unplanned gaseous effluent releases occurred during 2011.

### 8.5.3 Abnormal, Unplanned Liquid Effluent Releases

No abnormal, unplanned liquid effluent releases occurred during 2011.

## 8.6 Resin Releases to the LVW Pond

A total of 927 $ft^3$ of powdex resin was transferred to the LVW pond during the period covered by this report. The cumulative activity deposited in the LVW pond since operations began through the end of 2011 is 2.14E-3 Curies, consisting of Co-58, Co-60, Cs-134, Cs-137, I-131, Sr-90 and Sb-125.

## 8.7 Changes to the Liquid, Gaseous, and Solid Waste Treatment Systems

In accordance with the CPNPP Process Control Program, Section 6.2.6.2, changes to the Radwaste Treatment Systems (liquid, gaseous and solid) should be summarized and reported to the Commission in the Radioactive Effluent Release Report if the changes implemented required a 10CFR50.59 safety evaluation.

For the reporting period of this report, no changes to the Radwaste Treatment Systems occurred that meet the reporting criteria of the Process Control Program.

## 8.8 Groundwater Tritium monitoring Program

Seepage Sump
Samples of perched groundwater are taken quarterly in accordance with the site groundwater tritium monitoring program. During 2011, samples from the Water Production Plant seepage sump (storm drain) had positive values for tritium as listed in the table below. The source of the tritium is from a small leak of Squaw Creek Reservoir (SQR) water that feeds the water plant. Because CPNPP discharges its effluents into Squaw Creek Reservoir, there is always a low level background concentration of tritium in the reservoir water. Essentially the seepage sump is discharging diluted Squaw Creek Reservoir water back to Squaw Creek Reservoir.

Basin A
Variations in the tritium values from the Pond A Leachate are thought to come from pockets of water trapped in between the inner and outer liner by many inches of lake sediment resting on top of the liner. These pockets of water are from basin water previously transferred to the space between the liners to test for liner repair work effectiveness. Work is in progress to remove this sediment from the pond. As the sediment is removed, pockets of residual basin water are reintroduced into the Leachate sample.

Basin A only receives Surface Water Treatment System wastewater; therefore, there is a high level of confidence the source of the tritium is Squaw Creek Reservoir water. Also, there is no indication of a release from the secondary liner, since tritium was not detected in down gradient monitoring wells.

In both of these cases, the tritium concentrations are well below the state reportable limit of 20,000 pCi/L. The source of the tritium is from SQR.

This has been documented in CR-2011-003303, CR 2011-010251 and CR-2011-009873.

**Tritium Results in pCi/L**

| Date | Seepage Sump | Pond A Leachate |
|---|---|---|
| Mar-11 | 9300 | 11300 |
| Jun-11 | 10400 | 2050 |
| Sep-11 | Dry (no Sample) | 12100 |
| Dec-11 | 5030 | 2260 |

# SECTION 9.0
# EFFLUENT TABLES

# Table 9.1

## Site Liquid and Gaseous Batch Release Summary (2011)

## A. Liquid Releases

| | Units | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Annual |
|---|---|---|---|---|---|---|
| 1. Number of batch releases | | 15 | 15 | 19 | 12 | 61 |
| 2. Total time period for Batch releases | ( Minutes ) | 4.69E+03 | 4.46E+03 | 5.93E+03 | 3.76E+03 | 1.88E+04 |
| 3. Maximum time period for a batch release | ( Minutes ) | 3.45E+02 | 3.30E+02 | 3.40E+02 | 3.40E+02 | 3.45E+02 |
| 4. Average time period for a batch release | ( Minutes ) | 3.13E+02 | 2.97E+02 | 3.12E+02 | 3.13E+02 | 3.09E+02 |
| 5. Minimum time period for a batch release | ( Minutes ) | 2.90E+02 | 2.39E+02 | 2.60E+02 | 2.82E+02 | 2.39E+02 |
| 6. Average stream flow during periods of release of liquid Effluent into a flowing stream | ( GPM ) | 6.35E+04 | 7.99E+04 | 4.91E+04 | 7.14E+04 | 2.64E+05 |

## B. Gaseous Releases

| | Units | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Annual |
|---|---|---|---|---|---|---|
| 1. Number of batch releases | | 27 | 29 | 28 | 34 | 118 |
| 2. Total time period for batch releases | ( Minutes ) | 9.73E+03 | 1.16E+04 | 9.57E+03 | 1.30E+04 | 4.39E+04 |
| 3. Maximum time period for a batch release | ( Minutes ) | 4.46E+02 | 2.10E+03 | 4.11E+02 | 1.06E+03 | 2.10E+03 |
| 4. Average time period for a batch release | ( Minutes ) | 3.60E+02 | 4.00E+02 | 3.42E+02 | 3.82E+02 | 3.72E+02 |
| 5. Minimum time period for a batch release | ( Minutes ) | 2.31E+02 | 1.72E+02 | 1.82E+02 | 5.10E+01 | 5.10E+01 |

# Table 9.2
## Site Abnormal Liquid and Gaseous Batch Release Summary (2011)

| A. Liquid Releases | Units | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Totals |
|---|---|---|---|---|---|---|
| 1. Number of Releases | | 0 | 0 | 0 | 0 | 0 |
| 2. Total Time For All Releases | ( Minutes ) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 3. Maximum Time For A Release | ( Minutes ) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 4. Average Time For A Release | ( Minutes ) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 5. Minimum Time For A Release | ( Minutes ) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 6. Total activity for all releases | ( Curies ) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

**B. Gaseous Releases**

| | Units | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Totals |
|---|---|---|---|---|---|---|
| 1. Number of Releases | | 1 | 0 | 0 | 0 | 1 |
| 2. Total Time For All Releases | ( Minutes ) | 3.12E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.12E+02 |
| 3. Maximum Time For A Release | ( Minutes ) | 3.12E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.12E+02 |
| 4. Average Time For A Release | ( Minutes ) | 3.12E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.12E+02 |
| 5. Minimum Time For A Release | ( Minutes ) | 3.12E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.12E+02 |
| 6. Total activity for all releases | ( Curies ) | 2.05E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.05E-01 |

# Table 9.3
## Site Gaseous Effluents - Summation of All Releases (2011)

| Type of Effluent | Units | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Total |
|---|---|---|---|---|---|---|
| **A. Fission And Activation Gases** | | | | | | |
| 1. Total Release | Curies | 2.86E+00 | 3.35E+01 | 3.46E-01 | 5.99E-01 | 3.73E+01 |
| 2. Average Release rate for period | uCi/sec | 3.63E-01 | 4.24E+00 | 4.39E-02 | 7.60E-02 | 4.72E+00 |
| 3. Percent of Applicable Limit | % | * | * | * | * | * |
| **B. Radioiodines** | | | | | | |
| 1. Total Iodine-131 | Curies | 2.89E-06 | 1.85E-06 | 0.00E+00 | 0.00E+00 | 4.74E-06 |
| 2. Average Release rate for period | uCi/sec | 3.67E-07 | 2.35E-07 | 0.00E+00 | 0.00E+00 | 6.02E-07 |
| 3. Percent of Applicable Limit | % | * | * | * | * | * |
| **C. Particulates** | | | | | | |
| 1. Particulates ( Half-Lives > 8 Days ) | Curies | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 2. Average Release rate for period | uCi/sec | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 3. Percent of Applicable Limit | % | * | * | * | * | * |
| **D. Tritium & C14** | | | | | | |
| 1. Total Release | Curies | 1.45E+01 | 2.08E+01 | 2.17E+01 | 1.45E+01 | 7.14E+01 |
| 2. Average Release rate for period | uCi/sec | 1.83E+00 | 2.65E+00 | 2.74E+00 | 1.83E+00 | 9.04E+00 |
| 3. Percent of Applicable Limit | % | * | * | * | * | * |
| **E. Gross Alpha** | | | | | | |
| 1. Total Release | Curies | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 2. Average Release rate for period | uCi/sec | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

*** Applicable limits are expressed in terms of dose.**

**Estimated Total Error For All Values Reported Is < 1.0%**

# 2011 Table 9.4
# Site Gaseous Effluents - Ground Level Releases (2011)

*Continuous Mode*

| Nuclides Released | Unit | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Total |
|---|---|---|---|---|---|---|
| **Fission Gases** | | | | | | |
| Xe-133 | Curies | 2.12E+00 | 6.19E+00 | 0.00E+00 | 0.00E+00 | 8.32E+00 |
| Xe-135 | Curies | 4.14E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.14E-01 |
| **Total For Period** | Curies | 2.54E+00 | 6.19E+00 | 0.00E+00 | 0.00E+00 | 8.73E+00 |
| **Iodines** | | | | | | |
| I-131 | Curies | 2.89E-06 | 1.85E-06 | 0.00E+00 | 0.00E+00 | 4.74E-06 |
| **Total For Period** | Curies | 2.89E-06 | 1.85E-06 | 0.00E+00 | 0.00E+00 | 4.74E-06 |
| **Particulates** | | | | | | |
| No Nuclides Found | Curies | N/A | N/A | N/A | N/A | N/A |
| **Tritium & C-14** | | | | | | |
| H-3 | Curies | 8.14E+00 | 1.55E+01 | 1.56E+01 | 8.76E+00 | 4.79E+01 |
| C-14 | Curies | 1.87 | 1.60 | 1.82 | 1.70 | 7.00 |
| **Gross Alpha** | | | | | | |
| No Nuclides Found | Curies | N/A | N/A | N/A | N/A | N/A |

# 2009 Table 9.4 (cont)
# Site Gaseous Effluents - Ground Level Releases (2011)

*Batch Mode*

| Nuclides Released | Unit | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Total |
|---|---|---|---|---|---|---|
| **Fission Gases** | | | | | | |
| Ar-41 | Curies | 2.96E-01 | 7.65E-02 | 8.11E-02 | 1.62E-01 | 6.15E-01 |
| Kr-85m | Curies | 0.00E+00 | 1.99E-02 | 0.00E+00 | 7.42E-04 | 2.07E-02 |
| Kr-85 | Curies | 0.00E+00 | 4.52E-01 | 2.65E-01 | 3.77E-01 | 1.09E+00 |
| Kr-87 | Curies | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.82E-04 | 3.82E-04 |
| Kr-88 | Curies | 0.00E+00 | 3.08E-03 | 0.00E+00 | 1.28E-03 | 4.36E-03 |
| Xe-131m | Curies | 0.00E+00 | 3.61E-01 | 0.00E+00 | 1.44E-05 | 3.61E-01 |
| Xe-133m | Curies | 0.00E+00 | 4.59E-01 | 0.00E+00 | 1.35E-03 | 4.61E-01 |
| Xe-133 | Curies | 1.42E-02 | 2.47E+01 | 7.30E-04 | 4.21E-02 | 2.48E+01 |
| Xe-135m | Curies | 0.00E+00 | 7.66E-04 | 0.00E+00 | 2.06E-03 | 2.83E-03 |
| Xe-135 | Curies | 1.15E-02 | 1.20E+00 | 0.00E+00 | 1.31E-02 | 1.23E+00 |
| **Total For Period** | Curies | 3.22E-01 | 2.73E+01 | 3.46E-01 | 5.99E-01 | 2.85E+01 |
| **Iodines** | | | | | | |
| No Nuclides Found | Curies | N/A | N/A | N/A | N/A | N/A |
| **Particulates** | | | | | | |
| No Nuclides Found | Curies | N/A | N/A | N/A | N/A | N/A |
| **Tritium** | | | | | | |
| H-3 | Curies | 8.16E-02 | 7.64E-02 | 2.39E-02 | 3.42E-02 | 2.16E-01 |
| C-14 | Curies | 4.37 | 3.74 | 4.24 | 3.97 | 16.32 |
| **Gross Alpha** | | | | | | |
| No Nuclides Found | Curies | N/A | N/A | N/A | N/A | N/A |

* Zeroes in this table indicate that no radioactivity was present at detectable levels.

# Table 9.5
## Site Liquid Effluents - Summation Of All Releases (2011)

| | Units | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Annual |
|---|---|---|---|---|---|---|
| **A. Fission And Activation Products** | | | | | | |
| 1. Total Release (not including tritium, gases, alpha) | Curies | 2.64E-04 | 1.79E-03 | 2.66E-03 | 1.85E-03 | 6.56E-03 |
| 2. Average diluted concentration during period | uCi/ml | 1.73E-11 | 1.06E-10 | 1.23E-10 | 1.40E-10 | 3.86E-10 |
| 3. Percent of Applicable Limit | % | * | * | * | * | * |
| **B. Tritium** | | | | | | |
| 1. Total Release | Curies | 1.14E+03 | 6.42E+02 | 7.33E+02 | 2.72E+02 | 2.79E+03 |
| 2. Average diluted concentration during period | uCi/ml | 7.47E-05 | 3.79E-05 | 3.39E-05 | 2.06E-05 | 1.67E-04 |
| 3. Percent of Applicable Limit | % | * | * | * | * | * |
| **C. Dissolved and Entrained Gases** | | | | | | |
| 1. Total Release | Curies | 4.78E-03 | 2.45E-02 | 6.34E-04 | 4.61E-04 | 3.04E-02 |
| 2. Average diluted concentration during period | uCi/ml | 3.15E-10 | 1.45E-09 | 2.93E-11 | 3.49E-11 | 1.83E-09 |
| 3. Percent of Applicable Limit | % | * | * | * | * | * |
| **D: Gross Alpha Radioactivity** | | | | | | |
| 1. Total Release | Curies | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **E: Waste Vol Release (Pre-Dilution)** | Liters | 1.10E+06 | 1.03E+06 | 1.36E+06 | 8.89E+05 | 4.38E+06 |
| **F. Volume of Dilution Water Used** | Liters | 1.52E+10 | 1.69E+10 | 2.16E+10 | 1.32E+10 | 6.69E+10 |

*** Applicable limits are expressed in terms of dose.**

**Estimated Total Error For All Values Reported Is < 1.0%**

# Table 9.6
# Site Liquid Effluents (2011)

***Continuous Mode***

| Nuclides Released | Units | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Annual |
|---|---|---|---|---|---|---|
| **Fission & Activation Products** | | | | | | |
| No Nuclides Found | Curies | N/A | N/A | N/A | N/A | N/A |
| **Tritium** | | | | | | |
| H-3 | Curies | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **Dissolved And Entrained Gases** | | | | | | |
| No Nuclides Found | Curies | N/A | N/A | N/A | N/A | N/A |
| **Gross Alpha Radioactivity** | Curies | 0 | 0 | 0 | 0 | 0 |

***Batch Mode***

| Nuclides Released | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Annual |
|---|---|---|---|---|---|
| **Fission & Activation Products** | | | | | |
| Cr-51 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.30E-04 | 1.30E-04 |
| Mn-54 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.40E-06 | 7.40E-06 |
| Co-57 | 0.00E+00 | 0.00E+00 | 4.07E-06 | 0.00E+00 | 4.07E-06 |
| Co-58 | 2.09E-04 | 1.73E-03 | 2.56E-03 | 1.62E-03 | 6.12E-03 |
| Co-60 | 5.50E-05 | 3.74E-05 | 9.13E-05 | 7.30E-05 | 2.57E-04 |
| Nb-95 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.02E-05 | 2.02E-05 |
| Ba-139 | 0.00E+00 | 2.58E-05 | 0.00E+00 | 0.00E+00 | 2.58E-05 |
| **Total For Period** | 2.64E-04 | 1.79E-03 | 2.66E-03 | 1.85E-03 | 6.56E-03 |
| **Tritium** | | | | | |
| H-3 | 1.14E+03 | 6.42E+02 | 7.33E+02 | 2.72E+02 | 2.79E+03 |
| **Dissolved And Entrained Gases** | | | | | |
| Kr-85m | 0.00E+00 | 4.31E-05 | 0.00E+00 | 3.06E-06 | 4.62E-05 |
| Kr-85 | 1.24E-03 | 9.35E-04 | 0.00E+00 | 0.00E+00 | 2.18E-03 |
| Kr-88 | 0.00E+00 | 2.92E-06 | 0.00E+00 | 0.00E+00 | 2.92E-06 |
| Xe-131m | 0.00E+00 | 5.04E-04 | 0.00E+00 | 0.00E+00 | 5.04E-04 |
| Xe-133m | 0.00E+00 | 1.89E-04 | 0.00E+00 | 0.00E+00 | 1.89E-04 |
| Xe-133 | 3.54E-03 | 2.27E-02 | 6.34E-04 | 4.49E-04 | 2.73E-02 |
| Xe-135 | 0.00E+00 | 1.12E-04 | 0.00E+00 | 8.19E-06 | 1.20E-04 |
| **Total For Period** | 4.78E-03 | 2.45E-02 | 6.34E-04 | 4.61E-04 | 3.04E-02 |

* Zeroes in this table indicate that no radioactivity was present at detectable levels

# Table 9.7
# Dose to a member of the public due to Liquid Releases (2011)

## Cumulative Doses per Quarter

| Organ | Limit | Units | Quarter 1 | % of Tech Spec Limit | Quarter 2 | % of Tech Spec Limit | Quarter 3 | % of Tech Spec Limit | Quarter 4 | % of Tech Spec Limit |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Body | 1.50E+00 | mRem | 3.26E-02 | 2.17E+00 | 3.43E-02 | 2.29E+00 | 3.85E-02 | 2.57E+00 | 4.34E-02 | 2.89E+00 |
| Thyroid | 5.00E+00 | mRem | 3.26E-02 | 6.52E-01 | 3.43E-02 | 6.87E-01 | 3.85E-02 | 7.70E-01 | 4.34E-02 | 8.68E-01 |
| Organ | 5.00E+00 | mRem | 3.26E-02 | 6.52E-01 | 3.43E-02 | 6.87E-01 | 3.85E-02 | 7.70E-01 | 4.34E-02 | 8.68E-01 |
| Bone | 5.00E+00 | mRem | 0.00E+00 | 0.00E+00 | 1.07E-10 | 2.14E-09 | 0.00E+00 | 0.00E+00 | 4.00E-08 | 8.01E-07 |

## Cumulative Doses per Year

| Organ | Tech Spec Limit | Units | Year to Ending Date | % of Tech Spec Limit | Receptor | Limit |
|---|---|---|---|---|---|---|
| Total Body | 2.50E+01 | mRem | 1.49E-01 | 5.95E-01 | Liquid Receptor - Adult | 40CFR190.10 (a) TB |
| Thyroid | 7.50E+01 | mRem | 1.49E-01 | 1.98E-01 | Liquid Receptor - Adult | 40CFR190.10 (a) Thyroid |
| Organ | 2.50E+01 | mRem | 1.49E-01 | 5.96E-01 | Liquid Receptor - Adult | 40CFR190.10 (a) Organ |
| Bone | 2.50E+01 | mRem | 4.01E-08 | 1.61E-07 | Liquid Receptor - Adult | 40CFR190.10 (a) Organ |
| Total Body | 3.00E+00 | mRem | 1.49E-01 | 4.96E+00 | Liquid Receptor - Adult | Liq Annual TB Dose |
| Thyroid | 1.00E+01 | mRem | 1.49E-01 | 1.49E+00 | Liquid Receptor - Adult | Liq Annual Organ Dose |
| Organ | 1.00E+01 | mRem | 1.49E-01 | 1.49E+00 | Liquid Receptor - Adult | Liq Annual Organ Dose |
| Bone | 1.00E+01 | mRem | 4.01E-08 | 4.01E-07 | Liquid Receptor - Adult | Liq Annual Organ Dose |

| | |
|---|---|
| **Total Dilution Volume for Quarter 1** | 1.52E+10 |
| **Total Dilution Volume for Quarter 2** | 1.69E+10 |
| **Total Dilution Volume for Quarter 3** | 2.16E+10 |
| **Total Dilution Volume for Quarter 4** | 1.32E+10 |

Organ = GI-Lii, Kidney, Liver, or Lung

# Table 9.8
# Air Dose Due To Gaseous Releases – Site (2011)

**Cumulative Doses Per Quarter**

| Type of Radiation | Tech Spec Limit | Units | Quarter 1 | % of Tech Spec Limit | Quarter 2 | % of Tech Spec Limit | Quarter 3 | % of Tech Spec Limit | Quarter 4 | % of Tech Spec Limit |
|---|---|---|---|---|---|---|---|---|---|---|
| Gamma Air | 5.00E+00 | mRad | 6.21E-05 | 1.24E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Beta Air | 1.00E+01 | mRad | 7.54E-05 | 7.54E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

**Cumulative Doses Per Year**

| Type of Radiation | Tech Spec Limit | Units | Year to Ending Date | % of Tech Spec Limit | Receptor | Limit |
|---|---|---|---|---|---|---|
| Gamma Air | 1.00E+01 | mRad | 6.21E-05 | 6.21E-04 | Gas Receptor SB - Adult | NG Annual Gamma Air Dose |
| Gamma Air | 1.00E+01 | mRad | 6.21E-05 | 6.21E-04 | Gas Receptor SB - Teen | NG Annual Gamma Air Dose |
| Gamma Air | 1.00E+01 | mRad | 6.21E-05 | 6.21E-04 | Gas Receptor SB - Child | NG Annual Gamma Air Dose |
| Gamma Air | 1.00E+01 | mRad | 6.21E-05 | 6.21E-04 | Gas Receptor SB - Infant | NG Annual Gamma Air Dose |
| Beta Air | 2.00E+01 | mRad | 7.54E-05 | 3.77E-04 | Gas Receptor SB - Adult | NG Annual Beta Air Dose |
| Beta Air | 2.00E+01 | mRad | 7.54E-05 | 3.77E-04 | Gas Receptor SB - Teen | NG Annual Beta Air Dose |
| Beta Air | 2.00E+01 | mRad | 7.54E-05 | 3.77E-04 | Gas Receptor SB - Child | NG Annual Beta Air Dose |
| Beta Air | 2.00E+01 | mRad | 7.54E-05 | 3.77E-04 | Gas Receptor SB - Infant | NG Annual Beta Air Dose |

## Table 9.9

## Dose to A Member Of The Public Due To Radioiodines, Tritium, and Particulates in Gaseous Releases (2011)

### Cumulative Doses Per Quarter

| Organ | Tech Spec Limit | Units | Quarter 1 | % of Tech Spec Limit | Quarter 2 | % of Tech Spec Limit | Quarter 3 | % of Tech Spec Limit | Quarter 4 | % of Tech Spec Limit |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Body | 7.5 | mRem | 2.27E-02 | 3.03E-01 | 3.14E-02 | 4.19E-01 | 3.27E-02 | 4.36E-01 | 2.25E-02 | 3.00E-01 |
| Thyroid | 7.5 | mRem | 1.46E-02 | 1.95E-01 | 2.38E-02 | 3.17E-01 | 2.18E-02 | 2.91E-01 | 1.23E-02 | 1.64E-01 |
| Organ | 7.5 | mRem | 2.27E-02 | 3.03E-01 | 3.14E-02 | 4.19E-01 | 3.27E-02 | 4.36E-01 | 2.25E-02 | 3.00E-01 |
| Skin | 7.5 | mRem | 6.40E-08 | 8.54E-07 | 4.10E-08 | 5.46E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Bone | 7.5 | mRem | 5.81E-02 | 7.75E-01 | 4.97E-02 | 6.62E-01 | 5.64E-02 | 7.52E-01 | 5.28E-02 | 7.04E-01 |

Organ = GI-LIi, Kidney, Liver, or Lung

Quarterly limit values are the same for both 40CFR190.10 (a) and Gas Annual Organ Dose limits

### Cumulative Doses per Year

| Organ | Tech Spec Limit | Units | Year to Ending Date | % of Tech Spec Limit | Receptor | Limit |
|---|---|---|---|---|---|---|
| Total Body | 25 | mRem | 1.09E-01 | 4.38E-01 | Gas Receptor SB - Child | 40CFR190.10 (a) TB |
| Thyroid | 75 | mRem | 7.26E-02 | 9.67E-02 | Gas Receptor SB - Child | 40CFR190.10 (a) Thyroid |
| Organ | 25 | mRem | 1.09E-01 | 4.38E-01 | Gas Receptor SB - Child | 40CFR190.10 (a) Organ |
| Skin | 25 | mRem | 1.05E-07 | 4.20E-07 | Gas Receptor SB - Child | 40CFR190.10 (a) Organ |
| Bone | 25 | mRem | 2.17E-01 | 8.68E-01 | Gas Receptor SB - Child | 40CFR190.10 (a) Organ |
| Total Body | 15 | mRem | 1.09E-01 | 7.30E-01 | Gas Receptor SB - Child | Gas Annual Organ Dose |
| Thyroid | 15 | mRem | 7.26E-02 | 4.84E-01 | Gas Receptor SB - Child | Gas Annual Organ Dose |
| Organ | 15 | mRem | 1.09E-01 | 7.30E-01 | Gas Receptor SB - Child | Gas Annual Organ Dose |
| Skin | 15 | mRem | 1.05E-07 | 7.00E-07 | Gas Receptor SB - Child | Gas Annual Organ Dose |
| Bone | 15 | mRem | 2.17E-01 | 1.45E+00 | Gas Receptor SB - Child | Gas Annual Organ Dose |

Organ = GI-LIi, Kidney, Liver, or Lung

# TABLE 9.10
# SOLID RADWASTE AND IRRADIATED FUEL SHIPMENTS -2011

## A. Solid Waste Shipped Offsite for Burial or Disposal (Not Irradiated Fuel)

| 1. **Type of Waste** | Shipped $M^3$ | Shipped Ci | Buried $m^3$ | Buried Ci | Percent Error |
|---|---|---|---|---|---|
| a. Spent resins/filters | 0 | 0 | 0 | 0 | N/A |
| b. Dry active waste | 662 | 0.213 | 70.7 | 0.149 | +/- 25% |
| c. Irradiated components | -0- | -0- | -0- | -0- | N/A |
| d. Other (oil/miscellaneous liquids sent to processor for volume reduction) | 5.1 | 1.22E-03 | -0- | -0- | N/A |
| TOTAL | 667 | 0.215 | 70.7 | 0.149 | |

Note: Shipped volumes and curies are not always equal to the buried volumes and curies since some disposal occurs outside the twelve month time period in which shipments occurred.

Dry active waste also includes some low-level radioactive resins, tank sediments and filters that are handled and processed in a manner that is consistent with this waste stream.

| 2. **Estimate of Major Nuclide Composition (by type of waste)** | Nuclide | % Abund. | Activity (Ci) |
|---|---|---|---|
| a. Spent resins/filters | -0- | -0- | -0- |

Nuclides representing <1% of total shipped activity: Mn-54,Co-57,Co-58,Fe-59,Zn-65,Sr-90,Nb-95,ZR-95,Ag-110m,Sn-113,Sb-125,Ce-144,Pu-238,Pu-239/240,Am-241,Pu-241,Cm-242,Cm-243/244.

# TABLE 9.10 (cont.)
# SOLID RADWASTE AND IRRADIATED FUEL SHIPMENTS -2011

## A. Solid Waste Shipped Offsite for Burial or Disposal (Not Irradiated Fuel) cont

| 2. Estimate of Major Nuclide Composition (by type of waste) | Nuclide | % Abund. | Activity (Ci) |
|---|---|---|---|
| b. Dry active waste | Fe-55 | 29.86 | 6.37E-02 |
| | Ni-63 | 22.25 | 4.75E-02 |
| | Co-60 | 19.95 | 4.26E-02 |
| | Co-58 | 19.82 | 4.23E-02 |
| | Nb-95 | 2.11 | 4.50E-03 |
| | Cr-51 | 1.38 | 2.95E-03 |
| | Zr-95 | 1.20 | 2.56E-03 |
| | Mn-54 | 1.04 | 2.23E-03 |
| | C-14 | 0.18 | 3.76E-04 |
| | H-3 | 0.01 | 1.47E-05 |
| | Tc-99 | LLD | -0- |
| | I-129 | LLD | -0- |
| | Other* | 2.20 | 4.70E-03 |
| | Total | 100.00 | 2.13E-01 |

*Nuclides representing <1% of total shipped activity: Cr-51,Mn-54,Co-57,Nb-95,ZR-95,Sb-125,Cs-134,Cs-137,Ce-144,Pu-238,Pu-239/240,Am-241,Cm-242,Cm-243/244.

| 2. Estimate of Major Nuclide Composition (by type of waste) | Nuclide | % Abund. | Activity (Ci) |
|---|---|---|---|
| d. Other (oil/miscellaneous liquids sent to processor for volume reduction) | Ni-63 | 43.68 | 5.34E-04 |
| | Fe-55 | 39.76 | 4.86E-04 |
| | Co-60 | 15.53 | 1.90E-04 |
| | H-3 | LLD | -0- |
| | C-14 | LLD | -0- |
| | Tc-99 | LLD | -0- |
| | I-129 | LLD | -0- |
| | Other | 1.03 | 1.25E-05 |
| | Total | 100.00 | 1.22E-03 |

*Nuclides representing <1% of total shipped activity: Cr-51,Mn-54,Co-57,Nb-95,ZR-95,Sb-125,Cs-134,Cs-137,Ce-144,Pu-238,Pu-239/240,Am-241,Cm-242,Cm-243/244.

| | 3. Solid Waste Disposition (Mode of Transportation: Truck) | | | | |
|---|---|---|---|---|---|
| Waste Type | Waste Class | Container Type | Solidification Agent(s) | Number of Shipments | Destination |
| a. Resin/filters | N/A | N/A | N/A | N/A | N/A |
| b. Dry active waste | A | General Design | N/A | 10 | Energy Solutions Oak Ridge, TN |
| d. Other | A | General Design | N/A | * | Energy Solutions Oak Ridge, TN |

*Note: Solid Waste "Other" was included as part of a Dry Active Waste Shipment

## B. **Irradiated Fuel Shipments (Disposition)**

| Number of Shipments | Mode of Transportation | Destination |
|---|---|---|
| 0 | N/A | N/A |

# Attachment 10.1

# 2010 Meteorological Joint Frequency Table

R.G. 1.21 JOINT FREQUENCY TABLE

T. U. ELECTRIC COMPANY

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 01-JAN-11 00:00 TO 31-DEC-11 23:59

STABILITY CLASS: A
ELEVATION: 10 m.

| Wind Direction | Wind Speed (mph) at 10 m. level 1-3 | 4-7 | 8-12 | 13-18 | 19-24 | >24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 1 | 6 | 31 | 21 | 10 | 0 | 69 |
| NNE | 2 | 18 | 12 | 7 | 1 | 0 | 40 |
| NE | 2 | 23 | 7 | 2 | 0 | 0 | 34 |
| ENE | 6 | 12 | 0 | 0 | 0 | 0 | 18 |
| E | 2 | 13 | 4 | 0 | 0 | 0 | 19 |
| ESE | 0 | 20 | 39 | 3 | 0 | 0 | 62 |
| SE | 2 | 25 | 58 | 19 | 3 | 0 | 107 |
| SSE | 0 | 27 | 86 | 63 | 7 | 1 | 184 |
| S | 0 | 13 | 18 | 26 | 3 | 0 | 60 |
| SSW | 0 | 1 | 2 | 0 | 0 | 0 | 3 |
| SW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| WSW | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| W | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| WNW | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| NW | 0 | 1 | 6 | 6 | 5 | 8 | 26 |
| NNW | 0 | 2 | 17 | 24 | 19 | 11 | 73 |
| VARIABLE | 14 | 7 | 0 | 0 | 0 | 0 | 21 |
| Total | 30 | 169 | 280 | 171 | 49 | 20 | 719 |

Periods of calm(hours): 0
Hours of missing data: 11

R.G. 1.21 JOINT FREQUENCY TABLE

T. U. ELECTRIC COMPANY

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 01-JAN-11 00:00 TO 31-DEC-11 23:59

STABILITY CLASS: B
ELEVATION: 10 m.

| Wind Direction | Wind Speed (mph) at 10 m. level 1-3 | 4-7 | 8-12 | 13-18 | 19-24 | >24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 3 | 6 | 18 | 6 | 2 | 0 | 35 |
| NNE | 6 | 11 | 9 | 1 | 0 | 0 | 27 |
| NE | 10 | 11 | 3 | 0 | 0 | 0 | 24 |
| ENE | 2 | 15 | 1 | 1 | 0 | 0 | 19 |
| E | 1 | 8 | 0 | 0 | 0 | 0 | 9 |
| ESE | 0 | 10 | 8 | 3 | 0 | 0 | 21 |
| SE | 0 | 12 | 27 | 14 | 1 | 0 | 54 |
| SSE | 1 | 20 | 33 | 45 | 14 | 6 | 119 |
| S | 1 | 13 | 35 | 54 | 35 | 6 | 144 |
| SSW | 1 | 7 | 15 | 6 | 2 | 2 | 33 |
| SW | 2 | 4 | 7 | 1 | 0 | 0 | 14 |
| WSW | 0 | 2 | 4 | 2 | 0 | 0 | 8 |
| W | 0 | 1 | 3 | 1 | 1 | 0 | 6 |
| WNW | 0 | 2 | 0 | 1 | 1 | 0 | 4 |
| NW | 1 | 1 | 4 | 7 | 3 | 8 | 24 |
| NNW | 1 | 5 | 15 | 8 | 10 | 8 | 47 |
| VARIABLE | 17 | 1 | 0 | 0 | 0 | 0 | 18 |
| Total | 46 | 129 | 182 | 150 | 69 | 30 | 606 |

Periods of calm(hours): 0
Hours of missing data: 0

R.G. 1.21 JOINT FREQUENCY TABLE

T. U. ELECTRIC COMPANY

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 01-JAN-11 00:00 TO 31-DEC-11 23:59

STABILITY CLASS: C
ELEVATION: 10 m.

| Wind Direction | Wind Speed (mph) at 10 m. level 1-3 | 4-7 | 8-12 | 13-18 | 19-24 | >24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 4 | 6 | 16 | 13 | 4 | 0 | 43 |
| NNE | 2 | 4 | 12 | 3 | 1 | 0 | 22 |
| NE | 4 | 6 | 2 | 2 | 0 | 0 | 14 |
| ENE | 1 | 8 | 0 | 1 | 0 | 0 | 10 |
| E | 1 | 7 | 3 | 0 | 0 | 0 | 11 |
| ESE | 4 | 19 | 7 | 0 | 0 | 0 | 30 |
| SE | 2 | 8 | 16 | 9 | 0 | 0 | 35 |
| SSE | 2 | 8 | 24 | 48 | 15 | 6 | 103 |
| S | 2 | 11 | 38 | 77 | 52 | 21 | 201 |
| SSW | 0 | 5 | 22 | 38 | 7 | 3 | 75 |
| SW | 1 | 11 | 15 | 5 | 2 | 0 | 34 |
| WSW | 2 | 7 | 6 | 2 | 0 | 0 | 17 |
| W | 1 | 0 | 4 | 1 | 0 | 0 | 6 |
| WNW | 0 | 2 | 4 | 5 | 1 | 0 | 12 |
| NW | 1 | 9 | 7 | 9 | 5 | 7 | 38 |
| NNW | 3 | 5 | 8 | 21 | 17 | 11 | 65 |
| VARIABLE | 16 | 1 | 0 | 0 | 0 | 0 | 17 |
| Total | 46 | 117 | 184 | 234 | 104 | 48 | [illegible] |

Periods of calm(hours): 1
Hours of missing data: 4

R.G. 1.21 JOINT [illegible] TABLE

T. [illegible] ELECTRIC COMPANY

HOURS [illegible] AND SPEED AND DIRECTION

PERIOD OF RECORD: 01-JAN-11 00:00 TO 31-DEC-11 23:59

STABILITY CLASS: 7
ELEVATION: 10 m.

| Wind Direction | Wind Speed (mph) at 10 m. level 1-3 | 4-7 | 8-12 | 13-18 | 19-24 | >24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 14 | 76 | 199 | 121 | 15 | 0 | 425 |
| NNE | 11 | 44 | 101 | 34 | 0 | 0 | 190 |
| NE | 5 | 36 | 44 | 11 | 0 | 0 | 97 |
| ENE | 9 | 26 | 25 | 0 | 0 | 0 | 60 |
| E | 12 | 38 | 13 | 0 | 0 | 0 | 63 |
| ESE | 14 | 89 | 43 | 10 | 0 | 0 | 156 |
| SE | 11 | 105 | 226 | 81 | 3 | 0 | 426 |
| SSE | 13 | 62 | 301 | 432 | 116 | 17 | 941 |
| S | 2 | 43 | 281 | 342 | 132 | 19 | 819 |
| SSW | 7 | 41 | 93 | 70 | 9 | 1 | 221 |
| SW | 10 | 25 | 39 | 12 | 0 | 0 | 86 |
| WSW | 4 | 20 | 16 | 4 | 0 | 0 | 44 |
| W | 0 | 9 | 11 | 8 | 1 | 0 | 29 |
| WNW | 3 | 11 | 45 | 21 | 3 | 0 | 83 |
| NW | 1 | 15 | 40 | 44 | 12 | 6 | 118 |
| NNW | 9 | 19 | 135 | 158 | 56 | 8 | 385 |
| VARIABLE | 56 | 22 | 2 | 1 | 0 | 0 | 81 |
| Total | 182 | 681 | 1614 | 1349 | 347 | 51 | 4224 |

Periods of calm(hours): 3
Hours of missing data: 10

R.G. 1.21 JOINT FREQUENCY TABLE

T. U. ELECTRIC COMPANY

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 01-JAN-11 00:00 TO 31-DEC-11 23:59

STABILITY CLASS: E
ELEVATION: 10 m.

| Wind Direction | Wind Speed (mph) at 10 m. level 1-3 | 4-7 | 8-12 | 13-18 | 19-24 | >24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 3 | 25 | 38 | 7 | 0 | 0 | 73 |
| NNE | 3 | 32 | 28 | 1 | 0 | 0 | 64 |
| NE | 1 | 8 | 4 | 1 | 0 | 0 | 14 |
| ENE | 0 | 6 | 2 | 0 | 0 | 0 | 8 |
| E | 10 | 20 | 0 | 0 | 0 | 0 | 30 |
| ESE | 15 | 65 | 11 | 0 | 0 | 0 | 91 |
| SE | 22 | 202 | 135 | 2 | 0 | 0 | 361 |
| SSE | 6 | 127 | 220 | 31 | 0 | 0 | 384 |
| S | 11 | 56 | 83 | 7 | 0 | 0 | 157 |
| SSW | 16 | 46 | 55 | 28 | 0 | 0 | 145 |
| SW | 9 | 11 | 33 | 3 | 0 | 0 | 56 |
| WSW | 3 | 13 | 6 | 1 | 0 | 0 | 23 |
| W | 3 | 13 | 5 | 1 | 0 | 0 | 22 |
| WNW | 8 | 28 | 19 | 2 | 0 | 0 | 57 |
| NW | 9 | 48 | 27 | 2 | 0 | 0 | 86 |
| NNW | 3 | 24 | 24 | 4 | 1 | 0 | 56 |
| VARIABLE | 55 | 13 | 3 | 1 | 0 | 0 | 72 |
| Total | 177 | 737 | 693 | 91 | 1 | 0 | 1699 |

Periods of calm(hours): 7
Hours of missing data: 6

R.G. 1.21 JOINT FREQUENCY TABLE

T. U. ELECTRIC COMPANY

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 01-JAN-11 00:00 TO 31-DEC-11 23:59

STABILITY CLASS: F
ELEVATION: 10 m.

| | Wind Speed (mph) at 10 m. level | | | | | | |
|---|---|---|---|---|---|---|---|
| Wind Direction | 1-3 | 4-7 | 8-12 | 13-18 | 19-24 | >24 | TOTAL |
| N | 3 | 0 | 3 | 0 | 0 | 0 | 6 |
| NNE | 0 | 1 | 3 | 0 | 0 | 0 | 4 |
| NE | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| ENE | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| E | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| ESE | 3 | 4 | 0 | 0 | 0 | 0 | 7 |
| SE | 12 | 46 | 13 | 0 | 0 | 0 | 71 |
| SSE | 18 | 33 | 13 | 1 | 0 | 0 | 65 |
| S | 17 | 28 | 10 | 0 | 0 | 0 | 55 |
| SSW | 13 | 23 | 18 | 0 | 0 | 0 | 54 |
| SW | 28 | 25 | 8 | 0 | 0 | 0 | 61 |
| WSW | 27 | 27 | 6 | 0 | 0 | 0 | 60 |
| W | 12 | 12 | 3 | 0 | 0 | 0 | 27 |
| WNW | 11 | 15 | 1 | 0 | 0 | 0 | 27 |
| NW | 11 | 37 | 4 | 0 | 0 | 0 | 52 |
| NNW | 3 | 1 | 0 | 0 | 0 | 0 | 4 |
| VARIABLE | 23 | 1 | 0 | 0 | 0 | 0 | 24 |
| Total | 184 | 254 | 82 | 1 | 0 | 0 | 521 |

Periods of calm(hours): 3
Hours of missing data: 0

R.G. 1.21 JOINT FREQUENCY TABLE

T. U. ELECTRIC COMPANY

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 01-JAN-11 00:00 TO 31-DEC-11 23:59

STABILITY CLASS: G
ELEVATION: 10 m.

| Wind Direction | Wind Speed (mph) at 10 m. level 1-3 | 4-7 | 8-12 | 13-18 | 19-24 | >24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| NNE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ENE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ESE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SE | 0 | 4 | 1 | 0 | 0 | 0 | 5 |
| SSE | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| S | 8 | 3 | 1 | 0 | 0 | 0 | 12 |
| SSW | 14 | 17 | 4 | 0 | 0 | 0 | 35 |
| SW | 16 | 25 | 0 | 0 | 0 | 0 | 41 |
| WSW | 13 | 23 | 4 | 0 | 0 | 0 | 40 |
| W | 8 | 7 | 0 | 0 | 0 | 0 | 15 |
| WNW | 13 | 9 | 0 | 0 | 0 | 0 | 22 |
| NW | 4 | 20 | 0 | 0 | 0 | 0 | 24 |
| NNW | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| VARIABLE | 12 | 0 | 0 | 0 | 0 | 0 | 12 |
| Total | 92 | 109 | 10 | 0 | 0 | 0 | 211 |

Periods of calm(hours): 1
Hours of missing data: 0

R.G. 1.21 JOINT FREQUENCY TABLE

T. U. ELECTRIC COMPANY

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: 01-JAN-11 00:00 TO 31-DEC-11 23:59

STABILITY CLASS: ALL
ELEVATION: 10 m.

| Wind Direction | Wind Speed (mph) at 10 m. level 1-3 | 4-7 | 8-12 | 13-18 | 19-24 | >24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 30 | 119 | 305 | 168 | 31 | 0 | 653 |
| NNE | 24 | 110 | 165 | 46 | 2 | 0 | 347 |
| NE | 24 | 84 | 60 | 16 | 0 | 0 | 184 |
| ENE | 19 | 68 | 28 | 2 | 0 | 0 | 117 |
| E | 27 | 86 | 20 | 0 | 0 | 0 | 133 |
| ESE | 36 | 207 | 108 | 16 | 0 | 0 | 367 |
| SE | 49 | 402 | 476 | 125 | 7 | 0 | 1059 |
| SSE | 41 | 278 | 677 | 620 | 152 | 30 | 1798 |
| S | 41 | 167 | 466 | 506 | 222 | 46 | 1448 |
| SSW | 51 | 140 | 209 | 142 | 18 | 6 | 566 |
| SW | 66 | 101 | 102 | 21 | 2 | 0 | 292 |
| WSW | 50 | 93 | 42 | 9 | 0 | 0 | 194 |
| W | 24 | 42 | 26 | 11 | 2 | 0 | 105 |
| WNW | 35 | 67 | 69 | 29 | 6 | 0 | 206 |
| NW | 27 | 131 | 88 | 68 | 25 | 29 | 368 |
| NNW | 20 | 56 | 199 | 215 | 103 | 38 | 631 |
| VARIABLE | 193 | 45 | 5 | 2 | 0 | 0 | 245 |
| Total | 757 | 2196 | 3045 | 1996 | 570 | 149 | 8713 |

Periods of calm(hours): 15
Hours of missing data: 32

# Attachment 10.2

## Carbon 14 Supplemental Information

## Carbon-14 Supplemental Information

Carbon-14 (C-14) is a naturally occurring isotope of carbon produced by interactions with cosmic radiation in the atmosphere with a half-life of 5730 years. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. C-14 is also produced in commercial nuclear reactors, but the amounts are much less than the amounts produced from natural formation or from weapons testing.

In June 2009, the NRC provided revised guidance in Regulatory Guide 1.21, *Measuring, Evaluating and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste, Revision 2*, establishing an updated approach for identifying principal radionuclides. Because the overall quantity of radioactive releases has steadily decreased due to improvements in power plant operations, C-14 now qualifies as a "principal radionuclide" (anything greater than one percent of overall radioactivity in effluents) under federal regulations at many plants. In other words, C-14 has not increased and C-14 is not a new nuclear plant emission. Rather, the improvements in the mitigation of other isotopes have made C-14 more prominent.

The dose contribution of C-14 from liquid radioactive waste is essentially insignificant compared to that contributed by gaseous radioactive waste. Therefore the evaluation of C-14 in liquid radioactive waste is not required by the new Reg. Guide 1.21, Rev. 2. The Reg. Guide 1.21, Rev. 2 also states that the quantity of gaseous C-14 released to the environment can be estimated by use of a C-14 source term production model.

A recent study produced by EPRI (*Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents,* EPRI, Palo Alto, CA: 2010, 1021106) developed a model for estimation of C-14 source production. This model was used by CPNPP for the 2010 Radioactive Effluent Release Report. Also in the CPNPP report, the assumption that 70% of the C-14 gaseous effluent is estimated to be from batch releases (e.g. WGDTs), and 30% of C-14 gaseous effluent is estimated to be from continuous releases through the unit vents (Ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004).

The C-14 released from PWR's is primarily a mix of organic carbon and carbon dioxide released from the waste gas system. The C-14 species initially produced are primarily in the organic form, such as methane. The C-14 in the primary coolant can be converted to an inorganic chemical form of primarily carbon dioxide through a chemical transformation. Studies documented by the EPRI Report *Characterization of Carbon-14 Generated by the Nuclear Power Industry,* EPRI Palo Alto, CA: 1995, TR-105715, measured C-14 releases from PWRs indicating a range of 70% to 95% organic. The average value was indicated to be 80% organic with the remainder being carbon dioxide. As a result, a value of 80% organic C-14 is assumed by the CPNPP Radioactive Effluent Release Report methodology.

The public dose estimates from airborne C-14 in the CPNPP Effluent report are performed using dose models from NUREG-0133 and Regulatory Guide 1.109. The dose models and assumptions used for the dose estimates of C-14 are documented in the 2011 ODCM changes. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released during 2011 is well below the 10CFR50, Appendix I, ALARA design objective of 15 mRem/yr per unit.

## Putting Radiation Dose in Context

Humans are exposed to radiation every day. The majority comes from natural sources including the earth, food and water consumption, the air, the sun and outer space. A smaller fraction radiation comes from man-made source such as X-rays, nuclear medical treatments, building materials, nuclear power plants, smoke detectors and televisions.

Radiation is measured in units called millirem (mRem). One mRem is a very small amount of exposure. On average, Americans receive 620 mRem of radiation dose every year. Approximately one-half of the dose comes from natural sources and the other half comes from medical procedures such as CAT scans.

The table below can help to give some perspective to dose from various sources.

| Source | Average Annual Dose |
|---|---|
| Smoke detector in the home | 0.008 mRem |
| Live within 50 miles of a nuclear power plant | 0.009 mRem |
| Live within 50 miles of a coal-fired power plant* | 0.03 mRem |
| NRC guideline for keeping radiation dose from nuclear power plants as low as reasonably achievable (ALARA) | 5 mRem |
| Round trip flight from New York City to Los Angeles | 5 mRem |
| Medical X-ray | 10 mRem |
| EPA limit for dose to the public from the commercial nuclear fuel cycle | 25 mRem |
| Food and water consumed throughout the course of one year | 30 mRem |
| NRC limit for dose to the public from nuclear power plants | 100 mRem |
| Mammogram | 100 mRem |
| Average annual exposure for a nuclear power plant worker | 120 mRem |
| Average annual exposure from background radiation | 300 mRem |
| CT scan | 1,000 mRem |
| NRC's annual limit for occupational exposure | 5,000 mRem |
| Cardiac catheterization or coronary angiogram | 5,000 mRem |

*Coal is naturally radioactive.

*Sources: U.S. Environmental Protection Agency, Health Physics Society.*