VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

April 26, 2014

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

Serial No. 14-192
SS&L/JSA R0
Docket Nos. 50-280
50-281
72-2
72-55
License Nos. DPR-32
DPR-37
SNM-2501

Gentlemen:

**VIRGINIA ELECTRIC AND POWER COMPANY**
**SURRY POWER STATION UNITS 1 AND 2**
**INDEPENDENT SPENT FUEL STORAGE INSTALLATION**
**ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT**

Surry Units 1 and 2 Technical Specification 6.6.B.2 requires the submittal of an Annual Radiological Environmental Operating Report (AREOR) for Surry Power Station. Surry Independent Spent Fuel Storage Installation (ISFSI) Technical Specification Appendix C, Item 1.3.1 requires that the Surry ISFSI be included in the environmental monitoring for Surry Power Station. Accordingly, enclosed is the Surry Power Station AREOR for the period of January 1, 2013 through December 31, 2013, which includes environmental monitoring for the Surry ISFSI.

If you have any further questions, please contact Jason Eggart at 757-365-2010.

Sincerely,

Douglas C. Lawrence
Director Safety & Licensing
Surry Power Station

Attachment

Commitments made in this letter: None

IE25
NMSS26

Serial No. 14-192
Docket Nos.: 50-280
50-281
72-2
72-55

cc: U. S. Nuclear Regulatory Commission
Region II
Marquis One Tower
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Director, Nuclear Material Safety and Safeguards
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555-0001

NRC Senior Resident Inspector
Surry Power Station

Director
Division of Radiological Health
109 Governor Street, Room 730
Richmond, Virginia 23219

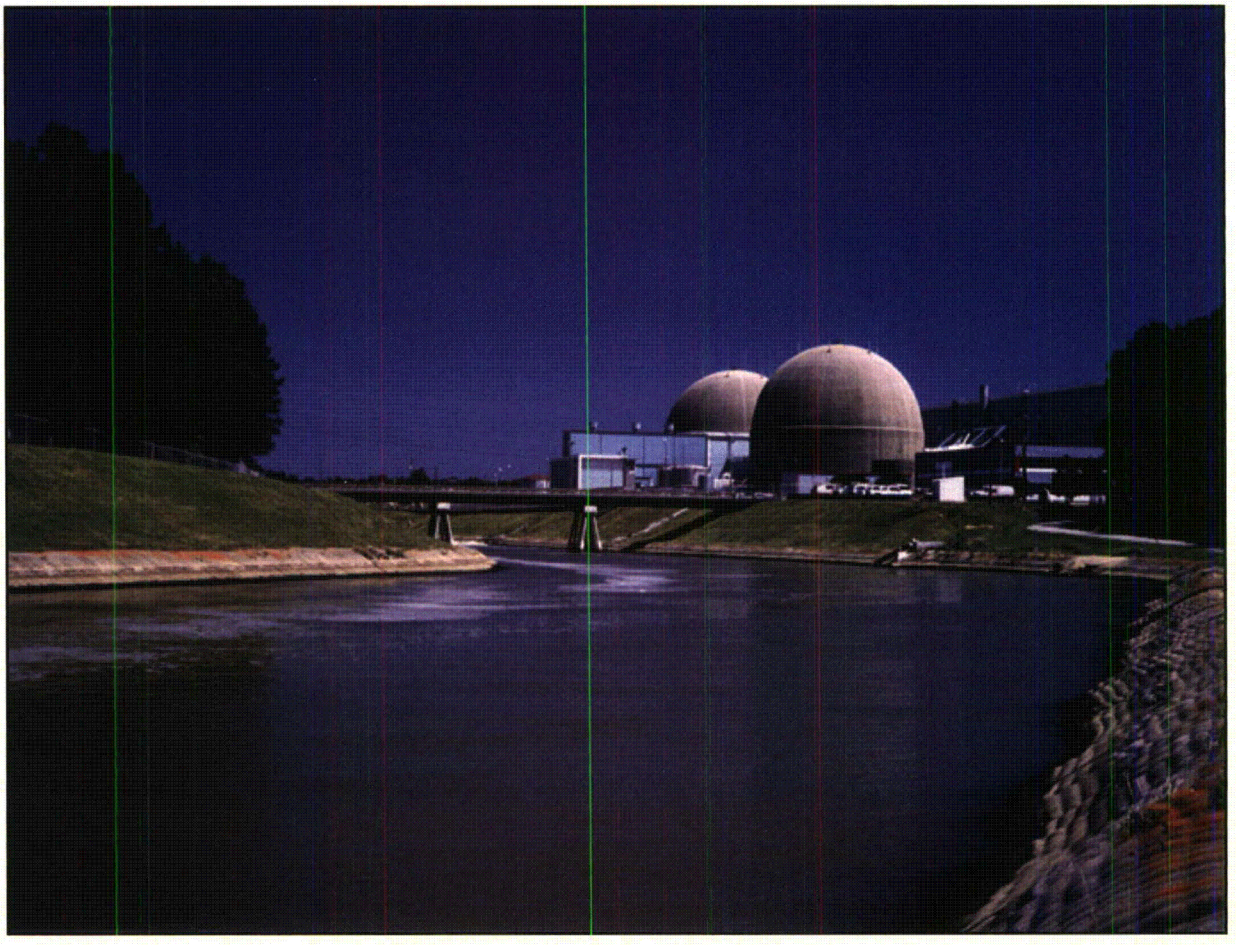
Serial No. 14-192
Docket Nos.: 50-280
50-281
72-2
72-55

**ATTACHMENT 1**

# 2013 Annual Radiological Environmental Operating Report

**SURRY POWER STATION UNITS 1 AND 2**
**VIRGINIA ELECTRIC AND POWER COMPANY**

# Surry Power Station



# 2013 Annual Radiological Environmental Operating Report

Dominion®

# Dominion

## Surry Power Station

## Radiological Environmental Monitoring Program

### January 1, 2013 to December 31, 2013

# Annual Radiological Environmental Operating Report

## Surry Power Station

**January 1, 2013 to December 31, 2013**

**Prepared by:** _____
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W. A. Terry
Supervisor Health Physics Technical Services

**Approved by:** _____
J. W. Eggart
Manager Radiological Protection and Chemistry

# Table of Contents

## PREFACE

This report is submitted as required by Technical Specification 6.6.B.2, Annual Radiological Environmental Operating Report, for Surry, Units 1 and 2, Virginia Electric and Power Company Docket Nos. 50-280 and 50-281.

# 1. EXECUTIVE SUMMARY

This document is a detailed report of the 2013 Surry Power Station Radiological Environmental Monitoring Program (REMP). Radioactivity levels from January 1 through December 31, 2013, in air, water, silt, shoreline sediment, milk, aquatic biota, food products and direct exposure pathways have been analyzed, evaluated and summarized. The REMP is designed to confirm that radiological effluent releases are As Low As is Reasonably Achievable (ALARA), no undue environmental effects occur and the health and safety of the public are protected. The program also detects any unexpected environmental processes that could allow radiation accumulations in the environment or food pathway chains.

Radiation and radioactivity in the environment are monitored within a 20-mile radius of the station. Surry Power Station personnel collect a variety of samples within this area. A number of sampling locations for each medium are selected using available meteorological, land use, and water use data. Two types of samples are obtained. The first type, control samples, is collected from areas that are beyond the measurable influence of Surry Power Station or any other nuclear facility. These samples represent normal background radiation levels. Background radiation levels can be compared to the environment surrounding the station. Indicator samples are the second sample type obtained. These samples show how much radiation is contributed to the environment by the station. Indicator samples are taken from areas close to the station where any station contribution will be at the highest concentration.

Prior to station operation, samples were collected and analyzed to determine the amount of radioactivity present in the area. The resulting values are used as a "pre-operational baseline." Analysis results from the indicator samples are compared to control sample values and the pre-operational baseline to determine if changes in radioactivity levels are attributable to station operations, or natural variation, or other causes such as the Chernobyl and Fukushima Daiichi accidents that released radioactive material to the environment.

Teledyne Brown Engineering, Inc. (TBE) provides radioanalyses for this program and Global Dosimetry Solutions, Inc. provides thermoluminescent dosimetry (TLD) services. Participation in an Interlaboratory Comparison Program provides an independent check of sample measurement precision and accuracy. Typically, radioactivity levels in the environment are so low that analysis values frequently fall below the minimum detection limits of state-of-the-art measurement methods. Because of this, the United States Nuclear Regulatory Commission (USNRC) requires that equipment used for radiological environmental monitoring must be able to detect specified minimum Lower Limits of Detection (LLDs). This ensures that analyses are as accurate as possible. The USNRC also mandates a reporting

level for radionuclides. Licensed nuclear facilities must report the radionuclide activities in those environmental samples that are equal to or greater than the specified reporting level. Environmental radiation levels are sometimes referred to as a percent of the reporting level.

Analytical results are reported for all possible radiation exposure pathways to man. These pathways include airborne, aquatic, terrestrial and direct radiation exposure. The airborne exposure pathway includes radioactive airborne iodine and particulates. The 2013 airborne results were similar to previous years. No station related radioactivity was detected and natural radioactivity levels remained at levels consistent with past years' results. Aquatic exposure pathway samples include well and river water, silt and shoreline sediments, crabs, fish, clams and oysters. Naturally occurring radionuclides such as potassium-40, thorium-228 and thorium-232 were detected at average environmental levels. No man-made radionuclides were detected in well water. This trend is consistent throughout the operational environmental monitoring program. Tritium was detected in one of eight river water samples at 5.4% of the USNRC reporting level, that sample being from the discharge canal. No other man-made radionuclides were detected in river water. Silt samples indicated the presence of cesium-137 and naturally occurring radionuclides. The cesium-137 activity was present in the control and indicator locations and is attributable to global fallout from past nuclear weapons testing and nuclear accidents such as Chernobyl. Shoreline sediment, which may provide a direct exposure pathway, contained no station related radionuclides. Naturally occurring radionuclides such as potassium-40, thorium-228 and thorium-232 were detected at average environmental levels. The terrestrial exposure pathway includes milk and food products. Iodine-131 was not detected in any 2013 milk samples and has not been detected in milk prior to or since the 1986 Chernobyl accident. Strontium-90 was also not detected in milk samples in 2013. No man-made radionuclides were detected in food product samples. Consistent with historical data, naturally occurring potassium-40 was detected in milk and food products. The direct exposure pathway measures environmental radiation doses using TLDs. TLD results have remained relatively constant over the years.

During 2013, as in previous years, the operation of Surry Power Station has created no adverse environmental effects or health hazards. The maximum total body dose calculated for a hypothetical individual at the station site boundary due to liquid and gaseous effluents released from the station during 2013 was 0.129 millirem. For reference, this dose may be compared to the 620 millirem average annual exposure to every person in the United States from natural and man-made sources. Natural sources in the environment provide approximately 50% of radiation exposure to man, while nuclear power contributes less than 0.1%. These results demonstrate compliance with federal and state regulations and also demonstrate the adequacy of radioactive effluent controls at Surry Power Station.

# 2. PROGRAM DESCRIPTION

## *2.1 Introduction*

This report documents the 2013 Surry Power Station operational Radiological Environmental Monitoring Program (REMP). The Dominion Surry Power Station is located on the Gravel Neck peninsula adjacent to the James River, approximately 25 miles upstream of the Chesapeake Bay. The site consists of two units, each with a pressurized water reactor (PWR) nuclear steam supply system and turbine generator furnished by Westinghouse Electric Corporation. Each unit is designed with a nominal gross electrical output of 910 megawatts electric (MWe). Unit 1 achieved commercial operation on December 22, 1972, and Unit 2 on May 1, 1973.

The United States Nuclear Regulatory Commission regulations (10CFR50.34a) require that nuclear power plants be designed, constructed and operated to keep levels of radioactive material in effluents to unrestricted areas As Low As is Reasonably Achievable. To ensure these criteria are met, the operating license for Surry Power Station includes Technical Specifications that address the release of radioactive effluents. In-plant monitoring is used to ensure that these release limits are not exceeded. As a precaution against unexpected or undefined environmental processes which might allow undue accumulation of radioactivity in the environment, a program for monitoring the station environs is also included in Surry Power Station Technical Specifications.

Dominion personnel are responsible for collecting the various indicator and control environmental samples. Global Dosimetry Solutions Incorporated is responsible for processing the TLDs. Teledyne Brown Engineering is responsible for sample analyses. The results of the analyses are used to determine if changes in radioactivity levels may be attributable to station operations. Measured values are compared with control values, which vary with time due to external events, such as cosmic ray bombardment, nuclear weapons test fallout and seasonal variations of naturally occurring radionuclides. Data collected prior to station operation is used to indicate the degree of natural variation to be expected. This pre-operational data is compared with data collected during the operational phase to assist in evaluating any radiological impact of station operation.

Occasionally, samples of environmental media may show the presence of man-made radionuclides. As a method of referencing the measured radionuclide concentrations in the sample media to a dose consequence to man, the data is compared to the reporting level concentrations listed in the USNRC Regulatory Guide 4.8, "Environmental Technical Specifications for Nuclear Power Plants", (December, 1975) and VPAP-2103S, Offsite Dose Calculation Manual (Surry).

These concentrations are based upon the annual dose commitment recommended by 10CFR50, Appendix I, to meet the criterion of "As Low As is Reasonably Achievable."

This report documents the results of the REMP for 2013 and satisfies the following objectives of the program:

- To provide measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposure of the maximum exposed member of the public resulting from station operations.

- To supplement the radiological effluent monitoring program by verifying that radioactive effluents are within allowable limits.

- To identify changes in radioactivity in the environment.

- To verify that station operations have no detrimental effect on the health and safety of the public.

## *2.2 Sampling and Analysis Program*

Table 2-1 summarizes the 2013 sampling program for Surry Power Station. All samples listed in Table 2-1 are taken at indicator locations except those labeled "control." Dominion personnel collect all samples listed in Table 2-1.

Table 2-2 summarizes the analysis program conducted by Teledyne Brown Engineering and Global Dosimetry Solutions for Surry Power Station. All samples, with the exception of the TLDs, are shipped to Teledyne Brown Engineering, located in Knoxville, TN, for analysis. The TLDs are shipped to Global Dosimetry Solutions, located in Costa Mesa, CA, for processing.

The Surry Radiological Monitoring Locations maps (Figures 1 – 5) denote sample locations for Surry Power Station. The locations are color coded to designate sample types.

# Table 2-1

SURRY - 2013

RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM UNIT NO. 1

| Sample Media | Location | Station | Distance Miles | Direction | Degrees | Collection Frequency | Remarks |
|---|---|---|---|---|---|---|---|
| **Environmental** | Control | (00) | - | - | - | Quarterly | Onsite (Stored in a lead shield outside the protected area) |
| **TLDs** | West North West | (02) | 0.2 | WNW | 293° | Quarterly | Site Boundary |
| | Surry Station Discharge | (03) | 0.4 | NW | 321° | Quarterly | Site Boundary |
| | North North West | (04) | 0.2 | NNW | 329° | Quarterly | Site Boundary |
| | North | (05) | 0.3 | N | 4° | Quarterly | Site Boundary |
| | North North East | (06) | 0.3 | NNE | 28° | Quarterly | Site Boundary |
| | North East | (07) | 0.3 | NE | 44° | Quarterly | Site Boundary |
| | East North East | (08) | 0.4 | ENE | 67° | Quarterly | Site Boundary |
| | East | (09) | 0.3 | E | 89° | Quarterly | Site Boundary |
| | West | (10) | 0.1 | W | 271° | Quarterly | Site Boundary |
| | West South West | (11) | 0.4 | WSW | 252° | Quarterly | Site Boundary |
| | South West | (12) | 0.3 | SW | 228° | Quarterly | Site Boundary |
| | South South West | (13) | 0.3 | SSW | 201° | Quarterly | Site Boundary |
| | South | (14) | 0.4 | S | 182° | Quarterly | Site Boundary |
| | South South East | (15) | 0.6 | SSE | 157° | Quarterly | Site Boundary |
| | South East | (16) | 0.9 | SE | 135° | Quarterly | Site Boundary |
| | Station Intake | (18) | 1.6 | ESE | 115° | Quarterly | Site Boundary |
| | Hog Island Reserve | (19) | 2.0 | NNE | 26° | Quarterly | Near Resident |
| | Bacon's Castle | (20) | 4.5 | SSW | 202° | Quarterly | Apx. 5 mile |
| | Route 633 | (21) | 4.9 | SW | 227° | Quarterly | Apx. 5 mile |
| | Alliance | (22) | 5.1 | WSW | 247° | Quarterly | Apx. 5 mile |
| | Surry | (23) | 7.7 | WSW | 256° | Quarterly | Population Center |
| | Route 636 and 637 | (24) | 4.0 | W | 270° | Quarterly | Apx. 5 mile |
| | Scotland Wharf | (25) | 5.0 | WNW | 284° | Quarterly | Apx. 5 mile |
| | Jamestown | (26) | 6.3 | NW | 308° | Quarterly | Apx. 5 mile |
| | Colonial Parkway | (27) | 3.8 | NNW | 333° | Quarterly | Apx. 5 mile |
| | Route 617 and 618 | (28) | 4.9 | NNW | 340° | Quarterly | Apx. 5 mile |
| | Kingsmill | (29) | 4.6 | N | 2° | Quarterly | Apx. 5 mile |
| | Williamsburg | (30) | 7.8 | N | 0° | Quarterly | Population Center |
| | Kingsmill North | (31) | 5.5 | NNE | 12° | Quarterly | Apx. 5 mile |
| | Budweiser | (32) | 5.8 | NNE | 27° | Quarterly | Population Center |
| | Water Plant | (33) | 5.0 | NE | 46° | Quarterly | Apx. 5 mile |

## Table 2-1

SURRY - 2013
RADIOLOGICAL SAMPLING STATIONS
DISTANCE AND DIRECTION FROM UNIT NO. 1

| Sample Media | Location | Station | Distance Miles | Direction | Degrees | Collection Frequency | Remarks |
|---|---|---|---|---|---|---|---|
| **Environmental** | BASF | (34) | 5.1 | ENE | 70° | Quarterly | Apx. 5 mile |
| **TLDs** | Lee Hall | (35) | 7.1 | ENE | 75° | Quarterly | Population Center |
| | Goose Island | (36) | 5.1 | E | 90° | Quarterly | Apx. 5 mile |
| | Fort Eustis | (37) | 4.9 | ESE | 104° | Quarterly | Apx. 5 mile |
| | Newport News | (38) | 19.3 | SE | 130° | Quarterly | Population Center |
| | James River Bridge | (39) | 17.1 | SE | 142° | Quarterly | Control Location |
| | Benn's Church | (40) | 17.0 | SSE | 159° | Quarterly | Control Location |
| | Smithfield | (41) | 13.4 | SSE | 167° | Quarterly | Control Location |
| | Rushmere | (42) | 5.3 | SSE | 156° | Quarterly | Apx. 5 mile |
| | Route 628 | (43) | 5.1 | S | 177° | Quarterly | Apx. 5 mile |
| **Air Charcoal** | Surry Station | (SS) | 0.3 | NNE | 18° | Weekly | Site boundary location with highest D/Q |
| and **Particulate** | Hog Island Reserve | (HIR) | 2.0 | NNE | 26° | Weekly | |
| | Bacon's Castle | (BC) | 4.5 | SSW | 202° | Weekly | |
| | Alliance | (ALL) | 5.1 | WSW | 247° | Weekly | |
| | Colonial Parkway | (CP) | 3.8 | NNW | 333° | Weekly | |
| | BASF | (BASF) | 5.1 | ENE | 70° | Weekly | |
| | Fort Eustis | (FE) | 4.9 | ESE | 104° | Weekly | |
| | Newport News | (NN) | 19.3 | SE | 130° | Weekly | Control Location |
| **River Water** | Surry Station Discharge | (SD) | 0.4 | NW | 323° | Monthly | |
| | Scotland Wharf | (SW) | 4.9 | WNW | 284° | Monthly | Control Location |
| **Well Water** | Surry Station | (SS) | 0.1 | SW | 227° | Quarterly | Onsite |
| | Hog Island Reserve | (HIR) | 2.0 | NNE | 28° | Quarterly | |
| | Construction Site | (CS) | 0.3 | E | 87° | Quarterly | |
| **Shoreline** | Hog Island Reserve | (HIR) | 0.6 | N | 7° | Semi-Annually | |
| **Sediment** | Chickahominy River | (CHIC) | 11.2 | WNW | 301° | Semi-Annually | Control Location |
| **Silt** | Chickahominy River | (CHIC) | 11.2 | WNW | 300° | Semi-Annually | Control Location |
| | Surry Station Discharge | (SD) | 1.3 | NNW | 341° | Semi-Annually | |

## Table 2-1

SURRY - 2013

RADIOLOGICAL SAMPLING STATIONS

DISTANCE AND DIRECTION FROM UNIT NO. 1

| Sample Media | Location | Station | Distance Miles | Direction | Degrees | Collection Frequency | Remarks |
|---|---|---|---|---|---|---|---|
| **Milk** | Colonial Parkway | (CP) | 3.7 | NNW | 336° | Monthly | |
| | Williams | (WMS) | 27.5 | S | 175° | Monthly | Control Location |
| | Epps | (EPPS) | 4.8 | SSW | 200° | Monthly | |
| **Oysters** | Point of Shoals | (POS) | 6.4 | SSE | 157° | Semi-Annually | |
| | Mulberry Point | (MP) | 4.9 | ESE | 124° | Semi-Annually | |
| | Lawne's Creek | (LC) | 2.4 | SE | 131° | | |
| **Clams** | Chickahominy River | (CHIC) | 11.2 | WNW | 300° | Semi-Annually | Control Location |
| | Surry Station Discharge | (SD) | 1.3 | NNW | 341° | Semi-Annually | |
| | Jamestown Island | (JI) | 3.9 | NW | 324° | Semi-Annually | |
| **Fish** | Surry Station Discharge | (SD) | 1.3 | NNW | 341° | Semi-Annually | |
| **Crabs** | Surry Station Discharge | (SD) | 1.3 | NNW | 341° | Annually | |
| **Crops** | Brock's Farm | (BROCK) | 3.8 | S | 183° | Annually | |
| **(Corn, Peanuts, Soybeans)** | Slade's Farm | (SLADE) | 3.2 | S | 179° | Annually | |

## Table 2-2

SURRY - 2013

SAMPLE ANALYSIS PROGRAM

| SAMPLE MEDIA | FREQUENCY | ANALYSIS | LLD* | REPORT UNITS |
|---|---|---|---|---|
| **Thermoluminescent Dosimetry (TLD)** | Quarterly | Gamma Dose | 2 | mR/Std. Month |
| **Air Iodine** | Weekly | I-131 | 0.07 | $pCi/m^3$ |
| **Air Particulate** | Weekly | Gross Beta | 0.01 | $pCi/m^3$ |
| | Quarterly (a) | Gamma Isotopic | | $pCi/m^3$ |
| | | Cs-134 | 0.05 | |
| | | Cs-137 | 0.06 | |
| **River Water** | Quarterly Composite of monthly sample | Tritium (H-3) | 2000 | pCi/L |
| | Monthly | I-131 | 10 | pCi/L |
| | | Gamma Isotopic | | pCi/L |
| | | Mn-54 | 15 | |
| | | Fe-59 | 30 | |
| | | Co-58 | 15 | |
| | | Co-60 | 15 | |
| | | Zn-65 | 30 | |
| | | Zr-95 | 30 | |
| | | Nb-95 | 15 | |
| | | Cs-134 | 15 | |
| | | Cs-137 | 18 | |
| | | Ba-140 | 60 | |
| | | La-140 | 15 | |
| **Well Water** | Quarterly | Tritium (H-3) | 2000 | pCi/L |
| | | I-131 | 1 | |
| | | Gamma Isotopic | | pCi/L |
| | | Mn-54 | 15 | |
| | | Fe-59 | 30 | |
| | | Co-58 | 15 | |
| | | Co-60 | 15 | |
| | | Zn-65 | 30 | |
| | | Zr-95 | 30 | |
| | | Nb-95 | 15 | |
| | | Cs-134 | 15 | |
| | | Cs-137 | 18 | |
| | | Ba-140 | 60 | |
| | | La-140 | 15 | |

*Footnotes located at end of table.*

## Table 2-2

SURRY - 2013

SAMPLE ANALYSIS PROGRAM

| SAMPLE MEDIA | FREQUENCY | ANALYSIS | LLD* | REPORT UNITS |
|---|---|---|---|---|
| **Shoreline Sediment** | Semi-Annually | Gamma Isotopic | | pCi/kg - dry |
| | | Cs-134 | 150 | |
| | | Cs-137 | 180 | |
| **Silt** | Semi-Annually | Gamma Isotopic | | pCi/kg - dry |
| | | Cs-134 | 150 | |
| | | Cs-137 | 180 | |
| **Milk** | Monthly | I-131 | 1 | pCi/L |
| | | Gamma Isotopic | | pCi/L |
| | | Cs-134 | 15 | |
| | | Cs-137 | 18 | |
| | | Ba-140 | 60 | |
| | | La-140 | 15 | |
| | Quarterly Composite of CP monthly sample | Sr-89 | NA | pCi/L |
| | | Sr-90 | NA | |
| **Oysters** | Semi-Annually | Gamma Isotopic | | pCi/kg - wet |
| | | Mn-54 | 130 | |
| | | Fe-59 | 260 | |
| | | Co-58 | 130 | |
| | | Co-60 | 130 | |
| | | Zn-65 | 260 | |
| | | Cs-134 | 130 | |
| | | Cs-137 | 150 | |
| **Clams** | Semi-Annually | Gamma Isotopic | | pCi/kg - wet |
| | | Mn-54 | 130 | |
| | | Fe-59 | 260 | |
| | | Co-58 | 130 | |
| | | Co-60 | 130 | |
| | | Zn-65 | 260 | |
| | | Cs-134 | 130 | |
| | | Cs-137 | 150 | |
| **Crabs** | Annually | Gamma Isotopic | | pCi/kg - wet |
| | | Mn-54 | 130 | |
| | | Fe-59 | 260 | |
| | | Co-58 | 130 | |
| | | Co-60 | 130 | |
| | | Zn-65 | 260 | |
| | | Cs-134 | 130 | |
| | | Cs-137 | 150 | |

*Footnotes located at end of table.*

## Table 2-2

SURRY - 2013

SAMPLE ANALYSIS PROGRAM

| SAMPLE MEDIA | FREQUENCY | ANALYSIS | LLD* | REPORT UNITS |
|---|---|---|---|---|
| **Fish** | Semi-Annually | Gamma Isotopic | | pCi/kg - wet |
| | | Mn-54 | 130 | |
| | | Fe-59 | 260 | |
| | | Co-58 | 130 | |
| | | Co-60 | 130 | |
| | | Zn-65 | 260 | |
| | | Cs-134 | 130 | |
| | | Cs-137 | 150 | |
| **Food Products** | Annually | Gamma Isotopic | | pCi/kg - wet |
| | | I-131 | 60 | |
| | | Cs-134 | 60 | |
| | | Cs-137 | 80 | |

**Note:** This table is not a complete listing of nuclides that can be detected and reported. Other peaks that ar are measurable and identifiable, together with the above nuclides, are also identified and reported.

* LLD is the Lower Limit of Detection as defined and required in the USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979. LLDs indicate those concentrations to which environmental samples are required to be analyzed. Actual analysis of samples may be lower than these listed values.

(a) Quarterly composites of each location's weekly air particulate samples are analyzed for gamma emitters.

NA None assigned

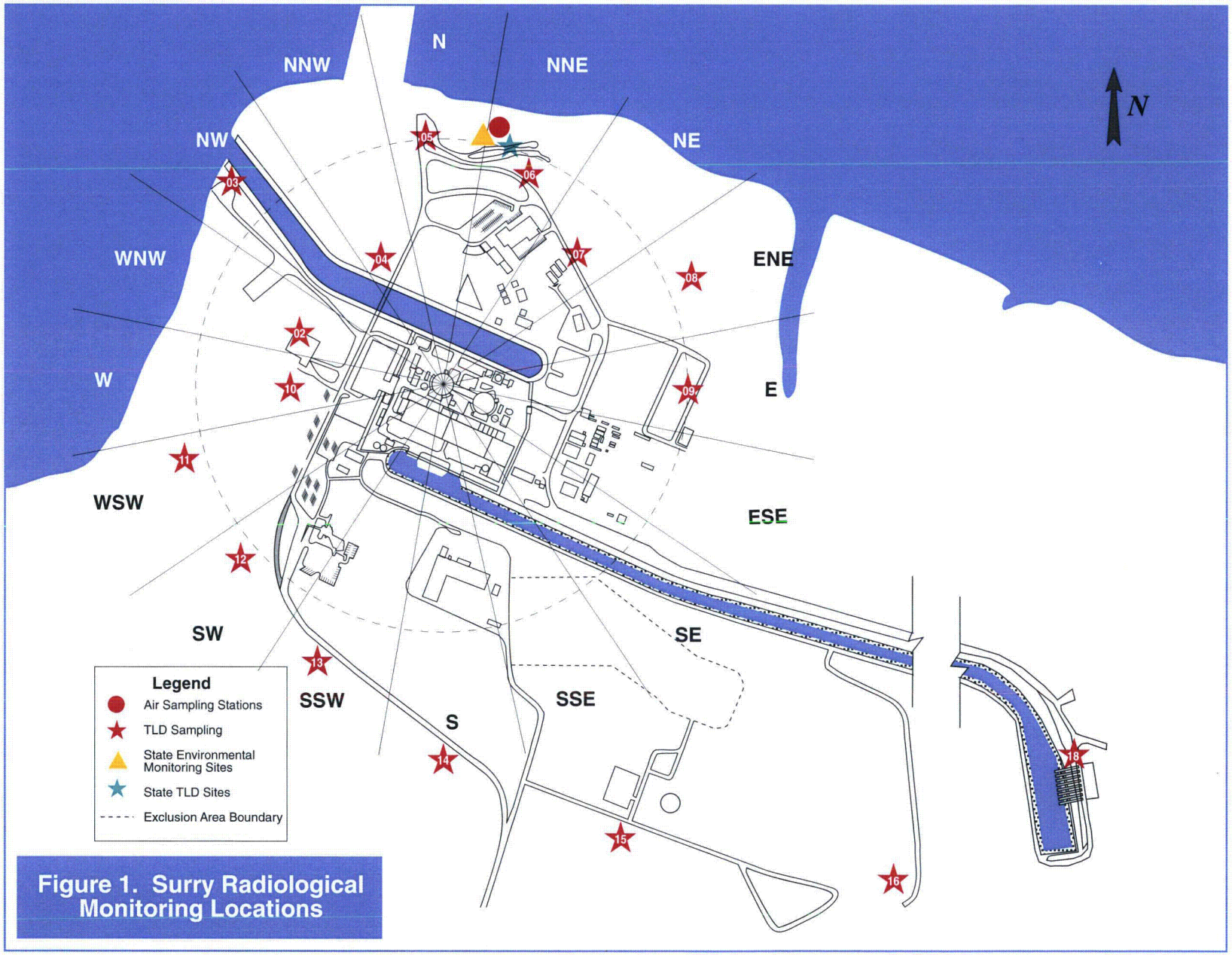


**Figure 1. Surry Radiological Monitoring Locations**

Graphics No. SV645F

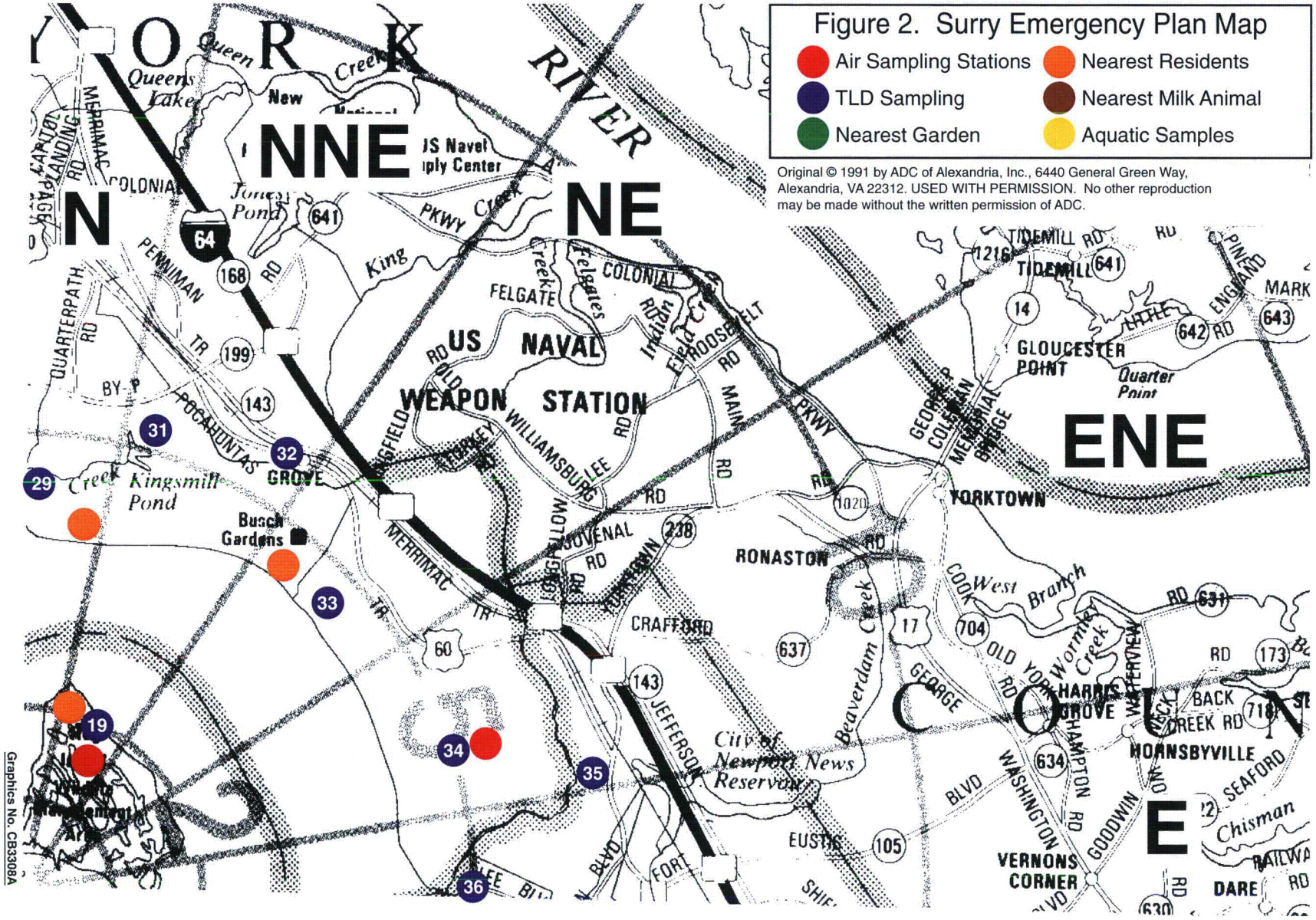
Figure 2. Surry Emergency Plan Map
Air Sampling Stations
Nearest Residents
TLD Sampling
Nearest Milk Animal
Nearest Garden
Aquatic Samples
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NNE
NE
ENE
E
N
US NAVAL WEAPON STATION
YORKTOWN
GLOUCESTER POINT
RONASTON
CRAFFORD
HORNSBYVILLE
VERNONS CORNER
City of Newport News Reservoir
Kingsmill Pond
Busch Gardens
Graphics No. CB3308A

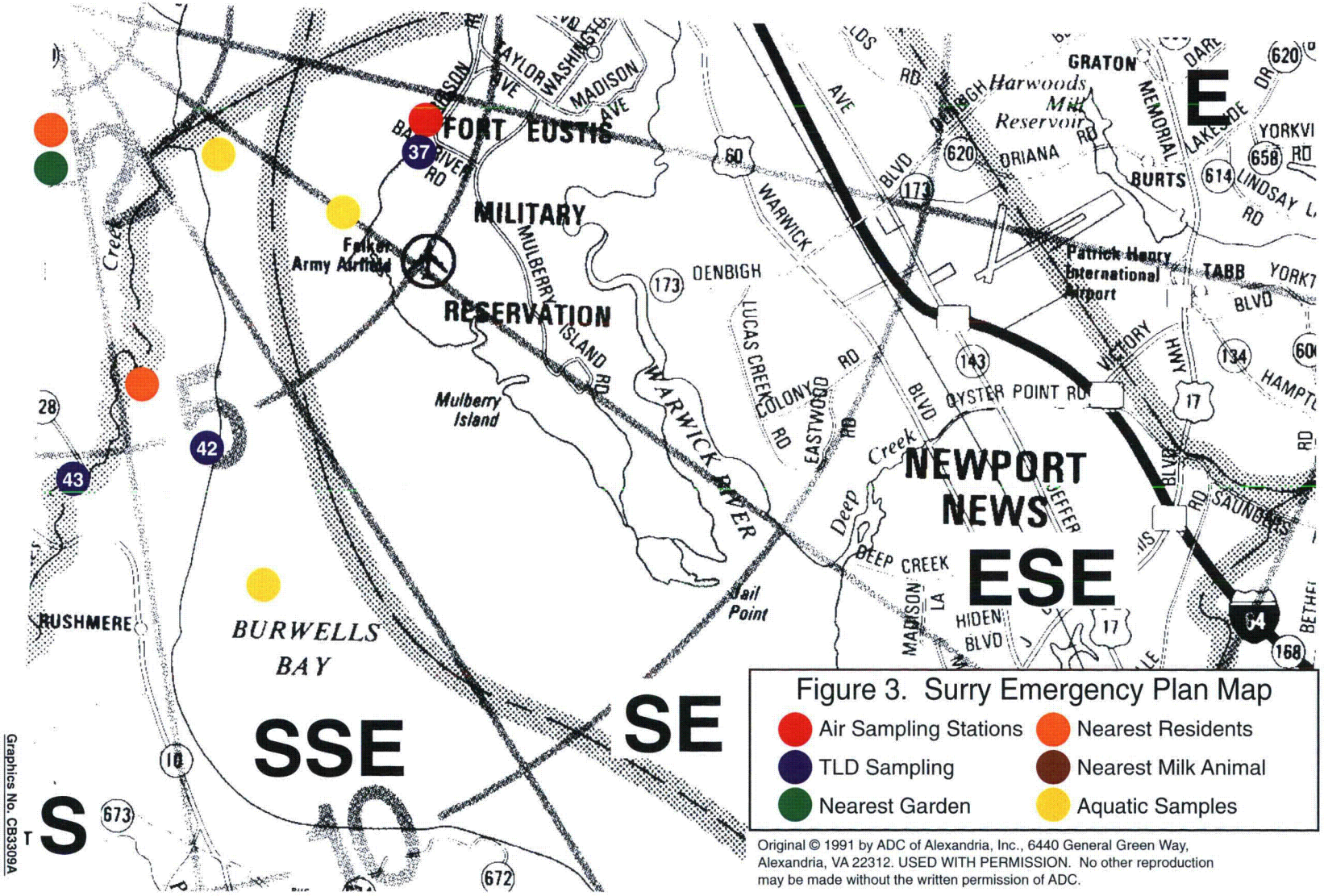



Figure 3. Surry Emergency Plan Map

- Air Sampling Stations
- Nearest Residents
- TLD Sampling
- Nearest Milk Animal
- Nearest Garden
- Aquatic Samples



Graphics No. CB3309A

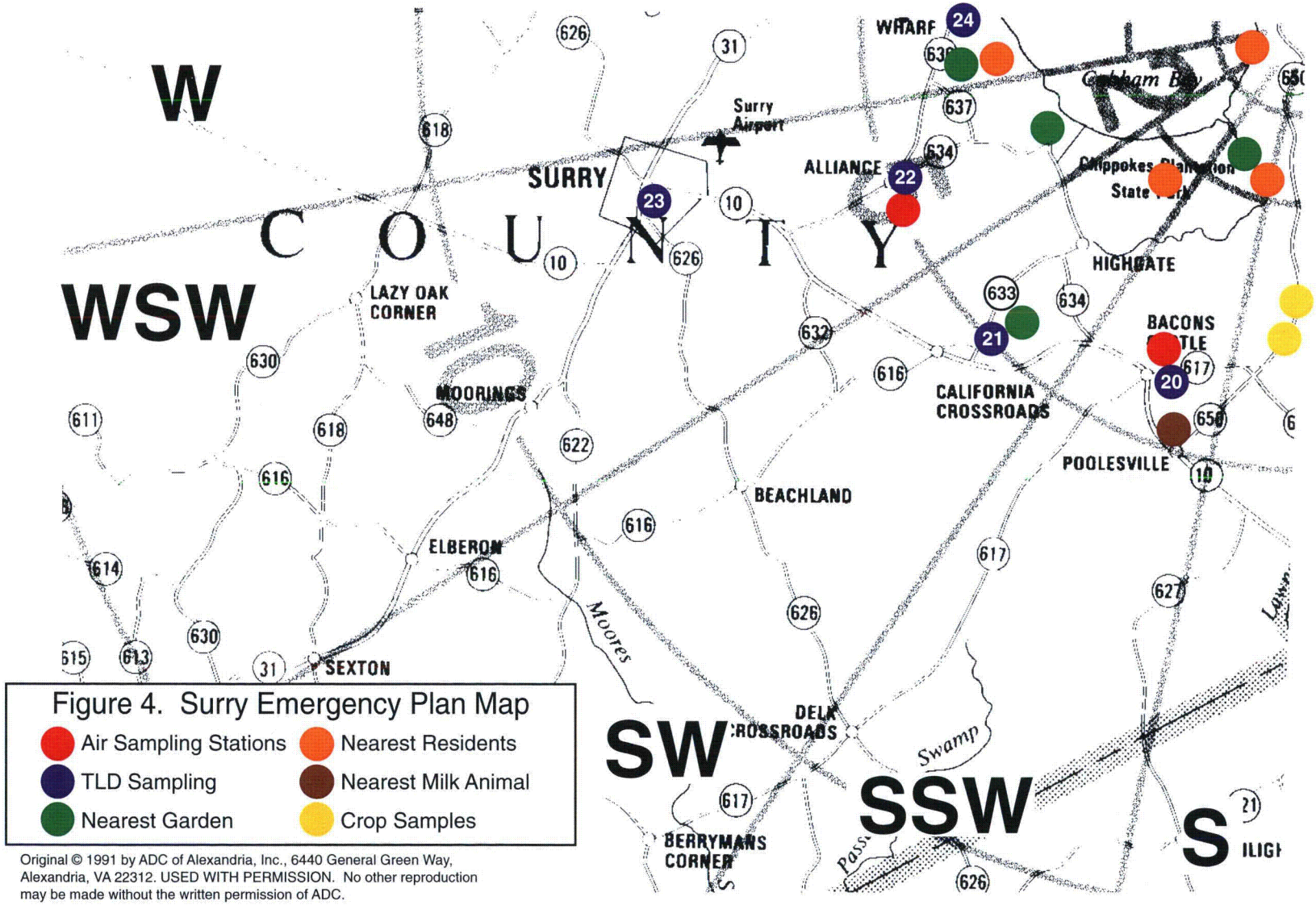


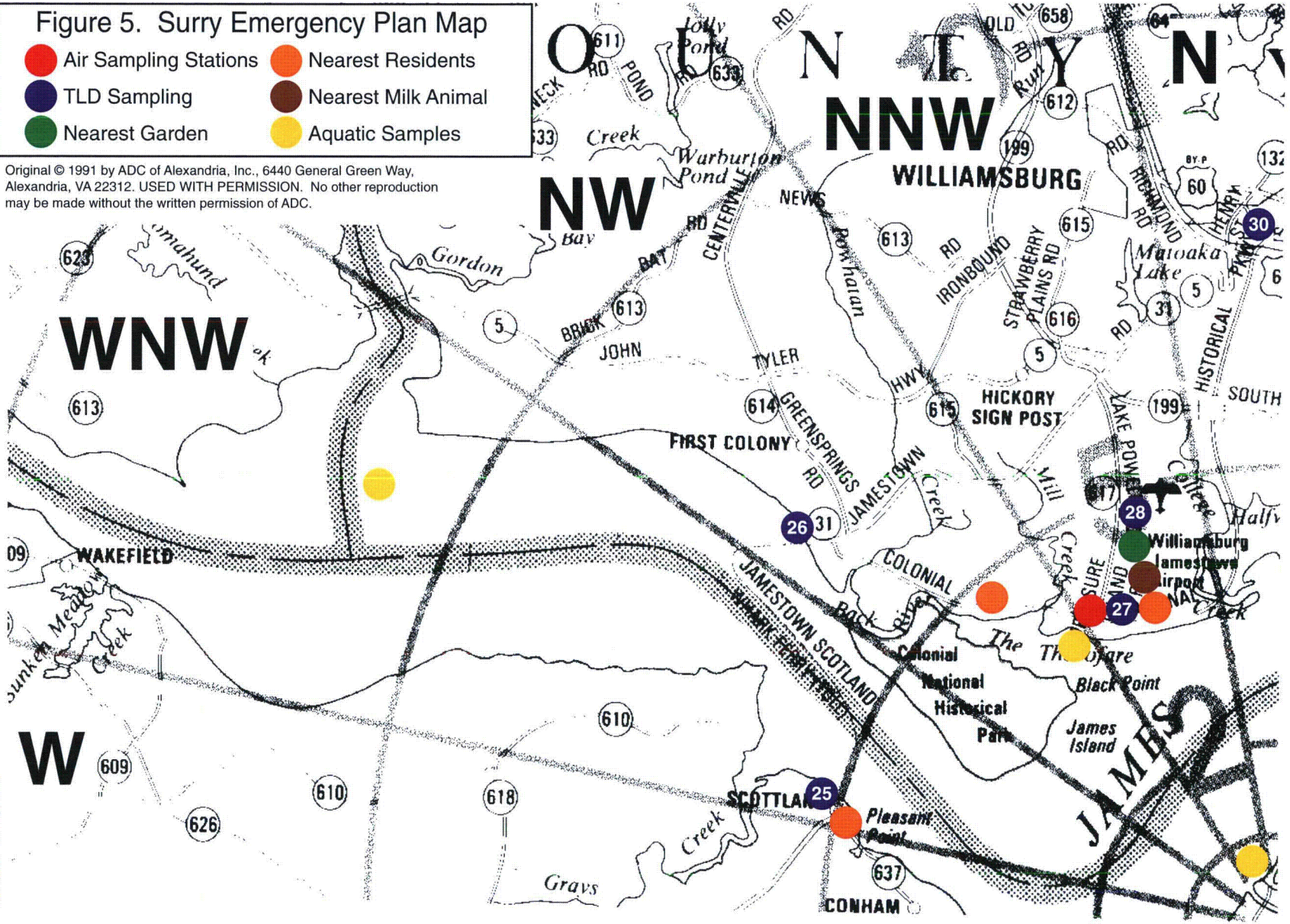

Figure 4. Surry Emergency Plan Map

- Air Sampling Stations
- Nearest Residents
- TLD Sampling
- Nearest Milk Animal
- Nearest Garden
- Crop Samples

## Figure 5. Surry Emergency Plan Map

- Air Sampling Stations
- TLD Sampling
- Nearest Garden
- Nearest Residents
- Nearest Milk Animal
- Aquatic Samples





# 3. ANALYTICAL RESULTS

## *3.1 Summary of Results*

In accordance with the Surry Offsite Dose Calculation Manual (ODCM), a summary table of the analytical results has been prepared and is presented in Table 3-1. This data is presented in accordance with the format of the USNRC Branch Technical Position, "Acceptable Radiological Environmental Monitoring Program", Revision 1, November 1979. A more detailed analysis of the data is given in Section 4.

## *TABLE 3-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY*

Surry Power Station, Surry County, Virginia - 2013
Docket No. 50-280-281 Page 1 of 7

| Medium or Pathway Sampled (Units) | Analysis Type | Analysis Total No. | LLD | Indicator Locations Mean Range | Location with Highest Mean Name | Location with Highest Mean Distance Direction | Location with Highest Mean Mean Range | Control Locations Mean Range | Non-Routine Reported Measurements |
|---|---|---|---|---|---|---|---|---|---|
| **Direct Radiation** *TLD (mR/ Std Month)* | **Gamma** | 164 | 2 | **5.5 (146/152) (3.9 - 7.9)** | **STA-9** | **0.3 mi E** | **7.8 (4/4) (7.6 - 7.9)** | **5.8 (12/12) (4.3 - 7.5)** | 0 |
| **Air Particulate** *(1E-3 pCi/m3)* | **Gross Beta** | 416 | 10 | **14.0 (364/364) (4.71 - 36.0)** | **ALL** | **5.1 mi WSW** | **15.5 (52/52) (5.71 - 31.3)** | **15.2 (52/52) (6.20 - 36.7)** | 0 |
| | **Gamma** | 32 | | | | | | | |
| | Be-7 | 32 | | **117 (28/28) (63.8 - 166)** | **ALL** | **5.1 mi WSW** | **134 (4/4) (105 - 166)** | **119 (4/4) (92.0 - 147)** | 0 |
| | K-40 | 32 | | **35.1 (3/28) (21.9 - 57.5)** | **HIR** | **2.0 mi NNE** | **57.5 (1/4) (57.5 - 57.5)** | < LLD | 0 |
| | Cs-134 | 32 | 50 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Cs-137 | 32 | 60 | < LLD | N/A | | < LLD | < LLD | 0 |
| **Air Iodine** *(1E-3 pCi/m3)* | **I-131** | 416 | 70 | < LLD | N/A | | < LLD | < LLD | 0 |
| **Milk** *(pCi/Liter)* | **Strontium** | 4 | | | | | | | |
| | Sr-89 | 4 | | < LLD | N/A | | < LLD | < LLD | 0 |
| | Sr-90 | 4 | | < LLD | N/A | | < LLD | < LLD | 0 |
| | **Gamma** | 36 | | | | | | | |
| | K-40 | 36 | | **1328 (24/24) (977 - 1460)** | **CP** | **3.7 mi NNW** | **1338 (12/12) (1220 - 1460)** | **1302 (12/12) (1160 - 1420)** | 0 |
| | Th-228 | 36 | | **9.07 (1/24) (9.07 - 9.07)** | **WMS** | **27.5 mi S** | **16.5 (1/24) (16.5 - 16.5)** | **16.5 (1/12) (16.5 - 16.5)** | 0 |
| | I-131 | 36 | 1 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Cs-134 | 36 | 15 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Cs-137 | 36 | 18 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Ba-140 | 36 | 60 | < LLD | N/A | | < LLD | < LLD | 0 |

## *TABLE 3-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY*

Surry Power Station, Surry County, Virginia - 2013
Docket No. 50-280-281 Page 2 of 7

| Medium or Pathway Sampled (Units) | Analysis Type | Analysis Total No. | LLD | Indicator Locations Mean Range | Location with Highest Mean Name | Location with Highest Mean Distance Direction | Location with Highest Mean Mean Range | Control Locations Mean Range | Non-Routine Reported Measurements |
|---|---|---|---|---|---|---|---|---|---|
| **Milk** *(pCi/Liter)* | **Gamma** | 36 | | | | | | | |
| | La-140 | 36 | 15 | < LLD | N/A | | < LLD | < LLD | 0 |
| **Food Products** *(pCi/kg wet)* | **Gamma** | 3 | | | | | | | |
| | K-40 | 3 | | **7377 (3/3) (2980 - 14500)** | **Slade** | **3.2 mi S** | **14500 (1/1) (14500-14500)** | N/A | 0 |
| | Be-7 | 3 | | **201 (1/3) (201 - 201)** | **Brock** | **3.8 mi S** | **201 (1/3) (201 - 201)** | N/A | |
| | Th-228 | 3 | | **17.5 (2/3) (12.4 - 22.5)** | **Brock** | **3.8 mi S** | **22.5 (1/2) (22.5 - 22.5)** | | |
| | I-131 | 3 | 60 | < LLD | N/A | | < LLD | N/A | 0 |
| | Cs-134 | 3 | 60 | < LLD | N/A | | < LLD | N/A | 0 |
| | Cs-137 | 3 | 80 | < LLD | N/A | | < LLD | N/A | 0 |
| **Well Water** *(pCi/Liter)* | **H-3** | 12 | 2000 | < LLD | N/A | | < LLD | N/A | 0 |
| | **Gamma** | 12 | | | | | | | |
| | Mn-54 | 12 | 15 | < LLD | N/A | | < LLD | N/A | 0 |
| | Co-58 | 12 | 15 | < LLD | N/A | | < LLD | N/A | 0 |
| | Fe-59 | 12 | 30 | < LLD | N/A | | < LLD | N/A | 0 |
| | Co-60 | 12 | 15 | < LLD | N/A | | < LLD | N/A | 0 |
| | Zn-65 | 12 | 30 | < LLD | N/A | | < LLD | N/A | 0 |

## *TABLE 3-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY*

Surry Power Station, Surry County, Virginia - 2013
Docket No. 50-280-281 Page 3 of 7

| Medium or Pathway Sampled (Units) | Analysis Type | Analysis Total No. | LLD | Indicator Locations Mean Range | Location with Highest Mean Name | Location with Highest Mean Distance Direction | Location with Highest Mean Mean Range | Control Locations Mean Range | Non-Routine Reported Measurements |
|---|---|---|---|---|---|---|---|---|---|
| **Well Water** *(pCi/Liter)* | Nb-95 | 12 | 15 | < LLD | N/A | | < LLD | N/A | 0 |
| | Zr-95 | 12 | 30 | < LLD | N/A | | < LLD | N/A | 0 |
| | I-131 | 12 | 1 | < LLD | N/A | | < LLD | N/A | 0 |
| | Cs-134 | 12 | 15 | < LLD | N/A | | < LLD | N/A | 0 |
| | Cs-137 | 12 | 18 | < LLD | N/A | | < LLD | N/A | 0 |
| | Ba-140 | 12 | 60 | < LLD | N/A | | < LLD | N/A | 0 |
| | La-140 | 12 | 15 | < LLD | N/A | | < LLD | N/A | 0 |
| **River Water** *(pCi/Liter)* | **H-3** | 8 | 2000 | **1610 (1/4) (1610 - 1610)** | **SD** | **0.4 mi NW** | **1610 (1/4) (1610 - 1610)** | N/A | 0 |
| | **Gamma** | 24 | | | | | | | |
| | K-40 | 24 | | **89.2 (9/12) (54.1 - 125)** | **SD** | **0.4 mi NW** | **89.2 (9/12) (54.1 - 125)** | **70.1 (5/12) (52.9 - 88.6)** | 0 |
| | Ra-226 | 24 | | < LLD | **SW** | **4.9 mi WNW** | **77.5 (1/12) (77.5 - 77.5)** | **77.5 (1/12) (77.5 - 77.5)** | 0 |
| | Th-228 | 24 | | **6.58 (1/12) (6.58 - 6.58)** | **SD** | **0.4 mi NW** | **6.58 (1/12) (6.58 - 6.58)** | < LLD | 0 |
| | Mn-54 | 24 | 15 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Co-58 | 24 | 15 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Fe-59 | 24 | 30 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Co-60 | 24 | 15 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Zn-65 | 24 | 30 | < LLD | N/A | | < LLD | < LLD | 0 |

## *TABLE 3-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY*

Surry Power Station, Surry County, Virginia - 2013
Docket No. 50-280-281 Page 4 of 7

| Medium or Pathway Sampled (Units) | Analysis Type | Analysis Total No. | LLD | Indicator Locations Mean Range | Location with Highest Mean Name | Location with Highest Mean Distance Direction | Location with Highest Mean Mean Range | Control Locations Mean Range | Non-Routine Reported Measurements |
|---|---|---|---|---|---|---|---|---|---|
| **River Water** *(pCi/Liter)* | Nb-95 | 24 | 15 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Zr-95 | 24 | 30 | < LLD | N/A | | < LLD | < LLD | 0 |
| | I-131 | 24 | 10 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Cs-134 | 24 | 15 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Cs-137 | 24 | 18 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Ba-140 | 24 | 60 | < LLD | N/A | | < LLD | < LLD | 0 |
| | La-140 | 24 | 15 | < LLD | N/A | | < LLD | < LLD | 0 |
| **Silt** *(pCi/kg dry)* | **Gamma** | 4 | | | | | | | |
| | Be-7 | 4 | | **1780 (1/2) (1780 - 1780)** | **SD** | **1.3 mi NNW** | **1780 (1/2) (1780 - 1780)** | < LLD | 0 |
| | K-40 | 4 | | **17800 (2/2) (15400-20200)** | **SD** | **1.3 mi NNW** | **17800 (2/2) (15400-20200)** | **18050 (2/2) (17200-18900)** | 0 |
| | Cs-134 | 4 | 150 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Cs-137 | 4 | 180 | **142 (2/2) (121 - 163)** | **SD** | **1.3 mi NNW** | **142 (2/2) (121 - 163)** | **206 (2/2) (175 - 206)** | 0 |
| | Ra-226 | 4 | | **3760 (2/2) (2210 - 5310)** | **SD** | **1.3 mi NNW** | **3760 (2/2) (2210 - 5310)** | **3040 (2/2) (2520 - 3560)** | 0 |
| | Ac-228 | 4 | | **384 (1/2) (384 - 384)** | **SD** | **1.3 mi NNW** | **384 (1/2) (384 - 384)** | < LLD | |
| | Th-228 | 4 | | **1425 (2/2) (1200 - 1650)** | **SD** | **1.3 mi NNW** | **1425 (2/2) (1200 - 1650)** | **1485 (2/2) (1290 - 1680)** | 0 |
| | Th-232 | 4 | | **1318 (2/2) (995 - 1640)** | **SD** | **1.3 mi NNW** | **1318 (2/2) (995 - 1640)** | **1205 (2/2) (1040 - 1370)** | 0 |

## *TABLE 3-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY*

Surry Power Station, Surry County, Virginia - 2013
Docket No. 50-280-281 Page 5 of 7

| Medium or Pathway Sampled (Units) | Analysis Type | Analysis Total No. | LLD | Indicator Locations Mean Range | Location with Highest Mean Name | Location with Highest Mean Distance Direction | Location with Highest Mean Mean Range | Control Locations Mean Range | Non-Routine Reported Measurements |
|---|---|---|---|---|---|---|---|---|---|
| **Shoreline Sediment** *(pCi/kg dry)* | K-40 | 4 | | **6085 (2/2) (5440 - 6730)** | **HIR** | **0.6 mi N** | **6085 (2/2) (5440 - 6730)** | **2410 (2/2) (1970 - 2850)** | 0 |
| | Cs-134 | 4 | 150 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Cs-137 | 4 | 180 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Ra-226 | 4 | | < LLD | **CHIC** | **11.2 mi WNW** | **4280 (1/2) (4280 - 4280)** | **4280 (1/2) (4280 - 4280)** | 0 |
| | Th-228 | 4 | | **223 (2/2) (131 - 314)** | **CHIC** | **11.2 mi WNW** | **2643 (2/2) (415 - 4870)** | **2643 (2/2) (415 - 4870)** | 0 |
| | Th-232 | 4 | | **235 (1/2) (235 - 235)** | **CHIC** | **11.2 mi WNW** | **2639 (2/2) (398 - 4880)** | **2639 (2/2) (398 - 4880)** | 0 |
| **Fish** *(pCi/kg wet)* | **Gamma** | 4 | | | | | | | |
| | K-40 | 4 | | **2370 (4/4) (2060 - 2820)** | **SD** | **1.3 mi NNW** | **2370 (4/4) (2060 - 2820)** | N/A | 0 |
| | Mn-54 | 4 | 130 | < LLD | N/A | | < LLD | N/A | 0 |
| | Co-58 | 4 | 130 | < LLD | N/A | | < LLD | N/A | 0 |
| | Fe-59 | 4 | 260 | < LLD | N/A | | < LLD | N/A | 0 |
| | Co-60 | 4 | 130 | < LLD | N/A | | < LLD | N/A | 0 |
| | Zn-65 | 4 | 260 | < LLD | N/A | | < LLD | N/A | 0 |
| | Cs-134 | 4 | 130 | < LLD | N/A | | < LLD | N/A | 0 |
| | Cs-137 | 4 | 150 | < LLD | N/A | | < LLD | N/A | 0 |

## *TABLE 3-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY*

Surry Power Station, Surry County, Virginia - 2013
Docket No. 50-280-281 Page 6 of 7

| Medium or Pathway Sampled (Units) | Analysis Type | Analysis Total No. | LLD | Indicator Locations Mean Range | Location with Highest Mean Name | Location with Highest Mean Distance Direction | Location with Highest Mean Mean Range | Control Locations Mean Range | Non-Routine Reported Measurements |
|---|---|---|---|---|---|---|---|---|---|
| **Oysters** *(pCi/kg wet)* | **Gamma** | 6 | | | | | | | |
| | K-40 | 6 | | **728 (4/6) (608 - 943)** | **LC** | **2.4 mi SE** | **841 (2/2) (738 - 943)** | N/A | 0 |
| | Mn-54 | 6 | 130 | < LLD | N/A | | < LLD | N/A | 0 |
| | Fe-59 | 6 | 260 | < LLD | N/A | | < LLD | N/A | 0 |
| | Co-58 | 6 | 130 | < LLD | N/A | | < LLD | N/A | 0 |
| | Co-60 | 6 | 130 | < LLD | N/A | | < LLD | N/A | 0 |
| | Zn-65 | 6 | 260 | < LLD | N/A | | < LLD | N/A | 0 |
| | Cs-134 | 6 | 130 | < LLD | N/A | | < LLD | N/A | 0 |
| | Cs-137 | 6 | 150 | < LLD | N/A | | < LLD | N/A | 0 |
| **Clams** *(pCi/kg wet)* | **Gamma** | 6 | | | | | | | |
| | K-40 | 6 | | **576 (2/4) (473 - 679)** | **JI** | **3.9 mi NW** | **679 (1/2) (679 - 679)** | **461 (1/2) (461 - 461)** | 0 |
| | Mn-54 | 6 | 130 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Co-58 | 6 | 130 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Fe-59 | 6 | 260 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Co-60 | 6 | 130 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Zn-65 | 6 | 260 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Cs-134 | 6 | 130 | < LLD | N/A | | < LLD | < LLD | 0 |
| | Cs-137 | 6 | 150 | < LLD | N/A | | < LLD | < LLD | 0 |

## *TABLE 3-1: RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY*

Surry Power Station, Surry County, Virginia - 2013
Docket No. 50-280-281 Page 7 of 7

| Medium or Pathway Sampled (Units) | Analysis Type | Analysis Total No. | LLD | Indicator Locations Mean Range | Location with Highest Mean Name | Location with Highest Mean Distance Direction | Location with Highest Mean Mean Range | Control Locations Mean Range | Non-Routine Reported Measurements |
|---|---|---|---|---|---|---|---|---|---|
| **Clams** *(pCi/kg wet)* | **Gamma** | 6 | | | | | | | |
| | Th-228 | 6 | | **152 (1/4) (152 - 152)** | **JI** | **3.9 mi NW** | **152 (1/4) (152 - 152)** | **95.2 (1/2) (95.2 - 95.2)** | 0 |
| **Crabs** *(pCi/kg wet)* | **Gamma** | 1 | | | | | | | |
| | K-40 | 1 | | **2670 (1/1) (2670 - 2670)** | **SD** | **1.3 mi NNW** | **2670 (1/1) (2670 - 2670)** | N/A | 0 |
| | Mn-54 | 1 | 130 | < LLD | N/A | | < LLD | N/A | 0 |
| | Co-58 | 1 | 130 | < LLD | N/A | | < LLD | N/A | 0 |
| | Fe-59 | 1 | 260 | < LLD | N/A | | < LLD | N/A | 0 |
| | Co-60 | 1 | 130 | < LLD | N/A | | < LLD | N/A | 0 |
| | Zn-65 | 1 | 260 | < LLD | N/A | | < LLD | N/A | 0 |
| | Cs-134 | 1 | 130 | < LLD | N/A | | < LLD | N/A | 0 |
| | Cs-137 | 1 | 150 | < LLD | N/A | | < LLD | N/A | 0 |

## *3.2 Analytical Results of 2013 REMP Samples*

Radiological analyses of environmental media characteristically approach and frequently fall below the detection limits of state-of-the-art measurement methods. The reported error is two times the standard deviation ($2\sigma$) of the net activity. Unless otherwise noted, the overall error (counting, sample size, chemistry, errors, etc.) is estimated to be 2 to 5 times that listed. Results are considered positive when the measured value exceeds $2\sigma$ uncertainty.

Teledyne Brown Engineering analytical methods meet the Lower Limit of Detection (LLD) requirements given in Table 2 of the USNRC Branch Technical Position, "An Acceptable Radiological Environmental Monitoring Program", (November 1979, Revision 1) and the Surry ODCM.

Data are given according to sample type as indicated below.

1. Gamma Exposure Rate
2. Air Particulates, Weekly Gross Beta Radioactivity
3. Air Particulates, Weekly I-131
4. Air Particulates, Quarterly Gamma Spectroscopy
5. Cow Milk
6. Food Products
7. Well Water
8. River Water
9. Silt
10. Shoreline Sediment
11. Fish
12. Oysters
13. Clams
14. Crabs

## *TABLE 3-2: GAMMA EXPOSURE RATE*

Surry Power Station, Surry County, Virginia - 2013

mR/Std Month ± 2 Sigma



| STATION NUMBER | FIRST QUARTER | SECOND QUARTER | THIRD QUARTER | FOURTH QUARTER | AVERAGE ± 2 SIGMA |
|---|---|---|---|---|---|
| 02 | 6.2 ± 0.6 | 6.1 ± 0.5 | 6.5 ± 1.0 | 6.9 ± 0.8 | 6.4 ± 0.7 |
| 03 | 6.4 ± 0.7 | 6.6 ± 1.5 | 6.5 ± 1.0 | 6.6 ± 0.8 | 6.5 ± 0.2 |
| 04 | 5.8 ± 0.9 | 5.8 ± 0.4 | 6.1 ± 0.6 | 6.3 ± 0.6 | 6.0 ± 0.5 |
| 05 | 5.9 ± 0.3 | 6.1 ± 0.6 | 6.3 ± 1.2 | 6.4 ± 0.7 | 6.2 ± 0.4 |
| 06 | 5.9 ± 0.4 | 5.9 ± 0.8 | 6.4 ± 1.3 | 6.3 ± 0.9 | 6.1 ± 0.5 |
| 07 | 5.9 ± 0.6 | 5.9 ± 0.4 | 6.4 ± 0.4 | 6.4 ± 1.1 | 6.2 ± 0.6 |
| 08 | 5.4 ± 0.7 | 5.4 ± 0.8 | 5.8 ± 0.9 | 5.8 ± 0.5 | 5.6 ± 0.5 |
| 09 | 7.8 ± 1.0 | 7.6 ± 1.2 | 7.8 ± 0.9 | 7.9 ± 1.1 | 7.8 ± 0.3 |
| 10 | 5.9 ± 1.0 | 6.2 ± 1.1 | 6.3 ± 1.3 | 6.4 ± 0.8 | 6.2 ± 0.4 |
| 11 | 5.1 ± 0.7 | 5.2 ± 0.2 | 5.3 ± 0.5 | 5.5 ± 0.5 | 5.3 ± 0.3 |
| 12 | 5.3 ± 0.7 | 5.4 ± 0.3 | 6.2 ± 1.8 | 5.9 ± 0.7 | 5.7 ± 0.8 |
| 13 | 5.7 ± 0.7 | 6.0 ± 1.2 | 6.2 ± 0.4 | 6.3 ± 0.8 | 6.1 ± 0.5 |
| 14 | 5.6 ± 0.7 | 6.0 ± 1.1 | 5.7 ± 1.4 | 6.4 ± 1.4 | 5.9 ± 0.7 |
| 15 | 5.8 ± 0.5 | 6.2 ± 1.4 | 6.4 ± 0.8 | 6.4 ± 0.7 | 6.2 ± 0.6 |
| 16 | 5.4 ± 0.9 | 5.5 ± 0.6 | 6.0 ± 0.5 | 6.0 ± 1.0 | 5.7 ± 0.6 |
| 18 | 4.6 ± 0.6 | 4.7 ± 0.4 | 4.8 ± 0.5 | 5.0 ± 0.7 | 4.8 ± 0.3 |
| 19 | 4.9 ± 0.8 | 4.8 ± 0.4 | 5.4 ± 0.7 | 5.3 ± 0.8 | 5.1 ± 0.6 |
| 20 | 4.7 ± 0.7 | 4.7 ± 0.5 | 4.9 ± 0.6 | 4.9 ± 0.4 | 4.8 ± 0.2 |
| 21 | 4.7 ± 0.4 | 4.9 ± 0.7 | 5.1 ± 0.9 | 5.3 ± 1.4 | 5.0 ± 0.5 |
| 22 | 4.3 ± 0.7 | 4.2 ± 0.4 | 4.3 ± 0.5 | 4.4 ± 0.9 | 4.3 ± 0.2 |
| 23 | 5.8 ± 0.9 | 5.9 ± 0.6 | 6.0 ± 0.8 | 6.1 ± 1.5 | 6.0 ± 0.3 |
| 24 | 4.6 ± 0.4 | 4.8 ± 0.6 | 5.0 ± 0.8 | 5.1 ± 0.4 | 4.9 ± 0.4 |
| 25 | 5.6 ± 0.1 | 6.1 ± 1.1 | 5.9 ± 0.6 | A | 5.9 ± 0.5 |
| 26 | 5.7 ± 0.5 | 5.8 ± 0.3 | 6.2 ± 1.3 | 6.3 ± 0.9 | 6.0 ± 0.6 |
| 27 | 4.6 ± 0.5 | 4.8 ± 0.5 | 5.0 ± 0.4 | 5.0 ± 1.2 | 4.9 ± 0.4 |
| 28 | 4.7 ± 0.5 | 4.8 ± 0.7 | 4.8 ± 0.3 | 4.9 ± 0.7 | 4.8 ± 0.2 |
| 29 | 4.2 ± 0.6 | 4.4 ± 1.0 | 4.5 ± 0.9 | 4.7 ± 0.9 | 4.5 ± 0.4 |
| 30 | 4.6 ± 0.7 | 5.1 ± 0.6 | 4.9 ± 0.4 | 4.9 ± 0.6 | 4.9 ± 0.4 |
| 31 | 3.9 ± 0.6 | 4.2 ± 0.6 | 4.1 ± 0.8 | 4.5 ± 1.9 | 4.2 ± 0.5 |
| 32 | 4.8 ± 0.4 | 5.1 ± 0.6 | 4.9 ± 0.6 | 5.0 ± 0.7 | 5.0 ± 0.3 |
| 33 | 4.5 ± 0.3 | 4.8 ± 0.4 | 4.6 ± 0.3 | 4.9 ± 0.9 | 4.7 ± 0.4 |
| 34 | 5.1 ± 0.4 | 5.0 ± 0.5 | 5.4 ± 0.7 | 5.4 ± 0.3 | 5.2 ± 0.4 |
| 35 | 5.5 ± 0.3 | 5.6 ± 0.9 | 5.7 ± 0.6 | 6.0 ± 0.4 | 5.7 ± 0.4 |
| 36 | 5.9 ± 0.6 | 6.0 ± 1.6 | 6.0 ± 0.9 | 6.3 ± 0.9 | 6.1 ± 0.3 |
| 37 | 4.9 ± 0.5 | 4.8 ± 0.7 | 5.2 ± 0.9 | 5.3 ± 1.3 | 5.1 ± 0.5 |
| 38 | 6.9 ± 1.0 | 7.1 ± 1.7 | 7.4 ± 0.9 | 7.4 ± 1.2 | 7.2 ± 0.5 |
| 39-C | 4.7 ± 0.6 | 4.3 ± 0.2 | 5.0 ± 0.8 | 5.0 ± 0.4 | 4.8 ± 0.7 |
| 40-C | 5.1 ± 0.5 | 5.1 ± 0.7 | 5.5 ± 0.9 | 5.6 ± 0.7 | 5.3 ± 0.5 |
| 41-C | 6.8 ± 0.8 | 7.2 ± 1.6 | 7.4 ± 1.1 | 7.5 ± 1.0 | 7.2 ± 0.6 |
| 42 | 5.0 ± 0.7 | 4.9 ± 0.9 | 5.6 ± 1.2 | 5.7 ± 0.8 | 5.3 ± 0.8 |
| 43 | 4.5 ± 0.5 | 4.5 ± 0.8 | 4.8 ± 1.2 | 5.2 ± 1.0 | 4.8 ± 0.7 |

**A** - TLD found missing at collection.

## *TABLE 3-3: GROSS BETA CONCENTRATION IN FILTERED AIR*

Surry Power Station, Surry County, Virginia - 2013

1.0E-3 pCi/m3 ± 2 Sigma



| COLLECTION DATE | SAMPLING LOCATIONS SS | HIR | BC | ALL | CP | BASF | FE | NN-C |
|---|---|---|---|---|---|---|---|---|
| January 08 | 28.8 ± 3.23 | 26.0 ± 3.10 | 30.8 ± 3.36 | 31.3 ± 3.27 | 36.0 ± 3.51 | 32.6 ± 3.32 | 35.7 ± 3.51 | 36.7 ± 3.55 |
| January 15 | 18.3 ± 3.25 | 15.8 ± 3.11 | 15.9 ± 3.13 | 21.0 ± 3.31 | 26.1 ± 3.61 | 21.3 ± 33.50 | 23.0 ± 3.49 | 19.5 ± 3.36 |
| January 22 | 13.2 ± 2.74 | 14.7 ± 2.78 | 14.6 ± 2.81 | 17.5 ± 2.92 | 13.6 ± 2.79 | 16.3 ± 2.88 | 15.0 ± 2.85 | 18.2 ± 3.04 |
| January 29 | 21.5 ± 3.18 | 19.4 ± 3.02 | 20.3 ± 3.10 | 21.7 ± 3.14 | 26.2 ± 4.02 | 19.0 ± 3.01 | 20.1 ± 3.08 | 25.9 ± 3.43 |
| February 05 | 20.2 ± 3.12 | 16.2 ± 2.87 | 18.2 ± 3.04 | 24.3 ± 3.26 | 23.7 ± 3.86 | 21.8 ± 3.15 | 20.0 ± 3.09 | 20.8 ± 3.17 |
| February 12 | 12.1 ± 2.80 | 10.50 ± 2.67 | 13.6 ± 2.89 | 15.2 ± 2.92 | 14.8 ± 2.96 | 14.5 ± 2.90 | 13.4 ± 2.86 | 15.6 ± 3.01 |
| February 19 | 11.6 ± 2.71 | 13.0 ± 2.75 | 13.3 ± 2.81 | 17.5 ± 2.98 | 15.1 ± 2.91 | 14.3 ± 2.82 | 16.1 ± 2.95 | 17.0 ± 3.05 |
| February 26 | 10.8 ± 2.72 | 11.2 ± 2.71 | 12.2 ± 2.82 | 10.1 ± 2.65 | 10.3 ± 2.72 | 11.0 ± 2.70 | 10.7 ± 2.72 | 11.1 ± 2.79 |
| March 05 | 6.40 ± 2.33 | 6.69 ± 2.30 | 9.14 ± 2.50 | 9.78 ± 2.49 | 10.4 ± 2.56 | 7.87 ± 2.38 | 8.04 ± 2.41 | 8.70 ± 2.50 |
| March 12 | 7.75 ± 2.39 | 6.75 ± 2.29 | 7.04 ± 2.34 | 7.95 ± 2.36 | 7.07 ± 2.33 | 9.10 ± 2.44 | 7.18 ± 2.35 | 11.0 ± 2.62 |
| March 18 | 15.7 ± 3.59 | 11.4 ± 3.32 | 14.9 ± 3.55 | 13.4 ± 3.41 | 13.7 ± 3.47 | 13.8 ± 3.43 | 14.2 ± 3.49 | 16.8 ± 3.69 |
| March 26 | 9.26 ± 2.32 | 8.96 ± 2.27 | 10.1 ± 2.37 | 12.1 ± 2.44 | 9.10 ± 2.30 | 12.7 ± 2.49 | 13.1 ± 2.53 | 11.4 ± 2.47 |
| **Qtr. Avg. ± 2 s.d.** | **14.6 ± 13.07** | **13.4 ± 11.06** | **15.0 ± 12.41** | **16.8 ± 13.72** | **17.2 ± 17.62** | **16.2 ± 13.56** | **16.4 ± 15.46** | **17.7 ± 15.45** |
| April 02 | 5.82 ± 2.46 | 9.06 ± 2.62 | 10.1 ± 2.72 | 10.0 ± 2.65 | 8.45 ± 2.60 | 8.49 ± 2.57 | 8.35 ± 2.60 | 6.97 ± 2.55 |
| April 09 | 13.9 ± 2.71 | 14.8 ± 2.73 | 16.3 ± 2.83 | 18.8 ± 2.93 | 17.4 ± 2.87 | 19.2 ± 2.94 | 19.6 ± 2.99 | 19.0 ± 2.97 |
| April 16 | 12.2 ± 2.61 | 11.4 ± 2.54 | 13.0 ± 2.64 | 13.0 ± 2.61 | 12.7 ± 2.62 | 11.2 ± 2.54 | 10.8 ± 2.52 | 12.8 ± 2.71 |
| April 23 | 9.78 ± 2.89 | 8.88 ± 2.80 | 11.3 ± 2.97 | 13.4 ± 3.02 | 9.94 ± 2.88 | 13.6 ± 3.04 | 10.3 ± 2.90 | 13.4 ± 3.11 |
| April 30 | 12.9 ± 2.70 | 11.7 ± 2.61 | 13.5 ± 2.75 | 13.7 ± 2.71 | 11.0 ± 2.58 | 13.0 ± 2.67 | 12.0 ± 2.65 | 14.3 ± 2.83 |
| May 07 | 6.71 ± 2.41 | 7.12 ± 2.41 | 5.42 ± 2.34 | 5.71 ± 2.30 | 5.92 ± 2.33 | 7.95 ± 2.46 | 5.79 ± 2.35 | 6.45 ± 2.41 |
| May 14 | 8.86 ± 2.67 | 8.93 ± 2.64 | 12.4 ± 2.89 | 11.4 ± 2.78 | 7.29 ± 2.57 | 10.4 ± 2.72 | 11.0 ± 2.79 | 12.3 ± 2.91 |
| May 21 | 13.6 ± 2.99 | 13.8 ± 2.95 | 13.8 ± 2.99 | 17.6 ± 3.13 | 13.7 ± 2.97 | 14.4 ± 2.99 | 15.9 ± 3.09 | 17.6 ± 3.19 |
| May 28 | 8.33 ± 2.40 | 7.85 ± 2.35 | 8.50 ± 2.42 | 12.0 ± 2.60 | 6.99 ± 2.30 | 10.3 ± 2.51 | 8.66 ± 2.43 | 10.1 ± 2.55 |
| June 04 | 9.23 ± 2.54 | 9.46 ± 2.51 | 9.48 ± 2.54 | 13.1 ± 2.73 | 12.3 ± 2.70 | 8.88 ± 2.48 | 12.6 ± 2.72 | 12.3 ± 2.71 |
| June 10 | 7.98 ± 2.80 | 5.59 ± 2.59 | 7.96 ± 2.79 | 7.07 ± 2.68 | 7.03 ± 2.75 | 6.78 ± 2.65 | 7.27 ± 2.76 | 8.03 ± 2.82 |
| June 17 | 12.3 ± 2.78 | 12.2 ± 2.73 | 14.4 ± 2.80 | 15.5 ± 2.81 | 16.1 ± 3.29 | 11.2 ± 2.58 | 14.1 ± 2.81 | 14.3 ± 2.80 |
| June 24 | 8.76 ± 2.42 | 9.78 ± 2.44 | 8.33 ± 2.40 | 10.9 ± 2.51 | 8.2 ± 2.40 | 12.3 ± 2.61 | 11.7 ± 2.62 | 10.2 ± 2.53 |
| **Qtr. Avg. ± 2 s.d.** | **10.0 ± 5.33** | **10.04 ± 5.26** | **11.1 ± 6.23** | **12.5 ± 7.38** | **10.5 ± 7.37** | **11.4 ± 6.54** | **11.4 ± 7.39** | **12.1 ± 7.58** |

## *TABLE 3-3: GROSS BETA CONCENTRATION IN FILTERED AIR*

Surry Power Station, Surry County, Virginia - 2013

**1.0E-3 pCi/m3 ± 2 Sigma**



| COLLECTION DATE | SAMPLING LOCATIONS SS | HIR | BC | ALL | CP | BASF | FE | NN-C |
|---|---|---|---|---|---|---|---|---|
| July 02 | 9.65 ± 2.21 | 11.0 ± 2.31 | 8.85 ± 2.22 | 11.3 ± 2.32 | 12.7 ± 2.44 | 11.4 ± 2.33 | 10.9 ± 2.33 | 10.5 ± 2.32 |
| July 09 | 7.00 ± 2.68 | 4.71 ± 2.41 | 5.73 ± 2.52 | 7.63 ± 2.58 | 6.10 ± 2.53 | 4.96 ± 2.44 | 5.11 ± 2.48 | 6.50 ± 2.59 |
| July 15 | 6.35 ± 2.55 | 6.37 ± 2.53 | 8.26 ± 2.69 | 7.81 ± 2.61 | 7.93 ± 2.65 | 8.53 ± 2.68 | 8.17 ± 2.68 | 7.73 ± 2.63 |
| July 23 | 10.6 ± 2.09 | 9.33 ± 19.8 | 10.8 ± 2.08 | 10.8 ± 2.05 | 11.2 ± 2.10 | 12.0 ± 2.14 | 12.3 ± 2.17 | 10.3 ± 2.05 |
| July 30 | 13.3 ± 2.87 | 9.91 ± 2.62 | 11.4 ± 2.75 | 11.8 ± 2.73 | 10.1 ± 2.68 | 12.5 ± 2.80 | 12.1 ± 2.79 | 13.1 ± 2.84 |
| August 06 | 18.7 ± 3.03 | 11.5 ± 2.58 | 15.3 ± 2.83 | 16.4 ± 2.86 | 11.6 ± 2.60 | 15.6 ± 2.82 | 18.0 ± 2.96 | 12.6 ± 2.63 |
| August 13 | 16.8 ± 3.00 | 11.1 ± 2.64 | 12.8 ± 2.84 | 14.6 ± 2.89 | 12.9 ± 2.74 | 14.6 ± 2.84 | 14.9 ± 2.86 | 16.0 ± 2.97 |
| August 20 | 8.68 ± 2.41 | 5.71 ± 2.16 | 8.03 ± 2.34 | 10.2 ± 2.45 | 8.33 ± 2.34 | 7.29 ± 2.26 | 9.66 ± 2.43 | 9.51 ± 2.41 |
| August 26 | 14.8 ± 3.06 | 10.5 ± 2.73 | 11.4 ± 2.82 | 13.3 ± 2.89 | 12.0 ± 2.85 | 11.9 ± 2.84 | 12.6 ± 2.90 | 13.7 ± 2.94 |
| September 03 | 21.4 ± 3.12 | 16.3 ± 2.82 | 18.3 ± 2.95 | 22.3 ± 3.09 | 19.2 ± 2.99 | 16.1 ± 2.83 | 23.3 ± 3.18 | 19.9 ± 2.99 |
| September 10 | 23.7 ± 3.27 | 16.5 ± 2.84 | 16.1 ± 2.85 | 18.1 ± 2.93 | 17.4 ± 2.92 | 17.1 ± 2.89 | 19.9 ± 3.06 | 17.7 ± 2.91 |
| September 17 | 26.7 ± 3.47 | 18.1 ± 3.00 | 23.4 ± 3.30 | 22.5 ± 3.21 | 19.9 ± 3.12 | 24.0 ± 3.29 | 24.0 ± 3.32 | 25.7 ± 3.36 |
| September 24 | 14.9 ± 2.96 | 10.3 ± 2.63 | 10.2 ± 2.66 | 12.5 ± 2.76 | 9.38 ± 2.61 | 10.1 ± 2.62 | 9.78 ± 2.63 | 11.8 ± 2.72 |
| **Qtr. Avg. ± 2 s.d.** | **14.8 ± 12.91** | **10.87 ± 8.22** | **12.4 ± 9.67** | **13.8 ± 9.7** | **12.2 ± 8.57** | **12.8 ± 9.78** | **13.9 ± 11.6** | **13.5 ± 10.57** |
| October 01 | 14.6 ± 2.71 | 9.69 ± 2.34 | 11.7 ± 2.51 | 11.5 ± 2.46 | 12.2 ± 2.53 | 11.0 ± 2.44 | 13.5 ± 2.62 | 13.6 ± 2.57 |
| October 08 | 31.8 ± 3.62 | 21.8 ± 3.09 | 26.4 ± 3.35 | 31.2 ± 3.55 | 22.2 ± 3.13 | 28 ± 3.37 | 24.2 ± 3.22 | 27.2 ± 3.33 |
| October 15 | 6.83 ± 2.51 | 6.65 ± 2.44 | 5.09 ± 2.30 | 8.22 ± 2.49 | 5.22 ± 2.30 | 6.39 ± 2.37 | 6.58 ± 2.42 | 6.20 ± 2.32 |
| October 22 | 22.0 ± 3.22 | 14.8 ± 2.78 | 16.5 ± 2.92 | 16.4 ± 2.89 | 14.6 ± 2.79 | 17.4 ± 2.93 | 15.8 ± 2.87 | 17.2 ± 2.95 |
| October 29 | 24.0 ± 3.30 | 16.1 ± 2.86 | 20.5 ± 3.12 | 23.1 ± 3.23 | 18.6 ± 3.02 | 19.5 ± 3.03 | 19.8 ± 3.09 | 23.1 ± 3.21 |
| November 05 | 27.1 ± 3.37 | 18.3 ± 2.9 | 23.2 ± 3.19 | 26.7 ± 3.32 | 20.2 ± 3.03 | 21 ± 3.06 | 19.8 ± 3.02 | 25.3 ± 3.22 |
| November 12 | 17.7 ± 2.89 | 11.7 ± 2.52 | 15.7 ± 2.79 | 17.9 ± 2.88 | 13.5 ± 2.65 | 15.1 ± 2.72 | 15.3 ± 2.74 | 17.9 ± 2.88 |
| November 19 | 16.2 ± 2.96 | 9.13 ± 2.50 | 10.8 ± 2.64 | 11.6 ± 2.68 | 9.16 ± 2.54 | 9.24 ± 2.55 | 10.2 ± 2.62 | 10.5 ± 2.59 |
| November 26 | 10.1 ± 2.63 | 8.25 ± 2.45 | 7.70 ± 2.45 | 12.4 ± 2.72 | 9.09 ± 2.53 | 9.20 ± 2.53 | 10.0 ± 2.60 | 11.6 ± 2.67 |
| December 03 | 25.8 ± 3.48 | 14.4 ± 2.84 | 17.1 ± 3.02 | 22.4 ± 3.26 | 17.3 ± 3.02 | 15.9 ± 2.92 | 15.3 ± 2.91 | 17.6 ± 3.02 |
| December 10 | 18.4 ± 3.15 | 11.0 ± 2.69 | 15.5 ± 2.98 | 18.3 ± 3.10 | 13.9 ± 2.88 | 14.4 ± 2.89 | 12.2 ± 2.80 | 14.7 ± 2.88 |
| December 16 | 26.9 ± 3.82 | 17.7 ± 3.29 | 23.5 ± 3.64 | 22.1 ± 3.53 | 22.9 ± 3.60 | 18.9 ± 3.37 | 24.4 ± 3.68 | 22.9 ± 3.58 |
| December 23 | 17.2 ± 3.10 | 11.4 ± 2.73 | 13.1 ± 2.92 | 17.0 ± 3.10 | 13.2 ± 2.92 | 10.3 ± 2.72 | 12.1 ± 2.86 | 15.1 ± 2.15 |
| December 31 | 24.6 ± 2.97 | 15.4 ± 2.45 | 19.5 ± 2.67 | 21.8 ± 2.77 | 20.5 ± 2.71 | 18.1 ± 2.57 | 19.7 ± 2.67 | 21.1 ± 2.71 |
| **Qtr. Avg. ± 2 s.d.** | **20.2 ± 14.1** | **13.3 ± 8.66** | **16.2 ± 12.3** | **18.6 ± 12.8** | **15.2 ± 10.7** | **15.3 ± 11.6** | **15.6 ± 10.7** | **17.4 ± 12.0** |
| **Ann. Avg. ± 2 s.d** | **15.0 ± 13.73** | **11.90 ± 8.76** | **13.7 ± 10.95** | **15.5 ± 11.9** | **13.7 ± 12.3** | **13.9 ± 11.0** | **14.3 ± 11.8** | **15.2 ± 12.3** |

## *TABLE 3-4: IODINE-131 CONCENTRATION IN FILTERED AIR*

Surry Power Station, Surry County, Virginia - 2013

**1.0E-3 pCi/m3 ± 2 Sigma**



| COLLECTION DATE | SAMPLING LOCATIONS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | SS | HIR | BC | ALL | CP | BASF | FE | NN-C |
| January 08 | 14.0 ± 25.2 | 13.9 ± 25.0 | 14.2 ± 25.6 | 13.5 ± 24.3 | -6.29 ± 24.6 | -6.12 ± 2.39 | -6.32 ± 24.7 | -6.30 ± 24.6 |
| January 15 | 3.16 ± 22.2 | 3.14 ± 22.1 | 3.16 ± 22.2 | 3.08 ± 21.7 | -6.16 ± 24.3 | -6.00 ± 23.7 | -6.16 ± 24.3 | -6.19 ± 24.5 |
| January 22 | 5.59 ± 17.0 | 5.45 ± 16.6 | 5.55 ± 16.9 | 5.43 ± 16.5 | 12.6 ± 16.9 | 12.2 ± 16.3 | 12.5 ± 16.6 | 12.5 ± 16.7 |
| January 29 | -4.76 ± 16.9 | -4.62 ± 16.4 | -4.72 ± 16.7 | -4.63 ± 16.4 | 3.56 ± 19.9 | 2.71 ± 15.1 | 2.72 ± 15.2 | 2.80 ± 15.6 |
| February 05 | 2.62 ± 19.1 | 2.55 ± 18.7 | 2.64 ± 19.3 | 2.54 ± 18.6 | -10.3 ± 21.2 | -7.94 ± 16.3 | -8.04 ± 16.5 | -8.16 ± 16.8 |
| February 12 | ± | ± | ± | ± | ± | ± | ± | ± |
| February 19 | -14.6 ± 13.9 | -14.4 ± 13.6 | -14.7 ± 13.9 | -14.3 ± 13.6 | -7.30 ± 15.1 | -7.10 ± 14.7 | -7.24 ± 15.0 | -7.39 ± 15.3 |
| February 26 | 6.77 ± 18.1 | 6.65 ± 17.7 | 6.82 ± 18.2 | 6.64 ± 17.7 | -2.83 ± 16.7 | -2.76 ± 16.2 | -2.80 ± 16.5 | -2.85 ± 16.8 |
| March 05 | -13.6 ± 21.3 | -13.3 ± 20.8 | -13.6 ± 21.3 | -13.3 ± 20.7 | 7.00 ± 13.3 | 6.87 ± 13.1 | 6.94 ± 13.2 | 7.09 ± 13.5 |
| March 12 | 0.55 ± 10.0 | 0.54 ± 9.80 | 0.55 ± 10.0 | 0.54 ± 9.76 | 7.68 ± 22.8 | 7.57 ± 22.5 | 7.69 ± 22.9 | 7.80 ± 23.2 |
| March 18 | -1.09 ± 15.1 | -1.07 ± 14.8 | -1.09 ± 15.1 | -1.06 ± 14.7 | 6.24 ± 17.9 | 6.14 ± 17.6 | 6.22 ± 17.8 | 6.33 ± 18.1 |
| March 26 | -6.94 ± 11.3 | -6.81 ± 11.2 | -6.96 ± 11.3 | -6.78 ± 11.0 | 9.48 ± 12.9 | 9.39 ± 12.7 | 9.45 ± 12.8 | 9.60 ± 13.0 |
| April 02 | -4.38 ± 17.1 | -4.30 ± 16.7 | -4.38 ± 17.1 | -4.25 ± 16.6 | -9.71 ± 21.1 | -9.55 ± 20.8 | -9.72 ± 21.1 | -9.83 ± 21.4 |
| April 09 | -11.0 ± 22.3 | -10.8 ± 21.9 | -10.9 ± 22.1 | -10.7 ± 21.7 | 9.82 ± 22.3 | 9.67 ± 23.0 | 9.81 ± 23.3 | 9.79 ± 23.2 |
| April 16 | -4.35 ± 12.5 | -4.32 ± 12.4 | -4.31 ± 12.4 | -4.24 ± 12.2 | 0.84 ± 13.2 | 0.85 ± 13.3 | 0.85 ± 13.3 | 0.87 ± 13.7 |
| April 23 | -8.47 ± 20.9 | -8.35 ± 20.6 | -8.46 ± 20.9 | -8.26 ± 20.4 | 14.3 ± 17.9 | 14.1 ± 17.7 | 14.3 ± 17.9 | 14.5 ± 18.2 |
| April 30 | -4.19 ± 18.6 | -4.14 ± 18.3 | -4.20 ± 18.6 | -4.08 ± 18.1 | -6.30 ± 16.8 | -6.19 ± 16.5 | -6.28 ± 16.8 | -6.42 ± 17.1 |
| May 07 | 9.96 ± 10.4 | 9.78 ± 10.2 | 9.98 ± 10.4 | 9.68 ± 10.1 | -0.27 ± 10.5 | -0.27 ± 10.5 | -0.28 ± 10.7 | -0.28 ± 10.7 |
| May 14 | -8.22 ± 12.2 | -8.07 ± 12.0 | -8.28 ± 12.3 | -8.05 ± 12.0 | -6.91 ± 15.2 | -6.79 ± 14.9 | -6.90 ± 15.2 | -7.40 ± 15.5 |
| May 21 | -6.95 ± 22.9 | -6.82 ± 22.5 | -6.92 ± 22.9 | -6.77 ± 22.3 | 4.54 ± 21.8 | 4.50 ± 21.6 | 4.55 ± 21.9 | 4.56 ± 21.9 |
| May 28 | -10.7 ± 22.2 | -10.5 ± 21.9 | -10.7 ± 22.2 | -10.5 ± 21.9 | 16.0 ± 21.0 | 16.0 ± 21.0 | 16.1 ± 21.2 | 16.3 ± 21.4 |
| June 05 | -9.68 ± 15.9 | -9.45 ± 15.5 | -9.62 ± 15.8 | -9.52 ± 15.6 | -1.98 ± 11.7 | -1.95 ± 11.5 | -1.98 ± 11.7 | -1.97 ± 11.7 |
| June 10 | 10.2 ± 24.2 | 10.5 ± 23.7 | -8.00 ± 28.9 | 10.4 ± 23.5 | -7.03 ± 24.0 | -6.76 ± 23.1 | -6.97 ± 23.8 | -6.96 ± 23.8 |
| June 17 | -0.08 ± 12.6 | -0.08 ± 12.4 | -0.08 ± 12.0 | -0.08 ± 11.6 | 5.10 ± 15.5 | 4.18 ± 12.7 | 4.31 ± 13.1 | 4.23 ± 12.9 |
| June 24 | -7.35 ± 15.3 | -7.19 ± 14.9 | -7.36 ± 15.3 | -7.16 ± 14.9 | 6.09 ± 13.9 | 5.94 ± 13.5 | 6.09 ± 13.9 | 6.09 ± 13.9 |

## *TABLE 3-4: IODINE-131 CONCENTRATION IN FILTERED AIR*

Surry Power Station, Surry County, Virginia - 2013

**1.0E-3 pCi/m3 ± 2 Sigma**



| COLLECTION DATE | SAMPLING LOCATIONS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | SS | HIR | BC | ALL | CP | BASF | FE | NN-C |
| July 02 | 11.1 ± 23.7 | 11.4 ± 24.3 | 11.6 ± 24.8 | 11.3 ± 24.2 | 4.60 ± 29.6 | 4.48 ± 28.8 | 4.56 ± 29.2 | 4.58 ± 29.5 |
| July 09 | -8.65 ± 25.8 | -8.27 ± 24.7 | -8.42 ± 25.1 | -8.21 ± 24.5 | -0.50 ± 23.9 | -0.50 ± 23.6 | -0.50 ± 23.9 | -0.50 ± 24 |
| July 15 | -1.57 ± 14.4 | -1.55 ± 14.3 | -1.57 ± 14.4 | -1.53 ± 14.1 | -9.03 ± 14.1 | -8.93 ± 14.0 | -9.06 ± 14.1 | -8.92 ± 13.9 |
| July 23 | 6.48 ± 13.8 | 6.32 ± 13.5 | 6.39 ± 13.6 | 6.23 ± 13.3 | -2.91 ± 14.5 | -2.90 ± 14.4 | -2.93 ± 14.6 | -2.90 ± 14.4 |
| July 30 | -9.09 ± 32.1 | -8.86 ± 31.3 | -8.99 ± 31.8 | -8.83 ± 31.2 | 10.7 ± 22.0 | 10.6 ± 21.8 | 10.7 ± 22.0 | 10.6 ± 21.8 |
| August 06 | -14.8 ± 24.1 | -14.5 ± 23.6 | -14.7 ± 23.9 | -14.5 ± 23.6 | 15.4 ± 20.3 | 15.3 ± 20.1 | 15.4 ± 20.2 | 15.1 ± 19.8 |
| August 13 | -15.4 ± 16.6 | -15.1 ± 16.3 | -15.8 ± 17.0 | -15.4 ± 16.6 | 2.44 ± 18.2 | 2.44 ± 18.2 | 2.44 ± 18.2 | 2.49 ± 18.5 |
| August 20 | -12.7 ± 16.0 | -12.4 ± 15.6 | -12.5 ± 15.7 | -12.3 ± 15.5 | -8.13 ± 18.4 | -8.08 ± 18.3 | -8.14 ± 18.5 | -8.06 ± 18.3 |
| August 26 | -2.12 ± 18.5 | -2.05 ± 17.9 | -2.09 ± 18.2 | -2.04 ± 17.8 | 8.35 ± 17.7 | 8.30 ± 17.6 | 8.36 ± 17.7 | 8.23 ± 17.5 |
| September 03 | 17.5 ± 22.9 | 17 ± 22.3 | 17.3 ± 22.7 | 16.9 ± 22.1 | -4.87 ± 20.2 | -4.83 ± 20.1 | -4.86 ± 20.2 | -4.77 ± 19.8 |
| September 10 | 19.4 ± 25.1 | 18.9 ± 24.5 | 19.2 ± 24.8 | 18.9 ± 24.4 | 31.5 ± 30.4 | 31.3 ± 30.2 | 31.5 ± 30.4 | 30.9 ± 29.8 |
| September 17 | -0.75 ± 16.8 | -0.73 ± 16.4 | -0.74 ± 16.6 | -0.72 ± 16.3 | 1.40 ± 15.9 | 1.37 ± 15.6 | 1.39 ± 15.8 | 1.37 ± 15.5 |
| September 24 | 6.57 ± 22.7 | 6.37 ± 22.1 | 6.47 ± 22.4 | 6.35 ± 22.0 | -20.5 ± 22.2 | -20.1 ± 21.8 | -20.4 ± 22.2 | -20.0 ± 21.8 |
| October 01 | 14.9 ± 28.3 | 14.4 ± 27.4 | 14.6 ± 27.9 | 14.3 ± 27.3 | -8.57 ± 29.0 | -8.46 ± 28.6 | -8.56 ± 28.9 | -8.28 ± 28.0 |
| October 08 | 24.2 ± 24.2 | 23.5 ± 23.4 | 23.9 ± 23.9 | 23.7 ± 23.6 | -5.99 ± 24.3 | -5.90 ± 23.9 | -5.94 ± 24.0 | -5.84 ± 23.6 |
| October 15 | -2.11 ± 11.2 | -2.05 ± 10.9 | -2.01 ± 10.7 | -1.99 ± 10.6 | -5.18 ± 10.7 | -5.13 ± 10.6 | -5.21 ± 10.8 | -5.00 ± 10.3 |
| October 22 | 22.4 ± 20.4 | 21.8 ± 19.8 | 22.2 ± 20.2 | 22.0 ± 20.0 | 12.5 ± 18.0 | 12.3 ± 17.8 | 12.4 ± 18.0 | 12.4 ± 17.9 |
| October 29 | -18.4 ± 39.6 | -18 ± 38.6 | -18.2 ± 39.2 | -18.2 ± 39.0 | -0.85 ± 36.3 | -0.84 ± 35.7 | -0.85 ± 36.3 | -0.84 ± 35.6 |
| November 05 | -22.8 ± 35.1 | -22.4 ± 34.5 | -22.9 ± 35.3 | -22.5 ± 34.6 | -3.72 ± 40.1 | -3.69 ± 39.9 | -3.72 ± 40.2 | -3.57 ± 38.6 |
| November 12 | 1.30 ± 20.4 | 1.28 ± 20.0 | 1.30 ± 20.4 | 1.28 ± 20.2 | 0.73 ± 20.1 | 0.72 ± 19.9 | 0.72 ± 19.9 | 0.72 ± 19.8 |
| November 19 | -3.68 ± 18.1 | -3.57 ± 17.5 | -3.63 ± 17.8 | -3.62 ± 17.8 | -5.05 ± 21.8 | -5.04 ± 21.7 | -5.08 ± 21.9 | -4.92 ± 21.2 |
| November 26 | -5.84 ± 39.0 | -5.67 ± 37.8 | -5.77 ± 38.5 | -5.70 ± 38.0 | -0.67 ± 41.0 | -0.66 ± 40.8 | -0.67 ± 41.1 | -0.65 ± 40.3 |
| December 03 | 4.55 ± 32.9 | 4.43 ± 32.0 | 4.49 ± 32.4 | 4.42 ± 31.9 | -7.08 ± 33.4 | -7.01 ± 33.0 | -7.08 ± 33.3 | -6.99 ± 32.9 |
| December 10 | -14.0 ± 25.7 | -13.6 ± 24.9 | -13.8 ± 25.5 | -13.7 ± 25.2 | -16.1 ± 20.0 | -15.9 ± 19.8 | -16.2 ± 20.0 | -15.7 ± 19.5 |
| December 16 | -28.4 ± 29.8 | -27.6 ± 29.0 | -28.1 ± 29.5 | -27.6 ± 29.0 | -19.7 ± 28.8 | -19.4 ± 28.4 | -19.6 ± 28.7 | -19.3 ± 28.2 |
| December 24 | 17.0 ± 30.4 | 16.6 ± 29.7 | 17.5 ± 31.3 | 17.3 ± 30.8 | -10.3 ± 28.5 | -10.2 ± 28.1 | -10.3 ± 28.4 | -10.1 ± 27.9 |
| December 31 | -30.8 ± 43.0 | -30.2 ± 42.3 | -30.2 ± 42.1 | -29.8 ± 41.6 | -25.9 ± 33.4 | -25.6 ± 33.0 | -25.8 ± 33.3 | -25.3 ± 32.7 |

## *TABLE 3-5: GAMMA EMITTER CONCENTRATION IN FILTERED AIR*

Surry Power Station, Surry County, Virginia - 2013

1.0E-3 pCi/m3 ± 2 Sigma



| SAMPLING LOCATIONS | NUCLIDE | FIRST QUARTER | SECOND QUARTER | THIRD QUARTER | FOURTH QUARTER | AVERAGE ± 2 SIGMA |
|---|---|---|---|---|---|---|
| SS | Cs-134 | -0.52 ± 0.53 | -0.36 ± 0.88 | -0.15 ± 0.57 | 0.31 ± 0.57 | |
| | Cs-137 | 0.05 ± 0.38 | 0.31 ± 0.75 | 0.09 ± 0.60 | -0.21 ± 0.51 | |
| | Be-7 | 104 ± 25.3 | 130 ± 26.9 | 129 ± 24.5 | 146 ± 26.1 | 127 ± 34.7 |
| | K-40 | | 21.9 ± 13.2 | | | 21.9 ± 13.2 |
| HIR | Cs-134 | 0.16 ± 0.56 | 1.02 ± 0.95 | 0.58 ± 0.77 | -0.10 ± 1.17 | |
| | Cs-137 | 0.00 ± 0.37 | 0.17 ± 0.94 | -0.49 ± 0.68 | 0.22 ± 1.09 | |
| | Be-7 | 63.8 ± 22.8 | 106 ± 25.9 | 97.0 ± 19.9 | 77.3 ± 27.8 | 86 ± 38.1 |
| | K-40 | | | 57.7 ± 15.8 | | 57.7 ± 15.8 |
| BC | Cs-134 | 1.12 ± 0.92 | 1.94 ± 1.11 | -0.15 ± 0.80 | -0.81 ± 0.87 | |
| | Cs-137 | -0.13 ± 0.66 | -0.21 ± 1.00 | 0.32 ± 0.58 | -0.12 ± 0.85 | |
| | Be-7 | 105 ± 22.4 | 126 ± 30.1 | 153 ± 29.1 | 102 ± 26.3 | 122 ± 47.1 |
| ALL | Cs-134 | -1.25 ± 0.66 | 0.21 ± 0.59 | -0.05 ± 0.61 | 0.89 ± 0.89 | |
| | Cs-137 | -0.20 ± 0.59 | 0.57 ± 0.74 | 0.08 ± 0.60 | 0.45 ± 0.86 | |
| | Be-7 | 120 ± 30.3 | 166 ± 26.5 | 105 ± 22.7 | 143 ± 28.6 | 134 ± 53.4 |
| | K-40 | | | | 25.8 ± 15.5 | 25.8 ± 15.5 |
| CP | Cs-134 | 1.79 ± 1.39 | -0.26 ± 0.54 | 1.06 ± 1.14 | 0.61 ± 1.08 | |
| | Cs-137 | -0.78 ± 1.28 | 0.27 ± 0.56 | -1.05 ± 1.22 | 0.07 ± 0.96 | |
| | Be-7 | 112 ± 40.3 | 136 ± 23.3 | 105 ± 26.4 | 86.8 ± 34.7 | 110 ± 40.7 |
| BASF | Cs-134 | 0.66 ± 0.96 | 0.82 ± 0.71 | -0.06 ± 0.80 | 0.14 ± 0.58 | |
| | Cs-137 | -1.41 ± 0.83 | -0.22 ± 0.55 | -0.08 ± 0.65 | -0.15 ± 0.60 | |
| | Be-7 | 127 ± 29.5 | 137 ± 22.7 | 127 ± 23.7 | 114 ± 21.8 | 126 ± 18.9 |
| FE | Cs-134 | 0.83 ± 1.11 | -0.06 ± 0.76 | 0.09 ± 0.60 | 0.75 ± 1.11 | |
| | Cs-137 | -0.22 ± 1.03 | 0.28 ± 0.79 | 0.00 ± 0.51 | -0.38 ± 1.18 | |
| | Be-7 | 99.6 ± 37.3 | 144 ± 27.1 | 116 ± 21.9 | 98.3 ± 33.4 | 114 ± 42.5 |
| NN-C | Cs-134 | -0.23 ± 0.50 | 0.32 ± 0.76 | 0.99 ± 0.78 | -0.03 ± 0.84 | |
| | Cs-137 | -0.21 ± 0.47 | -0.16 ± 0.60 | -0.28 ± 0.79 | 0.85 ± 0.83 | |
| | Be-7 | 105 ± 29.2 | 147 ± 29.1 | 130 ± 23.0 | 92.0 ± 23.3 | 119 ± 49.4 |

## *TABLE 3-6: GAMMA EMITTER AND STRONTIUM CONCENTRATIONS IN MILK*

Surry Power Station, Surry County, Virginia - 2013

pCi/Liter ± 2 Sigma



| NUCLIDE | EPPS | COLONIAL PARKWAY | WILLIAMS-C |
|---|---|---|---|
| **JANUARY** | | | |
| Cs-134 | -1.88 ± 4.34 | -0.35 ± 5.68 | -3.32 ± 4.61 |
| Cs-137 | -0.58 ± 3.92 | -0.75 ± 5.14 | -0.38 ± 4.11 |
| Ba-140 | 14.4 ± 22.8 | -4.30 ± 27.6 | 0.32 ± 20.2 |
| La-140 | -0.48 ± 5.45 | 3.58 ± 8.40 | 2.22 ± 7.02 |
| I-131 | -0.08 ± 0.39 | 0.10 ± 0.43 | 0.34 ± 0.34 |
| K-40 | 1270 ± 151 | 1260 ± 171 | 1160 ± 150 |
| **FEBRUARY** | | | |
| Cs-134 | -3.32 ± 4.63 | -8.88 ± 4.21 | -0.72 ± 3.73 |
| Cs-137 | -1.30 ± 3.94 | 1.42 ± 3.53 | -0.33 ± 3.41 |
| Ba-140 | 4.34 ± 20.1 | 26.0 ± 22.1 | -2.24 ± 17.1 |
| La-140 | 0.60 ± 6.24 | 0.69 ± 6.65 | -4.55 ± 5.51 |
| I-131 | 0.03 ± 0.35 | 0.10 ± 0.36 | 0.14 ± 0.34 |
| K-40 | 1410.0 ± 157 | 1290 ± 164 | 1340 ± 139 |
| **MARCH** | | | |
| Cs-134 | -1.34 ± 2.32 | -5.95 ± 2.95 | -1.35 ± 4.09 |
| Cs-137 | 0.53 ± 1.69 | -0.14 ± 2.83 | 3.94 ± 4.07 |
| Ba-140 | -1.97 ± 9.0 | 2.00 ± 13.6 | -17.0 ± 22.6 |
| La-140 | 0.7 ± 2.51 | -0.6 ± 4.23 | -2.47 ± 5.43 |
| I-131 | 0.29 ± 0.35 | -0.15 ± 0.38 | -1.03 ± 0.47 |
| K-40 | 1270 ± 81 | 1360 ± 110 | 1310 ± 163 |
| Sr-89 | | 3.04 ± 2.87 | |
| Sr-90 | | 0.75 ± 0.58 | |
| **APRIL** | | | |
| Cs-134 | 0.90 ± 3.46 | 1.28 ± 2.87 | -1.63 ± 2.52 |
| Cs-137 | -1.06 ± 3.12 | -0.11 ± 2.84 | 0.94 ± 2.30 |
| Ba-140 | -1.9 ± 15.2 | -5.04 ± 15.2 | 0.79 ± 13.2 |
| La-140 | 0.44 ± 5.17 | -0.32 ± 4.83 | 0.39 ± 3.49 |
| I-131 | -0.18 ± 0.32 | -0.16 ± 0.34 | 0.00 ± 0.30 |
| K-40 | 1330 ± 120 | 1260 ± 110 | 1420 ± 105 |

## *TABLE 3-6: GAMMA EMITTER AND STRONTIUM CONCENTRATIONS IN MILK*

Surry Power Station, Surry County, Virginia - 2013

pCi/Liter ± 2 Sigma



| NUCLIDE | EPPS | COLONIAL PARKWAY | WILLIAMS-C |
|---|---|---|---|
| **MAY** | | | |
| Cs-134 | -2.63 ± 3.19 | -1.27 ± 4.23 | 0.76 ± 3.89 |
| Cs-137 | 3.30 ± 3.42 | -2.29 ± 3.80 | -1.49 ± 3.69 |
| Ba-140 | 2.18 ± 17.4 | 8.07 ± 20.3 | -1.80 ± 18.9 |
| La-140 | 1.95 ± 6.07 | -0.96 ± 5.17 | -4.18 ± 4.56 |
| I-131 | -0.16 ± 0.41 | -0.26 ± 0.40 | -0.08 ± 0.42 |
| K-40 | 1440 ± 151 | 1260 ± 140 | 1210 ± 122 |
| Th-228 | | | 16.5 ± 11.2 |
| **JUNE** | | | |
| Cs-134 | -1.67 ± 4.38 | -0.85 ± 4.79 | 0.57 ± 3.45 |
| Cs-137 | 1.23 ± 4.16 | 1.29 ± 5.19 | -0.52 ± 3.00 |
| Ba-140 | 9.77 ± 21.4 | 13.50 ± 28.2 | 0.95 ± 14.4 |
| La-140 | 2.72 ± 6.48 | -7.34 ± 6.82 | -1.63 ± 3.72 |
| I-131 | -0.17 ± 0.55 | 0.66 ± 0.52 | -0.05 ± 0.39 |
| K-40 | 1360 ± 148 | 1220 ± 166 | 1370 ± 108 |
| Sr-89 | | 1.99 ± 1.91 | |
| Sr-90 | | -0.75 ± 0.53 | |
| **JULY** | | | |
| Cs-134 | 0.66 ± 2.40 | 1.73 ± 2.10 | -0.91 ± 3.50 |
| Cs-137 | -0.16 ± 2.52 | 0.71 ± 2.10 | -1.23 ± 2.43 |
| Ba-140 | -5.1 ± 18.0 | 6.02 ± 13.6 | 0.66 ± 18.3 |
| La-140 | 0.91 ± 6.33 | 1.17 ± 4.35 | 0.63 ± 4.47 |
| I-131 | 0.02 ± 0.32 | 0.10 ± 0.32 | -0.02 ± 0.39 |
| K-40 | 1390 ± 102 | 1390 ± 89.7 | 1320 ± 87.3 |
| **AUGUST** | | | |
| Cs-134 | -4.09 ± 4.22 | -4.77 ± 3.72 | -0.64 ± 4.59 |
| Cs-137 | 1.17 ± 4.20 | 4.00 ± 4.16 | 6.10 ± 4.00 |
| Ba-140 | -12.0 ± 19.1 | 15.6 ± 22.7 | 2.01 ± 21.3 |
| La-140 | 3.22 ± 6.00 | 1.18 ± 5.56 | -3.36 ± 7.38 |
| I-131 | 0.41 ± 0.48 | 0.58 ± 0.54 | 0.23 ± 0.47 |
| K-40 | 1360 ± 150 | 1460 ± 168 | 1320 ± 147 |

## *TABLE 3-6: GAMMA EMITTER AND STRONTIUM CONCENTRATIONS IN MILK*

Surry Power Station, Surry County, Virginia - 2013

pCi/Liter ± 2 Sigma



| NUCLIDE | EPPS | COLONIAL PARKWAY | WILLIAMS-C |
|---|---|---|---|
| **SEPTEMBER** | | | |
| Cs-134 | 1.48 ± 4.12 | -6.38 ± 3.80 | -2.16 ± 3.88 |
| Cs-137 | -0.02 ± 4.73 | 0.93 ± 3.90 | 1.92 ± 3.86 |
| Ba-140 | 12.2 ± 27.0 | 13.5 ± 23.6 | -5.74 ± 24.2 |
| La-140 | -4.13 ± 9.37 | 4.72 ± 7.37 | -0.71 ± 7.21 |
| I-131 | -0.07 ± 0.34 | 0.12 ± 0.37 | 0.19 ± 0.33 |
| K-40 | 1240 ± 159 | 1340 ± 148 | 1360 ± 144 |
| Sr-89 | | 3.35 ± 2.56 | |
| Sr-90 | | -0.56 ± 0.42 | |
| **OCTOBER** | | | |
| Cs-134 | 0.43 ± 3.97 | -1.25 ± 4.41 | 4.32 ± 4.03 |
| Cs-137 | 3.56 ± 4.09 | -1.65 ± 4.20 | 1.15 ± 4.62 |
| Ba-140 | 4.29 ± 25.0 | 18.50 ± 27.2 | -14.0 ± 27.9 |
| La-140 | 1.41 ± 5.57 | -0.65 ± 5.84 | -1.77 ± 7.62 |
| I-131 | -0.87 ± 0.48 | 0.11 ± 0.48 | 0.07 ± 0.40 |
| K-40 | 1390 ± 138 | 1430 ± 153 | 1320 ± 147 |
| **NOVEMBER** | | | |
| Cs-134 | -0.67 ± 3.23 | 0.56 ± 2.47 | -3.28 ± 4.64 |
| Cs-137 | -0.44 ± 3.10 | -0.48 ± 2.51 | -2.19 ± 5.19 |
| Ba-140 | -9.03 ± 35.5 | -2.25 ± 26.8 | -2.47 ± 24.5 |
| La-140 | -7.64 ± 9.59 | -5.07 ± 7.87 | -5.75 ± 8.22 |
| I-131 | -0.40 ± 0.44 | 0.09 ± 0.42 | 0.11 ± 0.24 |
| K-40 | 1370 ± 103 | 1390 ± 97.4 | 1290 ± 189 |
| **DECEMBER** | | | |
| Cs-134 | -1.85 ± 4.33 | -3.59 ± 3.68 | -0.03 ± 3.78 |
| Cs-137 | 0.25 ± 4.65 | -1.09 ± 4.04 | 1.26 ± 3.28 |
| Ba-140 | -8.83 ± 25.5 | -3.30 ± 22.8 | 10.40 ± 22.7 |
| La-140 | 5.39 ± 7.55 | -0.64 ± 6.02 | 2.52 ± 4.21 |
| I-131 | 0.31 ± 0.34 | -0.30 ± 0.41 | -0.59 ± 0.34 |
| K-40 | 977 ± 164 | 1400 ± 165 | 1200 ± 145 |
| Sr-89 | | 4.08 ± 2.88 | |
| Sr-90 | | 0.62 ± 0.43 | |

## *TABLE 3-7: GAMMA EMITTER CONCENTRATION IN FOOD PRODUCTS*

Surry Power Station, Surry County, Virginia - 2013

pCi/kg (wet) ± 2 Sigma



| SAMPLING LOCATIONS | COLLECTION DATE | SAMPLE TYPE | ISOTOPE | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Cs-134** | **Cs-137** | **I-131** | **K-40** | |
| **BROCK FARM** | 11/1/2013 | Corn | 17.0 ± 6.44 | 2.71 ± 5.4 | 12.30 ± 26.5 | 2980 ± 144 | |
| | | | **Cs-134** | **Cs-137** | **I-131** | **K-40** | **Be-7** |
| | 11/1/2013 | Peanuts | -0.97 ± 4.62 | 5.13 ± 4.39 | -5.16 ± 22.6 | 4650 ± 170 | 201 ± 67.8 |
| | | | **Th-228** | | | | |
| | | | 22.5 ± 9.84 | | | | |
| | | | **Cs-134** | **Cs-137** | **I-131** | **K-40** | **Th-228** |
| **SLADE FARM** | 11/11/2013 | Soybeans | -5.23 ± 4.76 | 7.52 ± 5.25 | -1.5 ± 10.4 | 14500 ± 287 | 12.4 ± 10.8 |

## *TABLE 3-8: GAMMA EMITTER AND TRITIUM CONCENTRATIONS IN WELL WATER*

Surry Power Station, Surry County, Virginia - 2013

pCi/Liter ± 2 Sigma



| SAMPLING LOCATIONS | COLLECTION DATE | ISOTOPE | | | | |
|---|---|---|---|---|---|---|
| | | **Mn-54** | **Co-58** | **Fe-59** | **Co-60** | **Zn-65** |
| **SS** | 3/12/2013 | 0.93 ± 2.72 | 0.96 ± 3.62 | -0.54 ± 5.70 | 0.58 ± 3.72 | -5.14 ± 7.54 |
| | 6/10/2013 | -0.68 ± 3.21 | -0.83 ± 2.90 | 0.67 ± 4.79 | 0.48 ± 3.01 | -6.46 ± 6.85 |
| | 9/4/2013 | 2.96 ± 3.42 | -0.20 ± 3.74 | 3.69 ± 8.25 | 2.23 ± 4.21 | -4.31 ± 7.42 |
| | 12/10/2013 | 0.59 ± 3.30 | -3.01 ± 3.56 | -0.95 ± 6.25 | -1.91 ± 2.80 | 7.50 ± 8.57 |
| | | **Nb-95** | **Zr-95** | **I-131** | **Cs-134** | **Cs-137** |
| | 3/12/2013 | 1.89 ± 3.70 | -2.51 ± 6.20 | -0.61 ± 5.64 | 1.17 ± 3.43 | -3.72 ± 3.72 |
| | 6/10/2013 | -0.23 ± 3.25 | 0.57 ± 4.46 | 0.00 ± 0.29 | 1.21 ± 2.94 | -0.28 ± 3.19 |
| | 9/4/2013 | 1.43 ± 4.23 | -5.12 ± 6.09 | -0.03 ± 0.36 | -9.52 ± 3.79 | -3.08 ± 3.42 |
| | 12/10/2013 | 3.05 ± 3.87 | -3.79 ± 6.42 | -0.35 ± 0.35 | -2.56 ± 3.52 | 1.63 ± 3.65 |
| | | **Ba-140** | **La-140** | **H-3** | | |
| | 3/12/2013 | -10.4 ± 15.10 | -0.55 ± 5.45 | 90.70 ± 494 | | |
| | 6/10/2013 | 4.81 ± 14.4 | -3.44 ± 5.61 | 6.70 ± 501 | | |
| | 9/4/2013 | -4.49 ± 25.7 | -8.00 ± 9.90 | -38.3 ± 506 | | |
| | 12/10/2013 | 5.83 ± 17.4 | 3.03 ± 6.51 | -172 ± 504 | | |
| | | **Mn-54** | **Co-58** | **Fe-59** | **Co-60** | **Zn-65** |
| **HIR** | 3/12/2013 | 1.17 ± 3.82 | -1.85 ± 3.15 | -0.43 ± 8.37 | 3.87 ± 4.32 | -5.43 ± 10.50 |
| | 6/10/2013 | 1.53 ± 2.76 | 1.07 ± 2.75 | 4.95 ± 5.75 | -1.38 ± 2.91 | -9.22 ± 6.26 |
| | 9/10/2013 | 0.06 ± 3.09 | -0.66 ± 3.35 | 1.44 ± 6.74 | -1.16 ± 3.79 | -4.15 ± 7.13 |
| | 12/10/2013 | 2.30 ± 3.78 | -1.42 ± 3.72 | -0.84 ± 7.41 | 2.28 ± 4.17 | -2.19 ± 9.04 |
| | | **Nb-95** | **Zr-95** | **I-131** | **Cs-134** | **Cs-137** |
| | 3/12/2013 | -0.72 ± 3.93 | -6.03 ± 7.21 | -0.44 ± 5.89 | -4.26 ± 4.10 | -0.31 ± 4.00 |
| | 6/10/2013 | 1.66 ± 2.61 | 0.90 ± 4.55 | 0.23 ± 0.32 | 0.64 ± 3.25 | 3.57 ± 3.27 |
| | 9/10/2013 | -1.03 ± 3.88 | -0.55 ± 5.91 | -0.12 ± 0.34 | 1.60 ± 3.89 | -2.36 ± 3.30 |
| | 12/10/2013 | 0.78 ± 4.18 | -1.12 ± 7.17 | 0.16 ± 0.37 | -1.16 ± 3.88 | 1.14 ± 3.78 |
| | | **Ba-140** | **La-140** | **H-3** | | |
| | 3/12/2013 | 7.11 ± 17.3 | 0.60 ± 5.94 | 220 ± 504 | | |
| | 6/10/2013 | -6.71 ± 14.8 | -2.42 ± 4.77 | -26.7 ± 495 | | |
| | 9/10/2013 | 8.56 ± 15.7 | -0.75 ± 6.37 | -207 ± 498 | | |
| | 12/10/2013 | -2.85 ± 17.6 | -0.02 ± 5.86 | 310 ± 444 | | |

## *TABLE 3-8: GAMMA EMITTER AND TRITIUM CONCENTRATIONS IN WELL WATER*

Surry Power Station, Surry County, Virginia - 2013

pCi/Liter ± 2 Sigma



| SAMPLING LOCATIONS | COLLECTION DATE | ISOTOPE | | | | |
|---|---|---|---|---|---|---|
| | | **Mn-54** | **Co-58** | **Fe-59** | **Co-60** | **Zn-65** |
| CS | 3/12/2013 | 0.457 ± 2.72 | 0.34 ± 2.54 | 1.44 ± 6.30 | -1.27 ± 2.97 | -5.83 ± 7.08 |
| | 6/10/2013 | 0.76 ± 2.61 | -1.77 ± 2.67 | -1.08 ± 2.85 | -0.49 ± 3.19 | -4.31 ± 6.44 |
| | 9/4/2013 | 0.71 ± 3.24 | -1.34 ± 3.72 | -0.32 ± 7.19 | 1.46 ± 3.73 | -1.34 ± 6.55 |
| | 12/10/2013 | -1.91 ± 3.18 | -0.03 ± 3.33 | 3.63 ± 7.55 | 2.07 ± 3.65 | -3.57 ± 8.22 |
| | | **Nb-95** | **Zr-95** | **I-131** | **Cs-134** | **Cs-137** |
| | 3/12/2013 | 0.51 ± 2.68 | 0.63 ± 5.23 | -1.52 ± 5.16 | -1.18 ± 4.52 | 2.05 ± 3.46 |
| | 6/10/2013 | -1.44 ± 2.82 | -4.57 ± 4.52 | 0.46 ± 0.29 | -0.89 ± 2.79 | 0.86 ± 3.18 |
| | 9/4/2013 | 1.24 ± 4.32 | 3.84 ± 5.86 | -0.16 ± 0.43 | -6.93 ± 4.10 | 1.01 ± 4.14 |
| | 12/10/2013 | 2.18 ± 4.14 | -2.85 ± 5.87 | 0.07 ± 0.36 | -5.68 ± 3.36 | -0.76 ± 3.67 |
| | | **Ba-140** | **La-140** | **H-3** | | |
| | 3/12/2013 | -2.25 ± 14.4 | 0.40 ± 3.84 | 694 ± 540 | | |
| | 6/10/2013 | -7.56 ± 13.3 | 2.95 ± 4.68 | 305 ± 533 | | |
| | 9/4/2013 | 15.7 ± 27.1 | -0.53 ± 7.33 | -223 ± 489 | | |
| | 12/10/2013 | 15.7 ± 17.1 | 1.05 ± 6.31 | 148 ± 428 | | |

## *TABLE 3-9: GAMMA EMITTER AND TRITIUM CONCENTRATIONS IN RIVER WATER*

Surry Power Station, Surry County, Virginia - 2013

pCi/Liter ± 2 Sigma



| SAMPLING LOCATIONS | COLLECTION DATE | ISOTOPE | | | | |
|---|---|---|---|---|---|---|
| | | **Mn-54** | **Co-58** | **Fe-59** | **Co-60** | **Zn-65** |
| SD | 1/15/2013 | 0.50 ± 1.01 | 0.06 ± 1.11 | 2.26 ± 2.48 | -0.01 ± 1.34 | 0.18 ± 2.40 |
| | 2/12/2013 | -1.06 ± 2.57 | -0.54 ± 2.46 | 0.26 ± 5.23 | -1.09 ± 2.65 | -8.2 ± 5.41 |
| | 3/12/2013 | 0.74 ± 1.94 | 0.52 ± 2.03 | -0.44 ± 3.79 | 1.01 ± 1.92 | -0.68 ± 4.67 |
| | 4/8/2013 | 1.20 ± 2.22 | 0.97 ± 2.07 | -2.84 ± 4.60 | -0.35 ± 2.16 | 0.50 ± 5.51 |
| | 5/21/2013 | 0.42 ± 1.08 | 0.82 ± 1.10 | 0.58 ± 2.22 | 0.35 ± 1.10 | -7.63 ± 2.45 |
| | 6/10/2013 | -1.14 ± 2.54 | -0.25 ± 2.68 | 2.32 ± 5.40 | 1.49 ± 2.83 | -1.21 ± 5.49 |
| | 7/8/2013 | 0.15 ± 1.87 | 0.05 ± 2.00 | 1.09 ± 3.93 | -1.36 ± 1.68 | -4.02 ± 4.23 |
| | 8/13/2013 | -0.34 ± 2.31 | -0.86 ± 2.68 | -1.33 ± 6.05 | -0.91 ± 2.75 | -7.71 ± 6.01 |
| | 9/17/2013 | 1.46 ± 2.63 | -0.55 ± 2.72 | 0.54 ± 5.14 | -1.43 ± 2.82 | -6.11 ± 6.04 |
| | 10/7/2013 | 1.79 ± 1.77 | -1.79 ± 1.86 | 1.19 ± 3.97 | 0.34 ± 1.89 | -3.24 ± 3.88 |
| | 11/11/2013 | 3.18 ± 2.84 | -0.24 ± 3.27 | 1.90 ± 5.56 | -0.86 ± 3.51 | -3.89 ± 7.73 |
| | 12/10/2013 | 2.92 ± 3.51 | 3.36 ± 3.49 | -4.72 ± 6.92 | 2.69 ± 3.38 | -8.47 ± 10.10 |
| | | **Nb-95** | **Zr-95** | **I-131** | **Cs-134** | **Cs-137** |
| | 1/15/2013 | 0.65 ± 1.12 | -1.06 ± 1.97 | -3.01 ± 4.09 | 0.09 ± 1.16 | 0.48 ± 1.17 |
| | 2/12/2013 | -0.14 ± 2.15 | 3.67 ± 4.42 | 4.53 ± 5.16 | 1.11 ± 2.40 | -0.66 ± 2.55 |
| | 3/12/2013 | 2.78 ± 2.07 | 0.36 ± 3.56 | -1.41 ± 3.47 | -3.00 ± 2.43 | -0.02 ± 2.17 |
| | 4/8/2013 | 1.73 ± 2.40 | -1.08 ± 4.02 | 5.58 ± 4.15 | -1.54 ± 3.00 | 0.15 ± 2.29 |
| | 5/21/2013 | -0.60 ± 1.18 | 2.65 ± 1.96 | 0.09 ± 2.35 | -0.82 ± 1.24 | -0.63 ± 1.18 |
| | 6/10/2013 | 2.26 ± 3.38 | -1.04 ± 5.54 | -1.02 ± 5.47 | 0.45 ± 3.14 | 0.31 ± 2.66 |
| | 7/8/2013 | 0.78 ± 2.28 | -0.24 ± 3.85 | -0.24 ± 3.60 | -0.55 ± 2.25 | 0.91 ± 1.95 |
| | 8/13/2013 | 1.70 ± 2.76 | 0.90 ± 4.88 | 3.55 ± 5.59 | 0.12 ± 3.11 | 1.39 ± 2.62 |
| | 9/17/2013 | -0.67 ± 2.74 | 4.93 ± 5.20 | 0.01 ± 5.35 | -0.05 ± 3.09 | -0.35 ± 2.87 |
| | 10/7/2013 | 1.54 ± 1.83 | 2.11 ± 3.38 | -0.18 ± 4.34 | -3.77 ± 2.02 | -0.40 ± 1.86 |
| | 11/11/2013 | 1.97 ± 3.16 | -1.76 ± 5.45 | 0.73 ± 5.33 | 3.53 ± 3.52 | 1.27 ± 3.32 |
| | 12/10/2013 | -1.79 ± 2.95 | -3.06 ± 6.04 | -0.74 ± 0.96 | -2.04 ± 3.70 | -0.45 ± 3.36 |
| | | **Ba-140** | **La-140** | **H-3** | **K-40** | **Th-228** |
| | 1/15/2013 | -4.26 ± 8.06 | -0.88 ± 2.28 | | 114 ± 27.4 | |
| | 2/12/2013 | -3.39 ± 13.2 | 2.20 ± 4.67 | | 87.1 ± 51.7 | |
| | 3/12/2013 | -6.96 ± 10.0 | -2.86 ± 3.04 | 151 ± 547 | 83.9 ± 44.8 | 6.58 ± 5.27 |
| | 4/8/2013 | -16.4 ± 11.5 | 0.89 ± 2.86 | | | |
| | 5/21/2013 | 2.64 ± 5.89 | -0.09 ± 1.86 | | | |
| | 6/10/2013 | 3.36 ± 13.6 | 3.27 ± 5.23 | -46.9 ± 491 | | |
| | 7/8/2013 | 0.45 ± 10.2 | -0.41 ± 3.21 | | 54.1 ± 31.7 | |
| | 8/13/2013 | -10.5 ± 13.4 | 0.78 ± 4.10 | | 60.0 ± 54.3 | |
| | 9/17/2013 | 2.30 ± 13.3 | -1.91 ± 5.12 | 1610 ± 605 | 87.3 ± 59.3 | |
| | 10/7/2013 | 8.33 ± 10.9 | -1.12 ± 3.14 | | 103 ± 40.6 | |
| | 11/11/2013 | -5.94 ± 14.9 | 1.75 ± 5.26 | | 125 ± 75.1 | |
| | 12/10/2013 | 5.12 ± 18.6 | 0.69 ± 6.99 | 77.4 ± 729 | 88.7 ± 58.5 | |

## *TABLE 3-9: GAMMA EMITTER AND TRITIUM CONCENTRATIONS IN RIVER WATER*

Surry Power Station, Surry County, Virginia - 2013

pCi/Liter ± 2 Sigma



| SAMPLING LOCATIONS | COLLECTION DATE | ISOTOPES | | | | |
|---|---|---|---|---|---|---|
| | | **Mn-54** | **Co-58** | **Fe-59** | **Co-60** | **Zn-65** |
| **SW-C** | 1/15/2013 | -0.01 ± 1.77 | -1.07 ± 1.89 | 1.43 ± 3.80 | 1.55 ± 1.74 | 1.57 ± 3.81 |
| | 2/12/2013 | -0.96 ± 2.52 | 1.65 ± 2.60 | 5.20 ± 5.37 | 0.74 ± 2.66 | -7.76 ± 6.66 |
| | 3/12/2013 | -0.98 ± 2.41 | -0.01 ± 2.55 | -3.09 ± 5.66 | -0.91 ± 2.31 | -7.06 ± 5.87 |
| | 4/9/2013 | 1.90 ± 2.67 | -1.32 ± 2.70 | -1.70 ± 5.56 | -0.15 ± 2.61 | -2.63 ± 5.67 |
| | 5/21/2013 | 0.65 ± 1.10 | -0.27 ± 1.17 | 1.48 ± 2.60 | 0.42 ± 1.12 | -3.11 ± 2.66 |
| | 6/10/2013 | 0.30 ± 2.82 | -1.96 ± 3.02 | 1.74 ± 5.97 | -1.52 ± 2.90 | -4.62 ± 5.18 |
| | 7/8/2013 | 1.71 ± 3.30 | 2.50 ± 3.64 | -1.86 ± 7.05 | -0.57 ± 4.02 | -0.49 ± 7.89 |
| | 8/13/2013 | 0.32 ± 2.94 | 1.77 ± 3.11 | -1.81 ± 5.79 | 0.29 ± 2.99 | -2.32 ± 6.31 |
| | 9/17/2013 | -2.10 ± 2.81 | -0.34 ± 2.53 | 2.16 ± 5.48 | 0.85 ± 2.56 | -3.54 ± 5.27 |
| | 10/8/2013 | -0.43 ± 1.74 | 1.46 ± 1.72 | -1.81 ± 3.46 | 1.41 ± 1.72 | -0.81 ± 3.30 |
| | 11/12/2013 | -0.09 ± 2.89 | 1.28 ± 3.07 | 2.61 ± 6.47 | -1.93 ± 3.86 | -3.65 ± 7.40 |
| | 12/10/2013 | 1.96 ± 3.38 | 0.86 ± 3.95 | -0.26 ± 7.23 | 0.06 ± 3.23 | -4.47 ± 8.36 |
| | | **Nb-95** | **Zr-95** | **I-131** | **Cs-134** | **Cs-137** |
| | 1/15/2013 | 0.77 ± 1.97 | 1.28 ± 3.43 | -6.01 ± 6.11 | -1.01 ± 1.97 | -0.04 ± 1.91 |
| | 2/12/2013 | -0.83 ± 2.74 | -1.26 ± 4.90 | 1.30 ± 5.66 | -6.89 ± 3.28 | 1.86 ± 2.79 |
| | 3/12/2013 | -0.94 ± 2.34 | 1.07 ± 4.59 | 1.17 ± 4.65 | -1.74 ± 2.87 | -1.57 ± 2.64 |
| | 4/9/2013 | 0.38 ± 2.63 | 1.34 ± 4.62 | -2.15 ± 4.32 | -2.59 ± 2.96 | -0.66 ± 2.70 |
| | 5/21/2013 | 0.91 ± 1.19 | 0.91 ± 2.08 | -0.93 ± 2.46 | 0.75 ± 1.22 | -0.11 ± 1.22 |
| | 6/10/2013 | 1.31 ± 3.09 | -0.52 ± 4.76 | 2.27 ± 5.95 | -3.25 ± 3.33 | -2.93 ± 3.20 |
| | 7/8/2013 | -0.82 ± 3.84 | 0.39 ± 6.78 | 1.34 ± 5.26 | -3.60 ± 3.47 | 0.97 ± 3.70 |
| | 8/13/2013 | 1.49 ± 3.06 | 5.74 ± 4.84 | -2.58 ± 5.90 | 0.33 ± 3.35 | 0.71 ± 3.00 |
| | 9/17/2013 | -2.88 ± 2.83 | -0.74 ± 4.83 | 4.87 ± 5.26 | -3.20 ± 2.96 | -0.86 ± 2.90 |
| | 10/8/2013 | 0.39 ± 1.78 | -0.25 ± 3.14 | -1.64 ± 3.52 | 0.77 ± 1.86 | 1.15 ± 1.78 |
| | 11/12/2013 | -0.24 ± 3.03 | -4.01 ± 5.33 | 3.45 ± 5.34 | 1.36 ± 2.95 | 0.39 ± 3.08 |
| | 12/10/2013 | -1.13 ± 3.30 | 5.08 ± 6.14 | -6.03 ± 6.70 | -3.93 ± 4.23 | -2.27 ± 3.63 |
| | | **Ba-140** | **La-140** | **H-3** | **K-40** | **Ra-226** |
| | 1/15/2013 | -5.01 ± 12.3 | 1.28 ± 4.21 | | 61.1 ± 45.5 | 77.5 ± 65.1 |
| | 2/12/2013 | 0.86 ± 15.9 | 0.41 ± 4.35 | | | |
| | 3/12/2013 | 8.47 ± 13.0 | 1.50 ± 3.82 | -327 ± 514 | | |
| | 4/9/2013 | -3.22 ± 12.0 | 1.27 ± 4.71 | | | |
| | 5/21/2013 | -2.44 ± 6.2 | -1.03 ± 1.98 | | | |
| | 6/10/2013 | -9.11 ± 16.2 | -1.30 ± 4.06 | 115 ± 496 | | |
| | 7/8/2013 | -7.67 ± 17.0 | 1.57 ± 5.93 | | | |
| | 8/13/2013 | 1.86 ± 16.1 | -1.14 ± 3.66 | | 70.5 ± 64.5 | |
| | 9/17/2013 | -0.97 ± 14.9 | -3.31 ± 4.15 | 541 ± 518 | 52.9 ± 25.2 | |
| | 10/8/2013 | -3.32 ± 9.46 | -0.65 ± 2.52 | | 88.6 ± 35.9 | |
| | 11/12/2013 | 10.1 ± 14.4 | -0.85 ± 4.72 | | | |
| | 12/10/2013 | -0.18 ± 18.9 | 3.93 ± 4.91 | 460 ± 775 | 77.2 ± 62.2 | |

## *TABLE 3-10: GAMMA EMITTER CONCENTRATIONS IN SILT*

Surry Power Station, Surry County, Virginia - 2013

pCi/kg (dry) ± 2 Sigma



| SAMPLING LOCATIONS | COLLECTION DATE | ISOTOPE | | | | |
|---|---|---|---|---|---|---|
| | | **Cs-134** | **Cs-137** | **K-40** | **Th-232** | **Th-228** |
| **SD** | 3/14/2013 | -8.36 ± 34.3 | 121 ± 48.6 | 15400 ± 1210 | 995 ± 166 | 1200 ± 944 |
| | 9/18/2013 | -12.3 ± 57.0 | 163 ± 102 | 20200 ± 1990 | 1640 ± 246 | 1650 ± 159 |
| | | **Ra-226** | **Be-7** | **Ac-228** | | |
| | 3/14/2013 | 2210 ± 837 | | 384 ± 316 | | |
| | 9/18/2013 | 5310 ± 2350 | 1780 ± 980 | | | |
| | | **Cs-134** | **Cs-137** | **K-40** | **Th-232** | **Th-228** |
| **CHIC-C** | 3/14/2013 | 19.1 ± 48.5 | 175 ± 96.6 | 17200 ± 1710 | 1040 ± 221 | 1290 ± 159 |
| | 9/18/2013 | 45.9 ± 68.6 | 237 ± 98.8 | 18900 ± 2020 | 1370 ± 330 | 1680 ± 167 |
| | | **Ra-226** | | | | |
| | 3/14/2013 | 2520 ± 1230 | | | | |
| | 9/18/2013 | 3560 ± 2600 | | | | |

## *TABLE 3-11: GAMMA EMITTER CONCENTRATIONS IN SHORELINE SEDIMENT*

Surry Power Station, Surry County, Virginia - 2013

pCi/kg (dry) ± 2 Sigma



| SAMPLING LOCATIONS | COLLECTION DATE | ISOTOPE | | | | |
|---|---|---|---|---|---|---|
| | | **Cs-134** | **Cs-137** | **K-40** | **Th-228** | **Th-232** |
| **HIR** | 2/12/2013 | 4.99 ± 19.9 | 11.9 ± 20.1 | 6730 ± 774 | 131 ± 40.4 | |
| | 8/20/2013 | 1.98 ± 20.6 | -15.2 ± 20.7 | 5440 ± 627 | 314 ± 45.7 | 235 ± 89.9 |
| **CHIC-C** | 2/12/2013 | -1.75 ± 23.1 | 13.3 ± 22.6 | 2850 ± 478 | 415 ± 57.0 | 398 ± 105 |
| | 8/20/2013 | 26.9 ± 44.3 | -50.8 ± 44.1 | 1970 ± 797 | 4870 ± 158 | 4880 ± 245 |
| | | **Ra-226** | | | | |
| | 2/12/2013 | | | | | |
| | 8/20/2013 | 4280 ± 1420 | | | | |

## *TABLE 3-12: GAMMA EMITTER CONCENTRATION IN FISH*

Surry Power Station, Surry County, Virginia - 2013

**pCi/kg (wet) ± 2 Sigma**



| SAMPLING LOCATION | COLLECTION DATE | SAMPLE TYPE | ISOTOPE | | | |
|---|---|---|---|---|---|---|
| | | | **K-40** | **Mn-54** | **Co-58** | **Fe-59** |
| **SD** | 4/9/2013 | Catfish | 2820 ± 1150 | 4.65 ± 54.3 | -71.5 ± 61.8 | 25.6 ± 127 |
| | 4/9/2013 | White Perch | 2260 ± 1260 | -10.2 ± 44.7 | 2.96 ± 56.6 | -12.4 ± 122 |
| | 10/1/2013 | Catfish | 2340 ± 760 | 16.2 ± 40.8 | -31.9 ± 43.3 | 31.2 ± 91.5 |
| | 10/1/2013 | White Perch | 2060 ± 1230 | -3.05 ± 45.7 | 3.86 ± 49.8 | 48.2 ± 112 |
| | | | **Co-60** | **Zn-65** | **Cs-134** | **Cs-137** |
| | 4/9/2013 | Catfish | 30.4 ± 57.3 | -21.9 ± 109 | -34.2 ± 58.6 | 6.44 ± 50.5 |
| | 4/9/2013 | White Perch | 18.8 ± 50.2 | 101 ± 75.8 | -11.6 ± 53.1 | 35.3 ± 52.2 |
| | 10/1/2013 | Catfish | -27.1 ± 38.9 | -66.3 ± 98.3 | 23.0 ± 45.0 | 12.4 ± 41.9 |
| | 10/1/2013 | White Perch | -20.3 ± 41.8 | -46.1 ± 93.0 | -16.9 ± 54.6 | -6.98 ± 36.4 |

## *TABLE 3-13: GAMMA EMITTER CONCENTRATIONS IN OYSTERS*

Surry Power Station, Surry County, Virginia - 2013

pCi/kg (wet) ± 2 Sigma



| SAMPLING LOCATIONS | COLLECTION DATE | ISOTOPE | | | |
|---|---|---|---|---|---|
| | | **Mn-54** | **Co-58** | **Fe-59** | **Co-60** |
| **POS** | 3/13/2013 | -15.2 ± 20.9 | 5.88 ± 25.3 | -20.3 ± 46.8 | -12.8 ± 21.7 |
| | 9/19/2013 | -16.4 ± 32.0 | -12.1 ± 38.5 | -35.2 ± 86.0 | -33.50 ± 29.7 |
| | | **Zn-65** | **Cs-134** | **Cs-137** | **K-40** |
| | 3/13/2013 | 17.2 ± 44.8 | -6.23 ± 23.4 | 6.65 ± 19.1 | 623 ± 418 |
| | 9/19/2013 | -32.5 ± 64.4 | -11.5 ± 34.2 | 7.54 ± 31.5 | |
| | | **Mn-54** | **Co-58** | **Fe-59** | **Co-60** |
| **MP** | 3/13/2013 | 10.80 ± 21.3 | -20.0 ± 23.7 | 20.9 ± 51.4 | -0.39 ± 22.4 |
| | 9/19/2013 | 0.33 ± 32.2 | 9.55 ± 45.8 | -30.1 ± 94.4 | 10.7 ± 32.4 |
| | | **Zn-65** | **Cs-134** | **Cs-137** | **K-40** |
| | 3/13/2013 | -28.4 ± 52.9 | -46.30 ± 27.3 | 7.2 ± 22.3 | 608 ± 444 |
| | 9/19/2013 | 32.2 ± 64.6 | 4.42 ± 36.1 | 29.5 ± 33.2 | |
| | | **Mn-54** | **Co-58** | **Fe-59** | **Co-60** |
| **LC** | 3/13/2013 | -10.3 ± 22.3 | 2.18 ± 26.4 | -4.23 ± 60.0 | -4.45 ± 19.0 |
| | 9/19/2013 | 11.1 ± 21.1 | -19.6 ± 25.1 | 29.4 ± 68.6 | -15.6 ± 20.9 |
| | | **Zn-65** | **Cs-134** | **Cs-137** | **K-40** |
| | 3/13/2013 | -4.25 ± 52.2 | -14.7 ± 25.9 | 4.03 ± 22.9 | 943 ± 464 |
| | 9/19/2013 | -56.0 ± 53.1 | -20.8 ± 23.7 | -11.7 ± 19.8 | 738 ± 400 |

## *TABLE 3-14: GAMMA EMITTER CONCENTRATIONS IN CLAMS*

Surry Power Station, Surry County, Virginia - 2013

pCi/kg (wet) ± 2 Sigma



| SAMPLING LOCATIONS | COLLECTION DATE | ISOTOPE | | | |
|---|---|---|---|---|---|
| | | **Mn-54** | **Co-58** | **Fe-59** | **Co-60** |
| JI | 3/14/2013 | 17.00 ± 22.9 | 2.8 ± 21.9 | -7.9 ± 48.4 | 7.65 ± 19.8 |
| | 9/18/2013 | 14.8 ± 24.5 | 46.8 ± 35.5 | -98.5 ± 72.9 | 11.9 ± 23.5 |
| | | **Zn-65** | **Cs-134** | **Cs-137** | **K-40** |
| | 3/14/2013 | 21.8 ± 40.5 | 13.90 ± 23.7 | -9.5 ± 22.4 | |
| | 9/18/2013 | 9.27 ± 48.7 | -11.5 ± 30.2 | 21.50 ± 26.6 | 679 ± 567 |
| | | **Th-228** | | | |
| | 3/14/2013 | | | | |
| | 9/18/2013 | 152 ± 101 | | | |
| | | **Mn-54** | **Co-58** | **Fe-59** | **Co-60** |
| SD | 3/14/2013 | 3.46 ± 21.8 | -13.8 ± 23.4 | 33.1 ± 48.8 | 10.3 ± 21.6 |
| | 9/18/2013 | -21.8 ± 20.2 | 16.2 ± 28.0 | 21.1 ± 76.3 | 9.64 ± 23.1 |
| | | **Zn-65** | **Cs-134** | **Cs-137** | **K-40** |
| | 3/14/2013 | 20.20 ± 49.6 | -5.96 ± 27.4 | -4.97 ± 23.5 | |
| | 9/18/2013 | -17.2 ± 55.3 | 10.4 ± 27.9 | -8.29 ± 21.4 | 473 ± 467 |
| | | **Mn-54** | **Co-58** | **Fe-59** | **Co-60** |
| CHIC-C | 3/14/2013 | 7.54 ± 21.4 | -4.87 ± 22.9 | -23.1 ± 45.6 | -3.39 ± 21.3 |
| | 9/18/2013 | -4.94 ± 24.0 | -6.37 ± 36.3 | -13.6 ± 78.7 | -2.22 ± 20.2 |
| | | **Zn-65** | **Cs-134** | **Cs-137** | **K-40** |
| | 3/14/2013 | 22.3 ± 40.0 | -3.39 ± 26.7 | -22.5 ± 21.7 | 461 ± 369 |
| | 9/18/2013 | 1.46 ± 62.1 | -55.3 ± 30.7 | -0.93 ± 22.3 | |
| | | **Th-228** | | | |
| | 3/14/2013 | 95.2 ± 67.8 | | | |
| | 9/18/2013 | | | | |

## *TABLE 3-15: GAMMA EMITTER CONCENTRATIONS IN CRABS*

Surry Power Station, Surry County, Virginia - 2013

**pCi/kg (wet) ± 2 Sigma** 

| SAMPLING LOCATIONS | COLLECTION DATE | ISOTOPE | | | |
|---|---|---|---|---|---|
| | | **K-40** | **Mn-54** | **Co-58** | **Fe-59** |
| **SD** | 7/10/2013 | 2670 ± 683 | 11.10 ± 29.8 | -13.40 ± 28.0 | -24.6 ± 60.5 |
| | | **Co-60** | **Zn-65** | **Cs-134** | **Cs-137** |
| | | 7.35 ± 34.5 | -91.0 ± 63.7 | 23.40 ± 32.3 | 9.35 ± 31.8 |

# 4. DISCUSSION OF RESULTS

Data from the radiological analyses of environmental media collected during 2013 and tabulated in Section 3, are discussed below. The procedures and specifications followed in the laboratory for these analyses are as required in the Teledyne Brown Engineering quality assurance manuals and laboratory procedures. In addition to internal quality control measures performed by the laboratories, they also participate in an Interlaboratory Comparison Program. Participation in this program ensures that independent checks on the precision and accuracy of the measurements of radioactive material in environmental samples are performed. The results of the Interlaboratory Comparison Program are provided in Appendix B.

The predominant radioactivity detected throughout 2013 was from external sources, such as fallout from nuclear weapons tests (cesium-137) and naturally occurring radionuclides. Naturally occurring nuclides such as beryllium-7, potassium-40, radium-226, thorium-228 and thorium-232 were detected in numerous samples.

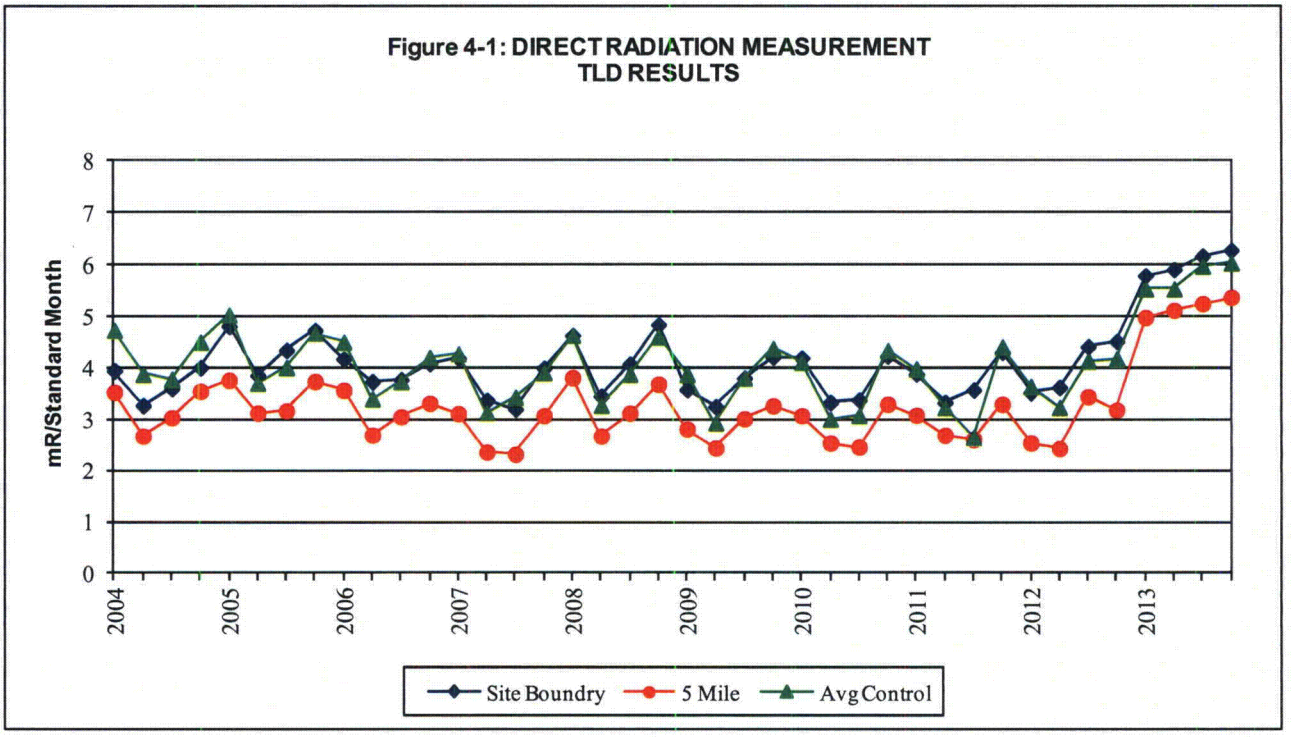
The following is a discussion and summary of the results of the environmental measurements taken during the 2013 reporting period.

## *4.1 Gamma Exposure Rate*

A thermoluminescent dosimeter (TLD) is an inorganic crystal used to detect ambient radiation. Two TLDs, made of CaF and LiF elements and specifically designed for environmental monitoring, are deployed at each sampling location. TLDs are placed in two concentric rings around the station. The inner ring is located in the vicinity of the site boundary, and the outer ring is located at approximately five miles from the station. TLDs are also placed in special interest areas, such as population centers and nearby residences. Additional TLDs serve as controls. Ambient radiation comes from naturally occurring radioisotopes in the air and soil, radiation from cosmic origin, fallout from nuclear weapons testing, station effluents and direct radiation from the station.

The results of the TLD analyses are presented in Table 3-2. Figure 4-1 shows a historical trend of TLD exposure rate measurements, comparing the average of indicator TLDs located near the site boundary and at 5 miles to the average of all control TLD locations. Control and indicator averages indicate a steady relationship. In 2013, Panasonic UD-814 environmental TLDs replaced Harshaw environmental TLDs that were used since 2001. Benchmarking showed that Panasonic UD-814 TLDs were the industry best environmental TLD with improved precision over the Harshaw TLDs. Along with implementing new environmental

TLDs in 2013, an improved method for calculating control dosimeter dose was implemented to estimate transit dose. A program review found that control dosimeters cannot be used directly to assess the transit dose, since control dosimeters also accrue dose from cosmic radiation while stored in the shielded storage cask/cave. Therefore, additional calculations must be made in order to determine the transit dose component. This transit dose component was determined by processing the control dosimeters, and subtracting out the monitoring period storage dose. Previously, control dosimeters were assumed to be a direct measurement of transit dose which resulted in a non-conservative (lower) result of reported field doses. The field dose with the replacement TLDs is higher than that of the previously used TLDs as the greater precision and accuracy of the replacement TLD along with improved control dosimeter dose provides a more representative response to ambient radiation



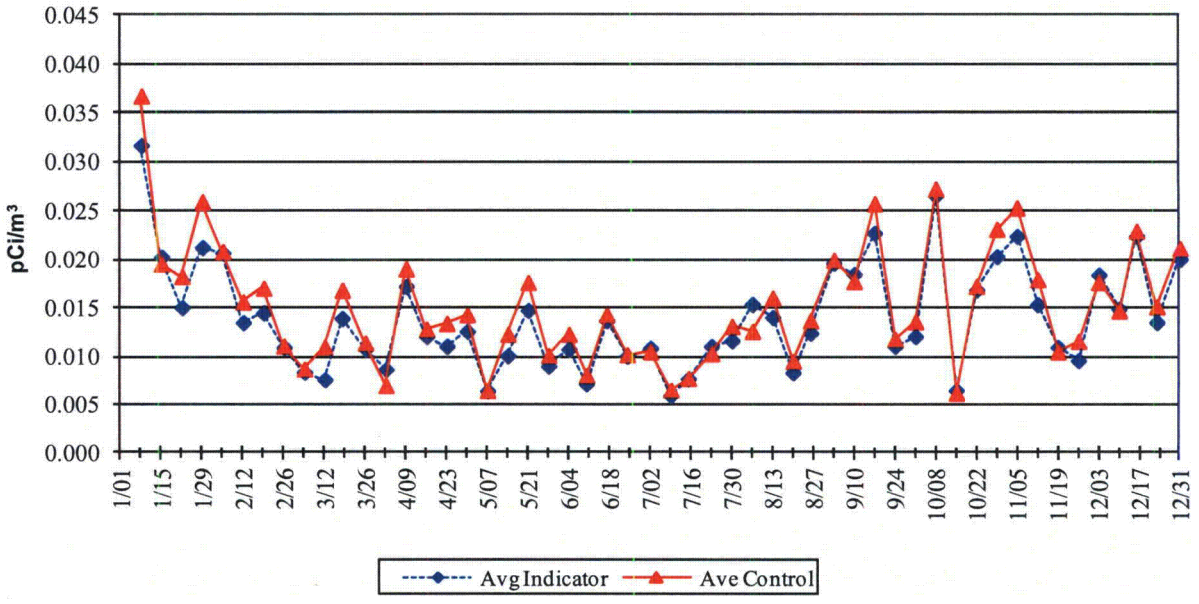

## *4.2 Airborne Gross Beta*

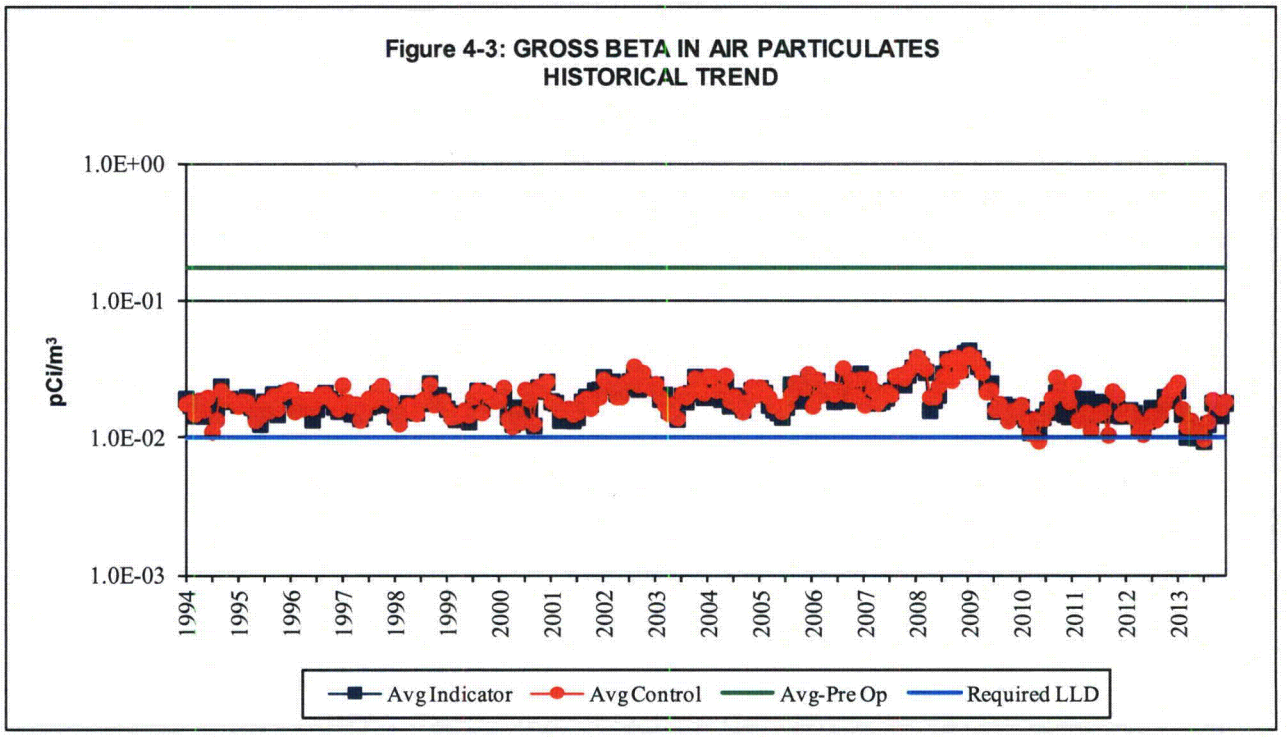
Air is continuously sampled by passing it through glass fiber particulate filters. The filters collect airborne particulate radionuclides. Once a week the samples are collected and analyzed for gross beta activity. Results of the weekly gross beta analyses are presented in Table 3-3. A review of the results from control and indicator locations continues to show no significant variation in measured activities (see Figure 4-2 and 4-3). This indicates that any station contribution is

not measurable.

Gross beta activity found during the pre-operational and early operating period of Surry Power Station was higher because of nuclear weapons testing. During that time, nearly 740 nuclear weapons were tested worldwide. In 1985 weapons testing ceased, and with the exception of the Chernobyl accident in 1986, airborne gross beta results have remained steady.

**Figure 4-2: 2013 GROSS BETA IN AIR PARTICULATES**






## *4.3 Airborne Radioiodine*

Air is also continuously sampled for radioiodines by passing it through charcoal cartridges. Once a week the charcoal cartridge samples are collected and analyzed. The results of the analyses are presented in Table 3-4. All results are below the lower limit of detection. No positive iodine-131 was detected. These results are similar to pre-operational data and the results of samples taken prior to and after the 1986 accident in the Soviet Union at Chernobyl and the Fukushima Daiichi nuclear incident in 2011.

## *4.4 Air Particulate Gamma*

The air particulate filters from the weekly gross beta analyses are composited by location and analyzed quarterly by gamma spectroscopy. The results are listed in Table 3-5. The results indicate the presence of naturally occurring potassium-40 and beryllium-7, which is produced by cosmic processes. No man-made radionuclides were identified. These analyses confirm the lack of station effects.

### *4.5 Cow Milk*

Analysis of milk samples is generally the most sensitive indicator of fission product existence in the terrestrial environment. This, in combination with the fact that consumption of milk is significant, results in this pathway usually being the most critical from the plant release viewpoint. This pathway also shows measurable amounts of nuclear weapons testing fallout. Therefore, this media needs to be evaluated very carefully when trying to determine if there is any station effect.

Results of gamma spectroscopy indicate no other detectable station related radioactivity in the milk samples. In years past, cesium-137 has been detected sporadically. The occurrences were attributed to residual global fallout from past atmospheric weapons testing. Cs-137 was not detected at a level above the LLD in 2013.

At the request of the Commonwealth of Virginia, a quarterly composite sample is prepared from the monthly milk samples from the Colonial Parkway collection station. The composite samples are analyzed for strontium-89 and strontium-90. No strontium was detected in the four composites analyzed. This is the second year since at least 1990 that strontium-90 has not been detected in at least one composite sample. The average Sr-90 concentration for the ten year period of 2002 to 2011 is 1.77 pCi/L. Sr-90 is not a component of the station radiological effluents and is a product of nuclear weapons testing fallout which has been well documented.

### *4.6 Food Products*

Three samples were collected and analyzed by gamma spectroscopy. The results of the analyses are presented in Table 3-7. As expected, naturally occurring potassium-40 was detected in all samples. The average concentration is consistent with that observed in previous years. Thorium-228 was also detected at typical historical concentrations. No station related radioactivity was detected. Berillium-7 was detected in one sample.

### *4.7 Well Water*

Well water is not considered to be affected by station operations because there are no discharges made to this pathway. However, Surry Power Station monitors well water quarterly at three indicator locations and analyzes for gamma radiation and for tritium. The results of these analyses are presented in Table 3-8. Consistent with past monitoring, no station related radioactivity was detected. No gamma emitting isotopes were detected during the pre-operational period.

### *4.8 River Water*

Samples of the James River water are collected monthly and the results are presented in Table 3-9. All samples are analyzed by gamma spectroscopy. The monthly samples are also composited and analyzed for tritium on a quarterly basis. With the exception of natural products, no other gamma emitters were detected. Tritium was detected in one of eight samples at 1,610 pCi/liter. This concentration represents 5.4% of the 30,000 pCi/liter NRC reporting level concentration. The tritium was detected at the station discharge canal indicator sample location. The water in the discharge canal is further diluted by the river water beyond the discharge structure. No tritium or gamma emitting radionuclides were detected in the control river water samples. Naturally occurring potassium-40, radium-226 and thorium-228 were detected in some samples. No station related radioactivity was detected.

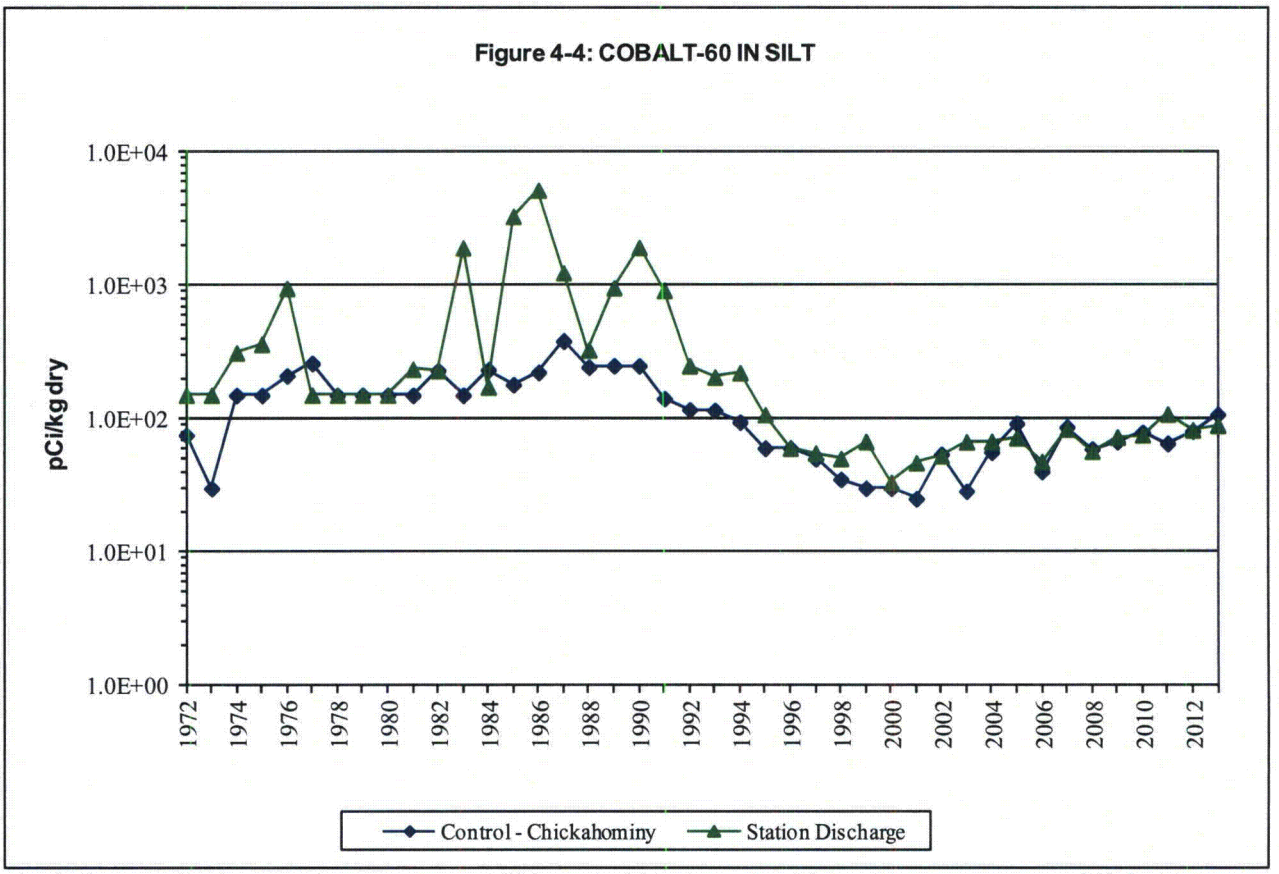
### *4.9 Silt*

Silt is sampled to evaluate any buildup of radionuclides in the environment due to the operation of the station. Sampling of this pathway provides a good indication of the dispersion effects of effluents to the river. Buildup of radionuclides in silt could indirectly lead to increasing radioactivity levels in clams, oysters, crabs and fish.

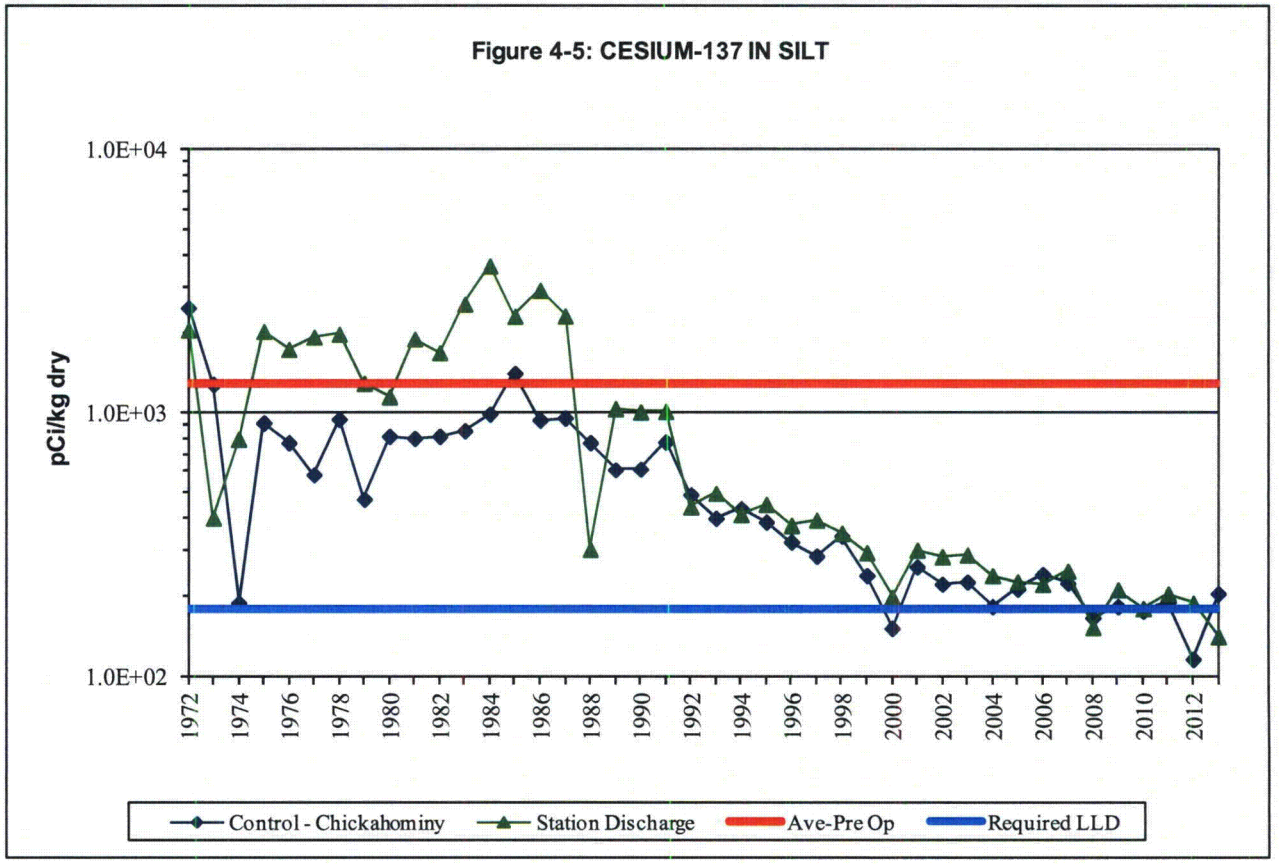
Samples of silt are collected from two locations, one upstream and one downstream of the station. The results of the gamma spectroscopy analyses are presented in Table 3-10. Naturally occurring beryllium-7, potassium-40, radium-226, thorium-228, actinium-228 and thorium-232 were detected. Historically, cobalt-60 has been detected in samples obtained from the indicator location (SD). Cobalt-60 has not been detected since 2003. Trend graphs of cobalt-60 and cesium-137 in silt appear in Figures 4-4 and 4-5.

Cesium-137 was detected, as expected, in both the control and indicator samples. The levels detected indicate a continual decreasing trend seen for over a decade. The detection of cesium-137 in both the control and indicator samples and decreasing levels indicate that the presence of cesium-137 is the result of accumulation and runoff into the river of residual weapons testing fallout. Its global presence has been well documented. During the pre-operational period, cesium-137 was detected in most silt samples with an average concentration as indicated in Figure 4-5. In 2013, cesium-137 was detected with an average indicator location concentration of 142 pCi/kg and an average control location concentration of 206 pCi/kg. These activities continue to represent fallout from nuclear weapons testing. Both indicator and control cesium-137 activities trend

closely as shown in Figure 4-5.




Chickahominy had detectable activity in 1982 and 1984 through 1994. Other years were <MDC, Minimum Detectable Concentration. Station Discharge was <MDC activity 1996 through 1998 and 2004 through 2013.




## *4.10 Shoreline Sediment*

Shoreline sediment, unlike river silt, may provide a direct dose to humans. Buildup of radionuclides along the shoreline may provide a source of direct exposure for those using the area for commercial and recreational uses. The results are presented in Table 3-11.

The naturally occurring radionuclides potassium-40, radium-226, thorium-228 and thorium-232 were detected at concentrations equivalent to normal background activities. The activities of these radionuclides indicate a steady trend. There were no radionuclides attributable to the operation of the station found in any shoreline sediment samples.

## *4.11 Fish*

The radioactivity measured in fish sampled from the station discharge canal and analyzed by gamma spectroscopy is presented in Table 3-12. These results are the same as those seen over the last decade. No activity was observed in this media except for naturally occurring potassium-40.

### *4.12 Oysters*

Oysters were collected from three different locations. The results of the oyster analyses are presented in Table 3-13.

There were no gamma emitting radionuclides detected in oysters sampled except for naturally occurring potassium-40. No station related radioactivity has been detected in this media since 1991. The absence of station related radionuclides is attributable to the replacement of steam generators in 1982 and past improvements made to liquid effluent treatment systems.

### *4.13 Clams*

Clams are analyzed from four different locations. The results of the gamma spectroscopy analyses are presented in Table 3-14. Like oysters, no station related radioactivity was detected. Naturally occurring potassium-40 and thorium-228 were detected.

### *4.14 Crabs*

A crab sample was collected in June from the station discharge canal and analyzed by gamma spectroscopy. The results of the analysis are presented in Table 3-15. Other than naturally occurring potassium-40, no other gamma emitting radionuclides were detected in the sample. This is consistent with pre-operational data and data collected over the past decade.

## 5. PROGRAM EXCEPTIONS

There were three REMP exceptions for scheduled sampling and analysis during 2013.

1. The Lawne's Creek clam sample station did not produce a sample during the spring shellfish sampling campaign. Finding clams at this station had been increasingly difficult over the past three to five years. Oysters were discovered in the same Lawne's Creek area and a sample of those oysters was obtained. The REMP sampling program has been changed to replace the clam sample with the oysters found in the same Lawne's Creek area.
2. The 4th quarter indicator environmental TLD #25 was missing when TLDs were collected. Therefore, there was no gamma dose evaluation available at this location for the 4th quarter.
3. The 1/8/13 Colonial Parkway (CP) milk sample was not analyzed to the required 15 pCi/Liter LLD for lanthanum-140. The reported LLD was 15.1 pCi/Liter. A software variable that controls the confidence level setting for Minimum Detectable Concentration (MDC) for one particular detector at the TBE laboratory was not set with the appropriate value to meet the 95% confidence level concentration criteria. The variable was set at a default value of 3.29 vice 4.66. Activity and 2 sigma uncertainty results are correct. The TBE laboratory initiated Non-Conformance Report 13-07 to document this issue. A revised analytical report was issued by TBE to document the actual MDC and the MDC variable now appears on the TBE laboratory analytical reports for review and verification by laboratory personnel.

# 6. CONCLUSIONS

The results of the 2013 Radiological Environmental Monitoring Program for Surry Power Station have been presented in previous sections. This section presents conclusions for each pathway.

- **Direct Radiation Exposure Pathway** - Control and indicator location averages continue to indicate a steady relationship and trend over the long term.

- **Airborne Exposure Pathway** - Analysis of charcoal cartridge samples for radioiodines indicated no positive activity was detected. Quarterly gamma isotopic analyses of the composite particulate samples identified only naturally occurring beryllium-7. Air particulate gross beta concentrations at all of the indicator locations for 2013 trend well with the control location.

- **Milk** - Milk samples are an important indicator measuring the effect of radioactive iodine and radionuclides in airborne releases. Cesium-137 and iodine-131 were not detected in any of the thirty-six samples. Naturally occurring potassium-40 was detected at a similar level when compared to the averages of the previous years.

  Strontium-90 was not detected in any samples this year. Although Strontium-90 is not a component of station effluents, but rather, a product of nuclear weapons testing fallout, this is only the second year that it was not detected.

- **Food Products** - As expected, naturally occurring potassium-40 was detected in all three samples. In the past, cesium-137 has occasionally been detected in these samples and is attributable to global fallout from past nuclear weapons testing. Cesium-137 was not detected in any of the three samples collected in 2013.

- **Well Water** - Well water samples were analyzed and the analyses indicated that there were no man-made radionuclides present. This trend is consistent throughout the monitoring period. No radioactivity attributable to the operation of the station was identified.

- **River Water** - All river water samples were analyzed for gamma emitting radionuclides. The naturally occurring radionuclides potassium-40, radium-226 and thorium-228 were detected. Tritium was detected in one of eight samples with a concentration of 1.610 pCi/liter. This represents 5.4% of the NRC reporting level concentration. Because river water is not used for drinking water or for crop irrigation, there is a reduced dose consequence to the public from this pathway.

- **Silt** - Cesium-137 was detected in both the control and indicator samples. The presence of cesium-137 is attributable to residual weapons testing fallout; its presence has been well documented. Cobalt-60 has not been detected since 2003.

- **Shoreline Sediment** - Naturally occurring radionuclides were detected at concentrations equivalent to normal background activities. There were no radionuclides attributable to the operation of Surry Power Station found in any sample.

**Aquatic Biota**

- **Fish** - As expected, naturally occurring potassium-40 was detected. There were no other gamma emitting radionuclides detected in any of the fish samples.

- **Oysters and Clams** – Other than naturally occurring potassium-40 and thorium-228, there were no other gamma emitting radionuclides detected in any of the oyster or clam samples.

- **Crabs** – Naturally occurring potassium-40 was detected. No other gamma emitting radionuclides were detected.

# REFERENCES

## *References*


1. NUREG-0472, "Radiological Effluent Technical Specifications for PWRs", Draft Rev. 3, March 1982.

2. United States Nuclear Regulatory Commission, Regulatory Guide 1.109, Rev. 1, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I", October 1977.

3. United States Nuclear Regulatory Commission, Regulatory Guide 4.8, "Environmental Technical Specifications for Nuclear Power Plants", December 1975.

4. United States Nuclear Regulatory Commission Branch Technical Position, "Acceptable Radiological Environmental Monitoring Program", Rev. 1, November 1979.

5. Dominion, Station Administrative Procedure, VPAP-2103S, "Offsite Dose Calculation Manual (Surry)".

6. Virginia Electric and Power Company, Surry Power Station Technical Specifications, Units 1 and 2.

7. HASL-300, Environmental Measurements Laboratory, "EML Procedures Manual," 27th Edition, Volume 1, February 1992.

8. NUREG/CR-4007, "Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements," September 1984.

9. NCRP Report No. 160, "Ionizing Radiation Exposure of the Population of the United States," March 2009.

# APPENDICES

# APPENDIX A: LAND USE CENSUS

**Year 2013**

## *LAND USE CENSUS**

**Surry Power Station, Surry County, Virginia**

January 1 to December 31, 2013 Page 1 of 1

| Sector | Direction | Nearest Resident | Nearest Garden** | Nearest Cow | Nearest Goat |
|---|---|---|---|---|---|
| A | N | 4.1 @ 10° | (a) | (a) | (a) |
| B | NNE | 1.9 @ 32° | (a) | (a) | (a) |
| C | NE | 4.7 @ 35° | (a) | (a) | (a) |
| D | ENE | (a) | (a) | (a) | (a) |
| E | E | (a) | (a) | (a) | (a) |
| F | ESE | (a) | (a) | (a) | (a) |
| G | SE | 2.8 @ 142° | (a) | (a) | (a) |
| H | SSE | 2.7 @ 158° | (a) | (a) | (a) |
| J | S | 1.7 @ 181° | 2.0 @ 183° | (a) | (a) |
| K | SSW | 1.9 @ 192° | 1.9 @ 192° | 4.8 @ 200° | (a) |
| L | SW | 2.3 @ 221° | 4.7 @ 228° | (a) | (a) |
| M | WSW | 0.4 @ 244° | 3.6 @ 245° | (a) | (a) |
| N | W | 3.1 @ 260° | 3.4 @ 260° | (a) | (a) |
| P | WNW | 4.9 @ 283° | (a) | (a) | (a) |
| Q | NW | 4.6 @ 321° | (a) | (a) | (a) |
| R | NNW | 3.8 @ 338° | 4.4 @ 334° | 3.7 @ 336° | (a) |

* *Locations are listed by miles and degrees heading relative to true north from center of Unit #1 Containment.*

** *Area greater than 50 $m^2$ and contains broadleaf vegetation.*

*(a) None*

# APPENDIX B: SUMMARY OF INTERLABORATORY COMPARISONS

**Year 2013**

## *INTRODUCTION*

This appendix covers the Interlaboratory Comparison Program (ICP) of Teledyne Brown Engineering (TBE). TBE use QA/QC samples provided by Eckert & Ziegler Analytics, Inc., Environmental Resource Associates (ERA) and the Mixed Analyte Performance Evaluation Program (MAPEP) to monitor the quality of analytical processing associated with the REMP. Each provider has a documented Quality Assurance program and the capability to prepare Quality Control materials traceable to the National Institute of Standards and Technology (NIST). The providers supply the samples to TBE, and upon receipt, the laboratories perform the analyses in a normal manner. The results are then reported to the provider for evaluation. The suite of QA/QC samples is designed to provide sample media and radionuclide combinations that are offered by the providers and included in the REMP and typically includes:

- milk for gamma nuclides and low-level iodine-131 analyses,
- milk for Sr-89 and Sr-90 analyses,
- water for gamma nuclides, low-level iodine-131, and gross beta analyses,
- water for tritium, Sr-89, and Sr-90 analyses,
- cartridge for I-131 analyses,
- air filter for gamma nuclide, gross beta, and Sr-90 analyses.

The accuracy of each result reported to Eckert & Ziegler Analytics, Inc. is measured by the ratio of the TBE result to the known value. Accuracy for all other results is based on statistically derived acceptance ranges calculated by the providers. An investigation is undertaken whenever the ratio or reported result fell outside of the acceptance range.

## *RESULTS*

The TBE ICP results are included in the following tables for the first through the fourth quarters of 2013. Three analyses did not meet the acceptance criteria. TBE initiated non-conformance reports (NCRs) to document and address the analyses. The results of the NCRs are as follows.

1. NCR 13-14, MAPEP filter sample 12-RdF29 failed Cs-134. The TBE value of -0.570 Bq/sample was evaluated as a failed false positive test based on MAPAP's evaluation of the result as a significant negative value at 3 standard deviations. The reported value was a calculated forced activity performed by the gamma software because the nuclide was not detected. No follow-on actions were deemed necessary by TBE.
2. NCR 13-15, Eckert & Ziegler Analytics Milk sample E10646 failed Sr-89 and Sr-90. The TBE analyses failed low. TBE determined the cause to be analyst error. Sample reanalysis with a different analyst was performed and

the results were acceptable. The first analyst is on an extended leave of absence and could not be retrained. TBE also determined the error was specific to sample E10646 only. TBE client samples for the associated time period were evaluated and TBE determined no client samples were affected by this failure.

**ECKERT & ZIEGLER ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM**
**TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES**
**(PAGE 1 OF 1)**

| Month/Year | Identification Number | Matrix | Nuclide | Units | Reported Value (a) | Known Value (b) | Ratio (c) TBE/Analytics | Evaluation (d) |
|---|---|---|---|---|---|---|---|---|
| March 2013 | E10477 | Milk | Sr-89 | pCi/L | 120 | 99.7 | 1.20 | A |
| | | | Sr-90 | pCi/L | 9.21 | 11.0 | 0.84 | A |
| | E10478 | Milk | I-131 | pCi/L | 87.1 | 100 | 0.87 | A |
| | | | Ce-141 | pCi/L | 186 | 187 | 0.99 | A |
| | | | Cr-51 | pCi/L | 463 | 472 | 0.98 | A |
| | | | Cs-134 | pCi/L | 201 | 214 | 0.94 | A |
| | | | Cs-137 | pCi/L | 262 | 266 | 0.98 | A |
| | | | Co-58 | pCi/L | 200 | 208 | 0.96 | A |
| | | | Mn-54 | pCi/L | 215 | 208 | 1.03 | A |
| | | | Fe-59 | pCi/L | 266 | 252 | 1.06 | A |
| | | | Zn-65 | pCi/L | 311 | 301 | 1.03 | A |
| | | | Co-60 | pCi/L | 384 | 400 | 0.96 | A |
| | E10480 | Filter | Ce-141 | pCi | 95.3 | 95.6 | 1.00 | A |
| | | | Cr-51 | pCi | 264 | 241 | 1.10 | A |
| | | | Cs-134 | pCi | 123 | 109 | 1.13 | A |
| | | | Cs-137 | pCi | 142 | 136 | 1.04 | A |
| | | | Co-58 | pCi | 112 | 106 | 1.06 | A |
| | | | Mn-54 | pCi | 115 | 106 | 1.08 | A |
| | | | Fe-59 | pCi | 139 | 129 | 1.08 | A |
| | | | Zn-65 | pCi | 163 | 153 | 1.07 | A |
| | | | Co-60 | pCi | 212 | 204 | 1.04 | A |
| | E10479 | Charcoal | I-131 | pCi | 90.1 | 92.6 | 0.97 | A |
| June 2013 | E10564 | Milk | Sr-89 | pCi/L | 110 | 95.0 | 1.16 | A |
| | | | Sr-90 | pCi/L | 15.8 | 17.0 | 0.93 | A |
| | E10545 | Milk | I-131 | pCi/L | 92.6 | 95.5 | 0.97 | A |
| | | | Ce-141 | pCi/L | 83.1 | 90.4 | 0.92 | A |
| | | | Cr-51 | pCi/L | 253 | 250 | 1.01 | A |
| | | | Cs-134 | pCi/L | 118 | 125 | 0.94 | A |
| | | | Cs-137 | pCi/L | 143 | 151 | 0.95 | A |
| | | | Co-58 | pCi/L | 87.1 | 94.0 | 0.93 | A |
| | | | Mn-54 | pCi/L | 171 | 172 | 0.99 | A |
| | | | Fe-59 | pCi/L | 125 | 120 | 1.04 | A |
| | | | Zn-65 | pCi/L | 220 | 217 | 1.01 | A |
| | | | Co-60 | pCi/L | 169 | 175 | 0.97 | A |

Footnotes are on page 3 of 3.

**ECKERT & ZIEGLER ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM**
**TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES**
**(PAGE 2 OF 3)**

| Month/Year | Identification Number | Matrix | Nuclide | Units | Reported Value (a) | Known Value (b) | Ratio (c) TBE/Analytics | Evaluation (d) |
|---|---|---|---|---|---|---|---|---|
| June 2013 | E10547 | Filter | Ce-141 | pCi | 56.8 | 56.7 | 1.00 | A |
| | | | Cr-51 | pCi | 168 | 157 | 1.07 | A |
| | | | Cs-134 | pCi | 85.2 | 78.4 | 1.09 | A |
| | | | Cs-137 | pCi | 101 | 94.6 | 1.07 | A |
| | | | Co-58 | pCi | 62.7 | 58.9 | 1.06 | A |
| | | | Mn-54 | pCi | 125 | 108 | 1.16 | A |
| | | | Fe-59 | pCi | 85.7 | 75.0 | 1.14 | A |
| | | | Zn-65 | pCi | 169 | 136 | 1.24 | W |
| | | | Co-60 | pCi | 116 | 110 | 1.05 | A |
| | E10546 | Charcoal | I-131 | pCi | 86.5 | 89.7 | 0.96 | A |
| September 2013 | E10646 | Milk | Sr-89 | pCi/L | 63.9 | 96.0 | 0.67 | N (1) |
| | | | Sr-90 | pCi/L | 8.88 | 13.2 | 0.67 | N (1) |
| | E10647 | Milk | I-131 | pCi/L | 93.9 | 98.3 | 0.96 | A |
| | | | Ce-141 | pCi/L | | | | NA (2) |
| | | | Cr-51 | pCi/L | 272 | 277 | 0.98 | A |
| | | | Cs-134 | pCi/L | 150 | 172 | 0.87 | A |
| | | | Cs-137 | pCi/L | 125 | 131 | 0.95 | A |
| | | | Co-58 | pCi/L | 105 | 108 | 0.97 | A |
| | | | Mn-54 | pCi/L | 138 | 139 | 0.99 | A |
| | | | Fe-59 | pCi/L | 125 | 130 | 0.96 | A |
| | | | Zn-65 | pCi/L | 264 | 266 | 0.99 | A |
| | | | Co-60 | pCi/L | 187 | 196 | 0.95 | A |
| | E10672 | Filter | Ce-141 | pCi | | | | NA (2) |
| | | | Cr-51 | pCi | 208 | 223 | 0.93 | A |
| | | | Cs-134 | pCi | 143 | 139 | 1.03 | A |
| | | | Cs-137 | pCi | 106 | 105 | 1.01 | A |
| | | | Co-58 | pCi | 97.0 | 86.5 | 1.12 | A |
| | | | Mn-54 | pCi | 116 | 112 | 1.04 | A |
| | | | Fe-59 | pCi | 98.6 | 105 | 0.94 | A |
| | | | Zn-65 | pCi | 219 | 214 | 1.02 | A |
| | | | Co-60 | pCi | 166 | 158 | 1.05 | A |
| | E10648 | Charcoal | I-131 | pCi | 76.3 | 71.7 | 1.06 | A |
| December 2013 | E10774 | Milk | Sr-89 | pCi/L | 97.3 | 93.8 | 1.04 | A |
| | | | Sr-90 | pCi/L | 13.3 | 12.9 | 1.03 | A |

Footnotes are on page 3 of 3.

**ECKERT & ZIEGLER ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM**
**TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES**
**(PAGE 3 OF 3)**

| Month/Year | Identification Number | Matrix | Nuclide | Units | Reported Value (a) | Known Value (b) | Ratio (c) TBE/Analytics | Evaluation (d) |
|---|---|---|---|---|---|---|---|---|
| December 2013 | E10775 | Milk | I-131 | pCi/L | 89.7 | 96.1 | 0.93 | A |
| | | | Ce-141 | pCi/L | 99.8 | 110 | 0.91 | A |
| | | | Cr-51 | pCi/L | 297 | 297 | 1.00 | A |
| | | | Cs-134 | pCi/L | 129 | 142 | 0.91 | A |
| | | | Cs-137 | pCi/L | 126 | 126 | 1.00 | A |
| | | | Co-58 | pCi/L | 116 | 112 | 1.04 | A |
| | | | Mn-54 | pCi/L | 167 | 168 | 0.99 | A |
| | | | Fe-59 | pCi/L | 117 | 110 | 1.06 | A |
| | | | Zn-65 | pCi/L | 757 | 741 | 1.02 | A |
| | | | Co-60 | pCi/L | 141 | 147 | 0.96 | A |
| | E10777 | Filter | Ce-141 | pCi | 85.1 | 88.0 | 0.97 | A |
| | | | Cr-51 | pCi | 278 | 238 | 1.17 | A |
| | | | Cs-134 | pCi | 123 | 114 | 1.08 | A |
| | | | Cs-137 | pCi | 102 | 101 | 1.01 | A |
| | | | Co-58 | pCi | 84.4 | 89.9 | 0.94 | A |
| | | | Mn-54 | pCi | 132 | 135 | 0.98 | A |
| | | | Fe-59 | pCi | 101 | 88.3 | 1.14 | A |
| | | | Zn-65 | pCi | 506 | 595 | 0.85 | A |
| | | | Co-60 | pCi | 118 | 118 | 1.00 | A |
| | E10776 | Charcoal | I-131 | pCi | 84.7 | 80.5 | 1.05 | A |

*(1) Milk, Sr-89/90 - The failure was due to analyst error. No client samples were affected by this failure. NCR 13-15*

*(2) The sample was not spiked with Ce-141*

*(a) Teledyne Brown Engineering reported result.*

*(b) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.*

*(c) Ratio of Teledyne Brown Engineering to Analytics results.*

*(d) Analytics evaluation based on TBE internal QC limits: A= Acceptable, reported result falls within ratio limits of 0.80-1.20. W-Acceptable with warning, reported result falls within 0.70-0.80 or 1.20-1.30. N = Not Acceptable, reported result falls outside the ratio limits of < 0.70 and > 1.30.*

**DOE's MIXED ANALYTE PERFORMANCE EVALUATION PROGRAM (MAPEP)**
**TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES**
**(PAGE 1 OF 2)**

| Month/Year | Identification Number | Media | Nuclide | Units | Reported Value (a) | Known Value (b) | Acceptance Range | Evaluation (c) |
|---|---|---|---|---|---|---|---|---|
| March 2013 | 13-MaW28 | Water | Cs-134 | Bq/L | 21.0 | 24.4 | 17.1 - 31.7 | A |
| | | | Cs-137 | Bq/L | 0.0446 | | (1) | A |
| | | | Co-57 | Bq/L | 28.3 | 30.9 | 21.6 - 40.2 | A |
| | | | Co-60 | Bq/L | 18.2 | 19.56 | 13.69 - 25.43 | A |
| | | | H-3 | Bq/L | 506 | 507 | 355 - 659 | A |
| | | | Mn-54 | Bq/L | 25.7 | 27.4 | 19.2 - 35.6 | A |
| | | | K-40 | Bq/L | 2.09 | | (1) | A |
| | | | Sr-90 | Bq/L | 10.5 | 10.5 | 7.4 - 13.7 | A |
| | | | Zn-65 | Bq/L | 29.2 | 30.4 | 21.3 - 39.5 | A |
| | 13-GrW28 | Water | Gr-A | Bq/L | 2.74 | 2.31 | 0.69 - 3.93 | A |
| | | | Gr-B | Bq/L | 15.6 | 13.0 | 6.5 - 19.5 | A |
| | 13-RdF28 | Filter | Cs-134 | Bq/sample | 1.73 | 1.78 | 1.25 - 2.31 | A |
| | | | Cs-137 | Bq/sample | 2.73 | 2.60 | 1.82 - 3.38 | A |
| | | | Co-57 | Bq/sample | 2.38 | 2.36 | 1.65 - 3.07 | A |
| | | | Co-60 | Bq/sample | 0.0302 | | (1) | A |
| | | | Mn-54 | Bq/sample | 4.36 | 4.26 | 2.98 - 5.54 | A |
| | | | Sr-90 | Bq/sample | 1.43 | 1.49 | 1.04 - 1.94 | A |
| | | | Zn-65 | Bq/sample | 3.14 | 3.13 | 2.19 - 4.07 | A |
| | 13-GrF28 | Filter | Gr-A | Bq/sample | 0.767 | 1.20 | 0.36 - 2.04 | A |
| | | | Gr-B | Bq/sample | 0.871 | 0.85 | 0.43 - 1.28 | A |
| September 2013 | 13-MaW29 | Water | Cs-134 | Bq/L | 29.1 | 30.0 | 21.0 - 39.0 | A |
| | | | Cs-137 | Bq/L | 34.5 | 31.6 | 22.1 - 41.1 | A |
| | | | Co-57 | Bq/L | 0.0358 | | (1) | A |
| | | | Co-60 | Bq/L | 24.6 | 23.58 | 16.51 - 30.65 | A |
| | | | H-3 | Bq/L | 2.45 | | (1) | A |
| | | | Mn-54 | Bq/L | 0.0337 | | (1) | A |
| | | | K-40 | Bq/L | 0.193 | | (1) | A |
| | | | Sr-90 | Bq/L | 9.12 | 7.22 | 5.05 - 9.39 | W |
| | | | Zn-65 | Bq/L | 38.1 | 34.6 | 24.2 - 45.0 | A |
| | 13-GrW29 | Water | Gr-A | Bq/L | 1.13 | 0.701 | 0.210 - 1.192 | A |
| | | | Gr-B | Bq/L | 7.61 | 5.94 | 2.97 - 8.91 | A |

**DOE's MIXED ANALYTE PERFORMANCE EVALUATION PROGRAM (MAPEP)**
**TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES**
**(PAGE 2 OF 2)**

| Month/Year | Identification Number | Media | Nuclide | Units | Reported Value (a) | Known Value (b) | Acceptance Range | Evaluation (c) |
|---|---|---|---|---|---|---|---|---|
| September 2013 | 13-RdF29 | Filter | Cs-134 | Bq/sample | -0.570 | | (1) | N (2) |
| | | | Cs-137 | Bq/sample | 2.85 | 2.7 | 1.9 - 3.5 | A |
| | | | Co-57 | Bq/sample | 3.30 | 3.4 | 2.4 - 4.4 | A |
| | | | Co-60 | Bq/sample | 2.41 | 2.3 | 1.6 - 3.0 | A |
| | | | Mn-54 | Bq/sample | 3.65 | 3.5 | 2.5 - 4.6 | A |
| | | | Sr-90 | Bq/sample | 1.40 | 1.81 | 1.27 - 2.35 | W |
| | | | Zn-65 | Bq/sample | 2.90 | 2.7 | 1.9 - 3.5 | A |
| | 13-GrF29 | Filter | Gr-A | Bq/sample | 0.872 | 0.9 | 0.3 - 1.5 | A |
| | | | Gr-B | Bq/sample | 1.57 | 1.63 | 0.82 - 2.45 | A |

*(1) False positive test.*

*(2) AP, Cs-134 - MAPEP evaluated the -0.570 as a failed false positive test. No client samples were affected by these failures. NCR 13-04*

*(a) Teledyne Brown Engineering reported result.*

*(b) The MAPEP known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.*

*(c) DOE/MAPEP evaluation: A=acceptable, W=acceptable with warning, N=not acceptable.*

**ERA ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM**
**TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES**
**(PAGE 1 OF 1)**

| Month/Year | Identification Number | Media | Nuclide | Units | Reported Value (a) | Known Value (b) | Acceptance Limits | Evaluation (c) |
|---|---|---|---|---|---|---|---|---|
| May 2013 | RAD-93 | Water | Sr-89 | pCi/L | 48.3 | 41.3 | 31.6 - 48.4 | A |
| | | | Sr-90 | pCi/L | 19.3 | 23.9 | 17.2 - 28.0 | A |
| | | | Ba-133 | pCi/L | 81.9 | 82.1 | 69.0 - 90.3 | A |
| | | | Cs-134 | pCi/L | 40.9 | 42.8 | 34.2 - 47.1 | A |
| | | | Cs-137 | pCi/L | 44.0 | 41.7 | 37.0 - 48.8 | A |
| | | | Co-60 | pCi/L | 61.9 | 65.9 | 59.3 - 75.0 | A |
| | | | Zn-65 | pCi/L | 202 | 189 | 170 - 222 | A |
| | | | Gr-A | pCi/L | 34.2 | 40.8 | 21.1 - 51.9 | A |
| | | | Gr-B | pCi/L | 18.0 | 21.6 | 13.0 - 29.7 | A |
| | | | I-131 | pCi/L | 23.8 | 23.8 | 19.7 - 28.3 | A |
| | | | U-Nat | pCi/L | 60.4 | 61.2 | 49.8 - 67.9 | A |
| | | | H-3 | pCi/L | 3970 | 4050 | 3450 - 4460 | A |
| | MRAD-18 | Filter | Gr-A | pCi/filter | Lost during processing | | | |
| November 2013 | RAD-95 | Water | Sr-89 | pCi/L | 25.5 | 21.9 | 14.4 - 28.2 | A |
| | | | Sr-90 | pCi/L | 14.3 | 18.1 | 12.8 - 21.5 | A |
| | | | Ba-133 | pCi/L | 57.2 | 54.2 | 44.7 - 59.9 | A |
| | | | Cs-134 | pCi/L | 83.3 | 86.7 | 71.1 - 95.4 | A |
| | | | Cs-137 | pCi/L | 201 | 206 | 185 - 228 | A |
| | | | Co-60 | pCi/L | 104 | 102 | 91.8 - 114 | A |
| | | | Zn-65 | pCi/L | 361 | 333 | 300 - 389 | A |
| | | | Gr-A | pCi/L | 29.5 | 42.8 | 22.2 - 54.3 | A |
| | | | Gr-B | pCi/L | 30.1 | 32.2 | 20.8 - 39.9 | A |
| | | | I-131 | pCi/L | 23.1 | 23.6 | 19.6 - 28.0 | A |
| | | | U-Nat | pCi/L | 5.53 | 6.24 | 47.0 - 7.44 | A |
| | | | H-3 | pCi/L | 17650 | 17700 | 15500 - 19500 | A |
| | MRAD-19 | Filter | Gr-A | pCi/filter | 33.0 | 83.0 | 27.8 - 129 | A |

*(a) Teledyne Brown Engineering reported result.*

*(b) The ERA known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.*

*(c) ERA evaluation: A=acceptable. Reported result falls within the Warning Limits. NA=not acceptable. Reported result falls outside of the Control Limits. CE=check for Error. Reported result falls within the Control Limits and outside of the Warning Limit.*