COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

DIVISION OF RADIOLOGICAL HEALTH
109 Governor Street, Room 730 Richmond, Virginia 23218-2448
Office (804) 864-8150 Fax (804) 864-8165

# 2008

# ENVIRONMENTAL RADIATION PROGRAM

## ANNUAL REPORT

VDH VIRGINIA DEPARTMENT OF HEALTH
*Protecting You and Your Environment*

# ACKNOWLEDGEMENTS

We would like to acknowledge the following organizations and agencies that contributed to the environmental surveillance program:

- Babcock & Wilcox Nuclear Operations Group
  (Formerly BWXT Inc. Naval Nuclear Fuel Division)

- Department of Agriculture and Consumer Services
  Dairy and Food Division

- Department of Conservation and Recreation
  Division of State Parks

- Department of Emergency Management
  Preparedness and Mitigation Division

- Department of General Services
  Division of Consolidated Laboratory Services

- Department of Health
  Division of Shellfish Sanitation

- Northrop Grumman Newport News
  (Formerly Newport News Shipbuilding & Drydock Company)

- U. S. Norfolk Naval Shipyard

- Dominion Virginia Power

## VIRGINIA DEPARTMENT OF HEALTH

# ENVIRONMENTAL RADIATION SURVEILLANCE DATA ANNUAL REPORT 2008

## TABLE OF CONTENTS


FOREWORD -i-
SAMPLING PROGRAM 1
SOURCES OF RADIOACTIVITY IN THE ENVIRONMENT 4

DATA TABLES:

NORTH ANNA and SURRY NUCLEAR POWER STATIONS & Selected Other Locations

Air Particulate 7
Ambient Gamma Exposure (Thermoluminescent Dosimeters) 10
Fish 13
Milk 14
Radiogas 15
Shellfish 16
Silt 17
Surface Water 20
Vegetation 23

BABCOCK & WILCOX NUCLEAR OPERATIONS GROUP (formerly BWXT)

Air Particulate 25
Soil 26
Surface Water 27
Vegetation 28

APPENDIX I: LOWER LIMITS OF DETECTION □LLD□ 29
APPENDIX II: SAMPLING LOCATIONS 41
APPENDIX III: EMERGENCY PREPAREDNESS 46

# FOREWORD

The Division of Radiological Health conducts an extensive environmental radiological monitoring program around nuclear facilities in the Commonwealth of Virginia to determine compliance with applicable federal and state regulations and guidelines.

Sampling locations are primarily located around the two nuclear power stations in the Commonwealth of Virginia.

(1) North Anna power Station, Louisa County, Virginia
(2) Surry power Station, Surry County, Virginia

Sampling locations are also present at:

(3) Babcock & Wilcox Nuclear Operations Group, Lynchburg, Virginia
(4) Northrop Grumman Newport News
(Formerly Newport News Shipbuilding & Drydock Company)

(5) Norfolk Naval Shipyard, Portsmouth, Virginia

Samples are also collected at various control locations. This data can be compared to data for samples collected at plant environs. This provides a comparison between naturally occurring radiation and any radiological deposition resulting from nuclear power plant operation or radioactive fallout.

All State samples (with two exceptions) are analyzed by Consolidated Laboratories of the Commonwealth of Virginia.

All the data, with the exception of higher than normal tritium levels in Lake Anna are within normal expected levels.

This report represents a compilation of all samples collected between January 1, 2008 and December 31, 2008.

---

Tritium, air particulate and radiogas analysis are performed by The Radiological Health Mobile Laboratory. Thermoluminescent dosimeter readings (ambient gamma exposure) are now calculated by Radiation Detection Company.

# PREFACE

The Division of Radiological Health conducts an extensive environmental monitoring program of radiological conditions around certain fixed nuclear facilities in the Commonwealth of Virginia to provide an independent assessment of each facility's compliance with applicable federal and state regulations. Each of these fixed nuclear facilities has it's own routine surveillance program. The objectives of a routine surveillance program includes :

a) Providing information useful In assessing the adequacy of protection of the public;
b) Meeting requirements of regulatory agencies;
c) Verifying radionuclide containment and plant waste management practices;
d) Meeting legal liability obligations; and
e) Providing public assurance and acceptance (NCRP,1976).

In addition to these stated objectives, the RHP as identified other objectives such as;

a) Maintenance of a database of background radionuclide levels and trends to assist with the assessment of other environmental data;
b) Identification of radiological releases not associated with the licensed facility; and
c) Maintenance of equipment and proficiency of capabilities used in emergency preparedness and response activities.

Part of this work is funded by the Virginia Department of Emergency Management.

This report is distributed to the licensee, as well as state and local agencies, which have a direct interest in the results. Single copies of this report are available by contacting:

Virginia Department of Health
Division of Radiological Health
109 Governor Street, Room 730
Richmond, Virginia 23219
(804) 864-8150

You are invited to submit any comments or questions regarding this report to the Radiological Health Program.

Leslie P. Foldesi, M.S., CHP
Director
Radiological Health Program

NCRP (1976) National Council on Radiation Protection and Measurements, Environmental *Radiation Measurements,* NCRP Report No. 50, National Council on Radiation Protection and Measurements, Washington.

# SAMPLING PROGRAM

The Division of Radiological Health maintains an environmental surveillance program with primary focus on the environs of the nuclear power facilities in Virginia. The objectives of this radiological monitoring program are:

(1) To detect and measure radioactive releases during routine nuclear power plant operation.

(2) To detect and measure radioactive releases during abnormal events occurring at nuclear facilities.

(3) To measure reconcentration of radioactive effluents in the environment particularly in human exposure pathways.

(4) To provide an independent means of verification of utility release reports.

These objectives are achieved through continuous sampling of air and ambient radiation, as well as, periodic sampling of water, milk, vegetation, fish, shellfish, etc. Details on sample locations and frequencies are outlined in Appendix III of this report.

A brief description of each sampling medium follows:

## AIR PARTICULATE AND RADIOGAS

Stationary air samplers are utilized at the Surry Power Station, the North Anna Power Station, and one control location at Pocahontas State Park. Pumps run approximately 168 hours per week at an average flow rate of 40 cubic feet per hour. All samplers are continuously equipped with a charcoal filter. Air particulate filters are used at every sampling location to measure any radioactive particulates. All stations except the control station duplicate utility stations. At BWX Technologies, Inc there is one air sampler located on site. This air pump is equipped with air particulate filters and run approximately 168 hours per week with an average flow rate of 55 cubic feet per hour.

Each quarterly air particulate filter is analyzed for a gross beta activity.

Charcoal filters are analyzed quarterly for gamma activity with special emphasis on I-131 retention.

Samples obtained from BWX Technologies, Inc. undergo gross alpha analysis following each filter change.

FISH

Fish samples are collected annually in Lake Anna near the North Anna Power Station. Each sample consists of approximately one kilogram of flesh from either catfish, sunfish, bass or bluegill.

All fish samples are counted for gamma activity with data based on wet weight.

MILK

Raw milk samples are collected quarterly from a dairy near each reactor site. Each sample consists of one gallon of raw milk with no preservatives added. Raw milk is a primary indicator of radioiodine incorporation in the food chain.

All milk samples are counted for gamma activity and analyzed quarterly for Strontium-89 & 90 and are also radiochemically separated for I-131.

SHELLFISH

Shellfish are collected as a part of the environmental surveillance program around Surry Power Station. Samples consisting of one kilogram of flesh are collected annually approximately 0.5 mile off the mouth of the SPS discharge canal in the James River and are indicators of incorporation of radioactivity within the food chain.

All shellfish samples are counted for gamma activity with data based on activity per unit of wet weight.

SILT

Silt is collected annually from each nuclear power station's water discharge canal. Each sample consists of one kilogram of bottom sediment and is an indicator of radioactive deposition in sediment.

Silt is collected quarterly at Norfolk Naval Shipyard (NNSY) on the Elizabeth River to ensure that shipyard operations result in minimal radioactive effluents. Silt is also collected quarterly at Northrop Grumman Newport News Shipbuilding and Drydock Company (NGNNSBDDC) on the James River to ensure that NGNNSBDDC operations result in minimal radioactive deposition. NGNNSBDDC was formerly known as Newport News Shipbuilding & Drydock Company (NNSBDDC).

Silt samples are counted for gamma activity and gross beta activity with data based on activity per unit of dry weight.

SOIL

Two soil samples are collected at the BWX facility. One sample site is located at a ballfield on the facility's eastern boundary and the other is a control location at the Department of Agriculture's Lynchburg Regional Animal Health Laboratory (LRAHL), located 5 miles southwest of the plant site, off Route 460. These samples are collected annually. Samples obtained undergo uranium separation followed by alpha analysis.

VEGETATION

Green leafy vegetation is collected from home gardens located near each nuclear power facility. Samples of one kilogram of kale, cabbage or turnip greens are collected annually at harvest. These samples would indicate incorporation of radioactivity in edible vegetation.

Vegetation is counted for gamma activity with data based on activity per unit wet weight.

Two vegetation samples are collected at BWX. These consist of one kilogram of grass from the ballfield at the eastern site boundary and one control location at the Department of Agriculture's Lynchburg Regional Animal Health Laboratory (LRAHL), located 5 miles southwest of the plant site, off Route 460. These samples are collected annually and undergo uranium separation followed by alpha analysis.

SURFACE WATER

Surface water is collected quarterly at each nuclear power facility. One gallon samples of station discharge water and an upstream control are collected. These samples provide data on radioactive effluents.

Two surface water samples are collected from the James River at BWX Technologies, Inc. on an annual basis. One is located approximately 3 miles downstream of the BWX plant near the ballfield at the eastern site boundary and the other is at a control location near Six Mile Bridge, which is approximately 1.5 miles upstream of the plant. Samples undergo uranium separation followed by alpha counting.

Surface water is also collected quarterly on the James River at Northrop Grumman Newport News Shipbuilding and Drydock Company (NGNNSBDDC) and on the Elizabeth River at the Norfolk Naval Shipyard (NNSY) to ensure that shipyard operations result in minimal radioactive effluents.

AMBIENT GAMMA EXPOSURE (TLD)

Ambient gamma exposure readings are collected using either Calcium fluoride or Lithium fluoride thermoluminescent dosimeters (TLD). There are twelve TLD sample stations surrounding North Anna Power Station and fourteen stations surrounding Surry Power Station. One control TLD station is located at Pocahontas State Park. Several stations at each site duplicate utility sampling stations.

The TLD's are read quarterly for net exposure during their time in the field, resulting in a millirem/quarter reading.

## Sources of Radioactivity in the Environment

Radioactivity from natural sources is found everywhere. Naturally occurring radioactivity comes from the decay of primordial terrestrial sources such as uranium and thorium. Other sources are continually produced in our upper atmosphere through interactions of atoms with cosmic rays. These naturally occurring sources produce the background levels of radioactivity.

In the past century, environmental radiation levels have been influenced by human practices using or manufacturing radioactive materials. Such practices include the use of radioactive materials in the healing arts, uranium mining and milling operations, nuclear power generation, nuclear weapons manufacturing and testing, storage and disposal of nuclear weapons.

Background radiation levels were most altered by residual fallout from nuclear weapons testing. The United States ceased atmospheric testing following adoption of the 1963 Nuclear Test Ban Treaty. Only long-lived fallout radionuclides remain.

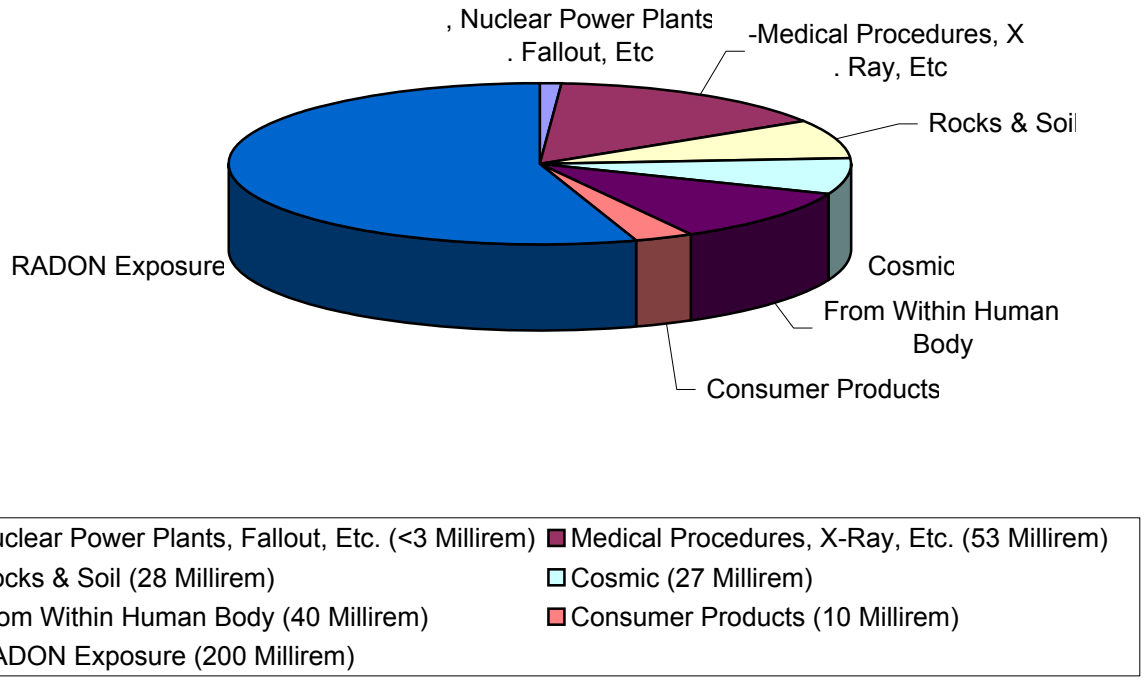
## Doses to the Public

The primary source of radiation dose received by the general public is due to radon exposure (See Figure 1 next page). The average individual receives approximately 200 mrem/year from radon and less than 1 mrem/year from nuclear facilities. Another 158 mrem/year are received from other natural sources and medical procedures. The total average whole body dose nationwide is approximately 360 mrem/year.

Inherent in all standards for radiation control is the philosophy of limiting exposure to levels “AS LOW AS REASONABLY ACHIEVABLE” (ALARA). In practice, this philosophy continues to result in the very low average doses to the public from nuclear facilities cited earlier. The monitoring program maintained by the Division of Radiological Health continues to verify compliance to these standards.

FIGURE 1. SOURCES OF RADIATION EXPOSURE

Source: National Council on Radiation Protection & Measurement; Estimated Annual Dose of 360 Millirem for an Average Person



COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

DIVISION OF RADIOLOGICAL HEALTH
109 Governor Street, Room 730 Richmond, Virginia 23218-2448
Office (804) 864-8150 Fax (804) 864-8165

# North Anna and Surry Nuclear Power Stations & Other Selected Locations

## Virginia Department of Health

# AIR PARTICULATE

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location | Station | Date Start | Date Stop | Gross Beta Activity pCi/meter3 |
|---|---|---|---|---|
| Surry Power Station | A-20 | 1/9/08 | 1/16/08 | 0.02 +/- 0.01 |
| Surry Power Station | A-20 | 4/24/08 | 5/8/08 | 0.02 +/- 0.01 |
| Surry Power Station | A-20 | 7/2/08 | 7/9/08 | 0.01 +/- 0.01 |
| Surry Power Station | A-20 | 12/3/08 | 12/10/08 | 0.03 +/- 0.01 |

**Virginia Department of Health**

## AIR PARTICULATE

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location | Station | Date Start | Date Stop | Gross Beta Activity pCi/meter3 |
|---|---|---|---|---|
| Pocahontas State Park | A-40 | 1/8/08 | 1/15/08 | 0.03 +/- 0.01 |
| Pocahontas State Park | A-40 | 4/23/08 | 5/7/08 | 0.03 +/- 0.01 |
| Pocahontas State Park | A-40 | 7/1/08 | 7/8/08 | 0.01 +/- 0.01 |
| Pocahontas State Park | A-40 | 12/9/08 | 12/16/08 | 0.01 +/- 0.01 |

## Virginia Department of Health

# AIR PARTICULATE

January 01, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location | Station | Date Start | | Date Stop | Gross Beta Activity pCi/meter3 | | |
|---|---|---|---|---|---|---|---|
| Louisa County Rt. 701 | A-88 | 1/8/08 | - | 1/15/08 | 0.04 | +/- | 0.02 |
| Louisa County Rt. 701 | A-88 | 4/23/08 | - | 5/7/08 | 0.04 | +/- | 0.03 |
| Louisa County Rt. 701 | A-88 | 7/1/08 | - | 7/8/08 | 0.01 | +/- | 0.01 |
| Louisa County Rt. 701 | A-88 | 12/2/08 | - | 12/9/08 | 0.04 | +/- | 0.01 |

data not available lab equipment down

**Virginia Department of Health**

# AMBIENT GAMMA EXPOSURE
# (THERMOLUMINESCENT DOSIMETERS)

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location | Station | Quarter | Net Exposure Rate mR/Std. Qtr +/- 2 S.D. |
|---|---|---|---|
| Surry Power Station | D-20 | 1st | 17.9 +/- 2.5 |
| Surry Power Station | D-20 | 2nd | xN/A +/- |
| Surry Power Station | D-20 | 3rd | xN/A +/- |
| Surry Power Station | D-20 | 4th | t18.00 +/- 5.1 |
| North Anna Power Station | D-35 | 1st | 20.6 +/- 2.7 |
| North Anna Power Station | D-35 | 2nd | xN/A +/- |
| North Anna Power Station | D-35 | 3rd | xN/A +/- |
| North Anna Power Station | D-35 | 4th | t21.00 +/- 5.1 |
| Pocahontas State Park | D-40 | 1st | 21.1 +/- 2.7 |
| Pocahontas State Park | D-40 | 2nd | xN/A +/- |
| Pocahontas State Park | D-40 | 3rd | xN/A +/- |
| Pocahontas State Park | D-40 | 4th | t22.00 +/- 5.1 |
| Surry-Lebanon Baptist Church | D-41 | 1st | 14.2 +/- 2.0 |
| Surry-Lebanon Baptist Church | D-41 | 2nd | xN/A +/- |
| Surry-Lebanon Baptist Church | D-41 | 3rd | xN/A +/- |
| Surry-Lebanon Baptist Church | D-41 | 4th | t18.00 +/- 5.1 |
| Surry Lawnes Creek | D-42 | 1st | 17.9 +/- 2.5 |
| Surry Lawnes Creek | D-42 | 2nd | xN/A +/- |
| Surry Lawnes Creek | D-42 | 3rd | xN/A +/- |
| Surry Lawnes Creek | D-42 | 4th | t19.00 +/- 5.1 |
| | | | +/- |
| Surry Rt. 628 | D-43 | 1st | 14.2 +/- 2.0 |
| Surry Rt. 628 | D-43 | 2nd | xN/A +/- |
| Surry Rt. 628 | D-43 | 3rd | xN/A +/- |
| Surry Rt. 628 | D-43 | 4th | t17.00 +/- 5.1 |
| Jamestown | D-44 | 1st | 17.3 +/- 2.4 |
| Jamestown | D-44 | 2nd | xN/A +/- |
| Jamestown | D-44 | 3rd | xN/A +/- |
| Jamestown | D-44 | 4th | t21.00 +/- 5.1 |
| Newport News-Lee Hall | D-45 | 1st | 17.3 +/- 2.4 |
| Newport News-Lee Hall | D-45 | 2nd | xN/A +/- |
| Newport News-Lee Hall | D-45 | 3rd | xN/A +/- |
| Newport News-Lee Hall | D-45 | 4th | t23.00 +/- 5.1 |
| Louisa Co. Mineral | D-50 | 1st | *N/A +/- |
| Louisa Co. Mineral | D-50 | 2nd | xN/A +/- |
| Louisa Co. Mineral | D-50 | 3rd | xN/A +/- |
| Louisa Co. Mineral | D-50 | 4th | t20.00 +/- 5.1 |
| Louisa Co.-Wares Cross | D-51 | 1st | 14.6 +/- 1.9 |
| Louisa Co.-Wares Cross | D-51 | 2nd | xN/A +/- |
| Louisa Co.-Wares Cross | D-51 | 3rd | xN/A +/- |

**Virginia Department of Health**

# AMBIENT GAMMA EXPOSURE
# (THERMOLUMINESCENT DOSIMETERS)

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location | Station | Quarter | Net Exposure Rate mR/Std. Qtr +/- 2 S.D. |
|---|---|---|---|
| Naval Weapons Station I | D-73 | 1st | 15.0 +/- 2.1 |
| Naval Weapons Station I | D-73 | 2nd | xN/A +/- |
| Naval Weapons Station I | D-73 | 3rd | xN/A +/- |
| Naval Weapons Station I | D-73 | 4th | t15.00 +/- 5.1 |
| Newport News-Fort Eustis | D-76 | 1st | 18.5 +/- 2.6 |
| Newport News-Fort Eustis | D-76 | 2nd | xN/A +/- |
| Newport News-Fort Eustis | D-76 | 3rd | xN/A +/- |
| Newport News-Fort Eustis | D-76 | 4th | t16.00 +/- 5.1 |
| Williamsburg Busch Gardens | D-77 | 1st | uN/A +/- |
| Williamsburg Busch Gardens | D-77 | 2nd | xN/A +/- |
| Williamsburg Busch Gardens | D-77 | 3rd | xN/A +/- |
| Williamsburg Busch Gardens | D-77 | 4th | t18.00 +/- 5.1 |
| Williamsburg Airport | D-78 | 1st | 17.4 +/- 2.5 |
| Williamsburg Airport | D-78 | 2nd | xN/A +/- |
| Williamsburg Airport | D-78 | 3rd | xN/A +/- |
| Williamsburg Airport | D-78 | 4th | t19.00 +/- 5.1 |
| Surry Scotland Wharf | D-79 | 1st | 13.6 +/- 1.9 |
| Surry Scotland Wharf | D-79 | 2nd | xN/A +/- |
| Surry Scotland Wharf | D-79 | 3rd | xN/A +/- |
| Surry Scotland Wharf | D-79 | 4th | t15.00 +/- 5.1 |
| Surry Bacon's Castle | D-80 | 1st | 15.4 +/- 2.2 |
| Surry Bacon's Castle | D-80 | 2nd | xN/A +/- |
| Surry Bacon's Castle | D-80 | 3rd | xN/A +/- |
| Surry Bacon's Castle | D-80 | 4th | t18.00 +/- 5.1 |
| Surry - Alliance | D-81 | 1st | 15.6 +/- 2.2 |
| Surry - Alliance | D-81 | 2nd | xN/A +/- |
| Surry - Alliance | D-81 | 3rd | xN/A +/- |
| Surry - Alliance | D-81 | 4th | t16.00 +/- 5.1 |
| Surry Hog Point | D-82 | 1st | 16.0 +/- 2.3 |
| Surry Hog Point | D-82 | 2nd | xN/A +/- |
| Surry Hog Point | D-82 | 3rd | xN/A +/- |
| Surry Hog Point | D-82 | 4th | t16.00 +/- 5.1 |
| Louisa Co. Rt. 685 | D-84 | 1st | 17.9 +/- 2.3 |
| Louisa Co. Rt. 685 | D-84 | 2nd | xN/A +/- |
| Louisa Co. Rt. 685 | D-84 | 3rd | xN/A +/- |
| Louisa Co. Rt. 685 | D-84 | 4th | t16.00 +/- 5.1 |
| Spotsylvania Rt. 713 | D-85 | 1st | 14.7 +/- 1.9 |
| Spotsylvania Rt. 713 | D-85 | 2nd | xN/A +/- |
| Spotsylvania Rt. 713 | D-85 | 3rd | xN/A +/- |
| Spotsylvania Rt. 713 | D-85 | 4th | t15.00 +/- 5.1 |
| Louisa Co. Bumpass | D-86 | 1st | 16.9 +/- 2.2 |
| Louisa Co. Bumpass | D-86 | 2nd | xN/A +/- |
| Louisa Co. Bumpass | D-86 | 3rd | xN/A +/- |
| Louisa Co. Bumpass | D-86 | 4th | t18.00 +/- 5.1 |
| Spotsylvania-Levy | D-87 | 1st | 19.6 +/- 2.6 |
| Spotsylvania-Levy | D-87 | 2nd | xN/A +/- |
| Spotsylvania-Levy | D-87 | 3rd | xN/A +/- |
| Spotsylvania-Levy | D-87 | 4th | t21.00 +/- 5.1 |
| Louisa Co. Rt. 700 | D-88 | 1st | 20.5 +/- 2.7 |
| Louisa Co. Rt. 700 | D-88 | 2nd | xN/A +/- |
| Louisa Co. Rt. 700 | D-88 | 3rd | xN/A +/- |
| Louisa Co. Rt. 700 | D-88 | 4th | t20.00 +/- 5.1 |

**Virginia Department of Health**

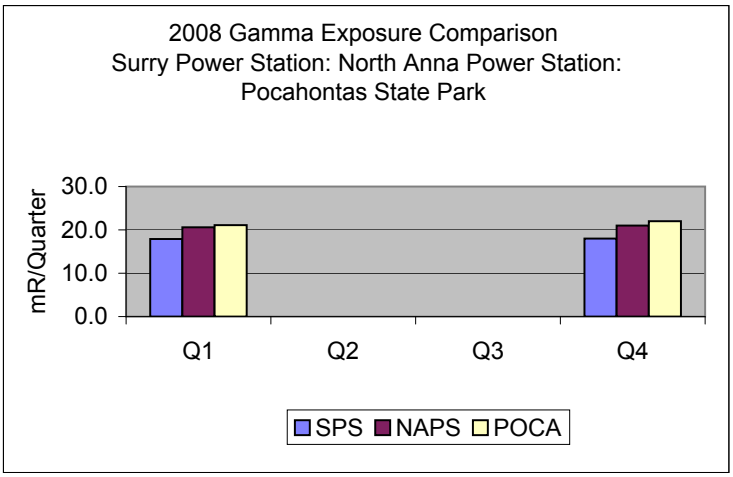
# AMBIENT GAMMA EXPOSURE
# (THERMOLUMINESCENT DOSIMETERS)

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location | Station | Quarter | Net Exposure Rate mR/Std. Qtr +/- 2 S.D. |
|---|---|---|---|
| Louisa Co. Aspen Hill | D-89 | 1st | 21.0 +/- 2.7 |
| Louisa Co. Aspen Hill | D-89 | 2nd | xN/A +/- |
| Louisa Co. Aspen Hill | D-89 | 3rd | xN/A +/- |
| Louisa Co. Aspen Hill | D-89 | 4th | t22.00 +/- 5.1 |
| Rad Health | Control 1 | 1st | 7.8 +/- 1.0 |
| Rad Health | Control 1 | 2nd | xN/A +/- |
| Rad Health | Control 1 | 3rd | xN/A +/- |
| Rad Health | Control 1 | 4th | t9.00 +/- 2.0 |
| Rad Health | Control 2 | 1st | 8.9 +/- 1.2 |
| Rad Health | Control 2 | 2nd | xN/A +/- |
| Rad Health | Control 2 | 3rd | xN/A +/- |
| Rad Health | Control 2 | 4th | t7.00 +/- 2.0 |

*N/A = TLD missing at time of collection
sN/A - unable to get reading from TLD
xN/A = data not available for 2nd & 3rd quarters due to TLD reader malfunction
t = Due to changeover to private vendor, 4th quarter exposures were only 78 days and 4th quarter dose calculations were performed by Radiation Detection Company using a different method



## Virginia Department of Health

# FISH

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location Name | Date | Isotope | pCi/gram |
|---|---|---|---|
| North Anna Lake<br>Second Cooling Lagoon<br>F-24<br>(Catfish) | 3/12/2008 | Ba | <0.14 |
| | | Cs-134 | <0.01 |
| | | Cs-137 | 0.02 +/- 0.01 |
| | | Co-58 | <0.01 |
| | | Co-60 | <0.01 |
| | | I-131 | <0.92 |
| | | Fe-59 | <0.04 |
| | | Mn-54 | <0.01 |
| | | Ru-106 | <0.08 |
| | | Ag-110M | <0.01 |
| | | Zn-65 | <0.02 |
| | | Nb-95 | <0.03 |
| North Anna Lake<br>Second Cooling Lagoon<br>F-24<br>(Catfish) | 10/29/2008 | Ba | <0.63 |
| | | Cs-134 | <0.01 |
| | | Cs-137 | 0.01 +/- 0.01 |
| | | Co-58 | <0.01 |
| | | Co-60 | <0.01 |
| | | I-131 | <1.4 |
| | | Fe-59 | <0.03 |
| | | Mn-54 | <0.01 |
| | | Ru-106 | <0.06 |
| | | Ag-110M | <0.01 |
| | | Zn-65 | <0.02 |

**Virginia Department of Health**

**MILK**

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location Name | Date | Isotope | Results pCi/Liter | Location Name | Date | Isotope | Results pCi/Liter |
|---|---|---|---|---|---|---|---|
| Louisa County | 1/16/08 | Ba | <24.0 | Surry County | 1/16/08 | Ba | <32.0 |
| Terrell Dairy | | Cs-134 | <5.0 | Epps Dairy | | Cs-134 | <5.0 |
| M-29 | | Cs-137 | <6.0 | M-66 | | Cs-137 | <6.0 |
| | | K-40* | 1.5+/-0.1 | | | K-40* | 1.6+/-0.1 |
| | | I-131 | 0.1+/-0.2 | | | I-131 | 0.0+/-0.2 |
| | | Sr-89 | <4.0 | | | Sr-89 | <4.0 |
| | | Sr-90 | 1.1+/-0.5 | | | Sr-90 | 0.9+/-0.4 |
| Louisa County | 4/17/08 | Ba | <6.0 | Surry County | 4/16/08 | Ba | <5.0 |
| Terrell Dairy | | Cs-134 | <5.0 | Epps Dairy | | Cs-134 | <5.0 |
| M-29 | | Cs-137 | <6.0 | M-66 | | Cs-137 | <6.0 |
| | | K-40* | 1.5+/-0.1 | | | K-40* | 1.5+/-0.1 |
| | | I-131 | 0.0+/- 0.1 | | | I-131 | 0.0+/-0.2 |
| | | Sr-89 | <4.0 | | | Sr-89 | <4.0 |
| | | Sr-90 | 0.6+/-0.5 | | | Sr-90 | 0.5+/-0.5 |
| Louisa County | 9/4/08 | Ba | <5.0 | Surry County | 9/2/08 | Ba | <5.0 |
| Terrell Dairy | | Cs-134 | <5.0 | Epps Dairy | | Cs-134 | <5.0 |
| M-29 | | Cs-137 | <6.0 | M-66 | | Cs-137 | <6.0 |
| | | K-40* | 1.4+/-0.1 | | | K-40* | 1.6+/-0.1 |
| | | I-131 | 0.1+/-0.1 | | | I-131 | 0.0+/-0.1 |
| | | Sr-89 | <4.0 | | | Sr-89 | <4.0 |
| | | Sr-90 | 0.4+/-0.4 | | | Sr-90 | 0.7+/-0.5 |
| Louisa County | 12/3/08 | Ba | <5.0 | Surry County | 12/4/08 | Ba | <6.0 |
| Terrell Dairy | | Cs-134 | <5.0 | Epps Dairy | | Cs-134 | <5.0 |
| M-29 | | Cs-137 | <4.0 | M-66 | | Cs-137 | <6.0 |
| | | K-40* | 2.1+/-0.1 | | | K-40* | 2.2+/-0.1 |
| | | I-131 | 0.0+/-0.1 | | | I-131 | 0.0+/-0.2 |
| | | Sr-89 | <4.0 | | | Sr-89 | <4.0 |
| | | Sr-90 | 0.7+/-0.9 | | | Sr-90 | 1.6+/-0.8 |

* = K-40 data reported in units of grams/liter

## Virginia Department of Health

# RADIOGAS

January 1, 2008 through December 31,2008

ANNUAL REPORT 2008

| Location | Station | Date Start | Stop | I-131 Activity pCi/meter$^3$ |
|---|---|---|---|---|
| Surry Power Station | C-20 | 01/09/08 - | 01/16/08 | <0.03 |
| Surry Power Station | C-20 | 04/24/08 - | 05/08/08 | <0.02 |
| Surry Power Station | C-20 | 07/02/08 - | 07/09/08 | <0.03 |
| Surry Power Station | C-20 | 12/03/08 - | 10/10/08 | <0.11 |
| Pocahontas State Park | C-40 | 01/08/08 - | 01/15/08 | <0.02 |
| Pocahontas State Park | C-40 | 04/23/08 - | 05/07/08 | <0.01 |
| Pocahontas State Park | C-40 | 07/01/08 - | 07/08/08 | <0.02 |
| Pocahontas State Park | C-40 | 12/09/08 - | 12/16/08 | <0.2 |
| Louisa County Rt. 700 | C-88 | 01/08/08 - | 01/15/08 | <0.08 |
| Louisa County Rt. 700 | C-88 | 04/23/08 - | 05/07/08 | <0.03 |
| Louisa County Rt. 700 | C-88 | 07/01/08 - | 07/08/08 | <0.05 |
| Louisa County Rt. 700 | C-88 | 12/02/08 - | 12/09/08 | <0.09 |

## Virginia Department of Health

# SHELLFISH

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location | Date Collected | Distance & Direction | Activity : pCi/gram (wet wt.) | |
|---|---|---|---|---|
| R-17 | N/A | approx. 0.5 mi. from mouth of canal | | N/A |
| James River Mouth of SPS Discharge Canal | | | Ba-140<br>Cs-134<br>Cs-137<br>Co-58<br>Co-60<br>Fe-59<br>I-131<br>Mn-54<br>Rh-106<br>Ag-110M<br>Zn-65<br>Zr-95 | |

N/A = live clams could not be found

**Virginia Department of Health**

**SILT**

January 1, 2008 through December 31,2008

ANNUAL REPORT 2008

| Location | Date Collected | Gross Beta pCi/Gram of Silt |
|---|---|---|
| James River | 3/25/08 | 27.2 +/- 4.8 |
| Pier 1 | 6/4/08 | 29.3 +/- 4.8 |
| NGNNSBDCC | 9/4/08 | 26.8 +/- 4.3 |
| S-15A | 11/20/08 | 27.5 +/- 4.8 |
| James River | 3/25/08 | 27.5 +/- 4.7 |
| Shipway 11 | 6/4/08 | 32.8 +/- 5.2 |
| NGNN | 9/4/08 | 30.5 +/- 4.4 |
| S-16 | 11/20/08 | 25.4 +/- 4.8 |

## Virginia Department of Health

# SILT

January 01, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location | Date Collected | Gamma Activity pCi/Gram (Wet) Cs-134 | Cs-137 | Co-58 | Co-60 | Gross Beta pCi/Gram (dry |
|---|---|---|---|---|---|---|
| Elizabeth River | 03/25/08 | <0.01 | 0.03 +/- 0.01 | <0.01 | <0.01 | 29.7 +/- 4.8 |
| Drydock #8 | 06/04/08 | <0.01 | 0.03 +/- 0.01 | <0.01 | <0.01 | 30.8 +/- 5.1 |
| NNSY | 09/04/08 | <0.01 | 0.03 +/- 0.01 | <0.01 | <0.01 | 34.4 +/- 4.6 |
| S-18 | 11/20/08 | <0.01 | 0.03 +/- 0.01 | <0.01 | <0.01 | 23.0 +/- 4.6 |
| Elizabeth River | 03/25/08 | <0.01 | 0.03 +/- 0.01 | <0.01 | <0.01 | 21.1 +/- 4.5 |
| Drydock #4 | 06/04/08 | <0.01 | 0.03 +/- 0.01 | <0.01 | <0.01 | 30.4 +/- 5.0 |
| NNSY | 09/04/08 | <0.01 | 0.03 +/- 0.01 | <0.01 | <0.01 | 26.9 +/- 4.3 |
| S-19 | 11/20/08 | <0.01 | 0.03 +/- 0.01 | <0.01 | <0.01 | 26.3 +/- 4.8 |
| Elizabeth River | 03/25/08 | <0.01 | 0.03 +/- 0.01 | <0.01 | <0.01 | 32.0 +/- 5.1 |
| Wetslip #1 | 06/04/08 | <0.01 | 0.03 +/- 0.01 | <0.01 | <0.01 | 27.0 +/- 4.7 |
| NNSY | 09/04/08 | <0.01 | 0.03 +/- 0.01 | <0.01 | <0.01 | 31.2 +/- 4.6 |
| S-20 | 11/20/08 | <0.01 | 0.03 +/- 0.01 | <0.01 | <0.01 | 31.0 +/- 5.0 |

## Virginia Department of Health

# SILT

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2007

| Location | Date Collected | Distance & Direction | Activity pCi/Gram (dry wt.) Cs-134 | Cs-137 | Co-60 |
|---|---|---|---|---|---|
| James River SPS Discharge Canal S-17 | N/A | 0.5 Miles NNW | N/A | N/A | N/A |
| NAPS Waste Treatment Shoreline Soil S-24 | 03/11/08 | 1.1 Miles SSE | <0.01 | 0.01 +/- 0.01 | <0.01 |
| NAPS Waste Treatment Shoreline Soil S-24 | 10/20/08 | 1.1 Miles SSE | <0.01 | <0.01 | <0.01 |

N/A = sample not collected

## Virginia Department of Health

# SURFACE WATER

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location | Station | Date Collected | Gamma Activity pCi/L Ba-140 | Cs-137 | I-131 | Mn-54 | Zn 65 | Zr-95/Nb-95 | Beta Activity | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | SS (pCi/L) | BS (pCi/L) |
| James River - | W - 15A | 03/25/08 | <9 | <6 | <12 | <5 | <11 | <10 | 0.4 +/- 0.3 | 1.3 +/- 0.8 |
| Pier 1 | W - 15A | 06/04/07 | <8 | <6 | <10 | <5 | <12 | <10 | 0.6 +/- 0.5 | 1.6 +/- 1.1 |
| NGNNSBDCC | W - 15A | 09/04/08 | <9 | <6 | <15 | <5 | <11 | <10 | 0.4 +/- 0.3 | 1.2 +/- 0.8 |
| | W - 15A | 11/20/08 | <10 | <5 | <16 | <5 | <11 | <10 | 0.3 +/- 0.5 | 3.2 +/- 1.2 |
| | | | | | | | | | SS (pCi/L) | BS (pCi/L) |
| James River - | W - 16 | 03/25/08 | <7 | <6 | <10 | <5 | <11 | <10 | 0.4 +/- 0.3 | 1.6 +/- 0.9 |
| Shipway 11 | W - 16 | 06/04/07 | <8 | <5 | <11 | <5 | <11 | <10 | 0.6 +/- 0.5 | 0.8 +/- 1.1 |
| NGNNSBDDCC | W - 16 | 09/04/08 | <7 | <5 | <11 | <5 | <11 | <9 | 0.2 +/- 0.3 | 0.0 +/- 0.8 |
| | W - 16 | 11/20/08 | <17 | <6 | <38 | <5 | <12 | <11 | 0.0 +/- 0.5 | 1.3 +/- 1.1 |

**SS = SUSPENDED SOLIDS**
**BS = BASIC SULFIDES**

## Virginia Department of Health

# SURFACE WATER

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location | Station | Date Collected | Gamma Activity pCi/L | | | | | | Beta Activity | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ba-140 | Cs-137 | I-131 | Mn-54 | Zn 65 | Zr-95/Nb-95 | SS (pCi/L) | BS (pCi/L) |
| Elizabeth River | W - 37 | 03/25/08 | <9 | <5 | <13 | <5 | <11 | <10 | 0.4 +/- 0.3 | 1.8+/- 0.9 |
| Dry Dock 4 | W - 37 | 06/04/08 | <5 | <5 | <6 | <5 | <11 | <9 | 0.6 +/- 0.5 | 0.0+/- 1.1 |
| NNSY | W - 37 | 09/4//08 | <7 | <4 | <9 | <5 | <11 | <9 | 0.0 +/- 0.3 | 1.3 +/- 0.9 |
| | W - 37 | 11/20/08 | <15 | <6 | <34 | <6 | <12 | <11 | 0.0 +/- 0.5 | 0.0 +/- 0.5 |
| | | | | | | | | | **SS (pCi/L)** | **BS (pCi/L)** |
| Elizabeth River | W - 38 | 03/25/08 | <10 | <3 | <17 | <5 | <12 | <10 | 0.4 +/- 0.3 | 0.6 +/- 0.8 |
| Wet Slip 1 | W - 38 | 06/04/08 | <6 | <6 | <7 | <5 | <11 | <9 | 0.3 +/- 0.5 | 0.5 +/- 1.1 |
| NNSY | W - 38 | 09/4//08 | <7 | <5 | <9 | <5 | <12 | <9 | 0.3 +/- 0.3 | 1.5 +/- 0.8 |
| | W - 38 | 11/20/08 | <20 | <5 | <52 | <6 | <12 | <12 | 0.2 +/- 0.5 | 1.7 +/- 1.2 |
| | | | | | | | | | **SS (pCi/L)** | **BS (pCi/L)** |
| Elizabeth River | W - 39 | 03/25/08 | <11 | <6 | <19 | <5 | <11 | <10 | 0.4 +/- 0.3 | 0.7 +/- 0.8 |
| Dry Dock 8 | W - 39 | 06/04/08 | <7 | <5 | <9 | <5 | <11 | <10 | 0.2 +/- 0.5 | 1.3 +/- 1.1 |
| NNSY | W - 39 | 09/4//08 | <7 | <5 | <8 | <5 | <11 | <10 | 0.1 +/- 0.3 | 1.1+/- 0.8 |
| | W - 39 | 11/20/08 | <10 | <6 | <17 | <5 | <11 | <10 | 0.0 +/- 0.5 | 1.1+/- 1.1 |

**SS = SUSPENDED SOLIDS**
**BS = BASIC SULFIDES**
**NA = NO ANALYSIS**

## Virginia Department of Health

# SURFACE WATER

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location | Station | Date Collected | Gamma Activity pCi/L Ba140 | Cs134 | Cs137 | Co58 | Co60 | I131 | Mn54 | Zn65 | Zr/Nb95 | H3 | Gross Beta | B.S. | S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPS | W-19 | Jan-08 | <11 | <5 | <5 | <6 | <5 | <19 | <5 | <12 | <11 | 300 | | 0.8+/-0.5 | 1.1+ |
| Discharge | W-19 | Apr-08 | <10 | <5 | <5 | <6 | <5 | <17 | <5 | <11 | <10 | 150 | | 1.4+/-0.8 | 0.3+ |
| Canal | W-19 | Jul-08 | <6 | <5 | <6 | <5 | <5 | <8 | <5 | <11 | <9 | NDC | | 3.8+/-1.3 | 1.1+ |
| | W-19 | Oct-08 | <8 | <5 | <5 | <5 | <5 | <13 | <5 | <11 | <10 | NDC | | 1.7+/-1.2 | 0.4+ |
| North Anna | W-27 | Jan-08 | <8 | <5 | <6 | <5 | <5 | <11 | <5 | <11 | <10 | 751 | 3+/-1 | | |
| River | W-27 | Apr-08 | <8 | <5 | <6 | <5 | <5 | <10 | <5 | <11 | <10 | NDC | 2+/-1 | | |
| | W-27 | Jul-08 | <8 | <5 | <6 | <5 | <5 | <9 | <5 | <11 | <10 | 1652 | 4+/-1 | | |
| | W-27 | Oct-08 | <10 | <5 | <5 | <6 | <5 | <16 | <3 | <11 | <10 | 2252 | 3+/-1 | | |
| NAPS | W-33 | Jan-08 | <11 | <5 | <5 | <6 | <5 | <19 | <5 | <11 | <11 | 3153 | 2+/-4 | | |
| Discharge | W-33 | Apr-08 | <12 | <5 | <5 | <6 | <5 | <20 | <5 | <12 | <10 | 3754 | 4+/-3 | | |
| Canal | W-33 | Jul-08 | <8 | <5 | <6 | <5 | <5 | <12 | <5 | <11 | <10 | 3754 | 3+/-3 | | |
| | W-33 | Oct-08 | <8 | <5 | <5 | <5 | <5 | <11 | <5 | <11 | <10 | 4279 | 4+/-3 | | |
| James River | W-79 | Jan-08 | <12 | <5 | <6 | <6 | <5 | <22 | <5 | <11 | <11 | NDC | | 0.4+/-0.5 | 0.3 |
| Scotland | W-79 | Apr-08 | <13 | <5 | <5 | <6 | <5 | <23 | <5 | <11 | <11 | 75 | | 0.7+/-0.8 | 0.1 |
| Wharf | W-79 | Aug-08 | <6 | <5 | <6 | <5 | <5 | <7 | <5 | <11 | <9 | NDC | | 0.2+/-0.8 | 0.1 |
| | W-79 | Oct-08 | <5 | <5 | <5 | <5 | <5 | <6 | <5 | <11 | <9 | NDC | | 1.2+/-1.1 | 0.2 |

NDC = No Detectable counts

## Virginia Department of Health

# VEGETATION

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location Name | Date | Type | Isotope | State Results pCi/Gram (wet wt.) |
|---|---|---|---|---|
| Surry County<br>Rickmond Garden<br>V-96B | N/A | Collard<br>Greens | I-131<br>Cs-134<br>Cs-137 | N/A<br>N/A<br>N/A |
| Louisa County<br>Garden<br>V-98B | N/A | Collard<br>Greens | I-131<br>Cs-134<br>Cs-137 | N/A<br>N/A<br>N/A |

N/A = no garden sample available/collected due to drought and/or unexpected death of owner

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

DIVISION OF RADIOLOGICAL HEALTH
109 Governor Street, Room 730 Richmond, Virginia 23218-2448
Office (804) 864-8150 Fax (804) 864-8165

# BABCOCK & WILCOX NUCLEAR OPERATIONS GROUP

## Virginia Department of Health
## Babcock & Wilcox Nuclear Operations Group

# AIR PARTICULATE COMPOSITE SAMPLES

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location Name | Date Start | | Stop | Gross Alpha pCi/meter3 | | |
|---|---|---|---|---|---|---|
| Eastern Site | 01/09/08 | - | 01/16/08 | <0.002 | +/- | N/A |
| Boundary | 04/02/08 | - | 04/09/08 | <0.004 | +/- | N/A |
| Ballfield | 07/02/08 | - | 07/09/08 | 0.001 | +/- | 0.001 |
| A-101 | 10/08/08 | - | 10/15/08 | 0.001 | +/- | 0.001 |

NA = not applicable

## Virginia Department of Health
## Babcock & Wilcox Nuclear Operations Group

# SOIL

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location Name | Distance & Direction | Type | Date | Alpha * pCi/Gram | | |
|---|---|---|---|---|---|---|
| Eastern Site Boundary-Ballfield S-101 | Site Boundary | Soil | 6/18/2008 | 1.3 | +/- | 0.4 |
| LRAHL Bldg. Off Rt. 460 control S-102 | 5 Miles SW | Soil | 6/18/2008 | 2.3 | +/- | 0.6 |

Alpha * - Uranium Separation Followed by Alpha Counting

LRAHL = Lynchburg Regional Animal Health Laboratory

**Virginia Department of Health**
**Babcock & Wilcox Nuclear Operations Group**

# SURFACE WATER

January 1, 2008 to December 31, 2008

ANNUAL REPORT 2008

| Location Name | Distance & Direction | Date | pCi/Liter Alpha * |
|---|---|---|---|
| from James River shoreline near Ballfield at eastern site boundary W-101 | approx. 3 mi. downstream from plant | 6/18/2008 | 0.8 +/- 0.3 |
| from James River shoreline near Six Mile Bridge control W-102 | approx. 1.5 mi. upstream from plant | 6/18/2008 | 0.6 +/- 0.3 |

Alpha * - Uranium Separation
Followed by Alpha Counting

## Virginia Department of Health
## Babcock & Wilcox Nuclear Operations Group

# VEGETATION

January 1, 2008 through December 31, 2008

ANNUAL REPORT 2008

| Location Name | Distance & Direction | Type | Date | Alpha * pCi/Gram |
|---|---|---|---|---|
| Eastern Site Boundary-Ballfield V-101 | Site Boundary | Vegetation | 6/18/2008 | 0.3 +/- 0.3 |
| LRAHL Bldg. Off RT 460 control V-102 | 5 Miles SW | Vegetation | 6/18/2008 | 0.3 +/- 0.2 |

Alpha * - Uranium Separation
Followed by Alpha Counting

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

DIVISION OF RADIOLOGICAL HEALTH
109 Governor Street, Room 730 Richmond, Virginia 23218-2448
Office (804) 864-8150 Fax (804) 864-8165

# APPENDIX I

# LOWER LIMITS OF DETECTION "LLD"

# LOWER LIMITS OF DETECTION
# "LLD"

Definition: **"Lower Limit of Detection"** – The smallest amount or concentration of a radioactive or nonradioactive element that can be reliably detected in a sample.

All radioactive measurements for samples are reported with an uncertainty. The uncertainty arises for a number of reasons including imperfections in the apparatus or procedure, human error and counting uncertainty. The counting uncertainty arises because radioactive decay is a random process. This means that if one counts the radioactive decay of a sample several times, each for a fixed time, one will find that the measured number of decays varies randomly. However, these random answers all cluster near an average value. It is usually assumed that the counting uncertainty is the dominant uncertainty. The uncertainties that are reported are the counting uncertainties only. The interpretation of this is that we are 95% confident that the true concentration in the sample lies somewhere between the measured concentration minus the counting uncertainty and the measured concentration plus the counting uncertainty.

One consequence of the uncertainties in a measurement of radioactivity is that it is not possible to determine a zero concentration of a radioisotope. Rather, when the uncertainty is such that one cannot distinguish between the sample and background counting rates, we report that the sample radioactivity is less than some concentration. This minimum concentration is termed the Lower Limit of Detection (LLD). Practical sample size, counting time, and background radiation all combine to determine the LLD. The LLD for most radioisotopes is at least several orders of magnitude (factors of ten) less than the standards for a level of a concern that has been set by the state or federal government.

# CONDITIONS

## Consolidated Laboratories

LLD values apply to samples analyzed immediately after collection with no decay corrections used in the calculations. Decay corrections normally required during sample processing may result in significant increases in the LLD's for the short-lived isotopes.

Gamma isotopic analysis is performed with a 4" X 4" Sodium Iodide (Tl) detector and a high purity Germanium detector.

Gross alpha, beta, Sr-89, and Sr-90 LLD's were based on variable averages normally encountered in sample processing. The LLD may vary from sample to sample depending on self-absorption corrections, counting efficiency, background changes, counting time and recovery yields. Fish values will depend on the wet to ash weight ratio of the collected sample.

The lower limits of detection for all analysis were calculated using the methods found on the following pages:

# LOWER LIMITS OF DETECTION (LLD's) FOR GAMMA COUNTING
## Consolidated Laboratories

For Tissue, Silt, Vegetation, etc., as provided by SPECTRAN-F V2 Technical Reference Manual using the HpGe Detector

Required Sample Size: 1 Kilogram

NOMINAL LLD's for selected isotopes are given below. Actual LLD's are determined at the time of analysis, and vary with decay time, background radiation, sample size, etc.

| Isotope* | LLD, pCi/Liter |
|---|---|
| Cs-134 | 0.0046 |
| Cs-137 | 0.0041 |
| Co-58 | 0.0041 |
| Co-60 | 0.0048 |
| I-131 | 0.0049 |
| Ru/Rh-106 | 0.0370 |
| Zn-65 | 0.0093 |
| Zr-95 | 0.0075 |
| Ba/La-140 | 0.0150 |
| Ag-110m | 0.0046 |
| Mn-54 | 0.0039 |
| Fe-59 | 0.0083 |

Canberra's Spectran-F Software calculates LLD using the following relationships:

$$* LLD = LD^* \frac{e^{(.693*Td/T\square)}}{T * Y * e * V * 0.037}$$

where:
- Td = Decay Time
- T□ = Half-Life
- T = Count Time
- Y = Yield of the gamma ray in question
- e = Detector efficiency at the energy of gamma ray in question
- V = Sample size
- 0.037= Conversion factor: gammas/second to picocuries

and: $LD = k^2 = 2*LC$

Where: LC is the weakest signal the instrument can detect as a peak.

and: k is a constant which depends on the desired confidence limit for the result. (At the 95% confidence level, k= 1.645.)

# LOWER LIMITS OF DETECTION (LLD's) FOR GAMMA COUNTING
## Consolidated Laboratories

For Water, Milk, etc, as provided by GAMMA-M SOFTWARE CISE 551 Technical Reference Manual using the NaI Detector

Required Sample Size: 3.5 Liters

NOMINAL LLD's for selected isotopes are given below. Actual LLD's are determined at the time of analysis, and vary with decay time, background radiation, sample size, etc.

| Isotope* | LLD, pCi/Liter |
|---|---|
| Cs-134 | 7.3 |
| Cs-137 | 7.6 |
| Co-58 | 7.2 |
| Co-60 | 12.0 |
| I-131 | 7.9 |
| Zn-65 | 21.0 |
| Zr-95 | 15.0 |
| Ba/La-140 | 10.0 |
| Mn-54 | 7.8 |
| Fe-59 | 19.0 |

Canberra's GAMMA-M Software calculates LLD using the following relationships:

$$* \text{LLD} = \text{LD}* \frac{e^{(.693*Td/T\square)}}{T * Y * e * V * 0.037}$$

where: Td = Decay Time
T□ = Half-Life
T = Count Time
Y = Yield of the gamma ray in question
e = Detector efficiency at the energy of gamma ray in question
V = Sample size
0.037= Conversion factor: gammas/second to picocuries

and: $LD = k^2 = 2*LC$

Where: LC is the weakest signal the instrument can detect as a peak.

and: k is a constant which depends on the desired confidence limit for the result. (At the 95% confidence level, k= 1.645.)

# LOWER LIMITS OF DETECTION (LLD's) FOR GAMMA COUNTING
## Consolidated Laboratories

For Air Particulate and Charcoal Canister, as provided by GAMMA-M Software CISE 551 Technical Reference Manual using the NaI Detector

Required Sample Size: 2300 $m^3$ (Air Particulate Composite)
Required Sample Size: 120 $m^3$ (Charcoal Canister)

NOMINAL LLD's for selected isotopes are given below. Actual LLD's are determined at the time of analysis, and vary with decay time, background radiation, sample size, etc.

| Isotope* | LLD, $pCi/m^3$ |
|---|---|
| Cs-134 in Air particulate Composite | 0.002 |
| Cs-137 in Air particulate Composite | 0.002 |
| I-131 in Charcoal Canister | 0.050 |

Canberra's Gamma-M Software calculates LLD using the following relationships:

$$LLD = 4.65 * \frac{(R_b/T_s)^{1/2}}{Y * e * V * d * 2.22}$$

where:
- $R_b$ = Background rate (CPM)
- $T_s$ = Sample Count Time
- Y = Chemical Yield (Gamma ray abundance for I-131 @ 364KeV)
- e = Detector efficiency
- V = Sample size
- d = Decay Correction Factor
- 2.22 = Conversion factor: counts/minute to picocuries

# LOWER LIMITS OF DETECTION (LLD's) FOR BETA COUNTING
## Consolidated Laboratories

For Milk and Water (Radiochemical Analysis).

| Matrix* | LLD | Weight or Volume Required |
|---|---|---|
| Sr-89/90 in Milk & Water: | | |
| Sr-89 | 4.00 pCi/Liter | 1000 ml |
| Sr-90 | 1.00 pCi/Liter | 1000 ml |
| I-131 in Water | 0.34 pCi/Liter | 1000 ml |
| I-131 in Milk | 0.36 pCi/Liter | 1000 ml |

$$LLD = 4.65^* \frac{\sqrt{p(Rb/Ts)}}{Y * e * V * d * 2.22}$$

where:
- Rb = Background rate (CPM)
- Ts = Sample Count Time
- Y = Chemical Yield
- e = Detector efficiency
- V = Sample size
- d = Decay Correction Factor
- 2.22 = Conversion factor: counts/minute to picocuries
- 4.65 = 95% Confidence Factor

# LOWER LIMITS OF DETECTION (LLD's) FOR BETA COUNTING
## Consolidated Laboratories

For Air Particulate, Surface and Ground Water, Saline Water, Silt, Soil, Fish.

| Matrix* | LLD | Weight or Volume Required |
|---|---|---|
| Air particulate | 0.01 pCi/$m^3$ | 120 $m^3$ |
| Surface and Ground Water | 0.82 pCi/Liter | 500 ml |
| Saline Water (Surry Power Station) | 49.00 pCi/Liter | 10 ml |
| Suspended Solids/ Saline Water | 0.54 pCi/Liter | 1000 ml |
| Basic Sulfides in Saline Water | 0.41 pCi/Liter | 1000 ml |
| Silt/Soil | 2.90 pCi/gram | 200 mg |
| Fish | 0.046 pCi/gram | 1000 grams |

$$LLD = 4.65^* \frac{\square\ \square(\sqrt{Rb/Ts})\ \square}{Y * e * V * d * 2.22}$$

where:
- Rb = Background rate (CPM)
- Ts = Sample Count Time
- Y = Chemical Yield
- e = Detector efficiency
- V = Sample size
- d = Decay Correction Factor
- 2.22 = Conversion factor: ~~counts/min~~ute to picocuries
- 4.65 = 95% Confidence Factor

# LOWER LIMITS OF DETECTION (LLD's) FOR ALPHA COUNTING
## Consolidated Laboratories

For Air Particulate, Surface and Ground Water, Saline Water, Silt and Soil.

| Matrix* | LLD | Weight or Volume Required |
|---|---|---|
| Air Particulate | 0.001 pCi/$m^3$ | 150 $m^3$ |
| Surface and Ground Water | 0.50 pCi/liter | 500 ml |
| Saline Water: (SS & BS) | | |
| Suspended Solids | 0.23 pCi/liter | 1000 ml |
| Basic Sulfides | 0.23 pCi/liter | 1000 ml |
| Silt/Soil | 1.9 pCi/gram | 100 mg |

$$LLD = 4.65^* \frac{(2.71/Ts) + (\sqrt{(Rb/Ts)})}{Y * e * V * d * 2.22}$$

where:
- Rb = Background rate (CPM)
- Ts = Sample Count Time
- Y = Chemical Yield (Gamma ray abundance for I-131 @ 634 KeV)
- e = Detector efficiency
- V = Sample size
- d = Decay Correction Factor
- 2.22 = Conversion factor: counts/minute to picocuries
- 4.65 = 95% Confidence Factor
- 2.71 = Conversion factor used to compensate for low backgrounds encountered in Alpha counting

# LOWER LIMITS OF DETECTION (LLD's) FOR ALPHA COUNTING
## Consolidated Laboratories

For Water, Vegetation, Silt and Soil (Uranium Radiochemical Analysis).

| Matrix* | LLD | Weight or Volume Required |
|---|---|---|
| Water | 0.20 pCi/Liter | 1000 ml |
| Vegetation | 0.02 pCi/gram | 1000 grams |
| Silt | 0.02 pCi/gram | 1000 grams |
| Soil | 0.02 pCi/gram | 1000 grams |

$$LLD = 4.65^* \frac{(2.71/Ts) + (\pm\sqrt{(Rb/Ts)})}{Y * e * V * d * 2.22}$$

where: Rb = Background rate (CPM)
Ts = Sample Count Time
Y = Chemical Yield (Gamma ray abundance for I-131 @ 634 KeV)
e = Detector efficiency
V = Sample size
d = Decay Correction Factor
2.22 = Conversion factor: counts/minute to picocuries
4.65 = 95% Confidence Factor
2.71 = Conversion factor used to compensate for low backgrounds encountered in Alpha counting

# LOWER LIMITS OF DETECTION (LLD's) FOR ALPHA COUNTING
## Consolidated Laboratories

For Air Particulate and Waste Water (Fluorometric Uranium Analysis).

| Matrix* | LLD | Weight or Volume Required |
|---|---|---|
| Air Particulate | 2.00 E-09 ug/ml | 1440 $m^3$ |
| Waste Water | 0.04 ug/Liter | 1000 ml |

$$LLD = 4.65^* \frac{(2.71/Ts) + (\sqrt{(Rb/Ts)})}{Y * e * V * d * 2.22}$$

where:
- Rb = Background rate (CPM)
- Ts = Sample Count Time
- Y = Chemical Yield (Gamma ray abundance for I-131 @ 634 KeV)
- e = Detector efficiency
- V = Sample size
- d = Decay Correction Factor
- 2.22 = Conversion factor: counts/minute to picocuries
- 4.65 = 95% Confidence Factor
- 2.71 = Conversion factor used to compensate for low backgrounds encountered in Alpha counting

# LOWER LIMITS OF DETECTION FOR TRITIUM ANALYSES

Required Volume: 50 ml
Sample Aliquot: 8 ml

| | APPROXIMATE LLD * COUNTING TIME |
|---|---|
| 80 pCi/L | 600 minutes |
| 200 pCi/L | 200 minutes |
| 400 pCi/L | 100 minutes |
| 1000 pCi/L | 20 minutes |
| 5000 pCi/L | 10 minutes |

$$* \text{ LLD in pCi/L} = \frac{4.66(R_{Bkg}/T)^{1/2}}{2.22\ (V)\ (E)}$$

where: $R_{Bkg}$ = Background rate (CPM)
T = Background Counting Time
E = Counter Efficiency
V = Sample Volume or Size
4.66 = 95% Confidence Factor

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

DIVISION OF RADIOLOGICAL HEALTH
109 Governor Street, Room 730 Richmond, Virginia 23218-2448
Office (804) 864-8150 Fax (804) 864-8165

# APPENDIX II

# SAMPLING LOCATIONS

## SPS Sampling Locations

| LOCATION | TYPE | FREQUENCY |
|---|---|---|
| Milk | | |
| * M-66 Surry County - W.B. Epps Dairy | Raw | Quarterly |
| Air | | |
| * A-20 Surry Power Station | Air Particulate | Quarterly |
| Charcoal Filter | | |
| * C-20 Surry Power Station | Release Gas | Quarterly |
| Dosimeters | | |
| *D-20 Surry Power Station | Gamma in Air | Quarterly |
| D-41 Surry Lebanon Baptist Church | Gamma in Air | Quarterly |
| D-42 Surry County - Lawnes Creek | Gamma in Air | Quarterly |
| D-43 Surry County - Route 628 | Gamma in Air | Quarterly |
| *D-44 Jamestown | Gamma in Air | Quarterly |
| D-45 Newport News - Lee Hall | Gamma in Air | Quarterly |
| D-73 Naval Weapons Station - Enlisted Quarter | Gamma in Air | Quarterly |
| *D-76 Newport News - Fort Eustis | Gamma in Air | Quarterly |
| D-77 Williamsburg - Busch Gardens | Gamma in Air | Quarterly |
| D-78 Williamsburg - Williamsburg Airport | Gamma in Air | Quarterly |
| D-79 Surry County - Scotland Wharf | Gamma in Air | Quarterly |
| *D-80 Surry County - Bacon's Castle | Gamma in Air | Quarterly |
| *D-81 Surry County - Alliance | Gamma in Air | Quarterly |
| *D-82 Surry County - Hog Point | Gamma in Air | Quarterly |
| Shellfish | | |
| R-17 James River - 1/2 Mile Off Discharge Canal | Clams | Annually |
| Silt | | |
| S-17 James River - 1/2 Mile Off Discharge Canal | Silt | Annually |
| Surface Water | | |
| * W-19 Surry Discharge Canal | Surface Water | Quarterly |
| * W-79 James River - Scotland Wharf | Surface Water | Quarterly |
| Vegetation | | |
| * V-96B Surry County - Rickmond Garden | Edible Vegetation | Annually |
| * V-97 James City - Carter's Grove Plantation | Edible Vegetation | Annually |

***Virginia and Virginia Power Duplicate Samples**

## NAPS Sampling Locations

| LOCATION | NAPS Station Designations | TYPE | FREQUENCY |
|---|---|---|---|
| Milk | | | |
| * M-29 Louisa County - E. A. Terrell Dairy | 13 | Raw | Quarterly |
| Air | | | |
| * A-88 Louisa County Route 700 | 22 | Air Particulate | Quarterly |
| Charcoal Filter | | | |
| * C-88 Louisa County Route 700 | 22 | Release Gas | Quarterly |
| Dosimeters | | | |
| * D-35 NAPS | | Gamma in Air | Quarterly |
| * D-50 Louisa County - Mineral | | Gamma in Air | Quarterly |
| * D-51 Louisa County - Wares Crossroads | | Gamma in Air | Quarterly |
| * D-52 Spotsylvania - Good Hope Church | | Gamma in Air | Quarterly |
| D-53 Spotsylvania - Route 614 | | Gamma in Air | Quarterly |
| D-54 Louisa County - Frederick's Hall | | Gamma in Air | Quarterly |
| D-84 Louisa County - Route 685 | | Gamma in Air | Quarterly |
| D-85 Spotsylvania Co. - Route 713 | | Gamma in Air | Quarterly |
| * D-86 Louisa County - Bumpass P.O. | | Gamma in Air | Quarterly |
| * D-87 Spotsylvania Co. - Levy | | Gamma in Air | Quarterly |
| * D-88 Louisa Co. - Rt. 700 (near station) | | Gamma in Air | Quarterly |
| * D-89 Louisa County - Aspen Hill | | Gamma in Air | Quarterly |
| Fish | | | |
| * F-24 North Anna Lake - Second Cooling Lagoon | 08 | Edible Fish | 2/Year |
| Soil | | | |
| S-24 NAPS Waste Treatment shoreline soil | 08 | Soil | Annually |
| Surface Water | | | |
| * W-27 North Anna River - Route 522 | | Surface Water | Quarterly |
| * W-33 North Anna Discharge Canal | | Surface Water | Quarterly |
| Vegetation | | | |
| * V-92A Spotsylvania County | | Edible Vegetation | Annually |
| * V-98C Louisa County | | Edible Vegetation | Annually |

***Virginia and Virginia Power Duplicate Samples**

**Sampling Locations - Babcock & Wilcox**

| SAMPLE | LOCATION | TYPE | FREQUENCY |
|---|---|---|---|
| AIR | | | |
| A-101 | Eastern Site Boundary<br>Ballfield | Air | Quarterly |
| SURFACE WATER | | | |
| W-101 | James River<br>3 mi. downstream of plant<br>at eastern site boundary | Surface Water | Annually |
| W-102 | James River<br>1.5 mi. upstream of plant<br>at Six Mile Bridge<br>control | Surface Water | Annually |
| SOIL | | | |
| S-101 | Eastern Site Boundary<br>Ballfield | Soil | Annually |
| S-102 | LRAHL Bldg. Off Route 460<br>5 Miles S.W.<br>Control | Soil | Annually |
| VEGETATION | | | |
| V-101 | Eastern Site Boundary<br>Ballfield | Grass | Annually |
| V-102 | LRAHL Bldg. Off Route 460<br>5 Miles S.W.<br>Control | Grass | Annually |

**Other Sampling Locations in VA**

| | LOCATION | TYPE | FREQUENCY |
|---|---|---|---|
| | Air | | |
| A-40 | Pocahontas State Park | Air Particulate | Quarterly |
| | Silt | | |
| S-15A | James River - NGNNSBDDC Pier 1 | Silt | Quarterly |
| S-16 | James River - NGNNSBDDC Shipway 11 | Silt | Quarterly |
| S-18 | Elizabeth River - NNSY - Drydock #8 | Silt | Quarterly |
| S-19 | Elizabeth River - NNSY - Drydock #4 | Silt | Quarterly |
| S-20 | Elizabeth River - NNSY - Wet Slip #1 | Silt | Quarterly |
| | Charcoal Filter | | |
| C-40 | Pocahontas State Park | Air Particulate | Quarterly |
| | Dosimeters | | |
| D-40 | Pocahontas State Park | Air Gamma | Changed 4/Year |
| | Surface Water | | |
| W-15 | James River - NGNNSBDDC Pier 1 | Surface Water | Quarterly |
| W-16 | James River - NGNNSBDDC Shipway 11 | Surface Water | Quarterly |
| W-37 | Elizabeth River - NNSY - Drydock #8 | Surface Water | Quarterly |
| W-38 | Elizabeth River - NNSY - Drydock #4 | Surface Water | Quarterly |
| W-39 | Elizabeth River - NNSY - Wet Slip #1 | Surface Water | Quarterly |

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

DIVISION OF RADIOLOGICAL HEALTH
109 Governor Street, Room 730 Richmond, Virginia 23218-2448
Office (804) 864-8150 Fax (804) 864-8165

# APPENDIX III
# EMERGENCY PREPAREDNESS

# EMERGENCY PREPAREDNESS

The Division of Radiological Health (DRH) is one of the lead response agencies for emergencies involving the potential or actual release of radioactive materials. Overall state level emergency response is described in the Commonwealth of Virginia Radiological Emergency Response Plan (COVRERP), which is developed and maintained by the Department of Emergency Management (DEM) for the Commonwealth of Virginia. In addition to generic guidelines for responding to any major radiological emergency, the response procedures contain segments addressing response to several types of accidents. There are sections, which provide information needed for response to Licensee and Transportation accidents. Other sections contain background information and response guidance for accidents at fixed nuclear facilities.

Primary tasks of the Virginia Department of Health (VDH) and DRH, in response to a radiological emergency are to locate, identify, and predict the impact of any radioactive materials released to the environment. Based on the predicted or known impact, the VDH then recommends appropriate measures to protect the public. The DRH also supervises cleanup and ensures proper disposal of radioactive waste. A duty officer maintains 24-hour coverage for the DRH to ensure personnel are available at all times for coverage in case of a radiological emergency.

Under the provisions of current Federal Emergency Management Agency regulations, the DRH conducts or participates in periodic drills that are designed to provide needed team training and to test our emergency plan and procedures. The scope of these drills ranges from receiving and acknowledging simulated emergency communications to full-scale team deployment. In the latter case, the DRH personnel are presented with problems similar to those that might be encountered during an actual emergency.

Federal regulations for commercial nuclear power generating facilities stipulate that a full-scale exercise involving appropriate local government participation and testing all significant response elements must be conducted and evaluated every other year. Because there are two such facilities, Surry and North Anna Nuclear Power Stations, Commonwealth of Virginia agencies will perform exercise activities on a yearly basis, alternating between the sites each year. The VDH, DRH, and DEM have elected to participate in each exercise as fully as resources and local response organizations participation permit.