COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

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

2006

ENVIRONMENTAL RADIATION PROGRAM

ANNUAL

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:

- BWX Technologies Inc
  (Formerly Babcock and Wilcox 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 2006

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 14
Milk 15
Radiogas 16
Shellfish 17
Silt 18
Surface Water 21
Vegetation 24

BWX TECHNOLOGIES, INC. (Formerly Babcock & Wilcox)

Air Particulate 26
Soil 27
Surface Water 28
Vegetation 29

APPENDIX I: INTERCOMPARISON RESULTS FOR 2006 30
APPENDIX II: LOWER LIMITS OF DETECTION □LLD□ 33
APPENDIX III: SAMPLING LOCATIONS 45
APPENDIX IV: EMERGENCY PREPAREDNESS 50

FOREWORD

The Radiological Health Program 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) BWX Technologies, Inc., 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, fell within normal expected levels.

This report represents a compilation of all samples collected between January 1, 2005 and December 31, 2005.

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

PREFACE

The Radiological Health Program 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
Radiological Health Program
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 Radiological Health Program 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 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.

A one kilogram silt sample is collected annually at B&W's equalization pond.

Silt is collected quarterly at Norfolk Naval Shipyard on the Elizabeth River to ensure that shipyard operations result in minimal radioactive effluents. Silt is also collected quarterly at Northrop Grumman Newport News, NGNN (Formerly Newport News Shipbuilding & Drydock Company) on the James River to ensure that NGNN operations result in minimal radioactive deposition.

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 the facility's eastern boundary and the other is a control location 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 or cabbage 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 eastern site boundary and one control location at the Department of Agriculture's Animal Health Laboratory, located 5 miles southwest of the plant site. 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 at BWX Technologies, Inc. on an annual basis. One is located downstream at the site boundary and the other is a control location six miles upstream at a bridge. Samples undergo uranium separation followed by alpha counting. Surface water is also collected quarterly at Northrop Grumman Newport News, NGNN (Formerly Newport News Shipbuilding & Drydock Company) on the James River and quarterly from Norfolk Naval Shipyard (NNSY) on the Elizabeth River 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 sixteen 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.

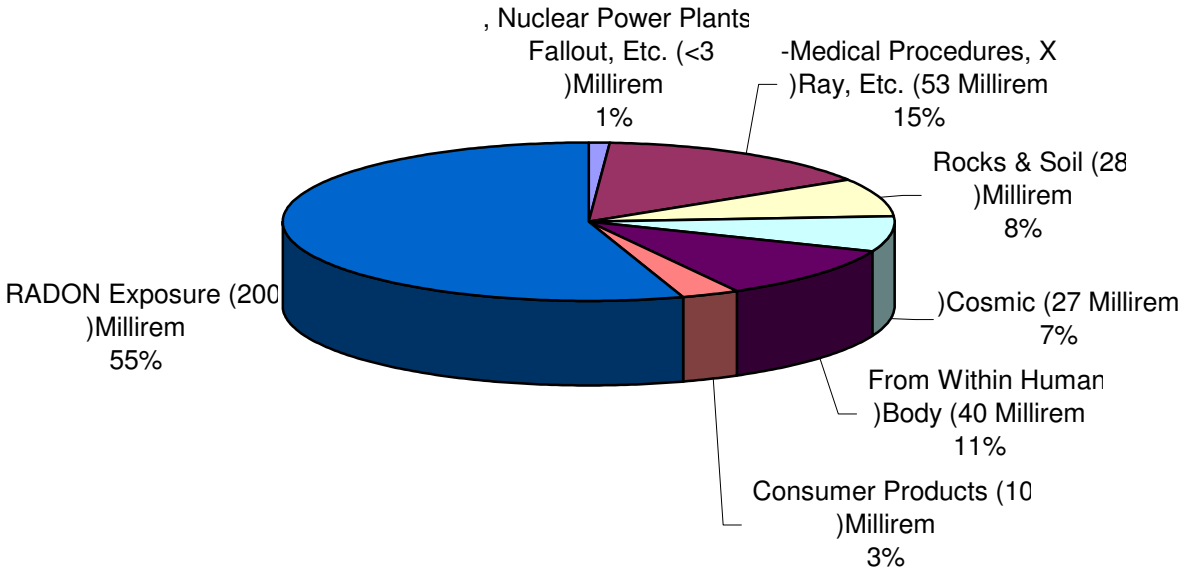
Doses to the Public

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 Radiological Health Program 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

RADIOLOGICAL HEALTH PROGRAM
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

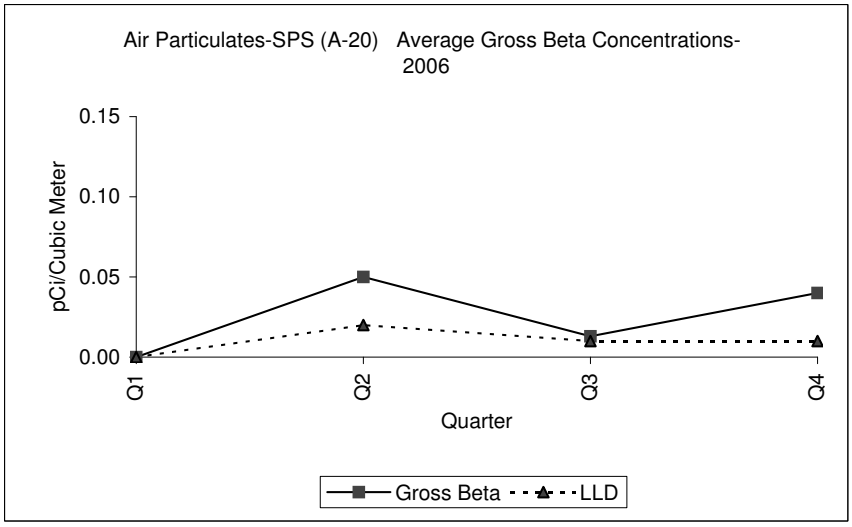
AIR PARTICULATE

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location	Station	Date Start	Date Stop	Gross Beta Activity pCi/meter3
Surry Power Station	A-20	1/5/06	1/12/06	*NA NA
Surry Power Station	A-20	4/6/06	4/13/06	0.05 +/- 0.02
Surry Power Station	A-20	7/6/06	7/13/06	0.01 +/- 0.01
Surry Power Station	A-20	10/5/06	10/12/06	0.03 0.01

ıta not available lab equipment down



Virginia Department of Health

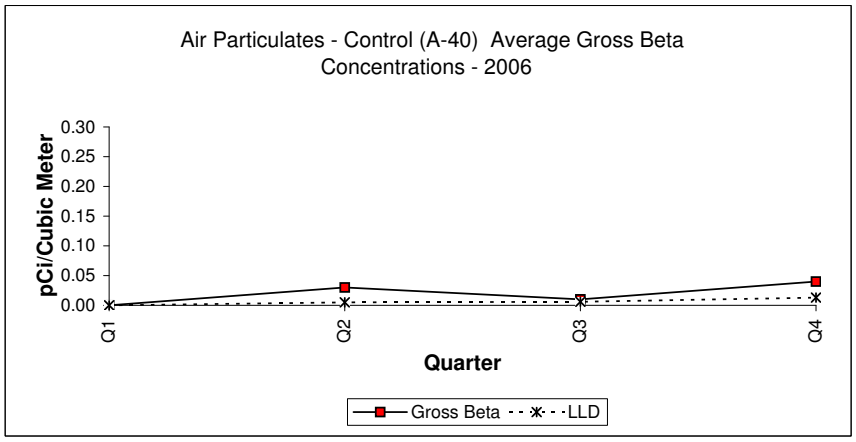
AIR PARTICULATE

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location	Station	Date Start	Date Stop	Gross Beta Activity pCi/meter3
Pocahontas State Park	A-40	1/4/06	1/11/06	*NA +/- NA
Pocahontas State Park	A-40	4/5/06	4/12/06	0.03 +/- 0.01
Pocahontas State Park	A-40	7/5/06	7/12/06	0.01 +/- 0.006
Pocahontas State Park	A-40	10/4/06	10/11/06	0.04 +/- 0.013

* = data not available lab equipment down



Virginia Department of Health

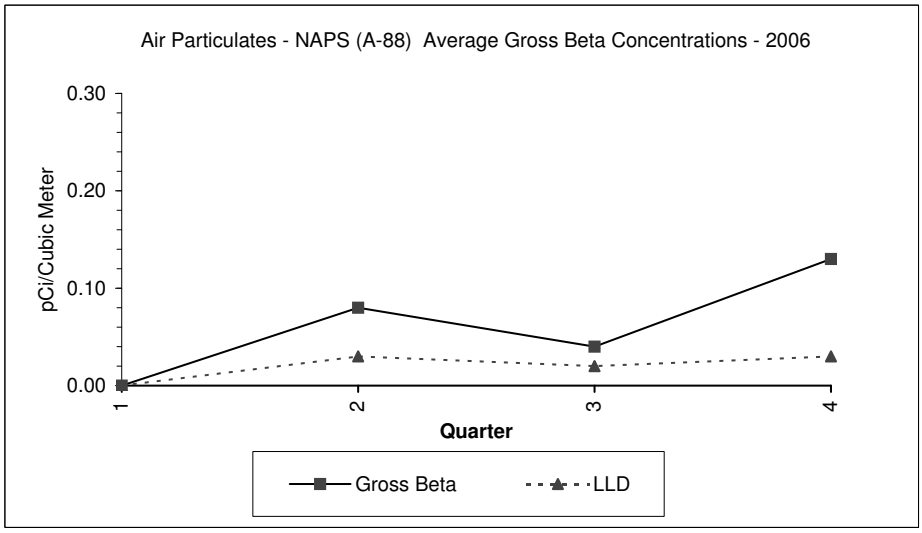
AIR PARTICULATE

January 01, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location	Station	Date Start		Date Stop	Gross Beta Activity pCi/meter3		
Louisa County Rt. 701	A-88	3/22/06	-	3/29/06	*NA	+/-	NA
Louisa County Rt. 701	A-88	4/5/06	-	4/12/06	0.08	+/-	0.03
Louisa County Rt. 701	A-88	7/5/06	-	7/12/06	0.04	+/-	0.02
Louisa County Rt. 701	A-88	10/4/06	-	10/11/06	0.13	+/-	0.03

data not available lab equipment down



Virginia Department of Health

AMBIENT GAMMA EXPOSURE (THERMOLUMINESCENT DOSIMETERS)

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location	Station	Quarter	Net Exposure Rate mR/Std. Qtr +/- 2 S.D.
Surry Power Station	D-20	1st	15.6 +/- 1.5
Surry Power Station	D-20	2nd	11.2 +/- 1.1
Surry Power Station	D-20	3rd	11.7 +/- 1.1
Surry Power Station	D-20	4th	14.0 +/- 1.4
North Anna Power Station	D-35	1st	17.5 +/- 1.7
North Anna Power Station	D-35	2nd	13.2 +/- 1.3
North Anna Power Station	D-35	3rd	14.1 +/- 1.4
North Anna Power Station	D-35	4th	19.1 +/- 1.9
Pocahontas State Park	D-40	1st	19.7 +/- 1.9
Pocahontas State Park	D-40	2nd	12.7 +/- 1.3
Pocahontas State Park	D-40	3rd	15.8 +/- 1.6
Pocahontas State Park	D-40	4th	18.1 +/- 1.8
Surry-Lebanon Baptist Church	D-41	1st	15.5 +/- 1.5
Surry-Lebanon Baptist Church	D-41	2nd	10.6 +/- 1.0
Surry-Lebanon Baptist Church	D-41	3rd	11.7 +/- 1.2
Surry-Lebanon Baptist Church	D-41	4th	15.7 +/- 1.5
Surry Lawnes Creek	D-42	1st	15.5 +/- 1.5
Surry Lawnes Creek	D-42	2nd	10.9 +/- 1.1
Surry Lawnes Creek	D-42	3rd	13.2 +/- 1.3
Surry Lawnes Creek	D-42	4th	14.7 +/- 1.4
			+/-
Surry Rt. 628	D-43	1st	16.6 +/- 1.6
Surry Rt. 628	D-43	2nd	8.7 +/- 0.9
Surry Rt. 628	D-43	3rd	10.2 +/- 1.0
Surry Rt. 628	D-43	4th	13.1 +/- 1.3
Jamestown	D-44	1st	14.4 +/- 1.4
Jamestown	D-44	2nd	10.5 +/- 1.0
Jamestown	D-44	3rd	11.2 +/- 1.1
Jamestown	D-44	4th	14.4 +/- 1.4
Newport News-Lee Hall	D-45	1st	15.2 +/- 1.5
Newport News-Lee Hall	D-45	2nd	12.3 +/- 1.2
Newport News-Lee Hall	D-45	3rd	11.6 +/- 1.1
Newport News-Lee Hall	D-45	4th	15.6 +/- 1.5
Louisa Co. Mineral	D-50	1st	NA +/- NA
Louisa Co. Mineral	D-50	2nd	10.8 +/- 1.1
Louisa Co. Mineral	D-50	3rd	13.7 +/- 1.3
Louisa Co. Mineral	D-50	4th	15.1 +/- 1.5

* = TLD not recovered

Virginia Department of Health

AMBIENT GAMMA EXPOSURE
(THERMOLUMINESCENT DOSIMETERS)

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location	Station	Quarter	Net Exposure Rate mR/Std. Qtr +/- 2 S.D.
Louisa Co.-Wares Cross	D-51	1st	13.8 +/- 1.4
Louisa Co.-Wares Cross	D-51	2nd	10.2 +/- 1.0
Louisa Co.-Wares Cross	D-51	3rd	10.1 +/- 1.0
Louisa Co.-Wares Cross	D-51	4th	14.3 +/- 1.4
Spotsylvania-GH Church	D-52	1st	20.2 +/- 2.0
Spotsylvania-GH Church	D-52	2nd	11.1 +/- 1.1
Spotsylvania-GH Church	D-52	3rd	13.9 +/- 1.4
Spotsylvania-GH Church	D-52	4th	16.1 +/- 1.6
Spotsylvania Rt. 614	D-53	1st	13.9 +/- 1.4
Spotsylvania Rt. 614	D-53	2nd	9.4 +/- 0.9
Spotsylvania Rt. 614	D-53	3rd	10.6 +/- 1.0
Spotsylvania Rt. 614	D-53	4th	13.6 +/- 1.3
Louisa Co. Fred Hall	D-54	1st	NA +/- NA
Louisa Co. Fred Hall	D-54	2nd	7.9 +/- 0.8
Louisa Co. Fred Hall	D-54	3rd	10.5 +/- 1.0
Louisa Co. Fred Hall	D-54	4th	13.4 +/- 1.3
Naval Weapons Station I	D-73	1st	13.8 +/- 1.4
Naval Weapons Station I	D-73	2nd	10.1 +/- 1.0
Naval Weapons Station I	D-73	3rd	10.2 +/- 1.0
Naval Weapons Station I	D-73	4th	14.2 +/- 1.4
Newport News-Fort Eustis	D-76	1st	12.8 +/- 1.3
Newport News-Fort Eustis	D-76	2nd	10.2 +/- 1.0
Newport News-Fort Eustis	D-76	3rd	10.3 +/- 1.0
Newport News-Fort Eustis	D-76	4th	15.2 +/- 1.5
Williamsburg Busch Gardens	D-77	1st	13.3 +/- 1.3
Williamsburg Busch Gardens	D-77	2nd	10.7 +/- 1.0
Williamsburg Busch Gardens	D-77	3rd	15.4 +/- 1.5
Williamsburg Busch Gardens	D-77	4th	15.7 +/- 1.5
Williamsburg Airport	D-78	1st	12.2 +/- 1.2
Williamsburg Airport	D-78	2nd	NA +/- NA
Williamsburg Airport	D-78	3rd	10.7 +/- 1.0
Williamsburg Airport	D-78	4th	13.4 +/- 1.3

Virginia Department of Health

AMBIENT GAMMA EXPOSURE (THERMOLUMINESCENT DOSIMETERS)

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location	Station	Quarter	Net Exposure Rate mR/Std. Qtr +/- 2 S.D.
Surry Scotland Wharf	D-79	1st	13.3 +/- 1.3
Surry Scotland Wharf	D-79	2nd	10.2 +/- 1.0
Surry Scotland Wharf	D-79	3rd	14.8 +/- 1.4
Surry Scotland Wharf	D-79	4th	13.6 +/- 1.3
Surry Bacon's Castle	D-80	1st	14.9 +/- 1.5
Surry Bacon's Castle	D-80	2nd	10.4 +/- 1.0
Surry Bacon's Castle	D-80	3rd	11.8 +/- 1.2
Surry Bacon's Castle	D-80	4th	14.2 +/- 1.4
Surry - Alliance	D-81	1st	12.9 +/- 1.3
Surry - Alliance	D-81	2nd	9.4 +/- 0.9
Surry - Alliance	D-81	3rd	10.1 +/- 1.0
Surry - Alliance	D-81	4th	13.9 +/- 1.4
Surry Hog Point	D-82	1st	13.1 +/- 1.3
Surry Hog Point	D-82	2nd	8.9 +/- 0.9
Surry Hog Point	D-82	3rd	10.8 +/- 1.1
Surry Hog Point	D-82	4th	13.7 +/- 1.3
Louisa Co. Rt. 685	D-84	1st	NA +/- NA
Louisa Co. Rt. 685	D-84	2nd	9.8 +/- 1.0
Louisa Co. Rt. 685	D-84	3rd	12.3 +/- 1.2
Louisa Co. Rt. 685	D-84	4th	17.6 +/- 1.7
Spotsylvania Rt. 713	D-85	1st	11.6 +/- 1.1
Spotsylvania Rt. 713	D-85	2nd	7.9 +/- 0.8
Spotsylvania Rt. 713	D-85	3rd	8.5 +/- 0.8
Spotsylvania Rt. 713	D-85	4th	13.0 +/- 1.3
Louisa Co. Bumpass	D-86	1st	16.5 +/- 1.6
Louisa Co. Bumpass	D-86	2nd	10.2 +/- 1.0
Louisa Co. Bumpass	D-86	3rd	11.2 +/- 1.1
Louisa Co. Bumpass	D-86	4th	14.7 +/- 1.4
Spotsylvania-Levy	D-87	1st	NA +/- NA
Spotsylvania-Levy	D-87	2nd	12.8 +/- 1.3
Spotsylvania-Levy	D-87	3rd	14.7 +/- 1.4
Spotsylvania-Levy	D-87	4th	19.5 +/- 1.9

Virginia Department of Health

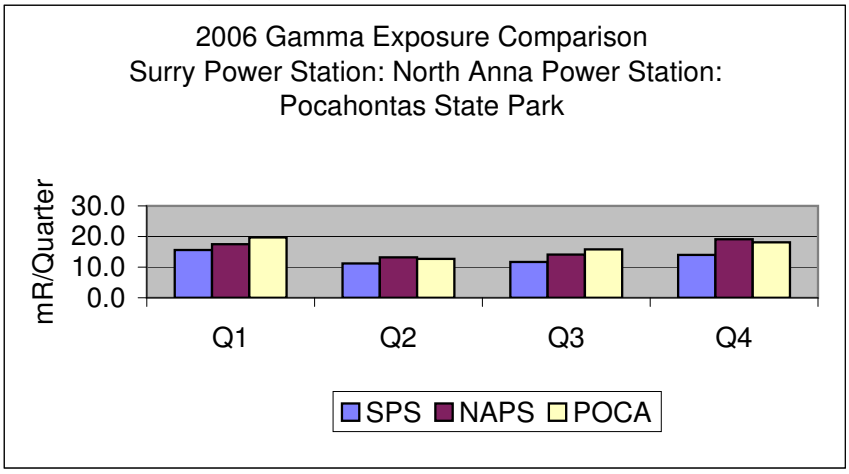
AMBIENT GAMMA EXPOSURE (THERMOLUMINESCENT DOSIMETERS)

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location	Station	Quarter	Net Exposure Rate mR/Std. Qtr +/- 2 S.D.
Louisa Co. Rt. 700	D-88	1st	15.3 +/- 1.5
Louisa Co. Rt. 700	D-88	2nd	13.3 +/- 1.3
Louisa Co. Rt. 700	D-88	3rd	12.7 +/- 1.2
Louisa Co. Rt. 700	D-88	4th	17.7 +/- 1.7
Louisa Co. Aspen Hill	D-89	1st	17.1 +/- 1.7
Louisa Co. Aspen Hill	D-89	2nd	12.6 +/- 1.2
Louisa Co. Aspen Hill	D-89	3rd	13.1 +/- 1.3
Louisa Co. Aspen Hill	D-89	4th	18.3 +/- 1.8
Rad Health	Control 1	1st	7.3 +/- 0.7
Rad Health	Control 1	2nd	4.1 +/- 0.4
Rad Health	Control 1	3rd	5.0 +/- 0.5
Rad Health	Control 1	4th	8.6 +/- 0.8
Rad Health	Control 2	1st	5.9 +/- 0.6
Rad Health	Control 2	2nd	4.1 +/- 0.4
Rad Health	Control 2	3rd	5.6 +/- 0.6
Rad Health	Control 2	4th	5.4 +/- 0.5

t = inconsistent TLD reading



Virginia Department of Health

FISH

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location Name	Date	Isotope	pCi/gram
North Anna Lake Second Cooling Lagoon F-24 (Catfish)	3/20/2006	Ba	<0.04
		Cs-134	<0.01
		Cs-137	0.01 +/- 0.01
		Co-58	<0.01
		Co-60	<0.01
		I-131	<0.13
		Fe-59	<0.03
		Mn-54	<0.01
		Ru-106	<0.10
		Zn-65	<0.03
		Nb-95	<0.02
North Anna Lake Second Cooling Lagoon F-24 (Catfish)	10/17/2006	Ba	<0.03
		Cs-134	<0.01
		Cs-137	0.02 +/- 0.01
		Co-58	<0.01
		Co-60	<0.01
		I-131	<0.06
		Fe-59	<0.03
		Mn-54	<0.01
		Ru-106	<0.10
		Zn-65	<0.02

Virginia Department of Health

MILK

ANNUAL REPORT 2006 January 1, 2003 through December 31, 2003

Location Name	Date	Isotope	Results pCi/Liter	Location Name	Date	Isotope	Results pCi/Liter
Louisa County	NA	Ba		Surry County	3/28/06	Ba	<7.0
Terrell Dairy		Cs-134		Epps Dairy		Cs-134	<5.0
M-29		Cs-137		M-66		Cs-137	<5.0
		K-40				K-40	1.4+/-0.1
		I-131				I-131	0.2+/-0.3
		St-89				St-89	<4.0
		St-90				St-90	0.2+/-0.6
Louisa County	6/21/06	Ba	<5.0	Surry County	7/19/06	Ba	<5.0
Terrell Dairy		Cs-134	<5.0	Epps Dairy		Cs-134	<5.0
M-29		Cs-137	<5.0	M-66		Cs-137	<5.0
		K-40	1.5+/-0.1			K-40	1.4+/-0.1
		I-131	0.0+/-0.2			I-131	0.0+/-0.7
		St-89	<4.0			St-89	<4.0
		St-90	0.7+/-0.4			St-90	1.3+/-0.5
Louisa County	NA	Ba		Surry County	NA	Ba	
Terrell Dairy		Cs-134		Epps Dairy		Cs-134	
M-29		Cs-137		M-66		Cs-137	
		K-40				K-40	
		I-131				I-131	
		St-89				St-89	
		St-90				St-90	
Louisa County	NA	Ba		Surry County	11/8/06	Ba	<6.0
Terrell Dairy		Cs-134		Epps Dairy		Cs-134	<5.0
M-29		Cs-137		M-66		Cs-137	<6.0
		K-40				K-40	1.5+/-0.1
		I-131				I-131	0.0+/-0.3
		St-89				St-89	0.8+/-0.6
		St-90				St-90	<4.0

NA = scheduled sampling not conducted

Virginia Department of Health

RADIOGAS

January 1, 2006 through December 31,2006

ANNUAL REPORT 2006

Location	Station	Date Start		Date Stop	I-131 Activity pCi/meter^3
Surry Power Station	C-20	01/05/06	-	01/12/06	<0.05
Surry Power Station	C-20	04/06/06	-	04/13/06	<0.04
Surry Power Station	C-20	07/13/06	-	07/13/06	<0.04
Surry Power Station	C-20	10/05/06	-	10/12/06	<0.04
Pocahontas State Park	C-40	01/04/06	-	01/11/06	<0.03
Pocahontas State Park	C-40	04/05/06	-	04/12/06	<0.03
Pocahontas State Park	C-40	07/05/06	-	07/12/06	<0.02
Pocahontas State Park	C-40	10/04/06	-	10/11/06	<0.02
Louisa County Rt. 700	C-88	03/22/06	-	03/29/06	<0.04
Louisa County Rt. 700	C-88	04/05/06	-	04/12/06	<0.04
Louisa County Rt. 700	C-88	07/05/06	-	07/12/06	<0.04
Louisa County Rt. 700	C-88	10/04/06	-	10/11/06	<0.05

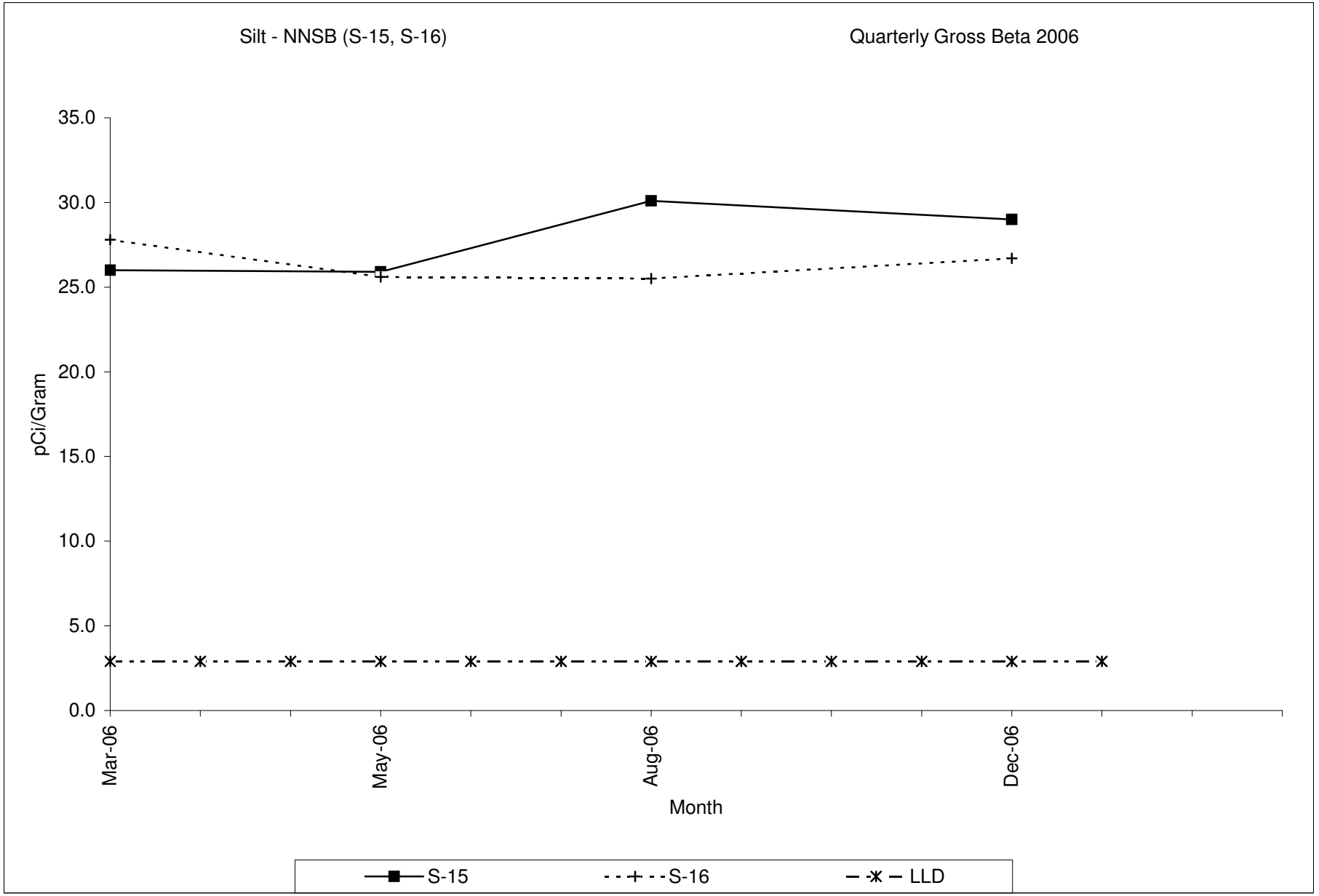
Virginia Department of Health

SHELLFISH

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location	Date Collected	Distance & Direction	Activity : pCi/gram (wet wt.)	
R-17	9/1/2005	NA	Ba-140	<0.12
James River			Cs-134	<0.01
Mouth of Discharge			Cs-137	<0.01
Canal			Co-58	<0.01
			Co-60	<0.01
			Fe-59	<0.03
			I-131	<0.76
			Mn-54	<0.01
			Rh-106	<0.06
			Ag-110M	<0.01
			Zn-65	<0.02
			Zr-95	<0.02


Silt - NNSB (S-15, S-16)
Quarterly Gross Beta 2006
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
pCi/Gram
Mar-06
May-06
Aug-06
Dec-06
Month
S-15
S-16
LLD

Virginia Department of Health

SILT

January 01, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location	Date Collected	Gamma Activity pCi/Gram (Wet) Cs-134	Cs-137	Co-58	Co-60	Gross Beta pCi/Gram (dry
Drydock #8	03/23/06	<0.01	0.03 +/- 0.01	<0.01	<0.01	28.7 +/- 4.6
Norfolk Naval	05/16/06	<0.01	0.03 +/- 0.01	<0.01	<0.01	29.2 +/- 4.8
Shipyard	08/17/06	<0.01	0.03 +/- 0.01	<0.01	<0.01	31.7 +/- 5.0
S-18	11/21/06	<0.01	0.03 +/- 0.01	<0.01	<0.01	30.4 +/- 4.7
Drydock #4	03/23/06	<0.01	0.04 +/- 0.01	<0.01	<0.01	34.2 +/- 4.8
Norfolk Naval	05/16/06	<0.01	0.04 +/- 0.01	<0.01	<0.01	30.4 +/- 4.8
Shipyard	08/17/06	<0.01	0.04 +/- 0.01	<0.01	<0.01	30.4 +/- 4.8
S-19	11/21/06	<0.01	0.03 +/- 0.01	<0.01	<0.01	27.8 +/- 4.6
Wetslip #1	03/23/06	<0.01	0.03 +/- 0.01	<0.01	<0.01	31.2 +/- 4.7
Norfolk Naval	05/16/06	<0.01	0.04 +/- 0.01	<0.01	<0.01	29.8 +/- 4.8
Shipyard	08/17/06	<0.01	0.04 +/- 0.01	<0.01	<0.01	26.2 +/- 4.5
S-20	11/21/06	<0.01	0.04 +/- 0.01	<0.01	<0.01	27.6 +/- 4.7

Virginia Department of Health

SILT

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location	Date Collected	Distance & Direction	Activity pCi/Gram (dry wt.) Cs-134	Cs-137	Co-60
James River Discharge Canal S-17	09/01/05	0.5 Miles NNW	<0.02	0.25 +/- 0.01	<0.04 +/- 0.01
North Anna Lake Shoreline Soil S-24	03/20/06	1.1 Miles SSE	<0.01	0.04 +/- 0.01	<0.01
North Anna Lake Shoreline Soil S-24	10/16/06	1.1 Miles SSE	<0.01	0.15 +/- 0.01	<0.01

Virginia Department of Health

SURFACE WATER

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

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	03/23/06	<10	<5	<16	<5	<11	<9	0.3 +/- 0.4	0.3 +/- 0.4
Pier 1	W - 15A	05/16/06	<5	<5	<6	<5	<10	<8	0.4 +/- 0.4	0.5 +/- 0.4
NGNN (1)	W - 15A	08/25/05	<11	<5	<19	<5	<10	<10	0.0 +/- 0.4	2.0 +/- 0.4
	W - 15A	12/12/06	<6	<5	<6	<5	<11	<9	0.0 +/- 0.4	1.1 +/- 0.4
									SS (pCi/L)	**BS (pCi/L)**
James River -	W - 16	03/23/06	<13	<5	<26	<5	<11	<10	0.3 +/- 0.4	0.0 +/- 0.4
Shipway II	W - 16	05/16/06	<8	<8	<9	<7	<16	<14	0.5 +/- 0.5	0.3 +/- 0.4
NGNN (1)	W - 16	08/25/05	<16	<5	<32	<5	<11	<10	0.5 +/- 0.5	0.4 +/- 0.4
	W - 16	12/12/06	<6	<5	<7	<5	<11	<9	0.1 +/- 0.4	0.5 +/- 0.4

SS = SUSPENDED SOLIDS
BS = BASIC SULFIDES
NA = NO ANALYSIS
NGNN = Northrup Grumman Newport News

Virginia Department of Health

SURFACE WATER

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

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	03/23/06	<11	<5	<18	<4	<10	<10	0.3 +/- 0.4	0.4+/- 0.4
Dry Dock 4	W - 37	05/16/06	<6	<5	NA	<5	<10	<9	0.3 +/- 0.4	0.6+/- 0.4
NNSY	W - 37	??	<21	<5	<56	<5	<11	<11	0.0 +/- 0.4	0.3 +/- 0.5
	W - 37	11/21/06	<8	<5	<11	<5	<11	<9	0.0 +/- 0.4	0.8 +/- 0.4
									SS (pCi/L)	**BS (pCi/L)**
Elizabeth River	W - 38	03/23/06	<7	<5	<10	<4	<10	<9	0.0 +/- 0.4	0.1 +/- 0.4
Wetslip I	W - 38	05/16/06	<6	<5	<6	<5	<10	<8	0.0 +/- 0.4	0.8 +/- 0.4
NNSY	W - 38	??	<23	<5	<64	<5	<11	<11	0.4 +/- 0.4	0.3 +/- 0.4
	W - 38	11/21/06	<7	<5	<10	<5	<12	<10	0.0 +/- 0.4	0.5 +/- 0.4
									SS (pCi/L)	**BS (pCi/L)**
Elizabeth River	W - 39	03/23/06	<7	<5	<10	<5	<10	<9	0.1 +/- 0.4	0.1 +/- 0.4
Wetslip I	W - 39	05/16/06	<7	<5	<10	<5	<10	<9	0.0 +/- 0.4	0.4 +/- 0.4
NNSY	W - 39	??	<20	<5	<50	<5	<11	<11	0.2 +/- 0.4	0.5+/- 0.5
	W - 39	11/21/06	<5	<4	<6	<5	<11	<9	0.3 +/- 0.4	0.1+/- 0.4

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

Virginia Department of Health

SURFACE WATER

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location	Station	Date Collected	Gamma Activity pCi/L Ba140	Cs134	Cs137	Co58	Co60	I131	Mn54	Zn65	ZrNb95	H3	Gross Beta	B.S.	S
Surry	W-19	Jan-06	<7	<5	<5	<5	<4	<10	<4	<10	<9	NDC		0.2+/-0.3	0.8+
Discharge	W-19	Apr-06	<7	<7	<5	<7	<7	<9	<7	<16	<13	450		0.5+/-0.4	1.0+
Canal	W-19	Jul-06	<9	<5	<5	<5	<4	<16	<5	<10	<10	NDC		0.2+/-0.3	0.8+
	W-19	Oct-06	<7	<5	<6	<5	<5	<9	<5	<12	<10	NDC		0.2+/-0.3	0.8+
North Anna	W-27	Jan-06	<12	<5	<5	<5	<4	<21	<5	<11	<9	NDC	3+/-1		
River	W-27	Apr-06	<11	<7	<8	<7	<7	<14	<7	<16	<14	NDC	3+/-1		
	W-27	Jul-06	<5	<5	<5	<5	<4	<6	<5	<10	<9	1130	3+/-1		
	W-27	Oct-06	<8	<5	<6	<6	<5	<12	<3	<11	<10	2330	3+/-1		
Lake Anna	W-33	Jan-06	<11	<4	<3	<5	<4	<19	<5	<10	<9	4650	5+/-3		
Discharge	W-33	Apr-06	<8	<5	<5	<5	<5	<11	<5	<10	<9	4730	7+/-4		
	W-33	Jul-06	<5	<4	<5	<5	<5	<6	<5	<10	<8	3450	4+/-3		
	W-33	Oct-06	<8	<5	<6	<5	<5	<12	<5	<12	<10	2700	6+/-3		
James River	W-79	Jan-06	<9	<4	<5	<5	<4	<15	<5	<10	<9	NDC		0.4+/-0.4	1.0
Scotland	W-79	Apr-06	<7	<5	<5	<5	<5	<9	<5	<10	<9	300		0.3+/-0.4	0.0
Wharf	W-79	Jul-06	<6	<4	<5	<5	<4	<8	<5	<10	<9	NDC		11.4+/-0.8	13.5
	W-79	Oct-06	<9	<5	<4	<5	<5	<16	<5	<11	<10	NDC		1.1+/-0.4	1.0

NDC = No Detectable counts

Virginia Department of Health

VEGETATION

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location Name	Date	Type	Isotope	State Results pCi/Gram (wet wt.)
Surry County Edmond's Garden V-96C	NA	Collard Greens	I-131 Cs-134 Cs-137	
Louisa County Hartley Garden V-98B	10/12/2006	Collard Greens	I-131 Cs-134 Cs-137	<0.04 <0.01 <0.01

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

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

BABCOCK & WILCOX NAVAL NUCLEAR FUEL DIVISION

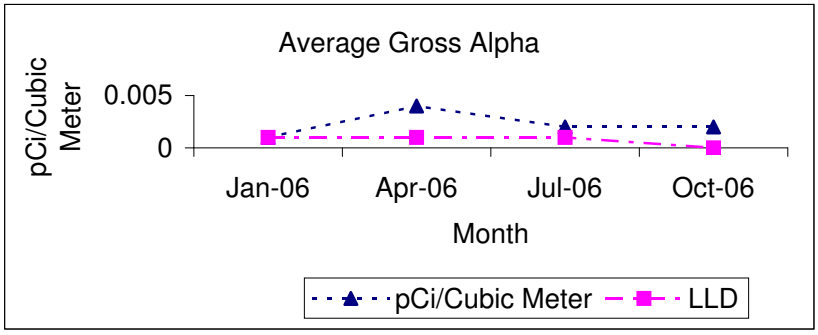
Virginia Department of Health
Babcock & Wilcox Naval Nuclear Fuel Division

AIR PARTICULATE COMPOSITE SAMPLES

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location Name	Date Start		Stop	Gross Alpha pCi/meter3
Eastern Site Boundary Ballfield A-101	01/04/06	-	01/11/06	<0.001 +/- ??
Eastern Site Boundary Ballfield A-101	04/05/06	-	04/12/06	<0.004 +/- ??
Eastern Site Boundary Ballfield A-101	07/05/06	-	07/12/06	<0.002 +/- ??
Eastern Site Boundary Ballfield A-101	10/04/06	-	10/11/06	<0.002 +/- ??



Virginia Department of Health
Babcock & Wilcox Naval Nuclear Fuel Division

SOIL

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location Name	Distance & Direction	Type	Date	Alpha * pCi/Gram		
Eastern Site Boundary-Ballfield S-101	Site Boundary	Soil	6/21/2006	1.2	+/-	0.4
Agricultural Bldg. Off Rt. 460 S-102	5 Miles SW	Soil	6/21/2006	1.4	+/-	0.4

Alpha * - Uranium Separation Followed by Alpha Counting

Virginia Department of Health
Babcock & Wilcox Naval Nuclear Fuel Division

SURFACE WATER

January 1, 2006 to December 31, 2006

ANNUAL REPORT 2006

Location Name	Distance & Direction	Date	pCi/Liter Alpha *
Downstream-Site Boundary 9 Mile Bridge W-101	Downstream of Site Boundary	6/21/2006	0.4 +/- 0.3
Upstream- 6 Mile Bridge W-102	Upstream 6 Miles	6/21/2006	0.3 +/- 0.2

Alpha * - Uranium Separation
Followed by Alpha Counting

Virginia Department of Health
Babcock & Wilcox Naval Nuclear Fuel Division

VEGETATION

January 1, 2006 through December 31, 2006

ANNUAL REPORT 2006

Location Name	Distance & Direction	Type	Date	Alpha * pCi/Gram
Eastern Site Boundary-Ballfield V-101	Site Boundary	Vegetation	6/21/2006	0.3 +/- 0.2
Ag Bldg Off RT 460 V-102	5 Miles SW	Vegetation	6/21/2006	0.2 +/- 0.2

Alpha * - Uranium Separation
Followed by Alpha Counting

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

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

APPENDIX 1

INTERCOMPARISON STUDIES

APPENDIX I

PURPOSE OF
INTERCOMPARISON STUDIES PROGRAM

The major objective of this program is to assist the laboratory in providing analytical data that accurately describes the composition of samples submitted for analysis. This activity enables the laboratory to document the precision and accuracy of its radiation data and to identify instrumental and procedural problems.

Virginia Department of Health

Division of Consolidated Laboratory Services
Radiation Laboratory Proficiency Testing

January 1, 2005 through December 31, 2005

Study	Nuclide	Month	Known Value	Control Limits	Lab Average	Unit
gross a/B	alpha	April	67.9	38.5 - 97.3	54.2	pCi / l
	Beta		51.1	33.8 - 68.4	47.2	pCi / l
gross a/B	alpha	November	54.2	30.7 - 77.7	60.8	pCi / l
	Beta		168.0	124 - 212	149	
Gamma	Cobalt-60	April	56.6	47.9 - 65.3	58.4	pCi / l
	Zinc-65		60.3	49.9 - 70.7	63.4	
	Cesium-134		64.9	56.2 - 73.6	57.3	
	Cesium-137		40.2	31.5 - 48.9	43.6	
Gamma	Cobalt-60	November	27.7	19.0 - 36.4	27.8	pCi / l
	Cesium-134		23.4	14.7 - 32.1	21.3	
	Cesium-137		64.2	55.5 - 72.9	66.1	
	Barium-133		36.0	27.3 - 44.7	34.2	
Strontium	Sr-89	April	29.4	20.7 - 38.1	29.1	pCi / l
	Sr-90		24.4	15.7 - 33.1	23.2	
Strontium	Sr-89	November	31.2	22.5 - 39.9	36.2	pCi / l
	Sr-90		25.9	17.2 - 34.6	23	
Iodine	I-131	July	15.5	10.3 - 20.7	17.1	pCi / l
Uranium	U	April	4.98	0.00 - 10.2	6.03	pCi / l
		November	9.3	4.10 - 14.5	8.8	
Barium	Ba-133	April	53.4	44.2 - 62.6	48.9	pCi / l
Radium	Ra-226	April	14.1	10.4 - 17.8	14.1	pCi / l
	Ra-228	April	13.7	7.77 -19.6	11.2	
Radium	Ra-226	November	16.1	11.9 - 20.3	16.0	pCi / l
	Ra-228	November	5.49	3.11 - 7.87	3.93	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

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

APPENDIX II

LOWER LIMITS OF DETECTION "LLD"

APPENDIX II

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:

APPENDIX II

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.)

APPENDIX II

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:

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

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: $\text{LD} = k^2 = 2*\text{LC}$

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.)

APPENDIX II

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

APPENDIX II

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

APPENDIX II

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

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

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

APPENDIX II

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 pi/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

APPENDIX II

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

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

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

APPENDIX II

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

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

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

APPENDIX II

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

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

APPENDIX III

SURVEILLANCE PROGRAM

APPENDIX III

SURRY AREA SURVEILLANCE PROGRAM

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-96C Surry County - Edmonds Garden	Edible Vegetation	Annually
* V-97 James City - Carter's Grove Plantation	Edible Vegetation	Annually

***Virginia and Virginia Power Duplicate Samples**

APPENDIX III

NORTH ANNA AREA SURVEILLANCE PROGRAM

LOCATION	NAPS Station Designations	TYPE	FREQUENCY
Milk			
* M-29 Louisa County - E. A. Terrell Dairy	13	Raw	Quarterly
Air			
* A-88 Route 700	22	Air Particulate	Quarterly
Charcoal Filter			
* C-88 Route 700	22	Release Gas	Quarterly
Dosimeters			
* D-35 NAPS - Weathertower		Air	Quarterly
* D-50 Louisa County - Mineral		Air	Quarterly
* D-51 Louisa County - Wares Crossroads		Air	Quarterly
* D-52 Spotsylvania - Good Hope Church		Air	Quarterly
D-53 Spotsylvania - Route 614		Air	Quarterly
D-54 Louisa County - Frederick's Hall		Air	Quarterly
D-84 Louisa County - Route 685		Air	Quarterly
D-85 Spotsylvania Co. - Route 714		Air	Quarterly
* D-86 Louisa County - Bumpass P.O.		Air	Quarterly
* D-87 Spotsylvania Co. - Levy (Rt. 622)		Air	Quarterly
* D-88 Louisa Co. - Rt. 700 (near station)		Air	Quarterly
* D-89 Louisa County - Aspen Hill		Air	Quarterly
Fish			
* F-24 North Anna Lake - Second Cooling Lagoon	08	Edible Fish	2/Year
Silt			
S-24 North Anna Lake - Second Cooling Lagoon	08	Silt	2/Year
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 - Humphrey's Garden		Edible Vegetation	Annually
* V-98 Louisa County - Hartley Garden		Edible Vegetation	Annually

***Virginia and Virginia Power Duplicate Samples**

APPENDIX III

BABCOCK WILCOX SURVEILLANCE PROGRAM

Sampling Sites: Babcock & Wilcox

SAMPLE	LOCATION	TYPE	FREQUENCY
AIR			
A-101	Babcock & Wilcox Eastern Site Boundary	Air	Quarterly
SURFACE WATER			
W-101	Downstream - Site Boundary 9 Mile Bridge	Surface Water	Annually
W-102	Upstream - Site Boundary 6 Mile Bridge	Surface Water	Annually
SOIL			
S-101	Eastern Site Boundary Ballfield	Soil	Annually
S-102	Control - Route 460 Agricultural Bldg. 5 Miles S.W.	Soil	Annually
SEDIMENT			
S-105	Babcock & Wilcox Equilization Pond	Sediment	Annually
VEGETATION			
V-101	Easter Site Boundary Ballfield	Grass	Annually
V-102	Control - Route 460	Grass	Annually

APPENDIX III

OTHER SURVEILLANCE SITES WITHIN COMMONWEALTH OF VIRGINIA

	LOCATION	TYPE	FREQUENCY
	Air		
A-40	Pocahontas State Park	Air Particulate	Quarterly
	Silt		
S-15A	James River - Pier 1 (NNSBDDC)	Silt	Quarterly
S-16	James River - Shipway II (NNSBDDC)	Silt	Quarterly
S-18	Elizabeth River - Norfolk Naval Shipyard - Drydock #8	Silt	Quarterly
S-19	Elizabeth River - Norfolk Naval Shipyard - Drydock #4	Silt	Quarterly
S-20	Elizabeth River - Norfolk Naval Shipyard - Wetslip #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 - Pier 3 (NGNN)	Surface Water	Quarterly
W-16	James River - Shipway II (NGNN)	Surface Water	Quarterly
W-37	Elizabeth River - Norfolk Naval Shipyard - Drydock # 8	Surface Water	Quarterly
W-38	Elizabeth River - Norfolk Naval Shipyard - Drydock #4	Surface Water	Quarterly
W-39	Elizabeth River - Norfolk Naval Shipyard - Wetslip #1	Surface Water	Quarterly

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

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

APPENDIX IV

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 Department of Health (DOH) 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 DOH 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 DOH, DRH, and DEM have elected to participate in each exercise as fully as resources and local response organizations participation permit.