

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

RADIOLOGICAL HEALTH PROGRAM
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2001

ENVIRONMENTAL
RADIATION
PROGRAM

ANNUAL
REPORT

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
- Newport News Shipbuilding & Drydock Company
- U. S. Norfolk Naval Shipyard
- Dominion Virginia Power

VIRGINIA DEPARTMENT OF HEALTH
ENVIRONMENTAL RADIATION SURVEILLANCE DATA
ANNUAL REPORT 2001

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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) Newport News Shipbuilding and Drydock Company, Newport News, Virginia
- (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, 2001 and December 31, 2001.

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 its 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 has 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:

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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 plant operation.
- (2) To detect and measure 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 around 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 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 in 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 at each nuclear power station's discharge. Each sample consists of one kilogram of surface 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 Newport News Shipbuilding and Drydock (NNSD) Company on the James River to ensure that NNSD 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 is located at the eastern site 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 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 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 Newport News Shipbuilding and Drydock Company (NNSBD) 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 based on a mR/Quarter reading for certain locations using thermoluminescent dosimeters (TLD). Calcium fluoride and Lithium fluoride dosimeters are used. There are twelve TLD 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 stations.

The TLD's are read quarterly for net exposure during time in field.

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.

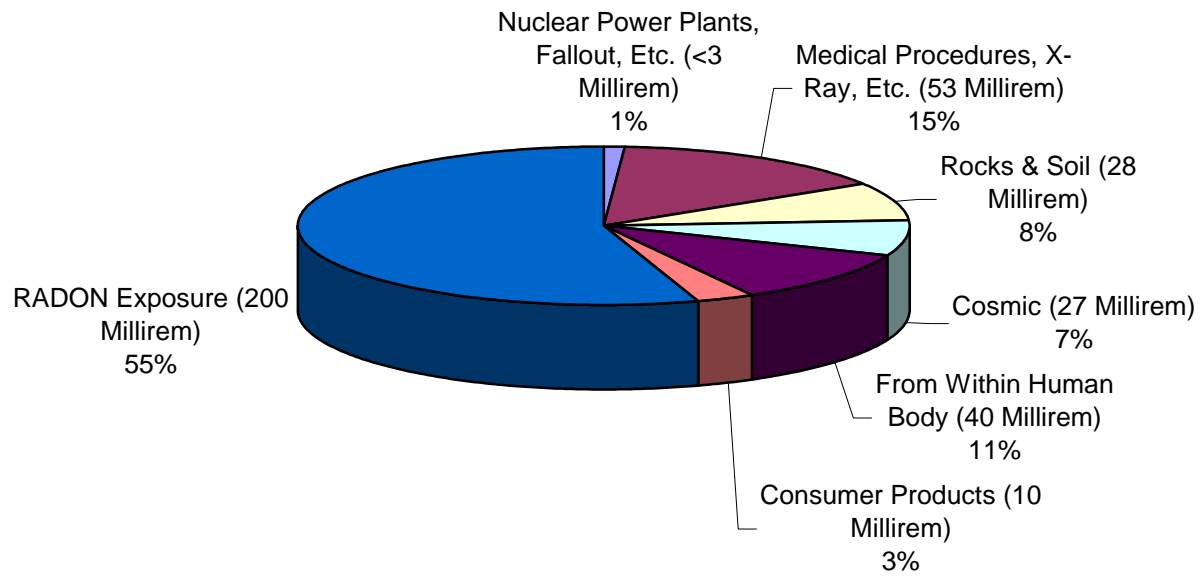
Doses to the Public

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



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North Anna and Surry
Nuclear Power Stations
&
Other Selected
Locations

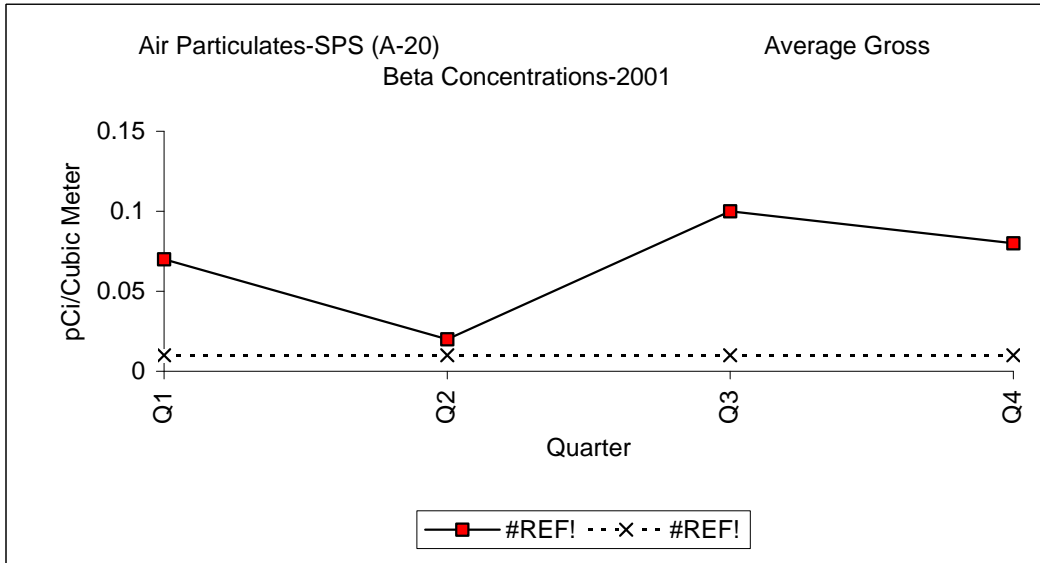
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AIR PARTICULATE

January 1, 2001 through December 31, 2001

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Location	Station	Date		Gross Beta Activity	
		Start	Stop	pCi/meter ³	+/-
Surry Power Station	A-20	03/27/01	04/05/01	0.650	0.004
Surry Power Station	A-20	06/29/01	07/06/01	0.170	0.002
Surry Power Station	A-20	09/27/01	09/27/01	0.10	0.01
Surry Power Station	A-20	12/27/01	01/08/01	0.077	0.003



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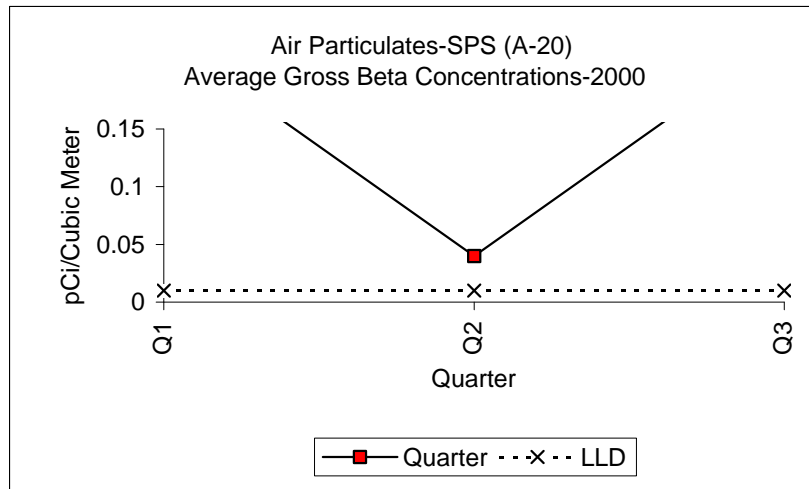
AIR PARTICULATE

January 1, 2000 through December 31, 2000

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Location	Station	Date		Gross Beta Activity		
		Start	Stop	pCi/meter ³		
Pocohontas State Park	A-40	03/27/01	04/05/01	0.23	+/-	0.007
Pocohontas State Park	A-40	06/29/01	07/06/01	0.04	+/-	0.004
Pocohontas State Park	A-40	09/27/01	09/27/01	0.23	+/-	0.01
Pocohontas State Park	A-40	12/27/01	01/08/01	0.10	+/-	0.005

(1) Missing Data



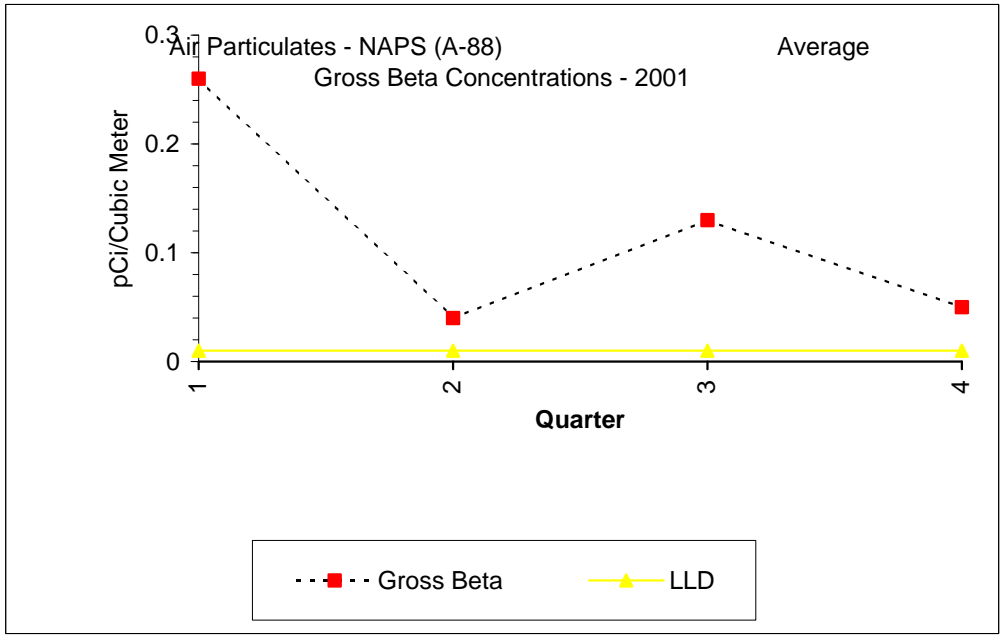
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AIR PARTICULATE

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Location	Station	Date		Gross Beta Activity pCi/meter ³
		Start	Stop	
Louisa County Rt. 701	A-88	03/28/01	04/04/01	0.26 +/- 0.01
Louisa County Rt. 701	A-88	06/28/01	07/05/01	0.040 +/- 0.004
Louisa County Rt. 701	A-88	09/26/01	10/03/01	0.13 +/- 0.01
Louisa County Rt. 701	A-88	12/26/01	01/02/01	0.05 +/- 0.01



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**AIR PARTICULATE
GAMMA COMPOSITE**

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Location		Quarter	Cs-134	pCi/m3	Cs-137
Surry Power Station	A-20	1st	<0.004		<0.003
Surry Power Station	A-20	2nd	<0.003		<0.003
Pocahontas State Park	A-40	1st	<0.004		<0.003
Pocahontas State Park	A-40	2nd	<0.003		<0.004
Louisa County Rt. 700	A-88	1st	<0.004		<0.004
Louisa County Rt. 700	A-88	2nd	<0.004		<0.004

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**AMBIENT GAMMA EXPOSURE
(THERMOLUMINESCENT DOSIMETERS)**

January 1, 2001 through December 31, 2001

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Location	Station	Quarter	Net Exposure Rate mR/Std. Qtr +/- 2 S.D.
Surry Power Station	D-20	1st	14.2 +/- 1.4
Surry Power Station	D-20	2nd	9.1 +/- 0.9
Surry Power Station	D-20	3rd	12.9 +/- 1.3
Surry Power Station	D-20	4th	(2)
North Anna Power Station	D-35	1st	17.5 +/- 1.7
North Anna Power Station	D-35	2nd	13.7 +/- 1.3
North Anna Power Station	D-35	3rd	21.5 +/- 2.1
North Anna Power Station	D-35	4th	14.2 +/- 1.4
Pocahontas State Park	D-40	1st	20.7 +/- 2.0
Pocahontas State Park	D-40	2nd	15.1 +/- 1.5
Pocahontas State Park	D-40	3rd	15.6 +/- 1.5
Pocahontas State Park	D-40	4th	21.0 +/- 2.1
Surry-Lebanon Baptist Church	D-41	1st	18.4 +/- 1.8
Surry-Lebanon Baptist Church	D-41	2nd	9.1 +/- 0.9
Surry-Lebanon Baptist Church	D-41	3rd	10.2 +/- 0.1
Surry-Lebanon Baptist Church	D-41	4th	10.9 +/- 1.1
Surry Lawnes Creek	D-42	1st	13.91 +/- 1.4
Surry Lawnes Creek	D-42	2nd	11.0 +/- 1.1
Surry Lawnes Creek	D-42	3rd	11.1 +/- 1.1
Surry Lawnes Creek	D-42	4th	15.4 +/- 1.5
Surry Rt. 628	D-43	1st	9.6 +/- 0.9
Surry Rt. 628	D-43	2nd	8.4 +/- 0.8
Surry Rt. 628	D-43	3rd	7.4 +/- 0.7
Surry Rt. 628	D-43	4th	11.1 +/- 1.5
Jamestown	D-44	1st	(1)
Jamestown	D-44	2nd	8.2 +/- 0.8
Jamestown	D-44	3rd	(2)
Jamestown	D-44	4th	10.0 +/- 1.0
Newport News-Lee Hall	D-45	1st	13.6 +/- 1.3
Newport News-Lee Hall	D-45	2nd	10.0 +/- 1.0
Newport News-Lee Hall	D-45	3rd	9.3 +/- 0.9
Newport News-Lee Hall	D-45	4th	11.3 +/- 1.1
Louisa Co. Mineral	D-50	1st	15.4 +/- 1.5
Louisa Co. Mineral	D-50	2nd	9.6 +/- 0.9
Louisa Co. Mineral	D-50	3rd	(2)
Louisa Co. Mineral	D-50	4th	11.0 +/- 1.1

(1) = TLD missing

(2) = Not Readable

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**AMBIENT GAMMA EXPOSURE
(THERMOLUMINESCENT DOSIMETERS)**

January 1, 2001 through December 31, 2001

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Location	Station	Quarter	Net Exposure Rate mR/Std. Qtr +/- 2 S.D.
Louisa Co.-Wares Cross	D-51	1st	10.2 +/- 1.0
Louisa Co.-Wares Cross	D-51	2nd	7.5 +/- 0.7
Louisa Co.-Wares Cross	D-51	3rd	9.2 +/- 0.9
Louisa Co.-Wares Cross	D-51	4th	8.6 +/- 0.8
Spotsylvania-GH Church	D-52	1st	12.5 +/- 1.2
Spotsylvania-GH Church	D-52	2nd	10.1 +/- 1.0
Spotsylvania-GH Church	D-52	3rd	10.3 +/- 1.0
Spotsylvania-GH Church	D-52	4th	14.4 +/- 1.4
Spotsylvania Rt. 614	D-53	1st	12.6 +/- 1.2
Spotsylvania Rt. 614	D-53	2nd	12.0 +/- 1.2
Spotsylvania Rt. 614	D-53	3rd	9.0 +/- 0.9
Spotsylvania Rt. 614	D-53	4th	14.7 +/- 1.4
Louisa Co. Fred Hall	D-54	1st	13.6 +/- 1.3
Louisa Co. Fred Hall	D-54	2nd	7.3 +/- 0.7
Louisa Co. Fred Hall	D-54	3rd	8.6 +/- 0.8
Louisa Co. Fred Hall	D-54	4th	8.2 +/- 0.8
Naval Weapons Station I	D-73	1st	14.2 +/- 1.4
Naval Weapons Station I	D-73	2nd	8.5 +/- 0.8
Naval Weapons Station I	D-73	3rd	15.6 +/- 1.5
Naval Weapons Station I	D-73	4th	12.9 +/- 1.3
Newport News-Fort Eustis	D-76	1st	10.5 +/- 1.0
Newport News-Fort Eustis	D-76	2nd	11.4 +/- 1.1
Newport News-Fort Eustis	D-76	3rd	10.4 +/- 1.0
Newport News-Fort Eustis	D-76	4th	19.0 +/- 1.9
Williamsburg Busch Gardens	D-77	1st	12.3 +/- 1.2
Williamsburg Busch Gardens	D-77	2nd	13.9 +/- 1.4
Williamsburg Busch Gardens	D-77	3rd	9.4 +/- 0.9
Williamsburg Busch Gardens	D-77	4th	14.6 +/- 1.4
Williamsburg Airport	D-78	1st	11.9 +/- 1.2
Williamsburg Airport	D-78	2nd	9.0 +/- 0.9
Williamsburg Airport	D-78	3rd	33.1 +/- 3.2
Williamsburg Airport	D-78	4th	12.7 +/- 1.2

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**AMBIENT GAMMA EXPOSURE
(THERMOLUMINESCENT DOSIMETERS)**

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Location	Station	Quarter	Net Exposure Rate mR/Std. Qtr +/- 2 S.D.
Surry Scotland Wharf	D-79	1st	7.9 +/- 0.8
Surry Scotland Wharf	D-79	2nd	7.6 +/- 0.7
Surry Scotland Wharf	D-79	3rd	6.3 +/- 0.6
Surry Scotland Wharf	D-79	4th	7.9 +/- 0.8
Surry Bacon's Castle	D-80	1st	14.8 +/- 1.4
Surry Bacon's Castle	D-80	2nd	8.4 +/- 0.8
Surry Bacon's Castle	D-80	3rd	12.0 +/- 1.2
Surry Bacon's Castle	D-80	4th	9.9 +/- 1.0
Surry - Alliance	D-81	1st	11.7 +/- 1.1
Surry - Alliance	D-81	2nd	8.9 +/- 0.9
Surry - Alliance	D-81	3rd	7.8 +/- 0.8
Surry - Alliance	D-81	4th	11.8 +/- 1.2
Surry Hog Point	D-82	1st	16.4 +/- 1.6
Surry Hog Point	D-82	2nd	7.7 +/- 0.8
Surry Hog Point	D-82	3rd	15.6 +/- 1.5
Surry Hog Point	D-82	4th	12.3 +/- 1.2
Louisa Co. Rt. 685	D-84	1st	13.9 +/- 1.4
Louisa Co. Rt. 685	D-84	2nd	13.3 +/- 1.3
Louisa Co. Rt. 685	D-84	3rd	10.43 +/- 1.02
Louisa Co. Rt. 685	D-84	4th	11.5 +/- 1.2
Spotsylvania Rt. 713	D-85	1st	8.1 +/- 0.8
Spotsylvania Rt. 713	D-85	2nd	7.9 +/- 0.8
Spotsylvania Rt. 713	D-85	3rd	6.1 +/- 0.6
Spotsylvania Rt. 713	D-85	4th	15.1 +/- 1.5
Louisa Co. Bumpass	D-86	1st	11.3 +/- 1.1
Louisa Co. Bumpass	D-86	2nd	9.8 +/- 1.0
Louisa Co. Bumpass	D-86	3rd	9.2 +/- 0.9
Louisa Co. Bumpass	D-86	4th	14.9 +/- 1.5
Spotsylvania-Levy	D-87	1st	17.3 +/- 1.7
Spotsylvania-Levy	D-87	2nd	(1)
Spotsylvania-Levy	D-87	3rd	11.1 +/- 1.1
Spotsylvania-Levy	D-87	4th	20.2 +/- 2.0

(1) = TLD missing

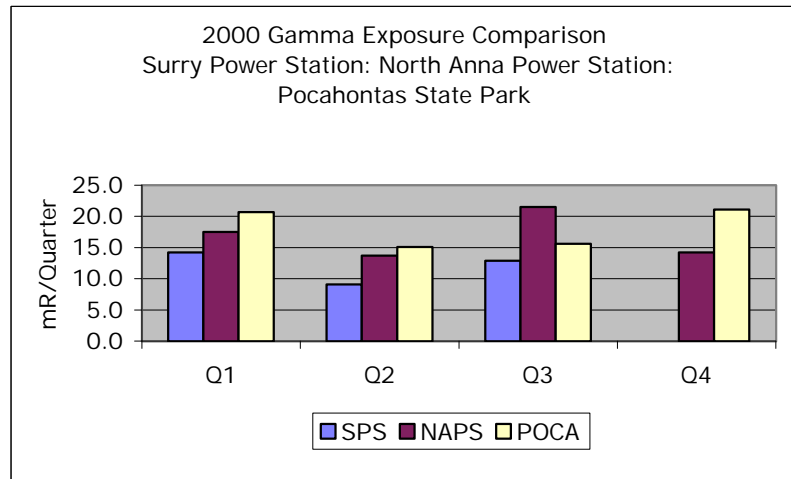
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**AMBIENT GAMMA EXPOSURE
(THERMOLUMINESCENT DOSIMETERS)**

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Location	Station	Quarter	Net Exposure Rate mR/Std. Qtr +/- 2 S.D.
Louisa Co. Rt. 700	D-88	1st	11.0 +/- 1.1
Louisa Co. Rt. 700	D-88	2nd	10.7 +/- 1.0
Louisa Co. Rt. 700	D-88	3rd	8.2 +/- 0.8
Louisa Co. Rt. 700	D-88	4th	12.8 +/- 1.3
Louisa Co. Aspen Hill	D-89	1st	14.3 +/- 1.4
Louisa Co. Aspen Hill	D-89	2nd	10.8 +/- 1.0
Louisa Co. Aspen Hill	D-89	3rd	11.2 +/- 1.1
Louisa Co. Aspen Hill	D-89	4th	12.8 +/- 1.3



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FISH

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Location Name	Date	Isotope	pCi/gram
North Anna Lake Second Cooling Lagoon F-24 (Catfish)	02/22/01	Cs-134	<0.01
		Cs-137	0.03 +/- 0.01
		Co-58	<0.01
		Co-60	<0.01
		I-131	<0.03
		Fe-59	<0.03
		Mn-54	<0.01
		Zn-65	<0.03
		Ru-106	<0.02
North Anna Lake Second Cooling Lagoon F-24 (Sunfish, Blue gill)	08/09/01	Cs-134	<0.01
		Cs-137	0.03 +/- 0.01
		Co-58	<0.01
		Co-60	<0.01
		I-131	<0.03
		Fe-59	<0.02
		Mn-54	<0.01
		Zn-65	<0.02
		Ru-106	<0.08

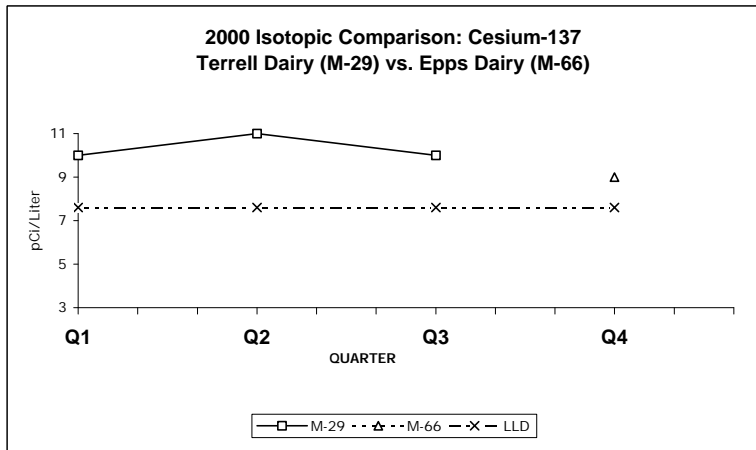
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MILK

ANNUAL REPORT 2001			January 1, 2000 through December 31, 2000				
Location Name	Date	Isotope	Results pCi/Liter	Location Name	Date	Isotope	Results pCi/Liter
Louisa County Terrell Dairy M-29	03/21/01	I-131 (1)	0.0 +/- 0.5	Surry County Epps Dairy M-66		NS	
		BaLa-140	<13				
		Cs-134	<9				
		Cs-137	<10				
		Sr-89	<4				
Sr-90	0.2 +/- 0.6						
Louisa County Terrell Dairy M-29	06/20/01	I-131 (1)	0.0 +/- 0.3	Surry County Epps Dairy M-66		NS	
		BaLa-140	<9				
		Cs-134	<9				
		Cs-137	<11				
		Sr-89	<4				
Sr-90	0.5 +/- 0.8						
Louisa County Terrell Dairy M-29	09/19/01	I-131 (1)	0.0 +/- 0.4	Surry County Epps Dairy M-66		NS	
		BaLa-140	<12				
		Cs-134	<9				
		Cs-137	<10				
		Sr-89	<4				
Sr-90	0.9 +/- 0.6						
Louisa County Terrell Dairy M-29		NS		Surry County Epps Dairy M-66	12/12/01	I-131	0.6 +/- 0.3
						BaLa-140	<9
						Cs-134	<9
						Cs-137	<9
						Sr-89	<4
Sr-90	1.5 +/- 0.7						

Sampling on a Quarterly Basis
(1) = Radiochemical Analysis for I-131

NS = No Sample



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RADIOGAS

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Location	Station	Date		I-131 Activity pCi/meter ³
		Start	Stop	
Surry Power Station	C-20	03/27/01	04/05/01	<0.04
Surry Power Station	C-20	06/29/01	07/06/01	<0.07
Surry Power Station	C-20	09/27/01	10/04/01	<0.07
Surry Power Station	C-20	12/27/01	01/03/02	<0.04

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RADIOGAS

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Location	Station	Date		I-131 Activity pCi/meter ³
		Start	Stop	
Pocahontas State Park	C-40	03/27/01	04/05/01	<0.04
Pocahontas State Park	C-40	06/29/01	07/06/01	<0.12
Pocahontas State Park	C-40	09/27/01	10/04/01	<0.07
Pocahontas State Park	C-40	12/27/01	01/09/02	<0.05

Virginia Department of Health

RADIOGAS

January 1, 2001 through December 31,2001

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Location	Station	Date		I-131 Activity pCi/meter ³
		Start	Stop	
Louisa County Rt. 700	C-88	03/28/01	- 04/04/01	<0.08
Louisa County Rt. 700	C-88	06/28/01	- 07/05/01	<0.12
Louisa County Rt. 700	C-88	09/26/01	- 10/03/01	<0.10
Louisa County Rt. 700	C-88	12/26/01	- 01/02/02	<0.15

Virginia Department of Health

SHELLFISH

January 1, 2001 through December 31, 2001

ANNUAL REPORT 2001

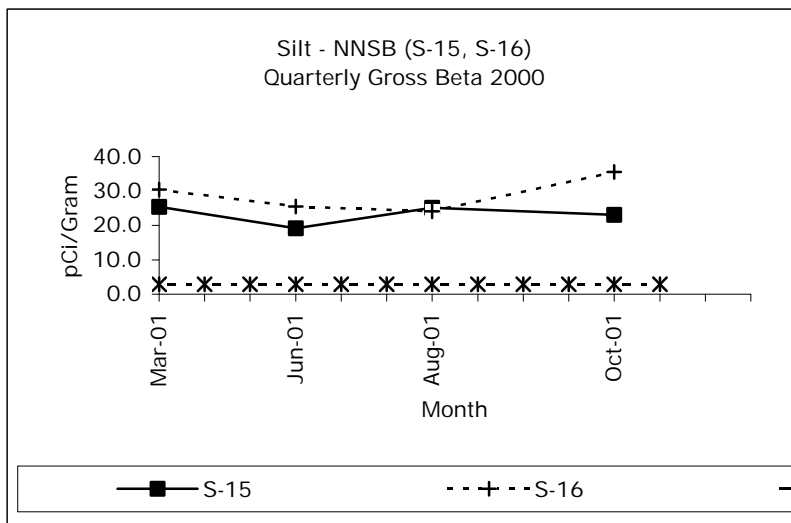
Location	Date Collected	Distance & Direction	Activity : pCi/gram (wet wt.)	
R-17	09/17/01	0.5 Miles East	Ba-140	<.01
James River			Cs-137	<.01
Mouth of			I-131	<.01
Canal			Rh-106	<.01
			Zn-65	<.01
			Zr-95	<.01

Virginia Department of Health

SILT

January 1, 2001 through December 31, 2001
ANNUAL REPORT 2001

Location	Date Collected	Gross Beta pCi/Gram of Silt		
James River	03/12/01	25.4	+/-	3.0
Pier 1	06/20/01	19.2	+/-	2.4
NNSBD (1)	08/30/01	25.1	+/-	2.8
S-15A	10/31/01	23.1	+/-	2.6
James River	03/12/01	30.4	+/-	3.3
Shipway II	06/20/01	25.5	+/-	2.8
NNSBD (1)	08/30/01	24.1	+/-	2.7
S-16	10/31/01	35.5	+/-	3.2



Virginia Department of Health

SILT

January 01, 2001 through December 31, 2001

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Location	Date Collected	Cs-134	Gamma Activity pCi/Gram (Wet)			Gross Beta pCi/Gram (dry)	Gross Alpha pCi/Gram (dry)
			Cs-137	Co-58	Co-60		
Drydock #8	03/12/01	<0.01	0.04 +/- 0.01	<0.01	<0.01	32.2 +/- 4.4	15.3 +/- 6.4
Norfolk Naval Shipyard	06/20/01	<0.01	0.03 +/- 0.01	<0.01	<0.01	30.0 +/- 4.2	11.5 +/- 5.5
S-18	08/30/01	<0.01	0.03 +/- 0.01	<0.01	<0.01	29.8 +/- 4.2	6.6 +/- 5.4
	10/31/01	<0.01	0.03 +/- 0.01	<0.01	<0.01	36.3 +/- 4.6	18.1 +/- 6.5
Drydock #4	03/12/01	<0.01	0.03 +/- 0.01	<0.01	<0.01	30.9 +/- 4.3	4.4 +/- 5.0
Norfolk Naval Shipyard	06/20/01	<0.01	0.03 +/- 0.01	<0.01	<0.01	29.2 +/- 4.2	6.0 +/- 4.2
S-19	08/30/01	<0.01	0.03 +/- 0.01	<0.01	<0.01	29.8 +/- 4.2	5.0 +/- 5.1
	10/31/01	<0.01	0.03 +/- 0.01	<0.01	<0.01	36.9 +/- 4.6	14.2 +/- 5.8
Wetslip #1	03/12/01	<0.01	0.04 +/- 0.01	<0.01	<0.01	28.1 +/- 4.1	18.1 +/- 7.4
Norfolk Naval Shipyard	06/20/01	<0.01	0.04 +/- 0.01	<0.01	<0.01	24.7 +/- 3.9	9.3 +/- 5.0
S-20	08/30/01	<0.01	0.04 +/- 0.01	<0.01	<0.01	29.0 +/- 4.1	7.2 +/- 5.5
	10/31/01	<0.01	0.03 +/- 0.01	<0.01	<0.01	33.0 +/- 4.4	14.3 +/- 6.0

Virginia Department of Health

SILT

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Location	Date Collected	Distance & Direction	Activity pCi/Gram (drv wt.)		
			Cs-134	Cs-137	Co-60
James River Discharge Canal S-17	09/13/2001	0.5 Miles NNW	<0.02	0.04 +/- 0.01	0.04 +/- 0.01
North Anna Lake Shoreline Soil S-24	02/19/01	1.1 Miles SSE	<0.01	0.09 +/- 0.01	<0.01

Virginia Department of Health

SURFACE WATER

January 1, 2001 through December 31,2001

ANNUAL REPORT 2001

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)
James River -	W - 15A	03/12/01	<27	<9	<52	<10	<21	<19	0.3 +/- 0.4	0.0 +/- 0.5
Pier 1	W - 15A	06/20/01	<8	<10	<10	<8	<20	<15	0.4 +/- 0.3	0.2 +/- 0.4
NNSBD (1)	W - 15A	08/30/01	<18	<9	<24	<8	<18	<17	0.0 +/- 0.5	0.2 +/- 0.6
	W - 15A	10/31/01	<14	<9	<8	<8	<20	<14	0.3 +/- 0.7	12.2 +/- 4.5
James River -	W - 16	03/12/01	<27	<9	<57	<9	<21	<18	0.1 +/- 0.5	0.3 +/- 0.4
Shipway II	W - 16	06/20/01	<11	<9	<13	<9	<20	<15	0.4 +/- 0.4	0.3 +/- 0.3
NNSBD (1)	W - 16	08/30/01	<15	<9	<25	<8	<8	<16	0.2 +/- 0.6	0.0 +/- 0.4
	W - 16	10/31/01	<10	<9	<9	<8	<8	<15	0.3 +/- 0.7	9.6 +/- 4.0

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

Virginia Department of Health

SURFACE WATER

January 1, 2001 through December 31,2001

ANNUAL REPORT 2001

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	03/12/01	<26	<7	<39	<8	<21	<17	0.0 +/- 0.4	0.6 +/- 0.4
Dry Dock 4	W - 37	06/20/01	<12	<10	<14	<9	<19	<15	0.0 +/- 0.4	0.6 +/- 0.5
NNSY	W - 37	08/30/01	<10	<10	<13	<9	<17	<16	0.6 +/- 0.4	1.1 +/- 0.3
	W - 37	10/31/01	<13	<9	<8	<8	<20	<14	0.7 +/- 0.5	2.7 +/- 2.4
									SS (pCi/L)	BS (pCi/L)
Elizabeth River	W - 38	03/12/01	<25	<9	<38	<9	<21	<17	0.1 +/- 0.1	0.3 +/- 0.3
Wetslip I	W - 38	06/20/01	<11	<10	<15	<8	<19	<16	0.1 +/- 0.1	0.3 +/- 0.6
NNSY	W - 38	08/30/01	<11	<9	<13	<9	<19	<15	0.3 +/- 0.4	0.2 +/- 0.3
	W - 38	10/31/01	<10	<8	<12	<9	<19	<14	0.0 +/- 0.5	0.6 +/- 0.3
									SS (pCi/L)	BS (pCi/L)
Elizabeth River	W - 39	03/03/01	<20	<10	<34	<9	<18	<18	0.2 +/- 0.5	0.4 +/- 0.4
Wetslip I	W - 39	06/23/01	<15	<10	<16	<9	<19	<17	0.0 +/- 0.4	0.6 +/- 0.4
NNSY	W - 39	08/03/01	<4	<4	<5	<4	<7	<8	0.2 +/- 0.4	0.1 +/- 0.3
	W - 39	10/19/01	<14	<9	<11	<8	<20	<15	0.1 +/- 0.5	0.7 +/- 0.3

SS = SUSPENDED SOLIDS

BS = BASIC SULFIDES

SURFACE WATER

January 1, 2001 through December 31,2001

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Location Name	Date	Isotope	Gamma Activity pCi/Liter	Location Name	Date	Isotope	Gamma Activity pCi/Liter
Surry Discharge Canal W-19	Jan-01	BaLa-140	<19	North Anna River W-27	Jan-01	BaLa-140	<20
		Cs-134	<16			Cs-134	<7
		Cs-137	<8			Cs-137	<8
		Co-58	<8			Co-58	<8
		Co-60	<9			Co-60	<9
		I-131	<22			I-131	<26
		Fe-59	<19			Fe-59	<19
		Mn-54	<7			Mn-54	<8
		Zn-65	<18			Zn-65	<17
		ZrNb-95	<14			ZrNb-95	<14
		H-3	<180			H-3	1050 +/- 350
Surry Discharge Canal W-19	Apr-01	BaLa-140	<11	North Anna River W-27	Apr-01	BaLa-140	<10
		Cs-134	<8			Cs-134	<8
		Cs-137	<9			Cs-137	<10
		Co-58	<9			Co-58	<8
		Co-60	<8			Co-60	<8
		I-131	<13			I-131	<10
		Fe-59	<18			Fe-59	<15
		Mn-54	<9			Mn-54	<9
		Zn-65	<21			Zn-65	<18
		ZrNb-95	<17			ZrNb-95	<14
		H-3	<200			H-3	<200

SURFACE WATER

January 1, 2001 through December 31,2001

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Location Name	Date	Isotope	Gamma Activity pCi/Liter	Location Name	Date	Isotope	Gamma Activity pCi/Liter
Surry Discharge Canal W-19	Jul-01	BaLa-140	<11	North Anna River W-27	Jul-01	BaLa-140	<10
		Cs-134	<10			Cs-134	<9
		Cs-137	<9			Cs-137	<10
		Co-58	<8			Co-58	<9
		Co-60	<9			Co-60	<8
		I-131	<13			I-131	<12
		Fe-59	<16			Fe-59	<16
		Mn-54	<8			Mn-54	<9
		Zn-65	<18			Zn-65	<18
		ZrNb-95	<15			ZrNb-95	<15
H-3	NA	H-3	NA				
Surry Discharge Canal W-19	Oct-01	BaLa-140	<26	North Anna River W-27	Oct-01	BaLa-140	<18
		Cs-134	<8			Cs-134	<6
		Cs-137	<9			Cs-137	<6
		Co-58	<10			Co-58	<7
		Co-60	<9			Co-60	<6
		I-131	<47			I-131	<34
		Fe-59	<21			Fe-59	<15
		Mn-54	<8			Mn-54	<7
		Zn-65	<19			Zn-65	<13
		ZrNb-95	<17			ZrNb-95	<11
H-3	<190	H-3	3150 +/- 400				

SURFACE WATER

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Location Name	Date	Isotope	Gamma Activity pCi/Liter	Location Name	Date	Isotope	Gamma Activity pCi/Liter
Lake Anna Discharge W-33		BaLa-140	<19	James River	Jan-01	BaLa-140	<18
		Cs-134	<7	Scotland		Cs-134	<7
		Cs-137	<7	Wharf		Cs-137	<8
		Co-58	<8	W-79		Co-58	<8
		Co-60	<9			Co-60	<9
		I-131	<23			I-131	<21
		Fe-59	<18			Fe-59	<19
		Mn-54	<7			Mn-54	<7
		Zn-65	<17			Zn-65	<18
		ZrNb-95	<13			ZrNb-95	<13
		H-3	3230 +/- 370			H-3	NA
Lake Anna Discharge W-33		BaLa-140	<10	James River	Apr-01	BaLa-140	<10
		Cs-134	<8	Scotland		Cs-134	<9
		Cs-137	<10	Wharf		Cs-137	<9
		Co-58	<9	W-79		Co-58	<9
		Co-60	<9			Co-60	<10
		I-131	<10			I-131	<12
		Fe-59	<15			Fe-59	<16
		Mn-54	<8			Mn-54	<9
		Zn-65	<20			Zn-65	<18
		ZrNb-95	<15			ZrNb-95	<16
		H-3	4200 +/- 400			H-3	NA

SURFACE WATER

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Location Name	Date	Isotope	Gamma Activity pCi/Liter	Location Name	Date	Isotope	Gamma Activity pCi/Liter
Lake Anna Discharge W-33		BaLa-140	<10	James River	Jul-01	BaLa-140	<11
		Cs-134	<10	Scotland		Cs-134	<10
		Cs-137	<10	Wharf		Cs-137	<9
		Co-58	<8	W-79		Co-58	<8
		Co-60	<9			Co-60	<9
		I-131	<12			I-131	<14
		Fe-59	<15			Fe-59	<15
		Mn-54	<8			Mn-54	<8
		Zn-65	<17			Zn-65	<17
		ZrNb-95	<14			ZrNb-95	<14
H-3	NA		H-3	NA			
Lake Anna Discharge W-33		BaLa-140	<31	James River	Oct-01	BaLa-140	<27
		Cs-134	<9	Scotland		Cs-134	<9
		Cs-137	<9	Wharf		Cs-137	<5
		Co-58	<10	W-79		Co-58	<9
		Co-60	<8			Co-60	<7
		I-131	<48			I-131	<46
		Fe-59	<19			Fe-59	<19
		Mn-54	<9			Mn-54	<9
		Zn-65	<16			Zn-65	<19
		ZrNb-95	<17			ZrNb-95	<14
H-3	3750 +/- 390		H-3	NA			

Virginia Department of Health

VEGETATION

ANNUAL REPORT 2001

Location Name	Date	Type	Isotope	State Results pCi/Gram (wet wt.)
Spotsylvania County Humphrey Garden V-92A	10/03/01	Turnip	I-131	<0.06
		Greens	Cs-134	<0.02
			Cs-137	<0.02
James City Carters Grove Plantation V-97	08/17/01	Kale	I-131	<0.03
			Cs-134	<0.02
			Cs-137	<0.01
Louisa County Bullock Garden V-98	10/03/01	Cabbage	I-131	<0.05
		Greens	Cs-134	<0.02
			Cs-137	<0.01
Richmond Garden V-96A	08/21/01	Kale	I-131	<0.05
			Cs-134	<0.05
			Cs-137	<0.05
Pemberton Garden V-100C	10/04/01	Turnip	I-131	<0.02
		Greens	Cs-134	<0.02
			Cs-137	<0.03

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

RADIOLOGICAL HEALTH PROGRAM

109 Governor Street, Room 730 Richmond, Virginia 23218-2448
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BABCOCK & WILCOX
NAVAL NUCLEAR FUEL
DIVISION

Virginia Department of Health
Babcock & Wilcox Naval Nuclear Fuel Division

AIR PARTICULATE COMPOSITE SAMPLES

January 1,2001 through December 31,2001

ANNUAL REPORT 2001

Location Name	Date	Analyses	Results ug/m3
Eastern Site Boundary Ballfield A-101	01/16/2001	Alpha *	.01+/- .002
Eastern Site Boundary Ballfield A-101	04/11/2001	Alpha *	.009+/- .002
Eastern Site Boundary Ballfield A-101	07/18/2001	Alpha *	.014 +/- .003
Eastern Site Boundary Ballfield A-101	10/10/2001	Alpha *	(1)

(1) = Alpha * - Uranium Separation
Followed by Alpha Counting

**Virginia Department of Health
Babcock & Wilcox Naval Nuclear Fuel Division**

AIR PARTICULATE SAMPLES

January 1, 2001 through December 31, 2001

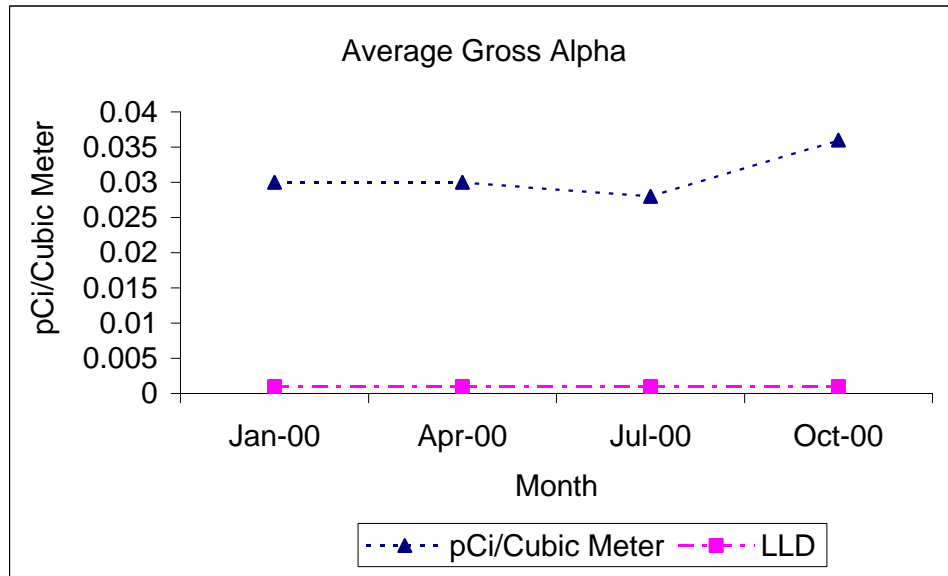
ANNUAL REPORT 2001

Location Name	Start	Date	Stop	Gross Alpha pCi/meter³
Eastern Site Boundary Ballfield A-101	01/10/01	-	01/16/01	0.030 +/- 0.003
Eastern Site Boundary Ballfield A-101	04/04/01	-	04/11/01	0.030 +/- 0.003
Eastern Site Boundary Ballfield A-101	07/11/01	-	07/18/01	0.028 +/- 0.003
Eastern Site Boundary Ballfield A-101	10/03/01	-	10/10/01	0.036 +/- 0.003

Virginia Department of Health

AIR PARTICULATE SAMPLES

Babcock & Wilcox Air Particulate Comparison (A-101 & A-106)



**Virginia Department of Health
Babcock & Wilcox Naval Nuclear Fuel Division**

SEDIMENT

January 1, 2001 through December 31, 2001
ANNUAL REPORT 2001

Location Name	Distance & Direction	Type	Date	Alpha * pCi/Gram		
Equalization Pond S-105	On Site	Sediment	06/05/2001	613	+/-	37.3

Alpha * - Uranium Separation Followed by Alpha Counting

**Virginia Department of Health
Babcock & Wilcox Naval Nuclear Fuel Division**

SOIL

January 1, 2001 through December 31, 2001

ANNUAL REPORT 2001

Location Name	Distance & Direction	Type	Date	Alpha * pCi/Gram		
Eastern Site Boundary-Ballfield S-101	Site Boundary	Soil	06/12/2001	0.40	+/-	0.40
Agricultural Bldg. Off Rt. 460 S-102	5 Miles SW	Soil	06/12/2001	0.50	+/-	0.50

Alpha * - Uranium Separation Followed by Alpha Counting

**Virginia Department of Health
Babcock & Wilcox Naval Nuclear Fuel Division**

SURFACE WATER

January 1, 2001 to December 31, 2001

ANNUAL REPORT 2001

Location Name	Distance & Direction	Date	pCi/Liter Alpha *
Downstream-Site Boundary 9 Mile Bridge W-101	Downstream of Site Boundary	06/05/01	0.4 +/- 0.4
Upstream- 6 Mile Bridge W-102	Upstream 6 Miles	06/05/01	0.5 +/- 0.4

Alpha * - Uranium Separation
Followed by Alpha Counting

**Virginia Department of Health
Babcock & Wilcox Naval Nuclear Fuel Division**

VEGETATION

January 1, 2001 through December 31, 2001

ANNUAL REPORT 2001

Location Name	Distance & Direction	Type	Date	Alpha * pCi/Gram
Eastern Site Boundary-Ballfield V-101	Site Boundary	Vegetation	06/05/2000	0.1 +/- 0.3
Off Rt. 460 V-102	5 Miles SW	Vegetation	06/05/2000	0.1 +/- 0.3

Alpha * - Uranium Separation
Followed by Alpha Counting

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

RADIOLOGICAL HEALTH PROGRAM
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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.

APPENDIX I

CONSOLIDATED LABORATORIES EPA INTRACOMPARISON RESULTS FOR 2000

Note: Reporting units are pCi/L except where noted

DATE	ANALYSIS	KNOWN VALUE pCi/Liter	MEASURED VALUE pCi/Liter
------	----------	--------------------------	-----------------------------

GROSS ALPH-BETA IN WATER

January	Alpha	30.5 +/- 7.6	21.4
	Beta	3.9 +/- 5.0	7.40
November	Alpha	47.2 +/- 20.5	31.9
	Beta	3.5 +/- 8.7	10.9

STRONTIUM IN WATER

January	Sr-89	18.3 +/- 8	19.00
	Sr-90	7.2 +/- 2.0	8.00

URANIUM-RADIUM IN WATER

February	Uranium	25.6 +/- 2.0	27
	Ra-226	7.2 +/- 0.2	5.90
	Ra-228	8.2 +/- 3.6	8.1
April	Uranium	3.1 +/- 2.3	5.00
	Ra-226	13.4 +/- 1.9	15.00
	Ra-228	8.7 +/- 1.0	8.20

APPENDIX I

CONSOLIDATED LABORATORIES EPA INTRACOMPARISON RESULTS FOR 2000

DATE	ANALYSIS	KNOWN VALUE gammas per sec	MEASURED VALUE gammas per sec
01/26/99	Cd-109	2006	2002
	Co-57	1068	1101
	Ce-139	1733	1710
	Hg-203	3218	3152
	Sn-113	2028	2015
	Cs-137	1324	1373
	Y-88	5295	5156
	Co-60	2569	2620
	Y-88	5566	5569
05/17/99	Cd-109	2006	2042
	Co-57	1068	1102
	Ce-139	1733	1702
	Hg-203	3218	2679
	Sn-113	2028	2001
	Cs-137	1324	1383
	Y-88	5295	5156
	Co-60	2569	2614
	Y-88	5566	5472

Virginia Department of Health

Division of Consolidated Laboratory Services
Radiation Laboratory Proficiency Testing

January 1, 2001 through December 31, 2001

Study	Nuclide	Month	Known Value	Control Limits	Lab Average	Unit
gross a/B	beta	July	340.0	252.0 - 428.0	315.0	pC / l
gross a/B	alpha Beta	Aug	17.8 53.0	9.1 - 26.5 35.7 - 70.3	15.2 51.4	pC / l
Gamma	Cobalt-60 Cesium-134 Cesium-137	July	26.4 16.9 170 +/- 202	17.7 - 35.1 8.20 - 25.6 170 - 202	30.9 18.9 185	pC / l
Gamma	Cobalt-60 Zinc-65 Cesium-134 Cesium-137 Barium-133	Aug	46.8 36.2 15.9 197 36.0	38.1 - 55.5 27.5 - 44.9 7.2 - 24.6 180.0 - 214.0 27.3 - 44.7	51.1 35.8 15.6 280.0 34.2	pC / l
Strontium	Sr-89 Sr-90	July	64.1 33.8	55.5 - 72.8 25.1 - 42.5	77.3 31.5	pC / l
	Sr-89 Sr-90	Sept	31.2 25.9	22.5 - 39.9 17.2 +/- 34.6	36.2 23	pC / l pC / l
Iodine	I-131	Dec	7.65	4.2 - 11.2	7.7	pC / l

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH

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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 shortlived isotopes.

Gamma isotopic analysis is performed with a 4" X 4" Sodium Iodide (TI) 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.

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:

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

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 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:

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

where:

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

Required Sample Size: 2300 m³ (Air Particulate Composite)

Required Sample Size: 120 m³ (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

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

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

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

- 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

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

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

$$LLD = 4.65 \cdot \frac{(2.71/T_s) + \sqrt{(2.71/T_s)^2 + (R_b/T_s)}}{Y \cdot e \cdot V \cdot d \cdot 2.22}$$

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

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

- 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

LLD *	APPROXIMATE 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

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

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

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APPENDIX III

SURVEILLANCE
PROGRAM

APPENDIX III

SURRY AREA SURVEILLANCE PROGRAM

LOCATION	TYPE	FREQUENCY
<u>Milk</u>		
* M-66 Surry County - W.B. Epps Dairy	Raw	Quarterly
<u>Air</u>		
* A-20 Surry Power Station	Air Particulate	Quarterly
<u>Charcoal Filter</u>		
* C-20 Surry Power Station	Release Gas	Quarterly
<u>Dosimeters</u>		
*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 Quarters	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
<u>Shellfish</u>		
R-17 James River - 1/2 Mile Off Discharge Canal	Clams	Annually
<u>Silt</u>		
S-17 James River - 1/2 Mile Off Discharge Canal	Silt	Annually
<u>Surface Water</u>		
* W-19 Surry Discharge Canal	Surface Water	Quarterly
* W-79 James River - Scotland Wharf	Surface Water	Quarterly
<u>Vegetation</u>		
* V-96A Surry County - Sprately 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
<u>Milk</u>			
* M-29 Louisa County - E. A. Terrell Dairy	13	Raw	Quarterly
<u>Air</u>			
* A-88 Route 700	22	Air Particulate	Quarterly
<u>Charcoal Filter</u>			
* C-88 Route 700	22	Release Gas	Quarterly
<u>Dosimeters</u>			
* 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
<u>Fish</u>			
* F-24 North Anna Lake - Second Cooling Lagoon	08	Edible Fish	2/Year
<u>Silt</u>			
S-24 North Anna Lake - Second Cooling Lagoon	08	Silt	2/Year
<u>Surface Water</u>			
* W-27 North Anna River - Route 522		Surface Water	Quarterly
* W-33 North Anna Discharge Canal		Surface Water	Quarterly
<u>Vegetation</u>			
* V-92A Spotsylvania County - Humphrey's Garden		Edible Vegetation	Annually
* V-98 Louisa County - Bullock Garden		Edible Vegetation	Annually
*Virginia and Virginia Power Duplicate Samples			

APPENDIX III

BABCOCK WILCOX SURVEILLANCE PROGRAM

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<u>SAMPLE</u>	<u>LOCATION</u>	<u>TYPE</u>	<u>FREQUENCY</u>
<u>AIR</u> A-101	Babcock & Wilcox Eastern Site Boundary	Air	Quarterly
<u>SURFACE WATER</u> W-101	Downstream - Site Boundary 9 Mile Bridge	Surface Water	Annually
W-102	Upstream - Site Boundary 6 Mile Bridge	Surface Water	Annually
<u>SOIL</u> S-101	Eastern Site Boundary Ballfield	Soil	Annually
S-102	Control - Route 460 Agricultural Bldg. 5 Miles S.W.	Soil	Annually
<u>SEDIMENT</u> S-105	Babcock & Wilcox Equilization Pond	Sediment	Annually
<u>VEGETATION</u> 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
	<u>Air</u>		
A-40	Pocahontas State Park	Air Particulate	Quarterly
	<u>Silt</u>		
S-15A	James River - Pier 1 (NNSBDDC)	Silt	Quarterly
S-16	James River - Shipway II (NNSBDDC)	Silt	Quarterly
S-18	Elizabeth River - NNS - Drydock #8	Silt	Quarterly
S-19	Elizabeth River - NNS - Drydock #4	Silt	Quarterly
S-20	Elizabeth River - NNS - Wetslip #1	Silt	Quarterly
	<u>Charcoal Filter</u>		
C-40	Pocahontas State Park	Air Particulate	Quarterly
	<u>Dosimeters</u>		
D-40	Pocahontas State Park	Air Gamma	Changed 4/Year
	<u>Surface Water</u>		
W-15	James River - Pier 3 (NNSBDDC)	Surface Water	Quarterly
W-16	James River - Shipway II (NNSBDDC)	Surface Water	Quarterly
W-37	Elizabeth River - NNS - Drydock # 8	Surface Water	Quarterly
W-38	Elizabeth River - NNS - Drydock #4	Surface Water	Quarterly
W-39	Elizabeth River - NNS - Wetslip #1	Surface Water	Quarterly

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APPENDIX IV

EMERGENCY
PREPAREDNESS

EMERGENCY PREPAREDNESS

The Radiological Health Program (RHP) 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 RHP, 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 RHP also supervises cleanup and ensures proper disposal of radioactive waste. A duty officer maintains 24-hour coverage for the RHP 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 RHP 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 RHP 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 which impact this state, 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, RHP, and DEM have elected to participate in each exercise as fully as resources and local response organizations participation permit.