

APPENDICES

APPENDIX A**NCRPS Regulatory Limit, Alert Level, Background Levels and
Estimated Lower Limits of Detection**

Environmental Medium (Units) (Sample Size)	Type of Analysis	Regulatory Limit ^a	Investigation Level	Average NC Background Level	Lower Level of Detection LLD (counting time in minutes) ^b
Air (pCi/m ³) (700m ³)	Gross Alpha	0.001	0.01	0.004	0.0005(100)
	Gross Beta	1 ^c	0.5	0.02	0.0011(100)
	Mn-54	1000	0.1	0	0.002 (420)
	Co-58	1000	0.1	0	0.002(420)
	Co-60	50	0.1	0	0.002 (420)
	Fe-59	500	0.1	0	0.004 (420)
	Zn-65	400	0.1	0	0.004 (420)
	Nb-95	2000	0.1	0	0.002 (420)
	Zr-95	400	0.1	0	0.003 (420)
	I-131	200	0.1	0	0.001 (420)
	Cs-134	200	0.1	0	0.002 (420)
	Cs-137	200	0.1	0.002	0.002 (420)
	Ba-140	2000	0.1	0	0.005 (420)
	La-140	2000	0.1	0	0.004 (420)
Total U	^d			0	1 uG/L(ICP-MS)
Air Cartridge	I-131	200	0.1	0	0.001 (420)
Finished or Groundwater (pCi/l) (3.5 liters)	Gross Alpha	15 ^{e,f}	5	0.5	0.058(100)
	Gross Beta	50 ^{e,f}	12.5	3.0	0.112(100)
	Tritium	2x10 ^{4e}	1x10 ⁴	< 250	250(300)
	Total U	2x10 ⁴	1	0.04	1uG/L(ICP-MS)
	Ra-226	5 ^{e,f,g}	3	1.0 ^h	ⁱ
	Ra-228	5 ^{e,f,g}	?	1.5 ^h	ⁱ
Raw Surface Water (pCi/l) (3.5 liters)	Gross Alpha	30, 15 ^f	5	1.0	0.058(100)
	Gross Beta	100 ^k , 50 ^f	12.5	4.0	0.112(100)
	Tritium	2x10 ^{4e}	1x10 ⁴	< 250	250 (300)
	Mn-54	3x10 ⁴	1.0	0	2.12(420)
	Co-58	2x10 ⁴	1.0	0	2.14(420)
	Co-60	3x10 ³	1.0	0	2.47 (420)
	Fe-59	1x10 ⁴	1.0	0	4.12 (420)
	Zn-65	5x10 ³	1.0	0	5.10 (420)
	Nb-95	3x10 ⁴	1.0	0	1.94 (420)
	Zr-95	2x10 ⁴	1.0	0	3.94 (420)
	I-131 ⁱ	1x10 ³	1.0	0	2.18 (420)
	Cs-134	9x10 ²	1.0	0	2.01 (420)
	Cs-137	1x10 ³	1.0	0	2.24 (420)
	Ba-140	8x10 ³	1.0	0	7.40 (420)
La-140	9x10 ³	1.0	0	3.81 (420)	
Total U	3x10 ²	5.0	0	1 uG/L(ICP-MS)	
Sewage Treatment Effluent (pCi/l) (3.5 liters)	Gross Alpha	20 15 ^f	5	1.4	0.058(100)
	Gross Beta	100 ^j 50 ^f	50	40	0.112(100)
	I-131	1x10 ⁴⁺¹	100	31	2.18 (420)
Precipitation (nCi/m ²) (0.5m ²)	Gross Beta		10	0.2	0.0008(100)

Environmental Medium (Units) (Sample Size)	Type of Analysis	Regulatory Limit ^a	Investigation Level	Average NC Background Level	Lower Level of Detection LLD (counting time in minutes) ^b
Milk (pCi/l) (3.5 liters)	I-131 Cs-137 Ba-140 K-40	10 ^m 2x10 ^{4k} 1x10 ⁴ⁿ	10 200 250 3x10 ³	0 2 3 1.5x10 ³	2.18(420) 2.24(420) 7.40 (420) 35.8(420)
Soil (pCi/g-dry) (600 g)	Gross Alpha Gross Beta Cs-137 Co-60 Ra-226 Total U		50 50 7 1 5 ^o	< 24 < 20 < 1.5 < 0.02 0.8	0.0003(100) 0.0007(100) 0.012(420) 0.013(420) _i 1 ug/L(ICP-MS)
Bottom Sediment (pCi/g-dry) (600 g)	Gross Alpha Gross Beta Co-60 Total U		30 100 1	8 10 0	0.0003(100) 0.0007(100) 0.013(420) 1ug/L(ICP-MS)
Fish Life (pCi/g-wet) (1 kg) (5% ash conversion)	Gross Alpha Gross Beta Cs-137 Ra-226 K-40		10 10 1 1 10	0.5 1.5 0.003 < 0.003 < 1.0	0.00018(100) wet 0.00042(100) wet 0.008(420)wet _i 0.208(420)
Vegetation (pCi/g-wet) (170 g) (2% ash conversion)	Gross Alpha Gross Beta Cs-137 Ra-226 Total U		10 20 10 1	0.3 5 0.04 < 0.003	0.0011(100) wet 0.0025(100) wet 0.044(420)wet _i 1 ug/L(ICP-MS)
TLD (mR/yr) (3 month sample)	Ambient Gamma	500	150	73	30

NOTE: All MDA derived from listed count interval. Samples counted for 420 min. are standard for environmental program.

^a All regulatory limits are based on North Carolina Regulations for Protection Against Radiation except for those with other notes.

^b LLD's listed are based on the normal measurement conditions used by the State's laboratory and defined as 4.66 K_s, with K as the proportional constant and S_g as the standard deviation of the background. Actual LLD's may vary for special analyses. Gamma-emitter LLD's are based upon Ge(Li) spectroscopy. Decay has not been accounted for in the estimation of these values. All errors are given at the 1 sigma interval.

^c Assuming that it is known that alpha-emitters and Ac-227 are not present.

^d D Class - this value is for uranium assumed to clear the lungs within one day and is the most restrictive value for this material based on Appendices A, B and C of 10 CFR 20 as incorporated into the North Carolina Regulations for Protection Against Radiation (15 NCAC 11).e) based on Environmental Protection agency Interim Drinking Water Standards.

^e Based on Environmental Protection agency Interim Drinking Water Standards.

^f Based on North Carolina Administrative Code TITLE 15, 2B.0211, Department of Environment, Health and Natural Resources.

^g Combined Ra-226 and Ra-228.

^h Average of gross alpha samples exceeding 5 pCi/l.

ⁱ Ra-226 and 228 analyses were discontinued in 2008 as part of budgetary and administrative changes at State Laboratory of Public Health. Both analyses are expected to be resumed in calendar year 2009.

^j Sample was prepared using radiochemical method.

^k Assuming that it is known that Ra-226 and Ra-228 are not present.

^l Based on monthly average – applies only to sewage effluent.

Appendix A

^m Based on *Federal Radiation Council Radiation Protection Guide*, top of Range I and an assumed intake of 1 liter/day.

ⁿ FRC recommended dose from daily intake (below 0.17 rem/yr).

^o Based on EPA advanced notice of proposed rule making (43 F.R.59022) under the Resource Conservation and recovery Act (RCRA), December 1978.

**A PRIORI LOWER LIMITS OF DETECTABILITY (LLD)
FOR Ge GAMMA SPECTROMETRY SYSTEMS
BRUNSWICK STEAM ELECTRIC PLANT**

*I-131 determined by radiochemical analysis. LLD is less than 0.5 pCi/unit.

Typical Values of LLD for Brunswick Nuclear Plant Taken from 2008 Radiological Environmental Operating Report.

**TYPICAL LOWER LIMITS OF DETECTION (A PRIORI)
GAMMA SPECTROMETRY**

Surface Water Samples (Saline Water)	
Isotope	LLD (pCi/l)
Mn-54	4
Co-58	5
Fe-59	13
Co-60	6
Zn-65	10
Zr-Nb-95	8 / 6
I-131	14.1
Cs-134	5
Cs-137	4
Ba-La-140	33 / 8
Air Particulates (Quarterly Composite)	
Isotope	LLD (pCi/m ³)
Cs-134	0.002
Cs-137	0.002
Shoreline Sediment	
Isotope	LLD (pCi/kg, dry)
Cs-134	109
Cs-137	110
Fish	
Isotope	LLD (pCi/kg, wet)
Mn-54	86
Co-58	91
Fe-59	242
Co-60	113
Zn-65	227
Cs-134	91
Cs-137	102
Food Products and Vegetation	
Isotope	LLD (pCi/kg, wet)
I-131	58.6
Cs-134	34
Cs-137	49

**A PRIORI LOWER LIMITS OF DETECTABILITY (LLD)
FOR Ge GAMMA SPECTROMETRY SYSTEMS**

**SHEARON HARRIS NUCLEAR POWER PLANT
Taken from 2008 Radiological Environmental Operating Report**

Typical Lower Limits of Detection (A Priori)
Gamma Spectrometry

Drinking Water/Surface Water Samples	
Isotope	LLD (pCi/L)
Mn-54	3
Co-58	4
Fe-59	10
Co-60	5
Zn-65	8
Zr-Nb-95	7 / 5
I-131	14.3
Cs-134	4
Cs-137	4
Ba-La-140	35 / 11
*I-131 (Separation Procedure)	*0.88
Air Particulates (Quarterly Composite)	
Isotope	LLD (pCi/m ³)
Cs-134	0.002
Cs-137	0.002
Milk	
Isotope	LLD (pCi/L)
Cs-134	11
Cs-137	12
Ba-La-140	44 / 13
*I-131 (Separation Procedure)	*0.93
Sediment	
Isotope	LLD (pCi/kg dry)
Cs-134	109
Cs-137	110
Fish	
Isotope	LLD (pCi/kg wet)
Mn-54	86
Co-58	91
Fe-59	242
Co-60	113
Zn-65	222
Cs-134	91
Cs-137	102

* Instrumental analysis of resin concentrates of samples.

*I-131 determined by radiochemical analysis. LLD is less than 0.5 pCi/unit.

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)

**McGUIRE NUCLEAR STATION
Taken from 2008 Annual Environmental Operating Report**

<u>Analysis</u>	<u>Water (pCi/l)</u>	<u>Airborne Particulate or Gas (pCi/m³)</u>	<u>Fish (pCi/kg,wet)</u>	<u>Milk (pCi/l)</u>	<u>Broad Leaf Vegetation (pCi/kg,wet)</u>	<u>Sediment (pCi/kg,dry)</u>
Gross Beta	4	0.01	NA	NA	NA	NA
H-3	2000*	NA	NA	NA	NA	NA
Mn-54	15	NA	130	NA	NA	NA
Fe-59	30	NA	260	NA	NA	NA
Co-58, 60	15	NA	130	NA	NA	NA
Zn-65	30	NA	260	NA	NA	NA
Zr-95	15	NA	NA	NA	NA	NA
Nb-95	15	NA	NA	NA	NA	NA
I-131	1	7×10^{-2}	NA	1	60	NA
Cs-134	15	5×10^{-2}	130	15	60	150
Cs-137	18	6×10^{-2}	150	18	80	180
Ba-140	15	NA	NA	15	NA	NA
La-140	15	NA	NA	15	NA	NA

* If no drinking water pathway exists, a value of 3000 pCi/l may be used.

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)

**GENERAL ELECTRIC FUEL FABRICATION PLANT
Taken from 2007 Supplement to Environmental Report**

**FIGURE 9.1
GNF-A'S ENVIRONMENTAL MONITORING PARAMETERS**

TYPE OF SAMPLE	ANALYSES	TYPICAL SAMPLING FREQUENCY	ROUTINE MINIMUM DETECTION LEVEL	
Air Particulates - Point Sources	Alpha	Continuous (Collection Weekly)	1.0E-12 microcuries per milliliter	
Ambient Air - On-Site	Alpha	Continuous (Collection Weekly)	0.5E-15 microcuries per milliliter	
Process Liquid At On-Site Discharge Point	Uranium Content Alpha; Beta	Daily; Weekly	0.02 parts per million - uranium	
			3.0E-8 microcuries per milliliter alpha	5E-8 microcuries per milliliter beta
Ground Water - On-Site	Uranium Content Alpha; Beta	Monthly; Quarterly	0.02 parts per million - uranium	
			5 picocuries per liter - alpha	20 picocuries per liter - beta
River Water - Upstream and Downstream of Site Discharge	Alpha; Beta	Monthly	5 picocuries per liter alpha	20 picocuries per liter beta
Sediment - Above Site Dam	Uranium	Annually	0.02 parts per million - uranium	
Soil - On-Site	Uranium	Semi-Annually	0.02 parts per million - uranium	
Vegetation - On-Site	Fluoride	Semi-Annually	1.0 parts per million - fluoride	

APPENDIX B

PROCEDURES FOR RADIOLOGICAL ANALYSIS IN THE STATE LABORATORY

Statewide Monitoring

The State Laboratory provides analytical capabilities for three programs. The first is environmental surveillance around nuclear facilities (mainly nuclear power plants) under an NRC contract. The second is a statewide program of environmental radiation monitoring. This program involves assistance from county health departments for sample collection. Finally, there are special projects conducted by the NCRPS along with analysis of groundwater samples for the Public Water Supply Branch.

Air Filters (Nuclear Facilities)

Gross alpha and gross beta radioactivity measurements are made by mounting 47 mm air particulate glass filters on planchets and counting for a minimum of 100 minutes on a Canberra-Tennelec XLB Series low background alpha/beta counter. Natural uranium and Cesium 137 (Cs-137) are sources used for gross alpha and gross beta calibration respectively in the system.

Monthly composites from non-contract sites are stacked on a planchet and counted for 7 hours on a high-purity germanium (HPGe) detector attached to a Canberra Apex based system with digital spectrum analyzer(DSA). The monthly composites for NRC contract sites are counted using the same procedure These analyses had been suspended at the State Lab due to budget based and administrative requirements but is now in the process of resumption.

Individual HPGe analyses are performed if gross beta is greater than 0.5 pCi/m³ or Cs-137 is greater than 0.1 pCi/m³ or if Iodine 131 (I-131) is detected in the composite sample. If the Cs-137 activity is greater than 0.2 pCi/m³, the sample will also be analyzed for Strontium 90 (Sr-90).The Sr-89 and Sr-90 analyses have been temporarily discontinued for budgetary and administrative reasons.

The gross alpha analyses for air filters collected weekly from the GE facility are performed using a Canberra XLB series low background alpha/beta counter. The resulting material is counted using inductively coupled plasma mass spectroscopy(ICP-MS). This procedure is found in *The Radiochemical Procedures Manual*, EPA/520/5-84-006. It should be kept in mind when comparing gross alpha and uranium results that there may be differences in total activity between

the alpha and uranium results due to the different filters, calibration sources and instrumentation used for counting these samples.

Air Filters (Statewide)

Planchet size (47 mm diameter) pieces are cut from high volume air filters (8 x 10 inch glass fiber). These are then counted for gross beta activity in a Canberra XLB series low background alpha/beta counter for a minimum of 100 minutes. If beta activity exceeds 0.5 pCi/m³, then the samples are gamma scanned using the Canberra Apex System of software, digital spectrum, analyzer, and a high purity germanium detector. If the Cs-137 activity exceeds 0.2 pCi/m³, the sample will be analyzed for Sr-90.

Air Iodine Cartridges

Routine analysis is performed by placing cartridges from independent sample sites, near a facility, in a container placed on an HPGe detector and counting the composite for 3 hours or longer. In the case of nuclear power plant indicator and control sites, cartridges are counted individually. Gamma isotopic analysis on the Canberra Apex system is performed on individual cartridges if I-131 is detected in the composite.

Food and Vegetation

For non-indicator/control sites, gamma analysis is done on the wet sample. The sample is then dried and ashed. A small aliquot of the ash (less than 100 mg) is counted for gross alpha and gross beta activity for 7 hours on a Canberra XLB series low-background alpha/beta counter. Strontium-89 (Sr-89) and Sr-90 analysis using procedure in PHS #999-RH-10 (1965), Procedures for Determinations of Stable Elements and Radionuclides in Environmental Studies, is performed if gross beta is greater than 20 pCi/g (ash). As discussed above, these analyses have been suspended at this time for regulatory and administrative reasons. For nuclear power plant indicator and control sites, a wet sample is placed inside a 1.0 liter marinelli beaker before being counted on an HPGe detector for 7 hours. For vegetation samples collected at GE, the samples are ashed and counted for gross alpha and beta activity. Samples exceeding 0.3 pCi/g wet weight are analyzed using inductively coupled plasma mass spectroscopy (ICP-MS) for uranium.

Shellfish

For statewide shellfish, the sample is prepared and counted using the same method as for food

and vegetation except in the case of Sr-89 and Sr-90 analysis which requires radiochemical preparation. These analyses have been suspended at this time as discussed above. This analysis is performed whenever gross beta is greater than 5 pCi/g (ash). For shellfish collected from fixed nuclear facilities, the edible portions are removed and counted using the Canberra Apex gamma spectroscopy system as described above.

Milk

Nuclear facility milk samples (3.5 liters) are transferred into a marinelli beaker and counted for at least 7 hours on the Canberra Apex system. For statewide milk samples, Sr-89 and Sr-90 analysis is performed on one third of the monthly samples on an alternating schedule regardless of gamma isotopic results and is mandated if Cs-137 is greater than 5 pCi/l in any sample. These analyses have been suspended at this time as discussed above. Low level iodine analysis is done for nuclear facility sites using a resin bed and solvent extraction.

Surface Water

For nuclear facility indicator and control sites contract samples, an aliquot (≤ 1000 ml) of each surface water sample is filtered. A portion of the liquid fraction is acidified and evaporated to a low volume, transferred to planchets, evaporated to total dryness under infrared lamp and then in an oven. The sample is then counted for at least 100 minutes on a Canberra XLB Series low background alpha/beta detector. The solid portion and the filter are ashed and the sample transferred to a tared planchet. After evaporation to dryness, the sample is counted 100 minutes on a Canberra XLB Series low background alpha/beta counter.

Gross alpha analysis in water for the GE Uranium Fuel Fabrication Plant is performed using a Canberra XLB Series low background alpha/beta counter. Samples with gross alpha activity above 5 pCi/l are submitted for inductively coupled plasma mass spectroscopy (ICP-MS) analysis for uranium. To analyze the sample for uranium content in water, the samples must first have the uranium separated out using radiochemical procedures. The resulting material is counted using an inductively coupled plasma mass spectrometer (ICP-MS). This procedure is found in The Radiochemical Procedures Manual, EPA 520/5-84-006.

It should be kept in mind when comparing gross alpha and uranium results that there may be differences in total activity between the alpha and uranium results due to the different filters, calibration sources used for counting these samples and whether equilibrium has been reached in the sample.

Nuclear facility water samples are also analyzed for tritium content. Samples are distilled to remove quenching materials and nonvolatile activity. Sixteen milliliters (ml) of scintillation cocktail (Packard Optifluor) are added to 4 ml of the distillate and the sample is counted on a coincidence type liquid scintillation spectrometer. A determination of low level iodine is done on the samples from nuclear facilities which are downstream from the plant.

Nuclear facility samples are analyzed for gamma activity by counting for varying times (generally 7 hours or 3 hours for surface and ground water samples, iodine cartridges and filters) on the Canberra Apex gamma spectroscopy system, while statewide samples are analyzed on an HPGe counting system for at least three hours.

Isotopic uranium analysis using ICP-MS is performed on water samples from GE with gross alpha activity exceeding 5 pCi/l. Total uranium analysis is done for non-contract samples with greater than 15 pCi/l of alpha activity. For total uranium, the water sample (1000 ml) is acidified and boiled to eliminate carbonate and bicarbonate ions. Uranium is co-precipitated with ferric hydroxide, separated from the sample and then separated from the other radionuclides by dissolving the precipitate in acid, passing this through an anion exchange column and eluting the uranium with acid. The eluate is evaporated and the residue is transferred to a planchet, dried, flamed and counted for alpha particle activity for 50 minutes on a Canberra XLB series low-background alpha/beta counter. This procedure is referenced in EPA's "*Uranium in Drinking Water, Method 908.0, EPA/600/4-80-032.*"

For isotopic uranium determinations, the sample is processed by a solvent extraction and extensive chemical treatment. The sample is counted using an ICP-MS method and the uranium content quantified. A report is then generated and printed.

Strontium-89 and Sr-90 analysis is performed according to "*Measurement of Sr-89 and Sr-90 in Environmental Waters, a Tentative Reference Method*", EPA-600/4-76-011 (1976) or "*13th Edition, Standard Methods*"; on any samples with Cs-137 greater than 10 pCi/l. For samples collected as part of statewide monitoring, a gamma scan is done if beta activity exceeds 5 pCi/l. Likewise, the sample is analyzed for Ra-226 if gross alpha activity exceeds 5 pCi/l. These analyses have been suspended temporarily as discussed above.

Ground Water (Nuclear Facilities)

Gross alpha, gross beta and tritium analyses are routinely performed on all samples as described

under surface water. Any sample with gross beta greater than 5 pCi/l is analyzed for gamma isotopic activity on the Canberra Apex gamma spectroscopy system. In addition, any GE sample with gross alpha greater than 5 pCi/l is analyzed for uranium using the ICP-MS method. Tritium analysis is not generally performed in the case of GE samples. In addition, any sample from nuclear facilities with a gross alpha greater than 15 pCi/l is analyzed for total uranium as discussed above.

Ground Water and Special Samples (Statewide)

Gross alpha and gross beta measurement is performed on all samples (See Surface Water). Samples with gross beta concentrations in excess of 5 pCi/l are counted on an HPGe gamma spectroscopy detector. If gross alpha is greater than or equal to 5 pCi/l, a radium analysis is performed. If the Ra-226 content of the sample is found to be greater than 3 pCi/l, the sample is prepared according to the Brooks-Blanchard method for determination of Radium 228 (Ra-228) concentration. Samples containing greater than 15 pCi/l gross alpha are analyzed for total uranium content as described under nuclear area surface water samples.

Soil and Sediment

Samples are dried at 110° C for at least 24 hours and sieved. A routine analysis involves gross alpha and gross beta determinations of a 100 mg sample on a Canberra XLB series low background alpha/beta counter, as well as gamma isotopic analyses of 0.5-liter samples on a Canberra Apex system. Gross beta activity in excess of 20 pCi/g (dry) requires analysis for Sr-89 and Sr-90 using techniques in PHS #999-RH-10 (1965). Samples exceeding 15 pCi/g (dry) of alpha activity are analyzed for total uranium. In the case where sediment samples are collected from fixed nuclear facility sites, the sediment is dried and gamma scanned using the Canberra Apex system. Sediment and soil samples collected from GE are dried and then counted for gross alpha and beta activity. Samples that exceed 15 pCi/g-dry of gross alpha activity are analyzed for uranium using the ICP-MS method.

Precipitation

The statewide precipitation samples are collected from three locations over a period of one month. The volume is measured and a portion is removed and filtered. The filtrate is acidified, held overnight and evaporated to a low volume. The filter is dissolved using 16N nitric acid and evaporated to near dryness. The dissolved and suspended fractions are transferred to planchets for gross beta counting, placed under infrared lamps and evaporated to dryness. After further

heating, sample are counted on a Canberra XLB series low background alpha/beta counter. Samples with gross beta in excess of 10 nCi/m² are analyzed for Sr-89 and Sr-90 using techniques in PHS#999-RH-10 (1965). These analyses have been temporarily as discussed above. The sample is also gamma scanned using the Canberra Apex system. Tritium analysis is also done on part of the sample using the Packard Tri-Carb Liquid Scintillation Counter.

Sewage Treatment Effluent Water

Gross alpha and beta analyses are performed on samples (200 ml), after separating fractions and evaporation, using Canberra XLB series low background alpha/beta counters. Routine screening also includes analysis on an HPGe counting system for at least 3 hours. Strontium-89 and Sr-90 analysis is performed according to procedures in PHS#999-RH-10 (1965) when gross beta activity exceeds 50 pCi/l. These analyses have been temporarily suspended as discussed above.

Thermoluminescent Dosimeters (TLD)

TLD badges (Panasonic Model UD-814-AR) utilizing one lithium borate element and three calcium sulfate elements are read on a Panasonic Model UD-706A manual badge reader. Badges are calibrated using a 600 millicurie Cs-137 source. The lithium borate element is not used in calculation of exposure rates. All TLD results are manually entered into data file notebooks.

APPENDIX C

NORTH CAROLINA RADIATION PROTECTION SECTION ENVIRONMENTAL RADIOLOGICAL VERIFICATION MONITORING PROGRAM AROUND NUCLEAR POWER PLANTS

Exposure Pathway and/or Sample	Number of Samples and Location	Sampling and Collection Frequency	Type and Frequency of Analysis
AIRBORNE:			
Particulate	One sample from location of highest calculated ground level concentration and in close proximity of licensee sampler. One sample from control location.	Continuous operation of sampler with sample collection as required by dust loading but at least once per 7 days.	Gross beta radioactivity following filter change; composite for gamma isotopic analysis monthly . Temporarily suspended. Will be resumed in 2009.
Radioiodine	Same as particulate.	Same as particulate.	Analyze for I-131.
WATERBORNE:			
Surface	One sample, split with licensee, from immediate area of discharge, (or at nearest downstream drinking water supply) and one sample at upstream control location.	Composite sample biweekly ^a	Gamma isotopic analysis biweekly and tritium biweekly .
INGESTION:			
Milk	One sample, split with licensee, at the off-site dairy farm or individual milk animal at the location having highest X/Q.	Monthly.	Gamma isotopic and radioiodine analyses.
Fish or Invertebrates	One sample, split with licensee, of a commercially or recreationally important species in vicinity of discharge point.	Semi-annually or in season.	Gamma isotopic of edible portions.
Food Products or Broad-leaf vegetation	Two samples split with licensee, of principal food products grown near point having the highest X/Q or from any area which is irrigated by water in which liquid plant wastes have been discharged or green leafy vegetables at a private garden or farm in the immediate area of the plant.	At time of harvest.	Gamma isotopic on edible portion or on green leafy vegetable.
SEDIMENT:			
Shoreline and Bottom sediment	One sample split with licensee of each .	Annually.	Gamma isotopic analysis.
TLD:			
Direct Radiation	a. TLD badges in 16 sectors around plant site at two distances from site boundary: 1) Site boundary out to 1 mile 2) Two to four miles from site boundary. b. Population centers within 10 miles. c. Maximum exposed residences within 3 miles. d. High public interest sites within 5 miles. e. Background control site (3) greater than 15 miles from plant.	Quarterly.	Analyses to be performed by Radiation Protection Section personnel.

^a For I-131 analyses of drinking water supplies, samples shall be composited over a maximum period of two weeks.

**NORTH CAROLINA RADIATION PROTECTION SECTION
ENVIRONMENTAL MONITORING PROGRAM AROUND GE PLANT**

Exposure Pathway and/or Sample	Number of Samples and Location	Sampling and Collection Frequency	Type and Frequency of Analysis
AIRBORNE: Particulate	One sample from location of potentially highest public exposure (South Fence). One sample from control location. Sampling stations co-located with licensee.	Weekly.	Gross alpha after each filter change, composite quarterly for uranium isotopic determination. ^a
WATERBORNE: Surface	One sample each, split with licensee, from point of discharge into river (03), from the upstream control location (04) and from the treated process water upstream of the site dam (01).	Quarterly.	Gross alpha uranium isotopic determination ^a if gross alpha exceeds screening level of 5 pCi/l.
Ground	One sample, split with licensee, from a well near the Process Lagoon (PL3).	Quarterly.	Gross alpha uranium isotopic determination ^a if gross alpha exceeds screening level of 5 pCi/l.
Waste	One sample, split with licensee, from a well near the waste treatment facility (WT7), near the south fence (F3), and supply well (Well 9).	Semi-annually.	Gross alpha uranium isotopic determination ^a if gross alpha exceeds screening level of 5 pCi/l.
	Sample from final effluent control point (02).	Monthly.	Gross alpha uranium isotopic determination ^a if gross alpha exceeds screening level of 5 pCi/l.
INGESTION: Vegetation	One sample each from <u>two</u> sites, split with licensee, of vegetation grown near plant site.	Annually.	Gross alpha; uranium isotopic determination ^a if gross alpha exceeds screening level of 0.3 pCi/g (wet).
Soil	<u>Two</u> samples, split with licensee, from same locations as vegetation samples.	Annually.	Gross alpha; uranium isotopic determination ^a if gross alpha exceeds screening level of 15 pCi/g (dry).
Sediment	Three samples, split with licensee, from same locations as surface water samples.	Annually.	Gross alpha; uranium isotopic determination ^a if gross alpha exceeds screening level of 15 pCi/g (dry).

^a Uranium analysis by ICP-MS method.

APPENDIX D

RESULTS OF INTERCOMPARISON STUDIES BY STATE LABORATORY OF
PUBLIC HEALTH *

RAD PT-66

Analyte	Units	SLPH Value (#1)	SLPH Value (#2)	SLPH Value (#3)	SLPH Value (Average)	ERA Assigned Value	ERA Acceptance Limits	Performance Evaluation
Barium-133	pCi/L	89.7	90.0	87.8	89.2	88.1	72.9 – 103	Acceptable
Cesium-134	pCi/L	45.8	49.9	50.9	48.9	54.1	45.4 – 62.8	Acceptable
Cesium-137	pCi/L	23.1	238	229	233	238	217 – 259	Acceptable
Cobalt-60	pCi/L	102	108	106	105	99.7	91.0 – 108	Acceptable
Zinc-65	pCi/L	141	97.3	98.5	112	121	100 – 142	Acceptable

RAD PT-64

Analyte	Units	SLPH Value (#1)	SLPH Value (#2)	SLPH Value (#3)	SLPH Value (Average)	ERA Assigned Value	ERA Acceptance Limits	Performance Evaluation
Barium-133	pCi/L	93.5	91.6	97.4	94.2	95.0	78.6 – 111	Acceptable
Cesium-134	pCi/L	19.1	21.5	18.4	19.7	23.1	14.4 – 31.8	Acceptable
Cesium-137	pCi/L	109	104	108	107	111	101 – 121	Acceptable
Cobalt-60	pCi/L	98.1	103	99.6	100	95.3	86.6 – 104	Acceptable
Zinc-65	pCi/L	197	256	187	213	192	159 – 225	Acceptable

*Intercomparison studies conducted on liquid matrices for gamma emitters.