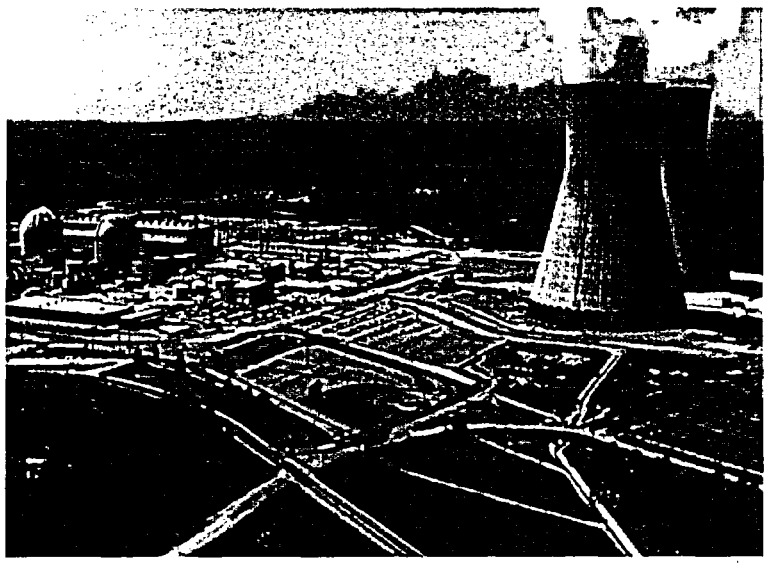
ENCLOSURE 3

Vogtle Electric Generating Plant

Annual Radiological Environmental Operating Report for 2002

# VOGTLE ELECTRIC GENERATING PLANT ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT FOR 2002



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# LIST OF ACRONYMS

Acronyms presented in alphabetical order.

| Acronym | Definition |
|---|---|
| ASTM | American Society for Testing and Materials |
| CL | Confidence Level |
| EL | Georgia Power Company Environmental Laboratory |
| EPA | Environmental Protection Agency |
| GPC | Georgia Power Company |
| ICP | Interlaboratory Comparison Program |
| MDC | Minimum Detectable Concentration |
| MDD | Minimum Detectable Difference |
| MWe | MegaWatts Electric |
| NA | Not Applicable |
| NDM | No Detectable Measurement(s) |
| NRC | Nuclear Regulatory Commission |
| ODCM | Offsite Dose Calculation Manual |
| Po | Preoperation |
| PWR | Pressurized Water Reactor |
| REMP | Radiological Environmental Monitoring Program |
| RL | Reporting Level |
| RM | River Mile |
| TLD | Thermoluminescent Dosimeter |
| TS | Technical Specification |
| VEGP | Alvin W. Vogtle Electric Generating Plant |

# 1.0 INTRODUCTION

The Radiological Environmental Monitoring Program (REMP) is conducted in accordance with Chapter 4 of the Offsite Dose Calculation Manual (ODCM). The REMP activities for 2002 are reported herein in accordance with Technical Specification (TS) 5.6.2 and ODCM 7.1.

The objectives of the REMP are to:

1) Determine the levels of radiation and the concentrations of radioactivity in the environs and;

2) Assess the radiological impact (if any) to the environment due to the operation of the Alvin W. Vogtle Electric Generating Plant (VEGP).

The assessments include comparisons between results of analyses of samples obtained at locations where radiological levels are not expected to be affected by plant operation (control stations) and at locations where radiological levels are more likely to be affected by plant operation (indicator stations), as well as comparisons between preoperational and operational sample results.

VEGP is owned by Georgia Power Company (GPC), Oglethorpe Power Corporation, the Municipal Electric Authority of Georgia, and the City of Dalton, Georgia. It is located on the southwest side of the Savannah River approximately 23 river miles upstream from the intersection of the Savannah River and U.S. Highway 301. The site is in the eastern sector of Burke County, Georgia, and across the river from Barnwell County, South Carolina. The VEGP site is directly across the Savannah River from the Department of Energy Savannah River Site. Unit 1, a Westinghouse Electric Corporation Pressurized Water Reactor (PWR), with a licensed core thermal power of 3565 MegaWatts (MWt), received its operating license on January 16, 1987 and commercial operation started on May 31, 1987. Unit 2, also a Westinghouse PWR rated for 3565 MWt, received its operating license on February 9, 1989 and began commercial operation on May 19, 1989.

The preoperational stage of the REMP began with initial sample collections in August of 1981. The transition from the pre-operational to the operational stage of the REMP occurred as Unit 1 reached initial criticality on March 9, 1987.

A description of the REMP is provided in Section 2 of this report. Maps showing the sampling stations are keyed to a table which indicates the direction and distance of each station from a point midway between the two reactors. Section 3 provides a summary of the results of the analyses of REMP samples for the year. The results are discussed, including an assessment of any radiological impacts upon the environment and the results of the land use census and the river survey, in Section 4. The results of the Interlaboratory Comparison Program (ICP) are provided in Section 5. Conclusions are provided in Section 6.

# 2.0 REMP DESCRIPTION

A summary description of the REMP is provided in Table 2-1. This table summarizes the program as it meets the requirements outlined in ODCM Table 4-1. It details the sample types to be collected and the analyses to be performed in order to monitor the airborne, direct radiation, waterborne and ingestion pathways, and also delineates the collection and analysis frequencies. In addition, Table 2-1 references the locations of stations as described in ODCM Section 4.2 and in Table 2-2 of this report. The stations are also depicted on maps in Figures 2-1 through 2-3.

REMP samples are collected by Georgia Power Company's (GPC) Environmental Laboratory (EL) personnel. The same lab performs all the laboratory analyses at their headquarters in Smyrna, Georgia.

TABLE 2-1 (SHEET 1 of 5)

SUMMARY DESCRIPTION OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

| Exposure Pathway and/or Sample | Number of Representative Samples and Sample Locations | Sampling and Collection Frequency | Type and Frequency of Analysis |
|---|---|---|---|
| 1. Direct Radiation | Thirty nine routine monitoring stations with two or more dosimeters placed as follows:<br><br>An inner ring of stations, one in each compass sector in the general area of the site boundary;<br><br>An outer ring of stations, one in each compass sector at approximately 5 miles from the site; and<br><br>Special interest areas, such as population centers, nearby recreation areas, and control stations. | Quarterly | Gamma dose, quarterly |
| 2. Airborne Radioiodine and Particulates | Samples from seven locations:<br><br>Five locations close to the site boundary in different sectors;<br><br>A community having the highest calculated annual average ground level D/Q; and | Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading. | Radioiodine canister: I-131 analysis, weekly.<br><br>Particulate sampler: Gross beta analysis[1] following filter change and gamma isotopic analysis[2] of composite (by location), quarterly. |

## TABLE 2-1 (SHEET 2 of 5)

## SUMMARY DESCRIPTION OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

| Exposure Pathway and/or Sample | Number of Representative Samples and Sample Locations | Sampling and Collection Frequency | Type and Frequency of Analysis |
|---|---|---|---|
| 2. Airborne Radioiodine and Particulates (cont.) | A control location near a population center at a distance of about 14 miles. | | |
| 3. Waterborne | | | |
| a. Surface[3] | One sample upriver.<br><br>Two samples downriver. | Composite sample over one month period[4]. | Gamma isotopic analysis[2], monthly. Composite for tritium analysis, quarterly. |
| b. Drinking | Two samples at each of the two nearest water treatment plants that could be affected by plant discharges.<br><br>Two samples at a control location. | Composite sample of river water near the intake of each water treatment plant over two week period[4] when I-131 analysis is required for each sample; monthly composite otherwise; and grab sample of finished water at each water treatment plant every two weeks or monthly, as appropriate. | I-131 analysis on each sample when the dose calculated for the consumption of the water is greater than 1 mrem per year[5]. Composite for gross beta and gamma isotopic analysis[2] on raw water, monthly. Gross beta, gamma isotopic and I-131 analyses on grab sample of finished water, monthly. Composite for tritium analysis on raw and finished water, quarterly. |
| c. Sediment from Shoreline | One sample from downriver area with existing or potential recreational value. | Semiannually | Gamma isotopic analysis[2], semiannually. |

## TABLE 2-1 (SHEET 3 of 5)

## SUMMARY DESCRIPTION OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

| Exposure Pathway and/or Sample | Number of Representative Samples and Sample Locations | Sampling and Collection Frequency | Type and Frequency of Analysis |
|---|---|---|---|
| c. Sediment from Shoreline (cont.) | One sample from upriver area with existing or potential recreational value. | | |
| 4. Ingestion | | | |
| a. Milk | Two samples from milking animals[6] at control locations at a distance of about 10 miles or more. | Biweekly | Gamma isotopic analysis[2,7], biweekly. |
| b. Fish | At least one sample of any commercially or recreationally important species near the plant discharge.<br><br>At least one sample of any commercially or recreationally important species in an area not influenced by plant discharges.<br><br>At least one sample of any anadromous species near the plant discharge. | Semiannually<br><br>During the spring spawning season. | Gamma isotopic analysis[2] on edible portions, semiannually.<br><br>Gamma isotopic analysis[2] on edible portions, annually. |

TABLE 2-1 (SHEET 4 of 5)

SUMMARY DESCRIPTION OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

| Exposure Pathway and/or Sample | Number of Representative Samples and Sample Locations | Sampling and Collection Frequency | Type and Frequency of Analysis |
|---|---|---|---|
| c. Grass or Leafy Vegetation | One sample from two onsite locations near the site boundary in different sectors.<br><br>One sample from a control location at a distance of about 17 miles. | Monthly during growing season. | Gamma isotopic analysis[2, 7], monthly. |

## TABLE 2-1 (SHEET 5 of 5)

## SUMMARY DESCRIPTION OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Notes:

(1) Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

(2) Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

(3) Upriver sample is taken at a distance beyond significant influence of the discharge. Downriver samples are taken beyond but near the mixing zone.

(4) Composite sample aliquots shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) to assure obtaining a representative sample.

(5) The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

(6) A milking animal is a cow or goat producing milk for human consumption.

(7) If the gamma isotopic analysis is not sensitive enough to meet the Minimum Detectable Concentration (MDC) for I-131, a separate analysis for I-131 may be performed.

## TABLE 2-2 (SHEET 1 of 3)

## RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

| Station Number | Station Type | Descriptive Location | Direction[1] | Distance (miles)[1] | Sample Type |
|---|---|---|---|---|---|
| 1 | Indicator | River Bank | N | 1.1 | Direct Rad. |
| 2 | Indicator | River Bank | NNE | 0.8 | Direct Rad. |
| 3 | Indicator | Discharge Area | NE | 0.6 | Airborne Rad. |
| 3 | Indicator | River Bank | NE | 0.7 | Direct Rad |
| 4 | Indicator | River Bank | ENE | 0.8 | Direct Rad. |
| 5 | Indicator | River Bank | E | 1.0 | Direct Rad. |
| 6 | Indicator | Plant Wilson | ESE | 1.1 | Direct Rad. |
| 7 | Indicator | Simulator Building | SE | 1.7 | Airborne Rad. Direct Rad. Vegetation |
| 8 | Indicator | River Road | SSE | 1.1 | Direct Rad. |
| 9 | Indicator | River Road | S | 1.1 | Direct Rad. |
| 10 | Indicator | Met Tower | SSW | 0.9 | Airborne Rad. |
| 10 | Indicator | River Road | SSW | 1.1 | Direct Rad. |
| 11 | Indicator | River Road | SW | 1.2 | Direct Rad. |
| 12 | Indicator | River Road | WSW | 1.2 | Airborne Rad. Direct Rad. |
| 13 | Indicator | River Road | W | 1.3 | Direct Rad. |
| 14 | Indicator | River Road | WNW | 1.8 | Direct Rad. |
| 15 | Indicator | Hancock Landing Road | NW | 1.5 | Direct Rad. Vegetation |
| 16 | Indicator | Hancock Landing Road | NNW | 1.4 | Airborne Rad. Direct Rad. |
| 17 | Other | Sav. River Site (SRS), River Road | N | 5.4 | Direct Rad. |
| 18 | Other | SRS, D Area | NNE | 5.0 | Direct Rad. |
| 19 | Other | SRS, Road A.13 | NE | 4.6 | Direct Rad. |
| 20 | Other | SRS, Road A.13.1 | ENE | 4.8 | Direct Rad. |
| 21 | Other | SRS, Road A.17 | E | 5.3 | Direct Rad. |
| 22 | Other | River Bank | ESE | 5.2 | Direct Rad. |
| 23 | Other | River Road | SE | 4.6 | Direct Rad. |
| 24 | Other | Chance Road | SSE | 4.9 | Direct Rad. |
| 25 | Other | Chance Road near Highway 23 | S | 5.2 | Direct Rad. |
| 26 | Other | Highway 23 and Ebenezer Church Road | SSW | 4.6 | Direct Rad. |
| 27 | Other | Highway 23 opposite Boll Weevil Road | SW | 4.7 | Direct Rad. |
| 28 | Other | Thomas Road | WSW | 5.0 | Direct Rad. |

## TABLE 2-2 (SHEET 2 of 3)

## RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

| Station Number | Station Type | Descriptive Location | Direction[1] | Distance (miles)[1] | Sample Type |
|---|---|---|---|---|---|
| 29 | Other | Claxton-Lively Road | W | 5.1 | Direct Rad. |
| 30 | Other | Nathaniel Howard Road | WNW | 5.0 | Direct Rad. |
| 31 | Other | River Road at Allen's Chapel Fork | NW | 5.0 | Direct Rad. |
| 32 | Other | River Bank | NNW | 4.7 | Direct Rad. |
| 35 | Other | Girard | SSE | 6.6 | Airborne Rad. Direct Rad. |
| 36 | Control | GPC Waynesboro Op. HQ | WSW | 13.9 | Airborne Rad. Direct Rad. |
| 37 | Control | Substation Waynesboro, GA | WSW | 16.7 | Direct Rad Vegetation |
| 43 | Other | Employee's Rec. Center | SW | 2.2 | Direct Rad. |
| 47 | Control | Oak Grove Church | SE | 10.4 | Direct Rad. |
| 48 | Control | McBean Cemetery | NW | 10.2 | Direct Rad. |
| 51 | Control | SGA School Sardis, GA | S | 11.0 | Direct Rad. |
| 52 | Control | Oglethorpe Substation; Alexander, GA | SW | 10.7 | Direct Rad. |
| 80 | Control | Augusta Water Treatment Plant | NNW | 29.0 | Drinking Water[2] |
| 81 | Control | Sav River | N | 2.5 | Fish[3] Sediment[4] |
| 82 | Control | Sav River (RM 151.2) | NNE | 0.8 | River Water |
| 83 | Indicator | Sav River (RM 150.4) | ENE | 0.8 | River Water Sediment[4] |
| 84 | Other | Sav River (RM 149.5) | ESE | 1.6 | River Water |
| 85 | Indicator | Sav River | ESE | 4.3 | Fish[3] |
| 87 | Indicator | Beaufort-Jasper County Water Treatment Plant | SE | 76 | Drinking Water[5] |
| 88 | Indicator | Cherokee Hill Water Treatment Plant, Port Wentworth, Ga | SSE | 72 | Drinking Water[6] |
| 98 | Control | W.C. Dixon Dairy | SE | 9.8 | Milk |
| 99 | Control | Boyceland Dairy | W | 20.9 | Milk |

## TABLE 2-2 (SHEET 3 of 3)

## RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

Notes:

(1) Direction and distance are determined from a point midway between the two reactors.

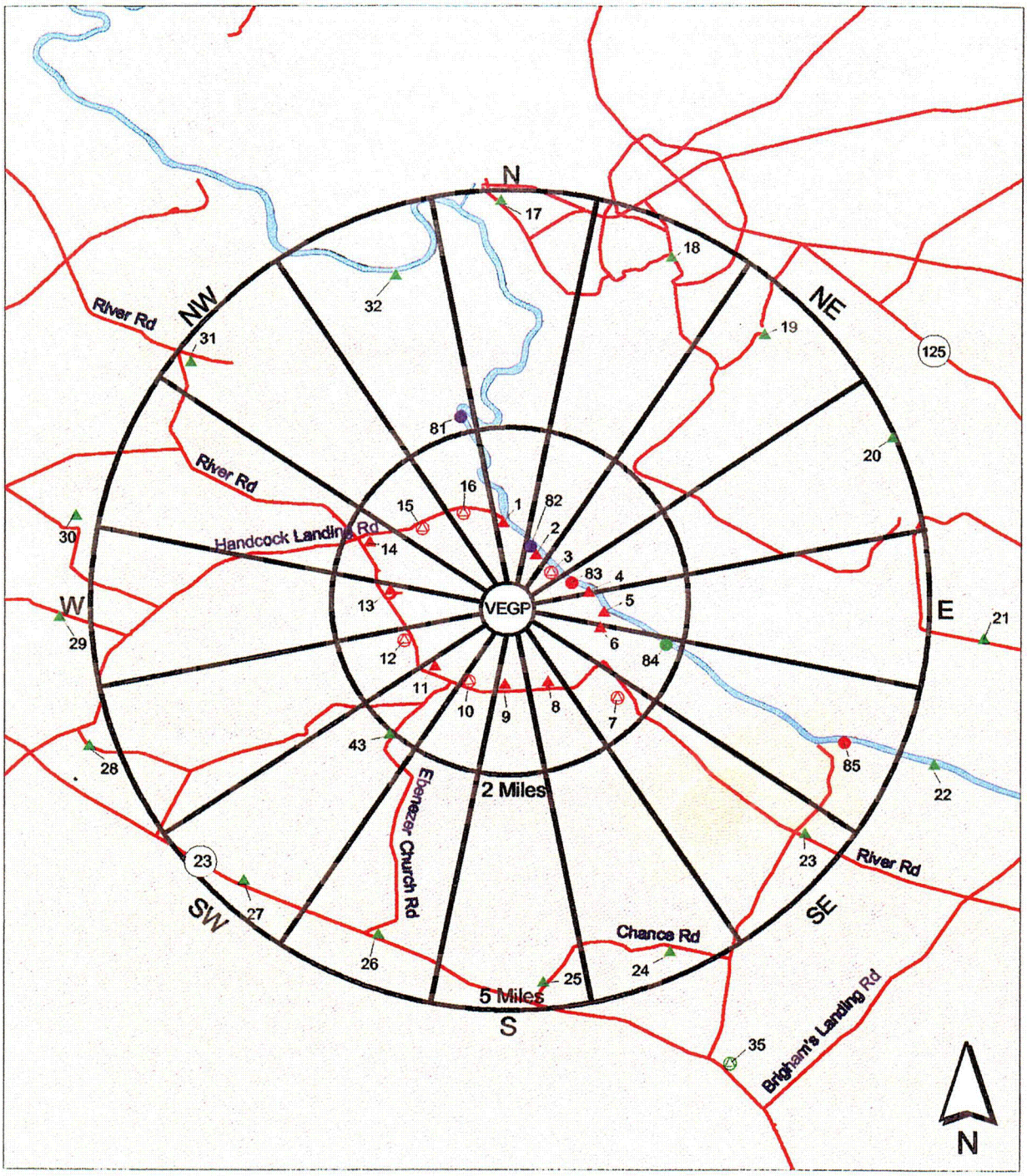
(2) The intake for the Augusta Water Treatment Plant is located on the Augusta Canal. The entrance to the canal is at River Mile (RM) 207 on the Savannah River. The canal effectively parallels the river. The intake to the pumping station is about 4 miles down the canal.

(3) A 5 mile stretch of the river is generally needed to obtain adequate fish samples. Samples are normally gathered between RM 153 and 158 for upriver collections and between RM 144 and 149.4 for downriver collections.

(4) Sediment is collected at locations with existing or potential recreational value. Because high water, shifting of the river bottom, or other reasons could cause a suitable location for sediment collections to become unavailable or unsuitable, a stretch of the river between RM 148.5 and 150.5 was designated for downriver collections while a stretch between RM 153 and 154 was designated for upriver collections. In practice, collections are normally made at RM 150.2 for downriver collections and RM 153.3 for upriver collections.

(5) The intake for the Beaufort-Jasper County Water Treatment Plant is located at the end of a canal that begins at RM 39.3 on the Savannah River. This intake is about 16 miles by line of sight down the canal from its beginning on the Savannah River.

(6) The intake for the Cherokee Hill Water Treatment Plant is located on Abercorn Creek which is about one and a quarter creek miles from its mouth on the Savannah River at RM 29.



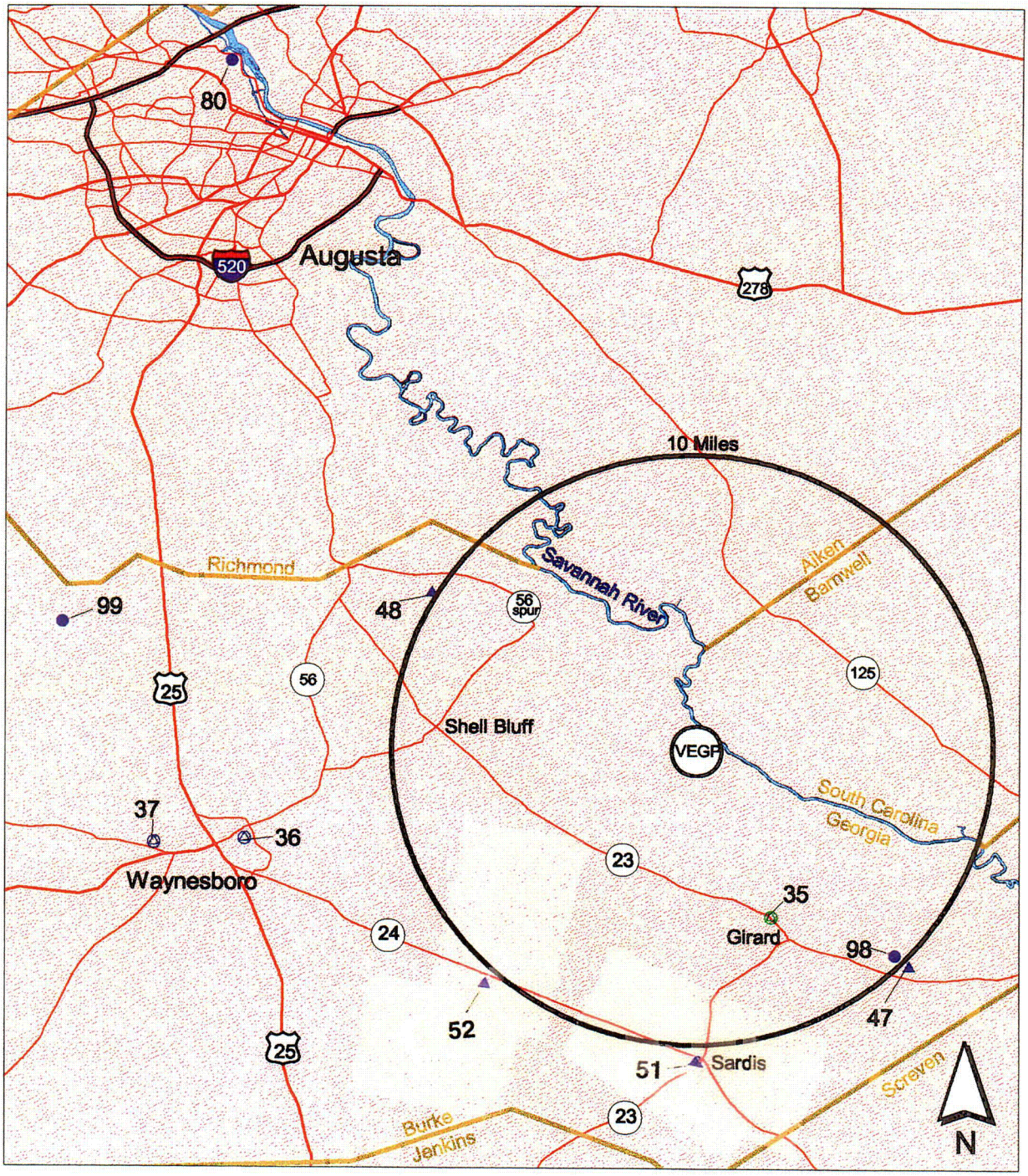

| Radiological Environmental Sampling Locations | | | |
|---|---|---|---|
| | Indicator | Control | Additional |
| TLD | ▲ | ▲ | ▲ |
| Other | ● | ● | ● |
| TLD & Other | ◬ | ◬ | ◬ |

**REMP Stations in the Plant Vicinity**

Figure 2-1



C01



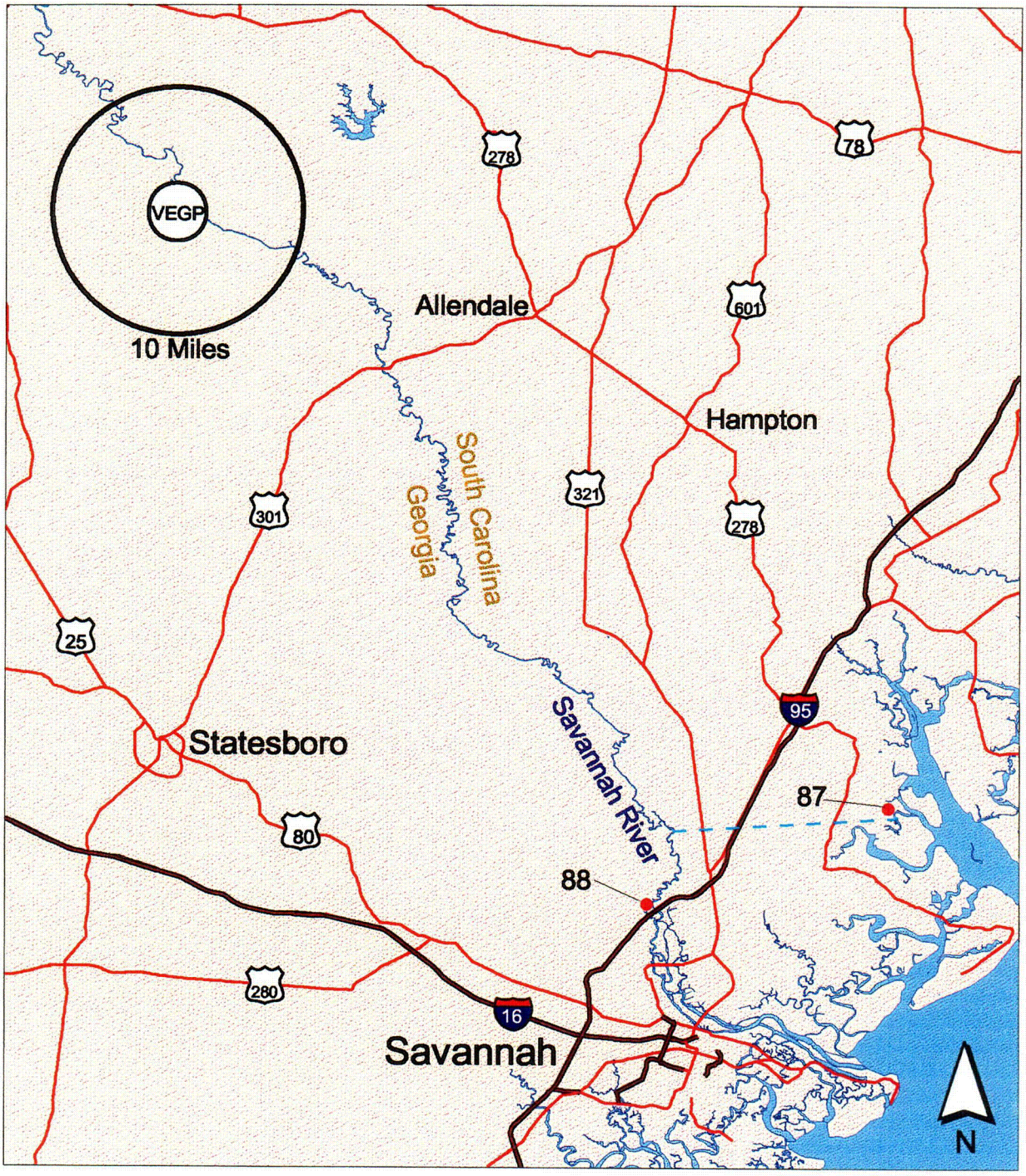

| Radiological Environmental Sampling Locations | Indicator | Control | Additional |
|---|---|---|---|
| TLD | ▲ | ▲ | ▲ |
| Other | ● | ● | ● |
| TLD & Other | ◬ | ◬ | ◬ |

**REMP Control Stations for the Plant**

Figure 2-2



C02




| Radiological Environmental Sampling Locations | | | |
|---|---|---|---|
| | Indicator | Control | Additional |
| TLD | ▲ | ▲ | ▲ |
| Other | ● | ● | ● |
| TLD & Other | ◬ | ◬ | ◬ |

**REMP Indicator Drinking Water Stations**

Figure 2-3



C03

# 3.0 RESULTS SUMMARY

In accordance with ODCM 7.1.2.1, the summarized and tabulated results for all of the regular samples collected for the year at the designated indicator and control stations are presented in Table 3-1. The format of Table 3-1 is similar to Table 3 of the Nuclear Regulatory Commission (NRC) Branch Technical Position, "An Acceptable Radiological Environmental Monitoring Program", Revision 1, November 1979. Results for samples collected at locations other than indicator or control stations are discussed in Section 4 under the particular sample type.

As indicated in ODCM 7.1.2.1, the results for naturally occurring radionuclides that are also found in plant effluents must be reported along with man-made radionuclides. The radionuclide Be-7 which occurs abundantly in nature is found in some years in the plant's liquid and gaseous effluent. No other naturally occurring radionuclides are found in the plant's effluent releases. Therefore, the only radionuclides of interest in the REMP samples are the man-made radionuclides and Be-7, when it is detected in the effluent.

## TABLE 3-1 (SHEET 1 of 8)

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY

**Vogtle Electric Generating Plant, Docket Nos. 50-424 and 50-425**
**Burke County, Georgia**

| Medium or Pathway Sampled (Unit of Measurement) | Type and Total Number of Analyses Performed | Minimum Detectable Concentration (MDC) (a) | Indicator Locations Mean (b), Range (Fraction) | Location with the Highest Annual Mean | | Other Stations (g) Mean (b), Range (Fraction) | Control Locations Mean (b), Range (Fraction) |
|---|---|---|---|---|---|---|---|
| | | | | Name Distance & Direction | Mean (b), Range (Fraction) | | |
| Airborne Particulates (fCi/m3) | Gross Beta 364 | 10 | 19.9<br>5-33<br>(260/260) | Station 16<br>Hancock<br>Landing Road<br>1.4 miles NNW | 20.6<br>9-30<br>(52/52) | 18.6<br>5-29<br>(52/52) | 18.9<br>6-26<br>(52/52) |
| | Gamma Isotopic 28 | | | | | | |
| | Cs-134 | 50 | NDM (c) | | NDM | NDM | NDM |
| | Cs-137 | 60 | NDM | | NDM | NDM | NDM |
| Airborne Radioiodine (fCi/m3) | I-131 364 | 70 | NDM | | NDM | NDM | NDM |
| Direct Radiation (mR/91 days) | Gamma Dose 158 | NA (d) | 12.8<br>9.6-18.0<br>(63/63) | Station 01<br>River Bank<br>1.1 mile N | 16.7<br>15.0-18.0<br>(4/4) | 12.6<br>8.8-17.9<br>(72/72) | 12.9<br>10.5-16.9<br>(23/23) |

## TABLE 3-1 (SHEET 2 of 8)

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY

**Vogtle Electric Generating Plant, Docket Nos. 50-424 and 50-425**
**Burke County, Georgia**

| Medium or Pathway Sampled (Unit of Measurement) | Type and Total Number of Analyses Performed | Minimum Detectable Concentration (MDC) (a) | Indicator Locations Mean (b), Range (Fraction) | Location with the Highest Annual Mean | | Other Stations (g) Mean (b), Range (Fraction) | Control Locations Mean (b), Range (Fraction) |
|---|---|---|---|---|---|---|---|
| | | | | Name Distance & Direction | Mean (b), Range (Fraction) | | |
| Milk (pCi/l) | Gamma Isotopic 52 | | | | | | |
| | Cs-134 | 15 | NA | | NDM | NA | NDM |
| | Cs-137 | 18 | NA | | NDM | NA | NDM |
| | Ba-140 | 60 | NA | | NDM | NA | NDM |
| | La-140 | 15 | NA | | NDM | NA | NDM |
| | I-131 52 | 1 | NA | | NDM | NA | NDM |
| Vegetation (pCi/kg-wet) | Gamma Isotopic 36 | | | | | | |
| | I-131 | 60 | NDM | | NDM | NA | NDM |
| | Cs-134 | 60 | NDM | | NDM | NA | NDM |
| | Cs-137 | 80 | NDM | Station 37 Waynesboro, GA 16.7 miles WSW | 98.3 98.3-98.3 (1/12) | NA | 98.3 98.3-98.3 (1/12) |

TABLE 3-1 (SHEET 3 of 8)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY
Vogtle Electric Generating Plant, Docket Nos. 50-424 and 50-425
Burke County, Georgia

| Medium or Pathway Sampled (Unit of Measurement) | Type and Total Number of Analyses Performed | Minimum Detectable Concentration (MDC) (a) | Indicator Locations Mean (b), Range (Fraction) | Location with the Highest Annual Mean | | Other Stations (g) Mean (b), Range (Fraction) | Control Locations Mean (b), Range (Fraction) |
|---|---|---|---|---|---|---|---|
| | | | | Name Distance & Direction | Mean (b), Range (Fraction) | | |
| River Water (pCi/l) | Gamma Isotopic 36 | | | | | | |
| | Mn-54 | 15 | NDM | | NDM | NDM | NDM |
| | Fe-59 | 30 | NDM | | NDM | NDM | NDM |
| | Co-58 | 15 | NDM | | NDM | NDM | NDM |
| | Co-60 | 15 | NDM | | NDM | NDM | NDM |
| | Zn-65 | 30 | NDM | | NDM | NDM | NDM |
| | Zr-95 | 30 | NDM | | NDM | NDM | NDM |
| | Nb-95 | 15 | NDM | | NDM | NDM | NDM |
| | I-131 | 15 | NDM | | NDM | NDM | NDM |
| | Cs-134 | 15 | NDM | | NDM | NDM | NDM |
| | Cs-137 | 18 | NDM | | NDM | NDM | NDM |
| | Ba-140 | 60 | NDM | | NDM | NDM | NDM |
| | La-140 | 15 | NDM | | NDM | NDM | NDM |
| | Tritium 12 | 3000 | 2628 1570-3180 (4/4) | Station 83 0.8 miles ENE (Downriver 0.4 miles) | 2628 1570-3180 (4/4) | 1280 738-1510 (4/4) | 437 219-710 (4/4) |

TABLE 3-1 (SHEET 4 of 8)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY
Vogtle Electric Generating Plant, Docket Nos. 50-424 and 50-425
Burke County, Georgia

| Medium or Pathway Sampled (Unit of Measurement) | Type and Total Number of Analyses Performed | Minimum Detectable Concentration (MDC) (a) | Indicator Locations Mean (b), Range (Fraction) | Location with the Highest Annual Mean<br>Name Distance & Direction | Mean (b), Range (Fraction) | Other Stations (g) Mean (b), Range (Fraction) | Control Locations Mean (b), Range (Fraction) |
|---|---|---|---|---|---|---|---|
| Water Near Intakes to Water Treatment Plants (pCi/l) | Gross Beta<br>36 | 4 | 3.09<br>0.56-5.10<br>(24/24) | Station 87<br>Beaufort<br>76 miles SE | 3.28<br>1.04-5.10<br>(12/12) | NA | 2.61<br>0.94-5.00<br>(12/12) |
| | Gamma Isotopic<br>36 | | | | | | |
| | Mn-54 | 15 | NDM | | NDM | NA | NDM |
| | Fe-59 | 30 | NDM | | NDM | NA | NDM |
| | Co-58 | 15 | NDM | | NDM | NA | NDM |
| | Co-60 | 15 | NDM | | NDM | NA | NDM |
| | Zn-65 | 30 | NDM | | NDM | NA | NDM |
| | Zr-95 | 30 | NDM | | NDM | NA | NDM |
| | Nb-95 | 15 | NDM | | NDM | NA | NDM |
| | I-131(f) | 15 | NDM | | NDM | NA | NDM |
| | Cs-134 | 15 | NDM | | NDM | NA | NDM |
| | Cs-137 | 18 | NDM | | NDM | NA | NDM |
| | Ba-140 | 60 | NDM | | NDM | NA | NDM |
| | La-140 | 15 | NDM | | NDM | NA | NDM |
| | Tritium<br>12 | 3000 | 938<br>521-1310<br>(8/8) | Station 87<br>Beaufort<br>76 miles SE | 1028<br>770-1310<br>(4/4) | NA | 304<br>257-348<br>(4/4) |

TABLE 3-1 (SHEET 5 of 8)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY
Vogtle Electric Generating Plant, Docket Nos. 50-424 and 50-425
Burke County, Georgia

| Medium or Pathway Sampled (Unit of Measurement) | Type and Total Number of Analyses Performed | Minimum Detectable Concentration (MDC) (a) | Indicator Locations Mean (b), Range (Fraction) | Location with the Highest Annual Mean<br>Name Distance & Direction | Mean (b), Range (Fraction) | Other Stations (g) Mean (b), Range (Fraction) | Control Locations Mean (b), Range (Fraction) |
|---|---|---|---|---|---|---|---|
| Finished Water at Water Treatment Plants (pCi/l) | Gross Beta<br>36 | 4 | 2.80<br>0.87-4.38<br>(24/24) | Station 88<br>Port Wentworth, GA<br>72 miles SSE | 2.93<br>0.87-4.38<br>(12/12) | NA | 2.61<br>0.90-5.22<br>(12/12) |
| | Gamma Isotopic<br>36 | | | | | | |
| | Mn-54 | 15 | NDM | | NDM | NA | NDM |
| | Fe-59 | 30 | NDM | | NDM | NA | NDM |
| | Co-58 | 15 | NDM | | NDM | NA | NDM |
| | Co-60 | 15 | NDM | | NDM | NA | NDM |
| | Zn-65 | 30 | NDM | | NDM | NA | NDM |
| | Zr-95 | 30 | NDM | | NDM | NA | NDM |
| | Nb-95 | 15 | NDM | | NDM | NA | NDM |
| | I-131 | 1 | NDM | | NDM | NA | NDM |
| | Cs-134 | 15 | NDM | | NDM | NA | NDM |
| | Cs-137 | 18 | NDM | | NDM | NA | NDM |
| | Ba-140 | 60 | NDM | | NDM | NA | NDM |
| | La-140 | 15 | NDM | | NDM | NA | NDM |
| | Tritium<br>12 | 2000 | 1060<br>762-1950<br>(8/8) | Station 87<br>Beaufort<br>76 miles SE | 1132<br>762-1950<br>(4/4) | NA | 340<br>295-385<br>(2/4) |

## TABLE 3-1 (SHEET 6 of 8)

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY

**Vogtle Electric Generating Plant, Docket Nos. 50-424 and 50-425**
**Burke County, Georgia**

| Medium or Pathway Sampled (Unit of Measurement) | Type and Total Number of Analyses Performed | Minimum Detectable Concentration (MDC) (a) | Indicator Locations Mean (b), Range (Fraction) | Location with the Highest Annual Mean | | Other Stations (g) Mean (b), Range (Fraction) | Control Locations Mean (b), Range (Fraction) |
|---|---|---|---|---|---|---|---|
| | | | | Name Distance & Direction | Mean (b), Range (Fraction) | | |
| Anadromous Fish (pCi/kg-wet) | Gamma Isotopic 1 | | | | | | |
| | Mn-54 | 130 | NDM | | NDM | NA | NA |
| | Fe-59 | 260 | NDM | | NDM | NA | NA |
| | Co-58 | 130 | NDM | | NDM | NA | NA |
| | Co-60 | 130 | NDM | | NDM | NA | NA |
| | Zn-65 | 260 | NDM | | NDM | NA | NA |
| | Cs-134 | 130 | NDM | | NDM | NA | NA |
| | Cs-137 | 150 | NDM | | NDM | NA | NA |
| Fish (pCi/kg-wet) | Gamma Isotopic 5 | | | | | | |
| | Mn-54 | 130 | NDM | | NDM | NA | NDM |
| | Fe-59 | 260 | NDM | | NDM | NA | NDM |
| | Co-58 | 130 | NDM | | NDM | NA | NDM |
| | Co-60 | 130 | NDM | | NDM | NA | NDM |
| | Zn-65 | 260 | NDM | | NDM | NA | NDM |
| | Cs-134 | 130 | NDM | | NDM | NA | NDM |
| | Cs-137 | 150 | 58.9<br>47.9-69.9<br>(2/2) | Station 81<br>2.5 miles N | 132.6<br>22.8-321.5<br>(3/3) | NA | 132.6<br>22.8-321.5<br>(3/3) |

## TABLE 3-1 (SHEET 7 of 8)

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY

**Vogtle Electric Generating Plant, Docket Nos. 50-424 and 50-425**
**Burke County, Georgia**

| Medium or Pathway Sampled (Unit of Measurement) | Type and Total Number of Analyses Performed | Minimum Detectable Concentration (MDC) (a) | Indicator Locations Mean (b), Range (Fraction) | Location with the Highest Annual Mean | | Other Stations (g) Mean (b), Range (Fraction) | Control Locations Mean (b), Range (Fraction) |
|---|---|---|---|---|---|---|---|
| | | | | Name Distance & Direction | Mean (b), Range (Fraction) | | |
| Sediment (pCi/kg-dry) | Gamma Isotopic 4 | | | | | | |
| | Co-60 | 70(e) | 49.7<br>49.7-49.7<br>(1/2) | Station 83<br>0.8 miles ENE<br>(RM 150.4) | 49.7<br>49.7-49.7<br>(1/2) | NA | NDM |
| | Cs-134 | 150 | NDM | | NDM | NA | NDM |
| | Cs-137 | 180 | 189.3<br>65.1-313.6<br>(2/2) | Station 83<br>0.8 miles ENE<br>(RM 150.4) | 189.3<br>65.1-313.6<br>(2/2) | NA | 59.5<br>10.9-108.1<br>(2/2) |

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY

**Vogtle Electric Generating Plant, Docket Nos. 50-424 and 50-425**
**Burke County, Georgia**

Notes:

a. The MDC is defined in ODCM 10.1. Except as noted otherwise, the values listed in this column are the detection capabilities required by ODCM Table 4-3. The values listed in this column are a priori (before the fact) MDCs. In practice, the a posteriori (after the fact) MDCs are generally lower than the values listed. Any a posteriori MDC greater than the value listed in this column is discussed in Section 4.

b. Mean and range are based upon detectable measurements only. The fraction of all measurements at a specified location that are detectable is placed in parenthesis.

c. No Detectable Measurement(s).

d. Not Applicable.

e. The EL has determined that this value may be routinely attained under normal conditions. No value is provided in ODCM Table 4-3.

f. Item 3 of ODCM Table 4-1 implies that an I-131 analysis is not required to be performed on water samples when the dose calculated from the consumption of water is less then 1 mrem per year. However, I-131 analyses have been performed on the finished drinking water samples.

g. "Other" stations, as identified in the "Station Type" column of Table 2-2, are "Community" and/or "Special" stations.

# 4.0 DISCUSSION OF RESULTS

Included in this section are evaluations of the laboratory results for the various sample types. Comparisons were made between the difference in mean values for pairs of station groups (e.g., indicator and control stations) and the calculated Minimum Detectable Difference (MDD) between these pairs at the 99% Confidence Level (CL). The MDD was determined using the standard Student's t-test. A difference in the mean values that was less than the MDD was considered to be statistically indiscernible.

The 2002 results were compared with past results, including those obtained during preoperation. As appropriate, results were compared with their Minimum Detectable Concentrations (MDC) and Reporting Levels (RL) which are listed in Tables 4-1 and 4-2 of this report, respectively. The required MDCs were achieved during laboratory sample analysis. Any anomalous results are explained within this report.

Results of interest are graphed to show historical trends. The data points are tabulated and included in this report. The points plotted and provided in the tables represent mean values of only detectable results. Periods for which no detectable measurements (NDM) were observed or periods for which values were not applicable (e.g., milk indicator, etc.) are plotted as and listed in the tables as 0's.

## Table 4-1

## Minimum Detectable Concentrations (MDC)

| Analysis | Water (pCi/l) | Airborne Particulate or Gases (fCi/m3) | Fish (pCi/kg-wet) | Milk (pCi/l) | Grass or Leafy Vegetation (pCi/kg-wet) | Sediment (pCi/kg) |
|---|---|---|---|---|---|---|
| Gross Beta | 4 | 10 | | | | |
| H-3 | 2000 (a) | | | | | |
| Mn-54 | 15 | | 130 | | | |
| Fe-59 | 30 | | 260 | | | |
| Co-58 | 15 | | 130 | | | |
| Co-60 | 15 | | 130 | | | |
| Zn-65 | 30 | | 260 | | | |
| Zr-95 | 30 | | | | | |
| Nb-95 | 15 | | | | | |
| I-131 | 1 (b) | 70 | | 1 | 60 | |
| Cs-134 | 15 | 50 | 130 | 15 | 60 | 150 |
| Cs-137 | 18 | 60 | 150 | 18 | 80 | 180 |
| Ba-140 | 60 | | | 60 | | |
| La-140 | 15 | | | 15 | | |

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

(b) If no drinking water pathway exists, a value of 15 pCi/l may be used.

## Table 4-2
## Reporting Levels (RL)

| Analysis | Water (pCi/l) | Airborne Particulate or Gases (fCi/m3) | Fish (pCi/kg-wet) | Milk (pCi/l) | Grass or Leafy Vegetation (pCi/kg-wet) |
|---|---|---|---|---|---|
| H-3 | 20,000 (a) | | | | |
| Mn-54 | 1000 | | 30,000 | | |
| Fe-59 | 400 | | 10,000 | | |
| Co-58 | 1000 | | 30,000 | | |
| Co-60 | 300 | | 10,000 | | |
| Zn-65 | 300 | | 20,000 | | |
| Zr-95 | 400 | | | | |
| Nb-95 | 700 | | | | |
| I-131 | 2 (b) | 900 | | 3 | 100 |
| Cs-134 | 30 | 10,000 | 1000 | 60 | 1000 |
| Cs-137 | 50 | 20,000 | 2000 | 70 | 2000 |
| Ba-140 | 200 | | | 300 | |
| La-140 | 100 | | | 400 | |

(a) This is the 40 CFR 141 value for drinking water samples. If no drinking water pathway exists, a value of 30,000 may be used.

(b) If no drinking water pathway exists, a value of 20 pCi/l may be used.

Atmospheric nuclear weapons tests from the mid 1940s through 1980 distributed man-made nuclides around the world. The most recent atmospheric tests in the 1970s and in 1980 had a significant impact upon the radiological concentrations found in the environment prior to and during preoperation, and the earlier years of operation. Some long lived radionuclides, such as Cs-137, continue to have some impact. A significant component of the Cs-137 which has often been found in various samples over the years (and continues to be found) is attributed to the nuclear weapons tests.

Data in this section has been modified to remove any obvious non-plant short term impacts. The specific short term impact data that has been removed includes: the nuclear atmospheric weapon test in the fall of 1980; abnormal releases from the Savannah River Site (SRS) during 1987 and 1991; and the Chernobyl incident in the spring of 1986.

In accordance with ODCM 4.1.1.2.1, deviations from the required sampling schedule are permitted, if samples are unobtainable due to hazardous conditions, unavailability, inclement weather, equipment malfunction or other just reasons. Deviations from conducting the REMP as described in Table 2-1 are summarized in Table 4-3 along with their causes and resolutions. As discussed in Section 4.3, during 2002 only two deviations resulted in loss of data. During the mid-quarter inspection for the 2nd quarter, the Station 07 TLDs were found lying on the ground, outside of the plastic bag. These TLDs were replaced for the remainder of the quarter. However, the results obtained from the replacement TLDs failed Chauvenet's criterion and were excluded from the direct radiation data. At the end of quarter 4, the Station 48 TLDs were missing, therefore no data was available from this station for the 4th quarter.

All results were tested for conformance with Chauvenet's criterion (G. D. Chase and J. L. Rabinowitz, Principles of Radioisotope Methodology, Burgess Publishing Company, 1962, pages 87-90) to identify values which differed from the mean of a set by a statistically significant amount. Identified outliers were investigated to determine the reason(s) for the difference. If equipment malfunction or other valid physical reasons were identified as causing the variation, the anomalous result was excluded from the data set as non-representative. No data were excluded exclusively for failing Chauvenet's criterion. Data exclusions are discussed in this section under the appropriate sample type.

## TABLE 4-3

## DEVIATIONS FROM RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

| COLLECTION PERIOD | AFFECTED SAMPLES | DEVIATION | CAUSE | RESOLUTION |
|---|---|---|---|---|
| 04/09/02 - 04/16/02 | Girard Air Filter and Air Cartridge Station 35 | Non-representative sample of airborne particulates. | Hole found in air filter when collected. | Replaced iodine cartridge and particulate filter. |
| 04/16/02 - 04/23/02 | Girard Air Filter and Air Cartridge Station 35 | Non-representative sample of airborne particulates. | Hole found in air filter when collected. | Replaced iodine cartridge and particulate filter. |
| 05/07/02 - 05/14/02 | Girard Air Filter and Air Cartridge Station 35 | Non-representative sample of airborne particulates. | Hole found in air filter when collected. | Replaced iodine cartridge and particulate filter. |
| 2nd Quarter 02 | Simulator Building TLD Station 07 | Station 07 TLDs were not in place for the entire quarter. | Station 07 TLDs found on the ground (outside of plastic bags) at mid-quarter. | Replaced with blank TLDs to obtain results for remainder of quarter. |
| 08/20/02 – 08/27/02 | Discharge Area Air Filter and Air Cartridge Station 03 | Airborne particulates and radioiodine monitoring were not performed for 34 hours. | Sample pump motor locked up. | Sample pump motor was replaced and sampler returned to service. |
| 10/29/02 – 11/05/02 | Girard Air Filter and Air Cartridge Station 35 | Airborne particulates and radioiodine monitoring were not performed for 13.1 hours. | Sample pump motor locked up. | Sample pump motor was replaced and sampler returned to service. |
| 4th Quarter 02 | McBean Cemetery TLD Station 48 | No direct radiation measurement obtained. | TLDs were missing at end of quarter. | TLDs replaced. |

# 4.1 Land Use Census and River Survey

In accordance with ODCM 4.1.2, a land use census was conducted on November 12, 2002 to determine the locations of the nearest permanent residence, milk animal, and garden of greater than 500 square feet producing broad leaf vegetation, in each of the 16 compass sectors within a distance of 5 miles; the locations of the nearest beef cattle in each sector were also determined. A milk animal is a cow or goat producing milk for human consumption. Land within SRS was excluded from the census. The census results are tabulated in Table 4.1-1.

## Table 4.1-1

## LAND USE CENSUS RESULTS

**Distance in Miles to the Nearest Location in Each Sector**

| SECTOR | RESIDENCE | MILK ANIMAL | BEEF CATTLE | GARDEN |
|---|---|---|---|---|
| N | None | None | None | None |
| NNE | None | None | None | None |
| NE | None | None | None | None |
| ENE | None | None | None | None |
| E | None | None | None | None |
| ESE | 4.2 | None | None | None |
| SE | 4.4 | None | 5.0 | None |
| SSE | 4.6 | None | 4.6 | None |
| S | 4.4 | None | None | None |
| SSW | 4.7 | None | 4.5 | None |
| SW | 2.7 | None | 2.7 | 4.8 |
| WSW | 1.2 | None | 4.5 | 3.2 |
| W | 3.7 | None | 4.4 | 4.2 |
| WNW | 1.8 | None | None | 3.4 |
| NW | 1.6 | None | 1.9 | 2.5 |
| NNW | 1.5 | None | None | None |

ODCM 4.1.2.2.1 requires a new controlling receptor to be identified, if the land use census identifies a location that yields a calculated receptor dose greater than the one in current use. It was determined that no change in the controlling receptor was required in 2002.

ODCM 4.1.2.2.2 requires that whenever the land use census identifies a location which yields a calculated dose (via the same ingestion pathway) 20% greater than that of a current indicator station, the new location must become a REMP station (if samples are available). None of the identified locations yielded a calculated

dose 20% greater than that for any of the current indicator stations. No milk animals were identified within five miles of the plant.

A survey of the Savannah River downstream of the plant for approximately 100 miles was conducted on September 17, 2002 to identify any withdrawal of water from the river for drinking or irrigation purposes. No such usage was identified. These results were corroborated by checking with the Georgia Department of Natural Resources and the South Carolina Department of Health and Environmental Control. Each of these agencies confirmed that no water withdrawal permits for drinking or irrigation purposes had been issued for this stretch of the Savannah River. The two water treatment plants used as indicator stations for drinking water are located farther downriver.

## 4.2 Airborne

As specified in Table 2-1 and shown in Figures 2-1 through 2-3, airborne particulate filters and charcoal canisters are collected weekly at 5 indicator stations (Stations 3, 7, 10, 12 and 16) which encircle the plant at the site periphery, at a nearby community station (Station 35) approximately 7 miles from the plant, and at a control station (Station 36) which is approximately 14 miles from the plant. At each location, air is continuously drawn through a glass fiber filter to retain airborne particulate and an activated charcoal canister is placed in series with the filter to adsorb radioiodine.

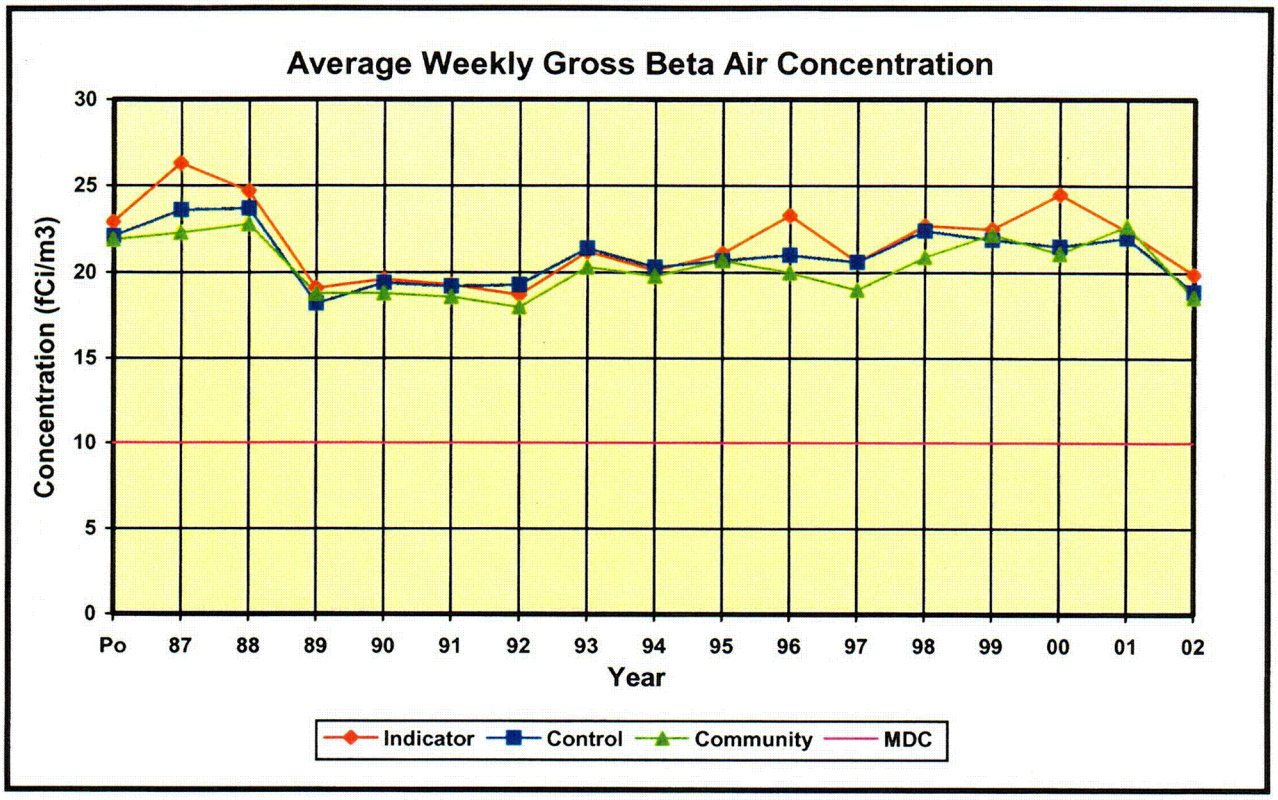
Each particulate filter is counted for gross beta activity. A quarterly gamma isotopic analysis is performed on a composite of the air particulate filters for each station. Each charcoal canister is analyzed for I-131.

As provided in Table 3-1, the 2002 annual average weekly gross beta activity was 19.9 $fCi/m^3$ for the indicator stations. This concentration is slightly lower than in previous years of operation. It was 1.0 $fCi/m^3$ greater than the control station average for the year. This difference is not statistically discernible, since it is less than the calculated MDD of 1.9 $fCi/m^3$.

The 2002 annual average weekly gross beta activity at the Girard community station was 18.6 $fCi/m^3$ which was 0.3 $fCi/m^3$ less than the control station average. This difference is not statistically discernible since it is less than the calculated MDD of 2.4 $fCi/m^3$.

The historical trending of the average weekly gross beta air concentrations for each year of operation and the preoperational period (September, 1981 to January, 1987) at the indicator, control and community stations is plotted in Figure 4.2-1 and listed in Table 4.2-1. In general, there is close agreement between the results for the indicator, control and community stations. This close agreement supports the position that the plant is not contributing significantly to the gross beta concentrations in air.

## Figure 4.2-1




## Table 4.2-1

## Average Weekly Gross Beta Air Concentration

| Period | Indicator (fCi/m3) | Control (fCi/m3) | Community (fCi/m3) |
|---|---|---|---|
| Pre-op | 22.9 | 22.1 | 21.9 |
| 1987 | 26.3 | 23.6 | 22.3 |
| 1988 | 24.7 | 23.7 | 22.8 |
| 1989 | 19.1 | 18.2 | 18.8 |
| 1990 | 19.6 | 19.4 | 18.8 |
| 1991 | 19.3 | 19.2 | 18.6 |
| 1992 | 18.7 | 19.3 | 18.0 |
| 1993 | 21.2 | 21.4 | 20.3 |
| 1994 | 20.1 | 20.3 | 19.8 |
| 1995 | 21.1 | 20.7 | 20.7 |
| 1996 | 23.3 | 21.0 | 20.0 |
| 1997 | 20.6 | 20.6 | 19.0 |
| 1998 | 22.7 | 22.4 | 20.9 |
| 1999 | 22.5 | 21.9 | 22.2 |
| 2000 | 24.5 | 21.5 | 21.1 |
| 2001 | 22.4 | 22.0 | 22.7 |
| 2002 | 19.9 | 18.9 | 18.6 |



C04

During 2002, no man-made radionuclides were detected from the gamma isotopic analysis of the quarterly composites of the air particulate filters. In 1987, Cs-137 was found in one indicator composite at a concentration of 1.7 fCi/$m^3$. During preoperation, Cs-137 was found in approximately 12% of the indicator composites and 14% of the control composites with average concentrations of 1.7 and 1.0 fCi/$m^3$, respectively. The MDC for airborne Cs-137 is 60 fCi/$m^3$. Also, during preoperations, Cs-134 was found in about 8% of the indicator composites at an average concentration of 1.2 fCi/m3. The MDC for Cs-134 is 50 fCi/m3.

The naturally occurring radionuclide Be-7 is typically detected in all indicator and control station gamma isotopic analysis of the quarterly composites of the air particulate filters. In 2002, Be-7 was not identified in plant gaseous effluents therefore it is not included in the 2002 REMP summary table. Be-7 has been detected in gaseous effluents eight of the sixteen years of plant operation. However, there was not a statistically discernible difference between the indicator and control station Be-7 concentrations in air samples in any of the years.

Airborne I-131 was not detected in any sample during 2002. During preoperation, positive results were obtained only during the Chernobyl incident when concentrations as high as 182 fCi/$m^3$ were observed. The MDC and RL for airborne I-131 are 70 and 900 fCi/$m^3$, respectively.

Table 4-3 lists REMP deviations that occurred in 2002. None of the deviations listed in Table 4-3 required data to be excluded from the calculation of the mean detectable air sample values.

# 4.3 Direct Radiation

Direct (external) radiation is measured with thermoluminescent dosimeters (TLDs). Two Panasonic UD-814 TLD badges are placed at each station. Each badge contains three phosphors composed of calcium sulfate crystals (with thulium impurity). The gamma dose at each station is based upon the average readings of the phosphors from the two badges. The badges for each station are placed in thin plastic bags for protection from moisture while in the field. The badges are nominally exposed for periods of a quarter of a year (91 days). An inspection is performed near mid-quarter to assure that all badges are on-station and to replace any missing or damaged badges.

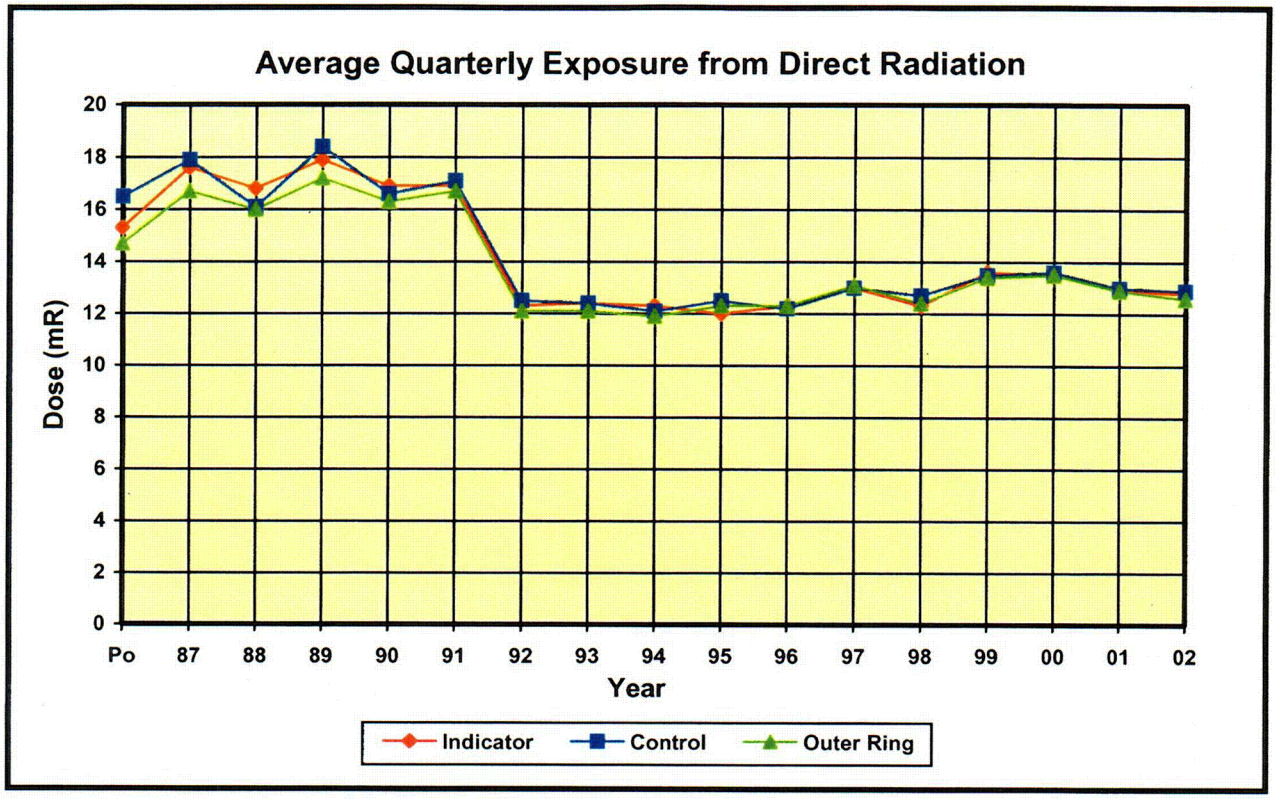
Two TLD stations are established in each of the 16 compass sectors, to form 2 concentric rings. The inner ring (Stations 1 through 16) is located near the plant perimeter as shown in Figure 2-1 and the outer ring (Stations 17 through 32) is located at a distance of approximately 5 miles from the plant as shown in Figure 2-2. The 16 stations forming the inner ring are designated as the indicator stations. The two ring configuration of stations was established in accordance with NRC Branch Technical Position "An Acceptable Radiological Environmental Monitoring Program", Revision 1, November 1979. The 6 control stations (Stations 36, 37, 47, 48, 51 and 52) are located at distances greater than 10 miles from the plant as shown in Figure 2-2. Monitored special interest areas consist of the following: Station 35 at the town of Girard, and Station 43 at the employee recreational area. The TLD mean and range values presented in the "Other" column in Table 3-1 (page 1 of 8) includes the outer ring stations (stations 17 through 32) as well as stations 35 and 43.

As provided in Table 3-1 the average quarterly exposure measured at the indicator stations was 12.8 mR with a range of 9.6 to 18.0 mR. This average was 0.1 mR less than the average quarterly exposure measured at the control stations. This difference is not statistically discernible since it is less than the MDD of 1.1 mR. Over the operational history of the site, the annual average quarterly exposures shows a variation of no more than 0.7 mR difference between the indicator and control stations. The overall average quarterly exposure for the control stations during preoperation was 1.2 mR greater than that for the indicator stations.

The quarterly exposures acquired at the outer ring stations during 2002 ranged from 8.8 to 17.9 mR with an average of 12.6 mR which was 0.3 mR less than that for the control stations. However, this difference is not discernible since it is less than the MDD of 1.2 mR. For the entire period of operation, the annual average quarterly exposures at the outer ring stations vary by no more than 1.2 mR from those at the control stations. The overall average quarterly exposure for the outer ring stations during preoperation was 1.8 mR less than that for the control stations.

The historical trending of the average quarterly exposures for the indicator inner ring, outer ring, and the control stations are plotted in Figure 4.3-1 and listed in Table 4.3-1. The decrease between 1991 and 1992 values is attributed to a change in TLDs from Teledyne to Panasonic. It should be noted however that the differences between indicator and control and outer ring values did not change. The close agreement between the station groups supports the position that the plant is not contributing significantly to direct radiation in the environment.

## Figure 4.3-1




## Table 4.3-1

### Average Quarterly Exposure from Direct Radiation

| Period | Indicator (mR) | Control (mR) | Outer Ring (mR) |
|---|---|---|---|
| Pre-op | 15.3 | 16.5 | 14.7 |
| 1987 | 17.6 | 17.9 | 16.7 |
| 1988 | 16.8 | 16.1 | 16.0 |
| 1989 | 17.9 | 18.4 | 17.2 |
| 1990 | 16.9 | 16.6 | 16.3 |
| 1991 | 16.9 | 17.1 | 16.7 |
| 1992 | 12.3 | 12.5 | 12.1 |
| 1993 | 12.4 | 12.4 | 12.1 |
| 1994 | 12.3 | 12.1 | 11.9 |
| 1995 | 12.0 | 12.5 | 12.3 |
| 1996 | 12.3 | 12.2 | 12.3 |
| 1997 | 13.0 | 13.0 | 13.1 |
| 1998 | 12.3 | 12.7 | 12.4 |
| 1999 | 13.6 | 13.5 | 13.4 |
| 2000 | 13.5 | 13.6 | 13.5 |
| 2001 | 12.9 | 13.0 | 12.9 |
| 2002 | 12.8 | 12.9 | 12.6 |



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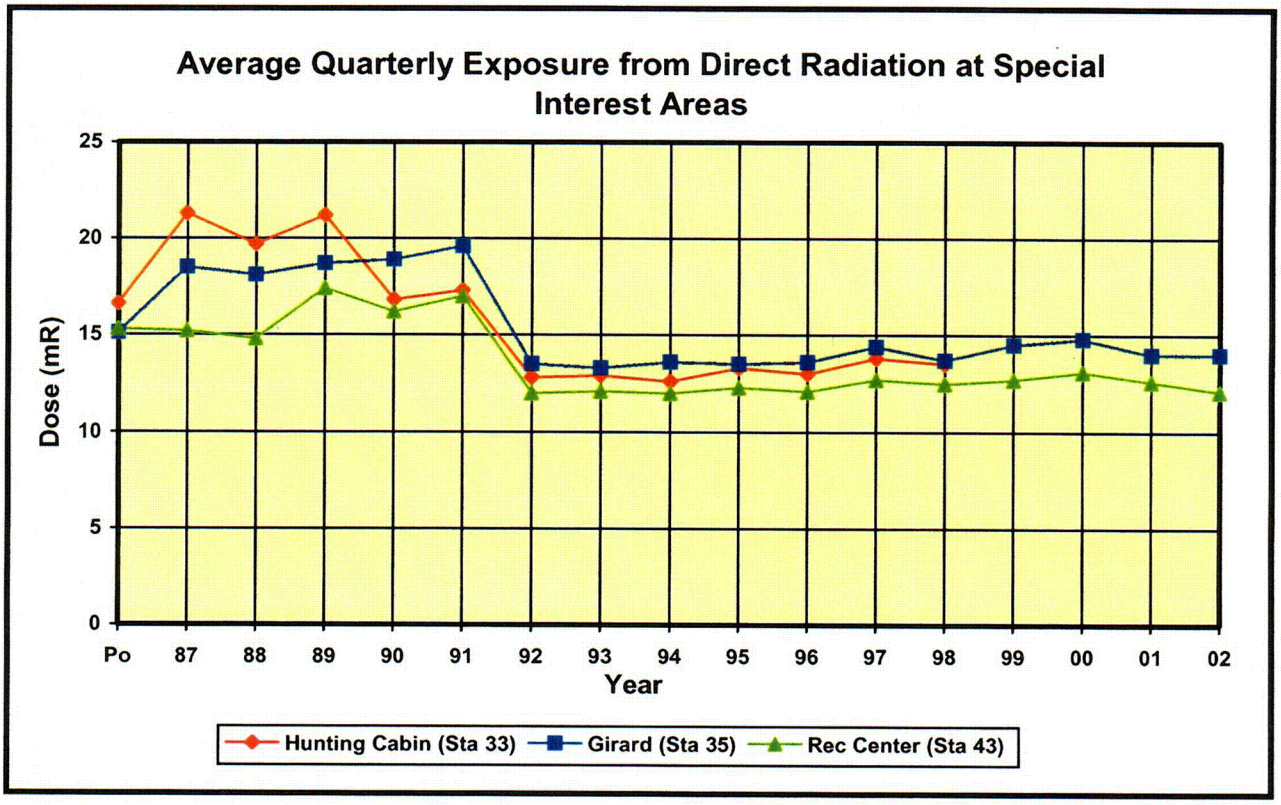
The historical trending of the average quarterly exposures at the special interest areas for the same periods are provided in Figure 4.3-2 and listed in Table 4.3-2. These exposures are within the range of those acquired at the other stations. They too, show that the plant is not contributing significantly to direct radiation at the special interest areas.

**Figure 4.3-2**






C06

## Table 4.3-2

## Average Quarterly Exposure from Direct Radiation at Special Interest Areas

| Period | Station 33 (mR) | Station 35 (mR) | Station 43 (mR) |
|---|---|---|---|
| Pre-op | 16.6 | 15.1 | 15.3 |
| 1987 | 21.3 | 18.5 | 15.2 |
| 1988 | 19.7 | 18.1 | 14.8 |
| 1989 | 21.2 | 18.7 | 17.4 |
| 1990 | 16.8 | 18.9 | 16.2 |
| 1991 | 17.3 | 19.6 | 17.0 |
| 1992 | 12.8 | 13.5 | 12.0 |
| 1993 | 12.9 | 13.3 | 12.1 |
| 1994 | 12.6 | 13.6 | 12.0 |
| 1995 | 13.3 | 13.5 | 12.3 |
| 1996 | 13.0 | 13.6 | 12.1 |
| 1997 | 13.8 | 14.4 | 12.7 |
| 1998 | 13.5 | 13.7 | 12.5 |
| 1999 | NA | 14.5 | 12.7 |
| 2000 | NA | 14.8 | 13.1 |
| 2001 | NA | 14.0 | 12.6 |
| 2002 | NA | 14.0 | 12.1 |

The hunting cabin activities at Station 33 have been discontinued and, consequently, this location is no longer considered as an area of special interest. Monitoring at this location was discontinued at the end of 1998.

There were two deviations from the REMP pertaining to measuring quarterly gamma doses during 2002. These deviations are listed in Table 4-3. One deviation occurred during the 2nd quarter when the dosimeter at Station 07 was discovered at mid-quarter inspection lying on the ground. The badge was replaced and the replacement remained on station until the end of the quarter. However, the resulting value failed Chauvenet's criterion and was excluded form the direct radiation data. The second deviation occurred at Station 48 during the 4th quarter. At sample collection, this dosimeter was discovered missing. Therefore, no data was available for Station 48 for the 4th quarter.

The standard deviation for the quarterly result for each badge was subjected to a self imposed limit of 1.4. This limit is based upon the standard deviations obtained with the Panasonic UD-814 badges during 1992 and is calculated using a method developed by the American Society of Testing and Materials (ASTM Special Technical Publication 15D, ASTM Manual on Presentation of Data and Control Chart Analysis, Fourth Revision, Philadelphia, PA, October 1976).

The limit serves as a flag to initiate an investigation. To be conservative, readings with a standard deviation greater than 1.4 are excluded since the high standard deviation is interpreted as an indication of unacceptable variation in TLD response.

The readings for the following badges were deemed unacceptable since the standard deviation for each badge was greater than the self-imposed limit of 1.4:

| | |
|---|---|
| First Quarter: | None |
| Second Quarter: | 03B and 16B |
| Third Quarter: | None |
| Fourth Quarter: | 32B |

However, for these cases when only one badge exceeded a standard deviation of 1.4, the companion badges were available and were used for determining the quarterly doses. The badges exceeding the self-imposed limit were visually inspected under a microscope and the glow curve and test results for the anneal data and the element correction factors were reviewed. No reason was evident for the high standard deviation.

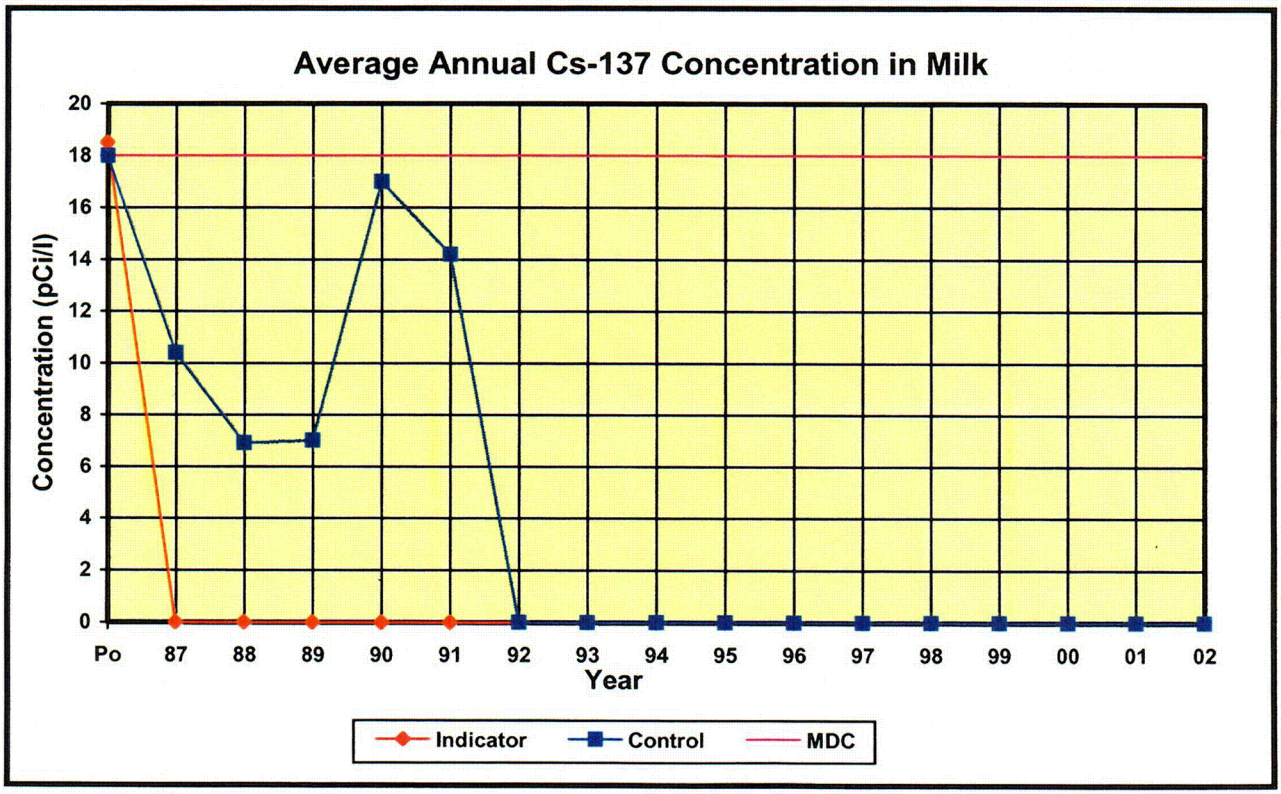
# 4.4 Milk

In accordance with Tables 2-1 and 2-2, milk samples are collected biweekly from two control locations, the W. C. Dixon Dairy (Station 98) and the Boyceland Dairy (Station 99). Gamma isotopic and I-131 analyses are performed on each sample.

No indicator station (a location within 5 miles of the plant) for milk has been available since April 1986. As discussed in Section 4.1, no milk animal was found during the 2002 land use census.

No man-made radionuclide was identified during the gamma isotopic analysis of the milk samples in 2002. The MDC and RL for Cs-137 in milk are 18 and 70 pCi/l, respectively. During preoperation and each year of operation through 1991, Cs-137 was found in 2 to 6% of the samples at concentrations ranging from 5 to 27 pCi/l. During preoperation, Cs-134 was detected in one sample and in the first year of operation, Zn-65 was detected in one sample. Figure 4.4-1 and Table 4.4-1 provide the historical trending of the Cs-137 concentration in milk.

**Figure 4.4-1**






C07

## Table 4.4-1

## Average Annual Cs-137 Concentration in Milk

| Year | Indicator (pCi/l) | Control (pCi/l) |
|---|---|---|
| Pre-op | 18.5 | 18 |
| 1987 | 0 | 10.4 |
| 1988 | 0 | 6.9 |
| 1989 | 0 | 7 |
| 1990 | 0 | 17 |
| 1991 | 0 | 14.2 |
| 1992 | 0 | 0 |
| 1993 | 0 | 0 |
| 1994 | 0 | 0 |
| 1995 | 0 | 0 |
| 1996 | 0 | 0 |
| 1997 | 0 | 0 |
| 1998 | 0 | 0 |
| 1999 | 0 | 0 |
| 2000 | 0 | 0 |
| 2001 | 0 | 0 |
| 2002 | 0 | 0 |

During 2002, I-131 was not detected in any of the milk samples. Since operations began in 1987, I-131 may have been detected in one sample in 1996 and two during 1990; however, its presence in these cases was questionable, due to large counting uncertainties. During preoperation, positive I-131 results were found only during the Chernobyl incident with concentrations ranging from 0.53 to 5.07 pCi/l. The MDC and RL for I-131 in milk are 1 and 3 pCi/l, respectively.

# 4.5 Vegetation

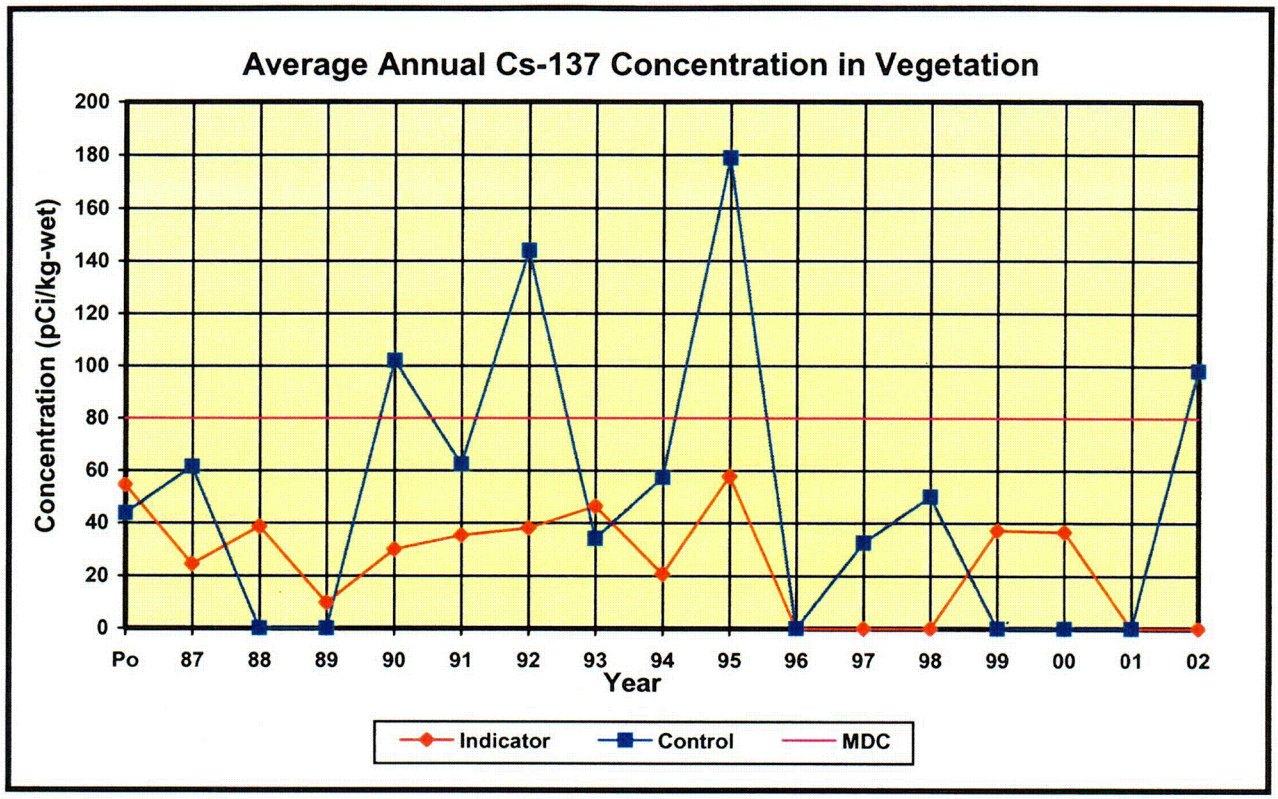
In accordance with Tables 2-1 and 2-2, grass samples are collected monthly at two indicator locations onsite near the site boundary (Stations 7 and 15) and at one control station located about 17 miles WSW from the plant (Station 37). Gamma isotopic analyses are performed on the samples. During 2002, one sample out of the twelve samples collected at the control station was positive for the man-made radionuclide, Cs-137. None of the twenty-four samples collected at the indicator stations were positive for man-made radionuclides.

Since Cs-137 is sometimes detected in environmental samples, as a result of atmospheric weapons testing and the Chernobyl incident, the historical trending of the average concentration of Cs-137 at the indicator and control stations is provided in Figure 4.5-1 and listed in Table 4.5-1. No trend is recognized in this data. The MDC and RL for Cs-137 in vegetation samples are 80 and 2000 pCi/kg-wet, respectively. Cs-137 is the only man-made radionuclide that has been identified in vegetation samples during the operational history of the plant. During preoperation, Cs-137 was found in approximately 60% of the samples from indicator stations and in approximately 20% of the samples from the control station. These percentages have generally decreased during operation.

The naturally occurring radionuclide Be-7 is typically detected in indicator and control station vegetation samples. Be-7 was not detected in gaseous effluents in 2002, therefore it is not included in the REMP summary table. Be-7 has been detected in gaseous effluents eight of the sixteen years of plant operation and is therefore of interest in the REMP program. However, the levels of Be-7 found in the REMP make no significant contribution to dose.

In May and June of 1986 during preoperation, as a consequence of the Chernobyl incident, I-131 was found in nearly all the samples collected for a period of several weeks in the range of 200 to 500 pCi/kg-wet. The MDC and RL for I-131 in vegetation are 60 and 100 pCi/kg-wet, respectively. Also during this time period, Co-60 was found in one of the samples at a concentration of 62.5 pCi/kg-wet. There is no specified MDC or RL for Co-60 in vegetation.

## Figure 4.5-1




## Table 4.5-1

## Average Annual Cs-137 Concentration in Vegetation

| Year | Indicator (pCi/kg-wet) | Control (pCi/kg-wet) |
|---|---|---|
| Pre-op | 54.6 | 43.7 |
| 1987 | 24.4 | 61.5 |
| 1988 | 38.7 | 0.0 |
| 1989 | 9.7 | 0.0 |
| 1990 | 30.0 | 102.0 |
| 1991 | 35.3 | 62.4 |
| 1992 | 38.1 | 144.0 |
| 1993 | 46.4 | 34.1 |
| 1994 | 20.7 | 57.4 |
| 1995 | 57.8 | 179.0 |
| 1996 | 0 | 0 |
| 1997 | 0 | 32.6 |
| 1998 | 0 | 50.1 |
| 1999 | 37.2 | 0 |
| 2000 | 36.6 | 0 |
| 2001 | 0 | 0 |
| 2002 | 0 | 98.3 |



C08

# 4.6 River Water

Surface water from the Savannah River is obtained at three locations using automatic samplers. Small quantities are drawn at intervals not exceeding a few hours. The samples drawn are collected monthly; quarterly composites are produced from the monthly collections.

The collection points consist of a control location (Station 82) which is located about 0.4 miles upriver of the plant intake structure, an indicator location (Station 83) which is located about 0.4 miles downriver of the plant discharge structure, and a special location (Station 84) which is located approximately 1.3 miles downriver of the plant discharge structure. A statistically significant increase in the concentrations found in samples collected at the indicator station compared to those collected at the control station could be indicative of plant releases. Concentrations found at the special station are more likely to represent the activity in the river as a whole, which might include plant releases combined with those from other sources along the river.

A gamma isotopic analysis is conducted on each monthly sample. As in all previous years, there were no gamma emitting radionuclides of interest detected in the 2002 river water samples.

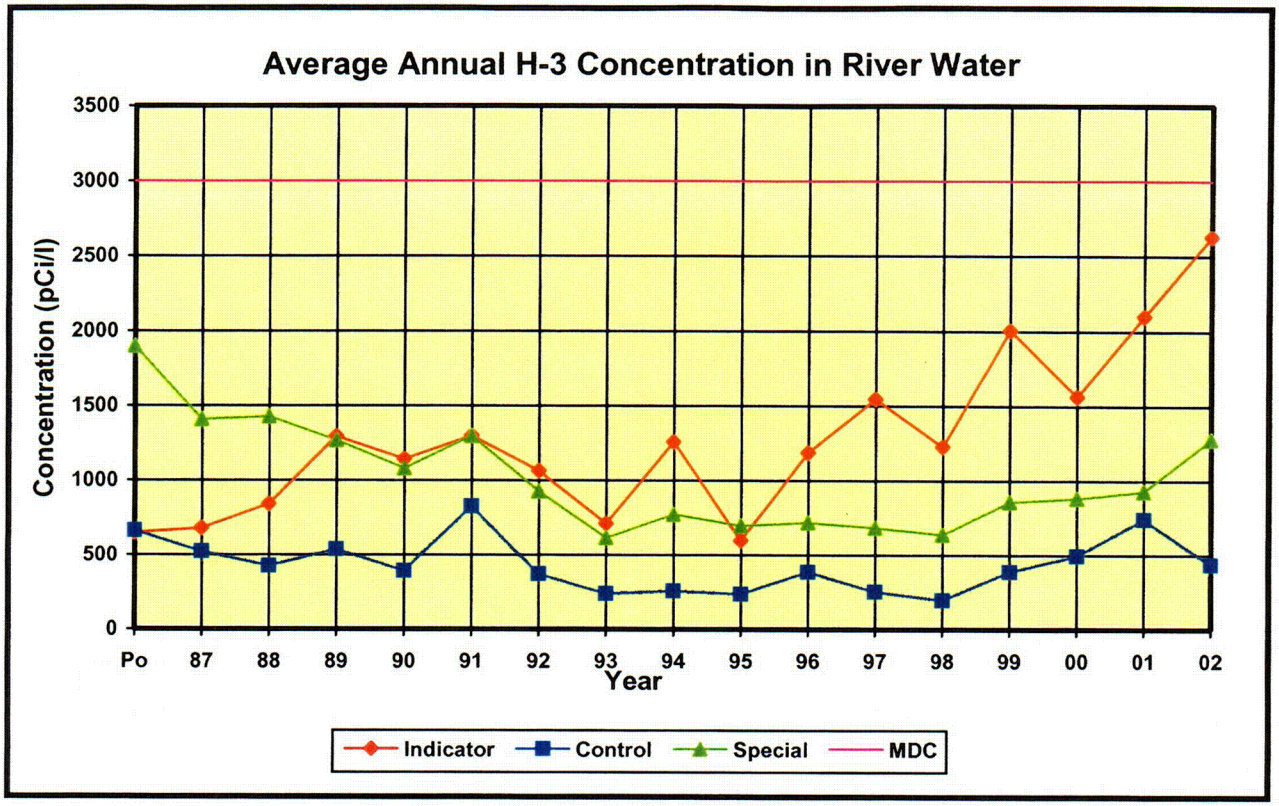
Each quarterly composite is analyzed for tritium. As indicated in Table 3-1, the average concentration found at the indicator station was 2190 pCi/l greater than that found at the control station. This difference is somewhat larger than in recent years and is statistically discernible since it is greater than the calculated MDD of 1211 pCi/l. Even though this concentration of tritium is less than 2% of the RL, the potential impact of this concentration is discussed in Section 6 of this report. The MDC for tritium in river water is 3000 pCi/l and the RL is 30,000 pCi/l.

At the special river water sampling station, the results ranged from 738 pCi/l to 1510 pCi/l with an average of 1280 pCi/l. The decrease in tritium concentration between the indicator station and the special station is due to the additional dispersion over the 0.9 miles that separates the two stations. In the first two years of operation, the tritium concentration at the special station was somewhat greater than that at the indicator station. Whereas in recent years, the level at the special station has generally become less than the level at the indicator station.

The historical trending of the average tritium concentrations found at the special, indicator and control stations along with the MDC for tritium is plotted on Figure 4.6-1. The data for the plot is listed in Table 4.6-1. Also included in the table are data from the calculated difference between the indicator and control stations; the MDD between the indicator and control stations; and the total curies of tritium released from the plant in liquid effluents.

The annual downriver survey of the Savannah River showed that river water is not being used for purposes of drinking or irrigation for at least 100 miles downriver (discussed in Section 4.1).

## Figure 4.6-1






C09

## Table 4.6-1

## Average Annual H-3 Concentration in River Water

| Year | Special (pCi/l) | Indicator (pCi/l) | Control (pCi/l) | Difference Between Indicator and Control (pCi/l) | MDD (pCi/l) | Annual Site Tritium Released (Ci) |
|---|---|---|---|---|---|---|
| Pre-op | 1900 | 650 | 665 | -15 | 145 | NA |
| 1987 | 1411 | 680 | 524 | 156 | 416 | 321 |
| 1988 | 1430 | 843 | 427 | 416 | 271 | 390 |
| 1989 | 1268 | 1293 | 538 | 755 | 518 | 918 |
| 1990 | 1081 | 1142 | 392 | 750 | 766 | 1172 |
| 1991 | 1298 | 1299 | 828 | 471 | 626 | 1094 |
| 1992 | 929 | 1064 | 371 | 693 | 714 | 1481 |
| 1993 | 616 | 712 | 238 | 474 | 1526 | 761 |
| 1994 | 774 | 1258 | 257 | 1001 | 2009 | 1052 |
| 1995 | 699 | 597 | 236 | 361 | 766 | 968 |
| 1996 | 719 | 1187 | 387 | 800 | 2147 | 1637 |
| 1997 | 686 | 1547 | 254 | 1293 | 1566 | 1449 |
| 1998 | 640 | 1226 | 196 | 1030 | 1313 | 1669 |
| 1999 | 859 | 2005 | 389 | 1616 | 1079 | 1674 |
| 2000 | 885 | 1564 | 496 | 1068 | 1786 | 869 |
| 2001 | 931 | 2101 | 743 | 1358 | 1696 | 1492 |
| 2002 | 1280 | 2628 | 437 | 2190 | 1211 | 1566 |

# 4.7 Drinking Water

Samples are collected at a control location (Station 80 - the Augusta Water Treatment Plant in Augusta, Georgia located about 56 river miles upriver), and at two indicator locations (Station 87 - the Beaufort-Jasper County Water Treatment Plant near Beaufort, South Carolina, 112 river miles downriver; and Station 88 - the Cherokee Hill Water Treatment Plant near Port Wentworth, Georgia, 122 river miles downriver). These upriver and downriver distances in river miles are the distances from the plant to the point on the river where water is diverted to the intake for each of these water treatment plants.

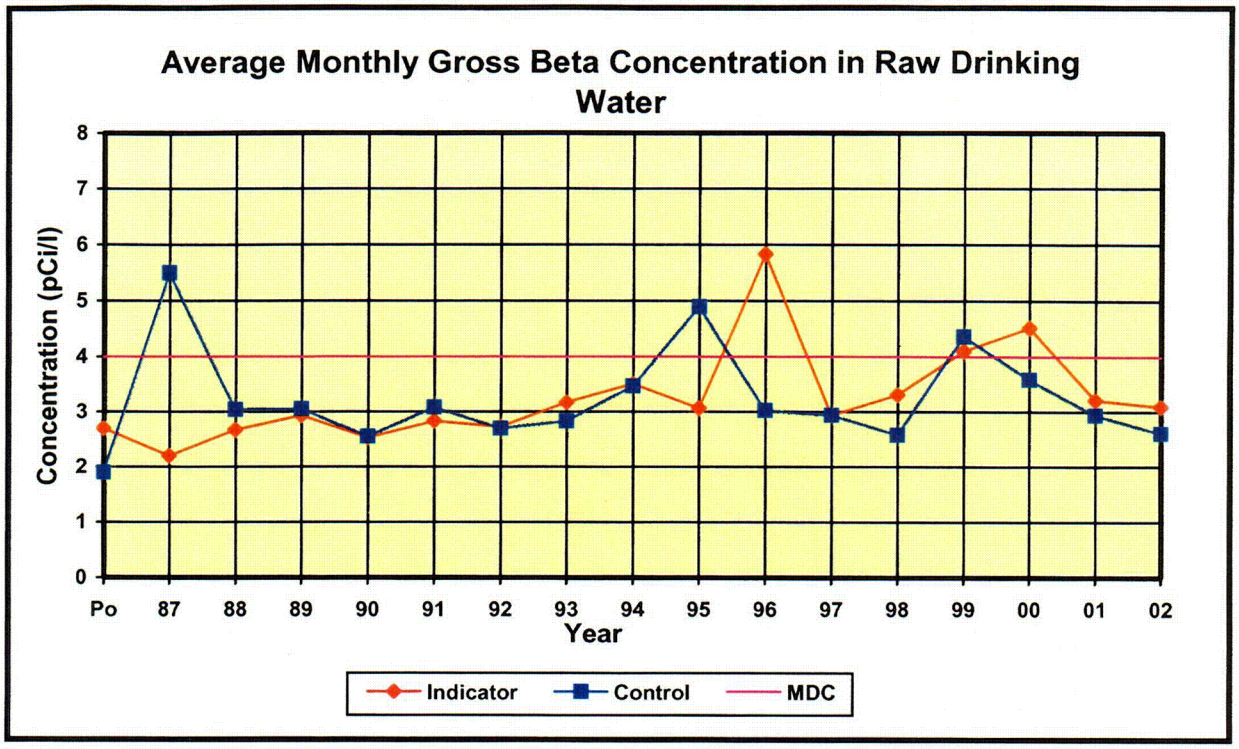
Water samples are taken near the intake of each water treatment plant (raw drinking water) using automatic samplers that take periodical small aliquots from the stream. These composite samples are collected monthly along with a grab sample of the processed water coming from the treatment plants (finished drinking water). Quarterly composites are made from these monthly collections for both raw and processed river water. Gross beta and gamma isotopic analyses are performed on each of the monthly samples while tritium analysis is conducted on the quarterly composites. An I-131 analysis is not required to be conducted on these samples, since the dose calculated from the consumption of water is less than 1 mrem per year (see ODCM Table 4-1). However, an I-131 analysis is conducted on each of the monthly finished water grab samples, since a drinking water pathway exists.

Provided in Figures 4.7-1 and 4.7-2 and Tables 4.7-1 and 4.7-2, are the historical trends of the average gross beta concentrations found in the monthly collections of raw and finished drinking water.

For 2002, the indicator station average gross beta concentration in the raw drinking water was 0.48 pCi/l greater than the average gross beta concentration at the control station. This difference is not statistically discernible, since it is less than the MDD of 1.0 pCi/l.

For 2002, the indicator station average gross beta concentration in the finished drinking water was 2.80 pCi/l, which was 0.19 pCi/l greater than the average gross beta concentration at the control station. This difference is less than the MDD of 1.0 pCi/l and not statistically discernible. The gross beta concentrations at the indicator stations ranged from 0.87 to 4.38 pCi/l while the concentrations at the control station ranged from 0.90 to 5.22 pCi/l. Concentrations for the past few years are higher than gross beta results for finished drinking water during previous years of plant operation. However, these concentrations are only slightly higher than gross beta concentrations found during preoperation. Further, the concentration of 2.80 pCi/l is less than the required MDC of 4.0 pCi/l. There is no RL for gross beta in drinking water.

## Figure 4.7-1




## Table 4.7-1

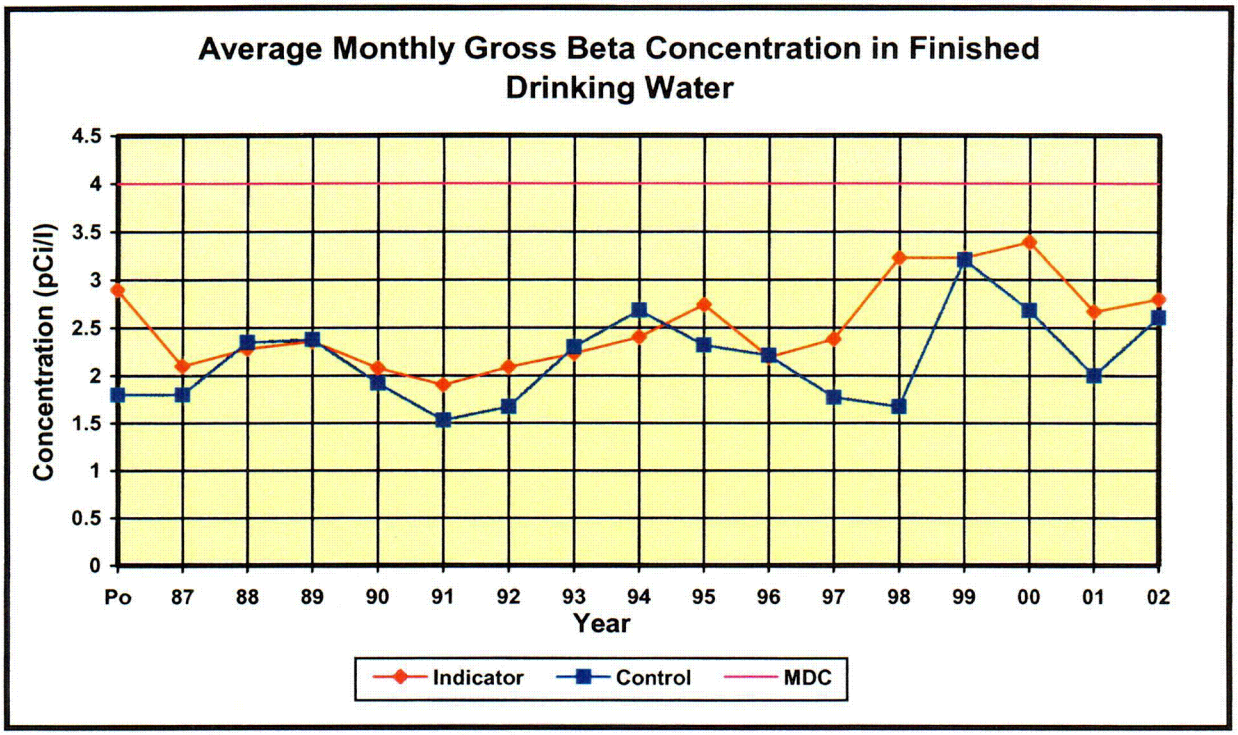
### Average Monthly Gross Beta Concentration in Raw Drinking Water

| Period | Indicator (pCi/l) | Control (pCi/l) |
|---|---|---|
| Pre-op | 2.70 | 1.90 |
| 1987 | 2.20 | 5.50 |
| 1988 | 2.67 | 3.04 |
| 1989 | 2.93 | 3.05 |
| 1990 | 2.53 | 2.55 |
| 1991 | 2.83 | 3.08 |
| 1992 | 2.73 | 2.70 |
| 1993 | 3.17 | 2.83 |
| 1994 | 3.51 | 3.47 |
| 1995 | 3.06 | 4.90 |
| 1996 | 5.83 | 3.02 |
| 1997 | 2.93 | 2.94 |
| 1998 | 3.31 | 2.58 |
| 1999 | 4.10 | 4.37 |
| 2000 | 4.52 | 3.59 |
| 2001 | 3.21 | 2.94 |
| 2002 | 3.09 | 2.61 |



C10

## Figure 4.7-2




## Table 4.7-2

### Average Monthly Gross Beta Concentration in Finished Drinking Water

| Period | Indicator (pCi/l) | Control (pCi/l) |
|---|---|---|
| Pre-op | 2.90 | 1.80 |
| 1987 | 2.10 | 1.80 |
| 1988 | 2.28 | 2.35 |
| 1989 | 2.36 | 2.38 |
| 1990 | 2.08 | 1.92 |
| 1991 | 1.90 | 1.53 |
| 1992 | 2.09 | 1.67 |
| 1993 | 2.23 | 2.30 |
| 1994 | 2.40 | 2.68 |
| 1995 | 2.74 | 2.32 |
| 1996 | 2.19 | 2.21 |
| 1997 | 2.38 | 1.77 |
| 1998 | 3.23 | 1.67 |
| 1999 | 3.23 | 3.21 |
| 2000 | 3.39 | 2.68 |
| 2001 | 2.67 | 2.00 |
| 2002 | 2.80 | 2.61 |



C11

As provided in Table 3-1, there were no positive results during 2002 for the radionuclides of interest from the gamma isotopic analysis of the monthly collections for both raw and finished drinking water. Only one positive result has been found since operation began. Be-7 was found at a concentration of 68.2 pCi/l in the sample collected for September 1987 at Station 87. During preoperation Be-7 was found in about 5% of the samples at concentrations ranging from 50 to 80 pCi/l. The MDC assigned for Be-7 in water is 124 pCi/l. Also during preoperation, Cs-134 and Cs-137 were detected in about 7% of the samples at concentrations on the order of their MDCs which are 15 and 18 pCi/l, respectively.

I-131 was detected in finished drinking water in 1997 at levels near the MDC. This was the first occurrence for detecting I-131 in finished drinking water since operation began. During preoperation, it was detected in only one of 73 samples at a concentration of 0.77 pCi/l at Port Wentworth. The MDC and RL for I-131 in drinking water are 1and 2 pCi/l, respectively.

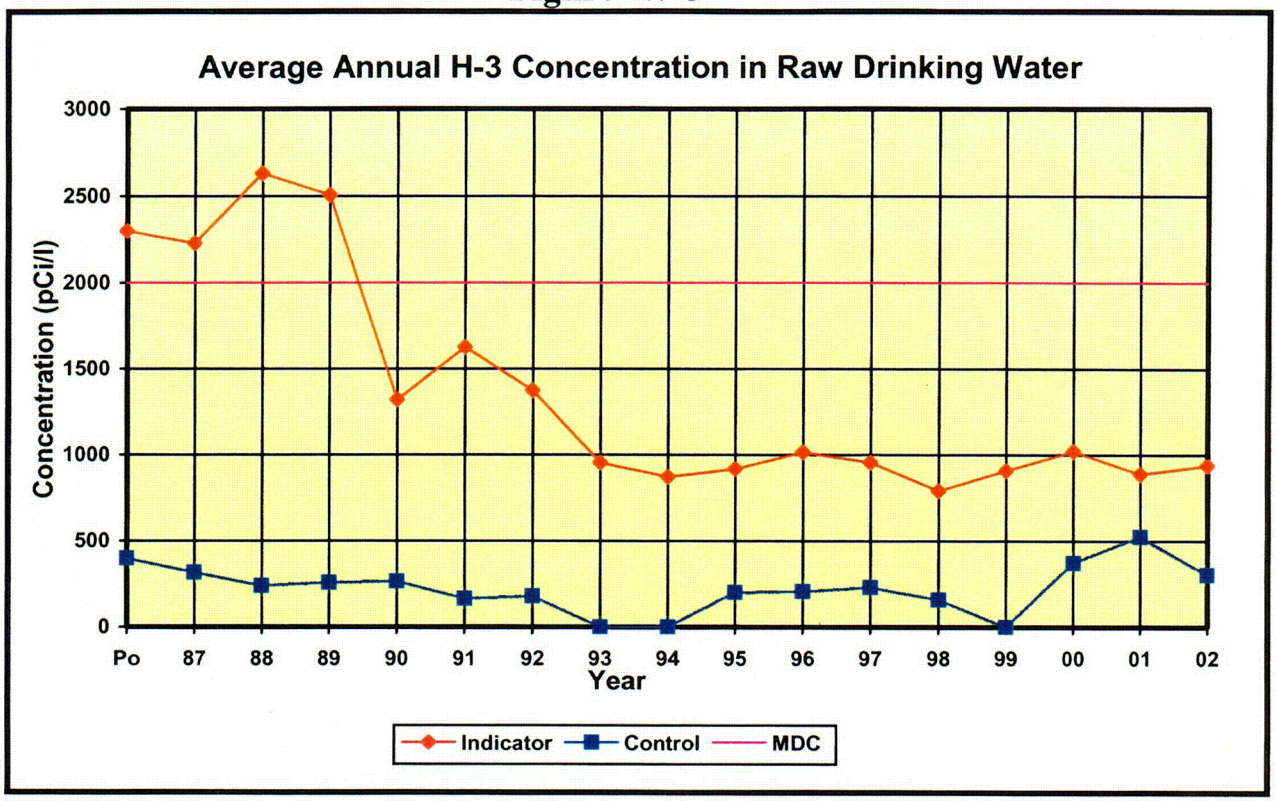
Figures 4.7-3 and 4.7-4 and Tables 4.7-3 and 4.7-4 provide historical trending for the average tritium concentrations found in the quarterly composites of raw and finished drinking water collected at the indicator and control stations. The tables also list the calculated differences between the indicator and control stations, and list the MDDs between these two station groups.

The graphs and tables show that the tritium concentrations in the drinking water samples, both raw and finished, have been gradually trending downward since 1988. The small increase in average concentrations at the indicator stations for 1991 and 1992 reflect the impact of the inadvertent release from SRS of 7,500 Ci of tritium to the Savannah River about 10 miles downriver of VEGP, in December 1991 (SRS release data was obtained from "Release of 7,500 Curies of Tritium to the Savannah River from the Savannah River Site", Georgia Department of National Resources, Environmental Protection Division, Environmental Radiation Program, January 1992).

The 2002 raw drinking water indicator station tritium was 938 pCi/l, which was 634 pCi/l greater than the concentration determined at the control station. This difference is statistically discernible since it is greater than the calculated MDD of 284 pCi/l. The 2002 raw drinking water indicator station tritium was less than approximately 39% of that found in preoperation samples and samples collected during the first three years of operation.

The finished drinking water tritium concentration at the indicator stations during 2002 was 1060 pCi/l, which was 720 pCi/l greater than that found at the control station. This difference is statistically discernible since it is greater than the calculated MDD of 416 pCi/l. The indicator station concentration of tritium in finished drinking water for 2002 was less than approximately 41% of the concentrations measured during preoperation and the first three years of operation.

## Figure 4.7-3



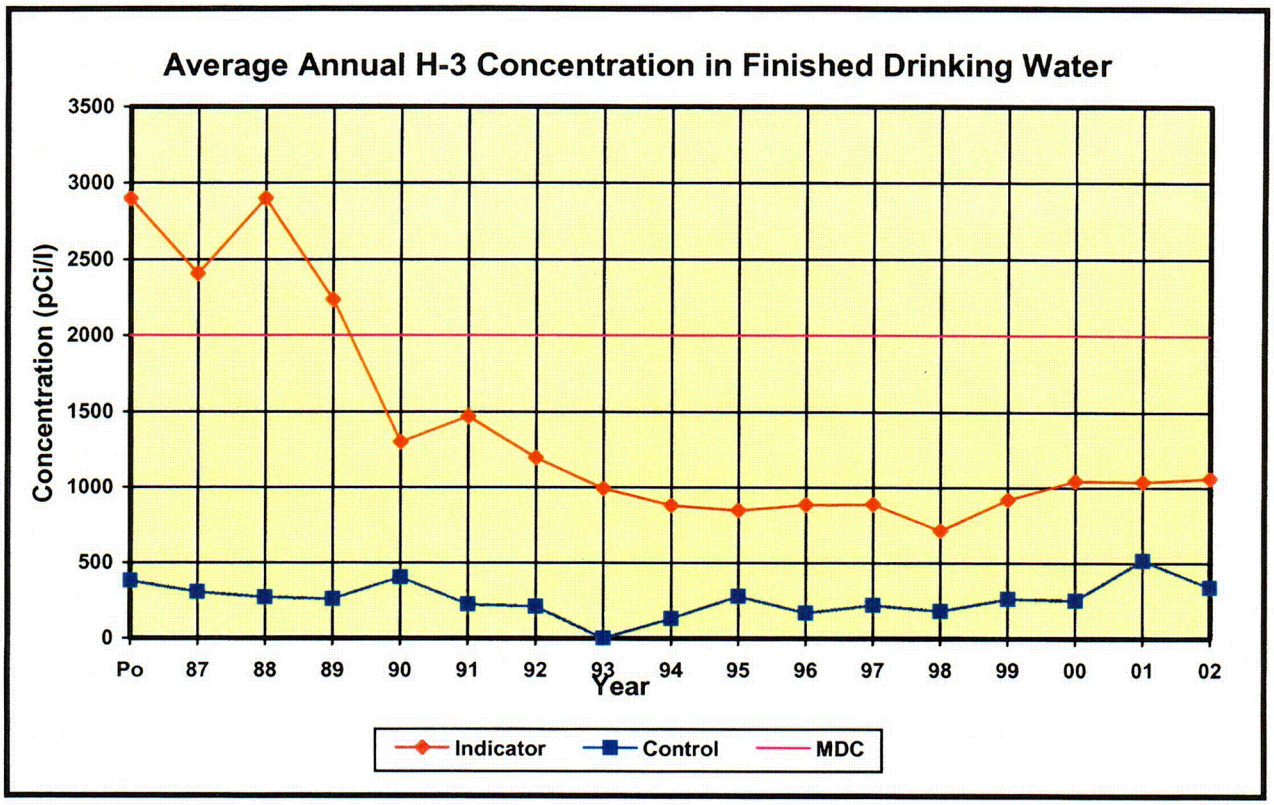

## Table 4.7-3
## Average Annual H-3 Concentration in Raw Drinking Water

| Period | Indicator (pCi/l) | Control (pCi/l) | Difference Between Indicator and Control (pCi/l) | MDD (pCi/l) |
|---|---|---|---|---|
| Pre-op | 2300 | 400 | 1900 | |
| 1987 | 2229 | 316 | 1913 | 793 |
| 1988 | 2630 | 240 | 2390 | 580 |
| 1989 | 2508 | 259 | 2249 | 1000 |
| 1990 | 1320 | 266 | 1054 | 572 |
| 1991 | 1626 | 165 | 1461 | 834 |
| 1992 | 1373 | 179 | 1194 | 353 |
| 1993 | 955 | 0 | 955 | NA |
| 1994 | 871 | 0 | 871 | NA |
| 1995 | 917 | 201 | 716 | NA |
| 1996 | 1014 | 207 | 807 | 151 |
| 1997 | 956 | 230 | 726 | 61 |
| 1998 | 791 | 160 | 631 | NA |
| 1999 | 908 | 0 | 908 | NA |
| 2000 | 1020 | 373 | 647 | 704 |
| 2001 | 889 | 525 | 364 | NA |
| 2002 | 938 | 304 | 634 | 284 |



C12

## Figure 4.7-4




## Table 4.7-4
## Average Annual H-3 Concentration in Finished Drinking Water

| Period | Indicator (pCi/l) | Control (pCi/l) | Difference Between Indicator and Control (pCi/l) | MDD (pCi/l) |
|---|---|---|---|---|
| Pre-op | 2900 | 380 | 2520 | |
| 1987 | 2406 | 305 | 2101 | 1007 |
| 1988 | 2900 | 270 | 2630 | 830 |
| 1989 | 2236 | 259 | 1977 | 627 |
| 1990 | 1299 | 404 | 895 | 1131 |
| 1991 | 1471 | 225 | 1246 | 647 |
| 1992 | 1195 | 211 | 984 | 427 |
| 1993 | 993 | 0 | 993 | NA |
| 1994 | 880 | 131 | 749 | 270 |
| 1995 | 847 | 279 | 568 | NA |
| 1996 | 884 | 168 | 716 | NA |
| 1997 | 887 | 221 | 666 | 383 |
| 1998 | 713 | 180 | 533 | NA |
| 1999 | 920 | 263 | 657 | NA |
| 2000 | 1043 | 251 | 792 | 833 |
| 2001 | 1037 | 516 | 521 | NA |
| 2002 | 1060 | 340 | 720 | 416 |



C13

# 4.8 Fish

Table 2-1 calls for the collection of at least one sample of any anadromous species of fish in the vicinity of the plant discharge during the spring spawning season, and for the semiannual collection of at least one sample of any commercially or recreationally important species in the vicinity of the plant discharge area and in an area not influenced by plant discharges. Table 2-1 specifies that a gamma isotopic analysis be performed on the edible portions of each sample collected.

As provided in Table 2-2, a 5-mile stretch of the river is generally needed to obtain adequate fish samples. For the semiannual collections, the control location (Station 81) extends from approximately 2 to 7 miles upriver of the plant intake structure, and the indicator location (Station 85) extends from about 1.4 to 7 miles downriver of the plant discharge structure. For anadromous species, all collection points can be considered as indicator stations.

American shad was collected as the anadromous species on March 12, 2002. As in all but two previous years of operation, no radionuclides were detected in 2002 from the gamma isotopic analysis of the anadromous species during the spring spawning season. In 1987, as well as in 1991, Cs-137 was found in a single sample of American shad at concentrations of 10 and 12 pCi/kg-wet, respectively.

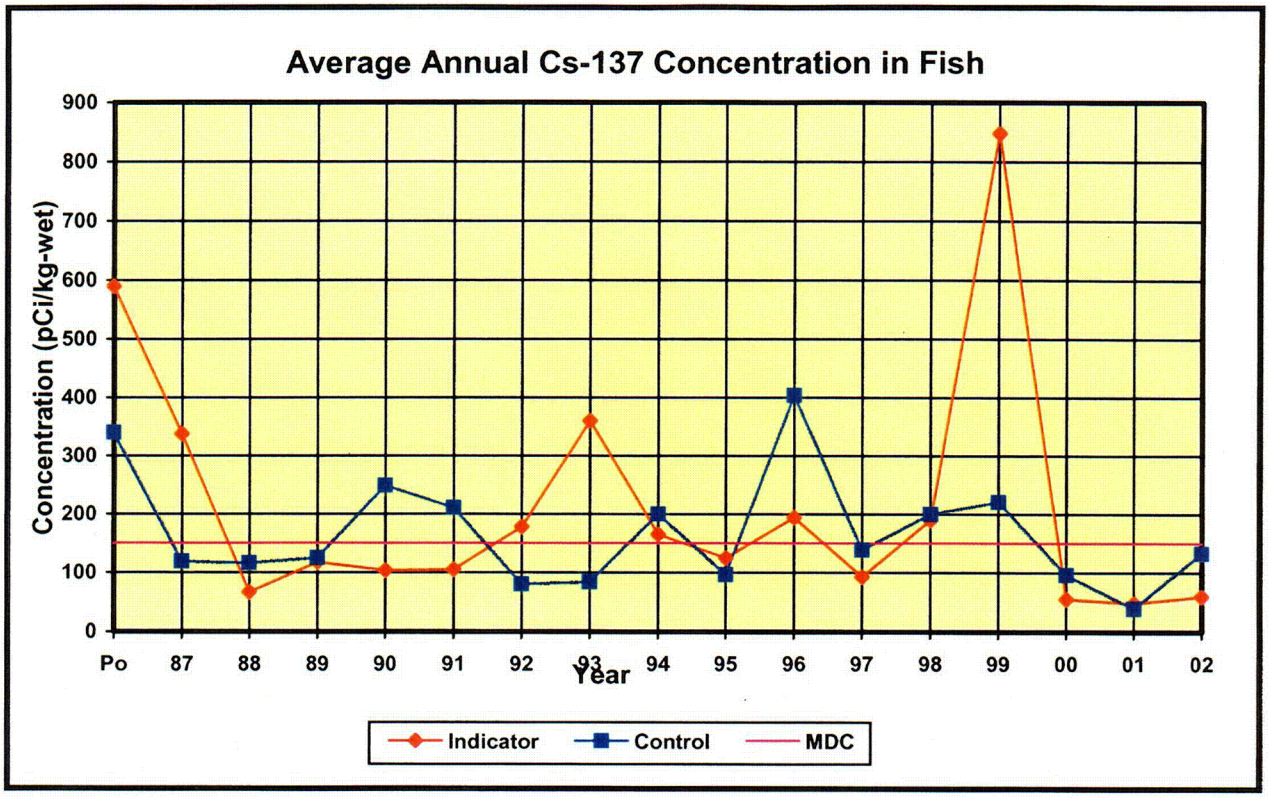
The dates and compositions of the semiannual catches at the indicator and control stations during 2002 are shown below.

| Date | Indicator | Control |
|---|---|---|
| April 09 | Channel Catfish | Largemouth Bass<br>Channel Catfish |
| October 15 | Largemouth Bass | Largemouth Bass |

As indicated in Table 3-1, Cs-137 was the only radionuclide found in the semiannual collections of a commercially or recreationally important species of fish. It has been found in all but 4 of the 113 samples collected during operation and in all but 5 of the 32 samples collected during preoperation. As provided in Table 3-1, the average concentration at the indicator station was 73.7 pCi/kg-wet less than that at the control station. This difference is not statistically discernible, as it is less than the calculated MDD of 665.6 pCi/kg-wet. No discernible difference has occurred for any year of operation or during preoperation.

Figure 4.8-1 and Table 4.8-1 provide the historical trending of the average concentrations of Cs-137 in units of pCi/kg-wet found in fish samples at the indicator and control stations. The indicator station fish sample concentration of Cs-137 in 1999 was greatly influenced by a largemouth bass collectected in October with a concentration of 2500 pCi/kg-wet. Other than the fact that largemouth bass are predators that concentrate Cs-137, no specific cause for the elevated concentration in this sample is known. No trend is recognized in this data. The MDC and RL for Cs-137 in fish are 150 and 2000 pCi/kg-wet, respectively.

## Figure 4.8-1




## Table 4.8-1
## Average Annual Cs-137 Concentration in Fish

| Year | Indicator (pCi/kg-wet) | Control (pCi/kg-wet) |
|---|---|---|
| Pre-op | 590 | 340 |
| 1987 | 337 | 119 |
| 1988 | 66 | 116 |
| 1989 | 117 | 125 |
| 1990 | 103 | 249 |
| 1991 | 105 | 211 |
| 1992 | 178 | 80 |
| 1993 | 360 | 84 |
| 1994 | 165 | 200 |
| 1995 | 125 | 96 |
| 1996 | 194 | 404 |
| 1997 | 93 | 139 |
| 1998 | 190 | 200 |
| 1999 | 848 | 221 |
| 2000 | 55 | 96 |
| 2001 | 48 | 39 |
| 2002 | 59 | 133 |



C14

The only other radionuclide found in fish samples during operation is I-131. In 1989, it was found in one sample at the indicator station at a concentration of 18 pCi/kg-wet. In 1990, it was found in one sample at the indicator station and in one sample at the control station, at concentrations of 13 and 12 pCi/kg-wet, respectively. The MDC assigned to I-131 in fish is 53 pCi/kg-wet.

During preoperation, Cs-134 was found in two of the 17 samples collected at the control station at concentrations of 23 and 190 pCi/kg-wet. The MDC and RL for Cs-134 are 130 and 1000 pCi/kg-wet, respectively. Nb-95 was also found in one of the control station samples at a concentration of 34 pCi/kg-wet. The assigned MDC and calculated RL for Nb-95 are 50 and 70,000 pCi/kg-wet, respectively.

# 4.9 Sediment

Sediment was collected along the shoreline of the Savannah River on April 09 and October 08, 2002 at Stations 81 and 83. Station 81 is a control station located about 2.5 miles upriver of the plant intake structure while Station 83 is an indicator station located about 0.6 miles downriver of the plant discharge structure. A gamma isotopic analysis was performed on each sample. The two radionuclides identified in 2002 samples were Be-7and Cs-137.

No Be-7 was identified in plant effluents during 2002. Therefore, the Be-7 found in sediment samples in 2002 is considered to be naturally occurring.

For Cs-137, the average concentration at the indicator station during 2002 was 129.8 pCi/kg-dry greater than that at the control station. However, the calculated MDD was 1582 pCi/kg-dry. Therefore, there is no discernible difference between Cs-137 concentration in sediment at the indicator and control stations. The Cs-137 level at the indicator station has averaged nearly 150 pCi/kg-dry greater than that at the control station over the entire period of operation. During preoperation, the Cs-137 was 170 pCi/kg-dry greater at the indicator station than at the control station.

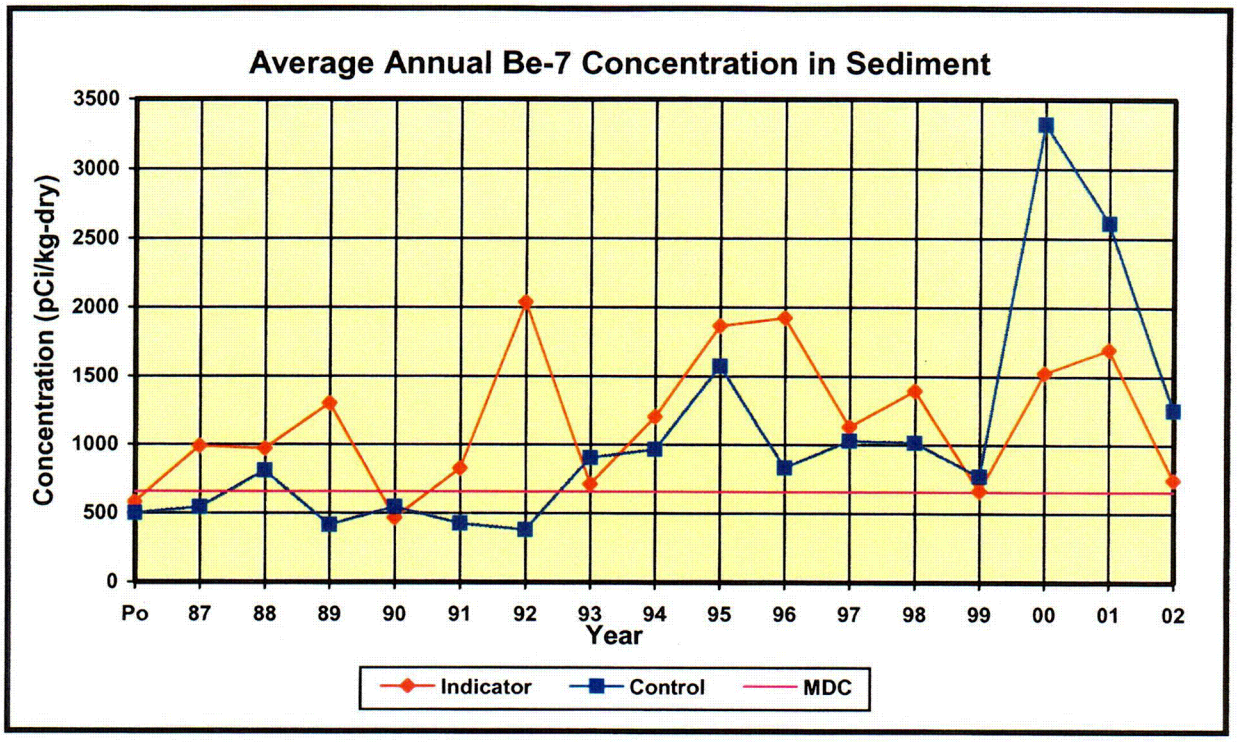
During 2002, Co-60 was detected in one sediment sample at the indicator station at a concentration of 49.7 pCi/kg-dry. Since no Co-60 was detected in sediment collected at the control station, this concentration of Co-60 must be attributed to plant releases or, potentially, to other facilities that release radioactive effluents in the vicinity of the plant.

The historical average concentrations of Be-7, Co-58, Co-60, and Cs-137 in sediment are plotted in Figures 4.9-1 through 4.9-4 along with listings of their concentrations in Tables 4.9-1 through 4.9-4. The concentrations of the solely man-made nuclides (Co-58, Co-60, & Cs-137) are consistent with past average concentrations. No pattern has been detected. Be-7, produced by man and nature, is also within the range that is typically seen.

During preoperation, Zr-95, Nb-95, Cs-134, and Ce-141 were detected in at least one of the control station samples and Nb-95 was detected in one of the indicator station samples. Be-7 and Cs-137 were found in several of the samples. The concentrations of these preoperational nuclides were on the order of their respective MDC values. The presence of these preoperational nuclides could be attributed to atmospheric weapons testing and the Chernobyl incident.

Mn-54 and I-131 were found sporadically over several years of operation. A summary of the positive results for these nuclides along with their applicable MDCs is provided in Table 4.9-5.

## Figure 4.9-1



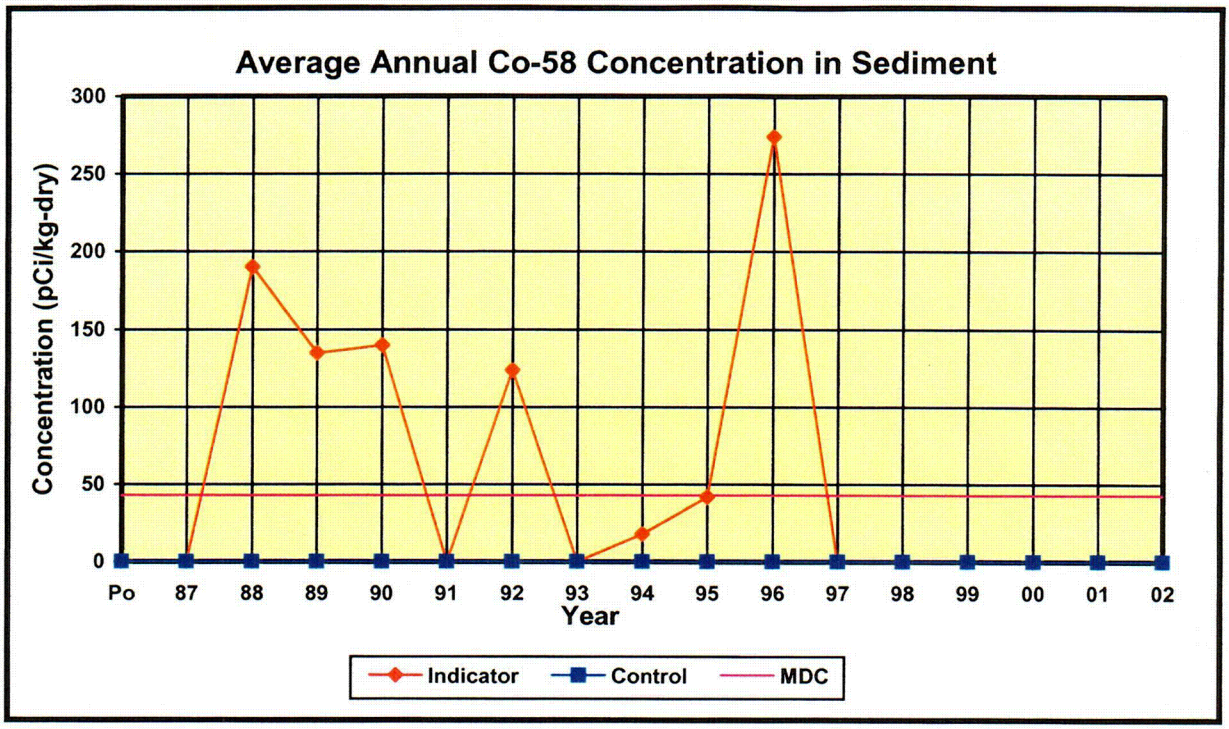

## Table 4.9-1
## Average Annual Be-7 Concentration in Sediment

| MDC=655 pCi/kg-dry | | |
|---|---|---|
| **Year** | **Indicator (pCi/kg-dry)** | **Control (pCi/kg-dry)** |
| Pre-op | 580 | 500 |
| 1987 | 987 | 543 |
| 1988 | 970 | 810 |
| 1989 | 1300 | 415 |
| 1990 | 465 | 545 |
| 1991 | 826 | 427 |
| 1992 | 2038 | 380 |
| 1993 | 711 | 902 |
| 1994 | 1203 | 964 |
| 1995 | 1865 | 1575 |
| 1996 | 1925 | 831 |
| 1997 | 1130 | 1028 |
| 1998 | 1396 | 1016 |
| 1999 | 662 | 769 |
| 2000 | 1526 | 3324 |
| 2001 | 1697 | 2614 |
| 2002 | 742 | 1254 |



C15

## Figure 4.9-2



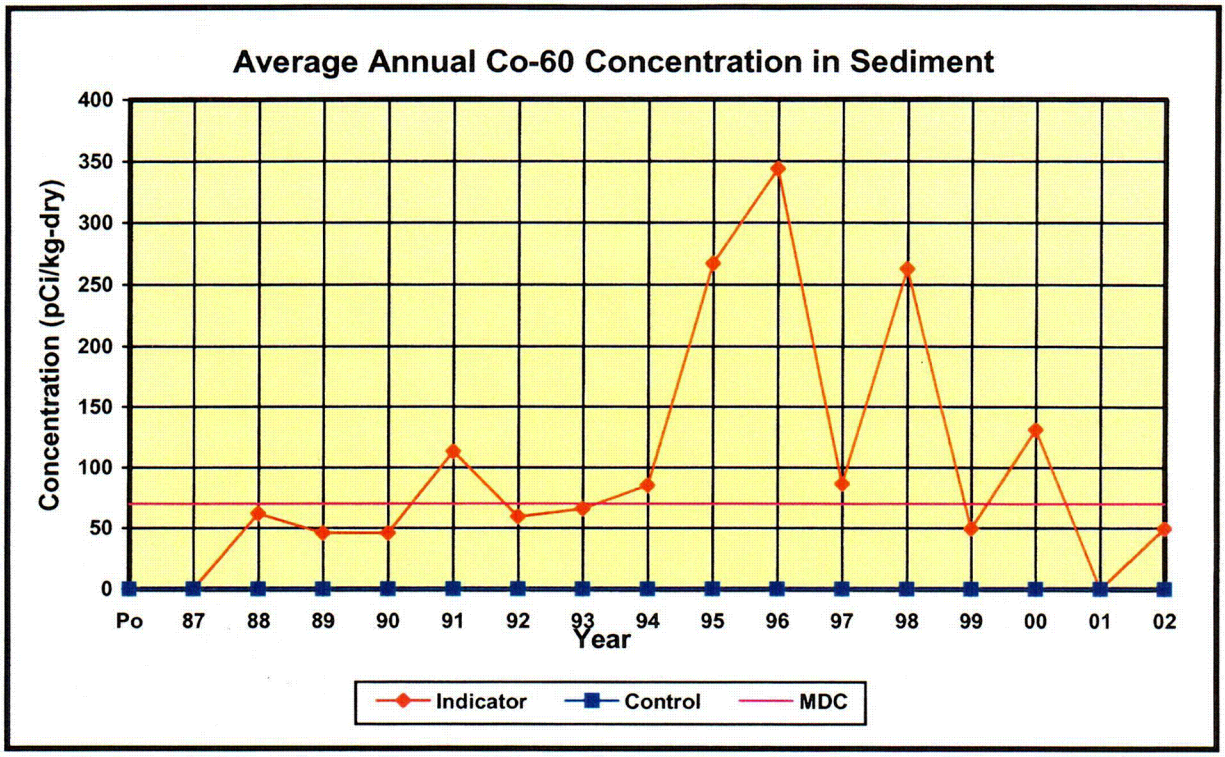

## Table 4.9-2
## Average Annual Co-58 Concentration in Sediment

| MDC=43 pCi/kg-dry | | |
|---|---|---|
| **Year** | **Indicator (pCi/kg-dry)** | **Control (pCi/kg-dry)** |
| Pre-op | 0 | 0 |
| 1987 | 0 | 0 |
| 1988 | 190 | 0 |
| 1989 | 135 | 0 |
| 1990 | 140 | 0 |
| 1991 | 0 | 0 |
| 1992 | 124 | 0 |
| 1993 | 0 | 0 |
| 1994 | 18.4 | 0 |
| 1995 | 42.4 | 0 |
| 1996 | 274 | 0 |
| 1997 | 0 | 0 |
| 1998 | 0 | 0 |
| 1999 | 0 | 0 |
| 2000 | 0 | 0 |
| 2001 | 0 | 0 |
| 2002 | 0 | 0 |



C16

## Figure 4.9-3




## Table 4.9-3

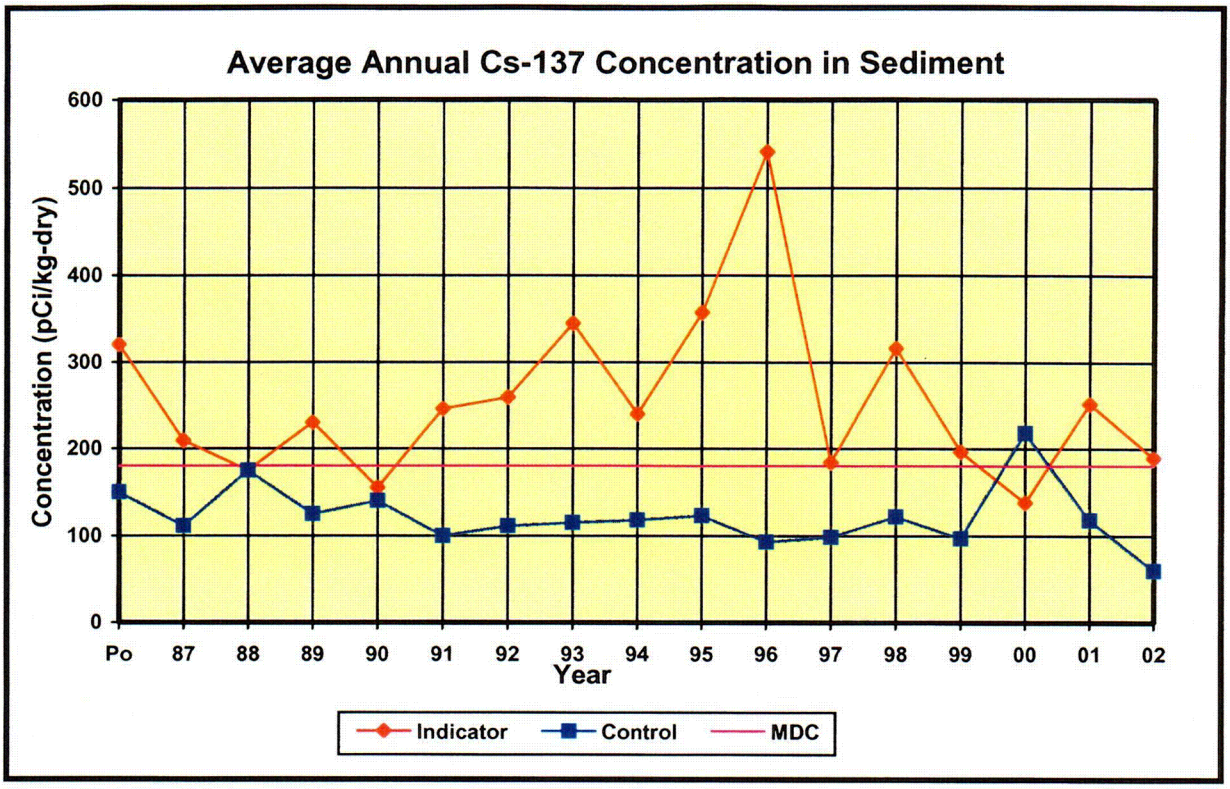
## Average Annual Co-60 Concentration in Sediment

| MDC=70 pCi/kg-dry | | |
|---|---|---|
| **Year** | **Indicator (pCi/kg-dry)** | **Control (pCi/kg-dry)** |
| Pre-op | 0 | 0 |
| 1987 | 0 | 0 |
| 1988 | 62 | 0 |
| 1989 | 46 | 0 |
| 1990 | 46 | 0 |
| 1991 | 113 | 0 |
| 1992 | 59.5 | 0 |
| 1993 | 65.9 | 0 |
| 1994 | 85.2 | 0 |
| 1995 | 267 | 0 |
| 1996 | 344 | 0 |
| 1997 | 86 | 0 |
| 1998 | 263 | 0 |
| 1999 | 49.5 | 0 |
| 2000 | 131.3 | 0 |
| 2001 | 0 | 0 |
| 2002 | 49.7 | 0 |



C17

## Figure 4.9-4




## Table 4.9-4
## Average Annual Cs-137 Concentration in Sediment

| MDC=180 pCi/kg | | |
|---|---|---|
| **Year** | **Indicator (pCi/kg)** | **Control (pCi/kg)** |
| Pre-op | 320 | 150 |
| 1987 | 209 | 111 |
| 1988 | 175 | 175 |
| 1989 | 230 | 125 |
| 1990 | 155 | 140 |
| 1991 | 246 | 100 |
| 1992 | 259 | 111 |
| 1993 | 345 | 115 |
| 1994 | 240 | 118 |
| 1995 | 357 | 123 |
| 1996 | 541 | 93 |
| 1997 | 184 | 98 |
| 1998 | 316 | 122 |
| 1999 | 197 | 97 |
| 2000 | 138 | 218 |
| 2001 | 252 | 118 |
| 2002 | 189 | 60 |



C18

## Table 4.9-5

## Additional Sediment Nuclide Concentrations

| Nuclide | YEAR | Indicator (pCi/kg-dry) | Control (pCi/kg-dry) | MDC (pCi/kg-dry) |
|---|---|---|---|---|
| Mn-54 | 1988 | 22 | 0 | 42 |
| | 1989 | 18 | 0 | |
| | 1994 | 32 | 0 | |
| I-131 | 1992 | 194 | 20 | 53 |
| | 1994 | 51 | 41 | |

# 5.0 INTERLABORATORY COMPARISON PROGRAM

In accordance with ODCM 4.1.3, the EL participates in an ICP that satisfies the requirements of Regulatory Guide 4.15, Revision 1, "Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment", February 1979. The guide indicates the ICP is to be conducted with the EPA (Environmental Protection Agency) Environmental Radioactivity Laboratory Intercomparison Studies (Cross-check) Program or an equivalent program, and the ICP should include all of the determinations (sample medium/radionuclide combinations) that are offered by the EPA and included in the REMP.

The ICP is conducted by Analytics, Inc. of Atlanta, Georgia. Analytics has a documented QA (Quality Assurance) program and the capability to prepare QC (Quality Control) materials traceable to the National Institute of Standards and Technology. The ICP is a third party blind testing program which provides a means to ensure independent checks are performed on the accuracy and precision of the measurements of radioactive materials in environmental sample matrices. Analytics supplies the crosscheck samples to the EL which performs the laboratory analyses in a normal manner. Each of the specified analyses is performed three times. The results are then sent to Analytics who performs an evaluation which may be helpful to the EL in the identification of instrument or procedural problems.

The samples offered by Analytics and included in the EL analyses are gross beta and gamma isotopic analyses of an air filter; gamma isotopic analyses of milk samples; and gross beta, tritium and gamma isotopic analyses of water samples.

The accuracy of each result is measured by the normalized deviation, which is the ratio of the reported average less the known value to the total error. The total error is the square root of the sum of the squares of the uncertainties of the known value and of the reported average. The uncertainty of the known value includes all analytical uncertainties as reported by Analytics. The uncertainty of the reported average is the propogated error of the values in the reported average by the EL. The precision of each result is measured by the coefficient of variation, which is defined as the standard deviation of the reported result divided by the reported average. An investigation is undertaken whenever the absolute value of the normalized deviation is greater than three or whenever the coefficient of variation is greater than 15% for all radionuclides other than Cr-51 and Fe-59. For Cr-51 and Fe-59, an investigation is undertaken when the coefficient of variation exceeds the values shown as follows:

| Nuclide | Concentration * | Total Sample Activity (pCi) | Percent Coefficient of Variation |
|---|---|---|---|
| Cr-51 | <300 | NA | 25 |
| Cr-51 | NA | >1000 | 25 |
| Cr-51 | >300 | <1000 | 15 |
| Fe-59 | <80 | NA | 25 |
| Fe-59 | >80 | NA | 15 |

* For air filters, concentration units are pCi/filter. For all other media, concentration units are pCi/liter.

As required by ODCM 4.1.3.3 and 7.1.2.3, a summary of the results of the EL's participation in the ICP is provided in Table 5-1 for: the gross beta analysis of an air filter; the gamma isotopic analysis of an air filter and water samples; and the tritium analysis of water samples. Delineated in this table for each of the media/analysis combinations, are: the specific radionuclides; Analytics' preparation dates; the known values with their uncertainties supplied by Analytics; the reported averages with their standard deviations; and the resultant normalized deviations and coefficients of variation expressed as a percentage.

It may be seen from Table 5-1 that all results were acceptable for precision, with one exception. The analysis of I-131 in a water sample prepared on 03/14/2002, exceeded the coefficient of variation acceptance criterion of 15%. The outcome of the investigation into the result that failed to meet this ICP acceptance criterion is provided in the following paragraph.

The precision deviation was from the determination of I-131 in water by gamma spectroscopy. The precision result (16.8%) was outside the upper control limit (15%). The variation of the gamma spectroscopy values was due to the low level of activity on the count date. The sample was shipped from Analytics on 03/14/02, and received at the EL on 03/20/02. The sample was counted on 03/21/02 through 03/25/02. During the counting period, the sample activity ranged from 33 pCi/l to 24 pCi/l. This level of activity is measurable by gamma spectroscopy with MDC of 15 pCi/l. The following corrective actions were implemented by the EL to reduce delays in analysis:

1) Alternate payment options were established with the supplier to prevent delays in sample shipments.
2) Steps have been taken to minimize the time between sample availability at Analytics and analysis by the EL.

The second quarter 2002 ICP samples were received and analyzed within three days of shipment and the results indicate excellent accuracy (104%) and precision (8.5%) for I-131.

As shown in Table 5-1, two analysis results failed to meet the acceptance criterion for accuracy, which is a normalized deviation no greater than three. The analysis of Cs-134 in a milk sample prepared on 03/14/02 exceeded the acceptance criterion for accuracy. Further, the analysis of Cs-134 on an air sample prepared on 09/12/02, failed the accuracy acceptance criterion. The outcomes of investigations into the causes contributing to these accuracy failures are discussed in the following paragraph.

The accuracy problem with Cs-134 was determined in an investigation in 2001 to be the summing of the two major gamma peaks from Cs-134, thereby underestimating the sample activity. In response to this finding in 2001, correction curves were developed from existing intercomparison data to correct for the summing loss. The Cs-134 results in 2002 indicate further corrective action is required to address this problem. Further investigation revealed that gamma spectroscopy efficiency curves are determined with standards containing radionuclides that cover the energy spectrum. However, the standards do not contain Cs-134. As a further corrective action, the gamma system will be calibrated in 2003 with standards that include Cs-134.

TABLE 5-1 (SHEET 1 OF 3)

INTERLABORATORY COMPARISON PROGRAM RESULTS

GROSS BETA ANALYSIS OF AN AIR FILTER (pCi/filter)

| Analysis or Radionuclide | Date Prepared | Reported Average | Known Value | Standard Deviation EL | Uncertainty Analytics (3S) | Percent Coef of Variation | Normalized Deviation |
|---|---|---|---|---|---|---|---|
| Gross Beta | 09/12/02 | 73.5 | 74 | 2.97 | 1.33 | 4.00 | -0.15 |

GAMMA ISOTOPIC ANALYSIS OF AN AIR FILTER (pCi/filter)

| Analysis or Radionuclide | Date Prepared | Reported Average | Known Value | Standard Deviation EL | Uncertainty Analytics (3S) | Percent Coef of Variation | Normalized Deviation |
|---|---|---|---|---|---|---|---|
| Ce-141 | 09/12/02 | 106 | 111 | 3.21 | 2.00 | 3.02 | -1.32 |
| Co-58 | 09/12/02 | 70 | 67 | 3.27 | 1.00 | 4.67 | 0.88 |
| Co-60 | 09/12/02 | 102 | 103 | 3.27 | 1.67 | 3.20 | -0.27 |
| Cr-51 | 09/12/02 | 176 | 158 | 16.06 | 2.67 | 9.12 | 1.11 |
| Cs-134 | 09/12/02 | 77 | 91 | 2.46 | 1.67 | 3.19 | -4.72 |
| Cs-137 | 09/12/02 | 90 | 88 | 3.52 | 1.33 | 3.91 | 0.53 |
| Fe-59 | 09/12/02 | 74 | 62 | 4.27 | 1.00 | 5.77 | 2.74 |
| Mn-54 | 09/12/02 | 117 | 106 | 4.33 | 1.67 | 3.70 | 2.37 |
| Zn-65 | 09/12/02 | 150 | 130 | 7.53 | 2.33 | 5.02 | 2.54 |

GAMMA ISOTOPIC ANALYSIS OF A MILK SAMPLE (pCi/liter)

| Analysis or Radionuclide | Date Prepared | Reported Average | Known Value | Standard Deviation EL | Uncertainty Analytics (3S) | Percent Coef of Variation | Normalized Deviation |
|---|---|---|---|---|---|---|---|
| Ce-141 | 03/14/02 | 306 | 326 | 10.71 | 4.00 | 3.50 | -1.75 |
| Co-60 | 03/14/02 | 146 | 158 | 5.55 | 2.00 | 3.80 | -2.04 |
| Cr-51 | 03/14/02 | 285 | 267 | 41.74 | 3.33 | 9.12 | 1.11 |
| Cs-134 | 03/14/02 | 105 | 122 | 4.00 | 1.67 | 3.81 | -3.92 |
| Cs-137 | 03/14/02 | 265 | 266 | 9.50 | 3.33 | 3.59 | -0.10 |

## TABLE 5-1 (SHEET 2 OF 3)

## INTERLABORATORY COMPARISON PROGRAM RESULTS

### GAMMA ISOTOPIC ANALYSIS OF A MILK SAMPLE (pCi/liter)

| Analysis or Radionuclide | Date Prepared | Reported Average | Known Value | Standard Deviation EL | Uncertainty Analytics (3S) | Percent Coef of Variation | Normalized Deviation |
|---|---|---|---|---|---|---|---|
| Fe-59 | 03/14/02 | 113 | 116 | 12.1 | 1.33 | 10.71 | -0.25 |
| I-131 | 03/14/02 | 92 | 92 | 12.21 | 1.00 | 13.28 | 0.00 |
| Mn-54 | 03/14/02 | 221 | 224 | 8.69 | 2.67 | 3.93 | -0.33 |
| Zn-65 | 03/14/02 | 226 | 221 | 13.27 | 2.67 | 5.87 | 0.37 |

### GROSS BETA ANALYSIS OF WATER SAMPLE (pCi/liter)

| Analysis or Radionuclide | Date Prepared | Reported Average | Known Value | Standard Deviation EL | Uncertainty Analytics (3S) | Percent Coef of Variation | Normalized Deviation |
|---|---|---|---|---|---|---|---|
| Gross Beta | 03/14/02 | 292 | 287 | 8.66 | 4.67 | 3.00 | -0.10 |
| | 06/13/02 | 281 | 280 | 8.22 | 4.67 | 9.00 | 0.06 |

### GAMMA ISOTOPIC ANALYSIS OF WATER SAMPLES (pCi/liter)

| Analysis or Radionuclide | Date Prepared | Reported Average | Known Value | Standard Deviation EL | Uncertainty Analytics (3S) | Percent Coef of Variation | Normalized Deviation |
|---|---|---|---|---|---|---|---|
| Ce-141 | 03/14/02 | 244.0 | 242 | 10.87 | 4.00 | 4.45 | 0.17 |
| | 06/14/02 | 87.0 | 83.0 | 8.36 | 4.00 | 9.61 | 0.43 |
| Co-58 | 06/14/02 | 97.0 | 93.0 | 7.23 | 1.00 | 7.45 | 0.55 |
| Co-60 | 03/14/02 | 118.0 | 117.0 | 44.56 | 3.33 | 20.44 | 0.45 |
| | 06/14/02 | 118.0 | 115.0 | 5.60 | 2.00 | 4.75 | 0.50 |
| Cr-51 | 03/14/02 | 218.0 | 242 | 41.31 | 4.00 | 17.07 | 0.00 |
| | 06/14/02 | 209.0 | 218.0 | 33.74 | 3.33 | 16.14 | -0.27 |
| Cs-134 | 03/14/02 | 82.0 | 91.0 | 4.58 | 1.67 | 5.59 | -1.85 |
| | 06/14/02 | 102.0 | 111.0 | 4.2 | 1.67 | 4.12 | -1.99 |

## TABLE 5-1 (SHEET 3 OF 3)

## INTERLABORATORY COMPARISON PROGRAM RESULTS

## GAMMA ISOTOPIC ANALYSIS OF WATER SAMPLES (pCi/liter)

| Analysis or Radionuclide | Date Prepared | Reported Average | Known Value | Standard Deviation EL | Uncertainty Analytics (3S) | Percent Coef of Variation | Normalized Deviation |
|---|---|---|---|---|---|---|---|
| Cs-137 | 03/14/02 | 206.0 | 197.0 | 9.31 | 3.33 | 4.52 | 0.91 |
| | 06/14/02 | 76.0 | 84.0 | 6.45 | 3.33 | 8.49 | -1.10 |
| Fe-59 | 03/14/02 | 91.0 | 86.0 | 11.76 | 1.33 | 12.93 | 0.42 |
| | 06/14/02 | 90.0 | 75.0 | 8.79 | 1.33 | 9.77 | 1.69 |
| I-131 | 03/14/02 | 62.0 | 61.0 | 10.43 | 1.00 | 16.82 | 0.10 |
| | 06/14/02 | 98.0 | 94.0 | 8.36 | 1.00 | 8.53 | 0.48 |
| Mn-54 | 03/14/02 | 172.0 | 166.0 | 8.10 | 2.67 | 4.71 | 0.70 |
| | 06/14/02 | 93.0 | 88.0 | 6.56 | 2.67 | 7.05 | 0.71 |
| Zn-65 | 03/14/02 | 174.0 | 164.0 | 15.06 | 2.67 | 8.66 | 0.65 |
| | 06/14/02 | 177.0 | 166.0 | 14.53 | 2.67 | 14.63 | 0.74 |

## TRITIUM ANALYSIS OF WATER SAMPLES (pCi/liter)

| Analysis or Radionuclide | Date Prepared | Reported Average | Known Value | Standard Deviation EL | Uncertainty Analytics (3S) | Percent Coef of Variation | Normalized Deviation |
|---|---|---|---|---|---|---|---|
| H-3 | 03/24/02 | 10721 | 10026 | 173 | 167.0 | 3.00 | 2.07 |
| | 06/14/02 | 7710 | 6970 | 165.0 | 116.3 | 5.00 | 1.85 |

# 6.0 CONCLUSIONS

This report confirms the licensee's conformance with the requirements of Chapter 4 of the ODCM during 2002. It provides a summary and discussion of the results of the laboratory analyses for each type of sample.

All of the radiological levels were low and generally trending downward.

In 2002, there were three instances in which the indicator station readings were greater than, and statistically discernible from, the control station readings. These instances are discussed in the following paragraphs.

Tritium was detected in surface water at the indicator station at a concentration of 2628 pCi/l, which is approximately 2% of the RL. Tritium was detected at the control station at an average concentration of 437 pCi/l. The difference of 2191pCi/l is greater than the calculated MDD of 1211 pCi/l. Therefore, this tritium concentration must be attributed to industrial effluents including VEGP. Although no drinking water pathway via surface water exists in the plant vicinity, a potential dose from tritium in the drinking water pathway was calculated using the methodology in the VEGP ODCM. This dose was calculated assuming that a person regularly consumed drinking water from the river downstream, near the indicator station for surface water sampling. Under these assumed circumstances, the potential dose to such an individual would be about 4.6E-2 mrem in a year. This dose would be approximately 1.5% of the annual dose limit for the total body, due to liquid effluents.

Tritium was detected in raw drinking water at the indicator station at an average concentration of 938 pCi/l and at the control station at 305 pCi/l. The difference of 633 pCi/l is statistically discernible since it is greater than the calculated MDD of 282 pCi/l. Therefore, this concentration must be attributed to industrial effluents including VEGP. This concentration corresponds to approximately 3.2% of the RL. Although raw river water is not intended for human consumption, a potential dose from tritium in the drinking water pathway was calculated using the methodology in the VEGP ODCM. This dose was calculated assuming that a person regularly consumed untreated water taken from the river near the intake to the water treatment plant. Under these assumed circumstances, the potential dose to such an individual would be about 1.3E-2 mrem in a year. This dose would be approximately 0.4% of the annual dose limit for the total body, due to liquid effluents.

Tritium was detected in finished drinking water at the indicator station at an average concentration of 1060 pCi/l and at the control station at 340 pCi/l. The difference of 720 pCi/l is statistically discernible since it is greater than the calculated MDD of 420 pCi/l. Therefore, this concentration must be attributed to industrial effluents including VEGP. This concentration corresponds to approximately 3.6% of the RL. Using the methodology described in the VEGP ODCM, the potential dose from tritium in drinking water was calculated assuming that a person regularly consumed finished water from the water treatment plant. The resulting potential dose to the total body of an individual would be about 1.5E-2 mrem in a year. This dose would be approximately 0.5% of the annual dose limit for the total body, due to liquid effluents.

No discernible radiological impact upon the environment or the public as a consequence of plant discharges to the atmosphere and to the river was established for any other REMP samples.