# QUAD CITIES NUCLEAR POWER STATION

# RADIOACTIVE WASTE AND ENVIRONMENTAL MONITORING

# ANNUAL REPORT 1985

TELEDYNE ISOTOPES MIDWEST LABORATORY

NORTHBROOK, ILLINOIS

MARCH 1986

# QUAD CITIES NUCLEAR POWER STATION

# RADIOACTIVE WASTE AND ENVIRONMENTAL MONITORING

# ANNUAL REPORT 1985

MARCH 1986

TABLE OF CONTENTS


| | | Page |
|---|---|---|
| | INTRODUCTION | 1 |
| | SUMMARY | 2 |
| 1.0 | EFFLUENTS | |
| | 1.1 Gaseous | 3 |
| | 1.2 Liquid | 3 |
| 2.0 | SOLID RADIOACTIVE WASTE | 3 |
| 3.0 | DOSE TO MAN | |
| | 3.1 Gaseous Effluent Pathways | 3 |
| | 3.2 Liquid Effluent Pathways | 5 |
| 4.0 | SITE METEOROLOGY | 5 |
| 5.0 | ENVIRONMENTAL MONITORING | 5 |
| | 5.1 Gamma Radiation | 6 |
| | 5.2 Airborne I-131 and Particulate Radioactivity | 6 |
| | 5.3 Aquatic Radioactivity | 6 |
| | 5.4 Milk | 7 |
| | 5.5 Special Collection | 7 |
| 6.0 | ANALYTICAL PROCEDURES | 7 |
| 7.0 | MILCH ANIMAL CENSUS | 7 |
| 8.0 | NEAREST RESIDENT CENSUS | 8 |
| 9.0 | INTERLABORATORY COMPARISON PROGRAM RESULTS | 8 |
| | APPENDIX I - DATA TABLES AND FIGURES | 21 |
| | Station Releases | |
| | Table 1.1-1 Gaseous Effluents | 22 |
| | Table 1.2-1 Liquid Effluents | 32 |
| | Table 2.0-1 Solid Waste Shipments | 36 |

TABLE OF CONTENTS (continued)


Page

APPENDIX I - DATA TABLES AND FIGURES

Station Releases (continued)

Figure 3.1-1 - Figure 3.1-4
Isodose and Concentration Contours . . . . . 48
Table 3.1-1 Maximum Doses Resulting from Airborne Releases . . . . 52
Table 3.2-1 Maximum Doses Resulting from Liquid Discharges . . . . 54

Environmental Monitoring

Figure 5.0-1 - Figure 5.0-3
Locations of Fixed Environmental Radiological Stations . . . . . 56
Table 5.0-1 Standard Radiological Sampling Program . . . . . 59
Table 5.0-2 Environmental Radiological Monitoring Program . . . . 60
Table 5.0-3 - Table 5.0-6
Environmental Summary Tables . . . . . 67
Table 5.1-1 Gamma Radiation Measurements (TLD) . . . . . 71

APPENDIX II - METEOROLOGICAL DATA . . . . . 74

APPENDIX III - ANALYTICAL PROCEDURES MANUAL . . . . . 103

APPENDIX IV - ERRATA . . . . . 150

# INTRODUCTION

Units 1 and 2 of the Quad Cities Station located near Cordova, Illinois next to the Mississippi River, are 800 MWe boiling water reactors, similar in design to Dresden Units 2 and 3. The plant has been designed to keep releases to the environment at levels below those specified in the regulations.

Liquid effluents from Quad Cities are released to the Mississippi River in controlled batches after radioassay of each batch. Gaseous effluents are released to the atmosphere after delay to permit decay of short half-life gases. Releases to the atmosphere are calculated on the basis of analyses of daily grab samples of noble gases and continuously collected composite samples of iodine and particulate matter. The results of effluent analyses are summarized on a monthly basis and reported to the Nuclear Regulatory Commission as required per Technical Specifications. Airborne concentrations of noble gases, I-131 and particulate radioactivity in off-site areas are calculated using effluent and meteorological data on isotopic composition of effluents.

Environmental monitoring is conducted by sampling at indicator and reference (background) locations in the vicinity of the Quad Cities plant to measure changes in radiation or radioactivity levels that may be attributable to plant operations. If significant changes attributable to Quad Cities are measured, these changes are correlated with effluent releases. External gamma radiation exposure from noble gases and I-131 in milk are the most critical pathways at this site; however, an environmental monitoring program is conducted which includes other pathways of less importance.

## SUMMARY

Gaseous and liquid effluents for the period remained at a fraction of the Technical Specification limits. Calculations of environmental concentrations based on effluent, Mississippi River flow, and meteorological data for the period indicate that consumption by the public of radionuclides attributable to the plant are unlikely to exceed the regulatory limits. Gamma radiation exposure from noble gases released to the atmosphere represented the critical pathway for the period with a maximum individual dose estimated to be 0.04 mrem for the year, when a shielding and occupancy factor of 0.7 is assumed. The assessment of radiation doses are performed in accordance with the Off-Site Dose Calculation Manual (ODCM). The results of analysis confirm that the station is operating in compliance with 10CFR50 Appendix I and 40 CFR 190.

## 1.0 EFFLUENTS

### 1.1 Gaseous Effluents to the Atmosphere

Measured concentrations and isotopic composition of noble gases, radioiodine, and particulate radioactivity released to the atmosphere during the year, are listed in Table 1.1-1. A total of 2.95E+03 curies of fission and activation gases was released with an average release rate of 9.33E+01 µCi/sec.

A total of 0.049 curies of I-131 was released during the year, with an average release rate of 7.20E-03 µCi/sec.

A total of 0.557 curies of beta-gamma emitters and 4.91E-05 curies of alpha emitters was released as airborne particulate matter, with an average release rate of 1.74E-02 µCi/sec.

A total of 52.5 curies of tritium was released, with an average release rate of 1.68 µCi/sec.

### 1.2 Liquids Released to the Mississippi

A total of 1.82E+06 liters of radioactive liquid waste (prior to dilution) containing 1.46 curies (excluding tritium, gases, and alpha) were discharged after dilution with a total of 1.35E+12 liters of water. These wastes were released at a quarterly average concentration of 9.6E-09 µCi/ml during the first and second quarters, dicharged on an unidentified nuclide basis; and 2.03E-07 µCi/ml during the third and fourth quarters, which is 33.4% of the Technical Specification release limits for unidentified radioactivity. A total of 1.5E-05 curies of alpha radioactivity and 3.41 curies of tritium were released. Quarterly release estimates and principal radio-nuclides in liquid effluents are given in Table 1.2-1.

## 2.0 SOLID RADIOACTIVE WASTE

Solid radioactive wastes were shipped to U. S. Ecology; Chem Nuclear Company, Tri-State; and Barnwell Nuclear Center, South Carolina. The record of waste shipments is summarized in Table 2.0-1.

## 3.0 DOSE TO MAN

### 3.1 Gaseous Effluent Pathways

#### Gamma Dose Rates

Gamma air and whole body dose rates off-site were calculated based on measured release rates, isotopic composition of the noble gases, and meteorological data for the period (Table 3.1-1). Isodose

contours of whole body dose are shown in Figure 3.1-1 for the year. Based on measured effluents and meteorological data, the maximum dose to an individual would be 0.04 mrem for the year, with an occupancy or shielding factor of 0.7 included. The maximum gamma air dose was 0.075 mrad.

Beta Air and Skin Rates

The range of beta particles in air is relatively small (on the order of a few meters or less): consequently, plumes of gaseous effluents may be considered "infinite" for purpose of calculating the dose from beta radiation incident on the skin. However, the actual dose to sensitive skin tissues is difficult to calculate because this depends on the beta particle energies, thickness of inert skin, and clothing covering sensitive tissues. For purposes of this report the skin is taken to have a thickness of 7 $mg/cm^2$ and an occupancy factor of 1.0 is used. The skin dose from beta and gamma radiation for the year was 0.089 mrem.

The air concentrations of radioactive noble gases at the off-site receptor locations are given in Figure 3.1-2. The maximum off-site beta air dose for the year was 0.044 mrad.

Radioactive Iodine

The human thyroid exhibits a significant capacity to concentrate ingested or inhaled iodine, and the radioiodine, I-131, released during routine operation of the plant, may be made available to man thus resulting in a dose to the thyroid. The principal pathway of interest for this radionuclide is ingestion of radioiodine in milk by an infant. Calculation made in previous years indicate that contributions to doses from inhalation of I-131 and I-133, and I-133 in milk are negligible.

Iodine-131 Concentrations in Air

The calculated concentration contours for I-131 in air are shown in Figure 3.1-3. Included in these calculations is an iodine cloud depletion factor which accounts for the phenomenon of elemental iodine deposition on the ground. The maximum off-site average concentration is estimated to be 1.64E-03 $pCi/m^3$ for the year.

Dose to Infant's Thyroid

The hypothetical thyroid dose to an infant living near the plant via ingestion of milk was calculated. The radionuclide considered was I-131 and the source of milk was taken to be the nearest dairy farm with the cows pastured from May to October. The maximum infant's thyroid dose was 0.29 mrem during the year (Table 3.1-1).

Concentrations of Particulates in Air

Concentration contours of radioactive airborne particulates are shown in Figure 3.1-4. The maximum off-site average level is estimated to be 1.26E-03 pCi/$m^3$.

Summary of Doses

Table 3.1-1 summarizes the doses resulting from releases of airborne radioactivity via the different exposure pathways.

## 3.2 Liquid Effluent Pathways

The three principal pathways through the aquatic environment for potential doses to man from liquid waste are ingestion of potable water, eating aquatic foods, and exposure while walking on the shoreline. Not all of these pathways are applicable at a given time or station but a reasonable approximation of the dose can be made by adjusting the dose formula for season of the year or type and degree of use of the aquatic environment. NRC* developed equations were used to calculate the doses to the whole body, lower GI tract, thyroid, bone and skin; specific parameters for use in the equations are given in the Commonwealth Edison Off-site Dose Calculation Manual. The maximum whole body dose for the year was 9.97E-01 mrem and no organ dose exceeded 1.45 mrem.

# 4.0 SITE METEOROLOGY

A summary of the site meteorological measurements taken during each quarter of the year is given in Appendix II. The data are presented as cumulative joint frequency distributions of 296' level wind direction and wind speed class by atmospheric stability class determined from the temperature difference between the 296' and 33' levels. Data recovery for all measurements on the tower was about 99.7%.

# 5.0 ENVIRONMENTAL MONITORING

Tables 5.0-1 and 5.0-2 provide an outline of the radiological environmental monitoring program as required in current Technical Specifications. This program went into effect in November 1977 and differs from previous programs in the number and types of analyses performed. Tables 5.0-3 to 5.0-6 summarize data for the year.

Except for tables of special interest, tables listing all data are no longer included in the annual report. All data tables are available for inspection at the Station or in the Corporate offices.

Specific findings for various environmental media are discussed in Sections 5.1 through 5.5.

---

* Nuclear Regulatory Commission, Regulatory Guide 1.109 (Rev. 1).

## 5.1 Gamma Radiation

External radiation dose from on-site sources and noble gases released to the atmosphere was measured at six indicator and ten reference (background) locations using solid lithium fluoride thermoluminescent dosimeters (TLD). A comparison of the TLD results for reference stations with on-site and off-site indicator stations is included in Table 5.1-1. A total of 61 additional TLDs were installed on June 1, 1980 such that each sector was covered at both five miles and the site boundary. Locations of the TLDs are shown in Figures 5.0-1 and 5.0-2.

## 5.2 Airborne I-131 and Particulate Radioactivity

Concentrations of airborne I-131 and particulate radioactivity at monitoring locations are summarized in Tables 5.0-2 through 5.0-5. Locations of the samplers are shown in figure 5.0-1. Airborne I-131 remained below the LLD of 0.1 $pCi/m^3$ throughout the year.

Gross beta concentrations ranged from 0.006 to 0.071 $pCi/m^3$ at indicator locations with an average concentration of 0.024 $pCi/m^3$ for the year. No radioactivity attributable to station operation was detected in any sample.

## 5.3 Aquatic Radioactivity

Surface water samples were collected daily and composited for analysis weekly from the Inlet Canal, Blowdown Diffuser Pipe, East Moline Water Works, and Davenport Water Works. The cooling water samples were analyzed weekly for gross beta concentrations. A composite sample from each quarter from the blowdown diffuser pipe did not indicate measurable radioactivity attributable to station operation except for the last three weeks in December, 1985. During these three weeks, the mean gross beta concentration in the inlet canal samples measured 19.8 pCi/l and 1566 pCi/l in the samples from the diffuser pipe blowdown. For the rest of the period, annual mean gross beta concentration in the blowdown diffuser and inlet canal pipe water samples measured 4.1 and 3.9 pCi/l, respectively.

Samples from the two water works were composited monthly and analyzed for gamma emmiters. All samples analyzed were below the limits of detection for the program indicating that there was no measurable amount of radioactivity due to station operation present.

Levels of gamma radioactivity in fish collected were measured and found in all cases to be below the lower limits of detection for the program.

A sediment sample was analyzed by gamma spectrometry. Gamma-emitters were below the limits of detection, indicating the presence of no radioactivity due to station operation.

### 5.4 Milk

Milk samples were collected monthly from November through April and weekly from May through October and analyzed for iodine-131. Sampled locations were the Hansen Dairy Farm located about 6.0 miles northeast of the Station, and Musal Dairy Farm located 5.5 miles southwest of the Station, both being the closest dairies to the station. Radioiodine was below the limits of detection of 0.5 pCi/l during the grazing period (May to October) and 5.0 pCi/l during the non-grazing period (November to April).

### 5.5 Special Collection

No special collections were made during the period.

## 6.0 ANALYTICAL PROCEDURES

A description of the procedures used for analyzing radioactivity in environmental samples is given in Appendix III of this report.

## 7.0 MILCH ANIMAL CENSUS

A census of milch animals was conducted within five miles of the Station. The survey was conducted by "door-to-door" canvas and by information from Illinois and Iowa Agricultural Agents. The census was conducted by G. Kreuder on August 16, 1985.

There were no dairy farms within a five mile radius of the Quad Cities Nuclear Power Station. The findings of the survey follow.

Within 2 Miles of the Plant

None

Within 2 - 6 Miles of the Plant

Illinois* -- Mel Hanson (Jeff) -- (309) 887-4568

6.0 miles NE -- Type: Holstein
Number: 35
Feed: Hay, corn sileage, commercial feed

Gene Dornbush -- (309) 887-4986

5-1/2 miles NE -- Type: Holstein
Number: 20
Feed: Hay, green chopped hay, corn

Within 2 - 6 Miles of the Plant (continued)

Iowa* -- Alan Musal, Rural Route, Princeton, Iowa - (319) 289-4786

5-1/2 miles SW -- Type: Holstein
Number: 55
Feed: Hay, chopped corn

Carl Otte, Rural Route, Princeton, Iowa

5-1/2 miles W -- Number: 30

## 8.0 NEAREST RESIDENT CENSUS

A census of the rearest residences within a five (5) mile radius was conducted on August 16, 1985 by G. Kreuder. The location of residences remained unchanged from the previous census. The nearest residences are listed below.

| Direction | Distance |
|---|---|
| N | 0.6 miles |
| NNE | 1.0 miles |
| NE | 1.3 miles |
| ENE | 2.8 miles |
| E | 2.3 miles |
| ESE | 2.0 miles |
| SE | 1.0 miles |
| SSE | 1.1 miles |
| S | 0.8 miles |
| SSW | 3.0 miles |
| SW | 2.8 miles |
| WSW | 2.0 miles |
| W | 2.5 miles |
| WNW | 2.5 miles |
| NW | 2.0 miles |
| NNW | 2.0 miles |

## 9.0 INTERLABORATORY COMPARISON PROGRAM RESULTS

Teledyne Isotopes Midwest Laboratory (formerly Hazleton Environmental Sciences) has participated in interlaboratory comparison (crosscheck) programs since the formulation of its quality control program in December 1971. These programs are operated by agencies which supply environmental-type samples (e.g., milk or water) containing concentrations of radionuclides known to the issuing agency but not to participant laboratories. The purpose of such a program is to provide an independent check on the laboratory's analytical procedures and to alert it to any possible problems.

Participant laboratories measure the concentrations of specified radionuclides and report them to the issuing agency. Several months later, the agency reports the known values to the participant laboratories and specifies control limits. Results consistently higher or lower than the known values or outside the control limits indicate a need to check the instruments or procedures used.

The results in Table A-1 were obtained through participation in the environmental sample crosscheck program for milk, water, air filters, and food samples during the period 1982 through 1985. This program has been conducted by the U. S. Environmental Protection Agency Intercomparison and Calibration Section, Quality Assurance Branch, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada.

The results in Table A-2 were obtained for thermoluminescent dosimeters (TLD's) during the period 1976, 1977, 1979, 1980, and 1981 through participation in the Second, Third, Fourth, and Fifth International Intercomparison of Environmental Dosimeters under the sponsorships listed in Table A-2.

Table A-1. U.S. Environmental Protection Agency's crosscheck program, comparison of EPA and Teledyne Isotopes Midwest Laboratory results for milk, water, air filters, and food samples, 1982 through 1985.[a]

| Lab Code | Sample Type | Date Collected | Analysis | Concentration in pCi/l[b] TIML Result ±2σ[c] | EPA Result ±3σ, n=1[d] |
|---|---|---|---|---|---|
| STW-270 | Water | Jan. 1982 | Sr-89 | 24.3±2.0 | 21.0±5.0 |
| | | | Sr-90 | 9.4±0.5 | 12.0±1.5 |
| STW-273 | Water | Jan. 1982 | I-131 | 8.6±0.6 | 8.4±1.5 |
| STW-275 | Water | Feb. 1982 | H-3 | 1580±147 | 1820±342 |
| STW-276 | Water | Feb. 1982 | Cr-51 | <61 | 0 |
| | | | Co-60 | 26.0±3.7 | 20±5 |
| | | | Zn-65 | <13 | 15±5 |
| | | | Ru-106 | <46 | 20±5 |
| | | | Cs-134 | 26.8±0.7 | 22±5 |
| | | | Cs-137 | 29.7±1.4 | 23±5 |
| STW-277 | Water | Mar. 1982 | Ra-226 | 11.9±1.9 | 11.6±1.7 |
| STW-278 | Water | Mar. 1982 | Gross alpha | 15.6±1.9 | 19±5 |
| | | | Gross beta | 19.2±0.4 | 19±5 |
| STW-280 | Water | Apr. 1982 | H-3 | 2690±80 | 2860±360 |
| STW-281 | Water | Apr. 1982 | Gross alpha | 75±7.9 | 85±21 |
| | | | Gross beta | 114.1±5.9 | 106±5.3 |
| | | | Sr-89 | 17.4±1.8 | 24±5 |
| | | | Sr-90 | 10.5±0.6 | 12±1.5 |
| | | | Ra-226 | 11.4±2.0 | 10.9±1.5 |
| | | | Co-60 | <4.6 | 0 |
| STW-284 | Water | May 1982 | Gross alpha | 31.5±6.5 | 27.5±7 |
| | | | Gross beta | 25.9±3.4 | 29±5 |
| STW-285 | Water | June 1982 | H-3 | 1970±1408 | 1830±340 |
| STW-286 | Water | June 1982 | Ra-226 | 12.6±1.5 | 13.4±3.5 |
| | | | Ra-228 | 11.1±2.5 | 8.7±2.3 |
| STW-287 | Water | June 1982 | I-131 | 6.5±0.3 | 4.4±0.7 |
| STW-290 | Water | Aug. 1982 | H-3 | 3210±140 | 2890±619 |

Table A-1. (continued)

| Lab Code | Sample Type | Date Collected | Analysis | Concentration in pCi/l[b] TIML Result ±2σ[c] | EPA Result ±3σ, n=1[d] |
|---|---|---|---|---|---|
| STW-291 | Water | Aug. 1982 | I-131 | 94.6±2.5 | 87±15 |
| STW-292 | Water | Sept. 1982 | Sr-89 | 22.7±3.8 | 24.5±8.7 |
| | | | Sr-90 | 10.9±0.3 | 14.5±2.6 |
| STW-296 | Water | Oct. 1982 | Co-60 | 20.0±1.0 | 20±8.7 |
| | | | Zn-65 | 32.3±5.1 | 24±8.7 |
| | | | Cs-134 | 15.3±1.5 | 19.0±8.7 |
| | | | Cs-137 | 21.0±1.7 | 20.0±8.7 |
| STW-297 | Water | Oct. 1982 | H-3 | 2470±20 | 2560±612 |
| STW-298 | Water | Oct. 1982 | Gross alpha | 32±30 | 55±24 |
| | | | Gross beta | 81.7±6.1 | 81±8.7 |
| | | | Sr-89 | <2 | 0 |
| | | | Sr-90 | 14.1±0.9 | 17.2±2.6 |
| | | | Cs-134 | <2 | 1.8±8.7 |
| | | | Cs-137 | 22.7±0.6 | 20±8.7 |
| | | | Ra-226 | 13.6±0.3 | 12.5±3.2 |
| | | | Ra-228 | 3.9±1.0 | 3.6±0.9 |
| STW-301 | Water | Nov. 1982 | Gross alpha | 12.0±1.0 | 19.0±8.7 |
| | | | Gross beta | 34.0±2.7 | 24.0±8.7 |
| STW-302 | Water | Dec. 1982 | I-131 | 40.0±0.0 | 37.0±10 |
| STW-303 | Water | Dec. 1982 | H-3 | 1940±20 | 1990±345 |
| STW-304 | Water | Dec. 1982 | Ra-226 | 11.7±0.6 | 11.0±1.7 |
| | | | Ra-228 | <3 | 0 |
| STW-306 | Water | Jan. 1983 | Sr-89 | 20.0±8.7 | 29.2±5 |
| | | | Sr-90 | 21.7±8.4 | 17.2±1.5 |
| STW-307 | Water | Jan. 1983 | Gross alpha | 29.0±4.09 | 29.0±13 |
| | | | Gross beta | 29.3±0.6 | 31.0±8.7 |
| STM-309 | Milk | Feb. 1983 | Sr-89 | 35±2.0 | 37±8.7 |
| | | | Sr-90 | 13.7±0.6 | 18±2.6 |
| | | | I-131 | 55.7±3.2 | 55±10.4 |
| | | | Cs-137 | 29±1.0 | 26±8.7 |
| | | | Ba-140 | <27 | 0 |
| | | | K-40 | 1637±5.8 | 1512±131 |

Table A-1. (continued)

| Lab Code | Sample Type | Date Collected | Analysis | Concentration in pCi/l[b] TIML Result ±2σ[c] | Concentration in pCi/l[b] EPA Result ±3σ, n=1[d] |
|---|---|---|---|---|---|
| STW-310 | Water | Feb. 1983 | H-3 | 2470±80 | 2560±612 |
| STW-311 | Water | March 1983 | Ra-226 | 11.9±1.3 | 12.7±3.3 |
| | | | Ra-228 | <2.7 | 0 |
| STW-312 | Water | March 1983 | Gross alpha | 31.6±4.59 | 31±13.4 |
| | | | Gross beta | 27.0±2.0 | 28±8.7 |
| STW-313 | Water | April 1983 | H-3 | 3240±80 | 3330±627 |
| STW-316 | Water | May 1983 | Gross alpha | 94±7 | 64±19.9 |
| | | | Gross beta | 133±5 | 149±12.4 |
| | | | Sr-89 | 19±1 | 24±8.7 |
| | | | Sr-90 | 12±1 | 13±2.6 |
| | | | Ra-226 | 7.9±0.4 | 8.5±2.25 |
| | | | Co-60 | 30±2 | 30±8.7 |
| | | | Cs-134 | 27±2 | 33±8.7 |
| | | | Cs-137 | 29±1 | 27±8.7 |
| STW-317 | Water | May 1983 | Sr-89 | 59.7±2.1 | 57±8.7 |
| | | | Sr-90 | 33.7±1.5 | 38±3.3 |
| STW-318[f] | Water | May 1983 | Gross alpha | 12.8±1.5 | 11±8.7 |
| | | | Gross beta | 49.4±3.9 | 57±8.7 |
| STM-320 | Milk | June 1983 | Sr-89 | 20±0 | 25±8.7 |
| | | | Sr-90 | 10±1 | 16±2.6 |
| | | | I-131 | 30±1 | 30±10.4 |
| | | | Cs-137 | 52±2 | 47±8.7 |
| | | | K-40 | 1553±57 | 1486±129 |
| STW-321 | Water | June 1983 | H-3 | 1470±89 | 1529±583 |
| STW-322 | Water | June 1983 | Ra-226 | 4.3±0.2 | 4.8±1.24 |
| | | | Ra-228 | <2.5 | 0 |
| STW-323 | Water | July 1983 | Gross alpha | 3±1 | 7±8.7 |
| | | | Gross beta | 21±0 | 22±8.7 |
| STW-324 | Water | August 1983 | I-131 | 13.3±0.6 | 14±10.4 |

Table A-1. (continued)

| Lab Code | Sample Type | Date Collected | Analysis | Concentration in pCi/l[b] TIML Result ±2σ[c] | EPA Result ±3σ, n=1[d] |
|---|---|---|---|---|---|
| STAF-326 | Air Filter | August 1983 | Gross beta | 42±2 | 36±8.7 |
| | | | Sr-90 | 14±2 | 10±2.6 |
| | | | Cs-137 | 19±1 | 15±8.7 |
| STW-328 | Water | Sept. 1983 | Gross alpha | 2.3±0.6 | 5±8.7 |
| | | | Gross beta | 10.7±1.2 | 9±8.7 |
| STW-329 | Water | Sept. 1983 | Ra-226 | 3.0±0.2 | 3.1±0.81 |
| | | | Ra-228 | 3.2±0.7 | 2.0±0.52 |
| STW-331 | Water | Oct. 1983 | H-3 | 1300±30 | 1210±570 |
| STW-335 | Water | Dec. 1983 | I-131 | 19.6±1.9 | 20±10.4 |
| STW-336 | Water | Dec. 1983 | H-3 | 2870±100 | 2389±608 |
| STAF-337 | Air Filter | Nov. 1983 | Gross alpha | 18.0±0.2 | 19±8.7 |
| | | | Gross beta | 58.6±1.2 | 50±8.7 |
| | | | Sr-90 | 10.9±0.1 | 15±2.6 |
| | | | Cs-137 | 30.1±2.5 | 20±8.7 |
| STW-339 | Water | Jan. 1984 | Sr-89 | 47.2±1.9 | 36±8.7 |
| | | | Sr-90 | 22.5±4.0 | 24±2.6 |
| STW-343 | Water | Feb. 1984 | H-3 | 2487±76 | 2383±607 |
| STM-347 | Milk | March 1984 | I-131 | 5.3±1.1 | 6±1.6 |
| STW-349 | Water | March 1984 | Ra-226 | 4.0±0.2 | 4.1±1.06 |
| | | | Ra-228 | 3.6±0.3 | 2.0±0.52 |
| STW-350 | Water | March 1984 | Gross alpha | 3.8±1.1 | 5±8.7 |
| | | | Gross beta | 24.2±2.0 | 20±8.7 |
| STW-354 | Water | April 1984 | H-3 | 3560±50 | 3508±630 |
| STW-355 | Water | April 1984 | Gross alpha | 21.0±4.1 | 35±15.2 |
| | | | Gross beta | 127.8±4.1 | 147±12.7 |
| | | | Sr-89 | 29.3±2.0 | 23±8.7 |
| | | | Sr-90 | 16.6±0.7 | 26±2.6 |
| | | | Ra-226 | 4.0±1.0 | 4.0±1.04 |
| | | | Co-60 | 32.3±1.4 | 30±8.7 |
| | | | Cs-134 | 33.6±3.1 | 30±8.7 |
| | | | Cs-137 | 33.3±2.2 | 26±8.7 |

Table A-1. (continued)

| Lab Code | Sample Type | Date Collected | Analysis | Concentration in pCi/l[b] TIML Result ±2σ[c] | Concentration in pCi/l[b] EPA Result ±3σ, n=1[d] |
|---|---|---|---|---|---|
| STW-358 | Water | May 1984 | Gross alpha | 3.0±0.6 | 3±8.7 |
| | | | Gross beta | 6.7±1.2 | 6±8.7 |
| STM-366 | Milk | June 1984 | Sr-89 | 21±3.1 | 25±8.7 |
| | | | Sr-90 | 13±2.0 | 17±2.6 |
| | | | I-131 | 46±5.3 | 43±10.4 |
| | | | Cs-137 | 38±4.0 | 35±8.7 |
| | | | K-40 | 1577±172 | 1496±130 |
| STW-368 | Water | July 1984 | Gross alpha | 5.1±1.1 | 6±8.7 |
| | | | Gross beta | 11.9±2.4 | 13±8.7 |
| STW-369 | Water | August 1984 | I-131 | 34.3±5.0 | 34.0±10.4 |
| STW-370 | Water | August 1984 | H-3 | 3003±253 | 2817±617 |
| STF-371 | Food | July 1984 | Sr-89 | 22.0±5.3 | 25.0±8.7 |
| | | | Sr-90 | 14.7±3.1 | 20.0±2.6 |
| | | | I-131 | <172 | 39.0±10.4 |
| | | | Cs-137 | 24.0±5.3 | 25.0±8.7 |
| | | | K-40 | 2503±132 | 2605±226.0 |
| STAF-372 | Air Filter | August 1984 | Gross alpha | 15.3±1.2 | 17±8.7 |
| | | | Gross beta | 56.0±0.0 | 51±8.7 |
| | | | Sr-90 | 14.3±1.2 | 18±2.4 |
| | | | Cs-137 | 21.0±2.0 | 15±8.7 |
| STW-375 | Water | Sept. 1984 | Ra-226 | 5.1±0.4 | 4.9±1.27 |
| | | | Ra-228 | 2.2±0.1 | 2.3±0.60 |
| STW-377 | Water | Sept. 1984 | Gross alpha | 3.3±1.2 | 5.0±8.7 |
| | | | Gross beta | 12.7±2.3 | 16.0±8.7 |
| STW-379 | Water | Oct. 1984 | H-3 | 2860±312 | 2810±356 |
| STW-380 | Water | Oct. 1984 | Cr-51 | <36 | 40±8.7 |
| | | | Co-60 | 20.3±1.2 | 20±8.7 |
| | | | Zn-65 | 150±8.1 | 147±8.7 |
| | | | Ru-106 | <30 | 47±8.7 |
| | | | Cs-134 | 31.3±7.0 | 31±8.7 |
| | | | Cs-137 | 26.7±1.2 | 24±8.7 |

Table A-1. (continued)

| Lab Code | Sample Type | Date Collected | Analysis | Concentration in pCi/l[b] TIML Result ±2[c] | EPA Result ±3, n=1[d] |
|---|---|---|---|---|---|
| STM-382 | Milk | Oct. 1984 | Sr-89 | 15.7±4.2 | 22±8.7 |
| | | | Sr-90 | 12.7±1.2 | 16±2.6 |
| | | | I-131 | 41.7±3.1 | 42±10.4 |
| | | | Cs-137 | 31.3±6.1 | 32±8.7 |
| | | | K-40 | 1447±66 | 1517±131 |
| STW-384 | Water (Blind) | Oct. 1984 Sample A | Gross alpha | 9.7±1.2 | 14±8.7 |
| | | | Ra-226 | 3.3±0.2 | 3.0±0.8 |
| | | | Ra-228 | 3.4±1.6 | 2.1±0.5 |
| | | | Uranium | NA[e] | 5±10.4 |
| | | Sample B | Gross beta | 48.3±5.0 | 64±8.7 |
| | | | Sr-89 | 10.7±4.6 | 11±8.7 |
| | | | Sr-90 | 7.3±1.2 | 12±2.6 |
| | | | Co-60 | 16.3±1.2 | 14±8.7 |
| | | | Cs-134 | <2 | 2±8.7 |
| | | | Cs-137 | 16.7±1.2 | 14±8.7 |
| STAF-387 | Air Filter | Nov. 1984 | Gross alpha | 18.7±1.2 | 15±8.7 |
| | | | Gross beta | 59.0±5.3 | 52±8.7 |
| | | | Sr-90 | 18.3±1.2 | 21±2.6 |
| | | | Cs-137 | 10.3±1.2 | 10±8.7 |
| STW-388 | Water | Dec. 1984 | I-131 | 28.0±2.0 | 36±10.4 |
| STW-389 | Water | Dec. 1984 | H-3 | 3583±110 | 3182±624 |
| STW-391 | Water | Dec. 1984 | Ra-226 | 8.4±1.7 | 8.6±2.2 |
| | | | Ra-228 | 3.1±0.2 | 4.1±1.1 |
| STW-392 | Water | Jan. 1985 | Sr-89 | <3.0 | 3.0±8.7 |
| | | | Sr-90 | 27.3±5.2 | 30.0±2.6 |
| STW-393 | Water | Jan. 1985 | Gross alpha | 3.3±1.2 | 5±8.7 |
| | | | Gross beta | 17.3±3.0 | 15±8.7 |
| STS-395 | Food | Jan. 1985 | Sr-89 | 25.3±6.4 | 34.0±5.0 |
| | | | Sr-90 | 27.0±8.8 | 26.0±1.5 |
| | | | I-131 | 38.0±2.0 | 35.0±6.0 |
| | | | Cs-137 | 32.7±2.4 | 29.0±5.0 |
| | | | K-40 | 1410±212 | 1382±120 |

Table A-1. (continued)

| Lab Code | Sample Type | Date Collected | Analysis | Concentration in pCi/l[b] TIML Result ±2σ[c] | EPA Result ±3σ, n=1[d] |
|---|---|---|---|---|---|
| STW-397 | Water | Feb. 1985 | Cr-51 | <29 | 48±8.7 |
| | | | Co-60 | 21.3±3.0 | 20±8.7 |
| | | | Zn-65 | 53.7±5.0 | 55±8.7 |
| | | | Ru-106 | <23 | 25±8.7 |
| | | | Cs-134 | 32.3±1.2 | 35±8.7 |
| | | | Cs-137 | 25.3±3.0 | 25±8.7 |
| STW-398 | Water | Feb. 1985 | H-3 | 3869±319 | 3796±634 |
| STM-400 | Milk | March 1985 | I-131 | 7.3±2.4 | 9.0±0.9 |
| STW-402 | Water | March 1985 | Ra-226 | 4.6±0.6 | 5.0±1.3 |
| | | | Ra-228 | <0.8 | 9.0±2.3 |
| | | Reanalysis | Ra-228 | 9.0±0.4 | |
| STW-404 | Water | March 1985 | Gross alpha | 4.7±2.3 | 6±8.7 |
| | | | Gross beta | 11.3±1.2 | 15±8.7 |
| STAF-405 | Air Filter | March 1985 | Gross alpha | 9.3±1.0 | 10.0±8.7 |
| | | | Gross beta | 42.0±1.1 | 36.0±8.7 |
| | | | Sr-90 | 13.3±1.0 | 15.0±2.6 |
| | | | Cs-137 | 6.3±1.0 | 6.0±8.7 |
| STW-407 | Water | April 1985 | I-131 | 8.0±0.0 | 7.5±1.3 |
| STW-408 | Water | April 1985 | H-3 | 3399±150 | 3559±630 |
| STW-409 | Water | April 1985 | | | |
| | (Blind) Sample A | | Gross alpha | 29.7±1.8 | 32.0±5.0 |
| | | | Ra-226 | 4.4±0.2 | 4.1±0.6 |
| | | | Ra-228 | NA[e] | 6.2±0.9 |
| | | | Uranium | NA[e] | 7.0±6.0 |
| | Sample B | | Gross beta | 74.3±11.8 | 72.0±5.0 |
| | | | Sr-89 | 12.3±7.6 | 10.0±5.0 |
| | | | Sr-90 | 14.7±2.4 | 15.0±1.5 |
| | | | Co-60 | 14.7±2.4 | 15.0±5.0 |
| | | | Cs-134 | 12.0±2.0 | 15.0±5.0 |
| | | | Cs-137 | 14.0±2.0 | 12.0±5.0 |

Table A-1. (continued)

| Lab Code | Sample Type | Date Collected | Analysis | Concentration in pCi/l[b] TIML Result ±2 [c] | EPA Result ±3 , n=1[d] |
|---|---|---|---|---|---|
| STW-413 | Water | May 1985 | Sr-89 | 36.0±12.4 | 39.0±5.0 |
| | | | Sr-90 | 14.3±4.2 | 15.0±1.5 |
| STW-414 | Water | May 1985 | Gross alpha | 8.3±4.1 | 12.0±5.0 |
| | | | Gross beta | 8.7±1.2 | 11.0±5.0 |
| STW-416 | Water | June 1985 | Cr-51 | 44.7±6.0 | 44.0±5.0 |
| | | | Co-60 | 14.3±1.2 | 14.0±5.0 |
| | | | Zn-65 | 50.3±7.0 | 47.0±5.0 |
| | | | Ru-106 | 55.3±5.8 | 62.0±5.0 |
| | | | Cs-134 | 32.7±1.2 | 35.0±5.0 |
| | | | Cs-137 | 22.7±2.4 | 20.0±5.0 |
| STW-418 | Water | June 1985 | H-3 | 2446±132 | 2416±351 |
| STM-421 | Milk | June 1985 | Sr-89 | 10.3±4.6 | 11.0±8.7 |
| | | | Sr-90 | 9.0±2.0 | 11.0±2.6 |
| | | | I-131 | 11.7±1.2 | 11.0±10.4 |
| | | | Cs-137 | 12.7±1.2 | 11.0±8.7 |
| | | | K-40 | 1512±62 | 1525±132 |
| STW-423 | Water | July 1985 | Gross alpha | 5.0±0.0 | 11.0±8.7 |
| | | | Gross beta | 5.0±2.0 | 8.0±8.7 |
| STW-425 | Water | August 1985 | I-131 | 25.7±3.0 | 33.0±10.4 |
| STW-426 | Water | August 1985 | H-3 | 4363±83 | 4480±776 |
| STAF-427 | Air Filter | August 1985 | Gross alpha | 11.3±0.6 | 13.0±8.7 |
| | | | Gross beta | 46.0±1.0 | 44.0±8.7 |
| | | | Sr-90 | 17.7±0.6 | 18.0±2.6 |
| | | | Cs-137 | 10.3±0.6 | 8.0±8.7 |
| STW-429 | Water | Sept. 1985 | Sr-89 | 15.7±0.6 | 20.0±8.7 |
| | | | Sr-90 | 7.0±0.0 | 7.0±2.6 |
| STW-430 | Water | Sept. 1985 | Ra-226 | 8.2±0.3 | 8.9±2.3 |
| | | | Ra-228 | 4.1±0.3 | 4.6±1.2 |
| STW-431 | Water | Sept. 1985 | Gross alpha | 4.7±0.6 | 8.0±8.7 |
| | | | Gross beta | 4.7±1.2 | 8.0±8.7 |

Table A-1. (continued)

| Lab Code | Sample Type | Date Collected | Analysis | Concentration in pCi/l[b] TIML Result ±2σ[c] | EPA Result ±3σ, n=1[d] |
|---|---|---|---|---|---|
| STW-433 | Water | Oct. 1985 | Cr-51 | <13 | 21.0±8.7 |
| | | | Co-60 | 19.30.6 | 20.0±8.7 |
| | | | Zn-65 | 19.7±0.6 | 19.0±8.7 |
| | | | Ru-106 | <19 | 20.0±8.7 |
| | | | Cs-134 | 17.0±1.0 | 20.0±8.7 |
| | | | Cs-137 | 19.3±1.2 | 20.0±8.7 |
| STW-435 | Water | Oct. 1985 | H-3 | 1957±50 | 1974±598 |

[a] Results obtained by Teledyne Isotopes Midwest Laboratory as a participant in the environmental sample crosscheck program operated by the Intercomparison and Calibration Section, Quality Assurance Branch, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, (EPA), Las Vegas, Nevada.

[b] All results are in pCi/l, except for elemental potassium (K) data, which are in mg/l; air filter samples, which are in pCi/filter; and food, which is in pCi/kg.

[c] Unless otherwise indicated, the TIML results are given as the mean ±2 standard deviations for three determinations.

[d] USEPA results are presented as the known values ± control limits of 3σ for n = 1.

[e] NA = Not analyzed.

[f] Analyzed but not reported to the EPA.

[g] Results after calculations corrected (error in calculations when reported to EPA).

Table A-2. Crosscheck program results, thermoluminescent dosimeters (TLDs).

| Lab Code | TLD Type | Measurement | mR: Teledyne Result ±2σ[a] | mR: Known Value | mR: Average ±2σ[d] (all participants) |
|---|---|---|---|---|---|
| 2nd International Intercomparison[b] | | | | | |
| 115-2[b] | $CaF_2$:Mn Bulb | Gamma-Field | 17.0±1.9 | 17.1[c] | 16.4±7.7 |
| | | Gamma-Lab | 20.8±4.1 | 21.3[c] | 18.8±7.6 |
| 3rd International Intercomparison[e] | | | | | |
| 115-3[e] | $CaF_2$:Mn Bulb | Gamma-Field | 30.7±3.2 | 34.9±4.8[f] | 31.5±3.0 |
| | | Gamma-Lab | 89.6±6.4 | 91.7±14.6[f] | 86.2±24.0 |
| 4th International Intercomparison[g] | | | | | |
| 115-4[g] | $CaF_2$:Mn Bulb | Gamma-Field | 14.1±1.1 | 14.1±1.4[f] | 16.0±9.0 |
| | | Gamma-Lab (Low) | 9.3±1.3 | 12.2±2.4[f] | 12.0±7.6 |
| | | Gamma-Lab (High) | 40.4±1.4 | 45.8±9.2[f] | 43.9±13.2 |
| 5th International Intercomparison[h] | | | | | |
| 115-5A[h] | $CaF_2$:Mn Bulb | Gamma-Field | 31.4±1.8 | 30.0±6.0[i] | 30.2±14.6 |
| | | Gamma-Lab at beginning | 77.4±5.8 | 75.2±7.6[i] | 75.8±40.4 |
| | | Gamma-Lab at the end | 96.6±5.8 | 88.4±8.8[i] | 90.7±31.2 |

Table A-2. (Continued)

| Lab Code | TLD Type | Measurement | mR | | |
|---|---|---|---|---|---|
| | | | Teledyne Result ±2σ[a] | Known Value | Average ± 2σ[d] (all participants) |
| 115-58[h] | LiF-100 Chips | Gamma-Field | 30.3±4.8 | 30.0±6[i] | 30.2±14.6 |
| | | Gamma-Lab at beginning | 81.1±7.4 | 75.2±7.6[i] | 75.8±40.4 |
| | | Gamma-Lab at the end | 85.4±11.7 | 88.4±8.8[i] | 90.7±31.2 |

[a] Lab result given is the mean ±2 standard deviations of three determinations.
[b] Second International Intercomparison of Environmental Dosimeters conducted in April of 1976 by the Health and Safety Laboratory (GASL), New York, New York, and the School of Public Health of the University of Texas, Houston, Texas.
[c] Value determined by sponsor of the intercomparison using continuously operated pressurized ion chamber.
[d] Mean ±2 standard deviations of results obtained by all laboratories participating in the program.
[e] Third International Intercomparison of Environmental Dosimeters conducted in summer of 1977 by Oak Ridge National Laboratory and the School of Public Health of the University of Texas, Houston, Texas.
[f] Value ±2 standard deviations as determined by sponsor of the intercomparison using continuously operated pressurized ion chamber.
[g] Fourth International Intercomparison of Environmental Dosimeters conducted in summer of 1979 by the School of Public Health of the University of Texas, Houston, Texas.
[h] Fifth International Intercomparison of Environmental Dosimeter conducted in fall of 1980 at Idaho Falls, Idaho and sponsored by the School of Public Health of the University of Texas, Houston, Texas and Environmental Measurements Laboratory, New York, New York, U.S. Department of Energy.
[i] Value determined by sponsor of the intercomparison using continuously operated pressurized ion chamber.

# APPENDIX I

## DATA TABLES AND FIGURES

Table 1.1-1

OCP 100-S25
Revision 3
May 1985

EFFLUENT AND WASTE DISPOSAL
SEMI-ANNUAL REPORT Jan-June 1985
GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

| | Unit | Quarter First | Quarter Second | Est. Total Error, % |
|---|---|---|---|---|
| A. FISSION & ACTIVATION GASES | | | | |
| 1. Total Release | Ci | 3.7E02 | 7.3E02 | |
| 2. Average release rate for period | µCi/sec | 4.8E01 | 9.3E01 | |
| 3. Percent of Tech Spec limit * Chimney & stack | % | 3.0E-01 / 1.0E-1 | 4.1E-1 / 1.7E-1 | |
| B. IODINE | | | | |
| 1. Total Iodine-131 | Ci | 1.4E-02 | 5.7E-03 | |
| 2. Average release rate for period | µCi/sec | 1.8E-03 | 7.2E-04 | |
| C. PARTICULATES | | | | |
| 1. Particulates with half-lives > 8 days | Ci | 3.2E-02 | 3.5E-02 | |
| 2. Average release rate for period | µCi/sec | 4.1E-03 | 4.5E-03 | |
| 3. Gross alpha radioactivity | Ci | 9.6E-06 | 1.1E-05 | |
| D. TRITIUM | | | | |
| 1. Total Release | Ci | 21.5 | 7.07 | |
| 2. Average release rate for period | µCi/sec | 2.80 | 0.90 | |
| E. Iodine 131 & 133, Tritium and Particulates | | | | |
| Percent of Tech spec Limit Chimney & stack | % | 1.7E-01 | 9.0E-01 | |

Nobel Gas Gamma/Beta

Table 1.1-1 (continued)

QCP 100-S25
Revision 3
May 1985

EFFLUENT AND WASTE DISPOSAL
SEMI-ANNUAL REPORT July-December 1985
GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

| | Unit | Quarter Third | Quarter Fourth | Est. Total Error, % |
|---|---|---|---|---|
| A. FISSION & ACTIVATION GASES | | | | |
| 1. Total Release | Ci | 6.5E02 | 1.2E03 | |
| 2. Average release rate for period | μCi/sec | 8.4E01 | 1.5E02 | |
| 3. Percent of Tech Spec limit * Chimney & stack | % | 2.3E-01 / 6.0E-2 | 5.6E-1 / 9.8E-2 | |
| B. IODINE | | | | |
| 1. Total Iodine-131 | Ci | 1.7E-02 | 1.2E-02 | |
| 2. Average release rate for period | μCi/sec | 2.1E-03 | 1.5E-03 | |
| C. PARTICULATES | | | | |
| 1. Particulates with half-lives > 8 days | Ci | 2.2E-01 | 2.7E-01 | |
| 2. Average release rate for period | μCi/sec | 2.7E-02 | 3.4E-02 | |
| 3. Gross alpha radioactivity | Ci | 1.34E-05 | 1.51E-05 | |
| D. TRITIUM | | | | |
| 1. Total Release | Ci | 7.34E00 | 1.63E01 | |
| 2. Average release rate for period | μCi/sec | 9.2E-01 | 2.1E00 | |
| E. Iodine 131 & 133, Tritium and Particulates | | | | |
| Percent of Tech spec Limit Chimney & stack | % | 2.3E00 | 5.1E-01 | |

*Noble Gas Gamma Radiation/Noble Gas Beta Radiation

Table 1.1-1 (continued)

QCP 100-525
Revision 3

MAIN CHIMNEY

GASEOUS EFFLUENTS

| | | Continuous Mode | | Batch Mode | |
|---|---|---|---|---|---|
| Nuclides Released | Unit | Quarter First | Quarter Second | Quarter | Quarter |
| 1. Fission gases | | | | | |
| Kr-85 | Ci | < LLD | < LLD | | |
| Kr-85m | Ci | 5.7E00 | 3.4E01 | | |
| Kr-87 | Ci | 5.1E00 | 3.5E01 | | |
| Kr-88 | Ci | 7.7E00 | 3.9E01 | | |
| Xe-133 | Ci | 3.1E01 | 1.7E02 | | |
| X3-135 | Ci | 7.3E01 | 2.4E02 | | |
| Xe-135m | Ci | 5.9E01 | 4.3E01 | | |
| Xe-138 | Ci | 1.7E02 | 1.3E02 | | |
| | Ci | -- | -- | | |
| | Ci | -- | -- | | |
| | Ci | -- | -- | | |
| Unidentified | Ci | -- | -- | | |
| Total for Period | Ci | 3.5E02 | 6.9E02 | | |
| 2. Iodines | | | | | |
| I-131 | Ci | 1.11E-02 | 4.63E-03 | | |
| I-133 | Ci | 6.70E-02 | 4.07E-02 | | |
| I-135 | Ci | 6.20E-02 | 7.21E-02 | | |
| Total for Period | Ci | 1.40E-01 | 1.17E-01 | | |

Table 1.1-1 (continued)

QCP 100-325
Revision 3

Main Chimney

GASEOUS EFFLUENTS

| | | Continuous Mode | | Batch Mode | |
|---|---|---|---|---|---|
| Nuclides Released | Unit | Quarter Third | Quarter Fourth | Quarter | Quarter |
| 1. Fission gases | | | | | |
| Kr-85 | Ci | <LLD | <LLD | | |
| Kr-85m | Ci | 5.1E01 | 8.1E01 | | |
| Kr-87 | Ci | 3.4E00 | 5.9E01 | | |
| Kr-88 | Ci | 1.7E01 | 1.1E02 | | |
| Xe-133 | Ci | 4.1E02 | 4.8E02 | | |
| X3-135 | Ci | 4.5E01 | 3.0E02 | | |
| Xe-135m | Ci | 3.8E+1 | 7.6E01 | | |
| Xe-138 | Ci | 9.0E01 | 6.8E01 | | |
| | Ci | | | | |
| | Ci | | | | |
| | Ci | | | | |
| Unidentified | Ci | <LLD | <LLD | | |
| Total for Period | Ci | 6.5E02 | 1.2E03 | | |
| 2. Iodines | | | | | |
| I-131 | Ci | 1.5E-02 | 9.0E-03 | | |
| I-133 | Ci | 8.9E-02 | 4.4E-02 | | |
| I-135 | Ci | 1.3E-01 | 8.7E-02 | | |
| Total for Period | Ci | 2.3E-01 | 1.4E-01 | | |

GASEOUS EFFLUENTS

| Nuclides Released | Unit | Continuous Mode Quarter First | Continuous Mode Quarter Second | Batch Mode Quarter --- | Batch Mode Quarter --- |
|---|---|---|---|---|---|
| 3. Particulates | | Main Chimney | | | |
| SR-89 | Ci | 1.22E-03 | 1.45E-03 | | |
| SR-90 | Ci | 3.65E-05 | 3.08E-05 | | |
| Cs-134 | Ci | 7.10E-05 | 1.17E-04 | | |
| Cs-137 | Ci | 4.34E-04 | 8.78E-04 | | |
| Ba-140 | Ci | 3.24E-03 | 2.54E-03 | | |
| La-140 | Ci | 8 Day | Half Line | | |
| Cr-51 | Ci | <LLD | <LLD | | |
| Mn-54 | Ci | <LLD | <LLD | | |
| Co-58 | Ci | <LLD | <LLD | | |
| Co-60 | Ci | 9.60E-04 | 1.02E-03 | | |
| I-131 | Ci | 7.50E-04 | 3.95E-04 | | |
| Ag-110m | Ci | <LLD | 2.1E-05 | | |
| | Ci | 7.38E-03 | 6.10E-03 | | |
| | Ci | 9.8 E-03 | 8.20E-03 | | |
| | Ci | | | | |
| | Ci | | | | |
| | Ci | | | | |
| Unidentified | Ci | | | | |

* Sr-89, Sr-90 Values for May and June are projected

Table 1.1-1 (continued)

QCP 100-525
Revision 3

Main Chimney

GASEOUS EFFLUENTS

| Nuclides Released | Unit | Continuous Mode Quarter Third | Continuous Mode Quarter Fourth | Batch Mode Quarter | Batch Mode Quarter |
|---|---|---|---|---|---|
| 3. Particulates | | | | | |
| SR-89 | Ci | 1.4E-03 | 3.3E-03 | | |
| SR-90 | Ci | 2.5E-05 | 1.3E-05 | | |
| Cs-134 | Ci | 1.39E-05 | <LLD | | |
| Cs-137 | Ci | 6.4E-04 | 8.1E-04 | | |
| Ba-140 | Ci | 4.7E-03 | 3.1E-03 | | |
| La-140 | Ci | <LLD | <LLD | | |
| Cr-51 | Ci | <LLD | <LLD | | |
| Mn-54 | Ci | <LLD | <LLD | | |
| Co-58 | Ci | <LLD | <LLD | | |
| Co-60 | Ci | 1.2E-03 | 9.1E-04 | | |
| I-131 | Ci | 1.1E-03 | 1.6E-03 | | |
| Ag-110m | Ci | <LLD | <LLD | | |
| I-133 | Ci | 1.1E-02 | 9.7E-03 | | |
| I-135 | Ci | 1.8E-01 | 2.4E-01 | | |
| Ru103 | Ci | 4.8E-4 | <LLD | | |
| | Ci | | | | |
| | Ci | | | | |
| Unidentified | Ci | <LLD | <LLD | | |
| TOTAL | Ci | 2.1E-01 | 2.6E-01 | | |

Table 1.1-1 (continued)

QCP 100-525
Revision 3

## GASEOUS EFFLUENTS

| Nuclides Released | Unit | Continuous Mode Quarter First | Continuous Mode Quarter Second | Batch Mode Quarter | Batch Mode Quarter |
|---|---|---|---|---|---|
| 1. Fission gases | | Reactor Vent | | | |
| Kr-85 | Ci | <LLD | <LLD | | |
| Kr-85m | Ci | <LLD | <LLD | | |
| Kr-87 | Ci | <LLD | 3.01 | | |
| Kr-88 | Ci | <LLD | <LLD | | |
| Xe-133 | Ci | 1.2 | 24.8 | | |
| X3-135 | Ci | 17.6 | 9.13 | | |
| Xe-135m | Ci | 3.01 | <LLD | | |
| Xe-138 | Ci | <LLD | <LLD | | |
| | Ci | --- | --- | | |
| | Ci | --- | --- | | |
| Total for Period | Ci | 21.8 | 36.9 | | |
| 2. Iodines | | | | | |
| I-131 | Ci | 1.99E-03 | 4.93E-04 | | |
| I-133 | Ci | 4.33E-03 | 3.02E-03 | | |
| I-135 | Ci | 4.38E-03 | 4.61E-03 | | |
| Total for Period | Ci | 8.81E-03 | 8.17E-03 | | |

Table 1.1-1 (continued)

QCP 100-525
Revision 3

Reactor Vents

GASEOUS EFFLUENTS

| Nuclides Released | Unit | Continuous Mode Quarter Third | Continuous Mode Quarter Fourth | Batch Mode Quarter | Batch Mode Quarter |
|---|---|---|---|---|---|
| 1. Fission gases | | | | | |
| Kr-85 | Ci | <LLD | <LLD | | |
| Kr-85m | Ci | <LLD | <LLD | | |
| Kr-87 | Ci | <LLD | <LLD | | |
| Kr-88 | Ci | <LLD | <LLD | | |
| Xe-133 | Ci | 5.4E-01 | 9.0E-02 | | |
| X3-135 | Ci | 9.8E00 | 8.7E00 | | |
| Xe-135m | Ci | <LLD | <LLD | | |
| Xe-138 | Ci | 3.2E00 | <LLD | | |
| | Ci | | | | |
| | Ci | | | | |
| Total for Period | Ci | 1.4E01 | 8.8E00 | | |
| 2. Iodines | | | | | |
| I-131 | Ci | 6.5E-04 | 8.4E-04 | | |
| I-133 | Ci | 2.5E-03 | 2.9E-03 | | |
| I-135 | Ci | 5.5E-03 | 5.4E-03 | | |
| Total for Period | Ci | 8.7E-03 | 9.1E-03 | | |

## GASEOUS EFFLUENTS

| Nuclides Released | Unit | Continuous Mode Quarter First | Continuous Mode Quarter Second | Batch Mode Quarter --- | Batch Mode Quarter --- |
|---|---|---|---|---|---|
| 3. Particulates | | Reactor Vents | | | |
| SR-89* | Ci | 5.38E-05 | 3.47E-04 | | |
| SR-90 | Ci | 4.53E-05 | 3.48E-05 | | |
| Cs-134 | Ci | 7.5E-05 | 5.03E-05 | | |
| Cs-137 | Ci | 3.26E-04 | 1.06E-03 | | |
| Ba-140 | Ci | 3.42E-04 | 4.45E-04 | | |
| La-140 | Ci | <8 Day | Half Line | | |
| Cr-51 | Ci | 5.90E-04 | 8.78E-04 | | |
| Mn-54 | Ci | <LLD | 3.7E-05 | | |
| Co-58 | Ci | <LLD | 3.6E-05 | | |
| Co-60 | Ci | 2.97E-03 | 2.01E-03 | | |
| I-131 | Ci | 1.36E-04 | 1.44E-04 | | |
| Ag-110m | Ci | <LLD | 4.56E-05 | | |
| I-133 | Ci | 1.80E-03 | 1.54E-03 | | |
| I-135 | Ci | 1.76E-03 | 7.65E-03 | | |
| Ru-103 | Ci | 1.87E-04 | <LLD | | |
| | Ci | --- | --- | | |
| | Ci | --- | --- | | |
| Unidentified | Ci | --- | --- | | |

* Sr-89, Sr-90 values for May and June are projected

Table 1.i-1 (continued)

QCP 100-S25
Revision 3

GASEOUS EFFLUENTS

| Nuclides Released | Unit | Continuous Mode Quarter Third | Continuous Mode Quarter Fourth | Batch Mode Quarter | Batch Mode Quarter |
|---|---|---|---|---|---|
| 3. Particulates | | | | | |
| SR-89 | Ci | 4.0E-04 | 2.5E-04 | | |
| SR-90 | Ci | 3.2E-05 | 5.1E-06 | | |
| Cs-134 | Ci | 3.8E-06 | 2.7E-05 | | |
| Cs-137 | Ci | 4.4E-04 | 5.0E-04 | | |
| Ba-140 | Ci | 1.2E-04 | 2.5E-05 | | |
| La-140 | Ci | <LLD | <LLD | | |
| Cr-51 | Ci | 4.8E-04 | 1.3E-03 | | |
| Mn-54 | Ci | 4.9E-05 | 1.3E-05 | | |
| Co-58 | Ci | 5.5E-05 | 8.4E-06 | | |
| Co-60 | Ci | 1.8E-03 | 2.1E-03 | | |
| I-131 | Ci | 1.1E-04 | 1.9E-04 | | |
| Ag-110m | Ci | <LLD | 3.3E-05 | | |
| I-133 | Ci | 1.1E-03 | 2.5E-03 | | |
| I-135 | Ci | 2.6E-03 | 2.3E-03 | | |
| Ru103 | Ci | 1.1E-04 | 6.8E-05 | | |
| As-76 | Ci | <LLD | 1.4E-05 | | |
| | Ci | | | | |
| Unidentified | Ci | | | | |
| TOTAL | Ci | 7.3E-03 | 9.3E-03 | | |

Table 1.2-1

QCP 100-S25
Revision 3

APPROVED

JUN 03 1035

O.C.O.S.R.

LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

| | Unit | Quarter First | Quarter Second | Est. Total Error, % |
|---|---|---|---|---|
| A. FISSION & ACTIVATION PRODUCTS | | | | |
| 1. Total release (not including tritium, gases, alpha) | Ci | 4.4E-03 | 3.8E-02 | |
| 2. Average diluted concentration during batch dischargesr period | µCi/ml | 2.2E-09 | 1.7E-08 | |
| 3. Percent of applicable limit * | % | .018 / .024 | .086 / .079 | |
| 4. Maximum diluted concentration during batch discharges | µCi/ml | 3.2E-09 | 5.6E-09 | |
| B. TRITIUM | | | | |
| 1. Total Release | Ci | .86 | 1.35 | |
| 2. Average diluted concentration during batch discharges | µCi/ml | 4.4E-07 | 6.0E-07 | |
| 3. Percent of applicable limit | % | 1.5E-02 | 2.0E-02 | |
| C. DISSOLVED AND ENTRAINED GASES | | | | |
| 1. Total release | Ci | 3.42E-04 | 2.18E-04 | |
| 2. Average diluted concentration during batch discharges | µCi/ml | 1.7E-10 | 9.6E-11 | |
| 3. Percent of applicable limit | % | 5.4E-05 | 1.9E-05 | |
| D. GROSS ALPHA RADIOACTIVITY | | | | |
| 1. Total Release | Ci | <LLD | <LLD | |
| 2. Average concentration released during batch discharges | µCi/ml | --- | --- | |
| E. VOLUME OF WASTE RELEASED (prior to dilution | Liters | 4.8E+05 | 5.3E+05 | |
| F. VOLUME OF DILUTION WATER USED DURING BATCH DISCHARGES | Liters | 1.96E+09 | 2.26E+09 | |
| G. TOTAL VOLUME OF DILUTION WATER DURING PERIOD (QUARTER) | Liters | 2.8E+11 | 2.0E+11 | |

*WHOLE BODY/ORGAN

APPROVED

JUN 03 1035

O.C.O.S.R.

LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

| | Unit | Quarter Third | Quarter Fourth | Est. Total Error, % |
|---|---|---|---|---|
| A. FISSION & ACTIVATION PRODUCTS | | | | |
| 1. Total release (not including tritium, gases, alpha) | Ci | 1.6E-02 | 1.4E00 | |
| 2. Average diluted concentration during batch dischargesr period | µCi/ml | 6.2E-09 | 4.0E-07 | |
| 3. Percent of applicable limit * | % | 1.5E-1 / 1.7E-1 | 3.3E01 / 4.5E01 | |
| 4. Maximum diluted concentration during batch discharges | µCi/ml | 1.10E-08 | 1.0E-06 | |
| B. TRITIUM | | | | |
| 1. Total Release | Ci | 3.9E-01 | 8.1E-01 | |
| 2. Average diluted concentration during batch discharges | µCi/ml | 1.5E-07 | 2.3E-07 | |
| 3. Percent of applicable limit | % | 5.0E-03 | 7.7E-03 | |
| C. DISSOLVED AND ENTRAINED GASES | | | | |
| 1. Total release | Ci | 2.3E-05 | 1.7E-02 | |
| 2. Average diluted concentration during batch discharges | µCi/ml | 8.8E-12 | 4.9E-09 | |
| 3. Percent of applicable limit | % | 1.5E-06 | 2.4E-03 | |
| D. GROSS ALPHA RADIOACTIVITY | | | | |
| 1. Total Release | Ci | <LLD | 1.5E-05 | |
| 2. Average concentration released during batch discharges | µCi/ml | --- | 4.3E-12 | |
| E. VOLUME OF WASTE RELEASED (prior to dilution | Liters | 3.1E05 | 4.94E05 | |
| F. VOLUME OF DILUTION WATER USED DURING BATCH DISCHARGES | Liters | 2.6E09 | 3.5E09 | |
| G. TOTAL VOLUME OF DILUTION WATER DURING PERIOD (QUARTER) | Liters | 5.02E11 | 3.70E11 | |

*WHOLE BODY, ORGAN

3702956

Table 1.2-1 (continued)



## LIQUID EFFLUENTS

| | | Continuous Mode | | Batch Mode | |
|---|---|---|---|---|---|
| Nuclides Released | Unit | Quarter First | Quarter Second | Quarter | Quarter |
| SR-89 * | Ci | | | 5.14E-05 | 3.17E-05 |
| SR-90 * | Ci | | | 8.03E-06 | 2.88E-02 |
| Cs-134 | Ci | | | 4.58E-05 | 3.68E-05 |
| Cs-137 | Ci | | | 7.70E-04 | 1.17E-03 |
| I-131 | Ci | | | 8.30E-06 | 5.91E-05 |
| Co-58 | Ci | | | 4.50E-05 | 1.82E-04 |
| Co-60 | Ci | | | 1.99E-03 | 5.17E-03 |
| Fe-59 | Ci | | | <LLD | 6.43E-05 |
| Zn-65 | Ci | | | 6.40E-05 | 6.11E-05 |
| Mn-54 | Ci | | | 1.92E-04 | 3.63E-04 |
| Cr-51 | Ci | | | 7.60E-04 | 1.33E-03 |
| Zr-95 | Ci | | | <LLD | <LLD |
| Nb-95 | Ci | | | <LLD | <LLD |
| Mo-99 | Ci | | | <LLD | <LLD |
| Ag-110m | Ci | | | <LLD | 3.60E-04 |
| Ba-104 | Ci | | | <LLD | <LLD |
| Cs-136 | Ci | | | <LLD | <LLD |
| La-140 | Ci | | | <8 Day | Half Line |
| Fe-55* | Ci | | | 4.18E-04 | 7.57E-04 |
| Unidentified | Ci | | | --- | --- |
| Total for Period (above) | Ci | | | 4.35E-03 | 3.84E-02 |
| Xe-133 | Ci | | | 1.95E-04 | 1.98E-04 |
| Xe-135 | Ci | | | 1.47E-04 | 1.98E-05 |

Prepared by Robert J. Ryan Approved by Frank Long
Rad-Chem Supervisor

APPROVED (final)

*Sr-89, Sr-90, Fe-55 for May and June are projected

Table 1.2-1 (continued)

QCP 100-525
Revision 3

LIQUID EFFLUENTS

| | | Continuous Mode | | Batch Mode | |
|---|---|---|---|---|---|
| Nuclides Released | Unit | Quarter Third | Quarter Fourth | Quarter Third | Quarter Fourth |
| SR-89 | Ci | <LLD | <LLD* | 4.3E-05 | 6.0E-02 |
| SR-90 | Ci | <LLD | <LLD* | 1.4E-02 | 2.2E-02 |
| Cs-134 | Ci | <LLD | <LLD | 2.9E-05 | 1.7E-01 |
| Cs-137 | Ci | <LLD | <LLD | 4.8E-04 | 1.1E00 |
| I-131 | Ci | <LLD | <LLD | 1.3E-05 | 1.2E-03 |
| Co-58 | Ci | <LLD | <LLD | 4.4E-05 | 6.5E-04 |
| Co-60 | Ci | <LLD | <LLD | 1.2E-03 | 3.1E-02 |
| Fe-59 | Ci | <LLD | <LLD | <LLD | <LLD |
| Zn-65 | Ci | <LLD | <LLD | <LLD | 3.9E-05 |
| Mn-54 | Ci | <LLD | <LLD | 8.6E-05 | 1.2E-03 |
| Cr-51 | Ci | <LLD | <LLD | 4.1E-05 | 2.7E-03 |
| Zr-95 | Ci | <LLD | <LLD | <LLD | <LLD |
| Nb-95 | Ci | <LLD | <LLD | <LLD | <LLD |
| Mo-99 | Ci | <LLD | <LLD | <LLD | <LLD |
| Ag-110m | Ci | <LLD | <LLD | 5.2E-05 | 8.4E-05 |
| Ba-140 | Ci | <LLD | <LLD | <LLD | <LLD |
| Cs-136 | Ci | <LLD | <LLD | <LLD | <LLD |
| La-140 | Ci | <LLD | <LLD | <LLD | <LLD |
| Fe55 | Ci | <LLD | <LLD* | 3.5E-04 | 2.0E-02 |
| I-133 | Ci | <LLD | <LLD | 3.3E-06 | <LLD |
| Total for Period (above) | Ci | <LLD | <LLD | 1.6E-02 | 1.4E00 |
| Xe-133 | Ci | <LLD | <LLD | 2.3E-05 | <LLD |
| Xe-135 | Ci | <LLD | <LLD | <LLD | 1.7E-02 |

Prepared by Robert Byo

APPROVED

(Final)

JUN 05 1995

Approved by Frank Lowry
Rad-Chem Supervisor

*Projected Values Based on Prior Analysis

Table 2.0-1

SOLID RADIOACTIVE WASTE SUMMARY

UNITS 1/2

QUAD-CITIES STATION

1/1985

| DATE | CO TRANS | BURIAL SITE | VOLUME | MILLICURIES |
|---|---|---|---|---|
| 01/03/85 | CN | BSC | 178.00 | 8280.00 |
| 01/03/85 | TRI-STATE | BSC | 26.20 | 13183000.00 |
| 01/07/85 | CN | BSC | 178.00 | 7603.00 |
| 01/11/85 | CN | BSC | 178.00 | 8216.00 |
| 01/11/85 | HACKE | USE | 872.00 | 408.62 |
| 01/12/85 | TRI-STATE | BSC | 26.20 | 11069000.00 |
| 01/14/85 | CN | BSC | 178.00 | 10390.00 |
| 01/16/85 | CN | BSC | 178.00 | 9894.00 |
| 01/16/85 | TRI-STATE | BSC | 26.20 | 10457000.00 |
| 01/18/85 | CN | BSC | 178.00 | 9549.00 |
| 01/19/85 | TRI-STATE | BSC | 26.20 | 10616000.00 |
| 01/21/85 | CN | BSC | 178.00 | 9566.00 |
| 01/23/85 | CN | BSC | 105.00 | 81.80 |
| 01/23/85 | CN | BSC | 178.00 | 7275.00 |
| 01/23/85 | HACKE | USE | 999.50 | 151.82 |
| 01/23/85 | TRI-STATE | BSC | 26.20 | 7482000.00 |
| 01/24/85 | CN | USE | 105.00 | 937.00 |
| 01/30/85 | CN | BSC | 178.00 | 9986.00 |
| MONTHLY TOTALS | | | 3814.50 | 52889338.24 |

USE - U.S. ECOLOGY
BSC - BARNWELL SOUTH CAROLINA
CN - CHEM NUCLEAR CO.
TS - TRI STATE

Table 2.0-1 (continued)

SOLID RADIOACTIVE WASTE SUMMARY

UNITS 1/2

QUAD-CITIES STATION

2/1985

| DATE | CO TRANS | BURIAL SITE | VOLUME | MILLICURIES |
|---|---|---|---|---|
| 02/04/85 | CN | BSC | 178.00 | 8875.00 |
| 02/08/85 | CN | BSC | 178.00 | 6718.60 |
| 02/11 85 | CN | BSC | 178.00 | 6241.00 |
| 02/13/85 | CN | BSC | 178.00 | 5928.60 |
| 02/21/85 | CN | BSC | 178.00 | 5076.00 |
| 02/22/85 | HACKE | USE | 1289.75 | 56.17 |
| 02/25/85 | CN | BSC | 178.00 | 4736.10 |
| 02/27/85 | CN | BSC | 178.00 | 5689.60 |
| 02/28/85 | HACKE | USE | 505.00 | 451.60 |
| MONTHLY TOTALS | | | 3120.75 | 43772.67 |

USE - U.S. ECOLOGY
BSC - BARNWELL SOUTH CAROLINA
CN - CHEM NUCLEAR CO.
TS - TRI STATE

Table 2.0-1 (continued)

SOLID RADIOACTIVE WASTE SUMMARY

UNITS 1/2

QUAD-CITIES STATION

3/1985

| DATE | CO TRANS | BURIAL SITE | VOLUME | MILLICURIES |
|---|---|---|---|---|
| 03/04/85 | CN | BSC | 178.00 | 5000.00 |
| 03/06/85 | CN | BSC | 178.00 | 5339.00 |
| 03/08/85 | CN | BSC | 178.00 | 3096.00 |
| 03/13/85 | CN | BSC | 178.00 | 7441.00 |
| 03/14/85 | HACKE | USE | 1289.75 | 93.49 |
| 03/18/85 | CN | BSC | 178.00 | 19151.00 |
| 03/21/85 | CN | BSC | 178.00 | 13547.00 |
| 03/26/85 | CN | BSC | 178.00 | 7528.00 |
| 03/27/85 | CN | BSC | 178.00 | 10614.00 |
| 03/29/85 | CN | USE | 110.50 | 1256.90 |
| MONTHLY TOTALS | | | 2824.25 | 73096.39 |

USE - U.S. ECOLOGY
BSC - BARNWELL SOUTH CAROLINA
CN - CHEM NUCLEAR CO.
TS - TRI STATE

Table 2.0-1 (continued)

SOLID RADIOACTIVE WASTE SUMMARY

UNITS 1/2

QUAD-CITIES STATION

4/1985

| DATE | CO TRANS | BURIAL SITE | VOLUME | MILLICURIES |
|---|---|---|---|---|
| 04/01/85 | CN | BSC | 178.00 | 9949.00 |
| 04/02/85 | HACKE | USE | 1289.75 | 412.50 |
| 04/03/85 | CN | BSC | 178.00 | 6380.10 |
| 04/10/85 | CN | BSC | 178.00 | 6111.00 |
| 04/11/85 | HACKE | USE | 570.00 | 500.21 |
| 04/15/85 | CN | BSC | 178.00 | 5298.70 |
| 04/17/85 | CN | BSC | 178.00 | 4551.00 |
| 04/19/85 | HACKE | USE | 1289.75 | 202.55 |
| 04/19/85 | CN | USE | 105.00 | 1747.80 |
| 04/22/85 | CN | BSC | 178.00 | 4113.00 |
| 04/29/85 | CN | BSC | 178.00 | 2648.00 |
| MONTHLY TOTALS | | | 4500.50 | 41913.86 |

USE - U.S. ECOLOGY
BSC - BARNWELL SOUTH CAROLINA
CN - CHEM NUCLEAR CO.
TS - TRI STATE

Table 2.0-1 (continued)

SOLID RADIOACTIVE WASTE SUMMARY

UNITS 1/2

QUAD-CITIES STATION

5/1985

| DATE | CO TRANS | BURIAL SITE | VOLUME | MILLICURIES |
|---|---|---|---|---|
| 05/02/85 | HACKE | USE | 532.50 | 653.80 |
| 05/02/85 | CN | BSC | 178.00 | 3668.00 |
| 05/06/85 | CN | BSC | 178.00 | 3708.10 |
| 05/08/85 | CN | BSC | 178.00 | 2965.00 |
| 05/08/85 | HACKE | USE | 1289.75 | 80.03 |
| 05/13/85 | CN | BSC | 178.00 | 10243.20 |
| 05/15/85 | HACKE | USE | 1289.75 | 106.58 |
| 05/16/85 | CN | BSC | 178.00 | 17762.00 |
| 05/20/85 | CN | BSC | 178.00 | 13265.00 |
| 05/23/85 | CN | BSC | 178.00 | 9893.00 |
| 05/30/85 | CN | BSC | 178.00 | 11069.00 |
| 05/31/85 | HACKE | USE | 1289.75 | 55.67 |
| 05/31/85 | CN | USE | 105.00 | 514.93 |
| MONTHLY TOTALS | | | 5930.75 | 73984.31 |

USE - U.S. ECOLOGY
BSC - BARNWELL SOUTH CAROLINA
CN - CHEM NUCLEAR CO.
TS - TRI STATE

Table 2.0-1 (continued)

SOLID RADIOACTIVE WASTE SUMMARY

UNITS 1/2

QUAD-CITIES STATION

6/1985

| DATE | CO TRANS | BURIAL SITE | VOLUME | MILLICURIES |
|---|---|---|---|---|
| 06/03/85 | CN | BSC | 178.00 | 8995.00 |
| 06/06/85 | CN | BSC | 178.00 | 11894.00 |
| 06/10/85 | CN | BSC | 178.00 | 10177.00 |
| 06/12/85 | CN | BSC | 178.00 | 7244.00 |
| 06/12/85 | HACKE | USE | 1289.75 | 81.88 |
| 06/17/85 | CN | BSC | 178.00 | 7529.00 |
| 06/19/85 | CN | BSC | 178.00 | 7533.00 |
| 06/20/85 | HACKE | USE | 728.50 | 352.19 |
| 06/24/85 | CN | BSC | 178.00 | 7600.00 |
| 06/26/85 | CN | BSC | 178.00 | 9017.40 |
| 06/27/85 | HACKE | USE | 1063.80 | 72.81 |
| MONTHLY TOTALS | | | 4506.05 | 70496.28 |

USE - U.S. ECOLOGY
BSC - BARNWELL SOUTH CAROLINA
CN - CHEM NUCLEAR CO.
TS - TRI STATE

Table 2.0-1 (continued)

SOLID RADIOACTIVE WASTE SUMMARY

UNITS 1/2

QUAD-CITIES STATION

7/85

| DATE | CO TRANS | BURIAL SITE | VOLUME | MILLICURIES |
|---|---|---|---|---|
| 07/01/85 | CN | BSC | 178.00 | 5445.00 |
| 07/05/85 | CN | BSC | 178.00 | 5843.00 |
| 07/08/85 | CN | BSC | 178.00 | 5764.00 |
| 07/12/85 | CN | BSC | 178.00 | 5076.40 |
| 07/15/85 | CN | BSC | 178.00 | 5076.40 |
| 07/18/85 | CN | BSC | 178.00 | 2913.00 |
| 07/18/85 | HACKE | USE | 502.50 | 993.78 |
| 07/22/85 | CN | BSC | 178.00 | 4557.60 |
| 07/25/85 | CN | BSC | 178.00 | 7336.70 |
| 07/29/85 | CN | BSC | 178.00 | 8930.00 |
| 07/29/85 | CN | BSC | 178.00 | 7337.00 |
| 07/31/85 | CN | BSC | 178.00 | 10060.00 |
| MONTHLY TOTALS | | | 2460.50 | 69332.88 |

USE - U.S. ECOLOGY
BSC - BARNWELL SOUTH CAROLINA
CN - CHEM NUCLEAR CO.
TS - TRI STATE

Table 2.0-1 (continued)

SOLID RADIOACTIVE WASTE SUMMARY

UNITS 1/2

QUAD-CITIES STATION

8/85

| DATE | CO TRANS | BURIAL SITE | VOLUME | MILLICURIES |
|---|---|---|---|---|
| 08/01/85 | HACKE | USE | 1041.25 | 131.78 |
| 08/05/85 | CN | BSC | 178.00 | 8884.80 |
| 08/08/85 | CN | BSC | 178.00 | 8334.00 |
| 08/12/85 | CN | BSC | 178.00 | 7967.00 |
| 08/15/85 | CN | BSC | 178.00 | 8115.00 |
| 08/16/85 | HACKE | USE | 1026.25 | 120.38 |
| 08/19/85 | CN | BSC | 178.00 | 6241.10 |
| 08/22/85 | HACKE | USE | 611.75 | 641.06 |
| 08/22/85 | CN | BSC | 178.00 | 10634.00 |
| 08/26/85 | CN | BSC | 178.00 | 11106.00 |
| 08/28/85 | CN | BSC | 178.00 | 10412.00 |
| 08/30/85 | HACKE | USE | 792.75 | 48.00 |
| 08/30/85 | CN | USE | 105.00 | 1476.67 |
| | MONTHLY TOTALS | | 5001.00 | 74112.09 |

USE - U.S. ECOLOGY
BSC - BARNWELL SOUTH CAROLINA
CN - CHEM NUCLEAR CO.
TS - TRI STATE

Table 2.0-1 (continued)

SOLID RADIOACTIVE WASTE SUMMARY

UNITS 1/2

QUAD-CITIES STATION

9/85

| DATE | CO TRANS | BURIAL SITE | VOLUME | MILLICURIES |
|---|---|---|---|---|
| 09/03/85 | CN | BSC | 178.00 | 8226.00 |
| 09/06/85 | CN | BSC | 178.00 | 5580.50 |
| 09/06/85 | HACKE | USE | 845.25 | 433.51 |
| 09/09/85 | CN | BSC | 178.00 | 5984.40 |
| 09/12/85 | CN | BSC | 178.00 | 8482.20 |
| 09/12/85 | HACKE | USE | 770.25 | 50.84 |
| 09/16/85 | CN | BSC | 178.00 | 7855.00 |
| 09/18/85 | CN | BSC | 178.00 | 13558.00 |
| 09/20/85 | CN | BSC | 178.00 | 11190.00 |
| 09/23/85 | CN | BSC | 178.00 | 9949.00 |
| 09/26/85 | HACKE | USE | 1289.75 | 66.11 |
| 09/26/85 | CN | BSC | 178.00 | 8391.00 |
| MONTHLY TOTALS | | | 4507.25 | 79766.59 |

USE - U.S. ECOLOGY
BSC - BARNWELL SOUTH CAROLINA
CN - CHEM NUCLEAR CO.
TS - TRI STATE

Table 2.0-1 (continued)

SOLID RADIOACTIVE WASTE SUMMARY

UNITS 1/2

QUAD-CITIES STATION

10/85

| DATE | CO TRANS | BURIAL SITE | VOLUME | MILLICURIES |
|---|---|---|---|---|
| 10/02/85 | HACKE | USE | 611.75 | 1619.80 |
| 10/03/85 | CN | BSC | 200.00 | 9379.00 |
| 10/07/85 | CN | BSC | 200.00 | 7067.00 |
| 10/09/85 | CN | BSC | 178.00 | 5677.00 |
| 10/11/85 | CN | BSC | 178.00 | 6679.00 |
| 10/15/85 | CN | BSC | 178.00 | 7026.30 |
| 10/18/85 | CN | USE | 105.00 | 1535.14 |
| 10/21/85 | CN | BSC | 178.00 | 6247.00 |
| 10/23/85 | CN | BSC | 178.00 | 8252.40 |
| 10/25/85 | CN | BSC | 178.00 | 8840.00 |
| 10/28/85 | CN | BSC | 178.00 | 7615.00 |
| 10/30/85 | CN | BSC | 178.00 | 9199.00 |
| | MONTHLY TOTALS | | 2540.75 | 79136.64 |

USE - U.S. ECOLOGY
BSC - BARNWELL SOUTH CAROLINA
CN - CHEM NUCLEAR CO.
TS - TRI STATE

Table 2.0-1 (continued)

SOLID RADIOACTIVE WASTE SUMMARY

UNITS 1/2

QUAD-CITIES STATION

11/85

| DATE | CO TRANS | BURIAL SITE | VOLUME | MILLICURIES |
|---|---|---|---|---|
| 11/01/85 | CN | BSC | 200.00 | 10349.00 |
| 11/04/85 | CN | BSC | 126.00 | 159713.00 |
| 11/06/85 | CN | BSC | 101.00 | 121162.00 |
| 11/08/85 | CN | BSC | 101.00 | 121162.00 |
| 11/12/85 | CN | BSC | 126.00 | 159713.00 |
| 11/13/85 | HACKE | USE | 585.00 | 142.70 |
| 11/14/85 | CN | BSC | 126.00 | 321864.00 |
| 11/18/85 | CN | BSC | 101.00 | 244173.00 |
| 11/19/85 | HACKE | USE | 800.25 | 215.11 |
| 11/20/85 | CN | BSC | 101.00 | 244173.00 |
| 11/25/85 | CN | BSC | 200.00 | 63645.00 |
| 11/26/85 | CN | BSC | 200.00 | 40437.00 |
| MONTHLY TOTALS | | | 2767.25 | 1486748.81 |

USE - U.S. ECOLOGY
BSC - BARNWELL SOUTH CAROLINA
CN - CHEM NUCLEAR CO.
TS - TRI STATE

Table 2.0-1 (continued)

SOLID RADIOACTIVE WASTE SUMMARY

UNITS 1/2

QUAD-CITIES STATION

12/85

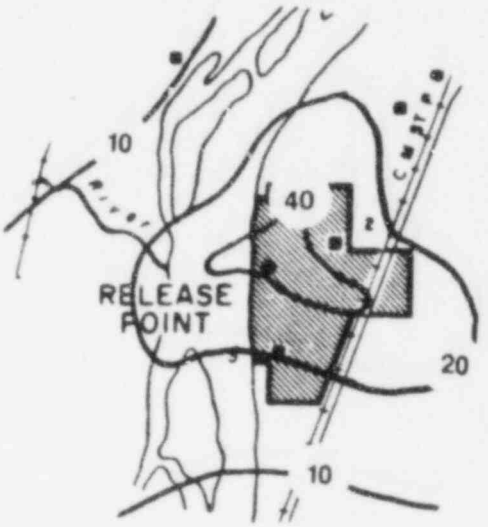
| DATE | CO TRANS | BURIAL SITE | VOLUME | MILLICURIES |
|---|---|---|---|---|
| 12/03/85 | CN | BSC | 200.00 | 32125.00 |
| 12/04/85 | CN | BSC | 200.00 | 35211.00 |
| 12/05/85 | HACKE | USE | 1093.75 | 183.09 |
| 12/06/85 | CN | BSC | 200.00 | 22304.00 |
| 12/09/85 | CN | BSC | 200.00 | 28589.00 |
| 12/11/85 | HACKE | USE | 502.50 | 1262.50 |
| 12/12/85 | CN | BSC | 200.00 | 30698.00 |
| 12/16/85 | CN | BSC | 178.00 | 35054.00 |
| 12/18/85 | CN | BSC | 200.00 | 47181.00 |
| 12/19/85 | HACKE | USE | 1289.75 | 243.12 |
| 12/20/85 | CN | BSC | 200.00 | 36577.00 |
| 12/23/85 | CN | BSC | 178.00 | 28116.00 |
| 12/27/85 | CN | BSC | 200.00 | 27975.00 |
| 12/30/85 | CN | BSC | 200.00 | 21594.00 |
| | MONTHLY TOTALS | | 5042.00 | 347112.71 |

USE - U.S. ECOLOGY
BSC - BARNWELL SOUTH CAROLINA
CN - CHEM NUCLEAR CO.
TS - TRI STATE

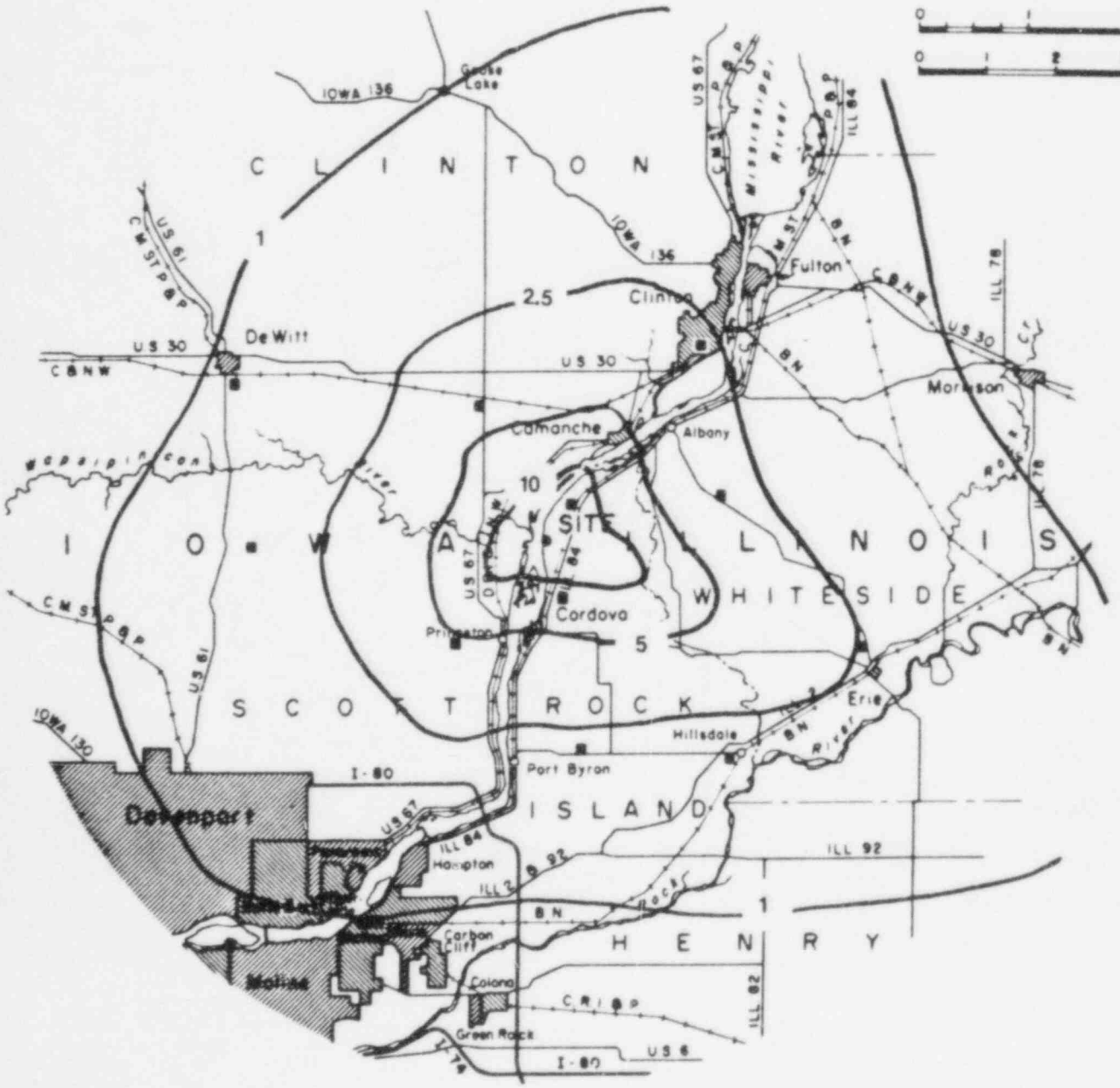
Figure 3.1-1

Estimated Cumulative Gamma Dose (mrem) from the Quad Cities Station for the period January-December 1985.

Isopleth Labels
Small figure - multiply by $10^{-3}$
Large figure - multiply by $10^{-3}$




SCALE
0 1 2 MILES
0 1 2 3 KM




SCALE
0 5 10 15 20 MILES
0 5 10 15 20 25 30 KM

Figure 3.1-2

Estimated Total Concentration (pCi/$m^3$) of Noble Gases from the Quad Cities Station for the period January-December 1985.

Isopleth Labels
Small figure - multiply by $10^{-1}$
Large figure - multiply by $10^{-1}$

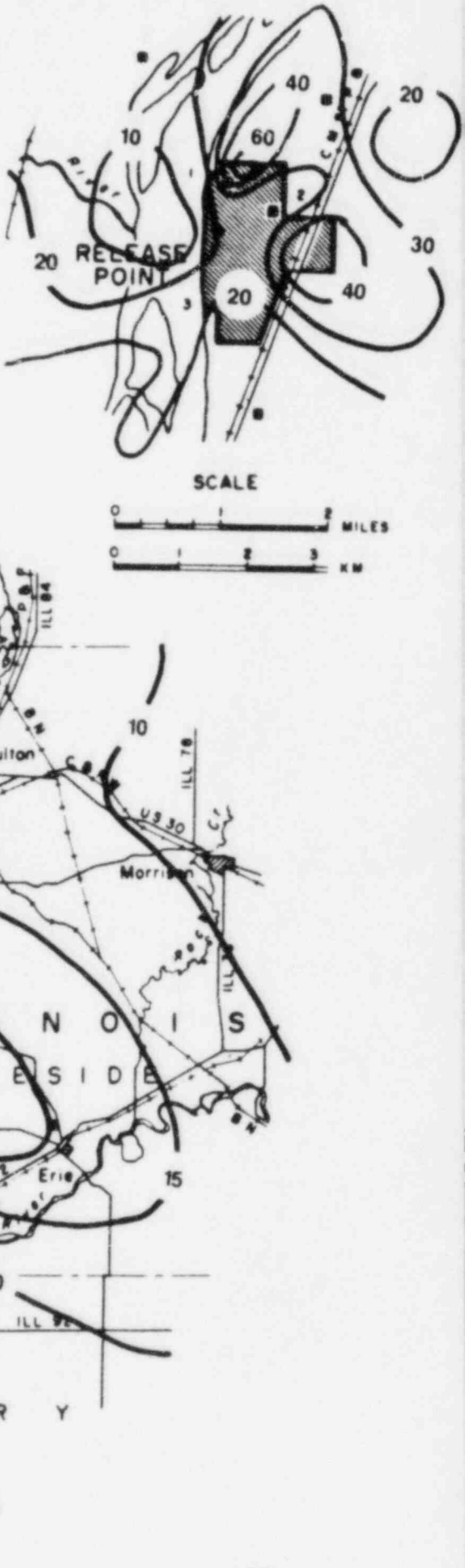
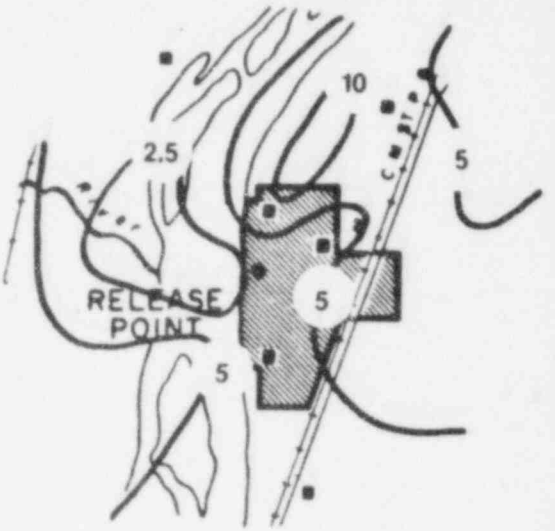


Figure 3.1-3

Estimated Total Concentration (pCi/$m^3$) of Iodine from the Quad Cities Station for the period January-December 1985.

Isopleth Labels
Small figure - multiply by $10^{-4}$
Large figure - multiply by $10^{-4}$



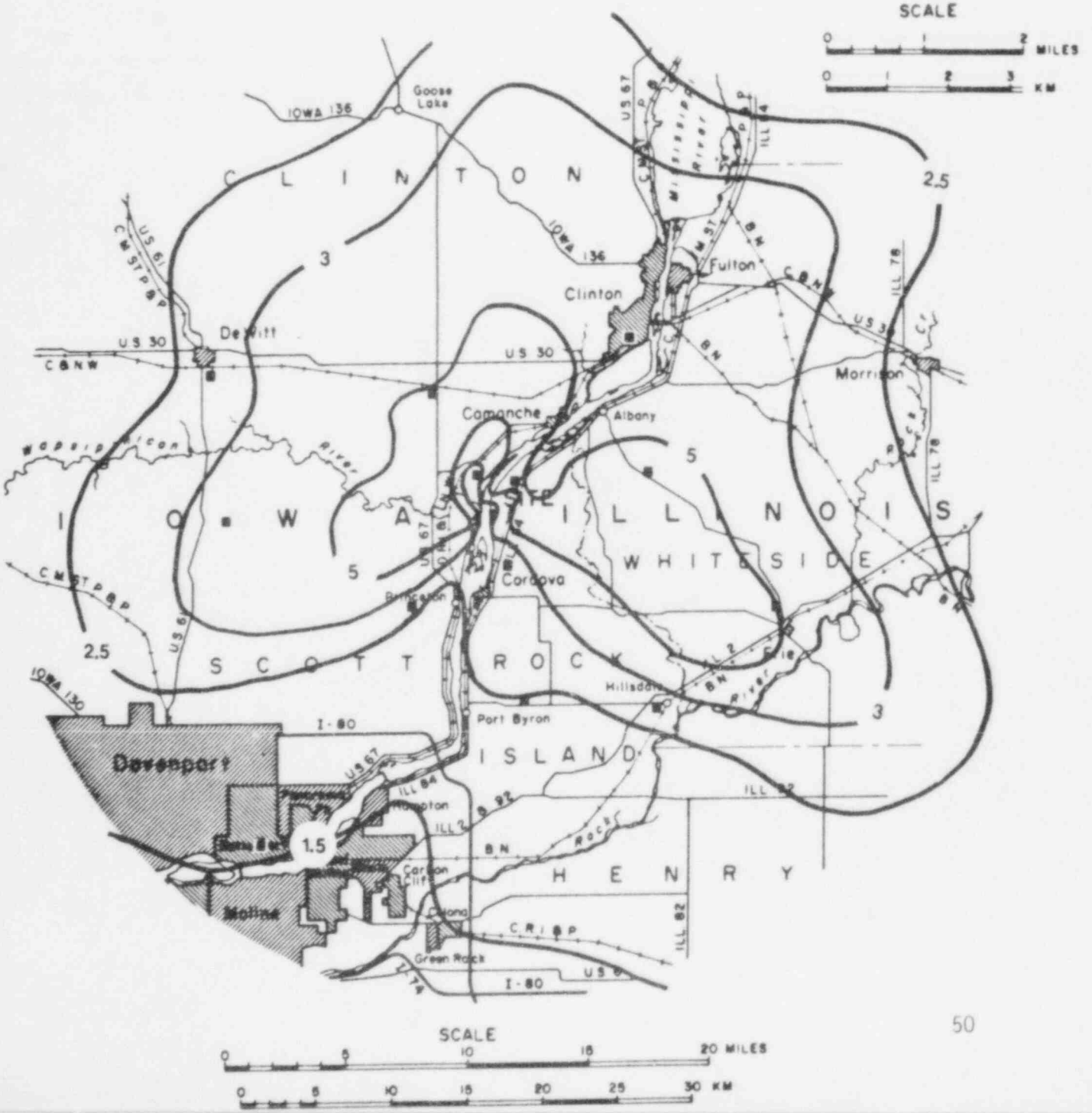
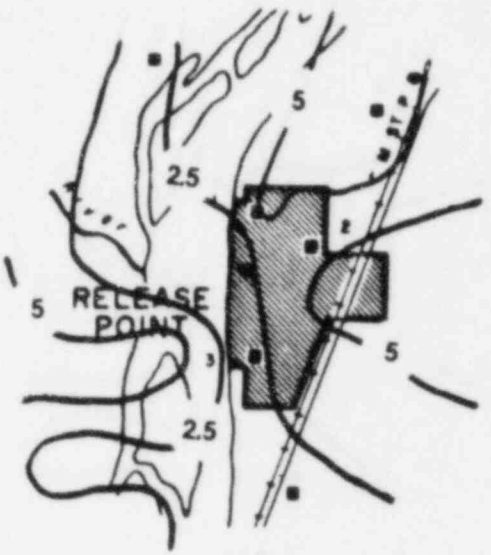



Figure 3.1-4

Estimated Total Concentration (pCi/m3) of Particulate Matter from the Quad Cities Station for the period January-December 1985.

Isopleth Labels
Small figure - multiply by $10^{-4}$
Large figure - multiply by $10^{-4}$



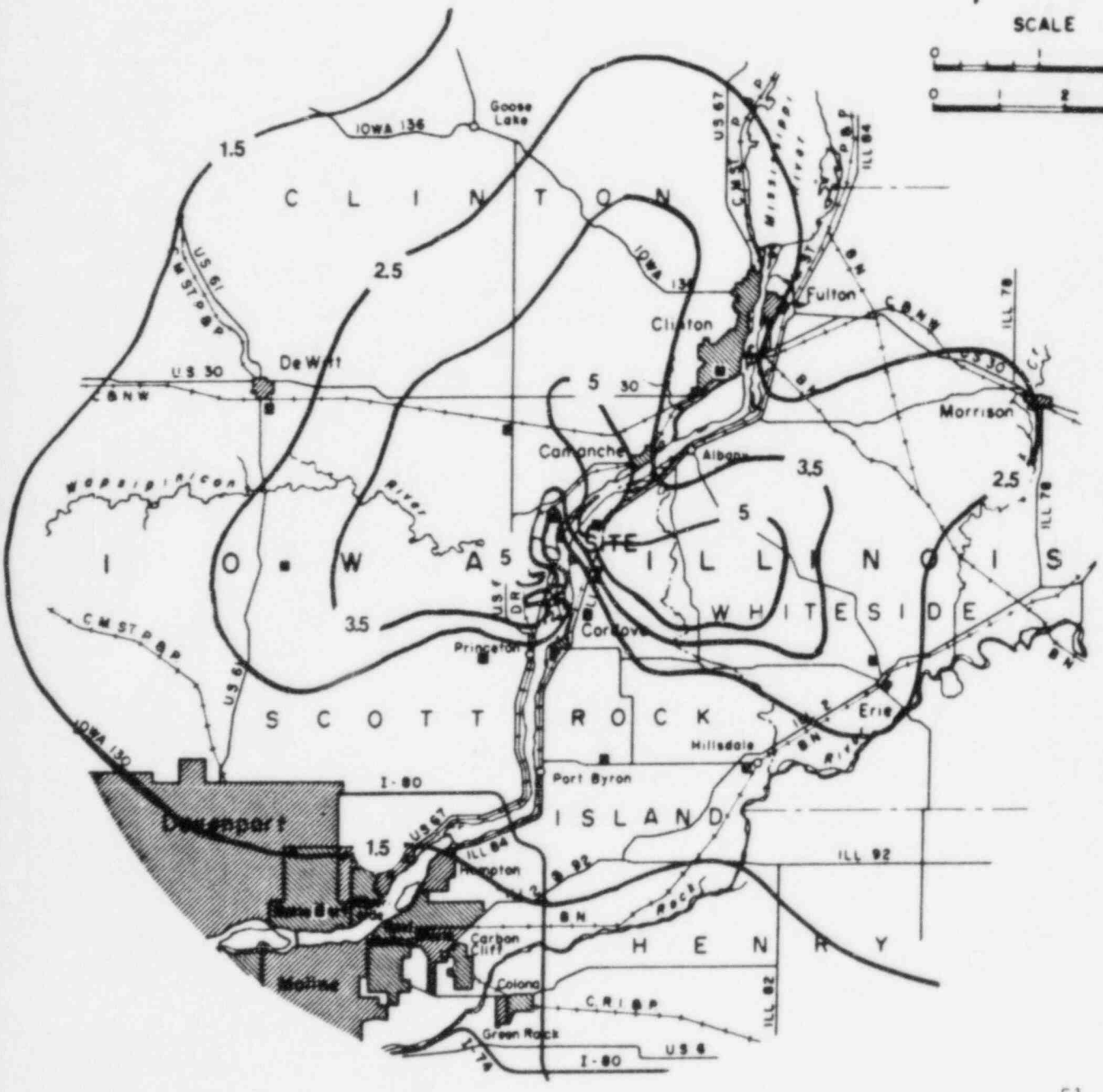



Table 3.1-1

QUAD CITIES UNIT ONE
MAXIMUM DOSES RESULTING FROM AIRBORNE RELEASES
PERIOD OF RELEASE - 1/ 1/85 TO 12/31/85 CALCULATED 02/06/86

| TYPE | 1ST QUARTER 1/85- 3/85 | 2ND QUARTER 4/85- 6/85 | 3RD QUARTER 7/85- 9/85 | 4TH QUARTER 10/85-12/85 | ANNUAL |
|---|---|---|---|---|---|
| GAMMA AIR (MRAD) | 7.44E-03 (ANN ) | 1.05E-02 (ANN ) | 5.59E-03 (N ) | 1.42E-02 (N ) | 3.78E-02 (N ) |
| BETA AIR (MRAD) | 5.24E-03 (NN ) | 1.02E-02 (NN ) | 3.33E-03 (NN ) | 5.19E-03 (NN ) | 2.49E-02 (NN ) |
| TOT. BODY (MREM) | 4.13E-03 (ANN ) | 5.39E-03 (N ) | 2.80E-03 (N ) | 7.63E-03 (N ) | 2.00E-02 (N ) |
| SKIN (MREM) | 1.09E-02 (ANN ) | 1.41E-02 (NN ) | 6.35E-03 (NN ) | 1.43E-02 (NN ) | 4.56E-02 (NN ) |
| ORGAN (MREM) | 6.61E-03 (ANN ) | 3.69E-02 (S ) | 9.24E-02 (S ) | 2.10E-02 (S ) | 1.56E-01 (S ) |
| | THYROID | THYROID | THYROID | THYROID | THYROID |

THIS IS A REPORT FOR THE CALENDAR YEAR 1985

COMPLIANCE STATUS - 10 CFR 50 APP. I

| | | % OF APP I. | | | | | |
|---|---|---|---|---|---|---|---|
| | % OF APP. I OBJ | 1ST QTR 1/85- 3/85 | 2ND QTR 4/85- 6/85 | 3RD QTR 7/85- 9/85 | 4TH QTR 10/85- 12/85 | YRLY OBJ | % OF APP. I |
| GAMMA AIR (MRAD) | 5.0 | 0.16 | 0.21 | 0.11 | 0.28 | 10.0 | 0.36 |
| BETA AIR (MRAD) | 10.0 | 0.06 | 0.10 | 0.03 | 0.05 | 20.0 | 0.12 |
| TOT. BODY (MREM) | 2.5 | 0.17 | 0.22 | 0.11 | 0.31 | 5.0 | 0.40 |
| SKIN (MREM) | 7.5 | 0.15 | 0.19 | 0.08 | 0.19 | 15.0 | 0.30 |
| ORGAN (MREM) | 7.5 | 0.09 | 0.49 | 1.23 | 0.28 | 15.0 | 1.04 |
| | | THYROID | THYROID | THYROID | THYROID | | THYROID |

Table 3.1-1 (continued)

QUAD CITIES UNIT TWO
MAXIMUM DOSES RESULTING FROM AIRBORNE RELEASES
PERIOD OF RELEASE - 1/ 1/85 TO 12/31/85 CALCULATED 02/06/86

| TYPE | 1ST QUARTER 1/85- 3/85 | 2ND QUARTER 4/85- 6/85 | 3RD QUARTER 7/85- 9/85 | 4TH QUARTER 10/85-12/85 | ANNUAL |
|---|---|---|---|---|---|
| GAMMA AIR (MRAD) | 7.20E-03 (W ) | 9.93E-03 (W ) | 5.76E-03 (WNW ) | 1.41E-02 (W ) | 3.70E-02 (W ) |
| BETA AIR (MRAD) | 3.82E-03 (NW ) | 7.40E-03 (NW ) | 3.39E-03 (NW ) | 4.68E-03 (NW ) | 1.93E-02 (NW ) |
| TOT. BODY (MREM) | 3.87E-03 (W ) | 5.32E-03 (W ) | 2.96E-03 (W ) | 7.59E-03 (W ) | 1.97E-02 (W ) |
| SKIN (MREM) | 8.37E-03 (WNW ) | 1.40E-02 (NW ) | 6.92E-03 (WNW ) | 1.39E-02 (NW ) | 4.31E-02 (NW ) |
| ORGAN (MREM) | 5.78E-03 (S ) | 2.76E-02 (S ) | 8.31E-02 (S ) | 1.71E-02 (S ) | 1.33E-01 (S ) |
| | LIVER | THYROID | THYROID | THYROID | THYROID |

THIS IS A REPORT FOR THE CALENDAR YEAR 1985

COMPLIANCE STATUS - 10 CFR 50 APP. I

| | | % OF APP I. | | | | | |
|---|---|---|---|---|---|---|---|
| | OTRLY OBJ | 1ST QTR 1/85- 3/85 | 2ND QTR 4/85- 6/85 | 3RD QTR 7/85- 9/85 | 4TH QTR 10/85- 12/85 | YRLY OBJ | % OF APP. I |
| GAMMA AIR (MRAD) | 5.0 | 0.14 | 0.20 | 0.12 | 0.28 | 10.0 | 0.37 |
| BETA AIR (MRAD) | 10.0 | 0.04 | 0.07 | 0.03 | 0.05 | 20.0 | 0.10 |
| TOT. BODY (MREM) | 2.5 | 0.15 | 0.21 | 0.12 | 0.30 | 5.0 | 0.39 |
| SKIN (MREM) | 7.5 | 0.11 | 0.19 | 0.09 | 0.18 | 15.0 | 0.29 |
| ORGAN (MREM) | 7.5 | 0.08 | 0.37 | 1.11 | 0.23 | 15.0 | 0.89 |
| | | LIVER | THYROID | THYROID | THYROID | | THYROID |

Table 3.2-1

QUAD CITIES UNIT ONE
MAXIMUM DOSES (MREM) RESULTING FROM LIQUID EFFLUENTS
PERIOD OF RELEASE - 1/ 1/85 TO 12/31/85 CALCULATED 02/06/86 *

| DOSE TYPE | 1ST QUARTER 1/85- 3/85 | 2ND QUARTER 4/85- 6/85 | 3RD QUARTER 7/85- 9/85 | 4TH QUARTER 10/85-12/85 | ANNUAL |
|---|---|---|---|---|---|
| TOTAL BODY | 2.25E-04 | 1.25E-03 | 2.23E-03 | 9.93E-01 | 9.97E-01 |
| INTERNAL ORGAN | 9.34E-04 | 3.88E-03 | 8.59E-03 | 1.45E+00 | 1.45E+00 |
| | LIVER | BONE | BONE | LIVER | LIVER |

* THIS IS A REPORT FOR THE CALENDAR YEAR 1985

COMPLIANCE STATUS - 10 CFR 50 APP. I

| | QTRLY OBJ | % OF APP I. 1ST QTR 1/85- 3/85 | 2ND QTR 4/85- 6/85 | 3RD QTR 7/85- 9/85 | 4TH QTR 10/85- 12/85 | YRLY OBJ | % OF APP. I |
|---|---|---|---|---|---|---|---|
| TOTAL BODY (MREM) | 1.5 | 0.02 | 0.08 | 0.15 | 66.21 | 3.0 | 33.23 |
| CRIT. ORGAN(MREM) | 5.0 | 0.02 | 0.08 | 0.17 | 28.91 | 10.0 | 14.48 |
| | | LIVER | BONE | BONE | LIVER | | LIVER |

Table 3.2-1 (continued)

DRAD CITIES UNIT TWO
MAXIMUM DOSES (MREM) RESULTING FROM LIQUID EFFLUENTS
PERIOD OF RELEASE - 1/ 1/85 TO 12/31/85 CALCULATED 02/06/86 *

| DOSE TYPE | 1ST QUARTER 1/85- 3/85 | 2ND QUARTER 4/85- 6/85 | 3RD QUARTER 7/85- 9/85 | 4TH QUARTER 10/85-12/85 | ANNUAL |
|---|---|---|---|---|---|
| TOTAL BODY | 2.98E-04 | 1.32E-03 | 2.23E-03 | 1.23E-04 | 3.97E-03 |
| INTERNAL ORGAN | 1.51E-03 | 3.95E-03 | 8.59E-03 | 1.82E-04 | 1.39E-02 |
| | LIVER | BONE | BONE | LIVER | BONE |

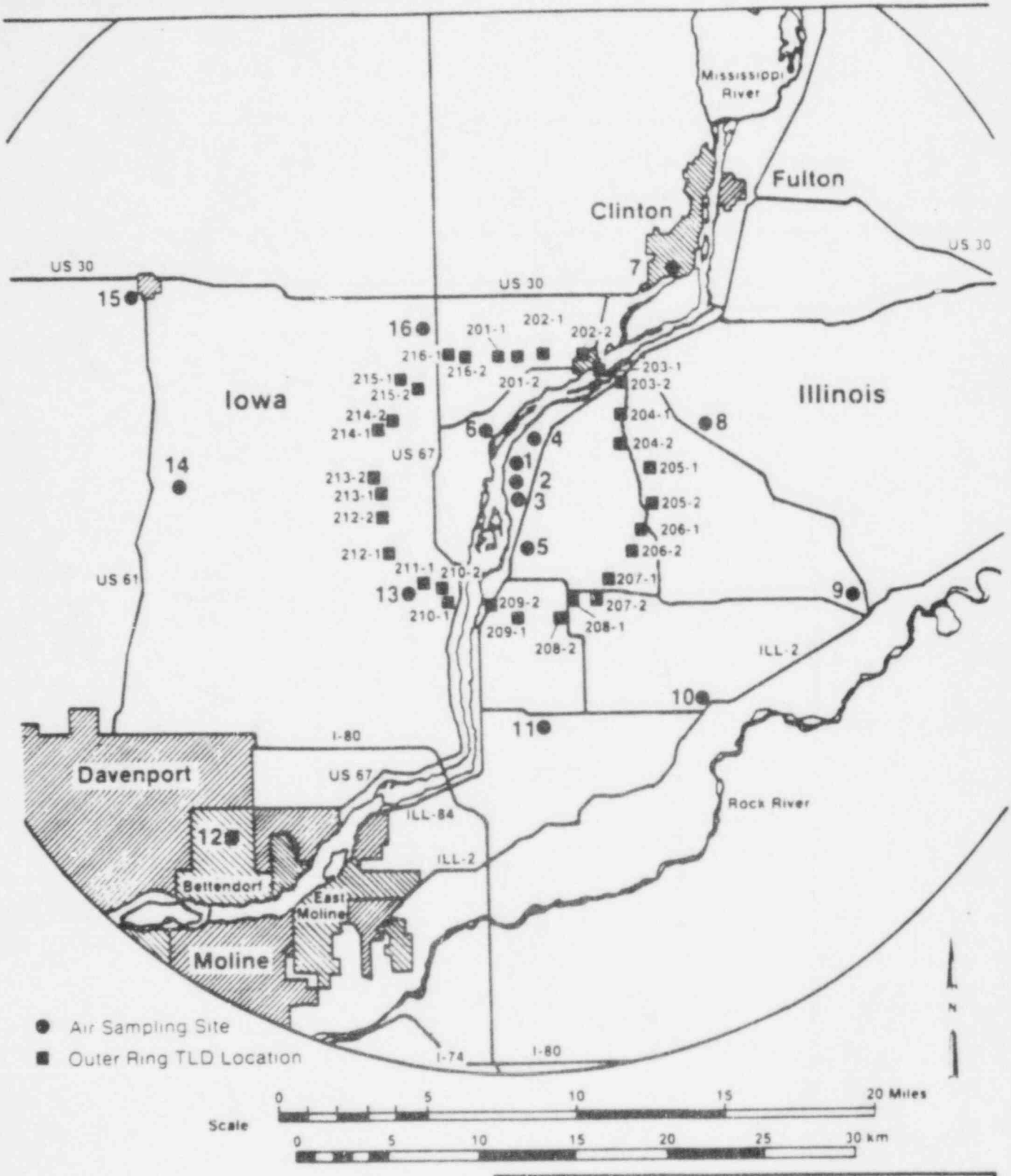
* THIS IS A REPORT FOR THE CALENDAR YEAR 1985

COMPLIANCE STATUS - 10 CFR 50 APP. I

| | QTRLY OBJ | % OF APP I. 1ST QTR 1/85- 3/85 | 2ND QTR 4/85- 6/85 | 3RD QTR 7/85- 9/85 | 4TH QTR 10/85- 12/85 | YRLY OBJ | % OF APP. I |
|---|---|---|---|---|---|---|---|
| TOTAL BODY (MREM) | 1.5 | 0.02 | 0.09 | 0.15 | 0.01 | 3.0 | 0.13 |
| CRIT. ORGAN(MREM) | 5.0 | 0.03 | 0.08 | 0.17 | 0.00 | 10.0 | 0.14 |
| | | LIVER | BONE | BONE | LIVER | | BONE |

Figure 5.0-1

DECEMBER 1985




**QUAD-CITIES STATION**
**Units 1 & 2**

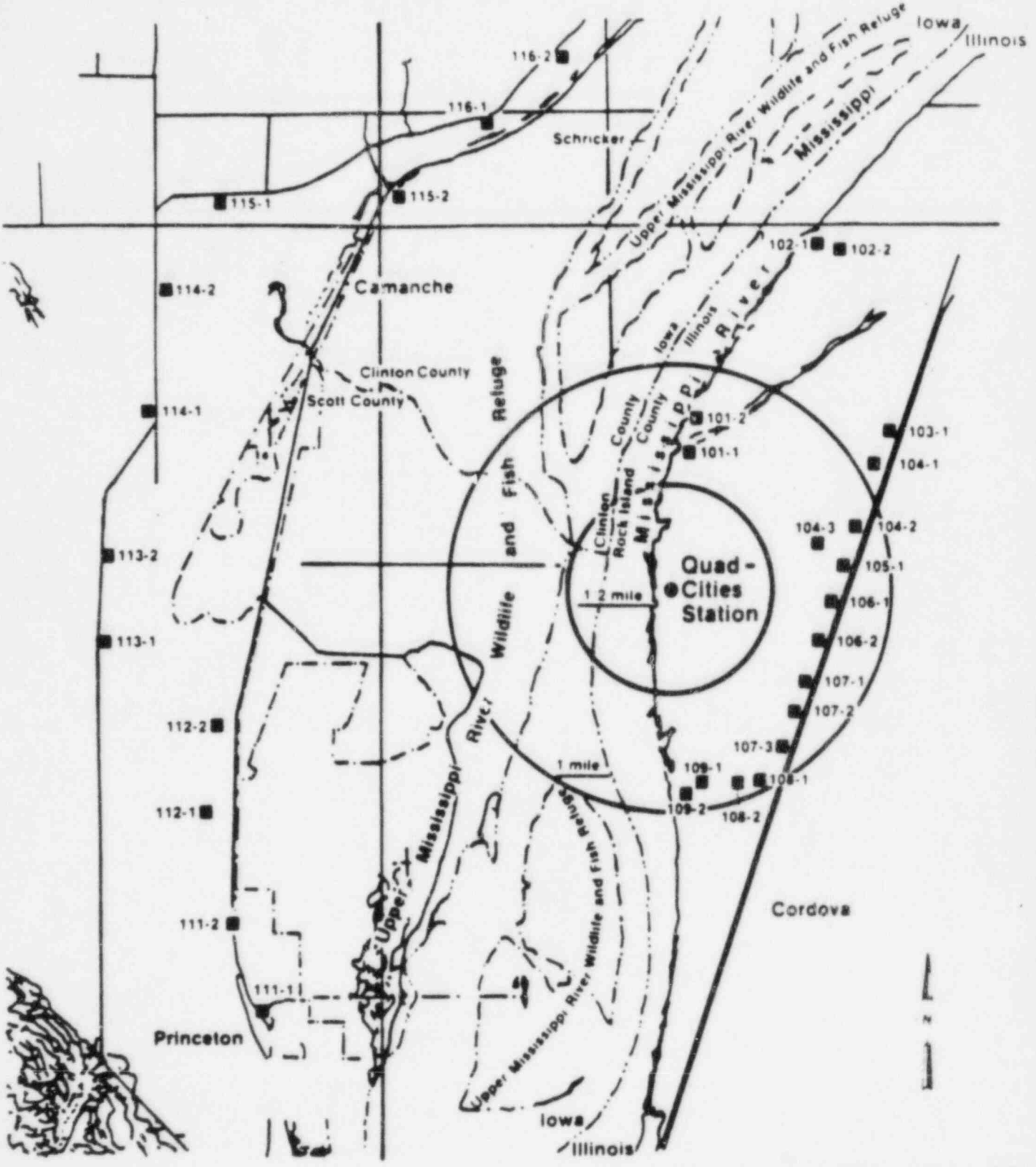
FIXED AIR SAMPLING SITES
AND OUTER RING TLD LOCATIONS



6415-1
10-85—372

Figure 5.0-2

DECEMBER 1988




**QUAD-CITIES STATION**
**Units 1 & 2**

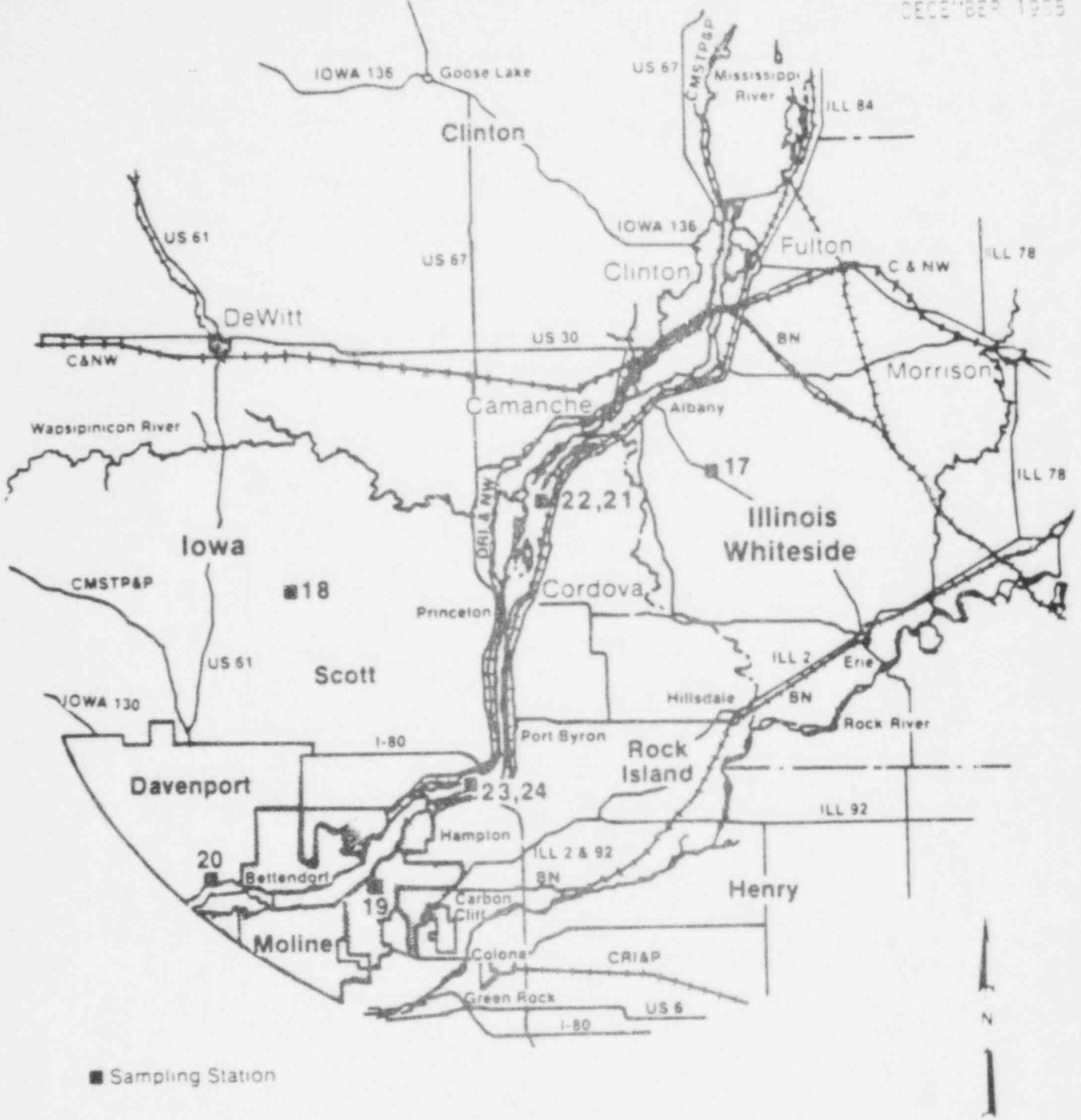
INNER RING TLD LOCATIONS



6415-3
10-85-372

Figure 5.0-3

DECEMBER 1985




**QUAD-CITIES STATION**
**Units 1 & 2**

MILK, FISH, WATER, AND SEDIMENT SAMPLE LOCATIONS

Table 5.0-1

QUAD CITIES NUCLEAR POWER STATION

STANDARD RADIOLOGICAL SAMPLING PROGRAM

| Location Code | Location Type[a] | Location Description | Media | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Air Samples | TLDs | Milk | Public Water | Cooling Water | Sediment | Fish | Census |
| Q-01 | | On-site No. 1 | X | X | | | | | | |
| -02 | | On-site No. 2 | X | X | | | | | | |
| -03 | | On-site No. 3 | X | X | | | | | | |
| -04 | | Nitrin | X | X | | | | | | |
| -05 | | Saddle Club | X | X | | | | | | |
| -06 | | Hanson's Boat Landing | X | X | | | | | | |
| -07 | | Clinton | X | X | | | | | | |
| -08 | | Sikkema Farm | X | X | | | | | | |
| -09 | C | Erie | X | X | | | | | | |
| -10 | C | Hillsdale | X | X | | | | | | |
| -11 | | Port Byron | X | X | | | | | | |
| -12 | | Bettendorf | X | X | | | | | | |
| -13 | | Princeton | X | X | | | | | | |
| -14 | C | Utica Ridge Road | X | X | | | | | | |
| -15 | C | DeWitt | X | X | | | | | | |
| -16 | C | Low Moor | X | X | | | | | | |
| -17 | C | Hansen Dairy Farm | | | X | | | | | X |
| -18 | | Musal Farm | | | X | | | | | X |
| -19 | | East Moline Water Works | | | | X | | | | |
| -20 | C | Davenport Water Works | | | | X | | | | |
| -21 | C | Inlet Canal | | | | | X | | | |
| -22 | | Discharge Canal | | | | | X | | | |
| -23 | | Lock and Dam No. 14 (Mississippi River) | | | | | | X | | |
| -24 | | Davenport Fish Market (Pool No. 14, Mississippi River) | | | | | | | X | |

[a] Control (background) locations are indicated by a "C" in this column. All other locations are indicators.

Table 5.0-2

QUAD CITIES STATION

ENVIRONMENTAL RADIOLOGIAL MONITORING PROGRAM, SAMPLING LOCATIONS

1. AIR SAMPLERS

| Site Code[a] | | Location | Distance (miles) | Direction (°) |
|---|---|---|---|---|
| Q-01 | a. | On-site Station No. 1 | 0.5 | 0 |
| Q-02 | b. | On-site Station No. 2 | 0.5 | 70 |
| Q-03 | c. | On-site Station No. 3 | 0.6 | 170 |
| Q-04 | d. | Nitrinite No. 4 | 1.5 | 40 |
| Q-05 | e. | Saddle Club Dairy Farm | 1.8 | 160 |
| Q-06 | f. | Hanson's Boat Landing | 1.8 | 340 |
| Q-07 | g. | Clinton | 9.0 | 40 |
| Q-08 | h. | Sikkema Farm | 7.0 | 70 |
| Q-09 (C) | i. | Erie | 13.0 | 110 |
| Q-10 (C) | j. | Hillsdale | 10.0 | 130 |
| Q-11 | k. | Port Byron | 8.0 | 170 |
| Q-12 | l. | Bettendorf | 13.0 | 218 |
| Q-13 | m. | Princeton | 4.8 | 220 |
| Q-14 (C) | n. | Utica Ridge Road | 11.0 | 270 |
| Q-15 (C) | o. | DeWitt | 13.0 | 300 |
| Q-16 (C) | p. | Low Moor | 6.5 | 330 |

2. TLDs

a. Same as No. 1.

b. Special TLD Samplers

| Revised Site Code[b] | Previous Site Code | Distance (miles) | Direction (°) |
|---|---|---|---|
| Q-101 1,2 | Same | 0.7 | 4 |
| Q-102 1,2 | Same | 1.7 | 21 |
| Q-103 1 | Same | 1.2 | 58 |
| Q-104 1 | Q-103 2 | 1.1 | 60 |
| Q-104 2 | Q-104 1 | 0.95 | 77 |
| Q-104 3 | Q-104 2 | 0.63 | 77 |
| Q-105 1 | Same | 0.75 | 91 |

[a] Control (reference) locations are denoted by a "C" after site code. All other locations are indicators.

[b] Effective August 1, 1985.

Table 5.0-2 (continued)

QUAD CITIES STATION

ENVIRONMENTAL RADIOLOGIAL MONITORING PROGRAM, SAMPLING LOCATIONS

2. TLDs

b. Special TLD Samplers (continued)

| Revised Site Code | Previous Site Code | Distance (miles) | Direction (°) |
|---|---|---|---|
| Q-106 1 | Q-105 2 | 0.71 | 109 |
| Q-106 2 | Q-106 1 | 0.71 | 118 |
| Q-107 1 | Q-106 2 | 0.71 | 128 |
| Q-107 2 | Q-107 1 | 0.73 | 137 |
| Q-107 3 | Q-107-2 | 0.78 | 146 |
| Q-108 1,2 | Same | 0.9 | 155 |
| Q-109 1,2 | Same | 0.95 | 176 |
| Q-111 1,2 | Same | 2.6 | 230 |
| Q-112 1,2 | Same | 2.4 | 246 |
| Q-113 1,2 | Same | 2.5 | 264 |
| Q-114 1,2 | Same | 2.6 | 286 |
| Q-115 1,2 | Same | 2.3 | 310 |
| Q-116 1,2 | Same | 2.2 | 339 |
| Q-201 1,2 | Same | 4.0 | 356 |
| Q-202 1,2 | Same | 4.4 | 17 |
| Q-203 1,2 | Same | 5.5 | 34 |
| Q-204 1,2 | Same | 4.5 | 61 |
| Q-205 1,2 | Same | 4.5 | 83 |
| Q-206 1,2 | Same | 4.8 | 113 |
| Q-207 1,2 | Same | 4.8 | 133 |
| Q-208 1,2 | Same | 4.4 | 158 |
| Q-209 1,2 | Same | 4.8 | 179 |
| Q-210 1,2 | Same | 4.4 | 210 |
| Q-211 1 | Same | 5.0 | 223 |
| Q-212 1,2 | Same | 4.8 | 242 |
| Q-213 1,2 | Same | 4.7 | 265 |
| Q-214 1,2 | Same | 4.8 | 310 |
| Q-215 1,2 | Same | 4.8 | 316 |
| Q-216 1,2 | Same | 4.5 | 333 |

3. MILK

| Site Code[a] | Location | Distance (miles) | Direction (°) |
|---|---|---|---|
| Q-17 (C) | a. Hansen Dairy Farm | 6.0 | 70 |
| Q-18 | b. Musal Farm | 5.5 | 225 |

[a] Control (reference) locations are denoted by a "C" after site code. All other locations are indicators.

Table 5.0-2 (continued)

QUAD CITIES STATION

ENVIRONMENTAL RADIOLOGIAL MONITORING PROGRAM, SAMPLING LOCATIONS

4. PUBLIC WATER SUPPLY

| Site Code[a] | Location | Distance (miles) | Direction (°) |
|---|---|---|---|
| Q-19 | a. East Moline Water Works | 16.0 | 206 |
| Q-20 (C) | b. Davenport Water Works | 18.0 | 219 |

5. COOLING WATER

| Site Code[a] | Location | Distance (miles) | Direction (°) |
|---|---|---|---|
| Q-21 (C) | a. Inlet | At Station | |
| Q-22 | b. Discharge | | |

6. FISH

| Site Code[a] | Location | Distance (miles) | Direction (°) |
|---|---|---|---|
| Q-24 | Davenport Fish Market | Pool No. 14 of Mississippi River | |

7. BOTTOM SEDIMENTS

| Site Code[a] | Location | Distance (miles) | Direction (°) |
|---|---|---|---|
| Q-23 | Lock and Dam No. 14 | 15.0 | 210 |

[a] Control (reference) locations are denoted by a "C" after site code. All other locations are indicators.

Table 5.0-2 (continued)

QUAD CITIES STATION

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM, SAMPLE COLLECTION AND ANALYSES

| Sample Media | Location Code[a] | Location Site | Collection Frequency | Type of Analysis | Frequency of Analysis | Remarks |
|---|---|---|---|---|---|---|
| 1. Airborne Particulates | a. Onsite and Near Field | | Continuous operation for one week. | Gross beta | Weekly | On all samples. Gamma Isot if gross beta in a sample exceeds by 5X the average concentration of the preceding calendar quarter for the sample location.<br><br>Non-routine Reporting Levels[b]<br><br>Cs-134 10 Cs-137 20 $pCi/m^3$. |
| | Q-1 | Onsite No. 1 | | | | |
| | Q-2 | Onsite No. 2 | | | | |
| | Q-3 | Onsite No. 3 | | | | |
| | Q-4 | Nitrin | | | | |
| | Q-5 | Saddle Club Dairy Farm | | | | |
| | Q-6 | Hanson's Boat Landing | | | | |
| | b. Far Field | | Same as 1a. | Filter Exchange | Weekly | Non-routine Reporting Levels[b]<br><br>Same as 1(a) when analyses are made. |
| | Q-7 | Clinton | | | | |
| | Q-8 | Sikkoma Farm | | | | |
| | Q-9 (C) | Erie | | | | |
| | Q-10 (C) | Hillsdale | | | | |
| | Q-11 | Port Byron | | | | |
| | Q-12 (C) | Bettendorf | | | | |
| | Q-13 | Princeton | | | | |
| | Q-14 (C) | Utica Ridge Road | | | | |
| | Q-15 (C) | DeWitt | | | | |
| | Q-16 | Low Moor | | | | |
| 2. Airborne Iodine | Same as 1. | | Continuous operation for two weeks | I-131 | Biweekly | Biweekly = Every two weeks. On all samples<br><br>Non-routine Reporting Level[b]<br><br>0.9 $pCi/m^3$ |
| 3. Air Sampling Train | Same as 1. | | -- | Test and Maintenance | Weekly | On all samplers. |

[a] Control (reference) locations are denoted by a "C" in this column. All other locations are indicators.
[b] Average concentration over calendar quarter.

Table 5.0-2 (continued)

QUAD CITIES STATION

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM, SAMPLE COLLECTION AND ANALYSES

| Sample Media | Location Code[a] | Location Site | Collection Frequency | Type of Analysis | Frequency of Analysis | Remarks |
|---|---|---|---|---|---|---|
| 4. TLD | Q-101 1,2<br>102 1,2<br>103 1<br>104 1,2,3<br>105 1<br>106 1,2<br>107 1,2,3<br>108 1,2<br>109 1,2<br>111 1,2<br>through<br>116 1,2 | Inner Ring | Quarterly | Gamma | Quarterly | Two sets at all AP locations. One set read quarterly. Second set read if required by Commonwealth Edison. At other locations, all sets read quarterly. Minimum of two TLDs per set. |
| | L-201 1,2<br>through<br>210 1,2<br>211<br>212 1,2<br>through<br>215 1,2 | Outer Ring | | | | |
| 5. Milk | Q-17 (C)<br>Q-18 | Hansen Dairy<br>Musal Farm | Weekly:<br>May through October | I-131 | Weekly:<br>May through October | On all samples. LLD: 0.5 pCi/l. |
| | | | Monthly:<br>November through April | I-131 | Monthly:<br>November through April | On all samples. LLD: 5.0 pCi/l.<br><br>Non-routine Reporting Levels[b]<br>I-131 3; Cs-134 60; Cs-137 70; Ba-La-140 300 pCi/l |

[a] Control (reference) locations are denoted by a "C" in this column. All other locations are indicators.
[b] Average concentration over calendar year.

Table 5.0-2 (continued)

QUAD CITIES STATION

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM, SAMPLE COLLECTION AND ANALYSES

| Sample Media | Location | | Collection Frequency | Type of Analysis | Frequency of Analysis | Remarks |
|---|---|---|---|---|---|---|
| | Code[a] | Site | | | | |
| 6. Public Water | Q-19 | East Moline Water Works | Weekly | Gamma Isot | Monthly | On monthly composite from each location.<br><br>Non-routine Reporting Levels[b]<br><br>(See footnote "c.") |
| | Q-20 (C) | Davenport Water Works | | | | |
| 7. Cooling Water | Q-21 (C) | Inlet Canal | Weekly | Gross beta | Weekly | On notification provided by station personnel. |
| | Q-22 | Discharge Canal | | | | |
| 8. Fish | Q-24 | Pool 14 of Mississippi River | Semiannually | Gamma .sot | Semiannually | On edible portions only. At least two species.<br><br>Non-routine Reporting Levels[b]<br><br>Mn-54 $3x10^4$; Fe-59 $1x10^4$; Co-58 $3x10^4$; Co-60 $1x10^4$; Zn-65 $2x10^4$; Cs-134 $1x10^3$; Cs-137 $1x10^3$ pCi/kg wet weight. |
| 9. Bottom Sediments | Q-23 | Lock and Dam No. 14 | Annually | Gamma Isot | Annually | |

[a] Control (reference) locations are denoted by a "C" in this column. All other locations are indicators.
[b] Average concentration over calendar year.
[c] H-3 $2x10^4$, Mn-54 $1x10^3$, Fe-59 $4x10^2$, Co-58 $1x10^2$, Co-60 $3x10^2$, Zn-65 $3x10^2$, Zr-Nb-95 $4x10^2$, I-131 2, Cs-134 30, Cs-137 50, Ba-La-140 $2x10^2$ pci/l.

Table 5.0-2 (continued)

QUAD CITIES STATION

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM, SAMPLE COLLECTION AND ANALYSES (continued)

| Sample Media | Location Code | Location Site | Collection Frequency | Type of Analysis | Frequency of Analysis | Remarks |
|---|---|---|---|---|---|---|
| 10. Dairy Census | a. | Site boundary to 2 miles | -- | a. Enumeration by a door-to-door or equivalent counting technique. | Annually | During grazing season. |
| | b. | 2 miles to 5 miles | -- | b. Enumeration by using referenced information from county agricultural agents or other reliable sources. | Annually | During grazing season. |
| | c. | At dairies listed in Item 5. | -- | c. Inquire as to feeding practices:<br>(1) Pasture only.<br>(2) Feed and chop only.<br>(3) Pasture and feed; if both, ask farmer to estimate fraction of food from pasture: <25%, 25-50%, 50-75%, or >75%. | Annually | During grazing season. |
| 11. Nearest Residence Census | In all 16 sectors | | | | Annually | |

Table 5.0-3

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM QUARTERLY SUMMARY

Name of Facility Quad Cities Nuclear Power Station Docket No. 50-254, 50-265

Location of Facility Rock Island, Illinois (County, State) Reporting Period 1st Quarter 1985

| Sample Type (Units) | Type and Number of Analyses | LLD | Indicator Locations Mean[a] Range | Location with Highest Quarterly Mean | | Control Locations Mean[a] Range | Number of Non-routine Results |
|---|---|---|---|---|---|---|---|
| | | | | Location | Mean Range | | |
| Air Particulates ($pCi/m^3$) | Gross Beta 77 | 0.01 | 0.025 (77/77) (0.009-0.056) | Q-05, Saddle Club Dairy, 1.8 mi @ 160° | 0.027 (13/13) (0.009-0.055) | None | 0 |
| Airborne Iodine ($pCi/m^3$) | I-131 36 | 0.10 | <LLD | - | - | None | 0 |
| Gamma Background (TLDs) (mR/Qtr.) | Gamma Dose 16 | 3.0 | 12.0 (6/6) (9.3-15.5) | Q-10, Hillsdale 10.0 mi @ 130° | 30.0 (1/1) - | 14.3 (10/10) (4.6-30.0) | 0 |
| Milk (pCi/l) | I-131 6 | 5.0 | <LLD | - | - | None | 0 |
| Cooling Water (pCi/l) | Gross Beta 26 | 2.0 | 4.2 (13/13) (3.1-6.1) | Q-22A, Diffuser Pipe Blowdown at Station | 4.4 (13/13) (3.1-6.1) | 4.2 (13/13) (2.9-5.5) | 0 |
| | Tritium 1 | 200 | 240 (1/1) | | 240 (1/1) | None | 0 |
| Public Water (pCi/l) | Gamma Spec. 6 | | | | | | |
| | Cs-134 10 | 10.0 | <LLD | - | - | None | 0 |
| | Cs-137 10 | 10.0 | <LLD | - | - | None | 0 |
| | Other Gammas | 20.0 | <LLD | - | - | None | 0 |

[a] Mean and range based on detectable measurements only. Fractions indicated in parentheses.

Table 5.0-4

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM QUARTERLY SUMMARY

Name of Facility Quad Cities Nuclear Power Station Docket No. 50-254, 50-265
Location of Facility Rock Island, Illinois (County, State) Reporting Period 2nd Quarter 1985

| Sample Type (Units) | Type and Number of Analyses | LLD | Indicator Locations Mean[a] Range | Location with Highest Quarterly Mean | | Control Locations Mean[a] Range | Number of Non-routine Results |
|---|---|---|---|---|---|---|---|
| | | | | Location | Mean Range | | |
| Air Particulates ($pCi/m^3$) | Gross beta 77 | 0.01 | 0.019 (75/77) (0.008-0.071) | Q-04, Nitrin 1.5 mi @ 40° | 0.029 (11/12) (0.015-0.073) | None | 0 |
| Airborne Iodine ($pCi/m^3$) | I-131 42 | 0.10 | <LLD | - | - | None | 0 |
| Gamma Background (TLDs) (mR/Qtr.) | Gamma Dose 16 | 3.0 | 11.6 (6/6) (10.3-13.9) | Q-10, Hillsdale 10.0 mi @ 130°<br>Q-12, Bettendorf 13.0 mi @ 218° | 16.5 (1/1)<br>-<br>16.5 (1/1)<br>- | 11.9 (10/10) (8.1-16.5) | 0 |
| Milk (pCi/l) | I-131 20 | 5/0.5[b] | <LLD | - | - | None | 0 |
| Cooling Water (pCi/l) | Gross Beta 26 | 1.0 | 4.5 (13/13) (3.5-7.5) | Q-21, Inlet Canal at Station | 4.9 (13/13) (3.4-6.2) | 4.5 (13/13) (3.9-5.3) | 0 |
| | Tritium 1 | 200 | <LLD | - | - | None | 0 |
| Public Water (pCi/l) | Gamma Spec. 6 | | | | | | |
| | Cs-134 10 | 10.0 | <LLD | - | - | None | 0 |
| | Cs-137 10 | 10.0 | <LLD | - | - | None | 0 |
| | Other Gammas | 20.0 | <LLD | - | - | None | 0 |
| Fish (pCi/g wet) | Gamma Spec. 4 | | | | | | |
| | Cs-134 | 0.1 | <LLD | - | - | None | 0 |
| | Cs-137 | 0.1 | <LLD | - | - | None | 0 |
| | Other Gammas | 0.2 | <LLD | - | - | None | 0 |

[a] Mean and range based on detectable measurements only. Fractions indicated in parentheses.
[b] November - April LLD = 5.0; May - October LLD = 0.5.

Table 5.0-5

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM QUARTERLY SUMMARY

Name of Facility Quad Cities Nuclear Power Station Docket No. 50-254, 50-265
Location of Facility Rock Island, Illinois Reporting Period 3rd Quarter 1985
(County, State)

| Sample Type (Units) | Type and Number of Analyses | LLD | Indicator Locations Mean[a] Range | Location with Highest Quarterly Mean | | Control Locations Mean[a] Range | Number of Non-routine Results |
|---|---|---|---|---|---|---|---|
| | | | | Location | Mean Range | | |
| Air Particulates ($pCi/m^3$) | Gross Beta 78 | 0.01 | 0.023 (78/78) (0.006-0.039) | Q-05, Saddle Club Dairy 1.8 mi @ 160° | 0.025 (12/12) (0.015-0.039) | None | 0 |
| | | | | Q-06, Hanson's Boat Dock 1.8 mi @ 340° | 0.025 (12/12) (0.016-0.035) | | |
| Airborne Iodine ($pCi/m^3$) | I-131 36 | 0.10 | <LLD | - | - | None | 0 |
| Gamma Background (TLDs) (mR/Qtr.) | Gamma Dose 16 | 3.0 | 10.6 (6/6) (7.0-13.0) | Q-11, Port Byron 8.0 mi @ 170° | 14.3 (1/1) - | 9.9 (10/10) (7.6-14.3) | 0 |
| Milk (pCi/l) | I-131 20 | 5/0.5[b] | <LLD | - | - | None | 0 |
| Cooling Water (pCi/l) | Gross Beta 26 | 1.0 | 3.4 (13/13) (3.0-4.4) | Q-22A, Diffuser Pipe Blowdown at Station | 3.6 (13/13) | 3.6 (13/13) (3.1-4.0) | 0 |
| | Tritium 1 | 200 | <LLD | - | - | None | 0 |
| Public Water (pCi/l) | Gamma Spec. 6 | | | | | | |
| | Cs-134 | 10.0 | <LLD | - | - | None | 0 |
| | Cs-137 | 10.0 | <LLD | - | - | None | 0 |
| | Other Gammas | 20.0 | <LLD | - | - | None | 0 |
| Bottom Sediments (pCi/g dry) | Gamma Spec. 1 | | | | | | |
| | Cs-134 | 0.1 | <LLD | - | - | None | 0 |
| | Cs-137 | 0.1 | <LLD | - | - | None | 0 |
| | Other Gammas | 0.2 | <LLD | - | - | None | 0 |

[a] Mean and range based on detectable measurements only. Fractions indicated in parentheses.

Table 5.0-6

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM QUARTERLY SUMMARY

Name of Facility Quad Cities Nuclear Power Station Docket No. 50-254, 50-265
Location of Facility Rock Island, Illinois (County, State) Reporting Period 4th Quarter 1985

| Sample Type (Units) | Type and Number of Analyses | LLD | Indicator Locations Mean[a] Range | Location with Highest Quarterly Mean | | Control Locations Mean[a] Range | Number of Non-routine Results |
|---|---|---|---|---|---|---|---|
| | | | | Location | Mean Range | | |
| Air Particulates (pCi/m$^3$) | Gross Beta 75 | 0.01 | 0.027 (75/75) (0.006-0.068) | Q-05, Saddle Club Dairy 1.8 mi @ 160° | 0.029 (14/14) (0.014-0.061) | None | 0 |
| Airborne Iodine (pCi/m$^3$) | I-131 39 | 0.10 | <LLD | - | - | None | 0 |
| Gamma Background (TLDs) (mR/Qtr.) | Gamma Dose 16 | 3.0 | 18.3 (6/6) (13.2-22.5) | Q-04, Nitrin 1.5 mi @ 40° | 22.5 (1/1) - | 16.1 (10/10) (11.6-21.3) | 0 |
| Milk (pCi/l) | I-131 20 | 5/0.5[b] | <LLD | - | - | None | 0 |
| Cooling Water (pCi/l) | Gross Beta 26 | 1.0 | 364.5 (13/13) (3.6-4242.9) | Q-22A, Diffuser Pipe Blowdown | 364.5 (13/13) (3.6-4242.9) | 7.1 (13/13) (1.1-35.7) | 4 |
| | Tritium 1 | 200 | 380 (1/1) | Q-22A, Diffuser Pipe Blowdown | 380 (1/1) | None | 0 |
| Public Water (pCi/l) | Gamma Spec. 6 | | | | | | |
| | Cs-134 | 10.0 | <LLD | - | - | None | 0 |
| | Cs-137 | 10.0 | <LLD | - | - | None | 0 |
| | Other Gammas | 20.0 | <LLD | - | - | None | 0 |
| Fish (pCi/g wet) | Gamma Spec. 8 | | | | | | |
| | Cs-134 | 0.1 | <LLD | - | - | None | 0 |
| | Cs-137 | 0.1 | <LLD | - | - | None | 0 |
| | Other Gammas | 0.2 | <LLD | - | - | None | 0 |

[a] Mean and range based on detectable measurements only. Fractions indicated in parentheses.
[b] November - April LLD = 5.0; May - October LLD = 0.5.

Table 5.1-1

GAMMA RADIATION AS MEASURED BY THERMOLUMINESCENT DOSIMETERS (TLDs)

STANDARD RADIOLOGICAL MONITORING PROGRAM

| | | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter |
|---|---|---|---|---|---|
| Date Placed: | | 12-28-84 | 03-28-85 | 06-29-85 | 09-28-85 |
| Date Removed: | | 03-28-85 | 06-29-85 | 09-28-85 | 12-27-85 |
| Days in the Field: | | 90 | 93 | 91 | 90 |
| Location | | Average mR/Quarter | | | |
| On-Site Indicator Locations | | | | | |
| Q-01 | On-Site No. 1 | 9.3±2.3 | 10.4±1.7 | 12.9±3.1 | 17.5±6.1 |
| Q-02 | On-Site No. 2 | 10.0±1.9 | 11.5±2.1 | 11.0±2.1 | 21.7±1.1 |
| Q-03 | On-Site No. 3 | 14.9±1.9 | 12.8±1.9 | 9.8±2.1 | 14.5±1.1 |
| Mean ± s.d. | | 11.4±3.0 | 11.6±1.2 | 11.2±1.6 | 17.9±3.6 |
| Off-Site Indicator Locations | | | | | |
| Q-04 | Nitrin | 11.3±2.9 | 10.3±2.2 | 9.7±1.8 | 22.5±1.4 |
| Q-05 | Saddle Club Dairy | 11.4±2.8 | 10.4±1.0 | 7.0±2.0 | 20.5±1.2 |
| Q-06 | Hanson's Dock | 15.5±2.4 | 13.9±1.7 | 13.0±1.3 | 13.2±0.9 |
| Mean ± s.d. | | 12.7±2.4 | 11.5±2.0 | 9.9±3.0 | 18.7±4.9 |
| Background Locations | | | | | |
| Q-07 | Clinton | 4.6±2.4 | 9.7±2.3 | 8.5±3.7 | 11.6±0.9 |
| Q-08 | Sitkema Farm | 9.8±2.5 | 10.3±1.8 | 7.9±1.7 | 19.0±3.3 |
| Q-09 | Erie | 8.0±2.6 | 11.2±1.2 | 12.0±1.7 | 16.0±1.3 |
| Q-10 | Hillsdale | 30.0±4.5 | 16.5±1.5 | 8.4±1.1 | 18.3±1.5 |
| Q-11 | Port Byron | 21.9±3.2 | 12.9±1.3 | 14.3±1.9 | 21.3±1.7 |
| Q-12 | Bettendorf | 12.0±2.4 | 16.5±2.0 | 10.8±1.5 | 15.5±1.3 |
| Q-13 | Princeton | 12.6±2.1 | 11.5±2.0 | 10.1±1.8 | 13.0±0.8 |
| Q-14 | Utica Ridge Road | 21.4±3.6 | 10.9±1.2 | 8.5±1.5 | 16.2±1.2 |
| Q-15 | DeWitt | 12.0±2.9 | 8.1±1.8 | 7.6±2.2 | 11.9±1.0 |
| Q-16 | Low Moor | 10.4±3.2 | 11.0±1.6 | 11.3±4.2 | 18.6±1.0 |
| Mean ± s.d. | | 14.3±7.7 | 11.9±2.8 | 9.9±2.2 | 16.1±3.2 |

Table 5.1-1 (continued)

GAMMA RADIATION AS MEASURED BY TLDs (continued)

SPECIAL PROGRAM

Inner Ring, Near Site Boundary, Indicator Locations

| | | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter |
|---|---|---|---|---|---|
| Date Placed: | | 12-28-84 | 03-28-85 | 06-29-85 | 09-28-85 |
| Date Removed: | | 03-28-84 | 06-29-85 | 09-28-85 | 12-27-85 |
| Days in the Field: | | 90 | 93 | 91 | 90 |
| Previous Location Code | Revised Location Code[a] | Average mR/Quarter | | | |
| Q-101-1 | same | 7.1±2.0 | 9.9±1.7 | 9.2±3.1 | 17.8±0.7 |
| Q-101-2 | same | 15.5±2.3 | 15.7±3.1 | 14.9±4.3 | 18.1±3.2 |
| Q-102-1 | same | 18.9±2.2 | 15.0±2.7 | 14.6±1.0 | 44.7±2.0[b] |
| Q-102-2 | same | 6.5±2.1 | 11.9±2.2 | 13.0±1.3 | ND[c] |
| Q-103-1 | same | 5.8±2.4 | 10.9±1.9 | 12.7±2.1 | 11.5±1.1 |
| Q-103-2 | 104-1 | 2.2±2.4 | 8.9±1.9 | 14.8±1.4 | 11.3±0.8 |
| Q-104-1 | 104-2 | 8.1±3.1 | 9.6±1.8 | 9.2±1.8 | 13.2±2.8 |
| Q-104-2 | 104-3 | 3.8±1.8 | 12.2±2.1 | 10.1±1.4 | 15.7±1.3 |
| Q-105-1 | same | 4.3±2.0 | 15.7±3.9 | 11.0±1.2 | 13.7±1.0 |
| Q-105-2 | 106-1 | 2.0±1.9 | 10.1±1.5 | 12.4±1.3 | 13.4±1.0 |
| Q-106-1 | 106-2 | 5.2±2.3 | 11.8±2.3 | 13.1±1.8 | 19.8±16.7[b] |
| Q-106-2 | 107-1 | 3.9±2.3 | 14.6±1.7 | 12.0±3.9 | 14.7±1.4 |
| Q-107-1 | 107-2 | 7.6±2.5 | 11.5±1.8 | 9.0±2.2 | 13.9±1.4 |
| Q-107-2 | 107-3 | 4.6±2.6 | 10.9±1.7 | 9.5±1.1 | 14.9±0.6 |
| Q-108-1 | same | 4.0±2.4 | 10.3±3.0 | 9.4±1.4 | 12.3±1.0 |
| Q-108-2 | same | 9.5±3.4 | 11.1±1.2 | 9.7±1.5 | 11.5±0.5 |
| Q-109-1 | same | 2.7±2.0 | 9.1±1.2 | 9.8±1.2 | 14.8±1.0 |
| Q-109-2 | same | 11.0±2.0 | 11.9±1.3 | 11.4±2.0 | 11.8±1.2 |
| Q-111-1 | same | 2.8±2.0 | 12.9±2.8 | 10.5±1.5 | 13.0±3.8 |
| Q-111-2 | same | 3.6±2.2 | 14.0±1.5 | 13.7±1.9 | 13.4±1.2 |
| Q-112-1 | same | 13.6±2.6 | 11.7±1.4 | 6.8±1.9 | 11.7±0.8 |
| Q-112-2 | same | 10.3±2.7 | 15.1±5.8 | 20.3±3.0 | 14.3±0.9 |
| Q-113-1 | same | 13.4±3.1 | 10.6±2.0 | 9.5±3.2 | 17.9±0.8 |
| Q-113-2 | same | 10.0±2.9 | 11.5±2.1 | 13.9±2.0 | 17.6±1.6 |
| Q-114-1 | same | 11.0±2.0 | 11.3±1.1 | 10.7±1.6 | 10.0±0.7 |
| Q-114-2 | same | 8.4±1.8 | 10.6±1.7 | 8.4±3.3 | 8.9±1.1 |
| Q-115-1 | same | 18.3±2.6 | 14.6±1.9 | 9.7±3.2 | 13.2±1.0 |
| Q-115-2 | same | 5.7±2.6 | 8.9±4.2 | 12.6±4.5 | 10.9±2.5 |
| Q-116-1 | same | 9.5±1.9 | 10.0±1.5 | 12.2±4.7 | 12.1±0.9 |
| Q-116-2 | same | 3.9±2.8 | 15.0±1.7 | 10.6±1.5 | 13.2±0.7 |
| Mean ± s.d. | | 7.8±4.7 | 12.2±2.4 | 11.5±2.6 | 13.5±2.4 |

[a] Effective 3rd quarter 1985.
[b] Chips damaged (white); not included in quarterly mean.
[c] ND = No data; TLD lost in the field.

Table 5.1-1 (continued)

GAMMA RADIATION AS MEASURED BY TLDs (continued)

SPECIAL PROGRAM

Outer Ring, Near 5 Mile Radius, Indicator Locations

| | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter |
|---|---|---|---|---|
| Date Placed: | 12-28-84 | 03-28-85 | 06-29-85 | 09-28-85 |
| Date Removed: | 03-28-85 | 06-29-85 | 09-28-85 | 12-27-85 |
| Days in the Field: | 90 | 93 | 91 | 90 |
| Location | Average mR/Qtr | | | |
| Q-201-1 | 10.8±2.2 | 15.3±1.8 | 13.4±1.8 | 14.4±1.5 |
| Q-201-2 | 12.0±2.3 | 17.0±1.7 | 11.8±1.9 | 14.7±0.6 |
| Q-202-1 | 10.6±4.9 | 9.0±2.8 | 7.8±2.6 | 11.2±0.8 |
| Q-202-2 | 11.8±2.1 | 12.2±2.3 | 8.2±1.5 | 10.5±1.0 |
| Q-203-1 | 8.8±5.7 | 9.3±2.8 | 10.8±3.2 | 14.6±0.6 |
| Q-203-2 | 13.8±5.5 | 17.8±1.1 | 10.7±1.4 | 27.4±2.4[a] |
| Q-204-1 | 13.212.3 | 11.1±1.1 | 15.6±2.1 | 15.7±3.4 |
| Q-204-2 | 13.7±3.2 | 13.9±5.1 | 12.1±1.8 | 13.9±1.2 |
| Q-205-1 | 12.6±2.8 | 15.0±1.6 | 12.5±1.8 | 13.3±2.8 |
| Q-205-2 | 8.3±3.0 | 14.7±1.6 | 11.9±1.3 | 16.4±3.4 |
| Q-206-1 | 11.2±2.2 | 16.3±1.5 | ND[b] | 16.4±3.9 |
| Q-206-2 | 11.9±2.7 | 13.6±2.2 | 12.0±1.8 | 46.1±3.1[a] |
| Q-207-1 | 11.9±2.4 | 15.4±2.1 | 11.0±1.4 | 16.4±1.4 |
| Q-207-2 | 9.5±2.9 | 12.4±2.5 | 13.4±2.1 | ND[b] |
| Q-208-1 | 11.9±2.7 | 14.4±2.6 | 14.4±4.6 | 27.1±1.3[a] |
| Q-208-2 | 12.9±2.4 | 13.5±1.6 | 10.6±1.6 | 15.2±3.6 |
| Q-209-1 | 12.4±2.2 | 17.7±1.4 | 12.9±1.8 | 14.3±3.1 |
| Q-209-2 | 10.2±2.0 | 16.6±2.2 | 10.0±2.7 | 13.8±2.8 |
| Q-210-1 | 12.7±1.9 | 13.2±3.4 | 9.4±1.7 | 14.4±4.8 |
| Q-210-2 | 9.6±2.3 | 17.2±6.1 | 10.2±1.4 | 13.8±1.0 |
| Q-211-1 | 10.6±2.6 | 14.3±2.2 | 13.0±2.9 | 18.6±1.6 |
| Q-212-1 | 12.9±2.1 | 13.3±2.0 | 10.8±2.4 | 12.7±0.7 |
| Q-212-2 | 12.9±2.1 | 11.1±1.5 | 10.5±1.3 | 25.2±1.5[a] |
| Q-213-1 | 13.6±1.9 | 11.2±2.7 | 9.2±1.2 | 14.9±1.2 |
| Q-213-2 | 11.9±1.9 | 12.3±1.5 | 10.3±2.9 | 34.4±1.6[a] |
| Q-214-1 | 12.7±2.0 | 11.4±1.2 | 9.4±1.2 | 27.0±1.7 |
| Q-214-2 | 14.3±2.3 | 15.1±2.2 | 13.7±1.0 | 28.2±4.9 |
| Q-215-1 | 10.8±2.7 | 13.7±1.1 | 16.7±1.9 | 12.1±0.9 |
| Q-215-2 | 14.3±2.9 | 15.4±1.9 | 19.3±2.4 | 26.6±0.6[a] |
| Q-216-1 | 10.9±2.9 | ND[a] | 17.7±1.2 | 14.0±1.2 |
| Q-216-2 | 11.1±2.5 | 15.9±1.8 | 15.3±1.0 | 28.1±1.0[a] |
| Mean ± s.d. | 11.8±1.6 | 14.0±2.4 | 12.2±2.8 | 15.5±4.2 |

[a] Chips damaged (white); not included in quarterly mean.
[b] ND = No data; TLDs lost in the field.

# APPENDIX II

# METEOROLOGICAL DATA

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - JANUARY-MARCH 1985
STABILITY CLASS - EXTREMELY UNSTABLE (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NNE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ENE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ESE | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| SE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SSE | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| S | 0 | 0 | 0 | 3 | 4 | 3 | 10 |
| SSW | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| SW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| WSW | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| W | 0 | 0 | 1 | 3 | 0 | 0 | 4 |
| WNW | 0 | 0 | 0 | 6 | 0 | 0 | 6 |
| NW | 0 | 0 | 1 | 0 | 2 | 0 | 3 |
| NNW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0 | 0 | 3 | 14 | 7 | 3 | 27 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 1

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - JANUARY-MARCH 1985
STABILITY CLASS - MODERATELY UNSTABLE (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .0-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| NNE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ENE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ESE | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| SE | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| SSE | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| S | 0 | 0 | 0 | 1 | 1 | 1 | 3 |
| SSW | 0 | 2 | 3 | 0 | 1 | 0 | 6 |
| SW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| WSW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| W | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| WNW | 0 | 0 | 1 | 3 | 0 | 0 | 4 |
| NW | 0 | 0 | 4 | 3 | 3 | 0 | 10 |
| NNW | 0 | 0 | 2 | 1 | 0 | 0 | 3 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0 | 2 | 10 | 12 | 7 | 1 | 32 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 1

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - JANUARY-MARCH 1985
STABILITY CLASS - SLIGHTLY UNSTABLE (DELTA T 296-33 F
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| NNE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ENE | 0 | 0 | 0 | 1 | 2 | 1 | 4 |
| E | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ESE | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| SE | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| SSE | 0 | 0 | 1 | 3 | 0 | 0 | 4 |
| S | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| SSW | 0 | 1 | 0 | 1 | 0 | 0 | 2 |
| SW | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| WSW | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| W | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| WNW | 0 | 0 | 0 | 2 | 2 | 0 | 4 |
| NW | 0 | 0 | 5 | 2 | 4 | 1 | 12 |
| NNW | 0 | 0 | 2 | 6 | 0 | 0 | 8 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0 | 2 | 9 | 16 | 11 | 3 | 41 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 1

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - JANUARY-MARCH 1983
STABILITY CLASS - NEUTRAL (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 1 | 4 | 7 | 12 | 6 | 0 | 30 |
| NNE | 0 | 1 | 4 | 3 | 3 | 0 | 11 |
| NE | 0 | 3 | 12 | 6 | 6 | 2 | 31 |
| ENE | 0 | 8 | 17 | 29 | 11 | 9 | 69 |
| E | 0 | 2 | 15 | 25 | 12 | 10 | 64 |
| ESE | 0 | 1 | 13 | 16 | 8 | 1 | 39 |
| SE | 0 | 5 | 14 | 21 | 11 | 1 | 52 |
| SSE | 0 | 2 | 9 | 14 | 3 | 4 | 32 |
| S | 0 | 0 | 5 | 19 | 7 | 2 | 33 |
| SSW | 0 | 5 | 7 | 28 | 7 | 0 | 47 |
| SW | 0 | 6 | 12 | 19 | 6 | 0 | 43 |
| WSW | 1 | 2 | 19 | 41 | 25 | 13 | 101 |
| W | 0 | 6 | 13 | 24 | 39 | 28 | 110 |
| WNW | 1 | 2 | 12 | 80 | 150 | 46 | 299 |
| NW | 0 | 2 | 17 | 44 | 43 | 28 | 134 |
| NNW | 0 | 1 | 10 | 22 | 16 | 4 | 53 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 3 | 48 | 186 | 413 | 365 | 143 | 1150 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 1

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - JANUARY-MARCH 1985
STABILITY CLASS - SLIGHTLY STABLE (DELTA T 296-33 FT
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 2 | 6 | 14 | 9 | 0 | 0 | 31 |
| NNE | 0 | 3 | 7 | 0 | 0 | 0 | 10 |
| NE | 2 | 6 | 7 | 5 | 0 | 0 | 20 |
| ENE | 6 | 5 | 15 | 13 | 0 | 0 | 39 |
| E | 2 | 1 | 8 | 21 | 6 | 1 | 39 |
| ESE | 2 | 2 | 4 | 11 | 6 | 0 | 25 |
| SE | 1 | 5 | 7 | 7 | 2 | 0 | 22 |
| SSE | 1 | 5 | 3 | 13 | 5 | 1 | 28 |
| S | 0 | 2 | 15 | 24 | 9 | 14 | 64 |
| SSW | 0 | 3 | 9 | 44 | 28 | 6 | 90 |
| SW | 1 | 4 | 22 | 14 | 6 | 0 | 47 |
| WSW | 0 | 1 | 4 | 11 | 11 | 2 | 29 |
| W | 1 | 5 | 6 | 23 | 24 | 1 | 60 |
| WNW | 3 | 8 | 8 | 45 | 22 | 1 | 87 |
| NW | 2 | 5 | 11 | 37 | 29 | 1 | 95 |
| NNW | 5 | 3 | 15 | 11 | 0 | 0 | 34 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 28 | 64 | 155 | 288 | 148 | 27 | 710 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 1

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - JANUARY-MARCH 1985
STABILITY CLASS - MODERATELY STABLE (DELTA T 296-30 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .0-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 1 | 2 | 0 | 0 | 3 |
| NNE | 1 | 1 | 0 | 1 | 0 | 0 | 3 |
| NE | 0 | 0 | 1 | 3 | 0 | 0 | 4 |
| ENE | 0 | 1 | 0 | 2 | 0 | 0 | 3 |
| E | 0 | 2 | 0 | 1 | 0 | 0 | 3 |
| ESE | 0 | 0 | 3 | 5 | 4 | 0 | 12 |
| SE | 0 | 0 | 1 | 1 | 2 | 0 | 4 |
| SSE | 0 | 1 | 1 | 7 | 1 | 0 | 10 |
| S | 0 | 0 | 1 | 7 | 0 | 0 | 8 |
| SSW | 1 | 1 | 3 | 5 | 0 | 0 | 10 |
| SW | 1 | 3 | 4 | 0 | 0 | 0 | 8 |
| WSW | 0 | 1 | 7 | 2 | 1 | 0 | 11 |
| W | 1 | 1 | 4 | 3 | 0 | 0 | 9 |
| WNW | 1 | 3 | 2 | 11 | 0 | 0 | 17 |
| NW | 1 | 2 | 2 | 5 | 0 | 0 | 10 |
| NNW | 1 | 6 | 6 | 2 | 1 | 0 | 16 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 7 | 22 | 36 | 57 | 9 | 0 | 131 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 1

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - JANUARY-MARCH 1985
STABILITY CLASS - EXTREMELY STABLE (DELTA T 296-33 FT
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 2 | 4 | 0 | 0 | 0 | 0 | 6 |
| NNE | 3 | 4 | 2 | 0 | 0 | 0 | 9 |
| NE | 0 | 2 | 0 | 1 | 0 | 0 | 3 |
| ENE | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| E | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| ESE | 2 | 1 | 0 | 2 | 0 | 0 | 5 |
| SE | 0 | 1 | 0 | 0 | 2 | 0 | 3 |
| SSE | 0 | 0 | 1 | 1 | 1 | 0 | 3 |
| S | 0 | 0 | 2 | 7 | 0 | 0 | 9 |
| SSW | 0 | 2 | 3 | 4 | 0 | 0 | 9 |
| SW | 1 | 0 | 3 | 2 | 0 | 0 | 6 |
| WSW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| W | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| WNW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NW | 0 | 0 | 2 | 1 | 2 | 0 | 5 |
| NNW | 0 | 2 | 0 | 3 | 0 | 0 | 5 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 9 | 19 | 14 | 21 | 5 | 0 | 68 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 1

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - APRIL-JUNE 1985
STABILITY CLASS - EXTREMELY UNSTABLE (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .0-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 0 | 4 | 0 | 0 | 4 |
| NNE | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| NE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ENE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| ESE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SE | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| SSE | 0 | 0 | 2 | 4 | 4 | 2 | 12 |
| S | 0 | 1 | 1 | 4 | 2 | 1 | 9 |
| SSW | 0 | 0 | 10 | 32 | 24 | 5 | 71 |
| SW | 0 | 0 | 4 | 8 | 1 | 0 | 13 |
| WSW | 0 | 2 | 0 | 6 | 3 | 1 | 10 |
| W | 0 | 0 | 12 | 5 | 2 | 1 | 20 |
| WNW | 0 | 1 | 8 | 10 | 2 | 3 | 24 |
| NW | 0 | 1 | 0 | 3 | 6 | 1 | 11 |
| NNW | 0 | 0 | 0 | 1 | 1 | 1 | 3 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0 | 5 | 39 | 77 | 45 | 15 | 181 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - APRIL-JUNE 1985
STABILITY CLASS - MODERATELY UNSTABLE (DELTA T 296-33 F
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 3 | 5 | 4 | 0 | 12 |
| NNE | 0 | 0 | 3 | 4 | 0 | 0 | 7 |
| NE | 0 | 0 | 6 | 2 | 0 | 0 | 8 |
| ENE | 0 | 0 | 1 | 2 | 0 | 0 | 3 |
| E | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| ESE | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| SE | 0 | 0 | 3 | 4 | 0 | 0 | 7 |
| SSE | 0 | 0 | 5 | 2 | 2 | 2 | 11 |
| S | 0 | 1 | 1 | 4 | 2 | 3 | 11 |
| SSW | 0 | 2 | 4 | 6 | 4 | 4 | 20 |
| SW | 0 | 4 | 2 | 5 | 0 | 0 | 11 |
| WSW | 0 | 6 | 0 | 3 | 4 | 1 | 14 |
| W | 0 | 3 | 1 | 4 | 3 | 4 | 15 |
| WNW | 0 | 2 | 7 | 4 | 5 | 6 | 25 |
| NW | 0 | 0 | 1 | 5 | 6 | 4 | 16 |
| NNW | 0 | 2 | 1 | 0 | 2 | 0 | 5 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0 | 21 | 39 | 54 | 32 | 24 | 169 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - APRIL-JUNE 1985
STABILITY CLASS - SLIGHTLY UNSTABLE (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | OT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 5 | 4 | 2 | 0 | 0 | 11 |
| NNE | 0 | 0 | 9 | 7 | 1 | 0 | 17 |
| NE | 0 | 1 | 8 | 5 | 1 | 1 | 16 |
| ENE | 0 | 0 | 7 | 4 | 1 | 0 | 12 |
| E | 0 | 0 | 7 | 6 | 0 | 0 | 13 |
| ESE | 0 | 0 | 2 | 4 | 2 | 0 | 8 |
| SE | 0 | 0 | 1 | 2 | 0 | 0 | 3 |
| SSE | 0 | 1 | 5 | 2 | 0 | 2 | 10 |
| S | 0 | 1 | 2 | 4 | 1 | 6 | 14 |
| SSW | 0 | 5 | 3 | 3 | 3 | 2 | 13 |
| SW | 0 | 5 | 2 | 2 | 3 | 0 | 12 |
| WSW | 0 | 2 | 2 | 2 | 1 | 1 | 8 |
| W | 0 | 3 | 2 | 3 | 3 | 5 | 16 |
| WNW | 0 | 6 | 1 | 1 | 11 | 8 | 27 |
| NW | 0 | 4 | 8 | 7 | 1 | 1 | 18 |
| NNW | 0 | 1 | 4 | 4 | 0 | 0 | 9 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0 | 34 | 64 | 60 | 30 | 26 | 214 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - APRIL-JUNE 1985
STABILITY CLASS - NEUTRAL (DELTA T 296-33 FT
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 9 | 32 | 10 | 10 | 1 | 62 |
| NNE | 0 | 6 | 14 | 20 | 4 | 0 | 44 |
| NE | 0 | 7 | 29 | 33 | 16 | 0 | 85 |
| ENE | 0 | 3 | 33 | 19 | 14 | 0 | 69 |
| E | 0 | 2 | 13 | 11 | 4 | 4 | 34 |
| ESE | 0 | 1 | 2 | 10 | 6 | 2 | 21 |
| SE | 1 | 2 | 12 | 7 | 0 | 0 | 22 |
| SSE | 1 | 1 | 8 | 9 | 6 | 8 | 33 |
| S | 1 | 1 | 7 | 14 | 19 | 14 | 56 |
| SSW | 1 | 7 | 10 | 18 | 11 | 21 | 68 |
| SW | 5 | 14 | 23 | 33 | 9 | 0 | 84 |
| WSW | 1 | 3 | 8 | 28 | 6 | 1 | 47 |
| W | 2 | 3 | 10 | 19 | 15 | 10 | 59 |
| WNW | 0 | 13 | 12 | 28 | 34 | 16 | 103 |
| NW | 4 | 8 | 16 | 22 | 14 | 1 | 65 |
| NNW | 1 | 3 | 17 | 5 | 3 | 0 | 29 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 17 | 83 | 246 | 286 | 171 | 78 | 981 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - APRIL-JUNE 1985
STABILITY CLASS - SLIGHTLY STABLE (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 1 | 10 | 2 | 0 | 0 | 13 |
| NNE | 1 | 4 | 7 | 6 | 1 | 0 | 19 |
| NE | 0 | 1 | 6 | 14 | 5 | 0 | 26 |
| ENE | 0 | 1 | 6 | 14 | 2 | 0 | 23 |
| E | 0 | 3 | 9 | 15 | 3 | 0 | 30 |
| ESE | 0 | 2 | 6 | 17 | 2 | 0 | 27 |
| SE | 0 | 2 | 3 | 3 | 0 | 0 | 8 |
| SSE | 1 | 2 | 4 | 9 | 6 | 5 | 27 |
| S | 1 | 4 | 6 | 28 | 24 | 13 | 76 |
| SSW | 0 | 1 | 12 | 39 | 23 | 11 | 86 |
| SW | 0 | 1 | 19 | 25 | 2 | 0 | 47 |
| WSW | 0 | 3 | 7 | 7 | 1 | 2 | 20 |
| W | 0 | 1 | 5 | 14 | 8 | 0 | 28 |
| WNW | 1 | 7 | 15 | 11 | 11 | 0 | 45 |
| NW | 0 | 2 | 8 | 13 | 3 | 0 | 26 |
| NNW | 0 | 0 | 10 | 5 | 0 | 0 | 15 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 4 | 35 | 133 | 222 | 91 | 31 | 516 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - APRIL-JUNE 1985
STABILITY CLASS - MODERATELY STABLE (DELTA T 296-33 FT
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| NNE | 0 | 1 | 9 | 2 | 0 | 0 | 12 |
| NE | 0 | 3 | 5 | 5 | 0 | 0 | 13 |
| ENE | 0 | 0 | 2 | 3 | 0 | 0 | 5 |
| E | 0 | 2 | 5 | 7 | 1 | 0 | 15 |
| ESE | 0 | 5 | 6 | 6 | 2 | 0 | 19 |
| SE | 0 | 3 | 4 | 6 | 1 | 0 | 14 |
| SSE | 2 | 6 | 7 | 6 | 0 | 0 | 21 |
| S | 0 | 2 | 7 | 6 | 5 | 0 | 20 |
| SSW | 0 | 1 | 2 | 3 | 0 | 0 | 6 |
| SW | 1 | 0 | 8 | 2 | 0 | 0 | 11 |
| WSW | 0 | 0 | 5 | 2 | 0 | 0 | 7 |
| W | 0 | 1 | 4 | 5 | 1 | 0 | 11 |
| WNW | 1 | 1 | 0 | 14 | 4 | 0 | 20 |
| NW | 0 | 2 | 1 | 2 | 1 | 0 | 6 |
| NNW | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 4 | 27 | 67 | 70 | 15 | 0 | 183 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - APRIL-JUNE 1985
STABILITY CLASS - EXTREMELY STABLE (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NNE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ENE | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| E | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| ESE | 0 | 2 | 4 | 0 | 1 | 0 | 7 |
| SE | 0 | 1 | 4 | 1 | 0 | 0 | 6 |
| SSE | 0 | 0 | 1 | 2 | 0 | 0 | 3 |
| S | 0 | 0 | 3 | 0 | 0 | 0 | 3 |
| SSW | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| SW | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| WSW | 1 | 0 | 2 | 1 | 0 | 0 | 4 |
| W | 0 | 1 | 2 | 2 | 0 | 0 | 5 |
| WNW | 1 | 1 | 2 | 0 | 0 | 0 | 4 |
| NW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NNW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 3 | 7 | 22 | 7 | 1 | 0 | 40 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - JULY-SEPTEMBER 1985
STABILITY CLASS - EXTREMELY UNSTABLE (DELTA T 296-33 FT
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NNE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ENE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ESE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SE | 0 | 0 | 0 | 4 | 0 | 0 | 4 |
| SSE | 0 | 0 | 4 | 3 | 0 | 0 | 7 |
| S | 0 | 0 | 0 | 5 | 7 | 1 | 13 |
| SSW | 0 | 0 | 11 | 20 | 14 | 0 | 45 |
| SW | 0 | 0 | 1 | 1 | 1 | 0 | 3 |
| WSW | 0 | 1 | 3 | 1 | 1 | 0 | 6 |
| W | 0 | 0 | 8 | 6 | 1 | 0 | 15 |
| WNW | 0 | 0 | 2 | 6 | 1 | 0 | 9 |
| NW | 0 | 0 | 6 | 6 | 0 | 0 | 12 |
| NNW | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0 | 1 | 35 | 55 | 25 | 1 | 117 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - JULY-SEPTEMBER 1985
STABILITY CLASS - MODERATELY UNSTABLE (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 6 | 0 | 0 | 0 | 6 |
| NNE | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| NE | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| ENE | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| E | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ESE | 0 | 0 | 0 | 2 | 1 | 0 | 3 |
| SE | 0 | 0 | 0 | 2 | 1 | 0 | 3 |
| SSE | 0 | 1 | 5 | 0 | 1 | 0 | 7 |
| S | 0 | 0 | 3 | 2 | 6 | 0 | 11 |
| SSW | 0 | 0 | 13 | 9 | 5 | 1 | 28 |
| SW | 0 | 5 | 3 | 1 | 0 | 0 | 9 |
| WSW | 0 | 1 | 1 | 2 | 3 | 0 | 7 |
| W | 0 | 3 | 1 | 1 | 1 | 0 | 6 |
| WNW | 0 | 1 | 2 | 2 | 1 | 0 | 6 |
| NW | 0 | 1 | 4 | 1 | 0 | 0 | 6 |
| NNW | 0 | 0 | 3 | 4 | 0 | 0 | 7 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0 | 12 | 42 | 31 | 19 | 1 | 105 |

OURS OF CALM IN THIS STABILITY CLASS - 0
OURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

OURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - JULY-SEPTEMBER 1985
STABILITY CLASS - SLIGHTLY UNSTABLE (DELTA T 296-33 FT
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 3 | 3 | 3 | 0 | 0 | 9 |
| NNE | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| NE | 0 | 2 | 1 | 2 | 0 | 0 | 5 |
| ENE | 0 | 0 | 3 | 4 | 0 | 0 | 7 |
| E | 0 | 0 | 0 | 4 | 0 | 0 | 4 |
| ESE | 0 | 1 | 8 | 4 | 0 | 0 | 13 |
| SE | 0 | 0 | 5 | 3 | 0 | 0 | 8 |
| SSE | 0 | 0 | 4 | 2 | 0 | 0 | 6 |
| S | 0 | 1 | 11 | 4 | 0 | 3 | 19 |
| SSW | 0 | 4 | 18 | 6 | 1 | 1 | 30 |
| SW | 0 | 3 | 5 | 3 | 1 | 0 | 12 |
| WSW | 0 | 3 | 1 | 4 | 1 | 0 | 9 |
| W | 1 | 3 | 3 | 4 | 0 | 1 | 12 |
| WNW | 0 | 4 | 0 | 5 | 2 | 0 | 11 |
| NW | 0 | 3 | 6 | 1 | 0 | 0 | 10 |
| NNW | 0 | 1 | 4 | 6 | 0 | 0 | 11 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 1 | 28 | 72 | 56 | 5 | 5 | 167 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - JULY-SEPTEMBER 1985
STABILITY CLASS - NEUTRAL (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 1 | 16 | 13 | 7 | 0 | 0 | 37 |
| NNE | 0 | 9 | 8 | 2 | 0 | 0 | 19 |
| NE | 0 | 10 | 21 | 32 | 2 | 0 | 65 |
| ENE | 0 | 9 | 13 | 13 | 1 | 0 | 36 |
| E | 0 | 12 | 16 | 23 | 1 | 0 | 52 |
| ESE | 0 | 13 | 32 | 19 | 0 | 0 | 64 |
| SE | 1 | 6 | 31 | 16 | 1 | 1 | 56 |
| SSE | 1 | 6 | 10 | 15 | 5 | 0 | 37 |
| S | 2 | 6 | 17 | 15 | 16 | 4 | 60 |
| SSW | 0 | 14 | 24 | 30 | 9 | 1 | 78 |
| SW | 5 | 22 | 23 | 16 | 5 | 0 | 71 |
| WSW | 6 | 14 | 14 | 12 | 8 | 1 | 55 |
| W | 2 | 5 | 13 | 21 | 19 | 6 | 66 |
| WNW | 4 | 9 | 8 | 11 | 4 | 0 | 36 |
| NW | 6 | 15 | 20 | 16 | 2 | 1 | 60 |
| NNW | 0 | 9 | 15 | 17 | 1 | 0 | 42 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 28 | 175 | 278 | 265 | 74 | 14 | 834 |

OURS OF CALM IN THIS STABILITY CLASS - 0
OURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

OURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - JULY-SEPTEMBER 1985
STABILITY CLASS - SLIGHTLY STABLE (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 7 | 14 | 10 | 1 | 0 | 32 |
| NNE | 0 | 7 | 12 | 8 | 0 | 0 | 27 |
| NE | 0 | 1 | 10 | 6 | 1 | 0 | 18 |
| ENE | 2 | 4 | 9 | 9 | 0 | 0 | 24 |
| E | 2 | 5 | 7 | 15 | 1 | 0 | 30 |
| ESE | 0 | 2 | 12 | 12 | 2 | 0 | 28 |
| SE | 0 | 6 | 12 | 23 | 1 | 0 | 42 |
| SSE | 0 | 3 | 13 | 21 | 3 | 0 | 40 |
| S | 1 | 4 | 15 | 28 | 35 | 1 | 84 |
| SSW | 1 | 2 | 17 | 48 | 30 | 1 | 99 |
| SW | 0 | 9 | 19 | 3 | 0 | 0 | 31 |
| WSW | 2 | 11 | 15 | 8 | 1 | 0 | 37 |
| W | 2 | 2 | 11 | 9 | 0 | 0 | 24 |
| WNW | 0 | 6 | 10 | 11 | 1 | 0 | 28 |
| NW | 1 | 7 | 17 | 12 | 1 | 0 | 38 |
| NNW | 1 | 6 | 7 | 7 | 0 | 0 | 21 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 12 | 82 | 200 | 230 | 77 | 2 | 603 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - JULY-SEPTEMBER 1985
STABILITY CLASS - MODERATELY STABLE (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 8 | 3 | 0 | 0 | 11 |
| NNE | 0 | 2 | 3 | 0 | 0 | 0 | 5 |
| NE | 0 | 2 | 8 | 1 | 0 | 0 | 11 |
| ENE | 0 | 1 | 4 | 7 | 0 | 0 | 12 |
| E | 1 | 4 | 4 | 7 | 1 | 0 | 17 |
| ESE | 0 | 1 | 7 | 22 | 3 | 0 | 33 |
| SE | 1 | 3 | 9 | 32 | 1 | 0 | 46 |
| SSE | 1 | 1 | 6 | 12 | 4 | 0 | 24 |
| S | 0 | 1 | 4 | 16 | 5 | 0 | 26 |
| SSW | 0 | 5 | 13 | 10 | 1 | 0 | 29 |
| SW | 0 | 15 | 2 | 0 | 0 | 0 | 17 |
| WSW | 1 | 3 | 7 | 3 | 0 | 0 | 14 |
| W | 0 | 3 | 0 | 7 | 0 | 0 | 10 |
| WNW | 0 | 3 | 5 | 3 | 2 | 0 | 13 |
| NW | 0 | 2 | 3 | 3 | 0 | 0 | 8 |
| NNW | 1 | 2 | 3 | 2 | 1 | 0 | 9 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 5 | 48 | 86 | 128 | 18 | 0 | 285 |

OURS OF CALM IN THIS STABILITY CLASS - 0
OURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

OURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - JULY-SEPTEMBER 1985
STABILITY CLASS - EXTREMELY STABLE (DELTA T 296-33 FT
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| NNE | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| NE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ENE | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| E | 0 | 2 | 1 | 1 | 0 | 0 | 4 |
| ESE | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| SE | 0 | 0 | 4 | 11 | 1 | 0 | 16 |
| SSE | 2 | 3 | 1 | 19 | 2 | 0 | 27 |
| S | 0 | 3 | 1 | 8 | 0 | 0 | 12 |
| SSW | 1 | 6 | 3 | 6 | 0 | 0 | 16 |
| SW | 1 | 4 | 1 | 0 | 0 | 0 | 6 |
| WSW | 0 | 1 | 3 | 0 | 0 | 0 | 4 |
| W | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| WNW | 0 | 1 | 0 | 1 | 0 | 0 | 2 |
| NW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NNW | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 9 | 23 | 16 | 46 | 3 | 0 | 97 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - OCTOBER-DECEMBER 1985
STABILITY CLASS - EXTREMELY UNSTABLE (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NNE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ENE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ESE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SSE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| S | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SSW | 0 | 0 | 3 | 6 | 0 | 0 | 9 |
| SW | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| WSW | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| W | 0 | 0 | 0 | 2 | 2 | 0 | 4 |
| WNW | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| NW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NNW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0 | 0 | 4 | 8 | 4 | 0 | 16 |

OURS OF CALM IN THIS STABILITY CLASS - 0
OURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

OURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - OCTOBER-DECEMBER 1985
STABILITY CLASS - MODERATELY UNSTABLE (DELTA T 296-33 FT
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NNE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NE | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| ENE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ESE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SSE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| S | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| SSW | 0 | 1 | 2 | 1 | 2 | 0 | 6 |
| SW | 0 | 1 | 1 | 1 | 0 | 0 | 3 |
| WSW | 0 | 0 | 3 | 7 | 0 | 1 | 11 |
| W | 0 | 0 | 2 | 10 | 8 | 1 | 21 |
| WNW | 0 | 0 | 0 | 2 | 2 | 1 | 5 |
| NW | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| NNW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0 | 2 | 9 | 22 | 14 | 3 | 50 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 5

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - OCTOBER-DECEMBER 1985
STABILITY CLASS - SLIGHTLY UNSTABLE (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NNE | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| NE | 0 | 0 | 1 | 1 | 3 | 0 | 5 |
| ENE | 0 | 2 | 5 | 4 | 0 | 0 | 11 |
| E | 0 | 1 | 1 | 1 | 0 | 0 | 3 |
| ESE | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| SE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SSE | 0 | 0 | 4 | 4 | 2 | 0 | 10 |
| S | 0 | 0 | 3 | 4 | 2 | 0 | 9 |
| SSW | 0 | 0 | 3 | 1 | 3 | 1 | 8 |
| SW | 0 | 3 | 5 | 1 | 0 | 2 | 11 |
| WSW | 0 | 1 | 0 | 3 | 0 | 7 | 11 |
| W | 0 | 2 | 3 | 11 | 10 | 8 | 34 |
| WNW | 0 | 0 | 6 | 17 | 18 | 6 | 47 |
| NW | 0 | 0 | 1 | 8 | 6 | 0 | 15 |
| NNW | 0 | 0 | 0 | 4 | 0 | 0 | 4 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0 | 9 | 34 | 59 | 44 | 24 | 170 |

OURS OF CALM IN THIS STABILITY CLASS - 0
OURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 9

OURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - OCTOBER-DECEMBER 1985
STABILITY CLASS - NEUTRAL (DELTA T 296-33 F
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 1 | 6 | 21 | 21 | 1 | 0 | 50 |
| NNE | 3 | 16 | 50 | 22 | 0 | 0 | 91 |
| NE | 1 | 17 | 42 | 31 | 25 | 1 | 117 |
| ENE | 0 | 11 | 40 | 43 | 6 | 0 | 100 |
| E | 2 | 15 | 42 | 32 | 16 | 1 | 108 |
| ESE | 0 | 12 | 21 | 25 | 11 | 2 | 71 |
| SE | 2 | 16 | 19 | 22 | 9 | 0 | 68 |
| SSE | 3 | 8 | 13 | 19 | 13 | 5 | 61 |
| S | 0 | 1 | 5 | 18 | 14 | 10 | 48 |
| SSW | 0 | 6 | 5 | 18 | 17 | 6 | 52 |
| SW | 2 | 6 | 14 | 19 | 4 | 0 | 45 |
| WSW | 4 | 5 | 10 | 29 | 32 | 5 | 85 |
| W | 0 | 5 | 18 | 58 | 29 | 6 | 116 |
| WNW | 1 | 8 | 25 | 65 | 36 | 32 | 167 |
| NW | 0 | 6 | 26 | 57 | 24 | 2 | 115 |
| NNW | 1 | 3 | 29 | 27 | 13 | 4 | 77 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 20 | 141 | 380 | 506 | 250 | 74 | 1371 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 59

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - OCTOBER-DECEMBER 1985
STABILITY CLASS - SLIGHTLY STABLE (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 6 | 5 | 0 | 0 | 11 |
| NNE | 0 | 1 | 9 | 8 | 0 | 0 | 18 |
| NE | 1 | 4 | 11 | 3 | 1 | 0 | 20 |
| ENE | 0 | 4 | 9 | 7 | 8 | 0 | 28 |
| E | 1 | 3 | 7 | 10 | 6 | 0 | 27 |
| ESE | 0 | 3 | 6 | 8 | 1 | 0 | 18 |
| SE | 0 | 6 | 1 | 6 | 4 | 0 | 17 |
| SSE | 1 | 0 | 3 | 4 | 5 | 2 | 15 |
| S | 0 | 1 | 5 | 25 | 8 | 1 | 40 |
| SSW | 0 | 4 | 17 | 29 | 4 | 0 | 54 |
| SW | 0 | 4 | 7 | 6 | 0 | 0 | 17 |
| WSW | 1 | 1 | 5 | 6 | 0 | 0 | 13 |
| W | 0 | 2 | 7 | 15 | 7 | 0 | 31 |
| WNW | 0 | 0 | 4 | 18 | 0 | 0 | 22 |
| NW | 0 | 0 | 1 | 3 | 0 | 0 | 4 |
| NNW | 2 | 2 | 6 | 6 | 1 | 0 | 17 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 6 | 35 | 104 | 159 | 45 | 3 | 352 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 17

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - OCTOBER-DECEMBER 1985
STABILITY CLASS - MODERATELY STABLE (DELTA T 296-33 FT
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 2 | 2 | 3 | 0 | 0 | 7 |
| NNE | 0 | 0 | 5 | 2 | 0 | 0 | 7 |
| NE | 0 | 0 | 2 | 6 | 0 | 0 | 8 |
| ENE | 0 | 0 | 0 | 5 | 0 | 0 | 5 |
| E | 0 | 1 | 1 | 3 | 0 | 0 | 5 |
| ESE | 0 | 0 | 1 | 4 | 0 | 0 | 5 |
| SE | 0 | 1 | 1 | 2 | 7 | 0 | 11 |
| SSE | 0 | 1 | 4 | 3 | 0 | 0 | 8 |
| S | 0 | 0 | 2 | 19 | 4 | 0 | 25 |
| SSW | 0 | 2 | 1 | 4 | 0 | 0 | 7 |
| SW | 0 | 1 | 2 | 0 | 0 | 0 | 3 |
| WSW | 0 | 0 | 0 | 4 | 0 | 0 | 4 |
| W | 0 | 1 | 2 | 1 | 0 | 0 | 4 |
| WNW | 0 | 0 | 0 | 8 | 0 | 0 | 8 |
| NW | 0 | 0 | 2 | 2 | 0 | 0 | 4 |
| NNW | 0 | 1 | 1 | 1 | 2 | 0 | 5 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 0 | 10 | 26 | 67 | 13 | 0 | 116 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 3

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

QUAD CITIES NUCLEAR POWER STATION
PERIOD OF RECORD - OCTOBER-DECEMBER 1985
STABILITY CLASS - EXTREMELY STABLE (DELTA T 296-33 FT)
WINDS MEASURED AT 296 FEET

| WIND DIRECTION | WIND SPEED (IN MPH) .8-3 | 4- 7 | 8-12 | 13-18 | 19-24 | GT 24 | TOTAL |
|---|---|---|---|---|---|---|---|
| N | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NNE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ENE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E | 0 | 0 | 0 | 1 | 1 | 0 | 2 |
| ESE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SSE | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| S | 0 | 4 | 3 | 9 | 2 | 0 | 18 |
| SSW | 1 | 2 | 5 | 2 | 2 | 0 | 12 |
| SW | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| WSW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| W | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| WNW | 0 | 1 | 0 | 2 | 0 | 0 | 3 |
| NW | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| NNW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| VARIABLE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 1 | 9 | 11 | 14 | 5 | 0 | 40 |

HOURS OF CALM IN THIS STABILITY CLASS - 0
HOURS OF MISSING WIND MEASUREMENTS IN THIS STABILITY CLASS - 0

HOURS OF MISSING STABILITY MEASUREMENTS IN ALL STABILITY CLASSES - 0

# APPENDIX III

# ANALYTICAL PROCEDURES

ANALYTICAL PROCEDURES MANUAL

TELEDYNE ISOTOPES MIDWEST LABORATORY

PREPARED FOR

COMMONWEALTH EDISON COMPANY

Note: These procedures are taken from the complete Procedures Manual. Only procedures applicable to the CECo Radiological Environmental Monitoring Programs are included in this manual.

Compiled by: B. Grob

B. Grob
Lab Supervisor

Approved by: L.G. Huebner

L.G. Huebner
General Manager

Revision 0, 11 February 1977
Revision 1, 23 May 1978
Revision 2, 22 May 1981
Revision 3, 15 June 1983
Revision 4, 1 June 1984
Revision 5, 7 February 1985

TABLE OF CONTENTS

SECTION I
SAMPLE PREPARATION


| | | |
|---|---|---|
| 1.1 | Fish | 2 |
| 1.2 | Bottom Sediments and Soil | 3 |
| 1.3 | Drinking (clear) Water (EPA Method 900.0) | 4 |


SECTIONS II, III, VIII
ANALYSES


| | | |
|---|---|---|
| 2.1 | Airborne Particulates (Gross alpha and/or Beta) | 5 |
| 2.2.2 | Gross Alpha and/or Gross Beta Activity in Dissolved Solids | 6 |
| 3.1 | Airborne Particulates - Gamma Spectroscopic Analysis by Germanium Detector | 8 |
| 3.2 | Airborne Iodine - Gamma Spectroscopic Analysis by Germanium Dectector | 9 |
| 3.3 | Water - Gamma Spectroscopic Analysis by Germanium Detector | 10 |
| 3.4 | Soil and Bottom Sediments - Gamma Spectroscopic Analysis by Germanium Detector | 11 |
| 3.5 | Fish and Wilflife - Gamma Spectroscopic Analysis by Germanium Detector | 12 |
| 3.6 | Ambient Radiation (TLD), Efficiency Calibration | 13 |
| 3.7 | Procedure for Preparation and Readout of TLD chips | 15 |
| 3.8 | Tritium in Water | 17 |
| 3.9 | Iodine-131 in Milk by Ion Exchange on Anion Exchange Column | 19 |
| 8.1 | Strontium-89 and Strontium-90 in Milk by Ion Exchange | 23 |
| 8.4 | Strontium-89 and Strontium-90 in Water Samples | 32 |
| 8.6 | Strontium-89 and Strontium-90 in Milk (Ash), Vegetation, Fish, Wildlife, Soil, and Bottom Sediment Samples - Sodium Carbonate Fusion | 37 |

SECTION 1.0

# SAMPLE PREPARATION

Different classes of samples require different preparations. In general, food products are prepared as for home use, while others are dried and ashed as received.

Rev. 4, 6-01-84
Approved by: L.G. Huebner

L.G. Huebner

1.1 Fish

1. Wash the fish.

2. Fillet and place the flesh immediately (to prevent moisture loss) in a 500 cc plastic container. Add a few cc of formaldehyde. Seal and record wet weight.

NOTE: If bones are to be analyzed, boil remaining fish in water for about 1 hour. Clean the bones. Air dry, weigh and record as wet weight. Dry at 125° C. Record dry weight. Ash at 800° C, cool, weigh, and record the ash weight. Grind to a homogeneous sample. The sample is ready for analysis.

3. Gamma scan fillet without delay or store in a freezer.

4. After gamma spectroscopic analysis is completed transfer the sample to a drying pan and dry at 125° C.

5. Cool, weigh, and record dry weight.

6. Ash by gradually increasing the temperature to 450° C. If considerable amounts of carbon remain after overnight ashing, the sample should be brushed and placed back in the muffle furnace until ashing is completed. Record ash weight. The sample is now ready for analysis.

NOTE: If there is sufficient quantity, use surplus flesh for drying and ashing, instead of waiting for gamma scanning to be completed.

## 1.2 Bottom Sediments and Soil

1. Air dry the entire sample. Grind or pulverize the sample and sieve through a #20 mesh screen.

2. For gamma-spectroscopic analysis, seal 500 cc of the ground sample in a Marinelli beaker. Record dry weight.

3. Seal the remaining sample (up to 1 kg) in a plastic container and save for other analyses or for possible future rechecking.

Rev. 4, 6-01-84
Approved by: L.G. Huebner

1.3 Drinking (clear) water (EPA Method 900.0)

A representative sample must be collected from a free-flowing source of drinking water, and should be large enough so that adequate aliquots can be taken to obtain the required sensitivity.

It is recommended that samples be preserved at the time of collection by adding enough 1N $HNO_3$ to the sample to bring it to pH 2 (15 ml 1N $HNO_3$ per liter of sample is usually sufficient) If samples are to be collected without preservation, they should be brought to the laboratory within 5 days, then preserved and held in the original container for a minimum of 16 hours before analysis or transfer of the sample.

The container choice should be plastic over glass to prevent loss due to breakage during transportation and handling.

If the sample was not acidified at the time of collection, use the following procedure:

Procedure

1. Remove 100 ml of sample for tritium analysis, if required.

   NOTE: Water should not be acidified for tritium analysis. If samples are acidified in the field, an additional aliquot should be collected.

2. Add 15 ml of 1N $HNO_3$ per liter of sample in the original container.

3. Hold the sample in the original container for a minimum of 16 hours before analysis or transfer of the sample.

4. When taking an aliquot for analysis, take acid addition into account. For example:

| Sample volume to be analyzed | Volume of aliquot required |
|---|---|
| 200 ml | 203 ml |
| 400 ml | 406 ml |
| 600 ml | 609 ml |
| 800 ml | 812 ml |
| 1000 ml | 1015 ml |
| 2000 ml | 2030 ml |
| 3000 ml | 3045 ml |
| 3500 ml | 3552 ml |

For other volumes, adjust aliquots correspondingly, at the rate of 1.5 ml per 100 ml of sample.

Rev. 4, 6-01-84
Approved by: L.G. Huebner

## 2.1 Airborne Particulates

### 2.1.1. Gross Alpha and/or Gross Beta Activity

Procedure

1. Store the sample for 5 days from the day of collection to allow for decay of short-lived radon and thoron daughters.

2. Place a 47 mm filter on a stainless steel planchet and count the sample in a proportional counter.

3. Calculate the activity in $pCi/m^3$ using computer program AIRPAT.

Calculations

Gross alpha (beta) concentration:

$$(pCi/m^3) = \frac{A}{B \times C \times 2.22} \pm \frac{2\sqrt{E_{sb}^2 + E_b^2}}{B \times C \times 2.22}$$

Where:

A = net alpha (beta) count rate (cpm)
B = efficiency for counting alpha (beta) activity (cpm/dpm)
C = volume of sample ($m^3$)
$E_{sb}$ = counting error of sample plus background
$E_b$ = counting error of background

Rev. 4, 6-01-84
Approved by: L.G. Huebner

## 2.2.2 Gross Alpha and/or Gross Beta Activity in Dissolved Solids (see note)

### Principle of Method

Water samples containing suspended matter are filtered through a membrane filter and the filtrate is analyzed. The filtered water sample is evaporated and the residue is transferred to a tared planchet for counting gross alpha and/or gross beta activity.

### Reagents

Lucite: 0.5 mg/ml in acetone
Nitric acid, $HNO_3$: 3N
Nitric acid, $HNO_3$: concentrated

### Apparatus

Filters; Millipore, membrane Type AA, 0.8 μ
Filtration equipment
Planchets (Standard 2" x 1/8" Beckman planchet)
Proportional counter

### Procedure

1. Filter a volume of sample containing not more than 100 mg of dissolved solids for alpha assay, or not more than 200 mg of dissolved solids for beta assay.

   Note: For gross alpha and gross beta assay in the same sample limit amount of solids to 100 mg.

2. Wash the non-filterable solids on the filter. (Save the filters with suspended matter for separate analyses. See Section 2.2.1).

3. Evaporate the filtrate to NEAR dryness on a hot plate. Add 25 ml concentrated $HNO_3$ and evaporate to NEAR dryness.

Note: For analysis of total residue (for clear water) proceed as described above but do not fiter the water. Measure out the appropriate amount and proceed with step 3.

Section 2.2.2.(continued)

4. With distilled water and a few drops of 3N $HNO_3$, transfer the residue to a 50 ml beaker. Evaporate to NEAR dryness.

5. Transfer quantitatively the residue to a TARED PLANCHET, using an eye dropper.

6. Wash the beaker with distilled water and combine the washing and the residue in the planchet. Evaporate to dryness.

7. Bake in muffle furnace at 500° C for 45 min., cool and weigh.

8. Add a few drops (6-7 drops) of lucite solution and dry under the infrared lamp for 10-20 minutes.

9. Store the sample in a desiccator until it is to be counted.

10. Count the gross alpha and/or the gross beta activity in a low background proportional counter.

11. Calculate the activity in pCi/l using computer program OWATAB.

Calculations:

Gross alpha (beta) concentration:

$$(\text{pCi/liter}) = \frac{A}{B \times C \times D \times 2.22} \pm \frac{2\sqrt{E_{sb}^2 + E_b^2}}{B \times C \times D \times 2.22}$$

Where:

A = net alpha (beta) count rate (cpm)
B = efficiency for counting alpha (beta) activity (cpm/dpm)
C = volume of sample (liters)
D = correction factor for self-absorption in the sample
$E_{sb}$ = counting error of sample plus background
$E_b$ = counting error of background

Reference: Radioassay Procedures for Environmental Samples, U.S. Department of Health, Education and Welfare. Environmental Health Series, January 1967.

Rev. 4, 6-01-84
Approved by: L.G. Huebner

## 3.1 Airborne Particulates - Gamma Spectroscopic Analyses by Germanium Detector

1. Put the air filter in a filter cup container.
2. Place the filter cup inside the shield on the detector.
3. Count long enough to meet the LLD requirements.
4. Store the spectra on the disc.
5. After storing, calculate gamma activities using computer and corresponding calibrated geometry.
6. Return the filters to the original envelopes for storage or further analyses.

## 3.2 Airborne Iodine Gamma Spectroscopic Analysis by Germanium Detector

NOTE: Because of the short half-life of I-131, count the samples as soon as possible after receipt and no later than 48 hours.

1. Load the charcoal cartridges in a specially designed holder or transfer charcoal from each cartridge to individual plastic bags. Seal the bags.

2. Label each bag with corresponding project ID, locations ID, and date of collection.

3. Place the bags in a standard geometry container, cap the container and secure the cap with a tape.

4. Place the holder or container on the detector and count for a period of time that will meet the required Lower Limit of Detection (LLD).

Calculation:

$$A_1 = \text{I-131 activity (pCi/sample)} = \frac{A}{2.22 \times B} \quad \text{(at counting time)} \qquad (1)$$

Where:

A= net count rate of I-131 in the 0.36 MeV peak (cpm)
B= efficiency for the I-131 in 0.36 MeV peak (cpm/dpm)

Correction for Equilibrium (assuming constant concentration over the sampling period) and Decay:

$$C = \frac{\lambda A_1 \, e^{\lambda t_1}}{F \, (1-e^{-\lambda t_2})} \qquad (2)$$

Where:

C = equilibrium concentration of I-131 ($pCi/m^3$)

$A_1$= activity of I-131 at the time of counting (pCi/sample)

e= the base of the natural logarithm = 2.71828

$\lambda$= 0.693/half life (days)=0.693/8.04 = 0.0862/day

$t_1$= elapsed time between the end of sampling and mid-counting point (in days)

$t_2$= duration of collection (in days)

F= $m^3$/day

Rev. 4, 6-01-84
Approved by: L.G. Huebner

3.3 Water - Gamma Spectroscopic Analyses by Germanium Detector

Procedure

1. Measure 3.5 liters of water into a Marinelli beaker.
2. Place the beaker inside the shield on the detector.
3. Count long enough to meet LLD requirements.
4. Store the spectrum on a disc.
5. After storing, calculate gamma activities, using computer program and corresponding calibrated geometry.
6. Transfer the sample back to the original container for further analyses.

Rev. 4, 6-01-84
Approved by: L.G. Huebner

## 3.4 Soil and Bottom Sediments - Gamma Spectroscopic Analyses by Germanium Detector

### Procedure

1. Transfer the portion of the ground sample set aside for gamma scanning into a 500 ml Marinelli container.
2. Record the dry weight.
3. Place the container inside the shield on the detector.
4. Count the gamma activity long enough to meet the LLD requirements.
5. Store the spectrum on a disc.
6. After storing, calculate gamma activities using computer and corresponding calibrated geometry.
7. Transfer the sample back to the original container for further analyses.

Rev. 4, 6-01-84
Approved by: L.G. Huebner

## 3.5 Fish and Wildlife - Gamma Spectroscopic Analyses by Ge(Li) Detector

### Procedure

1. Transfer a portion of the clean wet flesh of fish or animal into a 500 ml Marinelli container.
2. Record wet weight.
3. Add a few cc of formaldehyde and seal the container.
4. Place the container inside the shield on the detector.
5. Count long enough to meet the LLD requirements.
6. Store the spectrum on a disc.
7. After storing, calculate gamma activities using computer and corresponding calibrated geometry.
8. Transfer the sample back to the original container for further analyses.

## 3.6 Ambient Gamma Radiation

### A. Thermoluminescent Dosimeters (TLD) - Light Response (Efficiency)

Harshaw Lithium Fluoride TLD-100 chips, 1/8" x 1/8" x 0.035".

Procedure

1. Rinse the chips with warm trichloroethylene followed by the methanol rinse. Dry.
2. Place the chips in a platinum crucible.
3. Anneal for 1 hour at 400°C.
4. Cool quickly by placing the crucible on a metal plate.
5. Anneal for 2 hours at 100°C.

   Note: Avoid exposing the chips to the fluorescent light.
6. Seal 5 chips each in black plastic.
7. Mount the packs on the turntable.
8. Position the Ra-226 needle in the middle of the turntable and start rotation (appr. 60 revolutions per minute). Record the time.
9. Irradiate the chips for 2-6 hrs.
10. Remove the packages from the turntable. Return the Ra-226 needle to the lead container. Record the time.
11. Take the chips out of the plastic bag and place them in the vial.
12. Postanneal the chips for 10 minutes at 100°C.
13. Read each chip in the TLD Reader (For test procedure see "Performance Test Procedure for TLD Reader").
14. Calculate mean $\pm$ one sigma deviation of five chips.
15. Calculate light response of TLD's (correction factor) by the following equation:

Section 3.6 (continued)

Calculations

$$C.F.\ (\text{nanocoulombs/mR}) = \frac{A}{B}$$

Where:

C.F = correction factor (efficiency) to be applied in calculating exposure of field TLDs
A = Net reading in nanocoulombs
B = known exposure to TLDs

The exposure to the TLDs (B) is calculated as follows:

$$\text{mR/hr} = \frac{8400 \times \text{mg Ra-226}}{r^2}$$

For our setup use the following parameters:

Ra-226 = 0.0933 $\pm$ 1.5%

r = 19.6 cm

Thus:

$$\text{mR/hr} = \frac{8400 \times 0.0933}{384.16} = 2.040$$

The total exposure (B) is equal to:

B (mR) = 2.040 x hours of exposure to the Ra-226 needle.

Rev. 4, 6-01-84
Approved by: C.B. Huebner

## 3.7 Procedure for Preparation and Readout of TLD Chips

### Materials

Harshaw Lithium Fluoride TLD-100 chips, 1/8" x 1/8" x 0.035".
Black plastic bags or boxes
Plastic sealer
Vacuum needle (for handling the chips)
TLD reader

Note: Never handle the chips with bare hands. Use plastic-covered forceps or vacuum needle. Handle them gently, e.g. do not drop them into the vial or on the table. They chip off easily, resulting in efficiency change.

### Procedure

1. Rinse the chips with warm trichloroethylene followed by the methanol rinse. Dry.
2. Place the chips in a platinum crucible.
3. Anneal for 1 hour at 400°C.
4. Cool quickly by placing the crucible on a metal plate.
5. Anneal for 2 hours at 100°C.
6. Seal 3 to 5 chips (depending on the specifications) in black plastic or plastic boxes.
7. Label and send out by U.S. Mail.
8. Upon arrival at the lab, store TLDs in the big shield until readout day. Do not store longer than a few days.
9. Connect chips reader one day prior to readout.
10. Turn on gas for a few minutes before readout. Adjust to the mark.
11. Set parameter on the 2000P as follows:

HV - 470 V (It is 970 V, internal volts = 500).
Readout time: 20"
$T_1$ - 140° C (Preset)
$T_2$ - 250° C (Preset)
Rise time: -12°/sec (Preset)
Preheat - 100° C (Preset)
Start reading - 90° C

Section 3.7 (continued)

12. Prepare the chips as follows (do this before proceeding to the next step).
    12.1 Turn on small muffler furnace or drying oven and adjust to 100°C. Use glass thermometer. Muffler's indicator is not accurate. Let furnace stabilize.

    12.2 Unpack the chips (under reduced incandescent light) and gently place them in the glass vials marked with appropriate location numbers.

    12.3 Place the vials in the furnace. Preanneal for 10 min. at 100°C.

13. Open the drawer and read the standard. It should read 5.70±0.04. Adjust HV, if needed. Take 3 readings after final adjustment. Record.

14. Close the drawer.

15. Check bkg. It should read about 0.7-0.8 in 20". If it is higher, adjust the knob in the back of 2000 P (on left side when facing the instrument).

    Note: Adjust bkg as low as possible but do not let the needle hit zero. The instrument will not record below zero.

16. Make 10 bkg readings (no chip in). Record. Read (do not record) at least 2 dummies to stabilize the temperature.

17. Place the chip in, wait until temperature goes down to 90° C and press "read" button. Make sure the chip is in the cavity of the heating plate.

18. After readout is completed, record the reading, open the drawer, and place next chip.

19. Repeat Steps 17 and 18 until all chips are read out.

    Note: If reading will last longer than 1.5-2.0 hrs., check the standard and bkg about every 2.0 hrs.

20. After readout is completed, turn off the gas.

21. For calculations, use computer program OGTLD.PUB.

Rev. 4, 6-01-84
Approved by: C.G. Huebner

## 3.8 Tritium in Water (Direct Method)

### Principle of Method

The water sample is purified by distillation, and portion of the distillate is transferred to a counting vial containing a scintillation fluid. The contents of the vial are then mixed and counted in a liquid scintillation counter.

### Reagents

Scintillation medium, insta-gel scintillator
Tritium standard solution

### Apparatus

Condenser
Distillation flask, 250-ml capacity
Liquid scintillation counter
Liquid scintillation counting vials

### Procedure

1. Distill a 30 ml aliquot of the sample in a 250-ml distillation flask. Add a boiling chip to the flask. Connect a side arm adapter and a condenser to the outlet of the flask. Place a glass vial at the outlet of the condenser. Heat the sample to 100 - 150° C to distill, just to dryness. Collect the distillate for tritium analysis.

2. Dispense 13 ml of the distillate to a low potassium glass vial.

3. Prepare background and standard tritium-water solutions for counting, using the same amount as the sample. Use low tritium background distilled water for these preparations (distillate of most deep well water sources is acceptable, but each source should be checked for tritium activity before using).

4. Dark-adapt all samples, backgrounds, and standards. Add 10 ml of insta-gel scintillator. Count the samples, backgrounds and standards. Count samples containing less than 200 pCi/l for 300 minutes and samples containing more than 200 pCi/l for 200 minutes.

Section 3.8 (continued)

5. Counting efficiency:

$$Eff = \frac{\text{cpm of Standard-cpm of background}}{\text{dpm Standard}}$$

6. Sample Concentration:

$$pCi/ml = \frac{A}{2.22 \times E \times V \times e^{-\lambda t}}$$

Where:

A = net count rate (cpm)
E = efficiency (cpm/dpm)
V = volume (ml)
$\lambda = \frac{0.693}{12.26} = 0.05652$
t = elapsed time from the time of collection to the counting time (in years)

7. Calculate tritium activity using computer program H3.

## 3.9 Iodine-131 in Milk by Ion Exchange on Anion Exchange Column

After samples have been treated to convert all iodine in the sample to a common oxidation state, the iodine is isolated by solvent extraction or a combination of ion exchange and solvent extraction steps.

Iodine, as the iodide, is concentrated by adsorption on an anion exchanged column. Following a NaCl wash, the iodine is eluted with sodium hypochlorite. Iodine in the iodate form is reduced to $I_2$ and the elemental iodine extracted into $CCl_4$, back-extracted into water then finally precipitated as palladium iodide.

Chemical recovery of the added carrier is determined gravimetrically from the $PdI_2$ precipitate. I-131 is determined by beta counting the $PdI_2$.

### Reagents

Anion exchange resin, Dowex 1-X8 (50-100 mesh) chloride form.

Carbon tetrachloride, $CCl_4$ - reagent grade.

Hydrochloric acid, HCl, 1N.

Hydrochloric acid, HCl, 3N.

$H_2O$ - $HNO_3$ - $HN_2OH$ HCL wash solution: 50 ml $H_2O$; 10 ml 1M - $NH_2OH$-HCl; 10 ml conc. $HNO_3$.

Hydroxylamine hydrochloride, $NH_2OH$ HCl - 1 M.

Nitric acid, $HNO_3$ - concentrated.

Palladium chloride, $PdI_2$, 20 mg $Pd^{++}$/ml. (1.2 g $PdCl_2$/100 ml 6N HCl).

Sodium bisulfite, $NaHSO_3$ - 1 M

Sodium chloride, NaCl - 2M

Sodium hypochlorite, NaOCl - 5% (Clorox).

Section 3.9 (continued)

Special Apparatus

Chromatographic column, 20 mm x 150 mm (Reliance Glass Cat.#R2725T).

Vacuum filter holder, 2.5 $cm^2$ filter area

Filter paper, Whatman #42, 21 mm

Mylar

Polyester gummed tape, 1 1/2", Scotch #853

Drying oven

A. Ion Exchange Procedure

1. Set up an ion exchange column of 20 mm diameter and 150 mm length.

2. Pour 20 ml of a slurry of Dowex 1-X8, $Cl^-$ form (50-100 mesh) into the column and wash down sides with water. Add 2 ml of $I^-$ carrier to 2 liters milk, stir for 20 minutes.

3. Pass the sample through the ion exchange column at a flow rate of 20 ml/min. Save the effluent for other analyses and label it "iodine effluent".

4. Wash column with 500 ml of hot distilled water for milk samples or 200 ml of distilled water for water samples. Discard wash.

5. Wash column with 100 ml of 2 M NaCl at a flow rate of 4 ml/min. Discard wash.

6. Drain the solution from the column.

7. Measure 50 ml 5% sodium hypochlorite in a graduated cylinder. Add sodium hypochlorite to column in 10-20 ml increments, stirring resin as needed to eliminate gas bubbles and maintain flow rate of 2 ml/min. Collect eluate in 250-ml beaker and discard the resin.

B. Iodine Extraction Procedure

1. Acidify the eluate from step 7 using concentrated $HNO_3$ to make the sample 2-3 N in $HNO_3$, and transfer to 250 ml separatory funnel. (Add the acid slowly with stirring until the vigorous reaction subsides.) Volume of concetrated $HNO_3$ required will depend on eluate volume as follows):

Section 3.9 (continued)

B. Iodine Extraction Procedure (continued)

| eluate volume (ml) | concentrated $HNO_3$ (ml) |
|---|---|
| 50-60 | 10 |
| 60-70 | 12 |
| 70-80 | 14 |
| 80-90 | 16 |

2. Add 50 ml of $CCl_4$ and 10 ml of 1 M hydroxylamine hydrochloride (freshly prepared). Extract iodine into organic phase (about 2 minutes equilibration). Draw off the organic phase (lower phase) into another separatory funnel.

3. Add 25 ml of $CCl_4$ and 5 ml of 1 M hydroxylamine hydrochloride to the first separatory funnel and again equilibrate for 2 minutes. Combine the organic phases. Discard the aqueous phase (Upper phase) if no other analyses are required. If Pu, U or Sr is required on the same sample aliquot, submit the aqueous phase and data sheet to the approprate laboratory section.

4. Add 20 ml $H_2O$-$HNO_3$-$NH_2OH$ HCl wash solution to the separatory funnel containing the $CCl_4$. Equilibrate 2 minutes. Allow phases to separate and transfer $CCl_4$ (lower phase) to a clean separatory funnel. Discard the wash solution.

5. Add 25 ml $H_2O$ and 10 drops of 1 M sodium bisulfite (freshly prepared) to the separatory funnel containing the $CCl_4$. Equilibrate for 2 minutes. Discard the organic phase (lower phase). Drain aqueous phase (upper phase) into a 100-ml beaker. Proceed to the Precipitation of $PdI_2$.

C. Precipitation of Palladium Iodide

CAUTION: AMMONIUM HYDROXIDE INTERFERES WITH THIS PROCEDURE

1. Add 10 ml of 3 N HCl to the aqueous phase from the iodine extraction procedure in step 5.

2. Place the beaker on a stirrer-hot plate. Using the magnetic stirrer, boil and stir the sample until it evaporates to 30 ml or begins to turn yellow.

3. Add 1.0 ml of 20 mg Pd++/ml palladium chloride per liter of milk used dropwise, to the solution.

Section 3.9 (continued)

C. Precipitation of Palladium Iodide (continued)

4. Turn the heat off, but continue to stir the sample until it cools to room temperature. Place the beaker in a stainless steel tray and put in the refrigerator overnight.

5. Weigh a clean 21 mm Whatman #42 filter which has been stored over silica gel in a desiccator.

6. Place the weighed filter in the filter holder. Filter the sample and wash the residue with water and then with absolute alcohol.

7. Remove filter from filter holder and place it on a stainless steel planchet.

8. Dry under the lamp for 20 minutes.

9. Cut a 1 1/2" strip of polyester tape and lay it on a clean surface, gummed side up. Place the filter, precipitate side up, in the center of the tape.

10. Cut a 1 1/2" wide piece of mylar. Using a spatula to press it in place, put it directly over the precipitate and seal the edges to the polyester tape. Trim to about 5 mm from the edge of the filter with scissors.

11. Mount the sample on the plastic disc and write the sample number on the back side of the disc.

12. Count the sample on a proportional beta counter.

Calculations

Calculate the sample activity using computer program I131.

Reference: "Determination of 1-131 by Beta-Gamma coincidence Counting of $PdI_2$". Radiological Science Laboratory. Division of Laboratories and Research, New York State Department of Health, March 1975, Revised February 1977.

Rev. 4, 6-01-84
Approved by: E.G. Huebner

Section 8.1

## 8.1 Strontium-89 and Strontium-90 in Milk by Ion Exchange

### Principle of Method

A citrate complex of yttrium, strontium, and barium carriers at the pH of milk is added to the milk sample. The mixture is then passed successively through cation- and anion-exchange resin columns. Strontium, barium, and calcium are absorbed on the cation-exchange resin, and the yttrium carrier with the yttrium 90 daughter of strontium 90 is retained on the anion-exchange resin.

The yttrium is eluted from the anion resin with hydrochloric acid and precipitated as the oxalate. Lanthanum 140, which may be a contaminant, is removed by dissolving yttrium oxalate in concentrated nitric acid and extracting yttrium from the solution into an equal volume of pre-equilibated tributyl phosphate. The lanthanum 140 remains in the concentrated nitric acid to be discarded. Yttrium is re-extracted from the organic phase with dilute nitric acid and precipitated as the oxalate. The precipitate is weighed to determine recovery of yttrium carrier, then counted for yttrium 90 activity.

Strontium, barium, and calcium are eluted from the cation-exchange resin with sodium chloride solution. Following dilution of the eluate, the alkaline earths are precipitated as carbonates. The carbonates are then converted to nitrates, and strontium and barium nitrate are precipitated. The nitrate precipitate is dissolved, and barium is precipitated as the chromate, purified as the chloride, and then counted to determine the barium 140. From the supernate, strontium is precipitated as the nitrate, dissolved in water, and reprecipitated as strontium nitrate. The nitrate is converted to the carbonate, which is filtered, weighed to determine strontium carrier recovery, and counted for "total radiostrontium".

The concentration of strontium-89 is calculated as the difference between the activity for "total radiostrontium" and the activity due to strontium-90.

### Reagents

Ammonium acetate buffer: pH 5.0
Ammonium hydroxide, $NH_4OH$: concentrated (15N)
Ammonium oxalate, $(NH_4)_2C_2O_4.H_2O$: 1N
Anion-exchange resin: Dowex 1-X8 ($Cl^-$ form, 50-100 mesh)
Carrier solutions:
  $Ba^{+2}$ as barium nitrate, $Ba(NO_3)2$: 20 mg $Ba^{+2}$ per ml
  $Sr^{+2}$ as strontium nitrate, $Sr(NO_3)_2$: 20 mg $Sr^{+2}$ per ml
  $Y^{+3}$ as yttrium nitrate, $Y(NO_3)$: 10 mg $Y^{+3}$ per ml
Cation-exchange resin: Dowex 50W-X8 ($Na^+$ form, 50-100 mesh)
Citrate solution: 3N (pH 6.5)

Section 8.1 (Continued)

Diethyl ether, $(C_2H_5)_2$:anhydrous
Ethyl alcohol, $C_2H_5OH$: absolute (100%), 95%
Hydrochloric acid, HCl: concentrated (12N, 6N*, 2N*)
Hydrochloric acid-diethyl ether, HCl-$(C_2H_5)_2O$:5.1 v/v
Nitric acid, $HNO_3$:fuming (90%), concentrated (16N)*, 14N, 6N, 0.1 N*
Oxalic acid, $H_2C_2O_4.2H_2O$:2N*
Sodium carbonate, $Na_2CO_3$:3N, 0.1 N
Sodium chloride, NaCl:4N
Sodium chromate, $Na_2CrO_4$:3N
Tri-n-butyl phosphate (TBP), $(C_4H_9)_3PO_4$:pre-equilibrated with 14N $HNO_3$*

* Starred reagents are used only in processing the anion column effluent to determine strontium-90 concentration (Part A).

Apparatus

Ion-exchange system: The apparatus for this system is illustrated in Figure 8.1-1. It consists of three glass components connected one above the other for gravity flow. At the top is a graduated, 1-liter glass separatory funnel which serves as the reservoir. Below it is connected a 250 ml glass column, 5 cm in diameter and 25 cm long, which services as the cation column. Below this is connected the anion column, a 30-ml glass column, 1.9 cm in diameter and 10.5 cm long. Both columns have extra coarse, fritted glass disks at the bottom.

Five milliliters of distilled water are placed in the 30-ml column, and 15 ml Dowex 1 resin are poured into it. The cation column is filled by adding 170 ml Dowex 50W resin in the same way.

Millipore filtering apparatus (Pyrex Hydrosol Microanalysis Filter Holder)

Millipore Type OH membrane filter, 1.5-μ pore size, 2.5-cm diameter low-background beta counter.

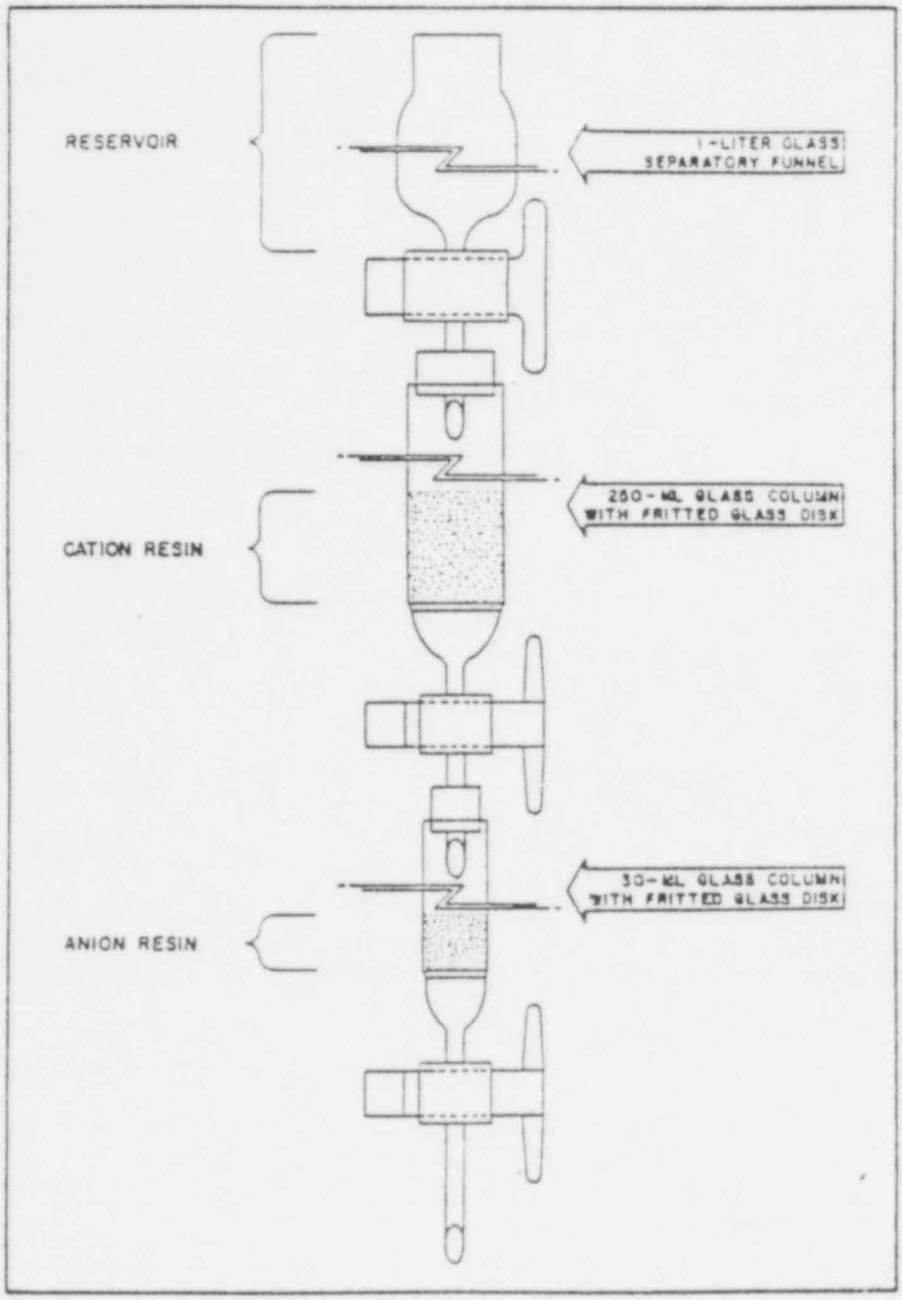



Figure 8-4 Ion-exchange system

Section 8.1 - Part A

Part A. Strontium-90

Procedure

1. Place 1 liter of milk into the graduated reservoir. Pipette 1.0 ml each of yttrium, strontium, and barium carrier solutions into 10 ml of citrate solution: swirl to mix and dissolve the barium citrate which forms. Transfer this mixture quantitatively to the milk with 5 ml of distilled water, and mix well.

2. Open the stopcocks of the reservior, anion column, and cation column, in that order. NOTE THE TIME. Control the flow rate at 10 milliliters per minute (ml/min) with the anion column stop-cock. Check occasionally by collecting effluent for 1 minute in a graduated cylinder. Stop flow when just enough milk remains in the columns to cover resin. NOTE THE TIME. Discard the effluent milk. RECORD THE MIDPOINT OF THE ELUTION PERIOD AS THE BEGINNING OF YTTRIUM 90 DECAY.

3. Replace the milk reservoir with a separatory funnel containing 300 ml of warm distilled water, and let the water flow through the columns at approximately 10 ml/min to displace the milk. Stop the flow when just enough water remains in the columns to cover the resin. Discard the effluent water.

4. Separate the columns.

   In order to collect eluate for "total radio-strontium", barium, and calcium determinations, and to regenerate the cation column for subsequent use, follow Step 5, Part B.

5. Gradually add 75-100 ml of 2N HCl to the anion colum. Control the effluent flow at 2 ml/min. Collect eluate in a 250-ml centrifuge bottle.

6. Add 5 ml of 2N oxalic acid to the eluate and adjust the pH to 1.5 with 6N $NH_4OH$ using a pH meter.

7. Stir and heat to near boiling in a water bath (approx. 20 min).

8. Cool in an ice bath and centrifuge. Decant and discard the supernatant. Proceed as in (a) or (b) depending on whether Ba-La-140 is absent or present from the gamma analysis of the sample.

   (a) If fresh fission products are known to be absent:

   Dissolve the ppt in 10 ml of $HNO_3$, filter solution through Whatman No. 541 paper into a 40 ml centrifuge tube. Wash paper, collecting the washing in tube and continue as in Step A-9.

Section 8.1 - Part A (Continued)

(b) If fresh fission products are present:

Dissolve the ppt in 10 ml of $HNO_3$, transfer the solution to a 60 ml separatory funnel, washing the tube with additional 10 ml of $HNO_3$. Add 10 ml of equilibrated TBP, shake 2-3 min, and when separated drain and discard the lower acid phase. Add 15 ml of 14N $HNO_3$ to the separatory funnel, shake 2-3 min, drain and discard the lower acid phase. Repeat the 14N $HNO_3$ treatment to remove eight lanthanide elements and La-140. Add 15 ml of $H_2O$ to the separator and shake. Drain the lower phase into a 125-ml centrifuge tube. Repeat the wash, using 15 ml of 0.1N $HNO_3$, adding it to the centrifuge tube.

9. Add 5 ml of 2N oxalic acid to the purified yttrium solution from (a) or (b). Adjust to a pH of 1.5 with $NH_4OH$, using a pH meter.

10. Digest the solution in a hot $H_2O$ bath for 10 min. with occasional stirring. Cool in an ice bath (20 min).

11. Filter on a weighed Whatman No. 42 (2.1 cm) filter paper. Wash with $H_2O$, ethyl alcohol and ether and dry at room temperature and weigh.

12. Mount and count in a proportional counter.

13. If analysis for Sr-89 is not required, disregard Section 8.1-Part B. Use the computer program SR8990 to calculate (Sr-90) activity.

Section 8.1 - Part B

Part B

Total Radiostrontium (Sr-89 separation)

Procedure

Continue following columns separation (Step A-4).

5. Connect 1 l separator funnel containing 1 l of 4N NaCl to the cation column. Allow the solution to flow at ~10 ml/min to elute the alkali metal and alkaline earth ions and to recharge the column. Collect 1 l of eluate into a 2 l beaker, but leave the resin covered with 2-3 ml of solution.

6. Wash the column with 500 ml of $H_2O$ or more to remove excess NaCl. Discard the wash.

7. Remove 20 ml of the NaCl eluate into a small bottle for the determination of stable calcium. (See section 6.1).

8. Dilute the eluate to 1500 ml with distilled water.

9. Heat the solution to 85°-90° C (near boiling on a hot plate) and add, with constant stirring, 100 ml of 3N $Na_2CO_3$. Stir gently while on hot plate to prevent bumping. Let stand overnight.

10. Decant most of the supernate. Transfer the precipitate to a 250 ml centrifuge bottle.

11. Wash the precipitate twice with 50 ml portions of $H_2O$. Dry it in an oven at 110° C for 1-2 hours.

12. Dissolve the ppt slowly with vigorous stirring in 10 ml of 6N $HNO_3$ (with magnetic stirrer). Filter through Whatman No. 541 paper into a 40 ml centrifuge tube. Rinse the bottle with little 6N $HNO_3$ and pour the washings through the paper. To the filtrate, add slowly 30 ml of 21N $HNO_3$ (fuming). Stir well and cool in an ice bath. Centrifuge and discard supernatant.

13. Carefully add 30 ml of conc. $HNO_3$ to the precipitate. Heat in a $H_2O$ bath with stirring for about 30 minutes. Cool the solution in an ice water bath for about 5 minutes. Centrifuge and discard supernatant.

14. Repeat step No. 13.

Section 8.1 - Part B (Continued)

15. Dissolve the ppt. in 10 ml. of $H_2O$ and 5 ml. of $NH_4AC$ buffer and heat in a water bath: Adjust pH to 5.5 using a pH meter and add immediately 1 ml. of 3N $Na_2CrO_4$ and mix well. Digest in a water bath for 5 min., centrifuge and decant the supernatant into another 40 ml. centrifuge tube.

16. Heat the supernate in a water bath. Adjust the pH to 8-8.5 with $NH_4OH$. With continuous stirring, cautiously add 5 ml of 3N $Na_2CO_3$ solution. Heat gently for 10 minutes. Centrifuge and decant the supernate. Wash the strontium carbonate precipitate with 0.1 N $Na_2CO_3$. Centrifuge again, and decant the supernate.

17. Dissolve the carbonate precipitate in 5 ml of 6N $HNO_3$. With continuous stirring, cautiously add 30 ml of fuming $HNO_3$ to the solution. (Stirring the solution longer helps in the precipitation of the strontium nitrate.) Cool in ice bath, centrifuge and decant the supernate.

18. Dissolve the strontium nitrate precipitate in 3 ml of $H_2O$ and 5 ml of 6N $HNO_3$. Add cautiously, with continuous stirring, 20 ml of fuming $HNO_3$. Cool in an ice bath, centrifuge and discard supernatant. RECORD TIME AS BEGINNING OF Y-90 INGROWTH.

19. Dissolve the precipitate in 10 ml of $H_2O$. Heat in a water bath. Adjust the pH to 8-8.5. With continuous stirring, add 5 ml of 3 N $Na_2CO_3$ solution. Heat gently for 10 minutes.

20. Cool and filter on a weighed No. 42 Whatman (2.1 cm) filter paper. Wash thoroughly with water and alcohol.

21. Dry the precipitate in an oven at 105° C or under the lamp for 30 minutes. Cool and weigh.

22. Mount and count without delay in a proportional counter as total strontium.

23. Calculate Sr-89 and Sr-90 activity (pCi/l) using computer program SR8990.

Section 8.1 (Continued)

Calculations

Part A.

$$\text{Strontium 90 concentration (pCi/liter)} = \frac{A}{B \times C \times D \times E \times F}$$

Where:

A = net beta count rate of yttrium 90 (cpm)
B = recovery of yttrium carrier
C = counter efficiency for counting yttrium-90 or yttrium oxalate mounted on a 2.1-cm diameter membrane filter (cpm/pCi)
D = sample volume (liters)
E = Correction factor $e^{-\lambda t}$ for yttrium-90 decay, where t is the time from midpoint of the elution time of milk (Step A-2) to the time of counting.
F = Correction factor $1-e^{-\lambda t}$ for the degree of equilibrium attained during the yttrium-90 ingrowth period, where t is the time from collection of the milk sample to the time of passage through the column (Step A-2)

Part B.

$$\text{Strontium 89 concentration (pCi/liter)} = \frac{1}{B \times C}\left(\frac{A}{D \times E} - F\,(G \times H + I \times J)\right)$$

Where:

A = net beta count rate of "Total radiostrontium" (cpm)
B = counter efficiency for counting strontium-89 as strontium oxalate mounted on a 2.1-cm diameter membrane filter (cpm/pCi)
C = correction factor $e^{-\lambda t}$ for strontium-89 decay, where t is the time from sample collection to the time of counting
D = recovery of strontium carrier
E = volume of milk sample (liters)
F = strontium 90 concentration (pCi/liter) from Part A
G = self-absorption factor for strontium-90 as strontium oxalate mounted on a 2.1-cm diameter filter, obtained from a self-absorption curve prepared by plotting the fraction of a standard activity absorbed against density thickness of the sample ($mg/cm^2$)
H = counter efficiency for counting strontium-90 as strontium oxalate mounted on a 2.1-cm diameter membrane filter (cpm/pCi)
I = counter efficiency for counting yttrium-90 as yttrium oxalate mounted on a 2.1-cm diameter membrane filter (cpm/pCi)

Section 8.1 (Continued)

J = correction factor $1-e^{-\lambda t}$ for yttrium-90 ingrowth, where it is the time from the last decantation of the nitric acid (Step B-18).

Reference: Radioassay Procedures for Environmental Samples U.S. Department of Health, Education and Welfare. Environmental Health Series, January 1967.

Rev. 4, 6-01-84
Approved by: L.G. Huebner

Section 8.4

## 8.4 Strontium 89 and Strontium 90 in Water Samples

### A. Principle of Method

The acidified sample of clear water with stable strontium, barium and calcium carriers is treated with oxalic acid at a pH of 3.0 to precipitate insoluble oxalates. The oxalates are dissolved in nitric acid and strontium nitrate is separated from calcium as a precipitate in 70% nitric acid. The residue is purified by adding iron and rare earth carriers and precipitating them as hydroxides. After a second strontium nitrate precipitation from 70% nitric acid, the nitrates are dissolved in water and with added yttrium carrier, are stored for ingrowth of yttrium-90. The strontium is again precipitated and separated from 70% nitric acid with the yttrium nitrate being in the supernate. Each fraction is precipitated separately as an oxalate and collected on No. 42 (2.1 cm) Whatman filter or planchet for counting either total radiostrontium or yttrium-90 or both.

#### Reagents

Acetic acid, $CH_3COOH$: 1.5N
Ammonium acetate, $NH_4C_2H_3O_2$: 3N
Ammonium acetate buffer: pH 5.0
Ammonium hydroxide, $NH_4OH$: concentrated (15 N), 6 N, 1 N
Ammonium oxalate, $(NH_4)_2C_2O_4.H_2O$: 0.5% w/v
Carrier solutions:
- $Ba^{+2}$ as barium nitrate, $Ba(NO_3)_2$: 20 mg $Ba^{+2}$ per ml
- $Ca^{+2}$ as calcium nitrate, $Ca(NO_3)_24H_2O$: 40 mg $Ca^{+2}$ per ml
- $Sr^{+2}$ as strontium nitrate, $Sr(NO_2)$: 20 mg $Sr^{+3}$ per ml
- $Y^{+3}$ as yttrium nitrate, $Y(NO_3)_3$: 10 mg $Y^{+3}$ per ml

Hydrochloric acid, HCl: concentrated (12 N), 0.5 N
Hydrogen peroxide, $H_2O_2$: 30% solution
Nitric acid, $HNO_3$: fuming (90%), concentrated (16 N), 6 N, 3 N
Oxalic acid, $H_2C_2O_2.2H_2O$: Saturated at room temperature

Scavenger solutions: 20 mg $Fe^{+3}$ per ml, 10 mg each $Ce^{+3}$ and $Zr^{+4}$ per ml
- $Fe^{+}$ as ferric chloride, $FeCl_3.6H_2O$
- $Ce^{+3}$ as cerous nitrate, $Ce(NO_3)_3.6H_2O$
- $Zr^{+4}$ as zirconyl chloride, $ZrOCl_2.8H_2O$

Sodium Carbonate, $Na_2CO_3$: 3N, 0.1N

Sodium Chromate, $Na_2CrO_4$: 3N

#### Apparatus

Analytical balance
Low background beta counter
Medium - porosity filter stick
pH meter

Section 8.4 A

Part A. Strontium 89

Procedure

1. Filter 1 liter of an acidified water sample using millipore filter paper.

2. Digest the filter paper with the residue with concentrated nitric acid ($HNO_3$) until all the organic matter is removed.

3. Evaporate to dryness and dissolve the residue with hot water and filter using No. 541 Whatman filter paper.

4. Combine the filtrates in a 2 liter beaker.

5. Add 1 ml of strontium carrier solution, 1 ml barium carrier solution, and if necessary, 1 ml of calcium carrier solution. (Improved precipitation may be obtained by adding calcium to soft waters.) Stir thoroughly and while stirring add 125 ml of saturated oxalic acid solution.

6. Using a pH meter, adjust the pH to 3.0 with 15 N $NH_4OH$, and allow the precipitate to settle for 5-6 hours.

7. Decant most of the supernate (liquid) and transfer the precipitate to a 250 ml centrifuge bottle. Wash the precipitate and the beaker wall with 0.5% ammonium oxalate and centrifuge. Discard the supernate.

8. Dissolve the precipitate with 10 ml of 6 N $HNO_3$ and transfer to a 250 ml beaker. Then use 20 ml of 16 N $HNO_3$ to rinse the centrifuge tube and combine it to the solution in the 250 ml beaker.

9. Evaporate the solution to dryness. Cool; then add 50 ml 16 N $HNO_3$ and repeat the acid addition and evaporation until the residue is colorless.

10. Transfer the residue to a 40-ml centrifuge tube, rinsing with a minimum volume of 16 N $HNO_3$. Cool in a refrigerator overnight. Centrifuge at 1500-1800 rpm for 10 minutes, and discard the supernate.

11. Dissolve the precipitate in 5 ml of 6N $HNO_3$ and then add 30 ml of fuming nitric acid. Centrifuge, and discard the supernate.

12. Dissolve the nitrate precipitate in about 10 ml of distilled water. Add 1 ml of scavenger solution. Adjust the pH of the mixture to 7 with 6 N $HN_4OH$. Heat, stir, and filter through a Whatman No. 541 filter. Discard the mixed hydroxide precipitate.

Section 8.4 A (continued)

Part A. Strontium 89

Procedure (continued)

13. To the filtrate, add 5 ml of ammonium acetate buffer. Adjust the pH with 3N $HNO_3$ or $NH_4OH$ to pH 5.5. (Note: the pH of the solution at this point is critical.) Add dropwise with stirring 1 ml of 3N $Na_2CrO_4$ solution. Heat in a water bath.

14. Cool and centrifuge. Decant the supernate into another centrifuge tube. Save the precipitate for Ba analysis if needed.

15. Heat the supernate in a water bath. Adjust the pH to 8-8.5 with $NH_4OH$. With continuous stirring, cautiously add 5 ml of 3N $Na_2CO_3$ solution. Heat gently for 10 minutes. Cool, centrifuge, and decant the supernate. Wash the precipitate with 0.1N $Na_2CO_3$. Centrifuge again and decant the supernate.

16. Dissolve the precipitate in no more than 4 ml of 3N $HNO_3$. Then add 20-30 ml of fuming $HNO_3$, cool in a water bath, and centrifuge. Decant and discard the supernate.

17. Repeat step 16. Then, RECORD THE TIME AND DATE AS THE BEGINNING OF YTTRIUM 90 INGROWTH. If no immediate count of total radiostrontium is desired add to the precipitate 1 ml of yttrium carrier solution and 4 ml of 6N $HNO_3$ and store 7-14 days to allow the yttrium 90 to grow in.

18. To determine total radiostrontium, dissolve the precipitate in 10 ml of water. Heat in water bath. Adjust the pH to 8-8.5. With continuous stirring add 5 ml of 3N $Na_2CO_3$ solution. Heat gently for 10 minutes.

19. Cool and filter on a weighed No. 42 (2.1 cm) Whatman filter paper. Wash thoroughly with water and alcohol.

20. Dry the precipitate under the lamp for 30 min. Cool and weigh.

21. Mount and count without delay its beta activity as "total radiostrontium" in a proportional counter.

Section 8.4

Part B. Strontium 90

Procedure

1. After counting total radiostrontium dissolve the precipitate on the filter in 6 N $HNO_3$ and transfer the solution to a 40 ml centrifuge tube. The total volume of dissolution and rinsing should be about 4 ml.

2. Add 1 ml of yttrium carrier solution and store until 7 to 14 days have elapsed since step 17 was completed.

3. Heat the equilibrated strontium-yttrium sample in a water bath at approximately 90°C. Adjust the pH to 8 with $NH_4OH$, stirring continuously.

4. Cool to room temperature in a cold water bath and centrifuge for 5 minutes. Record the hour and date of decantation as the end of the yttrium-90 ingrowth and the beginning of its decay in the yttrium fraction.

5. Dissolve by adding about 4 drops of HCl with stirring. Add 15-20 ml of water. Heat in a water bath and adjust the pH to 8 with $NH_4OH$, stirring continuously.

6. Cool to room temperature in a cold water bath and centrifuge for 5 minutes.

7. Repeat steps 5 and 6.

8. Add 3 drops of HCl to dissolve the precipitate, then add 20 ml of water. Filter using No. 541 filter paper. Heat in a water bath at approximately 90° C. Add 1 ml of saturated oxalic acid solution dropwise with vigorous stirring. Adjust to a pH of 2-3 with $NH_4OH$. Allow the precipitate to digest for about an hour.

9. Cool to room temperature in a cold water bath. Centrifuge for 10 minutes and decant most of the supernate. Filter by suction on a weighed filter paper. Wash the precipitate with water and alcohol.

10. Dry the precipitate under the lamp for 30 minutes. Cool and weigh. Mount and count without delay in a proportional counter.

11. Calculate Sr-89 and Sr-90 activity in pCi/l using the computer program for Sr-89,90.

Section 8.4 (continued)

Part B. Strontium 90

Calculations

For formulas used refer to Section 8.1.

Reference: Radioassay Procedures for Environmental Samples U.S. Department of Health, Eduction and Welfare. Environmental Health Series, January 1967.

Section 8.6

## 8.6 Strontium-89 and Strontium-90 in Milk (Ash), Vegetation, Fish, Wildlife, Soil and Bottom Sediment Samples - Sodium Carbonate Fusion.

### Principle of Method

Strontium is separated from calcium, other fission products,ard other natural radioactive elements. Fuming nitric acid separations remove the calcium and most of the other interfering ions. Radium, lead, and barium are removed with barium chromate. Traces of other fission products are scavenged with yttrium hydroxide. After the Sr-90 and Y-90 equilibrium has been attained, the Y-90 is precipitated as the hydroxide and converted to the oxalate for counting. Strontium is precipitated as the carbonate and counted for total activity. Strontium-89 activity is computed as the difference between the total radiostrontium and the strontium-90 (as yttrium-90) activity.

### Reagents

Ammonium acetate buffer, $(NH_4)_2$ Ac:pH = 5.0, 6M
Ammonium hydroxide, $NH_4OH$:6N
Carrier Solutions:
- $Ba^{+2}$, $Ba(No_3)_2$:20 mg/ml of $Ba^{+2}$
- $Fe^{+3}$, $Fe(NO_3)_3$, scavenger:5 mg/ml of $Fe^{+3}$
- $Sr^{+2}$, $Sr(NO_3)_2$:20 mg/ml of $Sr^{+3}$
- $Y^{+3}$, $Y(NO_3)_3$:10 mg/ml of $Y^{+3}$

Ethyl alcohol, $C_2H_5OH$:absolute
Hydrochloric acid, HCl:12N (conc.)
Nitric acid, $HNO_3$:16N (conc.), 6N, 3N, fuming
Oxalic acid, $H_2C_2O_4$:saturated
Potassium nitrate, $KNO_3$:powdered
Sodium carbonate, $Na_2CO_3$:powdered, 3N, 0.1N
Sodium chromate, $Na_2CrO_4$:3N
Sodium hydroxide, NaOH:pellets

### Apparatus

Teflon filter holder, or filter funnel and sample mount rings and discs
Magnetic stirrers with Teflon-Coated magnet bars
Mylar film
Glass fiber filters
Fisher filtrator
Brinkman dispenser - pipettor

Section 8.6 A

Part A. Sample Preparation - Sodium Carbonate Fusion

Procedure

1. Weigh out 3 g of ashed sample or silted soil and set aside.

2. Sift into a 250 ml nickel crucible enough $Na_2CO_3$ to very lightly cover the bottom.

3. Add 30 g of NaOH pellets and 5 g of $KNO_3$.

4. Add the weighed ash sample and tap the crucible gently to shake the ash down among the pellets.

5. Sift from 10 to 20 grams of $Na_2CO_3$ over the ash so it is completely covered.

6. Place in a muffle furnace at 600°C for 20 to 30 minutes to melt and fuse the mixture.

   NOTE: If carbon materials remain floating on the surface of the melt, cautiously add a few grains of $KNO_3$ and heat for another 5 to 10 minutes.

   Decomposition of organic matter is complete when no further reaction is noticed on addition of $KNO_3$.

7. Using a long-handled tongs, remove the crucible from the muffle furnace and immediately, but very cautiously, cool in an ice bath until the melt is completely solidified and cool enough to handle without gloves.

   NOTE: It is very important that no moisture come in contact with the melt at this time. One drop of water in the crucible could render the melt very difficult, if not impossible, to remove.

8. Transfer the melt to a 250 ml centrifuge bottle using distilled water and stir until completely dispersed.

   NOTE: Rotating the crucible in the palm of one's hand and very gently applying pressure should be sufficient to loosen the melt from the sides of the crucible.

9. Add 2 ml of strontium and 1 ml of barium carriers.

10. Bring to a gentle boil, cool, centrifuge and discard the supernatant.

Section 8.6 A (continued)

Part A. Sample Preparation - Sodium Carbonate Fusion

Procedure (continued)

11. To the residue add 50 ml 3N $Na_2CO_3$ as a wash, swirl and disperse the residue, heat for 10 minutes in a hot water bath, centrifuge and discard the supernatant.

12. Repeat step (11) three times to put the precipitate in a suitable form for further analysis.

13. Dissolve the precipitate in 50 ml of concentrated $HNO_3$, transfer to a 250 ml beaker, and take to dryness on a hot plate.

    NOTE: Evaporation may be done rapidly at first, and then very slowly to prevent spattering.

    A jelly-like substance may form at this point, due to hydrated silicic acid formed from the soluble silicates and will be removed in the following steps.

14. Bake the remaining residue for at least 1 hour at 120° to 130° C, cool, moisten the salts with 5 ml of $HNO_3$ and allow to stand at room temperature for 10 minutes. Then place on a hot plate, bring to a boil and add 45 ml of boiling water. DISPERSE ANY REMAINING RESIDUE WITH A GLASS STIRRING ROD AND FILTER IMMEDIATELY into a 250 ml beaker. Use Whatman No. 541 hardened filter paper.

    NOTE: To separate the silicic acid the hydrated acid must be changed to a less hydrated and less soluble acid by baking at 100° to 130°C.

    It is important at this point that evaporation be to complete dryness. (There should no longer be a smell of acid).

    Addition of 5 ml of $HNO_3$ converts any metal oxides which may have been formed back to nitrates so they will be dissolved and not removed with the silicates.

    Filtering must be done immediately as some of the silicates will tend to go back into solution. Also, due to this fact, removal of silicates by dehydration is not 100% efficient and the process must be repeated at least once and more often if necessary.

15. Evaporate and repeat step (14) at least once, again as often as necessary.

Section 8.6 A (continued)

Part A. Sample Preparation - Sodium Carbonate Fusion

Procedure (continued)

16. Evaporate the solution in a beaker to dryness on a hot plate. Cool, then add 40 ml of concentrated $HNO_3$ and evaporate to 20-25 ml. Then add another 40 ml $HNO_3$ and repeat the procedure.

    NOTE: The liquid portion of the sample at this point will be yellow. Should the color toward the end of the first evaporation be red-brown, or black, add more nitric acid and repeat the above procedure as often as necessary to obtain a clear yellow solution.

    The dark samples described above have been known to explode if evaporated to dryness without adding additional portions of nitric acid. These samples should be handled in a hood with the window down as far as possible to prevent possible personal injury to the operator.

    This step is to destroy any remaining organic materials. The darker colored solutions contain large amounts of organic matter.

17. Complete the analyses as described under Determination.

References: The basis for this procedure was presented by J.J. Bolan in the Public Health Service Manual, titled "Chemical Analysis of Environmental Radionuclides, Determination of radiostrontium in food" (1.11.3.A(8.65)). Modifications to this procedure were made by the North Dakota State Department of Health.

Section 8.6 B

Part B. Determination

I. Strontium - 89

Procedure

1. Transfer the solution to a 40 ml conical, heavy-duty centrifuge tube using a minimum of conc. $HNO_3$. Cool the centrifuge tube in an ice bath for about 10 minutes. Centrifuge and discard the supernatant.

   NOTE: The precipitate consists of calcium, strontium and barium-radium nitrates. The supernatant contains part of the sample's calcium and phosphate content.

2. Add 30 ml of conc. $HNO_3$ to the precipitate. Heat in a hot water bath with stirring for about 10 minutes. Cool the solution in an ice bath with stirring for about 5 minutes. Centrifuge and discard the supernatant.

   NOTE: Additional calcium is removed from the sample. Nitrate precipitations with 70% $HNO_3$ will afford a partial decontamination from soluble calcium while strontium, barium, and radium are completely precipitated.

   The separation of calcium is best at 60% $HNO_3$, however at 60% the precipitation of strontium is not complete. Therefore, it is common practice to precipitate $Sr(NO_3)_2$ with 70% $HNO_3$ which is the concentration of commercially available 16 N $HNO_3$.

   Most of the other fission products, induced activities and actinides are soluble in concentrated $HNO_3$ affording a good "gross" decontamination step from a wide spectrum of radionuclides. The precipitation is usually repeated several times.

3. Repeat step (2) two more times.

4. Dissolve the nitrate precipitate in about 10 ml distilled water. Add 1 ml of scavenger solution. Adjust the pH of the mixture to 7 with 6 N $NH_4OH$. Heat, stir, and filter through a Whatman No. 541 filter. Discard the mixed hydroxide precipitate.

Section 8.6

Part B Determination

1. Strontium-89

Procedure (continued)

5. To the filtrate add 5 ml of ammonium acetate buffer (pH 5.0). Adjust the pH to 5.5 with 3N $HNO_3$ or 6N $NH_4OH$. (Note: The pH of the solution at this point is critical. Barium chromate will not precipitate completely in more acidic solution and strontium will partially precipitate in more basic solutions.) Add dropwise with stirring 1 ml of 3N $Na_2CrO_4$ solution. Heat in a water bath to about 90°C and centrifuge. Decant the supernate into another centrifuge tube. Save the precipitate for Ba analysis if needed.

6. Heat the supernate in a water bath. Adjust the pH to 8-8.5 with $NH_4OH$. With continuous stirring, cautiously add 5 ml of 3N $Na_2CO_3$ solution. Heat gently for 10 minutes. Centrifuge, and when completeness of precipitation has been verified by adding a few drops of $Na_2CO_3$, centrifuge and decant the supernate. Wash the strontium carbonate precipitate with 0.1N $Na_2CO_3$. Centrifuge again, and decant the supernate.

7. Dissolve the carbonate precipitate in 5 ml 6N $HNO_3$. With continuous stirring, cautiously add 20 ml fuming $HNO_3$ to the solution. (Stirring the solution longer helps in the precipitation of strontium nitrate). Cool in an ice bath, centrifuge and decant the supernate.

8. Dissolve the strontium nitrate precipitate in 3 ml $H_2O$ and 5 ml 6N $HNO_3$. Add cautiously, with continuous stirring, 20 ml fuming $HNO_3$. Cool in ice bath, centrifuge and discard supernatant. RECORD TIME AS BEGINNING OF Y-90 INGROWTH.

9. Dissolve the precipitate in 10 ml of $H_2O$. Heat in a water bath. Adjust the pH to 8-8.5. With continuous stirring, add 5 ml of 3N $Na_2CO_3$ solution. Heat gently for 10 minutes.

10. Cool and filter on a weighed No. 42 (2.1 cm) Whatman filter paper. Wash thoroughly with water and alcohol.

11. Dry the precipitate under the lamp for 30 minutes. Cool and weigh.

12. Mount and count without delay in a proportional counter as total radiostrontium.

Section 8.6

Part B Determination

I. Strontium-90

Procedure

1. After counting total radiostrontium, dissolve the strontium carbonate precipitate on the filter in 6N $HNO_3$ and transfer the solution to a 40 ml centrifuge tube. The total volume of dissolution and rinsing should be about 4 ml.

2. Add 1 ml of yttrium carrier solution and store until 7 to 14 days have elapsed since Step B-I-8 was completed.

3. Heat the equilibrated strontium-yttrium sample in a water bath at approximately 90° C. Adjust the pH to 8 with $NH_4OH$, stirring continuously.

4. Cool to room temperature in a cold water bath and centrifuge for 5 minutes. Discard the supernate, record the time and date of the decantation as the end of the yttrium-90 ingrowth and the beginning of its decay in the yttrium fraction.

5. Dissolve precipitate by adding about 4 drops of HCl with stirring. Add 15-20 ml of water. Heat in a water bath and adjust the pH to 8 with $NH_4OH$, stirring continuously.

6. Cool to room temperature in a cold water bath and centrifuge for 5 minutes. Discard supernate.

7. Repeat steps 5 and 6.

8. Add 3 drops of HCl to dissolve the precipitate, then add 20 ml of water. Filter the solution using No. 541 Whatman hardened filter paper. Heat in a water bath at approximately 90° C. Add 1 ml of saturated oxalic acid solution dropwise with vigorous stirring. Adjust to a pH of 2-3 with $NH_4OH$. Allow the precipitate to digest for about an hour.

9. Cool to room temperature in a cold water bath. Centrifuge for 10 minutes and decant most of the supernate. Filter by suction on a weighed filter paper. Wash the precipitate with water and absolute ethyl alcohol.

10. Dry the precipitate under the lamp for 30 minutes. Cool and weigh. Mount and count without delay in a proportional counter as Y-90 (Sr-90).

11. Calculate Sr-89 and Sr-90 activity using the computer program for Sr-89,-90.

Section 8.6 B (continued)

Part B Determination

II. Strontium-90

Calculations

a. Strontium-90 concentration (pCi/g) = $\frac{A}{B \times C \times D \times E \times F}$

Where:

A = net beta count rate of yttrium-90 (cpm)
B = recovery of strontium carrier
C = efficiency for counting yttrium-90 as yttrium oxalate (cpm/pCi)
D = sample size (in grams)
E = correction factor $e^{-\lambda t}$ for yttrium-90 decay, where t is the time from decantation of the strontium supernate (Step B-II-4) to the time of counting (Step B-II-10)
F = correction factor $1 - e^{-\lambda t}$ for the degree of equilibrium attained during the yttrium-90 ingrowth period, where t is the time from strontium separation (Step B-I-8) to the time of strontium removal (Step B-II-4).

b. Strontium-89 concentration (pCi/g) = $\frac{1}{B \times C} \left( \frac{A}{DxE} - F(GxH + IxJ) \right)$

Where:

A = net beta count rate of "total radiostrontium": (cpm)
B = counter efficiency for counting strontium-89 as strontium oxalate mounted on a 2.1 cm diameter membrane filter (cpm/pCi)
C = correction factor $e^{-\lambda t}$ for strontium-89 decay, where t is the time from sample collection to the time of counting
D = recovery of strontium carrier
E = sample size (in grams)
F = strontium-90 concentration (pCi/g)
G = self-absorption factor for strontium-90 as strontium oxalate mounted on a 2.1 cm diameter membrane filter
H = counter efficiency for counting strontium-90 as strontium oxalate mounted on a 2.1 cm diameter membrane filter (cpm/pCi)
I = counter efficiency for counting yttrium-90 as yttrium oxalate mounted on a 2.1 cm diameter membrane filter (cpm/pCi).
J = correction factor $1 - e^{-\lambda t}$ for yttrium-90 ingrowth, where t is the time from the last decantation of the nitric acid supernate from the strontium nitrate precipitate to the time of counting (Step B-I-8).

References: Radioassay Procedures for Environmental Samples. U.S. Department of Health, Education and Welfare Environmental Health Series, January 1967. HASL Procedure Manual edited by John H. Harley, 1972.

# APPENDIX IV

# ERRATA

Table 5.0-4

Environmental Radiological Monitoring Program Quarterly Summary

Name of facility Quad Cities Nuclear Power Station Docket No. 50-254, 50-265

Location of facility Rock Island, Illinois (County, State) Reporting Period 3rd Quarter 1984

| Sample Type (Units) | Type and Number of Analyses | LLD | Indicator Locations Mean[a] Range | Location with Highest Quarterly Mean | | Control Locations Mean[a] Range | Number of Non-routine Results |
|---|---|---|---|---|---|---|---|
| | | | | Location | Mean Range | | |
| Air Particulates (pCi/m$^3$) | Gross Beta 77 | 0.01 | 0.028 (76/77) (0.017-0.051) | Q-05, Saddle Club Dairy 1.8 mi @ 160° | 0.032 (12/12) (0.022-0.051) | None | 0 |
| Airborne Iodine (pCi/m$^3$) | I-131 35 | 0.10 | <LLD | - | - | None | 0 |
| Gamma Background (TLDs) (mR/Qtr.) | Gamma Dose 16 | 3.0 | 11.2 (6/6) (8.5-12.6) | Q-11, Port Byron 8.0 mi @ 170° | 13.1 (1/1) - | 10.6 (10/10) (8.3-13.1) | 0 |
| Milk (pCi/l) | I-131 26 | 0.5 | <LLD | - | - | None | 0 |
| Cooling Water (pCi/l) | Gross Beta 42 | 1.0 | 4.2 (13/13) (1.9-5.3) | Q-22A, Diffuser Pipe Blowdown at Station and Q-21, Inlet Canal at station | 4.2 (13/13) | 4.2 (13/13) (1.6-4.8) | 0 |
| | Tritium 1 | 200 | <LLD | - | - | None | 0 |
| Public Water (pCi/l) | Gamma Spec. 6 | | | | | | |
| | Cs-134 10 | 10.0 | <LLD | - | - | None | 0 |
| | Cs-137 10 | 10.0 | <LLD | - | - | None | 0 |
| | Other Gammas | 20.0 | <LLD | - | - | None | 0 |
| Bottom Sediments | Gamma Spec. 1 | | | | | | |
| | Cs-134 | 0.1 | <LLD | - | - | None | 0 |
| | Cs-137 | 0.1 | 0.68 (1/1) | Q-23, Lock & Dam #14 Mississippi River, 15.0 mi @ 220° | 0.68 (1/1) | None | 0 |
| | Other Gammas | 0.2 | <LLD | - | - | None | 0 |

[a] Mean and range based on detectable measurements only. Fractions indicated in parentheses.

60a

TABLE 5.0-1 (continued)

QUAD CITIES STANDARD RADIOLOGICAL MONITORING PROGRAM

| Sample Media | Collection Site | Type of Analysis | Frequency | Non-Routine Reporting Levels[b] |
|---|---|---|---|---|
| 5. Public Water | (a) East Moline Water Works<br>(b) Davenport Water Works | 1. Gamma Isotopic | 1. Monthly Analysis of Weekly Composites | (See footnote e) |
| 6. Cooling Water[f] | (a) Inlet<br>(b) Discharge | 1. Gross Beta | 1. Weekly | |
| 7. Sediment | (a) Lock and Dam No. 14 | Gamma Isotopic | Annually | |
| 8. Dairy Census | (a) Site Boundary to 2 miles | (a) Enumeration by a door-to-door or equivalent counting technique | Annually, during grazing season | |
| | (b) 2 miles to 5 miles | (b) Enumeration by using referenced information from county agricultural agents or other reliable sources. | | |
| | (c) At dairies listed in item 4. | (c) Inquire as to feeding practices.<br>(1) pasture only<br>(2) Feed and chop only<br>(3) Pasture and feed; if both, ask farmer to estimate fraction of food from pasture<br><25%<br>25-50%<br>50-75%<br>>75% | | |

[a] Additional information giving the distance and direction of individual sampling locations may be found in Appendix III of the 1978 Annual Report.

[b] Average concentration over calendar quarter.

[c] A gamma isotopic analysis shall be performed whenever the gross beta concentration in a sample exceeds by five times (5x) the average concentration of the preceding calendar quarter for the sample location.

[d] Bi-weekly shall mean that the frequency is once every other week.

[e] H-3 $2\times10^{4}$, Mn-54 $1\times10^{3}$, Fe-59 $4\times10^{2}$, Co-58 $1\times10^{3}$ Co-60 $3\times10^{2}$, Zn-65 $3\times10^{2}$, Zr-Nb-95 $4\times10^{2}$, I-131 2, Cs-134 30, Cs-137 50, Ba-La-140 $2\times10^{2}$ pCi/l.

[f] Provided by station personnel.