Commonwealth Edison
Dresden Nuclear Power Station
6500 North Dresden Road
Morris, Illinois 60450
Telephone 815/942-2920

March 28, 1994

MDL VPLTR 94-0009

Mr. Jack Martin
Administrator
Nuclear Regulatory Commission
Region III
801 Warrenville Road
Lisle, IL 60532-4351

Dear Mr. Martin:

Enclosed is Part 3 of the 1993 Dresden Station Annual Radiological Environmental Operating Report, Docket Numbers 50-10, 50-237, and 50-249. This report contains the results of the Radiological Environmental and Meteorological Monitoring Programs for the calendar year 1993. Part 1, Facility Operating Experience was submitted under separate cover monthly and Part 2, Radioactive Effluents in August 1993 and February 1994.

Two copies of the report are provided for your use. Two copies will be forwarded to the Document Control Desk and one copy to the Resident Inspector.

Sincerely yours,

Gary Spedl for MDL

Michael D. Lyster
Site Vice President
Dresden Station

MDL:slb

enclosure

cc: File/Numerical
File/NRC

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DRESDEN STATION

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

1993

MARCH 1994

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INTRODUCTION

The Dresden Station is located approximately twelve miles southwest of Joliet, Illinois at the confluence of the Des Plaines and Kankakee Rivers where they form the Illinois River. This station uses two boiling water reactors (G.E. design) to generate electricity. Unit 1, which began operating in 1960 and had a rated power output of 200 megawatts electrical (MWe), was decommissioned on August 31, 1984. Unit 2 and 3 began operating in 1970 and 1971, respectively, each with a rated power output of 800 MWe. The General Electric Morris Operation Plant (GEMO) is located adjacent to Dresden.

Liquid effluents from Dresden are released to the Illinois 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 weekly grab samples of noble gases and continuously collected composite samples of iodine and particulate matter collected during the year. 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 offsite areas are calculated using isotopic composition of control effluent and meteorological data.

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

SUMMARY

Gaseous and liquid effluents for the period remained below the Technical Specification limits. Calculations of environmental concentrations based on effluent, Illinois River flow, and meteorological data for the period indicate that consumption by the public of radioactive materials attributable to the plant are unlikely to exceed regulatory limits. Radiation exposure from radionuclides released to the atmosphere represented the critical pathway for the period with a maximum adult dose estimated to be 1.66E-04 mrem for the year, where a shielding and occupancy factor of 0.7 is assumed. The assessment of radiation doses is performed in accordance with the Offsite Dose Calculation Manual (ODCM). The results of analysis confirm that the station is operating in compliance with 10CFR50 Appendix I and 40CFR190.

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. No measurable amount of noble gases was released from Dresden Unit 1 and a total of 3.82E+01 curies of noble gases with a maximum quarterly average release rate of 1.94 µCi/sec was released from Dresden Units 2 and 3.

A total of 1.01E-03 curies of I-131 was released during the year.

A total of 5.22E-02 curies of beta-gamma emitters and 1.05E-05 curies of Alpha emitters was released as airborne particulate matter with a maximum quarterly average release rate of 3.06E-03 µCi/sec. Also, 7.05 curies of tritium were released.

1.2 Liquids Released to Illinois River

A total of 7.63E+08 liters of radioactive liquid wastes containing 2.17E-01 curies (excluding tritium, gases and gross alpha) was discharged from the station. These wastes were released at a maximum quarterly average concentration of 3.37E-08 µCi/ml from Units 2 and 3. During the same period, 2.33E+01 curies of tritium and 2.06E-06 curies of alpha radioactivity were released. Quarterly release estimates are given in Table 1.2-1. This resulted in a calculated total body dose of 2.49E-02 mrem, which is <1.0% of the 10CFR50 Appendix I yearly total body dose limit (Table 3.2-1).

2.0 SOLID RADIOACTIVE WASTE

Solid radioactive wastes were shipped to CNSI, Barnwell, South Carolina; Quadrex, Oak Ridge, Tennessee; and SEG, Oak Ridge, Tennessee; CNSI, Channahon, Illinois. 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

Offsite gamma air and total body doses are shown in Table 3.1-1 and were calculated based on measured release rates, isotopic composition of the noble gases, and average meteorological data for the period. Isodose contours of gamma dose are shown in Figure 3.1-1. Based on measured effluents and meterological data, the maximum dose to an adult would be 1.66E-04 mrem for the year, with an occupancy or shielding factor of 0.7 included. The maximum gamma air dose was 2.72E-04 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 the 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 7.0 mg/cm^2 and an occupancy factor of 1.0 is used. This skin dose from beta and gamma radiation for the year was 3.56E-04 mrem (Table 3.1-1).

The air concentrations of radioactive noble gases at the offsite receptor locations are given in Figure 3.1-2. The maximum offsite beta air dose for the year was 4.49E-04 mrad.

Radioactive Iodine

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

Iodine Concentrations in Air

The calculated concentration contours for iodine in air are shown in Figure 3.1-3. These calculations include an iodine cloud depletion factor which accounts for the phenomenon of elemental iodine deposition on the ground. The maximum iodine offsite average concentration is estimated to be 4.88E-04 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 through October. The maximum infant's thyroid dose was less than 3.96E-02 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 offsite average level is estimated to be 6.17E-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 tracts, thyroid, bone, skin; specific parameters for use in the equations given in the Commonwealth Edison Offsite Dose Calculation Manual. The maximum whole body dose for the year was 2.49E-02 mrem and no organ dose exceeded 7.93E-02 mrem (Table 3.2-1).

3.3 Assessment of Dose to Member of Public

In Section 3/4.8 of the Dresden Technical Specifications, 40CFR190 calculations of total dose due to the Uranium Fuel Cycle are required only when calculated doses from liquid or gaseous releases of radioactivity exceed certain levels.

- The RETS limits on dose or dose commitment to a member of the public due to radioactive materials in liquid effluents from each reactor unit (3 mrem to the whole body or 10 mrem to any organ during any calendar quarter; 6 mrem to the whole body or 20 mrem to any organ during any calendar year).
- The RETS limits on air dose in noble gases released in gaseous effluents to a member of the public from each reactor unit (5 mrad for gamma radiation or 10 mrad for beta radiation during any calendar quarter; 10 mrad for gamma radiation or 20 mrad for beta radiation during any calendar year).
- The RETS limits on dose to a member of the public due to Iodine-131, Iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released from each reactor unit (7.5 mrem to any organ during any calendar quarter: 15 mrem to any organ during any calendar year).

During the period January to December, 1993, Dresden Station did not exceed these criteria offsite and members of the public did not exceed these criteria.

4.0 SITE METEOROLOGY

A summary of the site meterological measurements taken during each calendar quarter of the year is given in Appendix II. The data are presented as cumulative joint frequency distributions of the wind direction for the 300' level and wind speed class by atmospheric stability class determined from the temperature difference between the 300' and 35' levels. Data recovery for all measurements on the tower was 99.6%.

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

5.0 ENVIRONMENTAL MONITORING

Table 5.0-1 and Table 5.0-2 provides an outline of the Radiological Environmental Monitoring Program (REMP) as required in current Technical Specifications. Tables 5.0-3 to 5.0-6 summarize data for the year.

Except for tables of special interest, tabulated results of these analyses are no longer included in the annual report. All data tables are available for inspection at the Station or in the Corporate Office.

Specific findings for various environmental media are discussed below.

5.1 Gamma Radiation

External radiation dose from onsite sources and noble gases released to the atmosphere was measured at eleven indicator and six control (background) locations using $CaSO_4$:Tm thermoluminescent dosimeters (TLDs). Each location consists of 2 TLD sets. A comparison of the TLD results for reference stations with onsite and offsite indicator stations is included in Table 5.1-1. On June 1, 1980 52 TLD's at site boundary and five mile radius locations were installed. An additional 18 TLD's at 9 site boundary and five mile radius locations were added 4th Quarter 1993. TLD results are listed in Table 5.1-1 and locations are shown in Figures 5.0-1 and 5.0-2.

Quarterly external radiation dose at seventeen air sampling locations averaged 15.5 mR and was similar to that measured in 1985 (13.5 mR), 1986 (14.4 mR), 1987 (15.8 mR), 1988 (14.9 mR), 1989 (15.7 mR), 1990 (14.9 mR), 1991 (14.0 mR), and 1992 (15.6mR). The differences are not statistically significant.

5.2 Airborne I-131 and Particulate Radioactivity

Locations of the samplers are shown in Figure 5.0-3. Airborne I-131 remained below the LLD of 0.10 pCi/m^3 throughout the year in all samples.

Gross beta concentrations ranged from 0.004 to 0.051 pCi/m^3 and averaged 0.021 pCi/m^3, and were similar to those in 1983 (0.02 pCi/m^3), 1984 (0.02 pCi/m^3), 1985 (0.02 pCi/m^3), 1986 (0.025 pCi/m^3, except for the period from May 17 through June 7 when it was influenced by the nuclear reactor accident at Chernobyl), 1987 (0.024 pCi/m^3), 1988 (0.027 pCi/m^3), 1989 (0.024 pCi/m^3), 1990 (0.020 pCi/m^3) , and 1991 (0.020 pCi/m^3), and 1992 (0.022 pCi/m^3). Gamma emitting isotopes were below the LLD level of 0.01 pCi/m^3.

No radioactivity attributable to plant operation was detected in any sample.

5.3 Aquatic Radioactivity

Near station water locations and more distant water locations are shown in Figures 5.0-4 and 5.0-5, respectively.

Cooling water samples were collected daily and composited weekly for gross beta analysis from the Unit 1 Inlet Canal and Units 1 and 2/3 Discharge Canals. The yearly gross beta concentration averages for the Inlet Canal and the Discharge Canals for 1993 were 3.5 pCi/L and 3.4 pCi/L, respectively. During the 11 year sampling period (1983-1993) the concentration averages ranged from 3.1 pCi/L in the Unit 1 Inlet Canal (1992), to an average 6.2 pCi/L in the Units 2/3 Discharge Canals (1985). The overall concentration averages for the 11 years were 4.2 pCi/L for both.

In 1993 there were no unusual measurements of radioactivity in the Inlet Canal as previously seen and reported in 1990 and 1991. In 1990 the Inlet Canal sample collected on April 4, 1990 had detectable levels of Co-60 (227.8 pCi/L) and Cs-137 (72.8 pCi/L). In 1991 the Inlet Canal sample collected on March 1, 1991 had detectable levels of Cs-137 (178 pCi/L), Co-60 (92 pCi/L) and Mn-54 (19 pCi/L). The source of the unusual levels of radioactivity was investigated and believed to be caused by contaminated soil randomly being washed into the Inlet Canal via storm sewers.

Surface water samples collected weekly from the Illinois River at the EJ&E RR Bridge and Illinois River at Morris Water Works were composited monthly and analyzed for gamma emitters. Cs-134 and Cs-137 levels were below the detection limit of 10 pCi/L and all other gamma emitters were below the detection limit of 20 pCi/L in all samples collected during the year.

Identical results were obtained in 1983 through 1992.

Well water samples were collected quarterly beginning October 1980 and analyzed for gross alpha, gross beta, and tritium. The levels of activity detected were generally in the range to be expected in this medium in the environment and were not attributable to station operation.

Levels of gamma radioactivity in fish samples were measured and found in all cases to be below the lower limits of detection of 0.1 pCi/g wet weight for Cs-134 and Cs-137 and less than 0.2 pCi/g wet weight for other gammas. The results were similar to those obtained in 1983 through 1992.

A sediment sample was analyzed by gamma spectroscopy. Level of Cs-134 and Cs-137 was below the LLD level of 0.1 pCi/g dry weight. Other gamma emitters were below the LLD level of 0.2 pCi/g dry weight.

5.4 Milk

Milk sample locations are shown in Figure 5.0-5. Milk samples were collected weekly during the grazing season (May through October) and monthly during the balance of the year from two required farms: Vince Biros Farm (control location), located about 11.5 miles south southwest; and Halpin's Dairy, located about 16.0 miles south. I-131 was determined for each sample by chemical separation of 1-131 and beta counting.

I-131 remained below the detection limits of 5.0 pCi/L during the non-grazing period (November through April) and 0.5 pCi/L during the grazing period (May through October). The results were identical to those obtained during the 1983 - 1992 period except for samples collected during the second and third quarters of 1986. I-131 detected in milk samples during this period is attributable to the nuclear accident at Chernobyl.

5.5 Special Collections

Service water contaminated by leaks in the LPCI heat exchanger was released into the cooling lake early in 1978. To monitor effects on the concentration of radioactivity in the cooling canal, a program of collecting weekly grab samples of water at the Dresden Road and County Line Road crossings of the canal began in October 1978. Concentrations of both gross beta and gamma activities have not indicated the presence of detectable concentrations of radioactivity due to the station. Data are listed in Table 1.0-1.

5.6 Listing of Missed Samples

All samples were collected as scheduled except for those listed in Listing of Missed Samples, Appendix III.

5.7 Program Modifications

Various editorial changes were made to the ODCM Chapter 11. Figures 11-1, 11-2, and 11-3 were revised to include new TLD locations and update existing sampling locations.

Since 1990, Halpin's Dairy (D-26) has been incorrectly noted in the Annual Reports as:

1990	Figure 5.0-5 (page 37)	incorrectly located
	Table 5.0-2 (page 40)	5.6 miles @ 200°
	Appendix IV, Milch Animals Census, 1990	5.6 miles @ 200°
1991	Figure 5.0-5 (page 38)	incorrectly located
	Table 5.0-2 (page 41)	5.6 miles @ 200°
	Appendix IV, Milch Animals Census, 1991	15.8 miles @ 180°
1992	Figure 5.0-5 (page 39)	incorrectly located
	Table 5.0-2 (page 42)	5.6 miles @ 200°
	Appendix III, Milch Animals Census, 1992	15.8 miles @ 200°

This dairy was also incorrectly noted in the ODCM Table 11-1 as 6.1 miles, and incorrectly located on Figure 11-3. This dairy is actually located 16 miles @ 175° from Dresden Station. Figure 5.0-5 (page 36), Table 5.0-2 (page 39) and Appendix IV, Milch Animals Census, 1993 in this report have been revised to reflect this correction and the table and figure in the ODCM are in the process of being revised. Dresden Station's dose calculations for dairies assume a distance of 5 miles since there are no dairies within a 5 mile radius. This inaccuracy in the distance of the dairy from the

Station has no impact on the doses to the public which have been previously calculated.

Since 1989 Section 3.3 Direct Radiation (revised in 1990 to read Assessment of Dose to Member of the Public) incorrectly stated that "These levels are twice the following limits." This statement has been removed.

The following 18 TLDs at 9 site boundary and five mile radius locations were added for fourth quarter:

D-103-1,2
D-104-1,2
D-105-1,2
D-107-1,2
D-108-1,2
D-110-3,4
D-111-1,2
D-114-1,2
D-212-3,4

The 100 Series (site boundary) and 200 Series (at an approximately five mile radius) TLDs have been included in the Quarterly Summary Tables 5.0-1 through 5.0-4. The 100 Series and 200 series TLDs were both considered indicator TLDs.

A more rigid definition for the quarter has been adopted for 1994. Each quarter shall be 13 weeks long. The week shall start on Monday and end on Sunday, with Week #1 (1994) beginning on the first Monday of January (1/3/94). Due to this new definition all samples collected prior to 1/3/94 shall be reported as 19[illegible] amples.

The sample results are no longer reported as <LLD but as X±2S; TPU where X is the significant result, S is the one standard deviation counting uncertainty, and TPU is the total propogated uncertainty. The procedure governing the TPU calculation is located in Appendix VI.

6.0 ANALYTICAL PROCEDURES

Analytical procedures used for analyzing and reporting radioactivity in environmental samples are presented in Appendix VI.

7.0 MILCH ANIMALS AND NEAREST CATTLE CENSUSES

Censuses of milch animals and nearest cattle were conducted within a five mile radius of the station. The survey was conducted by "door-to-door" canvas by A. Lewis on August 23, 24, and 25, 1993. Results of the milch animal and nearest cattle censuses are presented in Appendix IV.

There are no dairy farms within a five mile radius of the Dresden Nuclear Power Station.

8.0 NEAREST RESIDENCES CENSUS

The nearest resident census was conducted on August 23, 24, and 25, 1993. Results of the nearest resident census are presented in Appendix IV.

9.0 INTERLABORATORY COMPARISON PROGRAM RESULTS

Teledyne's Interlaboratory Comparison Program Results are presented in Appendix V.

Commonwealth Edison's Thermoluminescent Dosimeter (TLD) Program is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) which requires biennial review and evaluation. In addition to the biennial ANSI tested requirement, Commonwealth Edison also tests to the ANSI standard during the non-NVLAP visitation year. Commonwealth Edison additionally had an internal irradiation program that tests each of the six nuclear station TLD processors once per quarter. The results of all TLD performance tests are retained by Commonwealth Edison's Corporate Health Physics Support.

APPENDIX I

DATA TABLES AND FIGURES

TABLE 1.0-1

DRESDEN NUCLEAR POWER STATION

Radioactivity in Water Samples from Dresden Cooling Lake

(Weekly Collections)
(pCi/L)

Collection Date	Dresden Road Crossing D-34A		County Line Road Crossing D-34B		Collection Date	Dresden Road Crossing D-34A		County Line Road Crossing D-34B	
	Gross Beta	Gamma Emitters	Gross Beta	Gamma Emitters		Gross Beta	Gamma Emitters	Gross Beta	Gamma Emitters
01-08-93	3.4±0.9;0.9	<10	3.3±0.9;0.9	<10	07-10-93	4.0±1.0;1.0	<10	3.1±0.9;0.9	<10
01-16-93	4.4±1.0;1.0	<10	4.2±1.0;1.0	<10	07-17-93	3.8±0.9;0.9	<10	3.9±0.9;0.9	<10
01-23-93	3.0±0.6;0.6	<10	6.1±1.2;1.3	<10	07-24-93	3.5±1.0;1.0	<10	4.9±1.0;1.0	<10
01-30-93	3.8±1.0;1.0	<10	3.0±0.9;0.9	<10	08-01-93	3.8±0.9;0.9	<10	3.7±1.0;1.0	<10
02-06-93	4.9±0.8;0.8	<10	4.4±1.0;1.0	<10	08-08-93	2.4±0.6;0.6	<10	3.3±1.1;1.1	<10
02-12-93	4.0±1.2;1.2	<10	4.5±1.0;1.0	<10	08-15-93	2.4±1.0;1.0	<10	3.8±1.0;1.0	<10
02-20-93	2.3±1.0;1.0	<10	4.3±1.0;1.0	<10	08-21-93	3.2±1.0;1.0	<10	3.2±1.0;1.0	<10
02-27-93	3.5±0.7;0.7	<10	3.5±0.7;0.7	<10	08-28-93	3.2±0.9;0.9	<10	3.5±1.1;1.1	<10
03-06-93	3.2±0.7;0.7	<10	3.5±0.6;0.6	<10	09-04-93	3.6±1.0;1.0	<10	3.7±0.9;0.9	<10
03-13-93	2.8±0.6;0.6	<10	2.4±0.6;0.6	<10	09-11-93	3.8±1.0;1.0	<10	4.4±1.0;1.0	<10
03-20-93	3.9±1.0;1.0	<10	4.0±1.0;1.0	<10	09-18-93	3.9±1.0;1.0	<10	4.1±1.0;1.0	<10
03-27-93	2.5±0.9;0.9	<10	3.3±1.0;1.0	<10	09-25-93	3.6±1.0;1.0	<10	3.2±0.9;0.9	<10
04-03-93	3.3±0.9;0.9	<10	3.7±1.0;1.0	<10	10-02-93	3.5±1.0;1.0	<10	3.2±0.9;0.9	<10
04-10-93	3.2±0.5;0.5	<10	2.7±0.9;0.9	<10	10-09-93	5.1±1.0;1.0	<10	4.2±1.0;1.0	<10
04-17-93	3.0±0.5;0.5	<10	3.1±0.9;0.9	<10	10-16-93	4.1±0.8;0.8	<10	3.4±0.7;0.7	<10
04-24-93	3.7±0.9;0.9	<10	4.2±0.7;0.7	<10	10-23-93	3.2±0.9;0.9	<10	4.9±1.0;1.0	<10
05-01-93	3.4±0.6;0.6	<10	3.4±0.7;0.7	<10	10-30-93	3.9±1.0;1.0	<10	4.6±1.0;1.0	<10
05-08-93	3.6±0.9;0.9	<10	4.3±1.0;1.0	<10	11-06-93	4.3±1.0;1.0	<10	3.7±1.0;1.0	<10
05-15-93	3.4±0.9;0.9	<10	2.9±0.9;0.9	<10	11-13-93	5.0±0.8;0.8	<10	4.4±1.1;1.1	<10
05-22-93	3.6±0.9;0.9	<10	3.3±1.0;1.0	<10	11-20-93	3.9±1.0;1.0	<10	4.2±1.1;1.1	<10
05-29-93	3.1±0.9;0.9	<10	3.0±0.9;0.9	<10	11-27-93	4.7±1.0;1.0	<10	4.9±0.7;0.8	<10
06-05-93	3.1±0.9;0.9	<10	3.9±1.0;1.0	<10	12-04-93	4.3±1.0;1.0	<10	4.2±1.0;1.0	<10
06-12-93	3.0±0.9;0.9	<10	3.5±1.0;1.0	<10	12-11-93	4.5±1.0;1.3	<10	3.5±1.0;1.0	<10
06-19-93	2.8±0.9;0.9	<10	3.1±0.9;0.9	<10	12-18-93	4.6±1.1;1.1	<10	3.8±0.7;0.7	<10
06-26-93	3.3±1.0;1.0	<10	3.3±0.9;0.9	<10	12-24-93	3.7±1.0;1.0	<10	2.7±0.9;0.9	<10
07-03-93	2.4±0.8;0.8	<10	3.6±0.9;0.9	<10	01-01-94	3.4±0.9;0.9	<10	4.8±1.1;1.1	<10

TABLE 1.1-1

DRESDEN NUCLEAR POWER STATION
UNITS 1,2, AND 3
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT
January Through June 1993

GASEOUS EFFLUENTS Docket Numbers: 50-10
50-237
SUMMATION OF ALL RELEASES 50-249

TYPE OF RELEASE	UNITS	1st QUARTER	2nd QUARTER	EST.TOTAL ERROR,%
FISSION AND ACTIVATION GASES				
1. Total Release	Ci	1.03+00	7.32E+00	7.31
2. Average Release Rate for Period	uCi/sec	1.32E-01	9.31E-01	
3. Percent of Technical Specification Limit	%	*	*	
B. IODINES				
1. Total Iodine-131	Ci	3.44E-04	1.32E-04	21.6
2. Average Release Rate of I-131 for Period	uCi/sec	4.42E-05	1.68E-05	
3. Percent of Technical Specification Limit	%	*	*	
4. Total Iodine-131,Iodine-133,and Iodine-135	Ci	3.17E-03	1.07E-03	
C. PARTICULATES				
1. Particulates with half-lives > 8 days	Ci	1.45E-02	2.41E-02	34.1
2. Average Release Rate for Period	uCi/sec	1.86E-03	3.06E-03	
3. Percent of Technical Specification Limit	%	*	*	
4. Gross Alpha Radioactivity	Ci	5.20E-06	8.12E-07	
D. TRITIUM				
1. Total Release	Ci	2.04E+00	1.51E+00	7.89
2. Average Release Rate for Period	uCi/sec	2.62E-01	1.93E-01	
3. Percent of Technical Specification Limit	%	*	*	

* The information is contained in the Radiological Impact on Man section of the report. Total airborne release data is provided which includes fission and activation gases, iodines, particulates, and tritium.

TABLE 1.1-1 (continued)

DRESDEN NUCLEAR POWER STATION
UNITS 1,2, AND 3
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT
July Through December 1993

GASEOUS EFFLUENTS Docket Numbers: 50-10
50-237
SUMMATION OF ALL RELEASES 50-249

TYPE OF RELEASE	UNITS	3rd QUARTER	4th QUARTER	EST.TOTAL ERROR,%
FISSION AND ACTIVATION GASES				
1. Total Release	Ci	1.44E+01	1.54E+01	7.31
2. Average Release Rate for Period	uCi/sec	1.81E+00	1.94E+00	
3. Percent of Technical Specification Limit	%	*	*	
B. IODINES				
1. Total Iodine-131	Ci	3.56E-04	1.80E-04	21.6
2. Average Release Rate of I-131 for Period	uCi/sec	4.48E-05	2.26E-05	
3. Percent of Technical Specification Limit	%	*	*	
4. Total Iodine-131,Iodine-133,and Iodine-135	Ci	2.64E-03	1.47E-03	
C. PARTICULATES				
1. Particulates with half-lives > 8 days	Ci	6.63E-03	6.94E-03	34.1
2. Average Release Rate for Period	uCi/sec	8.34E-04	8.73E-04	
3. Percent of Technical Specification Limit	%	*	*	
4. Gross Alpha Radioactivity	Ci	2.41E-06	2.06E-06	
D. TRITIUM				
1. Total Release	Ci	2.44E+00	1.06E+00	7.65
2. Average Release Rate for Period	uCi/sec	3.07E-01	1.33E-01	
3. Percent of Technical Specification Limit	%	*	*	

* The information is contained in the Radiological Impact on Man section of the report. Total airborne release data is provided which includes fission and activation gases, iodines, particulates, and tritium.

TABLE 1.2-1

DRESDEN NUCLEAR POWER STATION
UNITS 1, 2, and 3
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT
January Through June 1993
LIQUID EFFLUENTS

SUMMATION OF ALL RELEASES Docket Numbers: 50-10
50-237
50-249

	UNITS	1st QUARTER	2nd QUARTER	EST. TOTAL ERROR, %
A. FISSION AND ACTIVATION PRODUCTS				
1. Total Release (not incl. tritium, gases, alpha)	Ci	8.80E-02	4.04E-02	10.6
2. Average Diluted Conc. During Period	uCi/mL	3.37E-08	3.57E-09	
3. Percent of Applicable Limit	%	*	*	
B. TRITIUM				
1. Total Release	Ci	4.24E+00	5.61E+00	11.4
2. Average Diluted Conc. During Period	uCi/mL	1.63E-06	4.96E-07	
3. Percent of Applicable Limit	%	*	*	
C. DISSOLVED AND ENTRAINED GASES				
1. Total Release	Ci	<LLD	< LLD	5.58
2. Average Diluted Conc. During Period	uCi/mL	<LLD	< LLD	
3. Percent of Applicable Limit	%	*	*	
D. GROSS ALPHA RADIOACTIVITY				
1. Total Release	Ci	6.86E-07	1.37E-06	15.1
E. VOLUME OF WASTE RELEASED (prior to dilution)	Liters	7.42E+08	9.49E+06	5.00
F. VOLUME OF DILUTION WATER USED DURING PERIOD	liters	1.87E+09	1.13E+10	5.00

* The information is contained in the Radiological Impact on Man section of this report. Total liquid release data is provided which includes fission and activation products, tritium and dissolved and entrained gases.

TABLE 1.2-1 (continued)

DRESDEN NUCLEAR POWER STATION
UNITS 1, 2, and 3
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT
July Through December 1993
LIQUID EFFLUENTS

SUMMATION OF ALL RELEASES Docket Numbers: 50-10
50-237
50-249

	UNITS	3rd QUARTER	4th QUARTER	EST. TOTAL ERROR,%
A. FISSION AND ACTIVATION PRODUCTS				
1. Total Release (not incl. tritium, gases, alpha)	Ci	8.10E-02	7.89E-03	10.6
2. Average Diluted Conc. During Period	uCi/mL	1.78E-09	1.75E-08	
3. Percent of Applicable Limit	%	*	*	
B. TRITIUM				
1. Total Release	Ci	1.09E+01	2.50E+00	11.4
2. Average Diluted Conc. During Period	uCi/mL	2.40E-07	5.54E-06	
3. Percent of Applicable Limit	%	*	*	
C. DISSOLVED AND ENTRAINED GASES				
1. Total Release	Ci	<LLD	< LLD	5.58
2. Average Diluted Conc. During Period	uCi/mL	<LLD	< LLD	
3. Percent of Applicable Limit	%	*	*	
D. GROSS ALPHA RADIOACTIVITY				
1. Total Release	Ci	< LLD	< LLD	15.1
E. VOLUME OF WASTE RELEASED (prior to dilution)	Liters	9.53E+06	2.22E+06	5.00
F. VOLUME OF DILUTION WATER USED DURING PERIOD	liters	4.55E+10	4.51E+08	5.00

* The information is contained in the Radiological Impact on Man section of this report. Total liquid release data is provided which includes fission and activation products, tritium, and dissolved and entrained gases.

TABLE 2.0-1

DRESDEN NUCLEAR POWER STATION
UNITS 1, 2, AND 3
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT

January Through June 1993

Docket Numbers: 50-10
50-237
50-249

SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (NOT IRRADIATED FUEL)

1. Type of Waste

	Unit	6-month period	Est Tot. Error,%
a. Spent resins, filter sludges, evaporator bottoms, etc.	m3	1.86E+02	
	Ci	4.45E+02	12.4
b. Dry compressible waste, contaminated equip., etc.	m3	1.10E+03	
	Ci	1.36E+01	16.6
c. Irradiated components, control rods, etc.	m3	6.55E+00	
	Ci	1.89E+04	16.6
d. Other (describe)	m3	None	
	Ci	None	

2. Estimate of Major Nuclide Composition (by type of waste)

		%	Ci
a.	Co-60	29.2	1.30E+02
	Fe-55	58.7	2.61E+02
	Mn-54	6.40	2.85E+01
	Cs-137	3.98	1.77E+01
b.	Co-60	20.8	2.83E+00
	Fe-55	63.2	8.60E+00
	Mn-54	10.2	1.39E+00
	Ni-59	1.30	1.77E-01
	Ni-63	1.01	1.37E-01
	Cs-137	2.96	4.03E-01
c.	Co-60	32.3	6.11E+03
	Mn-54	2.58	4.87E+02
	Fe-55	58.2	1.10E+04
	Ni-63	6.51	1.23E+03

3. Solid Waste Disposition

NUMBER OF SHIPMENTS	MODE OF TRANSPORTATION	DESTINATION
49	Motor freight (exclusive use only)	CNSI, Barnwell, SC
11	Motor freight (exclusive use only)	Quadrex, Oak Ridge, TN
3	Motor freight (exclusive use only)	CNSI, Channahon, IL
4	Motor freight (exclusive use only)	SEG, Oak Ridge, TN

B. IRRADIATED FUEL SHIPMENTS (Disposition)

NUMBER OF SHIPMENTS	MODE OF TRANSPORTATION	DESTINATION
None		

TABLE 2.0-1 (continued)

DRESDEN NUCLEAR POWER STATION
UNITS 1, 2, AND 3
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT

July Through December 1993

Docket Numbers: 50-10
50-237
50-249

SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (NOT IRRADIATED FUEL)

1. Type of Waste	Unit	6-month period	Est Tot. Error, %
a. Spent resins, filter sludges, evaporator bottoms, etc.	m3	2.66E+02	
	Ci	7.20E+02	12.4
b. Dry compressible waste, contaminated equip., etc.	m3	5.56E+02	
	Ci	8.37E+00	16.6
c. Irradiated components, control rods, etc.	m3	1.64E+00	
	Ci	4.91E+02	16.6
d. Other (describe) sewage treatment plant dirt.	m3	1.09E+01	
	Ci	1.00E-01	

2. Estimate of Major Nuclide Composition (by type of waste)

		%	Ci
a.	Co-60	66.0	4.75E+02
	Fe-55	5.71	4.11E+01
	Mn-54	13.2	9.51E+01
	Cs-137	11.6	8.38E+01
	Ni-63	1.67	1.20E+01
b.	Co-60	25.2	2.11E+00
	Fe-55	58.8	4.92E+00
	Mn-54	9.35	7.83E-01
	Ni-59	2.23	1.87E-01
	Cs-137	2.62	2.19E-01
c.	Co-60	28.5	1.40E+02
	Fe-55	4.7	2.35E+01
	Ni-63	65.8	3.23E+02
d.	Co-60	56.8	5.68E-02
	Ni-59	9.11	9.11E-03
	Fe-55	2.68	2.68E-02
	Zn-65	1.87	1.87E-03
	Mn-54	3.21	3.21E-03

3. Solid Waste Disposition

NUMBER OF SHIPMENTS	MODE OF TRANSPORTATION	DESTINATION
60	Motor freight (exclusive use only)	CNSI, Barnwell, SC
1	Motor freight (exclusive use only)	Quadrex, Oak Ridge, TN
3	Motor freight (exclusive use only)	CNSI, Channahon, IL
7	Motor freight (exclusive use only)	SEG, Oak Ridge, TN

B. IRRADIATED FUEL SHIPMENTS (Disposition)

NUMBER OF SHIPMENTS	MODE OF TRANSPORTATION	DESTINATION
None		

TABLE 2.1-1

DRESDEN NUCLEAR POWER STATION
UNITS 1, 2, AND 3
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT

January Through June 1993

ABNORMAL RELEASES

A. LIQUID

1. Number of Releases: 1

2. Total Activity Released: 7.41E-02 Ci

B. GASEOUS

1. Number of Releases: 0

2. Total Activity Released: 0

TOTAL 1

A. 1. On February 18, a routine Service Water Sample from Unit 2 showed activity with a proportional counter. The concurrent Gamma spectroscopy showed no activity. All activity was assumed to be Sr-90 at 101 pCi/l. Water flow was calculated at 202,000 gpm. The activity was assumed to be present between samples with activity less than LLD (16 hrs). The resulting activity is:

Sr-90 7.41E-02Ci

TABLE 2.1-1 (continued)

DRESDEN NUCLEAR POWER STATION
UNITS 1, 2, AND 3
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT

July Through December 1993

ABNORMAL RELEASES

A. LIQUID

1. Number of Releases: 1

2. Total Activity Released: 7.40E-03 Ci

B. GASEOUS

1. Number of Releases: 0

2. Total Activity Released: 0

TOTAL 1

A. 1. In August, 1993, water was discovered on the floor of the Unit 1 Radwaste tunnel. Due to cracks in the floor, there was potential for release of radioactivity to the environment. The tunnel has since been repaired. Volume which may have been released was estimated as if the entire tunnel volume up to the level of the lowest penetration was filled and released. The resulting activity is:

Mn-54	8.4E-05 Ci
Co-60	2.6E-03 Ci
Cs-134	1.3E-05 Ci
Cs-137	4.7E-03 Ci

FIGURE 3.1-1

Estimated Cumulative Gamma Dose (in mrem) from the Dresden Station for the period January-December 1993

<u>Isopleth Labels</u>
Small figure - multiply by 10^{-6}
Large figure - multiply by 10^{-6}

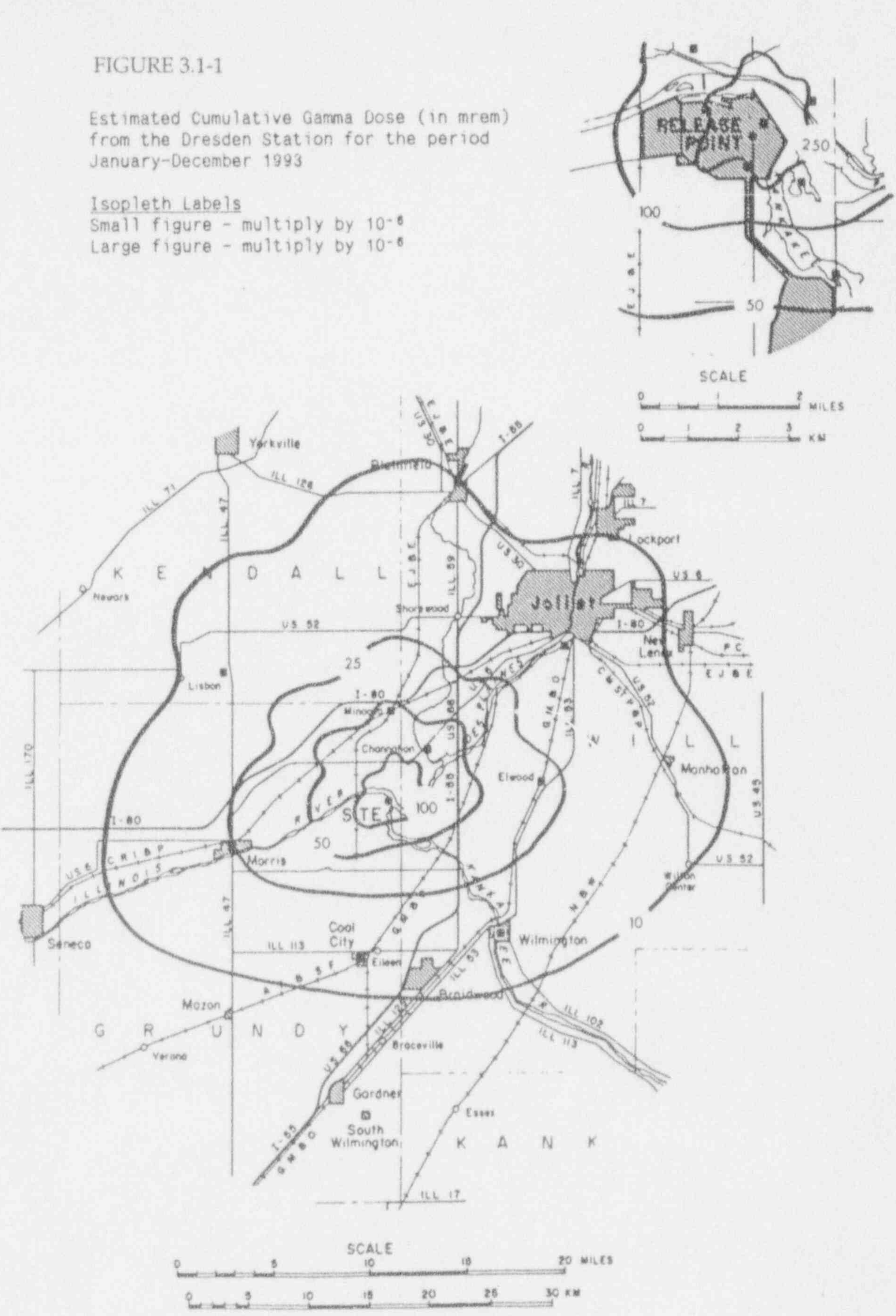


FIGURE 3.1-2

Estimated Total Concentrations (in pCi/m^3) of Noble Gases from the Dresden Station for the period January-December 1993

Isopleth Labels
Small figure - multiply by 10^{-2}
Large figure - multiply by 10^{-2}

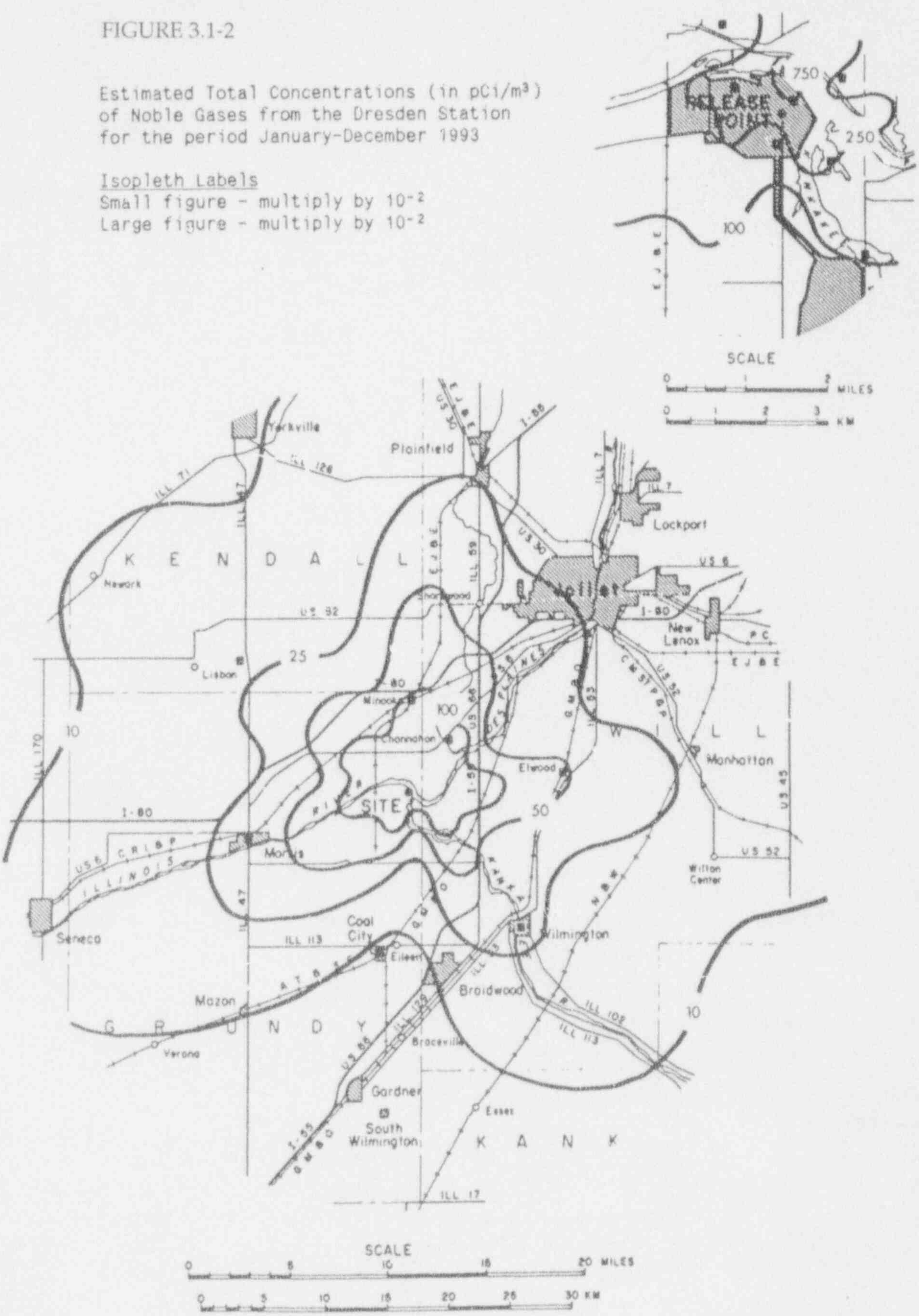


FIGURE 3.1-3

Estimated Total Concentrations (in pCi/m^3) of Iodine from the Dresden station for the period January-December 1993

<u>Isopleth Labels</u>
Small figure - multiply by 10^{-6}
Large figure - multiply by 10^{-6}

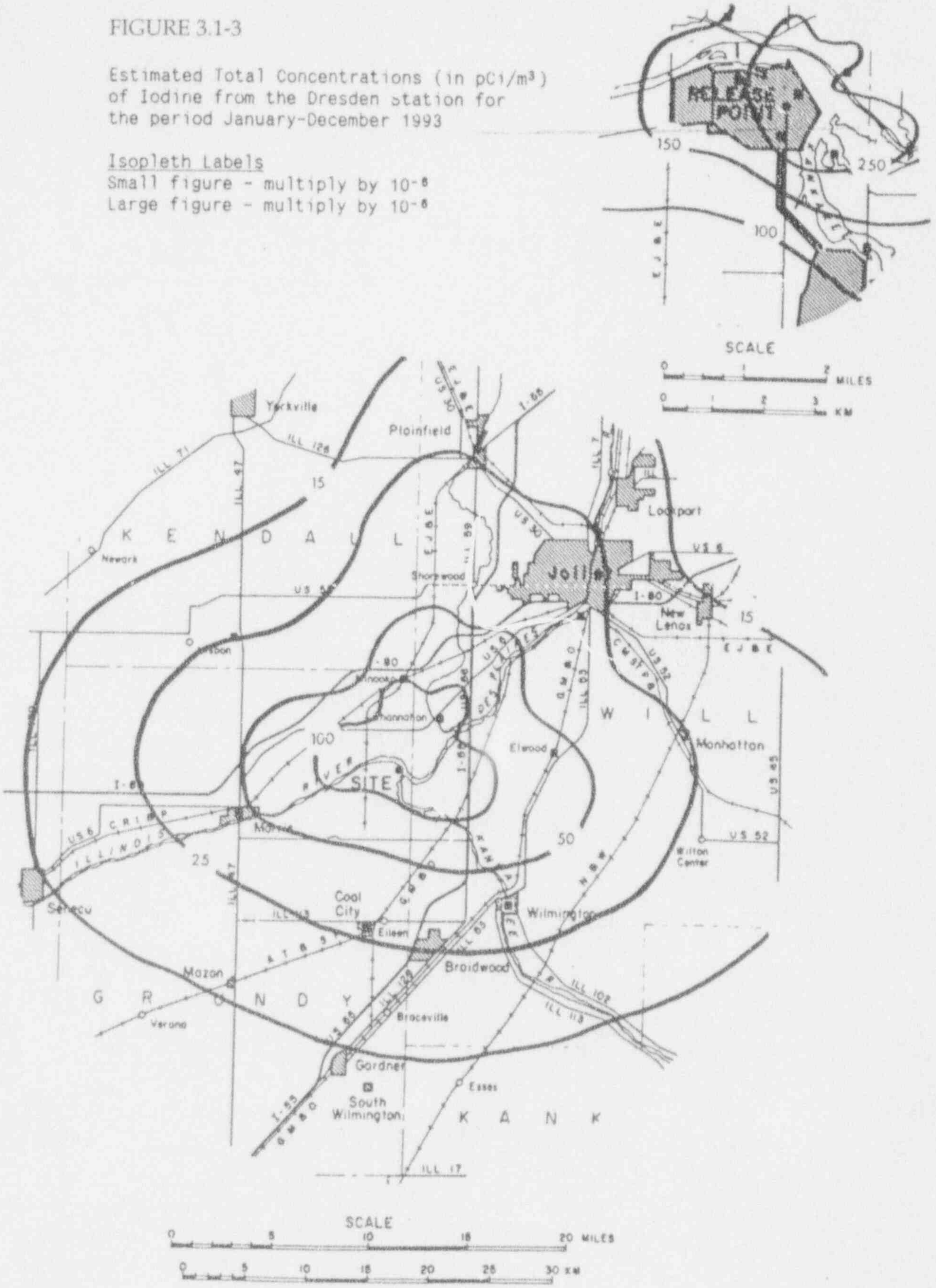
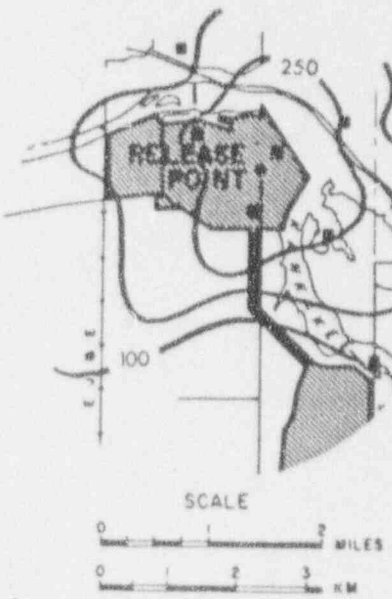


FIGURE 3.1-4

Estimated Total Concentrations (in pCi/m³) of Particulate Matter from the Dresden Station for the period January-December 1993

Isopleth Labels
Small figure - multiply by 10⁻⁵
Large figure - multiply by 10⁻⁵



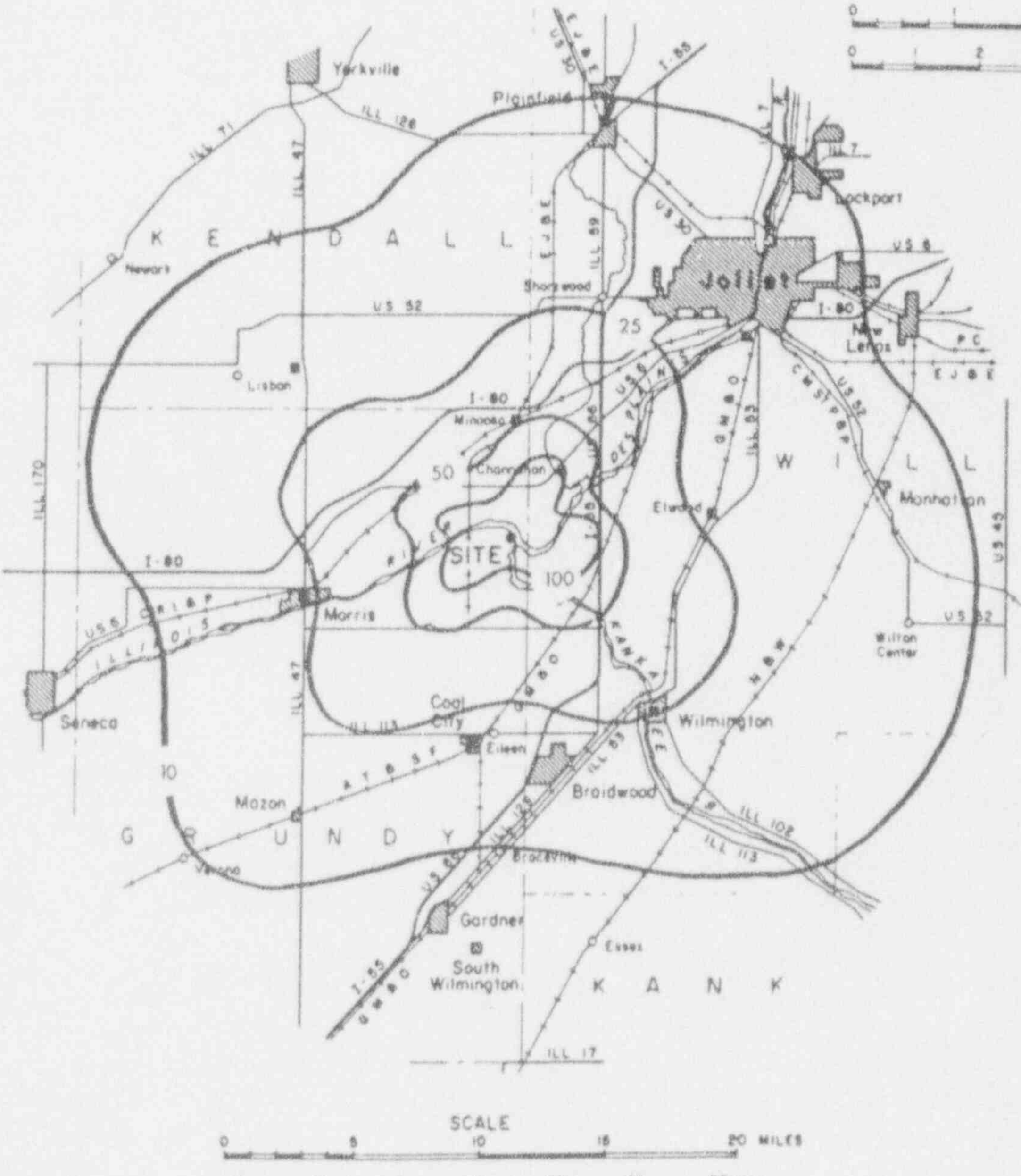


TABLE 3.1-1

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                                 DRESDEN STATION UNIT ONE

                                       ACTUAL 1993
                        MAXIMUM DOSES RESULTING FROM AIRBORNE RELEASES
              PERIOD OF RELEASE - 01/01/93 TO 12/31/93   CALCULATED 02/25/94
                                     INFANT RECEPTOR

                        1ST        2ND        3RD         4TH
TYPE                  QUARTER    QUARTER    QUARTER     QUARTER     ANNUAL
                      JAN-MAR    APR-JUN    JUL-SEP     OCT-DEC

GAMMA AIR             0.00E+00   0.00E+00   0.00E+00    0.00E+00    0.00E+00
 (MRAD)               (     )    (     )    (     )     (     )     (     )
BETA AIR              0.00E+00   0.00E+00   0.00E+00    0.00E+00    0.00E+00
 (MRAD)               (     )    (     )    (     )     (     )     (     )
TOT. BODY             0.00E+00   0.00E+00   0.00E+00    0.00E+00    0.00E+00
 (MREM)               (     )    (     )    (     )     (     )     (     )
SKIN                  0.00E+00   0.00E+00   0.00E+00    0.00E+00    0.00E+00
 (MREM)               (     )    (     )    (     )     (     )     (     )
ORGAN                 6.12E-05   1.29E-06   1.57E-06    3.41E-07    6.38E-05
 (MREM)               (SSE )     (E    )    (E    )     (E    )     (SSE )

                      LIVER      LUNG       THYROID     LUNG        LIVER
     THIS IS A REPORT FOR THE CALENDAR YEAR 1993


                              COMPLIANCE STATUS - 10CFR 50 APP. I
                                        INFANT RECEPTOR

                             ------------ % OF APP I. ------------

                     QTRLY   1ST QTR    2ND QTR    3RD QTR    4TH QTR    YRLY   % OF
                      OBJ    JAN-MAR    APR-JUN    JUL-SEP    OCT-DEC    OBJ    APP. I
GAMMA AIR (MRAD)      5.0      0.00       0.00       0.00       0.00     10.0     0.00
BETA AIR (MRAD)      10.0      0.00       0.00       0.00       0.00     20.0     0.00
TOT. BODY (MREM)      2.5      0.00       0.00       0.00       0.00      5.0     0.00
SKIN (MREM)           7.5      0.00       0.00       0.00       0.00     15.0     0.00
ORGAN (MREM)          7.5      0.00       0.00       0.00       0.00     15.0     0.00

                         LIVER      LUNG       THYROID    LUNG                LIVER

                RESULTS BASED UPON:     ODCM ANNEX REVISION    0.K JANUARY 1993
                                        ODCM SOFTWARE VERSION 0.1 APRIL 1993
                                        ODCM DATABASE VERSION 0.1 APRIL 1993
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TABLE 3.1-1 (continued)

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                      DRESDEN STATION UNIT ONE

                             ACTUAL 1993
              MAXIMUM DOSES RESULTING FROM AIRBORNE RELEASES
      PERIOD OF RELEASE - 01/01/93 TO 12/31/93   CALCULATED 02/25/94
                           ADULT RECEPTOR

                       1ST         2ND         3RD          4TH
TYPE                 QUARTER     QUARTER     QUARTER      QUARTER     ANNUAL
                     JAN-MAR     APR-JUN     JUL-SEP      OCT-DEC

GAMMA AIR           0.00E+00    0.00E+00    0.00E+00    0.00E+00    0.00E+00
 (MRAD)             (     )     (     )     (     )     (     )     (     )
BETA AIR            0.00E+00    0.00E+00    0.00E+00    0.00E+00    0.00E+00
 (MRAD)             (     )     (     )     (     )     (     )     (     )
TOT. BODY           0.00E+00    0.00E+00    0.00E+00    0.00E+00    0.00E+00
 (MREM)             (     )     (     )     (     )     (     )     (     )
SKIN                0.00E+00    0.00E+00    0.00E+00    0.00E+00    0.00E+00
 (MREM)             (     )     (     )     (     )     (     )     (     )
ORGAN               5.11E-05    8.64E-06    5.88E-06    1.07E-06    6.23E-05
 (MREM)             (SSE )      (SSE )      (SSE )      (SSE )      (SSE )

                    LIVER       BONE        THYROID     BONE        BONE
     THIS IS A REPORT FOR THE CALENDAR YEAR 1993


                 COMPLIANCE STATUS - 10CFR 50 APP. I
                            ADULT RECEPTOR

                          ------------ % OF APP I. ------------

                     QTRLY   1ST QTR    2ND QTR    3RD QTR    4TH QTR    YRLY    % OF
                     OBJ     JAN-MAR    APR-JUN    JUL-SEP    OCT-DEC    OBJ     APP. I
GAMMA AIR (MRAD)      5.0     0.00       0.00       0.00       0.00      10.0     0.00
BETA AIR (MRAD)      10.0     0.00       0.00       0.00       0.00      20.0     0.00
TOT. BODY (MREM)      2.5     0.00       0.00       0.00       0.00       5.0     0.00
SKIN (MREM)           7.5     0.00       0.00       0.00       0.00      15.0     0.00
ORGAN (MREM)          7.5     0.00       0.00       0.00       0.00      15.0     0.00

                             LIVER      BONE       THYROID    BONE                BONE

          RESULTS BASED UPON:      ODCM ANNEX REVISION   0.K JANUARY 1993
                                   ODCM SOFTWARE VERSION 0.1 APRIL 1993
                                   ODCM DATABASE VERSION 0.1 APRIL 1993
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TABLE 3.1-1 (continued)

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                         DRESDEN STATION UNIT TWO

                               ACTUAL 1993
               MAXIMUM DOSES RESULTING FROM AIRBORNE RELEASES
      PERIOD OF RELEASE - 01/01/93 TO 12/31/93   CALCULATED 02/25/94
                             INFANT RECEPTOR

                    1ST        2ND        3RD         4TH
TYPE              QUARTER    QUARTER    QUARTER     QUARTER     ANNUAL
                  JAN-MAR    APR-JUN    JUL-SEP     OCT-DEC

GAMMA AIR         1.24E-06   6.83E-06   5.32E-05    4.11E-05   1.02E-04
 (MRAD)           (N    )    (N    )    (N    )     (N    )    (N    )
BETA AIR          2.32E-07   1.39E-06   1.62E-04    1.01E-04   2.65E-04
 (MRAD)           (E    )    (E    )    (N    )     (N    )    (N    )
TOT. BODY         8.21E-07   4.57E-06   2.98E-05    2.39E-05   5.92E-05
 (MREM)           (N    )    (N    )    (N    )     (N    )    (N    )
SKIN              1.13E-06   6.50E-06   8.90E-05    6.24E-05   1.59E-04
 (MREM)           (N    )    (N    )    (N    )     (N    )    (N    )
ORGAN             1.78E-03   2.77E-03   7.90E-04    4.38E-04   5.73E-03
 (MREM)           (N    )    (N    )    (N    )     (N    )    (N    )

                  LUNG       LUNG       THYROID     THYROID    THYROID
     THIS IS A RFPORT FOR THE CALENDAR YEAR 1993



                      COMPLIANCE STATUS - 10CFR 50 APP. I
                              INFANT RECEPTOR

                     ------------ % OF APP I. ------------

                     QTRLY   1ST QTR   2ND QTR   3RD QTR   4TH QTR   YRLY   % OF
                      OBJ    JAN-MAR   APR-JUN   JUL-SEP   OCT-DEC   OBJ    APP. I
GAMMA AIR (MRAD)      5.0     0.00      0.00      0.00      0.00     10.0    0.00
BETA AIR (MRAD)      10.0     0.00      0.00      0.00      0.00     20.0    0.00
TOT. BODY (MREM)      2.5     0.00      0.00      0.00      0.00      5.0    0.00
SKIN (MREM)           7.5     0.00      0.00      0.00      0.00     15.0    0.00
ORGAN (MREM)          7.5     0.02      0.04      0.01      0.01     15.0    0.04

                             LUNG      LUNG     THYROID   THYROID          THYROID

          RESULTS BASEח UPON:      ODCM ANNEX REVISION   0.K JANUARY 1993
                                   ODCM SOFTWARE VERSION 0.1 APRIL 1993
                                   ODCM DATABASE VERSION 0.1 APRIL 1993
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TABLE 3.1-1 (continued)

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                         DRESDEN STATION UNIT TWO

                               ACTUAL 1993
              MAXIMUM DOSES RESULTING FROM AIRBORNE RELEASES
        PERIOD OF RELEASE - 01/01/93 TO 12/31/93   CALCULATED 02/25/94
                              ADULT RECEPTOR


                        1ST        2ND        3RD          4TH
TYPE                  QUARTER    QUARTER    QUARTER      QUARTER     ANNUAL
                      JAN-MAR    APR-JUN    JUL-SEP      OCT-DEC

GAMMA AIR             1.24E-06   6.83E-06   5.32E-05     4.11E-05   1.02E-04
 (MRAD)               (N    )    (N    )    (N    )      (N    )    (N    )
BETA AIR              2.32E-07   1.39E-06   1.62E-04     1.01E-04   2.65E-04
 (MRAD)               (E    )    (E    )    (N    )      (N    )    (N    )
TOT. BODY             8.21E-07   4.57E-06   2.98E-05     2.39E-05   5.92E-05
 (MREM)               (N    )    (N    )    (N    )      (N    )    (N    )
SKIN                  1.13E-06   6.50E-06   8.90E-05     6.24E-05   1.59E-04
 (MREM)               (N    )    (N    )    (N    )      (N    )    (N    )
ORGAN                 1.79E-03   2.82E-03   1.00E-03     4.93E-04   6.03E-03
 (MREM)               (N    )    (N    )    (N    )      (N    )    (N    )

                      LUNG       GI_LLI     THYROID      THYROID    THYROID
      THIS IS A REPORT FOR THE CALENDAR YEAR 1993



                    COMPLIANCE STATUS - 10CFR 50 APP. I
                              ADULT RECEPTOR

                   ------------ % OF APP I. ------------

                 QTRLY   1ST QTR   2ND QTR   3RD QTR   4TH QTR   YRLY   % OF
                  OBJ    JAN-MAR   APR-JUN   JUL-SEP   OCT-DEC   OBJ    APP. I
GAMMA AIR (MRAD)  5.0     0.00      0.00      0.00      0.00     10.0    0.00
BETA AIR (MRAD)  10.0     0.00      0.00      0.00      0.00     20.0    0.00
TOT. BODY (MREM)  2.5     0.00      0.00      0.00      0.00      5.0    0.00
SKIN (MREM)       7.5     0.00      0.00      0.00      0.00     15.0    0.00
ORGAN (MREM)      7.5     0.02      0.04      0.01      0.01     15.0    0.04

                          LUNG      GI_LLI    THYROID   THYROID          THYROID

          RESULTS BASED UPON:     ODCM ANNEX REVISION    0.K JANUARY 1993
                                  ODCM SOFTWARE VERSION 0.1 APRIL 1993
                                  ODCM DATABASE VERSION 0.1 APRIL 1993
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TABLE 3.1-1 (continued)

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                       DRESDEN STATION UNIT THREE

                              ACTUAL 1993
                MAXIMUM DOSES RESULTING FROM AIRBORNE RELEASES
       PERIOD OF RELEASE - 01/01/93 TO 12/31/93    CALCULATED 02/25/94
                              INFANT RECEPTOR

                          1ST        2ND        3RD         4TH
TYPE                    QUARTER    QUARTER    QUARTER     QUARTER     ANNUAL
                        JAN-MAR    APR-JUN    JUL-SEP     OCT-DEC

GAMMA AIR               5.21E-06   6.01E-05   6.89E-05    3.58E-05    1.70E-04
 (MRAD)                 (N    )    (N    )    (N    )     (N    )     (N    )
BETA AIR                9.74E-07   1.18E-05   1.65E-04    7.22E-06    1.84E-04
 (MRAD)                 (E    )    (E    )    (N    )     (E    )     (N    )
TOT. BODY               3.45E-06   4.00E-05   4.02E-05    2.37E-05    1.07E-04
 (MREM)                 (N    )    (N    )    (N    )     (N    )     (N    )
SKIN                    4.76E-06   5.62E-05   1.03E-04    3.28E-05    1.97E-04
 (MREM)                 (N    )    (N    )    (N    )     (N    )     (N    )
ORGAN                   1.60E-02   9.27E-03   4.98E-03    3.73E-03    3.38E-02
 (MREM)                 (N    )    (N    )    (N    )     (N    )     (N    )

                        LUNG       THYROID    THYROID     THYROID     THYROID
     THIS IS A REPORT FOR THE CALENDAR YEAR 1993
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                        COMPLIANCE STATUS - 10CFR 50 APP. I
                                INFANT RECEPTOR

                       ------------ % OF APP I. ------------

                   QTRLY   1ST QTR    2ND QTR   3RD QTR   4TH QTR   YRLY    % OF
                    OBJ    JAN-MAR    APR-JUN   JUL-SEP   OCT-DEC   OBJ     APP. I
GAMMA AIR (MRAD)    5.0     0.00       0.00      0.00      0.00     10.0    0.00
BETA AIR (MRAD)    10.0     0.00       0.00      0.00      0.00     20.0    0.00
TOT. BODY (MREM)    2.5     0.00       0.00      0.00      0.00      5.0    0.00
SKIN (MREM)         7.5     0.00       0.00      0.00      0.00     15.0    0.00
ORGAN (MREM)        7.5     0.21       0.12      0.07      0.05     15.0    0.23

                           LUNG     THYROID   THYROID   THYROID            THYROID

          RESULTS BASED UPON:     ODCM ANNEX REVISION    0.K JANUARY 1993
                                  ODCM SOFTWARE VERSION 0.1 APRIL 1993
                                  ODCM DATABASE VERSION 0.1 APRIL 1993
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TABLE 3.1-1 (continued)

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                         DRESDEN STATION UNIT THREE

                                ACTUAL 1993
                 MAXIMUM DOSES RESULTING FROM AIRBORNE RELEASES
      PERIOD OF RELEASE - 01/01/93 TO 12/31/93   CALCULATED 02/25/94
                              ADULT RECEPTOR

                      1ST        2ND        3RD         4TH
 TYPE               QUARTER    QUARTER    QUARTER     QUARTER     ANNUAL
                    JAN-MAR    APR-JUN    JUL-SEP     OCT-DEC

 GAMMA AIR          5.21E-06   6.01E-05   6.89E-05    3.58E-05   1.70E-04
  (MRAD)            (N   )     (N   )     (N   )      (N   )     (N   )
 BETA AIR           9.74E-07   1.18E-05   1.65E-04    7.22E-06   1.84E-04
  (MRAD)            (E   )     (E   )     (N   )      (E   )     (N   )
 TOT. BODY          3.45E-06   4.00E-05   4.02E-05    2.37E-05   1.07E-04
  (MREM)            (N   )     (N   )     (N   )      (N   )     (N   )
 SKIN               4.76E-06   5.62E-05   1.03E-04    3.28E-05   1.97E-04
  (MREM)            (N   )     (N   )     (N   )      (N   )     (N   )
 ORGAN              1.60E-02   1.05E-02   6.39E-03    4.19E-03   3.64E-02
  (MREM)            (N   )     (N   )     (N   )      (N   )     (N   )

                    LUNG       GI_LLI     THYROID     THYROID    GI_LLI
      THIS IS A REPORT FOR THE CALEÑDAR YEAR 1993


                      COMPLIANCE STATUS - 10CFR 50 APP. I
                                ADULT RECEPTOR

                        ------------ % OF APP I. ------------

                    QTRLY   1ST QTR   2ND QTR   3RD QTR   4TH QTR   YRLY   % OF
                    OBJ     JAN-MAR   APR-JUN   JUL-SEP   OCT-DEC   OBJ    APP. I
GAMMA AIR (MRAD)     5.0     0.00      0.00      0.00      0.00     10.0    0.00
BETA AIR (MRAD)     10.0     0.00      0.00      0.00      0.00     20.0    0.00
TOT. BODY (MREM)     2.5     0.00      0.00      0.00      0.00      5.0    0.00
SKIN (MREM)          7.5     0.00      0.00      0.00      0.00     15.0    0.00
ORGAN (MREM)         7.5     0.21      0.14      0.09      0.06     15.0    0.24

                           LUNG     GI_LLI    THYROID   THYROID          GI_LLI

          RESULTS BASED UPON:     ODCM ANNEX REVISION    0.K JANUARY 1993
                                  ODCM SOFTWARE VERSION 0.1 APRIL 1993
                                  ODCM DATABASE VERSION 0.1 APRIL 1993
```

TABLE 3.2-1

DRESDEN STATION UNIT TWO

ACTUAL 1993
MAXIMUM DOSES (MREM) RESULTING FROM AQUATIC EFFLUENTS
PERIOD OF RELEASE - 01/01/93 TO 12/31/93 CALCULATED 02/25/94
ADULT RECEPTOR

DOSE TYPE	1ST QUARTER JAN-MAR	2ND QUARTER APR-JUN	3RD QUARTER JUL-SEP	4TH QUARTER OCT-DEC	ANNUAL
TOTAL BODY	1.72E-02	8.36E-04	2.39E-03	5.95E-04	2.10E-02
INTERNAL ORGAN	6.91E-02	1.26E-03	3.64E-03	9.04E-04	7.33E-02
	BONE	LIVER	LIVER	LIVER	BONE

THIS IS A REPORT FOR THE CALENDAR YEAR 1993

COMPLIANCE STATUS - 10 CFR 50 APP. I

		------------	% OF APP I.	------------			
	QTRLY OBJ	1ST QTR JAN-MAR	2ND QTR APR-JUN	3RD QTR JUL-SEP	4TH QTR OCT-DEC	YRLY OBJ	% OF APP. I
TOTAL BODY (MREM)	1.5	1.14	0.06	0.16	0.04	3.0	0.70
CRIT. ORGAN(MREM)	5.0	1.38	0.03	0.07	0.02	10.0	0.73
		BONE	LIVER	LIVER	LIVER		BONE

RESULTS BASED UPON: ODCM ANNEX REVISION 0.K JANUARY 1993
ODCM SOFTWARE VERSION 0.1 APRIL 1993
ODCM DATABASE VERSION 0.1 APRIL 1993

TABLE 3.2-1 (continued)

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                          DRESDEN STATION UNIT THREE

                                 ACTUAL 1993
               MAXIMUM DOSES (MREM) RESULTING FROM AQUATIC EFFLUENTS
         PERIOD OF RELEASE - 01/01/93 TO 12/31/93   CALCULATED 02/25/94
                                ADULT RECEPTOR

                        1ST        2ND        3RD        4TH
DOSE TYPE             QUARTER    QUARTER    QUARTER    QUARTER    ANNUAL
                      JAN-MAR    APR-JUN    JUL-SEP    OCT-DEC

TOTAL                 1.65E-04   7.87E-04   2.39E-03   5.95E-04   3.94E-03
BODY
INTERNAL              2.43E-04   1.19E-03   3.64E-03   9.04E-04   5.98E-03
ORGAN
                      LIVER      LIVER      LIVER      LIVER      LIVER

       THIS IS A REPORT FOR THE CALENDAR YEAR 1993


                      COMPLIANCE STATUS - 10 CFR 50 APP. I

                        ------------ % OF APP I. ------------

                    QTRLY   1ST QTR    2ND QTR    3RD QTR    4TH QTR    YRLY    % OF
                     OBJ    JAN-MAR    APR-JUN    JUL-SEP    OCT-DEC    OBJ     APP. I

TOTAL BODY (MREM)   1.5      0.01       0.05       0.16       0.04       3.0     0.13

CRIT. ORGAN(MREM)   5.0      0.00       0.02       0.07       0.02      10.0     0.06

                            LIVER      LIVER      LIVER      LIVER              LIVER

          RESULTS BASED UPON:     ODCM ANNEX REVISION   0.K JANUARY 1993
                                  ODCM SOFTWARE VERSION 0.1 APRIL 1993
                                  ODCM DATABASE VERSION 0.1 APRIL 1993
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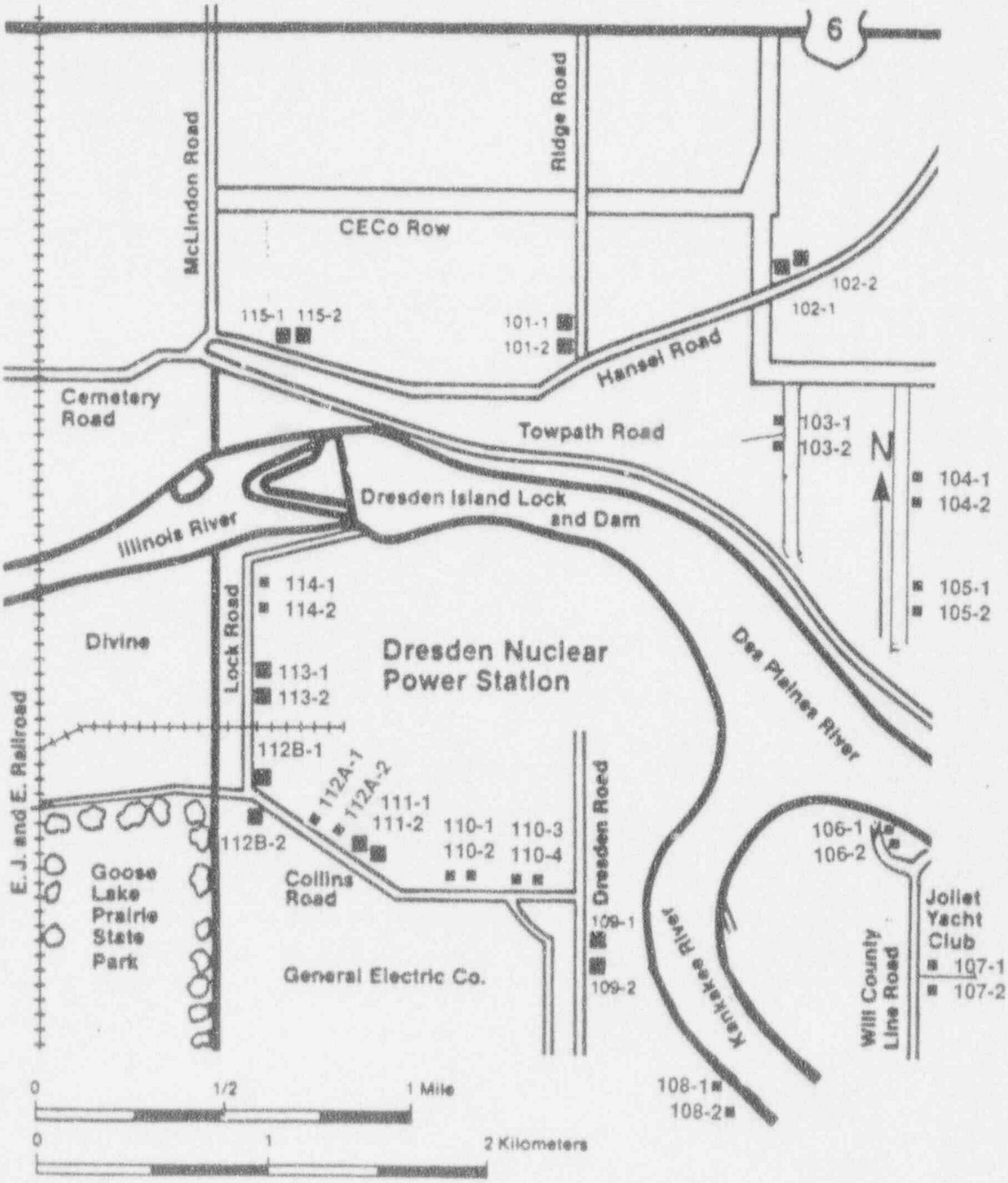
FIGURE 5.0-1

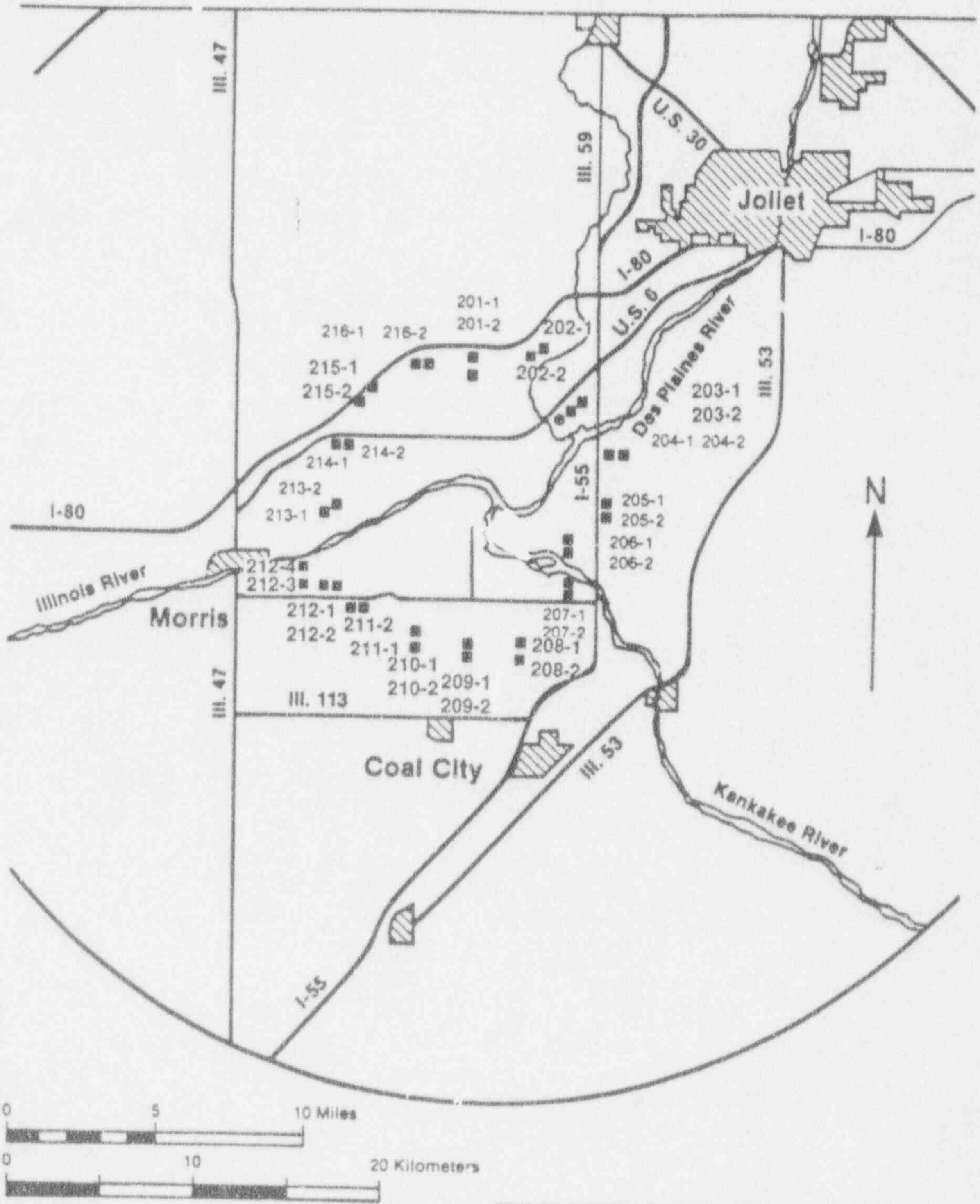


■ TLD Location

DRESDEN STATION
UNITS 1,2 & 3

INNER RING TLD LOCATIONS

FIGURE 5.0-2

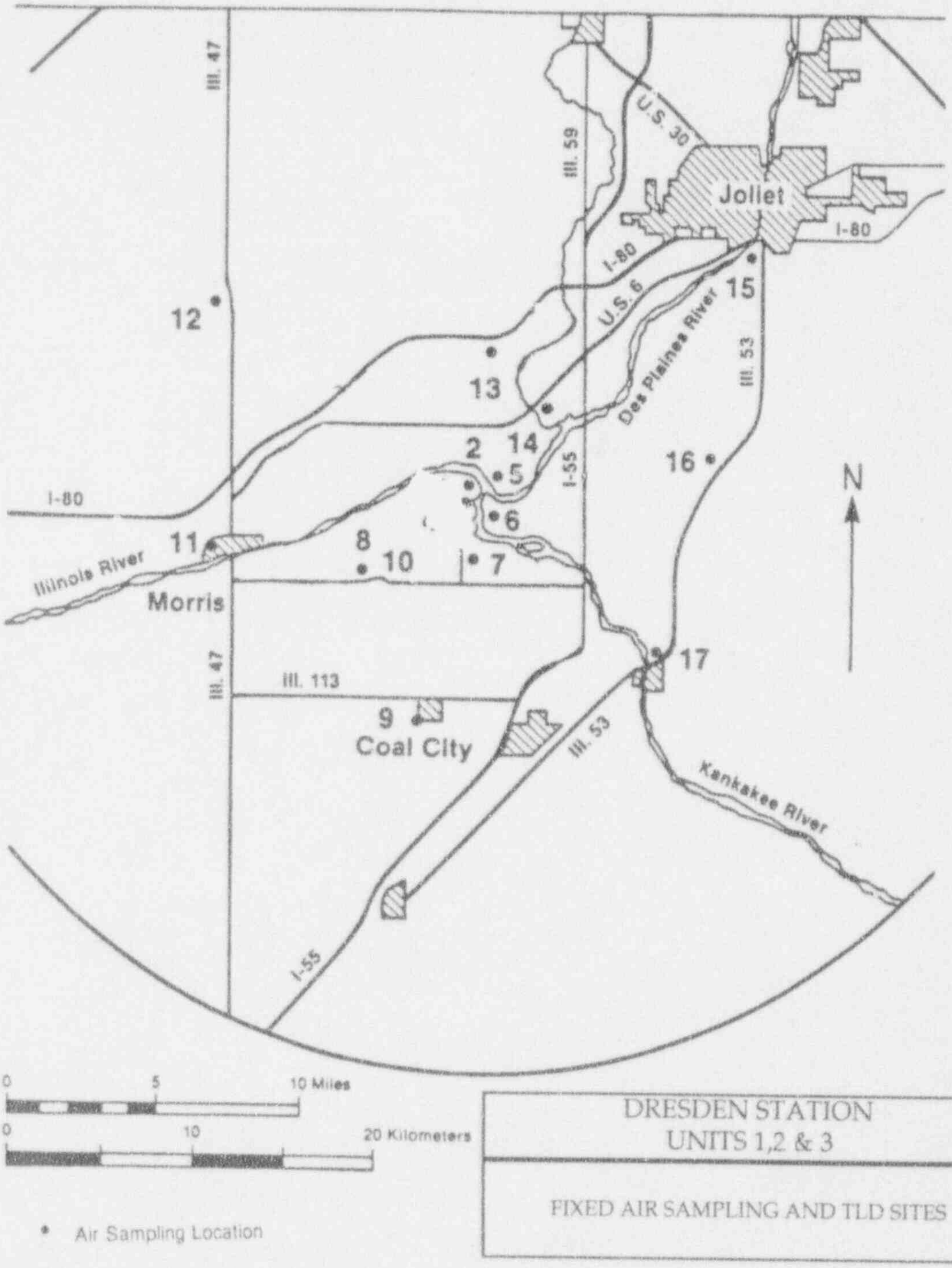


DRESDEN STATION
UNITS 1,2 & 3

OUTER RING TLD LOCATIONS

■ TLD Location

FIGURE 5.0-3



DRESDEN STATION
UNITS 1,2 & 3

FIXED AIR SAMPLING AND TLD SITES

D-01 Onsite Station 1
D-02 Onsite Station 2
D-03 Onsite Station 3
D-04 Collins Road
D-05 Bennitt Farm
D-06 Will County Road
D-07 Clay Products
D-08 Prairie Parks
D-09 Coal City
D-10 Goose Lake Village
D-11 Morris
D-12 Lisbon
D-13 Minooka
D-14 Channahon
D-15 Joliet
D-16 Elwood
D-17 Wilmington

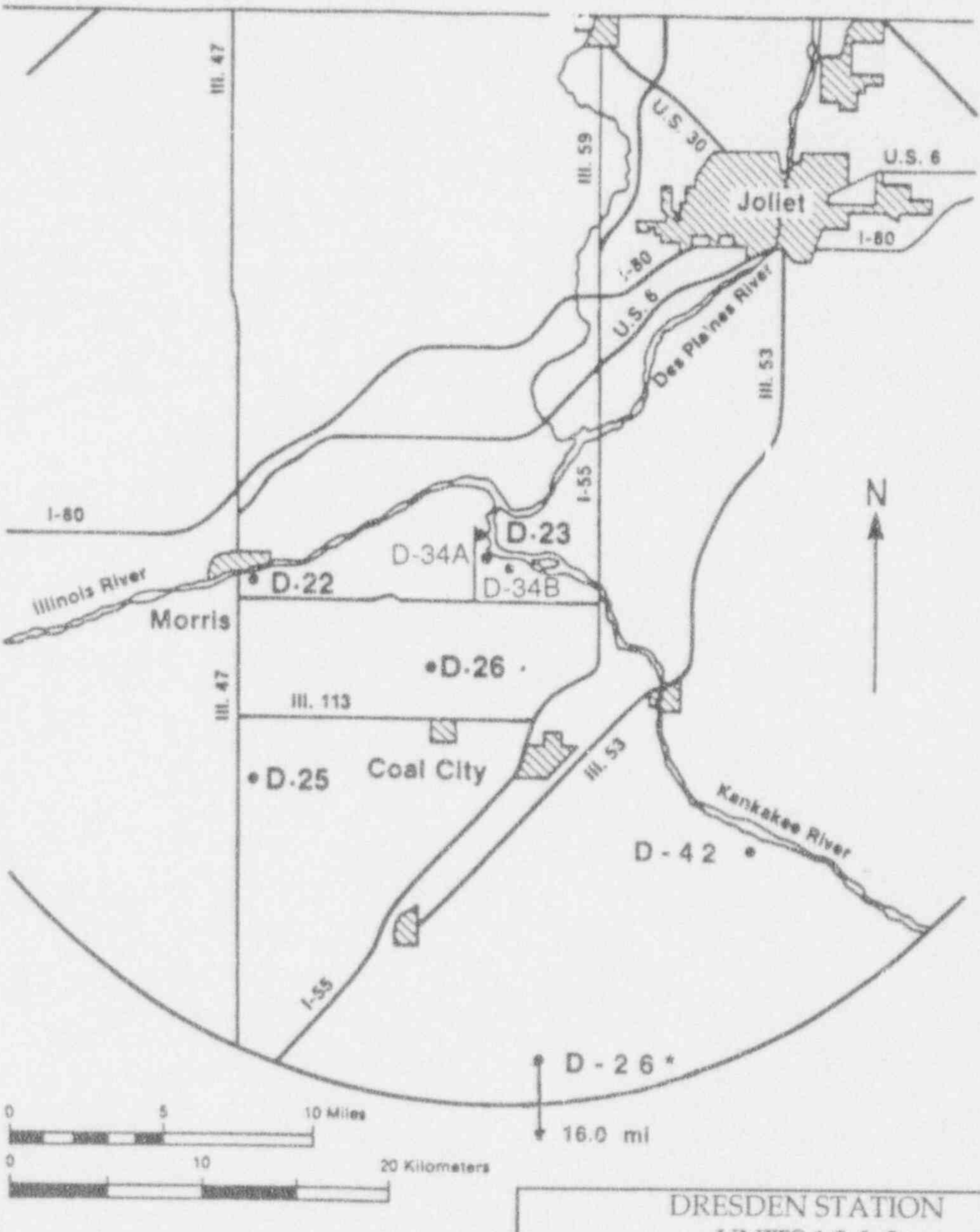
FIGURE 5.0-4

DRESDEN STATION
UNITS 1,2 & 3

NEAR STATION WATER SAMPLE LOCATIONS

D-18 Inlet Canal
D-19 Discharge - Unit 1
D-20 Discharge - Unit 2/3
D-21 Illinois River at EJ&E RR Bridge
D-28 Dresden Pool at Illinois River
D-35 Dresden Lock & Dam

FIGURE 5.0-5



• Sampling Location

* This location is incorrectly designated in the ODCM.

DRESDEN STATION
UNITS 1,2 & 3

MILK SAMPLE LOCATIONS AND MORE DISTANT WATER SAMPLE LOCATIONS

D-22 Illinois River at Morris Water Works
D-23 Thorsen Well
D-25 Vine Biros Farm
D-26 Halpin's Dairy
D-34A Cooling Lake - Dresden Road Crossing
D-34B Cooling Lake - County Line Crossing
D-42 Goodwin Dairy

TABLE 5.0-1

Dresden Station Radiological Environmental Monitoring Locations	Air Sampling	TLD	Cooling Water	Fish	Lake Water	Milk	Sediments	Surface Water	Ground/Well Water
D-01 Onsite Station 1	0	0	.	.	.	.	.	.	.
D-02 Onsite Station 2	0	0	.	.	.	.	.	.	.
D-03 Onsite Station 3	0	0	.	.	.	.	.	.	.
D-04 Collins Road	0	0	.	.	.	.	.	.	.
D-05 Bennitt Farm	0	0	.	.	.	.	.	.	.
D-06 Will County Road	0	0	.	.	.	.	.	.	.
D-07 Clay Products	0	0	.	.	.	.	.	.	.
D-08 Prairie Parks	0	0	.	.	.	.	.	.	.
D-09 Coal City	0	0	.	.	.	.	.	.	.
D-10 Goose Lake Village	0	0	.	.	.	.	.	.	.
D-11 Morris	0	0	.	.	.	.	.	.	.
D-12 Lisbon	0	0	.	.	.	.	.	.	.
D-13 Minooka	0	0	.	.	.	.	.	.	.
D-14 Channahon	0	0	.	.	.	.	.	.	.
D-15 Joliet	0	0	.	.	.	.	.	.	.
D-16 Elwood	0	0	.	.	.	.	.	.	.
D-17 Wilmington	0	0	.	.	.	.	.	.	.
D-18 Inlet Canal	.	.	0	.	.	.	.	.	.
D-19 Discharge - Unit 1	.	.	0	.	.	.	.	.	.
D-20 Discharge - Unit 2/3	.	.	0	.	.	.	.	.	.
D-21 Illinois River at EJ&E RR Bridge	.	.	.	.	.	.	.	0	.
D-22 Illinois River at Morris Water Works	.	.	.	.	.	.	.	0	.
D-23 Thorsen Well	.	.	.	.	.	.	.	.	0
D-25 Vince Biros Farm	.	.	.	.	.	0	.	.	.
D-26 Halpin's Dairy	.	.	.	.	.	0	.	.	.
D-27 Dresden Lock & Dam	.	.	.	.	.	.	0	.	.
D-28 Dresden Pool at Illinois River	.	.	.	0	0	.	.	.	.
D-34A Cooling Lake , Dresden Road Crossing	.	.	.	.	0	.	.	.	.
D-34B Cooling Lake , County Line Crossing	.	.	.	.	0	.	.	.	.
D-35 Dresden Lock & Dam	.	.	.	.	.	.	.	.	0
D-42 Goodwin Dairy	.	.	.	.	.	0	.	.	.

CENSUS
Dairy
Residence
Cattle

TABLE 5.0-2

DRESDEN STATION

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM, SAMPLING LOCATIONS

1. AIR SAMPLERS

Site Code[a]	Location	Distance (miles)	Direction (°)
D-01	Onsite Station 1	0.6	309
D-02	Onsite Station 2	0.3	43
D-03	Onsite Station 3	0.4	175
D-04	Collins Road	0.9	260
D-05	Bennitt Farm	0.9	72
D-06	Will County Road	1.4	132
D-07	Clay Products	2.0	180
D-08	Prairie Parks	4.0	230
D-09 (C)	Coal City	7.5	190
D-10	Goose Lake Village	3.8	210
D-11 (C)	Morris	8.0	250
D-12 (C)	Lisbon	10.0	310
D-13	Minooka	4.5	5
D-14	Channahon	3.5	40
D-15 (C)	Joliet	12.5	60
D-16 (C)	Elwood	8.0	80
D-17 (C)	Wilmington	8.0	130

2. TLDs

a. Same as No. 1.

b. Special TLD Samplers

Site Code	Distance (miles)	Direction (°)
Inner Ring		
D-101-1,2	1.0	4
D-102-1,2	1.3	25
D-103-1,2	1.2	44
D-104-1,2	1.5	67
D-105-1,2	1.4	90
D-106-1,2	0.9	105
D-107-1,2	1.3	128
D-108-1,2	1.9	157
D-109-1,2	0.8	175
D-110-1,2	0.6	211
D-110-3,4	0.5	203
D-111-1,2	0.6	225

---

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

TABLE 5.0-2 (continued)

DRESDEN STATION

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM, SAMPLING LOCATIONS

2. TLDs

b. Special TLD Samplers (continued)

Site Code	Distance (miles)	Direction (°)
Inner Ring (continued)		
D-112a-1,2	0.8	240
D-112b-1,2	0.9	241
D-113-1,2	0.9	277
D-114-1,2	1.0	292
D-115-1,2	0.8	309
D-116-1,2	1.0	341
Outer Ring		
D-201-1,2	4.5	0
D-202-1,2	5.0	20
D-203-1,2	4.5	42
D-204-1,2	5.0	65
D-205-1,2	4.2	90
D-206-1,2	3.5	118
D-207-1,2	4.5	135
D-208-1,2	5.0	156
D-209-1,2	5.0	180
D-210-1,2	4.8	200
D-211-1,2	5.0	225
D-212-1,2	4.8	240
D-212-3,4	6.0	239
D-213-1,2	4.5	260
D-214-1,2	4.5	290
D-215-1,2	5.1	310
D-216-1,2	4.8	340

3. MILK

Site Code[a]	Location	Distance (miles)	Direction (°)
D-25 (C)	Vince Biros Farm	11.5	206
D-26 (C)	Halpin's Dairy	16.0[b]	175
D-42 (C)	Goodwin Dairy[c]	12.8	135

---

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

[b] This distance was incorrectly noted in the ODCM as 5.6 miles.

[c] Additional dairy was not required by ODCM but included to assure that program has at least two

TABLE 5.0-2 (continued)

DRESDEN STATION

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM, SAMPLING LOCATIONS

4. GROUND/WELL WATER

Site Code	Location	Distance (miles)	Direction (°)
D-23	Thorsen Well	0.7	180
D-35	Dresden Lock & Dam	0.5	270

5. SURFACE WATER

Site Code	Location	Distance (miles)	Direction (°)
D-21	Illinois River at EJ & E Railroad Bridge	1.0	270
D-22	Ilinois River at Morris Water Works	8.0	270

6. LAKE WATER

Site Code	Location	Distance (miles)	Direction (°)
D-28	Dresden Pool at Illinois River	0.5	270
D-34A	Cooling Lake, Dresden Road Crossing	2.6	180
D-34B	Cooling Lake, County Line Crossing	3.0	160

7. COOLING WATER

Site Code	Location	Distance (miles)	Direction (°)
D-18	Inlet, Unit 1	At Station	0
D-19	Discharge, Unit 1	At Station	0
D-20	Discharge, Unit 2/3	At Station	0

8. FISH

Site Code	Location	Distance (miles)	Direction (°)
D-28	Dresden Pool of Illinois River	0.5	270

TABLE 5.0-2 (continued)

DRESDEN STATION

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM, SAMPLING LOCATIONS

9. SHORELINE SEDIMENTS

Site Code	Location	Distance (miles)	Direction (°)
D-27	Dresden Lock & Dam	0.5	270

TABLE 5.0-2 (continued)

DRESDEN STATION

RADIOLOGICAL ENVIRONMENTAL 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	Onsite and Near Field		Continuous operation for a week	Gross Beta	Weekly	On all samples.
				Filter exchange	Weekly	
	D-1	Onsite 1				
	D-2	Onsite 2		Gamma Isot.	Quarterly	
	D-3	Onsite 3		Gamma Isot.	Weekly	Gamma isotopic if gross beta in a sample exceeds 5X the average concentration of the preceding calendar quarter for the sample location.
	D-4	Collins Road				
	D-5	Bennitt Farm				
	D-6	Will County Road				
	Far Field					
	D-7	Clay Products				
	D-8	PrairieParks				
	D-9 (C)	Coal City				
	D-10	Goose Lake Village				
	D-11 (C)	Morris				
	D-12 (C)	Lisbon				
	D-13	Minooka				
	D-14	Channahon				
	D-15 (C)	Joliet				
	D-16 (C)	Elwood				
	D-17 (C)	Wilmington				
2. Airborne Iodine	Same as 1.		Continuous operation for two weeks	I-131	Biweekly	On all samples.
3. Air Sampling Train	Same as 1.		–	Test and Maintenance	Weekly	On all samples.
4. TLD	a. Same as 1.		Quarterly	Gamma	Quarterly	Two sets of TLD's at all air sampler locations. All sets read Quarterly.
	b. D-101-1,2 102-1,2 103-1,2 104-1,2 105-1,2 106-1,2	Inner Ring	Quarterly	Gamma	Quarterly	All sets read Quarterly.

---

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

TABLE 5.0-2 (continued)

DRESDEN STATION

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM, SAMPLE COLLECTION AND ANALYSES

Sample Media	Location		Collection Frequency	Type of Analysis	Frequency of Analysis	Remarks
	Code[a]	Site				
4. TLD (continued)	b. D-107-1,2					
	108-1,2					
	109-1,2					
	110-1,2,3,4					
	111-1,2					
	112a-1,2					
	112b-1,2					
	113-1,2					
	114-1,2					
	115-1,2					
	116-1,2					
	201-1,2	Outer Ring	Quarterly	Gamma	Quarterly	All sets read Quarterly.
	202-1,2					
	203-1,2					
	204-1,2					
	205-1,2					
	206-1,2					
	207-1,2					
	208-1,2					
	209-1,2					
	210-1,2					
	211-1,2					
	212-1,2,3,4					
	213-1,2					
	214-1,2					
	215-1,2					
	216-1,2					
5. Milk	D-25 (C)	Vince Biros Farm	Weekly: May through October	I-131	Weekly	On all samples: LLD: 0.5 pCi/L (Grazing Season).
	D-26 (C)	Halpin's Farm				
	D-42 (C)	Goodwin Dairy[b]				
			Monthly: November Through April	I-131	Monthly	On all samples: LLD: 0.5 pCi/L.

---

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

[b] Additional dairy was not required by ODCM but included to assure that the program has at least two dairies.

TABLE 5.0-2 (continued)

DRESDEN STATION

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM, SAMPLE COLLECTION AND ANALYSES

Sample Media	Location		Collection Frequency	Type of Analysis	Frequency of Analysis	Remarks
	Code	Site				
6. Ground/Well Water	D-35 D-23	Dresden Lock & Dam Thorsen Well	Quarterly	Gross Alpha Gross Beta Tritium	Quarterly Quarterly Quarterly	On all samples. On all samples. On all samples.
7. Surface Water	D-21	Illinois River at EJ&E Railroad Bridge	Weekly	Gamma Isot.	Monthly	On monthly composite of weekly samples.
	D-22	Illinois River at Morris Water Works	Weekly	Gamma Isot.	Monthly	On monthly composite of weekly samples.
8. Lake Water	D-28 D-34A D-34B	Dresden Pool at Illinois River Cooling Lake, Dresden Road Crossing Cooling Lake, County Line Crossing	Weekly	Gross Beta Gamma Isot.	Weekly Weekly	On all samples. On all samples.
9. Cooling Water	D-18 D-19 D-20	Inlet, Unit 1 Discharge, Unit 1 Discharge, Unit 2/3	Weekly	Gross Beta	Weekly	On all samples.
10. Fish	D-28	Dresden Pool of Illinois River	Semiannually	Gamma Isot.	Semiannually	On edible portions only.
11. Shoreline Sediments	D-27	Dresden Lock & Dam	Annually	Gamma Isot.	Annually	

TABLE 5.0-2 (continued)

DRESDEN STATION

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM, SAMPLE COLLECTION AND ANALYSES

Sample Media	Location		Collection Frequency	Type of Analysis	Frequency of Analysis	Remarks
	Code	Site				
12. Land Use Census						
Milch Animals	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: 1. Pasture only. 2. Feed and chop only. 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.
Nearest Residence Census	In all 16 sectors up to 5 miles				Annually	

TABLE 5.0-3

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM QUARTERLY SUMMARY

Name of Facility Dresden Nuclear Power Station Docket No. 50-10, 50-237, 50-549
Location of Facility Grundy, Illinois Reporting Period 1st Quarter 1993
(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	0.026 (78/78) (0.009-0.051)	D-02[b], Onsite Station 2 0.3 mi @ 43°	0.027 (13/13) (0.016-0.051)	None	0
	Gamma Spec. 6	0.01	<LLD	-	-	None	0
Airborne Iodine (pCi/m^3)	I-131 36	0.10	<LLD	-	-	None	0
Gamma Background (TLDs) (mR/Qtr.)	Gamma Dose 86	3.0	16.2(74/74) (13.0-19.8)	D-214, 4.5 mi @ 290°	19.8 (2/2) (20.4-19.2)	14.7 (12/12) (13.9-16.8)	0
Milk (pCi/L)	I-131 9	5.0	None	-	-	<LLD	0
Cooling Water (pCi/L)	Gross Beta 39	5.0	3.5 (26/26) (2.3-4.8)	D-18[c], Inlet Canal Unit 1, at Station	3.6 (13/13) (2.7-4.5)	3.6 (13/13) (2.7-4.5)	0
Surface Water (pCi/L)	Gamma Spec. 6						
	Cs-134	10	<LLD	-	-	None	0
	Cs-137	10	<LLD	-	-	None	0
	Other Gammas	20	<LLD	-	-	None	0

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

[b] Locations D-04, D-05,and D-06 had identical means of 0.027 pCi/m^3. Only D-02 is detailed in this summary.

[c] Locations D-18 and D-20 had identical means of 3.5pCi/L. Only D-18 is detailed in this summary.

TABLE 5.0-3 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM QUARTERLY SUMMARY

Name of Facility Dresden Nuclear Power Station Docket No. 50-10, 50-237, 50-549
Location of Facility Grundy, Illinois Reporting Period 1st Quarter 1993
(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		
Lake Water (pCi/L)	Gamma Spec. 39						
	Cs-134	10	<LLD	-	-	None	0
	Cs-137	10	<LLD	-	-	None	0
	Other Gammas	20	<LLD	-	-	None	0
	Gross Beta 39	5.0	4.2 (36/36) (2.3-7.4)	D-26 Dresden Pool at Illinois River, 0.5 mi @ 270°	5.2(12/12) (3.7-7.4)	None	0
Well Water (pCi/L)	Gross Beta 2	5.0	8.1 (2/2) (4.2-12.0)	D-35 Dresden Lock and Dam, 0.5 mi @ 270°	12.0(1/1)	None	0
	Gross Alpha 2	4.0	2.6(2/2) (0.5-4.6)	D-35 Dresden Lock and Dam, 0.5 mi @ 270°	4.6(1/1)	None	0
	Tritium 2	200	<LLD	-	-	None	0

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

TABLE 5.0-4

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM QUARTERLY SUMMARY

Name of Facility Dresden Nuclear Power Station
Docket No. 50-10, 50-237, 50-549
Location of Facility Grundy, Illinois
(County, State)
Reporting Period 2nd Quarter 1993

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	0.015(78/78) (0.004-0.026)	D-06, Will County Road, 1.4 mi @ 132°	0.017 (13/13) (0.009-0.022)	None	0
	Gamma Spec.	6	0.01	<LLD	-	-	None	0
Airborne Iodine (pCi/m^3)	I-131	42	0.10	<LLD	-	-	None	0
Gamma Background (TLDs) (mR/Qtr.)	Gamma Dose	86	3.0	15.3 (74/74) (12.0-19.0)	D-201[c] 4.5 mi @ 0°	19.0 (2/2) (18.5-19.4)	13.6 (12/12) (13.1-14.6)	0
Milk (pCi/L)	I-131	30	5.0/0.5[b]	None	-	-	<LLD	0
Cooling Water (pCi/L)	Gross Beta	39	5.0	3.2 (26/26) (2.0-3.9)	D-19 Discharge, Unit 1, at Station	3.2(13/13) (2.0-3.9)	3.1 (13/13) (1.2-4.1)	0
Surface Water (pCi/L)	Gamma Spec.	6						
	Cs-134		10	<LLD	-	-	None	0
	Cs-137		10	<LLD	-	-	None	0
	Other Gammas		20	<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.

[c] Locations D-201 and D-214 had identical means. Only D-201 is detailed in this summary.

TABLE 5.0-4 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM QUARTERLY SUMMARY

Name of Facility Dresden Nuclear Power Station Docket No. 50-10, 50-237, 50-549
Location of Facility Grundy, Illinois Reporting Period 2nd Quarter 1993
(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		
Lake Water (pCi/L)	Gamma Spec.	39						
	Cs-134		10	<LLD	-	-	None	0
	Cs-137		10	<LLD	-	-	None	0
	Other Gammas		20	<LLD	-	-	None	0
	Gross Beta	39	5.0	3.4(39/39) (2.2-5.3)	D-28 Dresden Pool at Illinois River, 0.5 mi @ 270°	3.5 (14/14) (2.2-5.3)	None	0
Well Water (pCi/L)	Gross Beta	2	5.0	9.3 (2/2) (4.2-14.3)	D-35 Dresden Lock and Dam, 0.5 mi @ 270°	14.3(1/1)	None	0
	Gross Alpha	2	4.0	2.6(2/2) (0.4-4.7)	D-35 Dresden Lock and Dam, 0.5 mi @ 270°	4.7(1/1)	None	0
	Tritium	2	200	230(1/1)	D-23-Thorsen Well, 0.7 mi @ 180°	230(1/1)	None	0
Fish (pCi/g wet)	Gamma Spec.	15						
	Cs-134		0.1	<LLD	-	-	<LLD	0
	Cs-137		0.1	<LLD	-	-	<LLD	0
	Other Gammas		0.2	<LLD	-	-	<LLD	0
Bottom Sediments (pCi/g dry)	Gamma Spec.	1						
	Cs-134		0.2	<LLD	-	-	None	0
	Cs-137		0.2	<LLD	-	-	None	0
	Other Gammas		0.2	<LLD	-	-	None	0

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

TABLE 5.0-5

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM QUARTERLY SUMMARY

Name of Facility Dresden Nuclear Power Station   Docket No. 50-10, 50-237, 50-549
Location of Facility Grundy, Illinois   Reporting Period 3rdQuarter 1993
(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 70	0.01	0.019 (70/70) (0.012-0.029)	D-06, Will County Road, 1.4 mi @ 132°	0.021 (13/13) (0.013-0.029)	None	0
	Gamma Spec. 6	0.01	<LLD	-	-	None	0
Airborne Iodine (pCi/m^3)	I-131 32	0.10	<LLD	-	-	None	0
Gamma Background (TLDs) (mR/Qtr.)	Gamma Dose 86	3.0	16.7 (74/74) (14.1-20.8)	D-214 4.5 mi @ 290°	20.8 (2/2) (20.6-20.9)	14.6 (12/12) (14.1-15.8)	0
Milk (pCi/L)	I-131 39	0.5	None	-	-	<LLD	0
Cooling Water (pCi/L)	Gross Beta 39	5.0	3.3 (26/26) (2.1-5.4)	D-18[b], Inlet, Unit 1, at Station	3.4(13/13) (2.5-5.0)	3.4(13/13) (2.5-5.0)	0
Surface Water (pCi/L)	Gamma Spec. 6						
	Cs-134	10	<LLD	-	-	None	0
	Cs-137	10	<LLD	-	-	None	0
	Other Gammas	20	<LLD	-	-	None	0

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

[b] Locations D-18 and D-20 had identical means of 3.4 pCi/L. Only D-18 is detailed in this summary.

TABLE 5.0-5 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM QUARTERLY SUMMARY

Name of Facility Dresden Nuclear Power Station Docket No. 50-10, 50-237, 50-549
Location of Facility Grundy, Illinois Reporting Period 3rdQuarter 1993
(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		
Lake Water (pCi/L)	Gamma Spec.	39						
	Cs-134		10	<LLD	-	-	None	0
	Cs-137		10	<LLD	-	-	None	0
	Other Gammas		20	<LLD	-	-	None	0
	Gross Beta	39	5.0	3.8 (39/39) (2.4-5.9)	D-28 Dresden Pool of Illinois River, 0.5 mi @ 270°	4.3 (13/13) (2.6-5.9)	None	0
Well Water (pCi/L)	Gross Beta	2	5.0	8.6(2/2) (4.1-13.2)	D-35 Dresden Lock and Dam, 0.5 mi @ 270°	13.2(1/1)	None	0
	Gross Alpha	2	4.0	1.8(2/2) (0.7-2.8)	D-35 Dresden Lock and Dam, 0.5 mi @ 270°	2.8(1/1)	None	0
	Tritium	2	200	<LLD	-	-	None	0

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

TABLE 5.0-6

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM QUARTERLY SUMMARY

Name of Facility Dresden Nuclear Power Station Docket No. 50-10, 50-237, 50-549
Location of Facility Grundy, Illinois Reporting Period 4th Quarter 1993
(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	77	0.01	0.025 (77/77) (0.014-0.038)	D-04, Collins Road, 0.9mi @ 260°	0.026 (13/13) (0.016-0.038)	None	0
	Gamma Spec.	6	0.01	<LLD	-	-	None	0
Airborne Iodine (pCi/m^3)	I-131	41	0.10	<LLD	-	-	None	0
Gamma Background (TLDs) (mR/Qtr.)	Gamma Dose	104	3.0	15.4 (92/92) (12.2-31.0)	D-111 0.6 mi @ 225°	31.0 (2/2) (30.9-31.1)	13.5 (12/12) (12.8-14.7)	0
Milk (pCi/L)	I-131	21	5.0/0.5[b]	None	-	-	<LLD	0
Cooling Water (pCi/L)	Gross Beta	39	5.0	3.5 (26/26) (2.4-5.0)	D-18 Inlet,Unit 1 at Station	3.9 (13/13) (1.7-5.1)	3.9 (13/13) (1.7-5.1)	0
Surface Water (pCi/L)	Gamma Spec.	6						
	Cs-134		10	<LLD	-	-	None	0
	Cs-137		10	<LLD	-	-	None	0
	Other Gammas		20	<LLD	-	-	None	0

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[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 5.0-6 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM QUARTERLY SUMMARY

Name of Facility Dresden Nuclear Power Station Docket No. 50-10, 50-237, 50-549
Location of Facility Grundy, Illinois Reporting Period 4th Quarter 1993
(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		
Lake Water (pCi/L)	Gamma Spec. 39						
	Cs-134	10	<LLD	-	-	None	0
	Cs-137	10	<LLD	-	-	None	0
	Other Gammas	20	<LLD	-	-	None	0
	Gross Beta 39	5.0	4.2 (39/39) (2.2-6.2)	D-28 Dresden Pool at Illinois River, 0.5 mi @ 270°	4.4(13/13) (2.2-6.2)	None	0
Well Water (pCi/L)	Gross Beta 2	5.0	10.2 (2/2) (4.3-16.0)	D-35 Dresden Lock and Dam, 0.5 mi @ 270°	16.0 (1/1)	None	0
	Gross Alpha 2	4.0	2.4(2/2) (0.8-4.1)	D-35 Dresden Lock and Dam, 0.5 mi @ 270°	4.1(1/1)	None	0
	Tritium 2	200	<LLD	-	-	None	0
Fish (pCi/g wet)	Gamma Spec. 15						
	Cs-134	0.1	<LLD	-	-	<LLD	0
	Cs-137	0.1	<LLD	-	-	<LLD	0
	Other Gammas	0.2	<LLD	-	-	<LLD	0

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

TABLE 5.1-1

GAMMA RADIATION AS MEASURED BY THERMOLUMINESCENT DOSIMETERS (TLDs)

Commonwealth Edison Company

Date: 31-JAN-94 Environmental Site Report for Dresden Page: 1

Gamma Radiation Measured in mR by TLDs

Site	Miles	Degrees	Description	Quarter 1 1993	Quarter 2 1993	Quarter 3 1993	Quarter 4 1993
On-Site Indicator Locations							
D-01	0.8	309	ON-SITE 1	17.4	15.7	19.2	15.9
D-02	0.3	43	ON-SITE 2	15.4	14.6	16.5	15.0
D-03	0.4	175	ON-SITE 3	14.4	13.4	14.4	13.7
D-04	0.9	260	COLLINS ROAD	17.3	16.0	16.9	15.9
Mean ± S.D.				16.1 ± 1.5	14.9 ± 1.2	16.7 ± 2.0	15.1 ± 1.0
Annual Mean and S.D.							15.7 ± 1.5
Off-Site Indicator Locations							
D-05	0.9	72	BENNITT FARM	17.8	16.3	18.0	17.1
D-06	1.4	132	PHEASANT TRAIL	16.7	15.4	16.8	15.1
D-07	2.0	180	CLAY PRODUCTS	15.9	14.8	16.4	15.1
D-08	4.0	230	PRAIRIE PARK	16.8	16.1	17.3	15.7
Mean ± S.D.				16.8 ± 0.8	15.6 ± 0.7	17.1 ± 0.7	15.8 ± 1.0
Annual Mean and S.D.							16.3 ± 1.0
Background Locations							
D-09	7.5	190	COAL CITY	14.2	13.4	14.2	12.9
D-10*	3.8	210	GOOSE LAKE VILLAGE	17.3	15.7	17.2	16.2
D-11	8.0	250	MORRIS	14.5	13.1	14.1	12.8
D-12	10.0	310	LISBON	14.3	13.4	14.9	13.6
D-13*	4.5	5	MINOOKA	15.1	15.3	15.2	13.8
D-14*	3.5	40	CHANNAHON	15.1	14.2	15.8	14.4
D-15	12.5	60	JOLIET BRANDON ROAD	16.8	14.6	15.8	14.7
D-16	8.0	80	ELWOOD	14.3	13.7	14.4	13.3
D-17	8.0	130	WILMINGTON	13.9	13.1	14.2	13.7
Mean ± S.D.				15.0 ± 1.2	14.0 ± 1.0	15.0 ± 1.0	13.9 ± 1.1
Annual Mean and S.D.							14.5 ± 1.2
Inner Ring, Near Site Boundary, Indicator Locations							
D-101	1.0	4	INNER RING NEAR SITE BOUNDARY	17.4	16.1	18.1	16.7
D-102	1.3	25	INNER RING NEAR SITE BOUNDARY	18.3	17.4	18.8	17.7
D-103	1.2	44		-	-	-	14.1
D-104	1.5	67		-	-	-	17.9

* Indicator Location.

TABLE 5.1-1 (continued)

GAMMA RADIATION AS MEASURED BY THERMOLUMINESCENT DOSIMETERS (TLDs)

Date: 31-JAN-94 Environmental Site Report for Dresden Page: 2

Site	Miles	Degrees	Description	Quarter 1 1993	Quarter 2 1993	Quarter 3 1993	Quarter 4 1993
D-105	1.4	90		-	-	-	16.7
D-106	0.9	105	INNER RING NEAR SITE BOUNDARY	16.8	15.4	17.6	16.1
D-107	1.3	128		-	-	-	14.1
D-108	1.9	157		-	-	-	15.8
D-109	0.8	175	INNER RING NEAR SITE BOUNDARY	17.3	16.5	18.3	16.7
D-110	0.6	211	INNER RING NEAR SITE BOUNDARY	15.5	14.9	18.3	17.1
D-111	0.6	225		-	-	-	31.0
D-112A	0.8	240	INNER RING NEAR SITE BOUNDARY	15.2	15.3	16.1	14.4
D-112B	0.9	241	INNER RING NEAR SITE BOUNDARY	13.0	12.0	13.4	12.2
D-113	0.9	277	INNER RING NEAR SITE BOUNDARY	14.8	14.3	15.8	14.7
D-114	1.0	292		-	-	-	15.6
D-115	0.8	309	INNER RING NEAR SITE BOUNDARY	16.6	16.3	17.5	16.3
D-116	1.0	341	INNER RING NEAR SITE BOUNDARY	17.7	17.0	18.5	17.4
Mean ± S.D.				16.2 ± 1.6	15.5 ± 1.6	17.2 ± 1.7	16.7 ± 4.0
Annual Mean and S.D.							16.5 ± 2.7
Outer Ring, Near 5 Mile Radius, Indicator Locations							
D-201	4.5	0	OUTER RING NEAR 5 MILE RADIUS	19.0	19.0	20.3	18.9
D-202	5.0	20	OUTER RING NEAR 5 MILE RADIUS	16.8	16.5	17.9	16.4
D-203	4.5	42	OUTER RING NEAR 5 MILE RADIUS	15.4	15.6	16.2	15.1
D-204	5.0	65	OUTER RING NEAR 5 MILE RADIUS	16.0	15.6	17.1	15.3
D-205	4.2	90	OUTER RING NEAR 5 MILE RADIUS	17.0	16.8	18.1	16.9
D-206	3.5	118	OUTER RING NEAR 5 MILE RADIUS	16.4	15.9	16.9	15.6
D-207	4.5	135	OUTER RING NEAR 5 MILE RADIUS	15.0	14.2	16.0	14.7
D-208	5.0	156	OUTER RING NEAR 5 MILE RADIUS	13.9	13.4	14.4	13.4
D-209	5.0	180	OUTER RING NEAR 5 MILE RADIUS	13.4	12.9	14.1	12.6
D-210	4.8	200	OUTER RING NEAR 5 MILE RADIUS	16.6	15.6	17.6	15.7
D-211	5.0	225	OUTER RING NEAR 5 MILE RADIUS	17.7	17.1	18.7	17.0
D-212	4.8	240	OUTER RING NEAR 5 MILE RADIUS	17.4	16.0	16.4	14.6
D-213	4.5	260	OUTER RING NEAR 5 MILE RADIUS	14.3	13.0	14.7	12.9
D-214	4.5	290	OUTER RING NEAR 5 MILE RADIUS	19.8	19.0	20.8	18.3
D-215	5.1	310	OUTER RING NEAR 5 MILE RADIUS	18.6	17.9	19.8	17.6
D-216	4.8	340	OUTER RING NEAR 5 MILE RADIUS	18.2	17.5	19.6	18.3
Mean ± S.D.				16.6 ± 2.0	16.0 ± 1.9	17.4 ± 2.1	15.9 ± 2.0
Annual Mean and S.D.							16.5 ± 2.0
RESTRICTED AREA MONITORING PROGRAM							
D-306A	0.0	0	RESTRICTED AREA MONITORING PROGRAM	27.5	36.1	44.4	34.8
D-306B	0.0	0	RESTRICTED AREA MONITORING PROGRAM	27.6	35.9	41.4	33.1
D-306C	0.0	0	RESTRICTED AREA MONITORING PROGRAM	27.4	36.1	41.3	32.3
D-310	0.0	0	RESTRICTED AREA MONITORING PROGRAM	23.0	24.3	29.3	24.0
D-313A	0.0	0	RESTRICTED AREA MONITORING PROGRAM	16.9	16.7	18.8	16.9
D-313B	0.0	0	RESTRICTED AREA MONITORING PROGRAM	17.1	16.5	17.2	16.1
Mean ± S.D.				23.3 ± 5.1	27.6 ± 9.7	32.1 ±12.1	26.2 ± 8.4
Annual Mean and S.D.							27.3 ± 9.1

APPENDIX II

METEOROLOGICAL DATA

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: JANUARY-MARCH 1993

STABILITY CLASS - EXTREMELY UNSTABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	0	4	4	0	1	9
NNE	0	2	2	2	0	0	6
NE	0	0	0	1	0	0	1
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	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	3	0	0	3
WNW	0	0	1	1	0	0	2
NW	0	0	1	3	0	0	4
NNW	0	1	1	2	0	1	5
VARIABLE	0	0	0	0	0	0	0
TOTAL	0	3	9	17	0	2	31

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: 2

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: JANUARY-MARCH 1993

STABILITY CLASS - MODERATELY UNSTABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	0	0	2	0	2	4
NNE	0	0	3	0	0	0	3
NE	0	0	0	5	1	0	6
ENE	0	0	0	0	0	0	0
E	0	0	2	0	0	0	2
ESE	0	0	0	4	0	0	4
SE	0	0	0	2	0	0	2
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	1	3	0	0	4
WNW	0	0	2	7	2	0	11
NW	0	1	1	2	1	0	5
NNW	0	4	2	3	0	0	9
VARIABLE	0	0	0	0	0	0	0
TOTAL	0	5	11	28	4	2	50

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: 2

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: JANUARY-MARCH 1993

STABILITY CLASS - SLIGHTLY UNSTABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	1	1	0	1	2	5
NNE	0	1	2	1	0	0	4
NE	1	1	2	2	0	0	6
ENE	0	1	1	0	0	0	2
E	0	0	0	2	0	0	2
ESE	0	0	2	4	1	0	7
SE	0	1	5	0	0	0	6
SSE	0	0	0	0	1	0	1
S	0	0	0	0	1	1	2
SSW	0	0	0	1	1	0	2
SW	0	2	0	2	0	0	4
WSW	0	2	1	4	2	0	9
W	0	0	4	3	0	0	7
WNW	0	1	0	9	4	0	14
NW	1	2	3	5	0	0	11
NNW	0	3	0	3	1	0	7
VARIABLE	0	0	0	0	0	0	0
TOTAL	2	15	21	36	12	3	89

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: 2

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: JANUARY-MARCH 1993

STABILITY CLASS - NEUTRAL (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	3	7	20	18	15	4	67
NNE	2	10	42	15	4	8	81
NE	0	9	48	43	14	16	130
ENE	1	14	33	31	33	0	112
E	3	10	36	21	17	0	87
ESE	2	13	29	32	21	1	98
SE	1	2	10	17	1	0	31
SSE	2	2	11	7	4	0	26
S	1	7	15	8	3	3	37
SSW	1	6	13	13	4	18	55
SW	3	7	11	19	5	2	47
WSW	1	17	13	21	10	3	65
W	0	26	28	30	30	7	121
WNW	3	19	50	73	46	3	194
NW	0	10	20	48	20	6	104
NNW	1	7	5	12	20	6	51
VARIABLE	0	0	0	0	0	0	0
TOTAL	24	166	384	408	247	77	1306

Hours of calm in this stability class: 0
Hours of missing wind measurements in this stability class: 75
Hours of missing stability measurements in all stability classes: 2

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: JANUARY-MARCH 1993

STABILITY CLASS - SLIGHTLY STABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

	WIND SPEED (in mph)						
WIND DIRECTION	1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	1	1	7	5	0	0	14
NNE	0	3	13	10	3	0	29
NE	0	0	17	5	1	0	23
ENE	0	4	9	6	0	0	19
E	0	6	5	16	5	0	32
ESE	0	4	8	8	13	0	33
SE	1	6	5	4	5	0	21
SSE	0	2	7	3	3	1	16
S	1	3	6	11	9	5	35
SSW	2	2	12	6	8	12	42
SW	5	5	7	8	11	0	36
WSW	4	4	15	15	6	7	51
W	4	10	7	12	10	0	43
WNW	0	5	11	14	6	0	36
NW	0	1	10	15	3	0	29
NNW	1	1	12	9	6	0	29
VARIABLE	0	0	0	0	0	0	0
TOTAL	19	57	151	147	89	25	488

Hours of calm in this stability class: 0
Hours of missing wind measurements in this stability class: 6
Hours of missing stability measurements in all stability classes: 2

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: JANUARY-MARCH 1993

STABILITY CLASS - MODERATELY STABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	0	1	0	0	0	1
NNE	0	0	2	1	0	0	3
NE	0	0	0	3	0	0	3
ENE	0	1	4	0	0	0	5
E	0	4	1	1	0	0	6
ESE	0	0	1	1	0	0	2
SE	0	1	0	0	0	0	1
SSE	0	0	0	1	0	0	1
S	1	0	0	2	0	0	3
SSW	0	1	3	7	1	0	12
SW	0	0	6	6	3	0	15
WSW	0	0	5	7	0	0	12
W	0	2	4	0	0	0	6
WNW	0	0	1	0	0	0	1
NW	0	0	3	0	0	0	3
NNW	0	0	3	1	0	0	4
VARIABLE	0	0	0	0	0	0	0
TOTAL	1	9	34	30	4	0	78

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: 2

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: JANUARY-MARCH 1993

STABILITY CLASS - EXTREMELY STABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	0	2	2	0	0	4
NNE	0	0	2	1	0	0	3
NE	0	0	1	2	0	0	3
ENE	0	1	1	0	0	0	2
E	0	0	2	0	0	0	2
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	1	0	0	0	0	0	1
S	0	2	0	0	0	0	2
SSW	0	2	0	0	0	0	2
SW	0	4	0	0	0	0	4
WSW	0	1	2	2	0	0	5
W	0	2	0	0	0	0	2
WNW	0	0	4	1	0	0	5
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	1	12	14	8	0	0	35

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: 2

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: APRIL-JUNE 1993

STABILITY CLASS - EXTREMELY UNSTABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	1	2	1	0	0	4
NNE	0	0	0	4	0	0	4
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	0	0	0	0	0
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	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	7	3	0	0	10
VARIABLE	0	0	0	0	0	0	0
TOTAL	0	1	9	8	0	0	18

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: 30

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: APRIL-JUNE 1993

STABILITY CLASS - MODERATELY UNSTABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	1	0	2	0	0	3
NNE	0	1	2	2	0	0	5
NE	0	0	5	3	0	0	8
ENE	0	0	2	0	0	0	2
E	0	0	0	1	0	0	1
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	0	0	0	0	0
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	0	0	0	0	0
NW	0	0	3	4	0	0	7
NNW	0	0	7	8	0	0	15
VARIABLE	0	0	0	0	0	0	0
TOTAL	0	2	19	20	0	0	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: 30

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: APRIL-JUNE 1993

STABILITY CLASS - SLIGHTLY UNSTABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	0	4	3	1	0	8
NNE	0	1	2	0	1	0	4
NE	0	2	7	2	1	0	12
ENE	0	1	10	1	0	0	12
E	0	0	2	1	0	0	3
ESE	0	2	0	0	2	0	4
SE	0	0	0	1	3	0	4
SSE	0	0	0	2	2	0	4
S	0	0	0	0	0	0	0
SSW	0	0	0	0	1	0	1
SW	0	0	0	0	0	0	0
WSW	0	1	5	0	0	0	6
W	0	0	1	0	0	0	1
WNW	0	1	3	2	1	0	7
NW	0	2	2	3	1	0	8
NNW	0	0	4	5	0	0	9
VARIABLE	0	0	0	0	0	0	0
TOTAL	0	10	40	20	13	0	83

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: 30

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: APRIL-JUNE 1993

STABILITY CLASS - NEUTRAL (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	0	7	13	11	2	33
NNE	1	2	8	5	8	13	37
NE	0	4	26	30	2	7	69
ENE	0	13	45	23	1	0	82
E	1	12	34	15	12	0	74
ESE	1	12	22	20	10	2	67
SE	0	5	17	30	16	1	69
SSE	1	5	23	40	18	1	88
S	0	0	8	12	27	3	50
SSW	2	1	7	27	19	12	68
SW	1	5	13	15	8	15	57
WSW	0	13	19	13	19	10	74
W	1	5	10	10	6	11	43
WNW	0	13	20	36	17	2	88
NW	1	8	13	29	12	0	63
NNW	0	7	4	26	13	2	52
VARIABLE	0	0	0	0	0	0	0
TOTAL	9	105	276	344	199	81	1014

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: 30

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: APRIL-JUNE 1993

STABILITY CLASS - SLIGHTLY STABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	4	5	14	2	1	26
NNE	0	4	6	6	5	0	21
NE	0	5	32	10	3	3	53
ENE	0	3	25	7	0	0	35
E	2	2	25	19	2	0	50
ESE	0	0	6	32	3	2	43
SE	1	6	19	67	14	2	109
SSE	0	5	18	26	26	4	79
S	0	5	5	22	21	7	60
SSW	0	2	5	15	24	7	53
SW	0	2	8	13	16	7	46
WSW	0	4	13	12	16	2	47
W	1	4	12	13	8	0	38
WNW	0	3	12	13	5	3	36
NW	0	3	12	21	1	0	37
NNW	0	2	5	8	0	1	16
VARIABLE	0	0	0	0	0	0	0
TOTAL	4	54	208	298	146	39	749

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: 30

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: APRIL-JUNE 1993

STABILITY CLASS - MODERATELY STABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	1	1	2	0	0	0	4
NNE	1	0	2	1	0	0	4
NE	0	1	0	3	0	0	4
ENE	1	0	1	0	0	0	2
E	0	0	0	4	1	0	5
ESE	1	2	1	2	1	0	7
SE	0	1	0	10	5	0	16
SSE	0	3	3	9	0	0	15
S	0	5	3	3	0	0	11
SSW	0	2	4	4	0	0	10
SW	2	3	3	10	8	1	27
WSW	2	0	17	20	3	1	43
W	1	1	10	6	0	1	19
WNW	1	4	4	5	0	0	14
NW	1	2	6	7	0	0	16
NNW	0	3	2	2	0	0	7
VARIABLE	0	0	0	0	0	0	0
TOTAL	11	28	58	86	18	3	204

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: 30

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: APRIL-JUNE 1993

STABILITY CLASS - EXTREMELY STABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	0	0	4	0	0	4
NNE	0	3	1	0	0	0	4
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	1	1	0	0	0	0	2
ESE	0	0	0	0	0	0	0
SE	2	2	0	0	0	0	4
SSE	0	0	2	1	3	0	6
S	0	0	0	0	0	0	0
SSW	0	0	0	1	0	0	1
SW	0	0	1	3	1	0	5
WSW	0	0	0	2	0	0	2
W	0	1	0	6	0	0	7
WNW	0	1	1	1	0	0	3
NW	0	1	2	0	0	0	3
NNW	0	2	1	1	0	0	4
VARIABLE	0	0	0	0	0	0	0
TOTAL	3	11	8	19	4	0	45

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: 30

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: JULY-SEPTEMBER 1993

STABILITY CLASS - EXTREMELY UNSTABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph)						
	1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	3	11	1	0	0	15
NNE	0	3	1	0	0	0	4
NE	0	0	1	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	2	0	0	0	0	2
SE	0	1	0	0	0	0	1
SSE	0	0	0	0	0	0	0
S	1	0	0	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	1	0	0	0	1
W	0	0	0	0	0	0	0
WNW	0	0	0	2	1	0	3
NW	1	0	6	3	2	0	12
NNW	0	5	8	4	0	0	17
VARIABLE	0	0	0	0	0	0	0
TOTAL	2	14	28	10	3	0	57

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: 6

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: JULY-SEPTEMBER 1993

STABILITY CLASS - MODERATELY UNSTABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	3	2	1	0	0	6
NNE	0	0	1	0	0	0	1
NE	1	2	1	0	0	0	4
ENE	1	2	0	0	0	0	3
E	0	2	3	0	0	0	5
ESE	0	5	3	0	0	0	8
SE	0	6	3	2	0	0	11
SSE	0	1	0	2	1	0	4
S	0	0	0	1	0	0	1
SSW	1	0	2	1	0	0	4
SW	0	2	5	2	0	0	9
WSW	0	2	1	1	1	0	5
W	1	1	1	0	0	0	3
WNW	0	0	7	4	2	0	13
NW	0	2	9	1	2	0	14
NNW	1	3	3	1	0	0	8
VARIABLE	0	0	0	0	0	0	0
TOTAL	5	31	41	16	6	0	99

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: 6

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: JULY-SEPTEMBER 1993

STABILITY CLASS - SLIGHTLY UNSTABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	1	3	3	1	0	0	8
NNE	0	1	4	0	0	0	5
NE	0	0	1	1	0	0	2
ENE	0	2	4	0	0	0	6
E	1	1	5	1	0	0	8
ESE	1	3	2	1	0	0	7
SE	0	3	6	7	0	0	16
SSE	1	3	4	2	1	0	11
S	0	5	10	4	2	2	23
SSW	0	6	9	6	0	1	22
SW	1	7	7	2	3	0	20
WSW	0	7	4	2	1	0	14
W	1	4	3	7	4	0	19
WNW	0	2	8	13	5	0	28
NW	3	2	4	3	1	0	13
NNW	1	1	2	2	0	0	6
VARIABLE	0	0	0	0	0	0	0
TOTAL	10	50	76	52	17	3	208

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: 6

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: JULY-SEPTEMBER 1993

STABILITY CLASS - NEUTRAL (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND	WIND SPEED (in mph)						
DIRECTION	1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	4	8	19	5	0	0	36
NNE	3	10	8	7	0	0	28
NE	6	3	5	1	0	0	15
ENE	2	12	31	16	0	0	61
E	3	13	32	24	2	0	74
ESE	1	16	27	13	1	0	58
SE	5	13	30	16	0	0	64
SSE	1	12	20	16	11	3	63
S	4	15	28	23	24	4	98
SSW	1	6	16	10	18	10	61
SW	4	10	25	18	5	2	64
WSW	2	6	12	13	2	3	38
W	1	7	13	20	4	1	46
WNW	1	9	11	17	12	0	50
NW	4	8	12	18	3	0	45
NNW	0	8	15	16	1	0	40
VARIABLE	0	0	0	0	0	0	0
TOTAL	42	156	304	233	83	23	841

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: 6

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: JULY-SEPTEMBER 1993

STABILITY CLASS - SLIGHTLY STABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	2	2	19	19	0	0	42
NNE	0	6	10	0	1	0	17
NE	0	8	15	5	0	0	28
ENE	1	7	30	2	0	0	40
E	2	9	20	2	1	0	34
ESE	1	7	11	17	0	0	36
SE	1	6	15	16	1	0	39
SSE	0	7	30	23	1	0	61
S	0	13	23	25	22	10	93
SSW	0	5	24	31	18	3	81
SW	1	12	20	20	9	0	62
WSW	0	10	13	16	2	0	41
W	0	8	29	19	12	0	68
WNW	2	7	10	28	12	0	59
NW	0	2	14	22	1	0	39
NNW	0	2	15	14	0	0	31
VARIABLE	0	0	0	0	0	0	0
TOTAL	10	111	298	259	80	13	771

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: 6

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: JULY-SEPTEMBER 1993

STABILITY CLASS - MODERATELY STABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	2	2	5	1	0	10
NNE	1	3	1	2	0	0	7
NE	0	3	4	0	0	0	7
ENE	2	5	2	1	0	0	10
E	3	3	0	0	0	0	6
ESE	0	3	2	6	1	0	12
SE	0	1	4	1	0	0	6
SSE	0	5	7	5	0	0	17
S	0	5	3	2	0	0	10
SSW	2	3	2	3	0	0	10
SW	0	1	5	7	3	0	16
WSW	1	7	3	18	0	0	29
W	1	2	9	1	0	0	13
WNW	0	7	2	3	0	0	12
NW	1	2	5	5	0	0	13
NNW	1	2	5	9	0	0	17
VARIABLE	0	0	0	0	0	0	0
TOTAL	12	54	56	68	5	0	195

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: 6

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: JULY-SEPTEMBER 1993

STABILITY CLASS - EXTREMELY STABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

	WIND SPEED (in mph)						
WIND DIRECTION	1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	2	0	0	0	0	2
NNE	0	0	0	0	0	0	0
NE	0	1	0	0	0	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	1	0	0	0	0	0	1
S	0	0	0	0	0	0	0
SSW	0	0	0	1	0	0	1
SW	0	3	1	2	0	0	6
WSW	1	0	0	0	0	0	1
W	0	5	1	0	0	0	6
WNW	0	2	0	0	0	0	2
NW	0	1	2	0	0	0	3
NNW	1	0	6	1	0	0	8
VARIABLE	0	0	0	0	0	0	0
TOTAL	3	14	10	4	0	0	31

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: 6

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: OCTOBER-DECEMBER 1993

STABILITY CLASS - EXTREMELY UNSTABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	1	0	0	1
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	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	2	0	2
W	0	0	0	0	0	0	0
WNW	0	0	0	4	0	0	4
NW	0	0	2	1	0	0	3
NNW	0	0	1	0	0	0	1
VARIABLE	0	0	0	0	0	0	0
TOTAL	0	0	3	6	2	0	11

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: 8

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: OCTOBER-DECEMBER 1993

STABILITY CLASS - MODERATELY UNSTABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	1	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	1	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	2	0	2
SSW	0	1	0	0	2	0	3
SW	0	1	1	0	0	1	3
WSW	0	0	0	0	3	1	4
W	0	0	0	0	0	0	0
WNW	0	0	1	5	2	1	9
NW	0	0	2	0	0	0	2
NNW	0	0	4	1	0	0	5
VARIABLE	0	0	0	0	0	0	0
TOTAL	0	3	9	6	9	3	30

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: 8

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: OCTOBER-DECEMBER 1993

STABILITY CLASS - SLIGHTLY UNSTABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	0	1	0	0	0	1
NNE	0	1	0	1	0	0	2
NE	0	0	1	1	0	0	2
ENE	0	0	0	0	0	0	0
E	0	2	0	0	0	0	2
ESE	0	4	0	0	0	0	4
SE	0	3	0	0	0	0	3
SSE	0	0	1	0	1	0	2
S	0	0	1	3	3	1	8
SSW	0	0	0	1	4	1	6
SW	0	0	2	6	2	2	12
WSW	0	4	6	6	0	1	17
W	0	0	4	1	1	3	9
WNW	0	0	1	3	2	0	6
NW	0	1	4	1	0	0	6
NNW	0	0	4	7	0	0	11
VARIABLE	0	0	0	0	0	0	0
TOTAL	0	15	25	30	13	8	91

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: 8

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: OCTOBER-DECEMBER 1993

STABILITY CLASS - NEUTRAL (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	1	4	19	26	14	1	65
NNE	3	7	17	21	5	8	61
NE	0	5	10	28	5	0	48
ENE	5	18	17	6	0	0	46
E	2	23	18	13	8	2	66
ESE	0	9	12	11	7	1	40
SE	0	6	9	12	4	2	33
SSE	0	2	15	25	20	2	64
S	0	3	29	43	35	13	123
SSW	0	7	23	31	31	11	103
SW	1	6	24	26	21	7	85
WSW	2	10	18	21	15	3	69
W	1	9	32	63	26	9	140
WNW	3	8	13	50	38	19	131
NW	0	5	25	42	17	4	93
NNW	3	5	32	35	13	3	91
VARIABLE	0	0	0	0	0	0	0
TOTAL	21	127	313	453	259	85	1258

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: 8

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: OCTOBER-DECEMBER 1993

STABILITY CLASS - SLIGHTLY STABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	1	2	2	6	0	0	11
NNE	0	0	5	14	3	0	22
NE	2	2	3	4	1	0	12
ENE	2	15	4	3	0	0	24
E	0	6	6	5	2	0	19
ESE	0	3	3	2	1	0	9
SE	1	3	5	9	2	0	20
SSE	0	4	14	17	3	0	38
S	0	1	10	33	20	5	69
SSW	0	0	16	48	30	3	97
SW	0	2	10	43	24	3	82
WSW	0	5	7	14	9	1	36
W	1	2	6	18	11	0	38
WNW	1	2	5	13	3	1	25
NW	0	2	11	16	0	0	29
NNW	0	3	2	2	4	0	11
VARIABLE	0	0	0	0	0	0	0
TOTAL	8	52	109	247	113	13	542

Hours of calm in this stability class: 0
Hours of missing wind measurements in this stability class: 11
Hours of missing stability measurements in all stability classes: 8

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: OCTOBER-DECEMBER 1993

STABILITY CLASS - MODERATELY STABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

	WIND SPEED (in mph)						
WIND DIRECTION	1-3	4-7	8-12	13-18	19-24	> 24	TOTAL
N	0	0	1	0	0	0	1
NNE	1	0	5	4	0	0	10
NE	1	3	4	0	0	0	8
ENE	1	8	2	0	0	0	11
E	0	0	0	0	0	0	0
ESE	0	2	3	1	3	0	9
SE	0	2	0	8	0	0	10
SSE	0	0	7	4	1	0	12
S	0	1	3	12	2	0	18
SSW	1	1	9	14	23	1	49
SW	0	2	0	24	6	0	32
WSW	0	3	1	14	0	0	18
W	0	3	6	8	1	0	18
WNW	0	0	5	6	0	0	11
NW	1	1	6	4	0	0	12
NNW	0	0	2	1	0	0	3
VARIABLE	0	0	0	0	0	0	0
TOTAL	5	26	54	100	36	1	222

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: 8

DRESDEN NUCLEAR POWER STATION

PERIOD OF RECORD: OCTOBER-DECEMBER 1993

STABILITY CLASS - EXTREMELY STABLE (DIFF TEMP 300-35 FT)
WINDS MEASURED AT 300 FEET

WIND DIRECTION	WIND SPEED (in mph) 1-3	4-7	8-12	13-18	19-24	> 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	1	0	0	0	0	0	1
ESE	1	1	0	0	0	0	2
SE	0	0	0	1	0	0	1
SSE	0	1	1	0	0	0	2
S	0	1	1	1	0	0	3
SSW	0	1	2	0	0	0	3
SW	0	1	0	2	1	0	4
WSW	0	0	0	0	0	0	0
W	0	1	0	0	0	0	1
WNW	0	0	1	0	0	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	2	6	5	4	1	0	18

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: 8

APPENDIX III

LISTING OF MISSED SAMPLES

LISTING OF MISSED SAMPLES

Sample Type[a]	Location	Collection Date	Reason
AP	D-01	07-10-93	No power
AP/I	D-01	07-17-93	No power
AP/I	D-03	08-28-93	No power
AP	D-03	09-04-93	No power
AP/I	D-03	09-11-93	No power
AP	D-03	09-18-93	No power
AP/I	D-03	09-25-93	No power
AP	D-03	10-02-93	No power
AP	D-03	10-02-93	No power
AP/I	D-03	10-09-93	Equipment failure; replaced pump.
TLD	D-103-2	01-01-94	Found missing.
Air Sampling Variances[b]			
AP/I	D-05	01-16-93	Volume estimated.
AP/I	D-01	04-24-93	Volume estimated; new timer installed
AP/I	D-04	05-29-93	Volume estimated; new timer installed.
AP	D-05	06-12-93	Low volume; no power
AP/I	D-01	07-03-93	Low volume; no power
AP	D-03	08-21-93	Low volume; no power
AP	D-04	09-04-93	Low volume; new pump installed.

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[a] AP/I = Air Particulate/Air Iodine.

[b] Air Sampling Variances are samples which have not been missed but indicate unusual sample results or factors which contribute to sample anomalies.

APPENDIX IV

MILCH ANIMALS, NEAREST LIVESTOCK, AND NEAREST RESIDENCES CENSUSES

MILCH ANIMALS CENSUS, 1993

A. 1. There are no dairy farms within a 2 mile radius of Dresden Station.

2. There are no dairy farms within 2 to 5 miles of Dresden Station.

B. Sampling Locations

D-25 V. Biros Dairy Farm
11.4 miles @ 220°

Number of cows - 91 Holsteins
Number of fresh cows - 70

Diet consists of feed, chopped hay, and some pasture.

D-26 Halpins Dairy Farm
16.0 miles @ 175°

Number of cows - 71 Holsteins
Number of fresh cows - 56

Diet consists of feed, chopped hay, and some pasture.

D-42 Irwin Goodwin Dairy Farm
12.8 miles @ 135°

Number of cows - 33 Brown Swiss
Number of fresh cows - 20

Diet consists of feed, chopped hay, and some pasture.

Census conducted by A. Lewis on August 23, 24, and 25, 1993.

NEAREST RESIDENCE CENSUS, 1993

Nearest resident of the Dresden Station within a five (5) mile radius.

Sector	Direction	Distance
A	N	1.2 miles
B	NNE	0.8 miles
C	NE	2.3 miles
D	ENE	0.8 miles
E	E	1.8 miles
F	ESE	1.0 miles
G	SE	0.6 miles
H	SSE	0.5 miles
J	S	0.5 miles
K	SSW	3.3 miles
L	SW	3.7 miles
M	WSW	5.8 miles
N	W	3.5 miles
P	WNW	3.7 miles
Q	NW	2.6 miles
R	NNW	0.8 miles

Census conducted by A. Lewis on August 23, 24, and 25, 1993.

DRESDEN

NEAREST LIVESTOCK CENSUS, 1993

Nearest livestock of the Dresden Station within a five (5) mile radius.

Sector	Direction	Distance
A	N	1.4 miles
B	NNE	5.4 miles
C	NE	4.8 miles
D	ENE	4.7 miles
E	E	None
F	ESE	None
G	SE	None
H	SSE	None
J	S	3.8 miles
K	SSW	2.7miles
L	SW	None
M	WSW	None
N	W	0.5 miles
P	WNW	0.5 miles
Q	NW	0.5 miles
R	NNW	1.0 miles

Census conducted by A. Lewis on August 23, 24, and 25, 1993.

APPENDIX V

INTERLABORATORY COMPARISON PROGRAM RESULTS

Appendix V

Interlaboratory Comparison Program Results

Teledyne Brown Engineering Environmental Services, Midwest Laboratory (formerly Teledyne Isotopes and Hazelton Environmental Services) has participated in interlaboratory comparison (crosscheck) programs since the formulation of it's 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 know 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 concentration 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 current year. This program is conducted by the U.S. Environmental Protection Agency Intercomparison and Calibration Section, Quality Assurance Branch, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada.

Table A-2 lists results of the analyses on in-house "spiked" samples.

Out-of-limit results are explained directly below the result.

Table A-1. U.S. Environmental Protection Agency's crosscheck program, comparison of EPA and Teledyne Brown Engineering Environmental Services, Midwest Laboratory results for various sample media[a].

				Concentration in pCi/L[b]		
Lab Code	Sample Type	Date Collected	Analyses	EPA Result[c] 1s, N=1	Control Limits	TBEESML Results ± 2 Sigma[d]
STW-680	WATER	Jan, 1993	Sr-89	15.0 ± 5.0	6.3 - 23.7	15.0 ± 2.0 ; 2.5
			Sr-90	10.0 ± 5.0	1.3 - 18.7	10.3 ± 1.2 ; 1.6
STW-681	WATER	Jan, 1993	Pu-239	20.0 ± 2.0	16.5 - 23.5	17.5 ± 1.6 ; 2.4
STW-682	WATER	Jan, 1993	Alpha	34.0 ± 9.0	18.4 - 49.6	17.1 ± 1.2 ; 2.1
			Beta	44.0 ± 5.0	35.3 - 52.7	46.7 ± 3.2 ; 5.7

Gross Alpha analysis was repeated with similar results. An investigation of possible causes for the deviation from the EPA was conducted with no cause discovered. The sample was spiked with Th-230; so Alpha Spec Analysis for Th-230 was performed in triplicate with results of 15.5±2.1, 13.4±1.4, and 14.8±2.0. It should be noted that 66% of all participants failed this analysis with a grand average of 17.1. This coupled with the support of the Alpha Spec results leaves TIML cause to believe that there may have been a dilution error at the EPA. It should be noted that on the next Gross Alpha EPA check, TIML reported results that where exactly the known value. Since no apparent cause can be found, and TIML had outstanding results on the following sample, it is felt that no further investigation is needed.

Lab Code	Sample Type	Date Collected	Analyses	EPA Result[c] 1s, N=1	Control Limits	TBEESML Results ± 2 Sigma[d]
STW-683	WATER	Feb, 1993	I-131	100.0 ± 10.0	82.7 - 117.3	106.0 ± 10.0 ; 14.6
STW-684	WATER	Feb, 1993	Uranium	7.6 ± 3.0	2.4 - 12.8	7.2 ± 0.5 ; 0.9
STW-685	WATER	Mar, 1993	Ra-226	9.8 ± 1.5	7.2 - 12.4	9.3 ± 1.3 ; 1.6
			Ra-228	18.5 ± 4.6	10.5 - 26.5	20.8 ± 2.2 ; 3.0
STW-686	WATER	Apr, 1993	Alpha	95.0 ± 24.0	53.4 - 136.6	88.3 ± 8.1 ; 12.0
			Ra-226	24.9 ± 3.7	18.5 - 31.3	25.4 ± 1.4 ; 2.9
			Ra-228	19.0 ± 4.8	10.7 - 27.3	17.4 ± 1.2 ; 2.1
			Uranium	28.9 ± 3.0	23.7 - 34.1	27.8 ± 2.2 ; 3.5
STW-687	WATER	Apr, 1993	Beta	177.0 ± 27.0	130.2 - 223.8	141.7 ± 9.0 ; 16.8
			Sr-89	41.0 ± 5.0	32.3 - 49.7	28.7 ± 9.4 ; 9.8
			Sr-90	29.0 ± 5.0	20.3 - 37.7	28.0 ± 3.5 ; 4.5
			Co-60	39.0 ± 5.0	30.3 - 47.7	41.3 ± 1.2 ; 4.3
			Cs-134	27.0 ± 5.0	18.3 - 35.7	24.7 ± 1.2 ; 2.7
			Cs-137	32.0 ± 5.0	23.3 - 40.7	30.0 ± 0.0 ; 3.0

The EPA report was received 08-16-93. No cause for the low result for Sr-89 was found. The analyst has been observed performing this procedure with no noted descrepancies. Teledyne will continue to monitor this procedure in the future. No further action is anticipated unless conditions warrant.

Lab Code	Sample Type	Date Collected	Analyses	EPA Result[c] 1s, N=1	Control Limits	TBEESML Results ± 2 Sigma[d]
STW-688	WATER	Jun, 1993	H-3	9844.0 ± 984.0	8136.8 - 11551.2	9613.3 ± 46.2 ; 962.4
STW-689	WATER	Jun, 1993	Co-60	15.0 ± 5.0	6.3 - 23.7	17.3 ± 4.6 ; 4.9
			Zn-65	103.0 ± 10.0	85.7 - 120.3	114.0 ± 13.2 ; 17.4
			Ru-106	119.0 ± 12.0	98.2 - 139.8	108.0 ± 8.0 ; 13.4
			Cs-134	5.0 ± 5.0	0.0 - 13.7	5.7 ± 1.2 ; 1.3
			Cs-137	5.0 ± 5.0	0.0 - 13.7	6.0 ± 2.0 ; 2.1
			Ba-133	99.0 ± 10.0	81.7 - 116.3	101.7 ± 10.3 ; 14.5

Table A-1. U.S. Environmental Protection Agency's crosscheck program, comparison of EPA and Teledyne Brown Engineering Environmental Services, Midwest Laboratory results for various sample media[a].

				Concentration in pCi/L[b]		
Lab Code	Sample Type	Date Collected	Analyses	EPA Result[c] 1s, N=1	Control Limits	TBEESML Results ± 2 Sigma[d]
STW-690	WATER	Jul, 1993	Sr-89	34.0 ± 5.0	25.3 - 42.7	28.3 ± 2.3 ; 3.7
			Sr-90	25.0 ± 5.0	16.3 - 33.7	25.0 ± 1.0 ; 2.7
STW-691	WATER	Jul, 1993	Alpha	15.0 ± 5.0	6.3 - 23.7	15.0 ± 2.7 ; 3.0
			Beta	43.0 ± 6.9	31.0 - 55.0	41.3 ± 4.9 ; 6.4
STW-692	WATER	Aug, 1993	Uranium	25.3 ± 3.0	20.1 - 30.5	24.9 ± 1.4 ; 2.9
STAF-693	AIR FILTER	Aug, 1993	Alpha	19.0 ± 5.0	10.3 - 27.7	17.0 ± 1.0 ; 2.0
			Beta	47.0 ± 5.0	38.3 - 55.7	47.3 ± 0.6 ; 4.8
			Sr-90	19.0 ± 5.0	10.3 - 27.7	19.3 ± 0.6 ; 2.0
			Cs-137	9.0 ± 5.0	0.3 - 17.7	10.0 ± 1.0 ; 1.4
STW-694	WATER	Sep, 1993	Ra-226	14.9 ± 2.2	11.1 - 18.7	15.9 ± 0.7 ; 1.7
			Ra-228	20.4 ± 5.1	11.6 - 29.2	21.0 ± 1.6 ; 2.6
STM-695	MILK	Sep, 1993	I-131	120.0 ± 12.0	99.2 - 140.8	125.3 ± 4.5 ; 13.3
			Sr-89	30.0 ± 5.0	21.3 - 38.7	19.3 ± 1.5 ; 2.5
			Sr-90	25.0 ± 5.0	16.3 - 33.7	22.0 ± 0.0 ; 2.2
			Cs-137	49.0 ± 5.0	40.3 - 57.7	49.0 ± 3.0 ; 5.7
			K	1679.0 ± 84.0	1533.3 - 1824.7	1616.7 ± 37.9 ; 166.0

Report was received 01-18-94; an investigation is underway as to the cause of the low Sr-89 results. In house spikes have been prepared and the analysis is in progress (see SPM-4848 and SPM-4849 in future reports). There is no apparent cause of the low Sr-89 results. In-house spikes have been prepared and the analysis is in progress. The analyst has been observed performing this procedure with no discrepancies noted. No further action is planned unless the results of the In-House spikes show a problem.

Lab Code	Sample Type	Date Collected	Analyses	EPA Result[c] 1s, N=1	Control Limits	TBEESML Results ± 2 Sigma[d]
STW-696	WATER	Oct, 1993	I-131	117.0 ± 12.0	96.2 - 137.8	116.7 ± 2.3 ; 11.9
STW-697	WATER	Oct, 1993	Gr. Alpha	40.0 ± 10.0	22.7 - 57.3	39.7 ± 1.5 ; 4.3
			Ra-226	9.9 ± 1.5	7.3 - 12.5	10.6 ± 0.5 ; 1.2
			Ra-228	12.5 ± 3.1	7.1 - 17.9	13.2 ± 1.5 ; 2.0
			Uranium	15.1 ± 3.0	9.9 - 20.3	15.3 ± 0.6 ; 1.6
STW-698	WATER	Oct, 1993	Beta	58.0 ± 10.0	40.7 - 75.3	52.0 ± 1.0 ; 5.3
			Sr-89	15.0 ± 5.0	6.3 - 23.7	11.3 ± 0.6 ; 1.3
			Sr-90	10.0 ± 5.0	1.3 - 18.7	11.0 ± 0.0 ; 1.1
			Co-60	10.0 ± 5.0	1.3 - 18.7	10.7 ± 0.6 ; 1.2
			Cs-134	12.0 ± 5.0	3.3 - 20.7	10.0 ± 1.0 ; 1.4
			Cs-137	10.0 ± 5.0	1.3 - 18.7	12.3 ± 1.2 ; 1.7
STW-699	WATER	Oct, 1993	Alpha	20.0 ± 5.0	11.3 - 28.7	18.3 ± 2.5 ; 3.1
			Beta	15.0 ± 5.0	6.3 - 23	13.7 ± 0.6 ; 1.5
STW-700	WATER	Nov, 1993	H-3	7398.0 ± 740.0	6114.1 - 8681.9	7310.0 ± 175.2 ; 751.7

Table A-1. U.S. Environmental Protection Agency's crosscheck program, comparison of EPA and Teledyne Brown Engineering Environmental Services, Midwest Laboratory results for various sample media[a].

				Concentration in pCi/L[b]		
Lab Code	Sample Type	Date Collected	Analyses	EPA Result[c] 1s, N=1	Control Limits	TBEESML Results ± 2 Sigma[d]
STW-701	WATER	Nov, 1993	Ba-133	79.0 ± 8.0	65.1 - 92.9	75.7 ± 7.6 ; 10.8
			Co-60	30.0 ± 5.0	21.3 - 38.7	30.7 ± 2.1 ; 3.7
			Cs-134	59.0 ± 5.0	50.3 - 67.7	51.3 ± 5.9 ; 7.8
			Cs-137	40.0 ± 5.0	31.3 - 48.7	41.7 ± 1.2 ; 4.3
			Ru-106	201.0 ± 20.0	166.3 - 235.7	163.3 ± 3.2 ; 16.6
			Zn-65	150.0 ± 15.0	124.0 - 176.0	157.0 ± 8.7 ; 17.9

The report was received on 02-14-94; the cause of the low Ru-106 is under investigation. It should be noted that the grand average of all participants in this analysis was 175.2 pCi/L, with 54% of the participants outside of limits.

---

[a] Results obtained by Teledyne Brown Engineering Environmental Services 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, Neveda.

[b] All results are in pCi/L, except for elemental potassium (K) data in milk, which are in mg/L; air filter samples, which are in pCi/Filter; and food products, which are in mg/Kg.

[c] USEPA results are presented as the known values and expected laboratory precision (1s, 1 determination) and control limits as defined by the EPA.

[d] Unless otherwise indicated, the TBEESML results are given as the mean ± 2 standard deviations for three determinations. The numbers after the semi-colon are the Total Propagated Uncertainty of the result.

Table A-2. In-house "spike" samples.

<table>
<tr><th rowspan="2">Lab Code</th><th rowspan="2">Sample Type</th><th rowspan="2">Date Collected</th><th rowspan="2">Analyses</th><th rowspan="2">Accepted Rejected</th><th colspan="3">Concentration in pCi/L[a]</th></tr>
<tr><th>Known Activity</th><th>Control Limits[b]</th><th>TBEESML Results 2s, n=1[c]</th></tr>
<tr><td>SPM-3341</td><td>MILK</td><td>Jan, 1993</td><td>Sr-89</td><td>A</td><td>8.7</td><td>4.7 - 12.7</td><td>6.7 ± 3.1 ; 3.2</td></tr>
<tr><td></td><td></td><td></td><td>Sr-90</td><td>A</td><td>19.2</td><td>14.9 - 23.5</td><td>20.0 ± 1.2 ; 2.3</td></tr>
<tr><td></td><td></td><td></td><td>Cs-134</td><td>A</td><td>21.3</td><td>16.5 - 26.1</td><td>17.1 ± 2.0 ; 2.6</td></tr>
<tr><td></td><td></td><td></td><td>Cs-137</td><td>A</td><td>23.8</td><td>18.5 - 29.1</td><td>21.4 ± 2.0 ; 2.9</td></tr>
<tr><td>SPM-3387</td><td>MILK</td><td>Feb, 1993</td><td>I-131</td><td>A</td><td>71.5</td><td>53.3 - 89.7</td><td>72.5 ± 8.4 ; 11.1</td></tr>
<tr><td>SPVE-3401</td><td>VEGETATION
(SAW DUST)</td><td>Feb, 1993</td><td>I-131</td><td>A</td><td>953.7</td><td>745.5 - 1161.9</td><td>994.5 ± 53.2 ; 112.8</td></tr>
<tr><td>SPCH-340</td><td>CHARCOAL</td><td>Feb, 1993</td><td>I-131</td><td>A</td><td>95.4</td><td>69.9 - 120.9</td><td>95.2 ± 12.8 ; 16.0</td></tr>
<tr><td>SPW-3434</td><td>WATER</td><td>Apr, 1993</td><td>Gr. Alpha</td><td>A</td><td>10.4</td><td>7.3 - 13.5</td><td>10.4 ± 1.8 ; 2.1</td></tr>
<tr><td></td><td></td><td></td><td>Gr. Beta</td><td>A</td><td>20.6</td><td>15.6 - 25.6</td><td>22.0 ± 2.0 ; 3.0</td></tr>
<tr><td>SPW-3556</td><td>WATER</td><td>Apr, 1993</td><td>Sr-89</td><td>A</td><td>22.2</td><td>14.7 - 29.7</td><td>18.2 ± 5.0 ; 5.3</td></tr>
<tr><td></td><td></td><td></td><td>Sr-90</td><td>A</td><td>17.0</td><td>12.6 - 21.4</td><td>20.1 ± 1.8 ; 2.7</td></tr>
<tr><td>SPW-3597</td><td>WATER</td><td>Apr, 1993</td><td>H-3</td><td>A</td><td>5428.0</td><td>4296.5 - 6559.5</td><td>5464.0 ± 219.0 ; 588.7</td></tr>
<tr><td>SPW-3599</td><td>WATER</td><td>Apr, 1993</td><td>I-131</td><td>A</td><td>145.0</td><td>115.4 - 174.6</td><td>149.8 ± 1.9 ; 15.1</td></tr>
<tr><td>SPW-3606</td><td>WATER</td><td>Apr, 1993</td><td>Co-60</td><td>A</td><td>21.5</td><td>16.0 - 27.0</td><td>24.8 ± 2.3 ; 3.4</td></tr>
<tr><td></td><td></td><td></td><td>Cs-134</td><td>A</td><td>26.4</td><td>20.5 - 32.3</td><td>26.4 ± 1.9 ; 3.3</td></tr>
<tr><td></td><td></td><td></td><td>Cs-137</td><td>A</td><td>31.7</td><td>24.3 - 39.1</td><td>33.9 ± 2.6 ; 4.3</td></tr>
<tr><td>SPM-3631</td><td>MILK</td><td>Apr, 1993</td><td>I-131</td><td>A</td><td>145.0</td><td>116.4 - 173.6</td><td>139.8 ± 1.6 ; 14.1</td></tr>
<tr><td></td><td></td><td></td><td>Cs-134</td><td>A</td><td>52.8</td><td>41.8 - 63.8</td><td>48.8 ± 2.9 ; 5.7</td></tr>
<tr><td></td><td></td><td></td><td>Cs-137</td><td>A</td><td>63.4</td><td>49.9 - 76.9</td><td>65.2 ± 2.9 ; 7.1</td></tr>
<tr><td>SPF-3681</td><td>FISH
(JELLO)</td><td>May, 1993</td><td>Cs-137</td><td>A</td><td>67.6</td><td>50.6 - 84.6</td><td>68.2 ± 7.7 ; 10.3</td></tr>
<tr><td colspan="8">Concentrations are in pCi/Total Volume (550g).</td></tr>
<tr><td>SPW-3842</td><td>WATER</td><td>Jun, 1993</td><td>Th-230</td><td>A</td><td>4.5</td><td>3.4 - 5.6</td><td>4.2 ± 0.5 ; 0.7</td></tr>
<tr><td>SPW-4160</td><td>WATER</td><td>Jun, 1993</td><td>Alpha</td><td>R</td><td>12.9</td><td>10.0 - 15.8</td><td>8.9 ± 1.4 ; 1.7</td></tr>
<tr><td></td><td></td><td></td><td>Beta</td><td>R</td><td>31.9</td><td>25.8 - 38.0</td><td>22.0 ± 1.9 ; 2.9</td></tr>
<tr><td colspan="8">A review of the raw data for the Alpha and Beta analyses revealed no errors in calculations or transcribing of data. The technician was observed performing this analysis; no discrepancies where noted. The technician's performance in the future will be monitored. It should be noted that TIML's results are within the EPA specified control limits. No further action is planned.</td></tr>
<tr><td>SPW-4232</td><td>WATER</td><td>Aug, 1993</td><td>Fe-55</td><td>A</td><td>1420.0</td><td>830.1 - 2009.9</td><td>1684.0 ± 415.0 ; 447.9</td></tr>
<tr><td>SPW-4246</td><td>WATER</td><td>Aug, 1993</td><td>Sr-90</td><td>A</td><td>30.4</td><td>23.2 - 37.6</td><td>32.2 ± 2.6 ; 4.1</td></tr>
<tr><td>SPM-4247</td><td>MILK</td><td>Aug, 1993</td><td>Sr-89</td><td>A</td><td>35.4</td><td>26.2 - 44.6</td><td>29.1 ± 4.9 ; 5.7</td></tr>
<tr><td></td><td></td><td></td><td>Sr-90</td><td>A</td><td>19.2</td><td>15.0 - 23.4</td><td>18.3 ± 1.3 ; 2.2</td></tr>
<tr><td>SPW-4248</td><td>WATER</td><td>Aug, 1993</td><td>H-3</td><td>A</td><td>10430.0</td><td>8351.6 - 12508.4</td><td>9910.0 ± 300.0 ; 1035.4</td></tr>
<tr><td>SPW-4250</td><td>WATER</td><td>Aug, 1993</td><td>Co-60</td><td>A</td><td>247.7</td><td>189.1 - 306.3</td><td>247.0 ± 23.1 ; 33.8</td></tr>
<tr><td></td><td></td><td></td><td>Cs-134</td><td>A</td><td>141.1</td><td>105.7 - 176.5</td><td>141.6 ± 15.9 ; 21.3</td></tr>
<tr><td></td><td></td><td></td><td>Cs-137</td><td>A</td><td>247.2</td><td>182.8 - 311.6</td><td>283.5 ± 27.8 ; 39.7</td></tr>
<tr><td>SPF-4251</td><td>FISH (JELLO)</td><td>Aug, 1993</td><td>Cs-134</td><td>A</td><td>75.3</td><td>60.1 - 90.5</td><td>68.8 ± 3.3 ; 7.6</td></tr>
<tr><td></td><td></td><td></td><td>Cs-137</td><td>A</td><td>198.1</td><td>156.3 - 239.9</td><td>203.6 ± 8.2 ; 21.9</td></tr>
</table>

Table A-2. In-house "spike" samples.

					Concentration in pCi/L[a]		
Lab Code	Sample Type	Date Collected	Analyses	Accepted Rejected	Known Activity	Control Limits[b]	TBEESML Results 2s, n=1[c]
SPS-4262	SEDIMENT (BOTTOM)	Aug, 1993	Cs-134	A	71.0	51.5 - 90.5	74.1 ± 9.9 ; 12.4
			Cs-137	A	197.8	152.1 - 243.5	212.4 ± 14.8 ; 25.9
SPW-4377	WATER	Sep, 1993	I-131	A	42.1	27.2 - 57.0	39.0 ± 10.0 ; 10.7
SPM-4378	MILK	Sep, 1993	I-131	A	42.1	30.8 - 53.4	44.5 ± 5.5 ; 7.1
SPCH-437	CHARCOAL	Sep, 1993	I-131	A	84.3	59.6 - 109.0	90.3 ± 13.5 ; 16.2
SPVE-4380	VEGETATION (SAW DUST)	Sep, 1993	I-131	A	170.2	125.4 - 215.0	193.2 ± 20.0 ; 27.8
SPW-4381	WATER	Sep, 1993	Sr-89	A	28.8	21.4 - 36.2	21.9 ± 4.0 ; 4.6
			Sr-90	A	19.0	14.4 - 23.6	19.5 ± 1.8 ; 2.7
SPW-4382	WATER	Sep, 1993	I-129	A	18.6	14.7 - 22.5	18.1 ± 1.0 ; 2.1
SPW-4421	WATER	Oct, 1993	H-3	A	17380.0	13912.4 - 20847.6	16900.0 ± 368.0 ; 1729.6
SPW-4428	WATER	Oct, 1993	Co-60	A	18.3	12.8 - 23.8	19.3 ± 3.1 ; 3.7
			Cs-134	A	33.5	25.6 - 41.4	31.5 ± 3.3 ; 4.6
			Cs-137	A	43.2	33.2 - 53.2	44.4 ± 3.6 ; 5.7
SPM-4426	MILK	Oct, 1993	I-131	A	44.5	30.1 - 58.9	49.7 ± 8.6 ; 9.9
			Cs-134	A	33.0	24.2 - 41.8	30.8 ± 4.5 ; 5.5
			Cs-137	A	43.2	31.5 - 54.9	43.4 ± 6.0 ; 7.4
SPW-4427	WATER	Oct, 1993	I-131	A	88.9	65.8 - 112.0	95.2 ± 10.6 ; 14.2

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[a] All results are in pCi/L, except for elemental potassium (K) data in milk, which are in mg/L.; air filter samples, which are in pCi/Filter; and food products, which are in mg/Kg.

[b] Control limits are based on the known value ± 10%+TPU (Where all parametric uncertainties, other than counting statistics, are less than 5%).

[c] All samples are the results of single determinations. The result is reported in the following format: Activity ± Counting Error ; Total Propagated Uncertainty.

APPENDIX VI

ANALYTICAL PROCEDURES

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DETERMINATION OF SELF-ABSORPTION FOR GROSS ALPHA AND/OR GROSS BETA IN WATER, SOIL/SEDIMENTS AND ORGANIC ASH SAMPLES

PROCEDURE NO. TIML-AB-02

Prepared by

Teledyne Isotopes Midwest Laboratory

Copy No. ___________

Revised Pages	Revision #	Date	Pages	Prepared by	Approved by
	0	08-14-92	6	B. Grob	L.G. Huebner

DETERMINATION OF SELF-ABSORPTION FOR GROSS ALPHA AND/OR GROSS BETA IN WATER, SOIL/SEDIMENTS AND ORGANIC ASH SAMPLES

Principle of Method

Equal amounts of standard solution is mixed with various amounts of solids, deposited on the planchets and counted. Self-absorption is determined from the ratio of samples containing solids to the weighless standard. Mathematical function is fitted to the data and the self-absorption curve is stored in the computer.

Instrument:

Gas flow proportional counter.

Standards:

1. Gross alpha - Americium-241.
2. Gross beta - Strontium-90 in equilibrium with yttrium-90.

   Standards in liquid form are obtainable from NIST, Amersham, EPA, or other sources traceable to NIST.

3. Standard Solution:
   Am-241, ca. 250 dpm/mL
   Sr-90-Y-90, ca. 500 dpm/mL

Materials:

Ringed stainless steel planchets, 47mm diameter
Calibrated pipetter
Plastic pipette, 1 mL
Lucite: 0.5 mg/mL in acetone
Infrared lamp
50 mL beakers
Concentrated salt solution (e.g. $Na_2 CO_3$, ca. 10mg/mL) in water
Fine soil or sediment of low activity
Ashed sawdust
Drying oven

Procedure

A. Standards

For preparation of standards follow procedures TIML-ST-01, ST-02, and "Procedure for Determination of Gross Alpha and Gross Beta Efficiencies for Proportional Planchet Counters", QCP Manual, Section 8.3.

B. Water

1. Wash 20 ringed planchets with decon solution, rinse with DI water and dry in an oven.
2. Cool planchets to room temperature.
3. Weigh each planchet and store in labeled Petrie dishes.
4. Take 7 labeled beakers for gross alpha measurements and put in appropriate amount of salt solution to give ca. 10, 20, 30, 50, 70, 100, and 130 mg of precipitate per planchet.
5. Take 10 labeled beaker for gross beta measurements and put in appropriate amount of salt solution to give ca. 10, 20, 30, 50, 70, 100, 150, 200, 250, and 300 mg of precipitate per planchet.
6. Add 2 mL of corresponding standard to each beaker.
7. Swirl each beaker to mix, put on hot plate and evaporate to ca. 4-5 mL.
8. Using new plastic eyedropper for each sample, transfer samples to the planchets, making sure that the solution does not spread to the rim (Figure 1) (Also see QCP Manual, Section 8.3)
9. Rinse each beaker several times with minimum amount of DI water and add wash water to the planchet.
10. Dry under the infrared lamp.

    NOTE 1: If more than 2 mL of solution is added to the planchet at one time, it may spread to the rim. To avoid this, repeat addition and evaporation several times.

    NOTE 2: If dry precipitate is not uniformly distributed, redissolve it in minimum amount of DI water, redistribute using the same eyedropper and dry.

11. Take 2 clean planchets and prepare weightless standards as described in "Procedure for Determination of Gross Alpha and Gross Beta Efficiencies for Proportional Planchet Counters", QCP Manual, Section 8.3.
12. Bake in muffler furnace for 45 minutes at 450°C. Cool.
13. Add 6-7 drops of the lucite solution and dry under the infrared lamp for 10-20 minutes.
14. Cool and weigh.
15. Store in the desiccator until counting.

C. Soil/Sediments

1. Weigh 17 clean planchets and record the weight (7 for gross alpha and 10 for gross beta).
2. Put ca. 10, 20, 30, 50, 70, 100, and 130 mg of fine soil on the planchets for gross alpha and ca. 10, 20, 30, 50, 70, 100, 150, 200, 250, and 300 mg of fine soil for gross beta.
3. Weigh each planchet and record net weight.
4. Add 2 mL of corresponding standard solution to each planchet.
5. Mix well and distribute the precipitate evenly over the planchet, making sure that the precipitate does not spread to the rim of the planchet (Figure 1).
6. Dry under the infrared lamp.
7. Add 6-7 drops of the lucite solution and dry under infrared lamp for 10-20 minutes.
8. Cool and weigh again. Use this final weight for calculations.
9. Store in the desiccator until counting.

D. Organic Ash

Follow steps 1-9, Part C, but use ashed sawdust instead of soil.

E. Counting

1. Count each sample long enough to obtain at least 10,000 counts.
2. Count weightless sample with each set.
3. Calculate self-absorption correction factor (CF) dividing cpm of the sample with precipitate by cpm of weightless sample.
4. Plot CF versus mg of precipitate. Fit a mathematical function to the data and draw this curve on the plot. (Figure 2).
5. Enter the equation of the function in the computer programs used in data reduction.

Calculation

$$\text{Correction Factor (CF)} = \frac{cpm^1}{cpm^0}$$

Where:

cpm^0 = counts per minute of weightless standard.

cpm^1 = counts per minute of the standard with corresponding mass of precipitate.

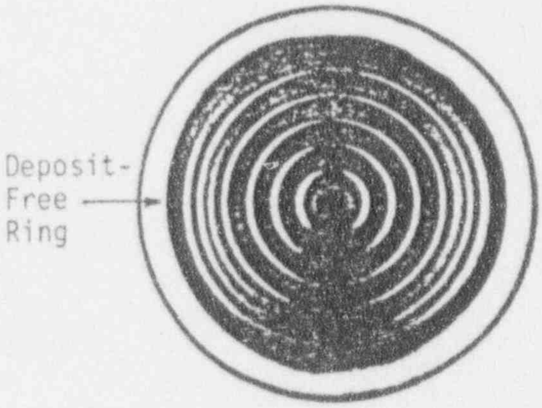
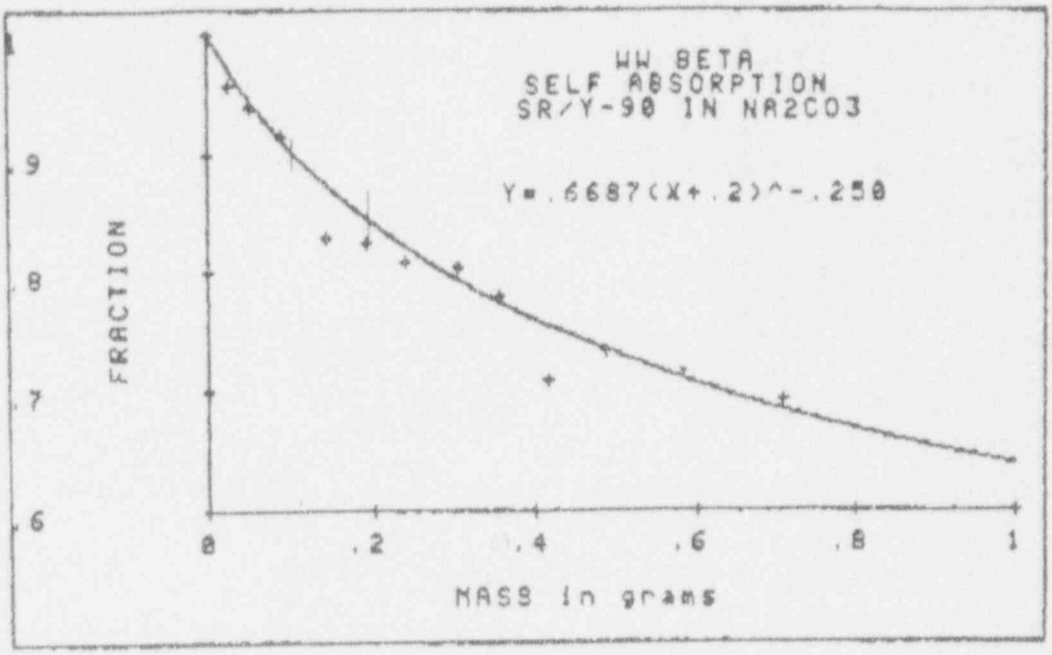


Figure 1. Distribution of the Standard on the Plachet.



X	Y
0.0249	0.9570
0.0488	0.9380
0.0889	0.9150
0.1432	0.8270
0.1885	0.8240
0.2389	0.8090
0.3030	0.8030
0.3543	0.7780
0.4139	0.7080
0.4833	0.7310
0.5831	0.7170
0.7061	0.6920

X = Mass in grams

Figure 2.

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DETERMINATION OF GROSS ALPHA AND/OR GROSS BETA IN AIR PARTICULATE FILTERS

PROCEDURE NO. TIML-AP-02

Prepared by

Teledyne Isotopes Midwest Laboratory

Copy No. ________

Revised Pages	Revision No.	Date	Pages	Prepared by	Approved by
	0	07-11-86	3	B. Grob	L. G. Huebner
2	1	07-15-91	3	B. Grob	L. G. Huebner

DETERMINATION OF GROSS ALPHA AND/OR GROSS BETA
IN AIR PARTICULATE FILTERS

Principle of Method

Air particulate filters are stored for at least 72 hours to allow for the decay of short-lived radon and thoron daughters and then counted in the proportional counter. | 1

Apparatus

Forceps
Loading Sheet
Proportional Counter
Stainless Steel Planchets (standard 2" x 1/8")

Procedure

1. Store the filters for at least 72 hours from the day of collection. | 1
2. Place filters on a stainless steel planchet.
3. Fill out a sample loading sheet. Fill in the date, counter number, counting time, sample identification number, sample collection date, and initials.

   NOTES: When loading samples in the holder, load blanks (unexposed filter paper) in positions 1, 12, 23, 34, 45, etc.

   If filters from more than one project are loaded, make sure that the appropriate blanks are loaded with each batch. Load the counter blank planchet as a last sample.
4. Count in a proporational counter long enough to obtain the required LLDs.
5. After counting is completed, return the filters to the original envelopes.
6. Submit the counter printout, field collection sheet, and the loading sheet to the data clerk for calculations.

Calculations

Gross alpha (beta) concentration:

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

Where:

A = Net alpha (beta) count (cpm)

B = Efficiency for counting alpha (beta) activity (cpm/dpm)

C = Volume of sample

E_{sb} = Counting error of sample plus background

E_b = Counting error of background

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PROCEDURE FOR COMPOSITING AIR PARTICULATE FILTERS FOR GAMMA SPECTROSCOPIC ANALYSIS

PROCEDURE NO. TIML-AP-03

Prepared by

Teledyne Isotopes Midwest Laboratory

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Revision No.	Date	Pages	Prepared by	Approved by
0	12-15-89	3	B. Grob	L. G. Huebner

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PROCEDURE FOR COMPOSITING AIR PARTICULATE FILTERS FOR GAMMA SPECTROSCOPIC ANALYSIS

Principle of Method

AP filters are placed in a Petrie Dish in chronological order, labeled and submitted to counting room for analysis.

Materials

Forceps (long)
Blank filter paper
Small Petrie Dish
Scotch Tape

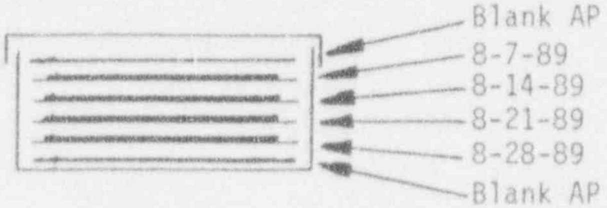
Procedure

1. Stack APs from each location in chronological order, with the latest collection date on top.
2. Place blank filter paper in the Petrie Dish.
3. Starting from the top of the stack, remove each AP from the envelope and place it in the Petrie Dish with the deposit facing up.
4. Continue transferring AP's from envelopes to the Petrie Dish until all are transferred.
5. Place blank filter paper on top.
6. Cap the Petrie Dish. Use scotch tape to hold cap in place, if needed.
7. Record sample ID (project), sample No., location, last date of collection, collection period and date composited in the Recording Book.
8. Write sample ID, sample No., last date of collection and collection period on the Petrie Dish using black marker.
9. Submit the samples to the counting room.
10. After counting, return AP's to the original envelopes in reverse order.

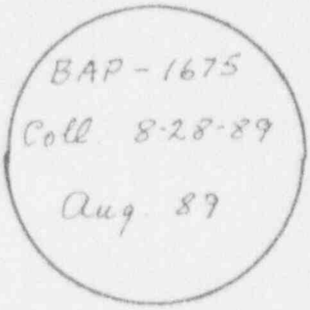
Example

Project: BAP
Location: 2
Sample No.: 1675
Last Collection Date: 08-28-89
Collection period: August, 1989
Samples collected: 8-7, 8-14, 8-21, 8-28

Side View



Top View



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PREPARATION AND STANDARDIZATION OF CARRIER SOLUTIONS

PROCEDURE NO. TIML-CAR-01

Prepared by

Teledyne Isotopes Midwest Laboratory

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	0	04-05-91	9	B. Grob	L. G. Huebner

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PREPARATION AND STANDARDIZATION OF CARRIER SOLUTIONS

Table of Contents

PREPARATION AND STANDARDIZATION OF CARRIER SOLUTIONS

Principle of Method

Carrier is prepared from "reagent-grade" chemical and the concentration of the carrier is established by standarization.

A. Barium (Total Radium)

Reagents

Barium Chloride:	$BaCl_2$
Nitric Acid:	HNO_3 (16N)
Sulfuric Acid:	H_2SO_4 (18N)

Apparatus

Heat Lamp
Planchets (Standard, 2" x 1/8", Ringed)
Analytical Balance

Procedure

1. Dissolve 56.92 grams of barium chloride in DI water. Add 5 mL concentrated nitric acid and dilute to 1000 mL with DI water. Stir the solution for a minimum of 30 minutes before standardization.

2. Pipet 1 mL of carrier solution into a 150 mL beaker and 100 mL of DI water. Heat to boiling and add 2 mL of 18N sulfuric acid, stirring constantly. Continue heating and stirring for 30 minutes. Allow to settle at room temperature for 1 hour. Decant supernate to waste and transfer the precipitate to a 40 mL centrifuge tube with DI water. Centrifuge for 10 minutes and decant supernate to waste. Wash the precipitate with 10 mL DI water. Centrifuge and decant supernate to waste. Transfer the precipitate onto a pre-weighed ringed planchet. Dry under the heat lamp and weigh.

3. Four of the above standardizations should be performed. The deviations in the results should be no more than 0.5%. Average the results.

4. Record the lot number, carrier number, and the precipitate weight in the "Carrier Recording Book" and submit to the Lab Supervisor for approval.

5. Transfer the standardized carrier into a bottle labeled with the carrier name, number, preparation date, and expiration date. The concentration will be approximately 55 mg of barium sulfate per 1 mL.

PREPARATION AND STANDARDIZATION OF CARRIER SOLUTIONS (continued)

B. Cerium (Radium-228)

Reagents

Cerium Nitrate:	$Ce(NO_3)_3$
Silver Oxide (Divalent):	AgO
Bis(2-Ethylhexyl) Hydrogen Phosphate:	HDEHP (15%)
Nitric Acid:	HNO_3 (16N)
Hydrogen Peroxide:	H_2O_2 (30%)
N-Heptane:	C_7H_{16}
Diammonium Oxalate:	$(NH_4)_2C_2O_4$ (0.2M)
Sodium Acetate:	$NaC_2H_3O_2$ (saturated)
Ethyl Alcohol:	C_2O_5OH (95%)

Apparatus

Filter, Whatman NO. 42, 2.4 cm
Filtration Equipment
Heat Lamp
Analytical Balance

Procedure

1. Add solid divalent silver oxide to 100 mL of 8N nitric acid until the solution remains black. Equilibrate 50 mL of this solution for 1 minute with 50 mL of 15% HDEHP in a 125 mL separatory funnel. Discard the aqueous layer. Dissolve 3.9 grams of cerium nitrate in 50 mL of 8M nitric acid and add divalent silver oxide until the solution remains black. Immediately extract the cerium with the pre-equilibrated 15% HDEHP for 1 minute. Discard the lower aqueous layer and wash the organic phase with 50 mL of 8M nitric acid. Strip the cerium from the organic phase twice (1 minute each) with 10 mL of 4M nitric acid containing 1 mL of hydrogen peroxide. Collect the strip solution in a clean separatory funnel, add 20 mL n-heptane, and mix for 1 minute. Drain the lower phase into a 100 mL beaker. Boil the solution for 5 minutes and dilute to 250 mL with 0.2M nitric acid. Stir the solution for a minimum of 30 minutes before standardization.

2. Pipet 1 mL of carrier solution into a 40 mL centrifuge tube. Dilute with DI water to 10 mL. Add 6 mL of saturated sodium acetate and 50 mL of 0.2M diammonium oxalate. Heat in a hot water bath for 5 minutes; cool. Filter the solution through pre-weighed filter paper (Whatman No. 42, 2.4 cm). Wash the precipitate with DI water and 95% ethyl alcohol. Dry the filter with the precipitate under the heat lamp and weigh it.

PREPARATION AND STANDARDIZATION OF CARRIER SOLUTIONS (continued)

B. Cerium (Radium-228) (continued)

Procedure (continued)

3. Four of the above standardizations should be performed. The deviations in the results should be no more than 0.5%. Average the results.

4. Record the lot number, carier number, and weight of the precipitate in the "Carrier Recording Book" and submit to the Lab Supervisor for approval.

5. Transfer the standardized carrier solution into a bottle labeled with the carrier name, carrier number, preparation date, and expiration date. The concentration will be approximately 13 mg of cerium oxalate per mL.

PREPARATION AND STANDARDIZATION OF CARRIER SOLUTIONS (continued)

C. Iodine

Reagents

Potassium Iodide:	KI
Sodium Bisulfide:	$NaHSO_3$ (1M)
Hydrochloric Acid:	HCl (3N)
Palladium Chloride:	$PdCl_2$
Ethyl Alcohol:	C_2H_5OH (95%)

Apparatus

Filter, Whatman No. 42, 2.4 cm
Filtration Equipment
Heat Lamp
Hot Plate
Analytical Balance

Procedure

1. Dissolve 26.16 g of potassium iodide (KI) in 100 mL DI water. Add 20 mL 1M sodium bisulfide. Dilute to 1000 mL with DI water. Stir the solution for a minimum of 30 minutes before standardization.

2. Pipet 1 mL of carrier into a 100 mL beaker. Add 25 mL of DI water, 10 mL of 3N of hydrochloric acid, and 10 drops of 1M sodium bisulfide. Heat and stir until about 30 mL of solution remains. Add 2 mL of palladium chloride solution. Refrigerate overnight. Filter the solution through pre-weighed filter paper (Whatman No. 42, 2.4 cm). Wash the precipitate with DI water and 95% ethyl alcohol. Dry the filter with the precipitate under the heat lamp and weigh it.

3. Four of the above standardizations should be performed. The deviations in the results should be no more than 0.5%. Average the results.

4. Record the lot number, carrier number, and precipitate weights in the "Carrier Recording Book" and submit to the Lab Supervisor for approval.

5. Transfer standardized carrier into a bottle labeled with carrier number, preparation, and expiration date. The concentration will be approximately 29 mg of potassium iodide per mL.

PREPARATION AND STANDARDIZATION OF CARRIER SOLUTIONS (continued)

D. Iron

Reagents

Iron Chloride: $FeCl_3$
Ammonium Carbonate: Na_2CO_3 (saturated)
Diammonium Phosphate: $(NH_4)_2HPO_4$ (2M)
Ammonium Hydroxide: NH_4OH (30%)

Apparatus

Copper Discs
Electroplating Apparatus
Analytical Balance

Procedure

1. Dissolve 84.8 g of iron chloride in 80 mL of DI water. Filter and dilute to 1000 mL. Stir for a minimum of 30 minutes before standardization.

2. Pipet 1 mL of carrier into electroplating cell. Add 5 mL DI water, 1 mL 2M diammonium phosphate, and 10 mL ammonium carbonate saturated in ammonium hydroxide. Electroplate for 2 hours. Rinse with tap water and methyl alcohol. Dry under heat lamp and weigh it.

3. Four of the above standardizations should be performed. The devieations in the results should be no more than 0.5%. Average the results.

4. Record the lot number, carrier number, and precipitate weights in the "Carrier Recording Book" and submit to the Lab Supervisor for Aproval.

5. Transfer standardized carrier into a bottle labeled with the carrier number, preparation date, and expiration date. The concentration will be approximately 18 mg of iron per mL.

PREPARATION AND STANDARDIZATION OF CARRIER SOLUTIONS (continued)

E. Strontium

Reagents

Strontium Nitrate:	$Sr(NO_3)_2$
Nitric Acid:	HNO_3 (16$\underline{N}$)
Ammonium Hydroxide:	NH_4OH (30%)
Ethyl Alcohol:	C_2H_5OH (95%)
Sodium Carbonate:	Na_2CO_3

Apparatus

Filter, Whatman No. 42, 2.4 cm
Filtration Equipment
Heat Lamp
Analytical Balance

Procedure

1. Dissolve 48.3 g of strontium nitrate in 900 mL DI water. Add 1 mL of 16 $\underline{N}$ nitric acid and dilute to 1000 mL with DI water. Stir the solution 30 minutes before standardization.

2. Pipet 1 mL of carrier solution into a 40 mL centrifuge tube and dilute to 20 mL with DI water. Heat the solution in hot water bath. Wile hot, adjust pH to 8 - 8.5 with concentrated ammonium hydroxide. Add 5 mL 3$\underline{N}$ sodium carbonate and stir vigorously. Heat the solution again for 5 minutes in a hot water bath; cool. Filter the solution through pre-weighed filer paper (Whatman No. 42, 2.4 cm). Wash the precipitate with DI water and 90% ethyl alcohol. Dry the filter with the precipitate under the heat lamp and weigh it.

3. Four of the above standardizations should be performed. The deviations in the results should be no more than 0.5%. Average the results.

4. Record the lot number, carrier number, and the precipitate weights in the "Carrier Recording Book" and submit to the Lab Supervisor for approval.

5. Transfer the standardized carrier into a bottle labeled with the carrier name and number, preparation date, and expiration date. The concentration will be approximately 35 mg of strontium carbonate per mL.

PREPARATION AND STANDARDIZATION OF CARRIER SOLUTIONS (continued)

F. Yttrium

Reagents

Yttrium Oxide: Y_2O_3
Nitric Acid: HNO_3 (16N)
Oxalic Acid: $C_2H_2O_4$ (saturated)
Ammonium Hydroxide: NH_4OH (30%)
Ethyl Alcohol: C_2H_5OH (95%)

Apparatus

Filter, Whatman No. 42, 2.4 cm
Filtration Equipment
Heat Lamp
Analytical Balance

Procedure

1. Dissolve 12.7 g yttrium oxide in 50 mL 16 N nitric acid. Heat until dissolved (avoid boiling). Dilute to 900 mL with DI water. Adjust to pH 2 with concentrated ammonium hydroxide and dilute to 1000 mL with DI water. Stir the solution for a minimum of 30 minutes before standardization.

2. Pipet 1 mL of carrier solution into 40 mL centrifuge tube, dilute to 20 mL with DI water, and ad 1 mL saturated oxalic acid. Adjust to pH 2 - 3 with concentrated ammonium hydroxide. Heat the solution for 30 minutes in a hot water bath and then cool. Filter the solution through pre-weighed filter paper (Whatman No. 42, 2.4 cm). Wash the precipitate with DI water and 95% ethyl alcohol. Dry the filter with the precipitate under the heat lamp and weigh it.

3. Four of the above standardizations should be performed. The deviations in the results should be no more than 0.5%. Average the results.

4. Record the chemical lot number, carrier number, and weights in the "Carrier Recording Book" and submit to the Lab Supervisor for approval.

5. Transfer standardized carrier into a bottle labeled with the carrier name and number, preparation date, and expiration date. The concentration will be approximately 33 mg of yttrium oxalate per mL.

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PROCEDURE FOR COMPOSITING
WATER AND MILK SAMPLES

PROCEDURE NO. TIML-COMP-01

Prepared by

Teledyne Isotopes Midwest Laboratory

Copy No. ______

Revised Pages	Revision No.	Date	Pages	Prepared by	Approved by
	0	11-07-88	2	B. Grob	L G Huebner

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TIML-COMP-01

Procedure for Compositing Water and Milk Samples

1. At the beginning of each composite period, (month, quarter, semi-annual), prepare a one-gallon cubitainer for a specific location and time-period.

2. Remove an equal aliquot of original sample (for example, one liter) and transfer to prepared cubitainer. Do this for each week, month, etc. Mark date of original sample on prepared cubitainer.

3. When prepared container is complete, give the sample to the recording clerk for assigning a number.

4. Analyze according to the client requirement.

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DETERMINATION OF EFFICIENCY
FOR
BERTHOLD PROPORTIONAL COUNTER
MODEL LB-770-1

PROCEDURE NO. TIML-E-01

Prepared by

Teledyne Isotopes Midwest Laboratory

COPY NO._______

Revision No.	Date	Pages	Prepared by	Approved by
0	11-22-85	4	LG Huebner	LG Huebner

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Determination of Efficiency
for
Berthold Proportional Counter
Model LB-770-1

Principle of Method

At least five (5) spiked samples, using different amounts of solids, are prepared in duplicate for single isotopes, such as P-32, Sr-89, Y-90, I-131, Ac-228, using standard procedures and NBS traceable standards. The prepared spiked samples are counted on all 10 detectors and the results corrected for recovery and decay corrected to counting time or to midpoint of counting time (for isotopes with half-life of $\leq$ 10 days). (For counting sequence, see Attachment TIML-E-01-A.)

For efficiency determination of Sr-90, the spiked samples are prepared one at a time (to reduce the ingrowth of a daughter, Y-90). For example, if Sr-90 spiked standards are prepared all at once and counted for 100 minutes each, there would be approximately 15% of Y-90 present in the samples by the time the last count is made.

The prepared spiked sample, No. 1, is counted immediately in Detector No. 1 while the second sample is being prepared. After all spiked samples are counted on Detector No. 1, Sr-90 in equilibrium with Y-90 is counted on all detectors and the counts are normalized to Detector No. 1. The Sr-90-Y-90 standard need not be traceable to NBS standard nor need the exact activity be known, since only ratios are used. After efficiency for Detector No. 1 is calculated for all spiked samples, the efficiency for the rest of the detectors is calculated by using the efficiency for Detector No. 1 and the ratios obtained for the rest of the detectors.

Calculation

$$\text{Eff} = \frac{\text{cpm (net)}}{\text{dpm} \times \text{Rec} \times e^{-\lambda t}}$$

where

cpm = counts per minute, spiked sample minus background

dpm = disintegration per minute, standard

Rec = recovery of spiked sample

e = base of the natural logarithm = 2.71828

$\lambda = \frac{0.693}{\text{Half-life of isotope}}$

t = elapsed time from the time of standard calibration to the counting time (or midpoint of the counting time)

or

elapsed time from the time of seperation to the midpoint of the counting time for Y-90.

Examples

1. Efficiency determination for I-131:

   a. cpm (net): 150
   b. dpm: 1000
   c. Recovery: 0.95 (95%)
   d. Standard calibration date: 11-10-85, 1200 hrs
   e. Counting started: 11-20-85, 1200 hrs
   f. Counting time: 100 min.
   g. Elapsed time between calibration and mid-counting time (11-10-85, 1200 and 11-20-85, 1200 plus 50 min): 10.03 days

$$\text{Eff} = \frac{150}{1000 \times 0.95 \times e^{\frac{-0.693 \times 10.03\ d}{8.04}}}$$

$$= \frac{150}{1000 \times 0.95 \times 0.421} = 0.375 \quad (37.5\%)$$

2. Efficiency determination for Sr-90:

   a. Efficiency for detector No. 1: 0.400 (40%)
   b. Count rate of Sr-90-Y-90 for Detector No. 1: 120 cpm
   c. Count rate of Sr-90-Y-90 for Detector No. 2: 115 cpm
   d. Ratio: $\frac{\text{Det No. 2}}{\text{Det No. 1}} = \frac{115}{120} = 0.958$

Eficiency for Detector No. 2 = 0.400 x 0.958 = 0.383 (38.3%).

ATTACHMENT TIML-E-01-A

COUNTING SEQUENCE OF SPIKED SAMPLES
FOR DETERMINATION OF EFFICIENCY
BERTHOLD MODEL LB-770-1
FOR
SINGLE ISOTOPES
(P-32, Sr-89, Y-90, I-131, Ac-228)

Detector No.'s (1st row)	1	2	3	4	5
Detector No.'s (2nd row)	6	7	8	9	10
1st count	1	2	3	4	5
	1A	2A	3A	4A	5A
2nd count	1A	2A	3A	4A	5A
	1	2	3	4	5
3rd count	5	1	2	3	4
	5A	1A	2A	3A	4A
4th count	5A	1A	2A	3A	4A
	5	1	2	3	4
5th count	4	5	1	2	3
	4A	5A	1A	2A	3A
6th count	4A	5A	1A	2A	3A
	4	5	1	2	3
7th count	3	4	5	1	2
	3A	4A	5A	1A	2A
8th count	3A	4A	5A	1A	2A
	3	4	5	1	2
9th count	2	3	4	5	1
	2A	3A	4A	5A	1A
10th count	2A	3A	4A	5A	1A
	2	3	4	5	1

Spiked samples - 1 through 5
Duplicates - 1A through 5A

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CALIBRATION OF PROPORTIONAL COUNTERS FOR I-131 EFFICIENCY

PROCEDURE NO. TIML-E-02

Prepared by

Teledyne Isotopes Midwest Laboratory

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	0	08-14-92	3	B Grob	LG Huebner

CALIBRATION OF PROPORTIONAL COUNTERS FOR I-131 EFFICIENCY

Principle of Method

Equal amount of standard I-131 solution is added to centrifuge tubes containing various amounts of iodine carrier. PdI_2 is precipitated, filtered, mounted and counted. Efficiency for various amounts of precipitate is calculated.

Instrument

Gas flow proportional counter

Reagents

Carrier Solution: I^+ as potassium iodide, KI: ca. 29 mg KI/mL (See Procedure TIML-CAR-01 for preparation).

Ethanol
Hydrochloric Acid; HCl, concentrated
Palladium Chloride, $PdCl_2$, 7.2 mg Pd^{++}/mL (1.2g $PdCl_2$/100 mL of 6 N HCl)

Standard Solution: I-131, ca. 500 dpm/mL at the time of counting. (For preparation, see Procedure TIML-ST-01 and ST-02).

Apparatus:

Analytical balance
Centrifuge
Hot water bath
Infrared heat lamp
Filter paper, Whatman #42, 21mm
Plastic rings
Calibrated pipetter
Plastic pipette, 1 mL

Procedure:

1. Prepare iodine carrier with a ratio of 1:4 as follows:

   Take 50 ml of the original standardized carrier solution (use 25 ml volumetric pipette which has been calibrated) and make up to 200 ml. Ratio: 1:4

2. From the diluted iodine carrier solution (1:4) take the following amount in duplicate.

Volume		Ratio
1 ml	=	0.25
2 ml	=	0.5
3 ml	=	0.75
4 ml	=	1.00
5 ml	=	1.25

3. Prepare centrifuge tubes with 10 ml of DI water in each tube.

4. Add the amount of carrier needed as above

5. Add 1 mL of I-131 standard solution to each tube.

6. Add 1 mL of concentrated HCL acid and 2 mL of $PdCl_2$ solution to each tube.

7. Heat in hot water bath for 15 min. to congeal the precipitate.

8. Cool and filter (Use double filter paper).

9. Rinse precipitate with DI water, followed with ethanol.

10. Dry under the heat lamp and weigh. Calculate recovery and use it to correct activity.
11. Mount and count in the proportional counter to accumulate at least 10,000 counts.

12. Calculate efficiency for each sample using efficiency program.

13. Plot efficiency versus mg of the precipitate and store it in the computer.

Calculation

$$\text{Efficiency} = \frac{cpm}{dpm \times R}$$

Where:

cpm = Net counts per minute.
dpm = disintegration per minute of I-131 standard at the time of counting.
R = carrier recovery.

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DETERMINATION OF GAMMA EMITTERS
BY GAMMA SPECTROSCOPY
(GERMANIUM DETECTORS)

PROCEDURE NO. TIML-GS-01

Prepared by

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0	07-21-86	5		LG Huebner
1	08-14-92	5		LG Huebner

DETERMINATION OF GAMMA EMITTERS
BY GAMMA SPECTROSCOPY
(GERMANIUM DETECTORS)

Principle of Method

The sample is placed in a calibrated container and counted for a length of time required to reach the required LLD. The results are decay corrected to the sampling time, where appropriate, using a dedicated computer and software.

Apparatus

Counting Containers
Counting Equipment
Cylinders
Marking Pens
Recording Books

A. Milk, Water, and other Liquid Samples

1. Measure accurately 500 mL, 1.0 L, 2.0 L or 3.5 L of sample and put it in the calibrated counting container (Marinelli beaker). Always use largest volume if sample is in sufficient quantity. 1

2. Cover and attach a gummed label to the cover; write the sample number, volume and date and time of collection on the label. Mark "I-131" if analysis for I-131 is required by gamma spectroscopy.

3. Count without delay for estimated time required to meet LLDs. Record file number, sample identification number, date and time counting started, detector number, geometry, sample size, and date and time of collection.

4. Stop counting; transfer specra to the disc and print out the results.

5. Check LLDs before taking the sample off. If LLDs are not met, continue counting until they do.

6. After counting is completed, record the date and time counting ended and counting time.

7. Return the sample to the original container and mark with a red marker.

B. Airborne Particulates

1. Place air filters in a small Petrie dish following Procedure TML AP-03.

2. Place Petrie dish (with marked side up) on the detector and count long enough to meet the LLD requirements.. Record the file number, sample identification number, date and time counting started, detector number, geometry, sample size, and date and time collected. 1

NOTE: When counting individual filter, place it in the Petrie dish with active (with deposit) side up. Mark the Petrie dish and place it on the detector with the active side up.

3. Stop counting and transfer spectra to the disc. Print out the results and check the LLDs before taking the sample off. If LLD levels are not met, continue counting until they do.

4. After counting is completed, record the date and time counting ended and counting time.

5. Replace air filters in the original envelopes for storage or further analyses.

C. Other Samples

NOTE: Sample, e.g. soil, vegetation, fish, etc., are prepared in the prep lab and delivered to the counting room.

1. Place the sample on the detector and count long enough to meet LLD requirements. Record the file number, sample identification number, date and time counting started, detector number, geometry, sample size, and date and time of collection.

2. Stop counting and transfer spectra to the disc. Print out the results and check the LLDs before taking the sample off. If LLD levels are not met, continue counting until they are.

3. After counting is completed, record date and time counting ended and counting time. Mark the container with red marker and return to the prep lab for transfer to the plastic bag for storage or further analyses.

D. Charcoal Cartridges

For counting charcoal cartridges, follow Procedures TIML-I-131-02, TIML-I-131-04 or TIML-I-131-05. 1

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DETERMINATION OF I-131 IN MILK
BY ANION EXCHANGE
(BATCH METHOD)

PROCEDURE NO. TIML-I-131-01

Prepared by

Teledyne Isotopes Midwest Laboratory

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	0	06-12-85	6	B Grob	LG Huebner
5	1	11-25-85	6	B Grob	LG Huebner
2,3,4,5	2	03-24-89	6	B Grob	LG Huebner
2,3,5	3	04-10-91	6	B Grob	LG Huebner
2	4	08-14-92	6	B Grob	LG Huebner
4	5	09-24-92	6	B Grob	LG Huebner

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Determination of I-131 in Milk by Ion Exchange

(Batch Method)

Principle of Method

Iodine, as the iodide, is concentrated by adsorption on an anion resin. 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 $CHCl_3$, 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 (20-50 mesh) chloride form

Chloroform, $CHCl_3$ - reagent grade

Hydrochloric Acid, HCl, 1N

Hydrochloric Acid, HCl, 3N

Wash Solution: H_2O - HNO_3 - NH_2OH HCL, 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, $PdCl_2$, 7.2 mg Pd^{++}/mL (1.2 g $PdCl_2$/100 mL of 6N HCl)

Sodium Bisulfite, $NaHSO_3$ - 1 M

Sodium Chloride, NaCl - 2M

Sodium Hypochlorite, NaOCl - 5% (Clorox)

Potassium Iodide, KI, ca 29 mg KI/mL (See Proc. TIML-CAR-01 for preparation) 4

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

Heat Lamp

Part A

Ion Exchange Procedure

1. Transfer 2 liters (if available) of sample to the beaker. Add 1.00 mL of standardized iodide carrier to each sample. 3

2. Add a clean magnetic stirring bar to each sample beaker. Stir each sample for 5 minutes or longer on a magnetic stirrer. Allow sample to equilibrate at least 1/2 hour. If a milk sample is curdled or lumpy, vacuum filter the sample through a Buchner funnel using a cheesecloth filter. Wash the curd thoroughly with deionized water, collecting the washings with the filtrate. Pour the filtrate back into the original washed and labeled 4 liter beaker and discard the curd.

3. Add approximately 45 grams of Dowex 1X8 (20-50 mesh) anion resin to each sample beaker and stir on a magnetic stirrer for at least 1 hour. Turn off the stirrer and allow the resin to settle for 10 minutes.

4. Gently decant and discard the milk or water sample taking care to retain as much resin as possible in the beaker. Add approximately 1 liter of deionized water to rinse the resin, allow to settle 2 minutes, and pour off the rinse. Repeat rinsing in the case of milk samples until all traces of milk are removed from the resin.

5. Using a deionized water wash bottle, transfer the resin to the column marked with the sample number. Allow resin to settle 2 minutes and drain the standing water. Wash the resin with 100 mL of 2M NaCl.

6. 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.

Part B

Iodine Extraction Procedure

CAUTION: Perform following steps in the fume hood.

1. Acidify the eluate from Step 6 by adding ca. 15 mL of 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). 5

2. Add 50 mL of $CHCl_3$ 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 $CHCl_3$ 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).

4. Add 20 mL H_2O-HNO_3-NH_2OH HCl wash solution to the separatory funnel containing the $CHCl_4$. Equilibrate 2 minutes. Allow phases to separate and transfer $CHCl_3$ (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 $CHCl_3$. 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.

Part 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. Turn the heat off. Remove the magnetic stirrer, rinse with deionized water.
4. Add, dropwise, to the solution, 2.0 mL of palladium chloride.
5. Cool the sample to room temperature. Place the beaker with sample on the stainless steel tray and put in the refrigerator overnight.
6. Weigh a clean 21 mm Whatman #42 filter which has been dried under a heat lamp.
7. Place the weighed filter in the filter holder. Filter the sample and wash the residue with water and then with absolute alcohol.
8. Remove filter from filter holder and place it in the labeled petri dish.
9. Dry under the lamp for 5-10 minutes.
10. Weigh the filter with the precipitate and calculate carrier recovery. | 4
11. 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.
12. 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.
13. Mount the sample on the plastic disc and write the sample number on the back side of the disc.
14. Count the sample on a proportional beta counter.

Calculations

Calculate the sample activity using computer program I131.

Part C

Precipitation of Palladium Iodide (continued)

I-131 concentration:

$$(\mathrm{pCi/l}) = \frac{A}{2.22 \times B \times C \times D \times R} \pm \frac{2\sqrt{E_{sb}^2 + E_b^2}}{2.22 \times B \times C \times D \times R}$$ 4

where:

A = Net cpm, sample

B = Efficiency for counting beta I-131 (cpm/dpm)

C = Volume of sample (liters)

D = Correction for decay to the time of collection = $e^{-\lambda t}$ =

$$\mathrm{Exp}\left(-\frac{0.693 \times t}{8.04}\right) = e^{-0.0862t}$$

where t = elapsed time from the time of collection to the counting time (in days)

E_{sb} = Counting error of sample plus background

E_b = Counting error of background

R = Carrier recovery

2.22 = dpm/pCi 4

Reference: "Determination of I-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.

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DETERMINATION OF AIRBORNE I-131 IN CHARCOAL CARTRIDGES BY GAMMA SPECTROSCOPY (INDIVIDUAL CARTRIDGE COUNTING METHOD) (FOR COUNTING CECo SAMPLES)

PROCEDURE NO. TIML-I-131-05

Prepared by

Teledyne Isotopes Midwest Laboratory

Copy No. ____________

Revision #	Date	Pages	Prepared by	Approved by
0	08-01-92	4	P. Grob	L G Huebner

DETERMINATION OF AIRBORNE I-131 IN CHARCOAL CARTRIDGES BY GAMMA SPECTROSCOPY

Principle of Method

Each charcoal cartridge is placed on the detector and counted. A peak of 0.36 MeV is used to calculate the concentration of I-131 at the time of collection.

Materials

Charcoal Cartridges

Apparatus

Germanium Detector

Procedure

NOTE: Because of the short half-life of I-131, count the samples as soon as possible after receipt, but no later than 8 days after collection.

1. Place the charcoal cartridge on the detector with the rim facing down and the arrow pointing away from the detector, (See Fig. 1).
2. Count long enough to meet the required Lower Limit of Detection (LLD).
3. Calculate concentration of I-131 (pCi/m^3) at the time of collection by inputting sample ID, volume in m^3, date and time of collection and date and time of counting (midpoint).
4. Notify your supervisor immediately if result is positive.

NOTE: At several CECo stations not all collected cartridges are analyzed. For these stations, follow the following procedure:

1. Analyze cartridges which require analysis.
2. If any of the cartridges show positive results, immediately retrieve the rest of the cartridges for that station and analyze. Inform your supervisor immediately.

Table below lists number of locations sampled and number analyzed.

Station	No. of Locations Sampled	Analyzed
Braidwood	09	09
Byron	12	12
Dresden	17	06
LaSalle	14	06
Quad CIties	16	06
Zion	13	03

Calculations:

I-131 concentration:

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

where:

A = Net count rate of I-131 in the 0.36 MeV peak (cpm)
B = Efficiency for counting I-131 in 0.36 MeV peak (cpm/dpm)
C = Volume of sample (m^3)
D = Correction for decay to the time of collection = $e^{-\lambda t}$ =

$$\mathrm{Exp}\left(-\frac{0.693 \times t}{8.04}\right) = e^{-0.0862t}$$

where t = elapsed time from the time of collection to the counting time (in days)
2.22 = dpm/pCi

E_{sb} = Counting error of sample plus background

E_b = Counting error of background

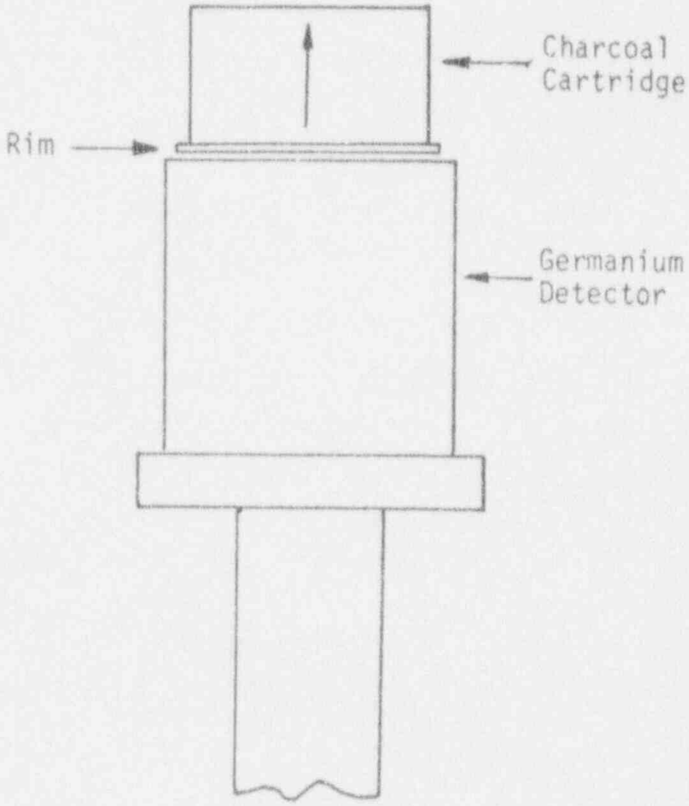

Figure 1.

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OPERATING PROCEDURE FOR LUDLUM MODEL 12S METER

SERIAL NO. 71700

PROCEDURE NO. TIML-METER-01

Prepared by

Teledyne Isotopes Midwest Laboratory

Copy No. _______

Revision No.	Date	Pages	Prepared by	Approved by
0	07-03-90	1	Tony Coral	L. G. Huebner
1	11-19-90	3	Tony Coral	L. G. Huebner
2	12-30-91	4	Tony Coral	L. G. Huebner

OPERATING PROCEDURE FOR SURVEY METER

Instrument: Ludlum Model 12S µR Meter, Serial No. 71700

Setting: Audio: "ON"; Response: "F" (fast)

Check Source: Cs-137, 5µCi, plastic encapsulated point source; Eberline Model Cs-7A; Reference date: Dec. 1984 2

Testing with Check Source

NOTE 1: Check the meter immediately after calibration.

NOTE 2: Test with check source at least once a week (on Monday unless it is a holiday or there are no samples to be surveyed)

1. Turn Range Selection Switch (RSS) to "BAT." If the battery is weak, notify the QC Officer.
2. Turn RSS to "x1000." Place check source against the front of the meter (see Figure 1). Reading should be about 1000±200 µR/hr. If the reading is less than 0.8 (800 µR/hr.) or higher than 1.2 (1200 µR/hr.), DO NOT USE the meter and notify the Quality Control Officer IMMEDIATELY.
3. Record date, reading, and initials in the Log Book.
4. Return check source to storage, away from meter and samples.

Sample Screening

1. Turn RSS to "x10." The reading should be between 0.6 and 1.2 (6 - 12 µR/hr.). This is the bkg reading.
2. Pass the meter in front of the samples (about 1" from container) at a rate of approximately 3 in./sec.
3. If the needle goes off the scale, turn RSS to "x100" or "x1000."
4. After detecting radioactive sample, turn response to "S" (slow) and hold the meter close to (but not touching) the sample for at least 30 seconds.
5. Record the reading and sample ID on the log sheet and notify the Lab Supervisor.
6. If the reading is less than bkg (6 - 12 µR/hr.) check off ( ) all surveyed samples in receiving/recording book.

Sample Screening (continued)

NOTES:

1. Return meter to QC Officer every 3 months for cleaning battery contacts.
2. Return meter to QC Officer every 12 months for calibration.
3. Always keep the meter clean.
4. To prevent accidentally leaving the meter "ON," leave audio in "ON" position.

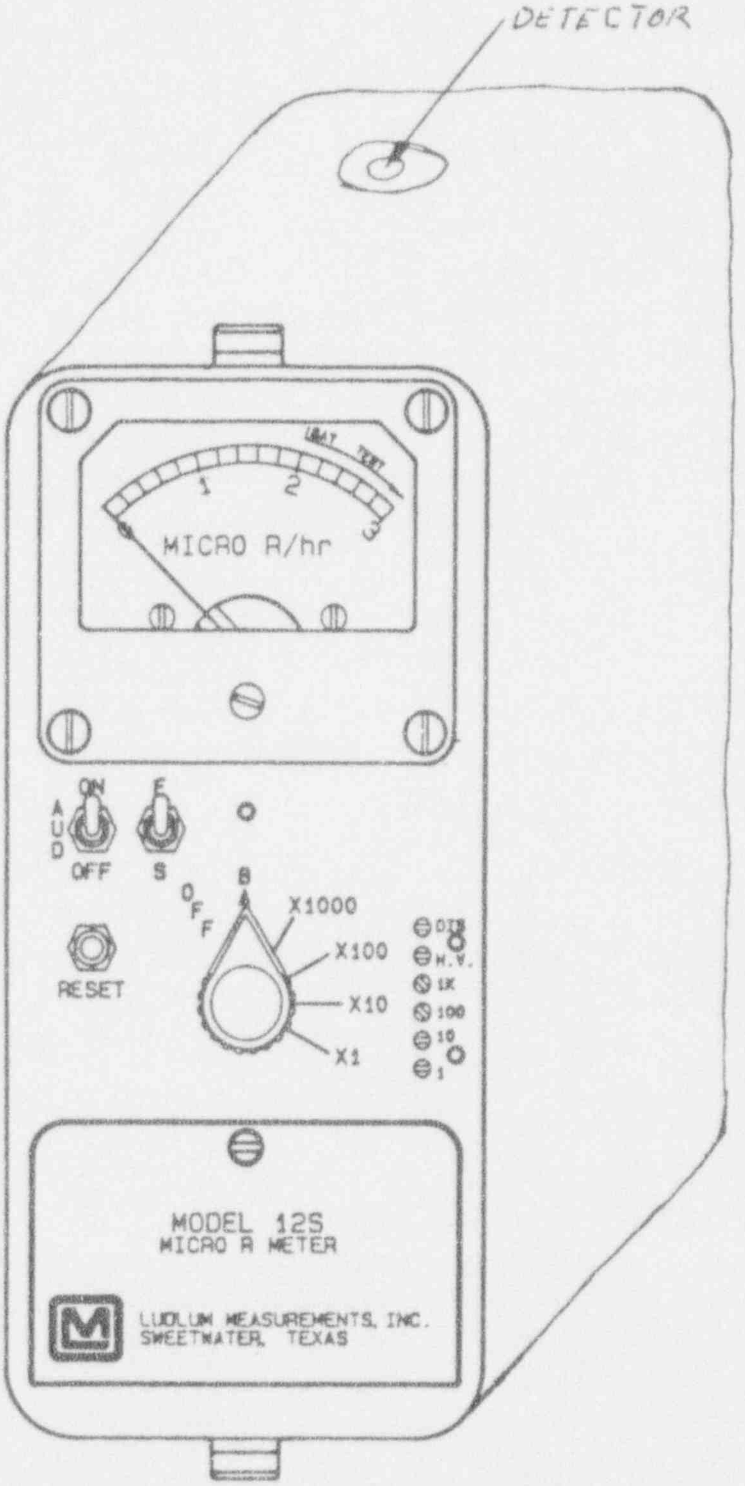
DETECTOR
MICRO R/hr
0
1
2
3
BAT
TEST
A
U
D
ON
OFF
F
S
OFF
B
X1000
X100
X10
X1
RESET
DIS
H.V.
1K
100
10
1
MODEL 12S
MICRO R METER
LUDLUM MEASUREMENTS, INC.
SWEETWATER, TEXAS
12/1/88
TOL:
SCALE: FULL
TITLE MODEL 12S MICRO R METER
LUDLUM
252

Figure 1.

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SAMPLE PREPARATION

PROCEDURE NO. TIML-SP-01

Prepared by

Teledyne Isotopes Midwest Laboratory

Copy No. ________

Revision No.	Date	Pages	Prepared by	Approved by
0	07-02-86	11	B. Grob	L G Huebner
1	08-14-92	11	B. Grob	L G Huebner

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TABLE OF CONTENTS

SAMPLE PREPARATION

Principle of Method

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.

Reagents

Formaldehyde

Apparatus

Balance
Ceramic Dishes
Counting Containers
Cutting Board
Drying Oven
Drying Pans
Grinder
High Temperature Marking Pen
Knives
Muffle Furnace
Plastic Bags
Pulverizer
Scissors
Spatulas

Procedure for Packing Standard Calibrated Counting Containers

A. 1.0 L, 2.0 L, 3.5 L - Pour 1.0, 2.0, or 3.5 liters of water into corresponding container. Mark the level and empty the container. Fill with the sample to the mark.

B. 500 mL - Fill to the rim on the inside wall, which is 1/4" from the top. 1

C. 4 oz - Fill to the 100 mL mark

Pack the sample tightly. When filling with soil and bottom sediments, make sure it is level.

A. Vegetables and Fruits

1. Wash and prepare vegetables and fruits as for eating.

2. Cut up vegetables and hard fruits into small pieces (about 1/4" cubes). Mash soft fruits.

3. Transfer the sample to a standard calibrated container. 1
Use the largest size possible for the amount of sample available. DO NOT FILL ABOVE THE MARK. Record the wet weight.

4. Add a few cc of formaldehyde to prevent spoilage.

5. Seal with cover. Attach paper tape on top of the cover and write sample number, net weight, and date and time collected.

6. Submit to the counting room for gamma spectroscopic analysis without delay or store in a cooler until counting (for short period).

   NOTE: If I-131 analysis is required, it is imperative that the sample be prepared and submitted to the counting room immediately. Mark "I-131" on the tape.

7. After gamma scanning is completed, transfer the sample to a drying pan and dry at 110° C.

   NOTES: If only gamma scan is required, skip drying and ashing (Steps 7 through 11). Transfer the sample to a plastic bag, seal, label, and store in the cooler until disposal.

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

8. Cool, weigh, and record dry weight. Grind.

9. Weigh out accurately in a tarred ceramic dish 100-120 g of the ground sample. Record the weight. (If sample weight is more than 100 g, 1
use two dishes; mark one as "A" and the second one as "B.") Ash in a muffle furnace by gradually increasing the temperature to 600° C. Ash overnight.

   NOTE: If ashing is incomplete (black carbon remains), cool the dish, crush the ash with spatula, and continue ashing overnight at 600° C. At this stage, it is not necessary to increase the temperature gradually. Set the temperature at 600° C and turn on the furnace.

10. Cool and weigh the ashed sample and record the ash weight. Grind to pass a 30 mesh screen. Transfer to 4 oz container, seal, and write sample number, weight, analysis required, and date and time of collection. The sample is now ready for analysis.

11. Store remaining ground sample in a plastic bag for possible future rechecking.

B. Grass, Green Leafy Vegetation and Cattle Feed

1. Take enough sample to fill 3.5 L or 2.0 L Marinelli beaker to the top.

2. Cut up grass and green leafy vegetation into approximately 1"-2" long stems and pack into 3.5 L or 2.0 L container. Pack cattle feed and silage as is. Use larger container if sufficient amount of sample is available. FILL TO THE TOP OF THE CONTAINER. Record the wet weight. 1

3. Add a few cc of formaldehide to prevent spoilage.

4. Seal with cover. Attach paper tape on top of the cover and label with sample number, net weight, and date and time collected.

5. Submit to the counting room for gamma spectroscopic analysis or store in a cooler until counting (for a short period) without delay.

   NOTE: If I-131 analysis is required, it is imperative that the sample be prepared and submitted to the counting room immediately. Mark "I-131" on the tape.

6. After gamma scanning is completed, transfer the sample to a drying pan and dry at 110° C.

   NOTES: If only gamma scan is required, skip drying and ashing (Steps 6 through 10). Transfer the sample to a plastic bag, seal, label, and store in the cooler until disposal.

   If there is sufficient quantity, use surplus sample for dryng and ashing instead of waiting for gamma scanning to be completed.

7. Cool, weigh, and record dry weight. Grind.

8. Weigh out accurately in a tarred ceramic dish 100-120 g. of the ground sample. Record the weight. (If sample weight is more than 100 g, use two dishes; mark one as "A" and the second one as "B.") Ash in a muffle furnace by gradually increasing the temperature to 600° C. Ash overnight. | 1

   NOTE: If ashing is incomplete (black carbon remains), cool the dish, crush the ash with spatula, and continue ashing overnight at 600° C. At this stage, it is not necessary to increase the temperature gradually. Set the temperature at 600° C and turn on the furnace.

9. Cool and weigh the ashed sample and record the ash weight. Grind to pass a 30 mesh screen. Transfer to 4 oz container, seal, and write sample number, weight, analyses required, and date and time of collection. The sample is now ready for analyses.

10. Store the remaining ground sample in a plastic bag for possible future rechecking.

C. Fish

1. Wash the fish.

2. Fillet and pack the fish immediately (to prevent moisture loss) in a 500 mL or 4 oz standard calibrated container. Use 500 mL size if enough sample is available. DO NOT FILL ABOVE THE RIM (500 mL cont.) OR 100 mL (4 oz cont.). Record the wet weight. 1

3. Add a few cc of formaldehyde.

4. Seal with cover. Attach paper tape on top of the cover and label with sample number, weight, and date and time of collection.

   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 110° 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.

4. Submit to the counting room for gamma spectroscopic analysis without delay or store in a refrigerator until counting.

   NOTE: If I-131 analysis is required, it is imperative that the sample be prepared and submitted to the counting room immediately. Mark "I-131" on the tape.

5. After gamma spectroscopic analysis is completed, transfer the sample to a drying pan and dry at 110° C.

   NOTES: If only gamma scan is required, skip drying and ashing (Steps 5 through 9). Transfer the sample to a plastic bag, seal, label, and store in the freezer until disposal.

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

6. Cool, weigh, and record dry weight.

7. Transfer to a tarred ceramic dish. Record dry weight for ashing.

8. Ash in a muffle furnace by gradually increasing the temperature to 450° C. If considerable amount of carbon remains after overnight ashing, the sample should be brushed and placed back in the muffle furnace until ashing is completed.

9. Cool and weigh the ashed sample and record the ash weight. Grind to pass a 30 mesh screen. Transfer to a 4 oz container, seal, and write sample number, weight, analyses required, and date and time of collection. The sample is now ready for analysis.

D. Waterfowl, Meat, and Wildlife

1. Skin and clean the animal. Remove a sufficient amount of flesh to fill an appropriate standard calibrated container (500 mL oz 4 oz). Weigh without delay (to prevent moisture loss). DO NOT FILL ABOVE THE RIM (500 mL cont.) OR 100 mL (4 oz cont.). Record the wet weight. 1

2. Add a few cc of formaldehyde.

   NOTE: If bones are to be analyzed, boil remaining flesh in water for about 1 hour. Clean the bones. Air dry, weigh, and record as wet weight. Dry at 110° 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. Seal with the cover. Attach paper tape on top of the cover and label with sample number, wet weight, and date and time of collection.

4. Submit to the counting room for gamma spectroscopic analysis without delay or store in a refrigerator until counting (for short period).

   NOTE: If I-131 analysis is required, it is imperative that the sample be prepared and submitted to the counting room immediately. Mark "I-131" on the tape.

5. After the gamma scanning is completed, transfer the sample to a drying pan and dry at 110° C.

6. Cool, weigh, and record dry weight.

7. Transfer to a tarred ceramic dish. Record dry weight for ashing.

8. Ash in a muffle furnace 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.

9. Cool and weigh the ashed sample and record the ash weight. Grind to pass a 30 mesh screen. Transfer to a 4 oz container. Seal and write sample number, weight, analyses required, and date and time of collection. The sample is now ready for analyses.

E. Eggs

1. Remove the egg shells and mix the eggs with a spatula. Use about one (1) dozen eggs.

2. Transfer the mixed eggs to a standard calibrated 500 mL container. Record the wet weight. DO NOT FILL ABOVE THE RIM. 1

3. Add a few cc of formaldehyde.

4. Seal with cover. Attach paper tape on top of the cover and label with sample number, wet weight, and date and time of collection.

5. Submit to the counting room for gamma spectroscopic analysis without delay or store in a refrigerator until counting (for short period).

6. After gamma spectrascopic analysis is completed, tranfer the sample to a plastic bag, seal, label, and store in a freezer until disposal.

   NOTE: If only a gamma scan is required, skip Steps 7 through 11.

7. Weigh the rest of the sample, record wet weight, and dry in an oven at 110° C.

8. Cool, weigh, and record dry weight.

9. Weigh out accurately 100-120 g of the sample in a tarred ceramic dish. Record the weight. Ash in a muffle furnace by gradually increasing the temperature to 550° C. If a considerable amount of carbon remains after overnight ashing, the sample should be crushed and placed back in the muffle furnace until ashing is completed.

10. Cool and weigh the ashed sample and record the weight. Grind to pass a 30 mesh screen. Transfer to a 4 oz container, seal, and write sample number, weight, analyses required, and date and time of collection. The sample is now ready for analysis.

11. Store the remaining ground sample in a plastic bag for possible future rechecking.

F. Slime and Aquatic Vegetation

1. Remove foreign materials.

2. Place the sample in a sieve pan and wash until all sand and dirt is removed (turn the sample over several times.)

3. Squeeze out the water by hand.

4. Place the sample in a standard calibrated 500 mL or 4 oz container. Weigh and record wet weight. Use 500 mL container if enough sample is available. DO NOT FILL ABOVE THE RIM (500 mL cont.) OR 100 mL (4 oz cont.). 1

5. Add a few cc of formaldehyde.

6. Seal with cover. Attach paper tape on top of the cover and label with sample number, weight, and date and time of collection.

7. Submit to the counting room without delay. Slime decomposes quickly even with formaldehyde. If gamma scanning must be delayed, freeze.

   NOTE: If I-131 analysis is required, it is imperative that the sample be prepared and analyzed immediately. Mark "I-131" on the tape.

8. After gamma scanning is completed, transfer the sample to a drying pan and dry at 110° C.

   NOTE: If only gamma scan is required, skip drying and ashing (Steps 8 through 11). Transfer the sample to a plastic bag, seal, label, and store in the freezer until disposal.

9. Cool, weigh, and record dry weight.

10. Transfer to a tarred ceramic dish, and record dry weight for ashing. Ash in a muffle furnace by gradually increasing the temperature to 600° C.

    NOTE: If ashing is incomplete (black carbon remains), cool the dish, crush the ash with spatula, and continue ashing overnight at 600° C. At this stage, it is not necessary to increase the temperature gradually. Set the temperature at 600° C. and turn on the furnace.

11. Cool and weigh the ashed sample and record ash weight. Grind to pass a 30 mesh screen. Transfer to a 4 oz container, seal, and label with sample number, weight, analyses required, and date and time of collection. The sample is now ready for analyses.

G. Bottom Sediments and Soil

1. Remove rocks, roots, and any other foreign materials.
2. Place approximately 1 kg of sample on the drying pan and dry at 110° C.
3. Seal, label, and save remaining sample.
4. Grind or pulverize the dried sample and sieve through a No. 20 mesh screen.
5. For gamma spectroscopic analysis, transfer sieved sample to a standard calibrated 500 mL or 4 oz container. DO NOT FILL ABOVE THE RIM (500 mL cont.) OR 100 mL (4oz cont.). Record dry weight. 1
6. Seal with cover. Attach paper tape on top of the cover and write sample number, weight, and date and time of collection.
7. Submit to the counting room for gamma spectroscopic analysis without delay.
8. For other analyses, e.g. gross beta, radiostrontium, etc., fill 4 oz container to the top, seal, and write sample number, types of analyses required, and date and time of collection.
9. Store the remaining sieved sample in a plastic bag for possible future rechecking.
10. After the gamma scanning is completed, transfer the sample to a plastic bag, seal, label, and store until disposal.

H. 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 and 1 l for I-131 analysis, if required.
2. Add 15 mL of 1:1 HNO_3 per gallon 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 accordingly, at the rate of 1.5 ml per 100 ml of sample.

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DETERMINATION OF TRITIUM IN WATER

(DIRECT METHOD)

PROCEDURE NO. TIML-T-02

Prepared by

Teledyne Isotopes Midwest Laboratory

Copy No. ________

Revised Pages	Revision No.	Date	Pages	Prepared by	Approved by
	0	11-22-85	5	L. G. Huebner	LG Huebner
2,3	1	09-27-91	4	B. Grob	LG Huebner

DETERMINATION OF TRITIUM IN WATER

(DIRECT METHOD)

Principle of Method

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

Reagents

Scintillation medium, Insta-Gel scintillator
Tritium standard solution
Dead water
Ethyl alcohol

Apparatus

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

Procedure

NOTE: All glassware must be dry. Dry it in the drying oven at 100-125°C. 1

1. Place 60-70 ml of the sample in a 250-ml distillation flask. Add a boiling chip to the flask. Add one NaOH pellet and ca. 0.02g $KMnO_4$. Connect a side arm adapter and a condenser to the outlet of the flask. Place a receptacle at the outlet of the condenser. Set variac at 70 mark. Heat to boiling to distill. Discard the first 5-10 ml of distillate. Collect next 20-25 ml of distillate for analysis. Do not distill to dryness. 1

2. Mark the vial caps with the sample number and date.

   Note: Use the same type of vial for the whole batch (samples, background, and standard.

3. Mark three (3) vial caps "Bkg 1", "Bkg 2", "Bkg 3", and date.

4. Mark three (3) vial caps "St-1", "St-2", "St-3"; standard number, and date.

5. Dispense 13 ml of sample into marked vials and "dead" water into vials marked Bkg-1,2, and 3.

   Note 1: Pipetter is set (and calibrated) to deliver 6.5 ml, so pipette twice into each vial. Use new tip for each sample and new tip (one) for three background samples.

   Note 2: Make sure the pipetter has not been reset. If it has been reset, or if you are not sure, do not use it; check with your supervisor.

   Note 3: Make sure the plastic tip is pushed all the way on to the pipetter and is tight. If it is not, the air will be drawn in and the volume withdrawn will not be correct (it will be smaller).

6. Dispense 13 ml (see Notes 1,2, and 3, above) of "dead" water into each vial marked "St-1", "St-2", and "St-3."

7. Take a 0.1 ml (100) pipetter and withdraw 0.1 ml of water from each of the three standard vials. Discard this 0.1 ml of water.

8. Take a new 0.1 ml tip. Dispense 0.1 ml of standard into each of the three vials marked "St-1", "St-2", and "St-3."

9. Take all vials containing samples, background, and standard to the counting room.

   Note: To avoid spurious counts, scintillator should not be added under flourescent light.

10. Dispense 10 ml of Insta-Gel into each vial (one at a time), cap tightly, and shake VIGOROUSLY for at least 0.5 minutes. Recheck the cap for tightness.

11. Wet a Kimwipe with alcohol and wipe off each vial in the following order:

    Background
    Samples
    Standard

12. Load the vials in the following order:
    Bkg 1
    St-1
    Samples
    Bkg-2*
    St-2*
    Samples
    Bkg-3
    St-3

    * Bkg 2 and St-2 should be approximately in the middle of the batch. |1

13. Let the vials dark- and temperature-adapt for about one hour.

    Note 1: To check if vials reached counter temperature, inspect one vial (Bkg). The liquid should be transparent. If the temperature is too high (or too low), the liquid will be white and very viscous.

    Note 2: The temperature inside the counter should be between 10° and 14° C (check thermometer). In this temperature range, the liquid is transparent.

14. Set the counter for 100 min counting time and infinite cycles. (Follow manufacturer's procedure for setting the counter.)

15. Fill out the loading sheet, being sure to indicate the date and time counting started, and your initials.

    Note: Do not count prepared background and standard sets with another batch of samples if plastic vials are used. Prepare new backgrounds and standards for each batch.

    If glass vials are used, the prepared background and standard sets can be counted with other batcher up to one (1) month after preparation provided they are not taken out of the counter (not warmed up) and the same vial type from the same manufacturing batch (the same carton) is used. After one month prepare new sets of backgrounds and standards.

Calculations

$$\text{pCi/l} = \frac{\frac{A}{t_1} - \frac{B}{t_2}}{2.22 \times E \times V \times e^{-\lambda t_3}} \pm \frac{2\sqrt{\frac{A}{t_1^2} + \frac{B}{t_2^2}}}{2.22 \times E \times V \times e^{-\lambda t_3}}$$

Where:

A = Total counts, sample
B = Total counts, background
E = Efficiency (cpm/dpm)
V = Volume (liter)
e = Base of the natural logorithm = 2.71828
$\lambda = \frac{0.693}{12.26} = 0.05652$
t_1 = Counting time, sample
t_2 = Counting time, background
t_3 = Elapsed time from the time of collection to the time of counting (in years)

DETERMINATION OF TOTAL PROPAGATED UNCERTAINTY
FOR SAMPLE ANALYSES
AT
TELEDYNE ISOTOPES MIDWEST LABORATORY

1.0 INTRODUCTION

The following constitutes the draft method for determining and calculating the Total Propagated Uncertainty (TPU) for analyses performed on samples at Teledyne Isotopes Midwest Laboratory. The TPU is a percentage uncertainty that results from an accumulation of systematic errors associated with collecting and analyzing a sample. This method was used for TPU calculations on all 1993 samples and was superseded by procedure TIML-TPU-01 beginning January 3, 1994.

A review of the collection procedures and analyses procedures was conducted to define and quantify pertinent systematic errors associated with each process. The TPU for a single sampling and analysis procedure is determined by combining the individual Field Sampling and Analytical errors using the error propagation formula outlined in Attachment 2. Since the counting error varies from sample to sample as the background and counting rates change, the counting error for a specific sample cannot be quantified until the time of the analysis, therefore, it is not assigned a value.

Attachment 1 is a listing of the combined sampling and analytical TPU for individual samples and analysis. Throughout this method of determining the TPU, human errors are not considered and the assumption is made that all equipment is properly calibrated and in good working order. All the errors listed represent the uncertainty at the one sigma confidence level.

Each sample type is listed with the possible sources of uncertainty along with a summary of the associated sampling and analytical uncertainties. The TPU is expressed as a percentage with [illegible] representing the counting error as a percentage at the one sigma confidence level.

2.0 CHARCOAL CARTRIDGE

2.1 I-131 ANALYSIS OF I-131 IN AIR

FIELD SAMPLING UNCERTAINTIES

A. Charcoal Cartridges [0.0%]: The error associated with Iodine collection by impregnated charcoal cartridge is considered to be insignificant since the efficiency of the cartridge is greater than 99.0%.

B. Master Rotometer [1.0%]: used the calibration report for Fischer & Porter dated August 12, 1993.

C. Pump Flowmeter [0.5%]: an estimated value based on flowmeter performance.

D. Field Rotometer [5.0%]: used the calibration report form Fischer & Porter dated June 21, 1993 and calibration procedure outlined in CECo AP-2 Form.

E. Environmental Changes [0.0%]: uncertainty associated with normal seasonal changes are considered insignificant relative to other uncertainties.

F. Timer Indicator [0.0%]: uncertainties associated with timer inefficiency are considered insignificant relative to other uncertainties.

G. Reading Pump Flowmeter Gauge [2.0%]: the uncertainty in reading the gauge is estimated based on a flowrate of 1 cubic foot per hour and a maximum flowrate of 100 cubic feet per hour.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML I-131-05).

B. Gamma Calibration Source [2.3%]: used the overall uncertainty for Cesium-137 with the calibration source number MZ6291 (Amersham) dated November 1, 1992.

C. Source Preparation for Gamma Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Attenuation Differences Between Calibration Source and Sample [0.0%]: considered insignificant for samples with density similar to that of the calibration source. A different calibration source is prepared for Bottom Sediments, Charcoal Cartridges, and Air Particulate Filters.

E. Uncertainty in Efficiencies due to Differences in Sample Volume [0.0%]: considered insignificant due to the use of a large variety of sample geometry's.

F. Calibration Efficiency [0.0%]: considered insignificant relative to other uncertainties.

G. Efficiency - Curve Fitting [5.0%]: considered insignificant relative to other uncertainties.

H. Abundance [2.5%]: used published values for nuclides with FE-59 as the reference.

I. Decay time [0.0%]: considered insignificant relative to other uncertainties.

J. Half-life [0.0%]: based on published values for each nuclide it is considered insignificant relative to other uncertainties.

K. Yield [1%]: an estimated value.

2.2 AIRBORNE I-131 ANALYSIS: TPU(%) = $\sqrt{(7.2)^2 + X^2}$

3.0 AIR PARTICULATE FILTER

3.1 GAMMA ISOTOPIC ANALYSIS

FIELD SAMPLING UNCERTAINTIES

A. EAir Particulate Filters [1.0%]: an estimated error due to loss during handling.

B. Master Rotometer [1.0%]: used the calibration report for Fischer & Porter dated August 12, 1993.

C. Pump Flowmeter [0.5%]: an estimated value based on flowmeter performance.

D. Field Rotometer [5.0%]: used the calibration report form Fischer & Porter dated June 21, 1993 and calibration procedure outlined in CECo AP-2 Form.

E. Environmental Changes [0.0%]: uncertainty associated with normal seasonal changes are considered insignificant relative to other uncertainties.

F. Timer Indicator [0.0%]: uncertainties associated with timer inefficiency are considered insignificant relative to other uncertainties.

G. Reading Pump Flowmeter Gauge [2.0%]: the uncertainty in reading the gauge is estimated based on a flowrate of 1 cubic foot per hour and a maximum flowrate of 100 cubic feet per hour.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML AP-03).

B. Gamma Calibration Source [2.3%]: used the overall uncertainty for Cesium-137 with the calibration source number MZ6291 (Amersham) dated November 1, 1992.

C. Source Preparation for Gamma Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Attenuation Differences Between Calibration Source and Sample [0.0%]: considered insignificant for samples with density similar to that of the calibration source. A different calibration source is prepared for Bottom Sediments, Charcoal Cartridges, and Air Particulate Filters.

E. Uncertainty in Efficiencies due to Differences in Sample Volume [0.0%]: considered insignificant due to the use of a large variety of sample geometry's.

F. Calibration Efficiency [0.0%]: considered insignificant relative to other uncertainties.

G. Efficiency - Curve Fitting [5.0%]: considered insignificant relative to other uncertainties.

H. Abundance [2.5%]: used published values for nuclides with FE-59 as the reference.

I. Decay time [0.0%]: considered insignificant relative to other uncertainties.

J. Half-life [0.0%]: based on published values for each nuclide it is considered insignificant relative to other uncertainties.

K. Yield [1%]: an estimated value.

L. Composites [1.0%]: an estimated error based on procedure for compositing air particulate filters (TIML AP-03).

3.2 GAMMA ISOTOPIC ANALYSIS TPU% = $\sqrt{(7.3)^2+X^2}$

3.3 GROSS BETA ANALYSIS

FIELD SAMPLING UNCERTAINTIES

A. Air Particulate Filters [1.0%]: an estimated error due to loss during handling.

B. Master Rotometer [1.0%]: used the calibration report for Fischer & Porter dated August 12, 1993.

C. Pump Flowmeter [0.5%]: an estimated value based on flowmeter performance.

D. Field Rotometer [5.0%]: used the calibration report form Fischer & Porter dated June 21, 1993 and calibration procedure outlined in CECo AP-2 Form.

E. Environmental Changes [0.0%]: uncertainty associated with normal seasonal changes are considered insignificant relative to other uncertainties.

F. Timer Indicator [0.0%]: uncertainties associated with timer inefficiency are considered insignificant relative to other uncertainties.

G. Reading Pump Flowmeter Gauge [2.0%]: the uncertainty in reading the gauge is estimated based on a flowrate of 1 cubic foot per hour and a maximum flowrate of 100 cubic feet per hour.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML AP-02).

B. Beta Calibration Source [3.4%]: used the overall uncertainty for calibration source number Sr-90-27 (EMSL) dated February 12, 1992.

C. Source Preparation for Beta Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 45).

D. Preparation of Self Absorption Sample [5.0%]: an estimated error based on diluting, weighting, and transferring variety of separate samples as part of the procedure (QCPM, p. 42).

E. Self Absorption Curve Fit [2.0%]: an estimated error based on the software used to generate the curve.

3.4 GROSS BETA ANALYSIS TPU% = $\sqrt{(9.0)^2+X^2}$

4.0 WATER

4.1 GROSS ALPHA ANALYSIS

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [3.0%]: an estimated value based on measurement errors encountered during the preparation required by the procedure (TIML W(DS)-01).

B. Alpha Calibration Source [4.3%]: used the overall uncertainty for calibration source number Am-241-15 (EMSL) dated October 22, 1990.

C. Source Preparation for Alpha Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 45).

D. Plateout [1.0%]: an estimated error due to sampling conditions prior to the sample arriving at the laboratory.

4.2 GROSS ALPHA ANALYSIS TPU% = $\sqrt{(6.1)^2+X^2}$

4.3 GROSS BETA ANALYSIS

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [3.0%]: an estimated value based on measurement errors encountered during the preparation required by the procedure (TIML W(DS)-01).

B. Beta Calibration Sourc [3.4%]: used the overall uncertainty for calibration source number Sr-90-27 (EMSL) dated February 12, 1992.

C. Source Preparation for Beta Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 45).

D. Preparation of Self Absorption Sample [5.0%]: an estimated error based on diluting, weighting, and transferring variety of separate samples as part of the procedure (QCPM, p. 42).

E. Self Absorption Curve Fit [2.0%]: an estimated error based on the software used to generate the curve.

F. Plateout [1.0%]: an estimated error due to sampling conditions prior to the sample arriving at the laboratory.

4.4 GROSS BETA ANALYSIS TPU% = $\sqrt{(7.7)^2+X^2}$

4.5 GAMMA ISOTOPIC

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML GS-01-03).

B. Gamma Calibration Source [2.3%]: used the overall uncertainty for Cesium-137 with the calibration source number MZ6291 (Amersham) dated November 1, 1992.

C. Source Preparation for Gamma Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Attenuation Differences Between Calibration Source and Sample [0.0%]: considered insignificant for samples with density similar to that of the calibration source. A different calibration source is prepared for Bottom Sediments, Charcoal Cartridges, and Air Particulate Filters.

E. Uncertainty in Efficiencies due to Differences in Sample Volume [0.0%]: considered insignificant due to the use of a large variety of sample geometry's.

F. Calibration Efficiency [0.0%]: considered insignificant relative to other uncertainties.

G. Efficiency - Curve Fitting [5.0%]: considered insignificant relative to other uncertainties.

H. Abundance [2.5%]: used published values for nuclides with FE-59 as the reference.

I. Decay time [0.0%]: considered insignificant relative to other uncertainties.

J. Half-life [0.0%]: based on published values for each nuclide it is considered insignificant relative to other uncertainties.

K. Yield [1%]: an estimated value.

L. Composites [2.0%]: an estimated error based on procedure for compositing water samples (TIML COMP-01).

M. Plateout [1.0%]: an estimated error due to sampling conditions prior to the sample arriving at the laboratory.

4.6 GAMMA ISOTOPIC ANALYSIS TPU% $=\sqrt{(5.2)^2+X^2}$

4.7 TRITIUM ANALYSIS

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [4.0%]: can estimated value based on measurement errors encountered during the preparation required by the procedure (TIML T-02).

B. Tritium Calibration Source [4.1%]: used the overall uncertainty for the calibration source number T-26B dated April 27, 1992.

C. Source Preparation for Tritium Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 45).

D. Difference in Quenching Between Sample and Standard [0.0%]: considered to be insignificant due to the fact that the sample and the standard are both distilled.

E. Composites [2.0%]: an estimated error based on procedure for compositing water samples (TIML COMP-01).

F. Plateout [1.0%]: an estimated error due to sampling conditions prior to the sample arriving at the laboratory.

4.8 TRITIUM ANALYSIS TPU% = $\sqrt{(6.8)^2+X^2}$

5.0 MILK

5.1 GAMMA ISOTOPIC ANALYSIS

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML GS-01-03).

B. Gamma Calibration Source [2.3%]: used the overall uncertainty for Cesium-137 with the calibration source number MZ6291 (Amersham) dated November 1, 1992.

C. Source Preparation for Gamma Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Attenuation Differences Between Calibration Source and Sample [0.0%]: considered insignificant for samples with density similar to that of the calibration source. A different calibration source is prepared for Bottom Sediments, Charcoal Cartridges, and Air Particulate Filters.

E. Uncertainty in Efficiencies due to Differences in Sample Volume [0.0%]: considered insignificant due to the use of a large variety of sample geometry's.

F. Calibration Efficiency [0.0%]: considered insignificant relative to other uncertainties.

G. Efficiency - Curve Fitting [5.0%]: considered insignificant relative to other uncertainties.

H. Abundance [2.5%]: used published values for nuclides with FE-59 as the reference.

I. Decay time [0.0%]: considered insignificant relative to other uncertainties.

J. Half-life [0.0%]: based on published values for each nuclide it is considered insignificant relative to other uncertainties.

K. Yield [1%]: an estimated value.

5.2 GAMMA ISOTOPIC ANALYSIS TPU% = $\sqrt{(4.6)^2+X^2}$

5.3 I-131 ANALYSIS

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [4.0%]: can estimated value based on measurement errors encountered during the preparation required by the procedure (TIML I-131-01).

B. I-131 Calibration Source [3.0%]: used the overall uncertainty for the calibration source number I-131-78 (EMSL) dated May 22, 1993.

C. Source Preparation for I-131 Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Standardization of Iodine Carrier Solution [0.5%]: estimated error based on the procedure used for the preparation of carrier solution (TIML CAR-01).

E. Self Absorption [2.0%]: an estimated value.

F. Chemical Yield [1.0%]: an estimated value based on measurement errors.

G. Stable Iodide Concentration in Milk [0.0%]: considered to be insignificant relative to other uncertainties.

H. Decay Time [4.0%]: the maximum amount of error based on the average length of time between collection and analysis.

5.4 I-131 ANALYSIS TPU% = $\sqrt{(7.4)^2+X^2}$

6.0 VEGETATION

6.1 GAMMA AND I-131 ANALYSIS

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML SP-01).

B. Gamma Calibration Source [2.3%]: used the overall uncertainty for Cesium-137 with the calibration source number MZ6291 (Amersham) dated November 1, 1992.

C. Source Preparation for Gamma Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Attenuation Differences Between Calibration Source and Sample [0.0%]: considered insignificant for samples with density similar to that of the calibration source. A different calibration source is prepared for Bottom Sediments, Charcoal Cartridges, and Air Particulate Filters.

E. Uncertainty in Efficiencies due to Differences in Sample Volume [0.0%]: considered insignificant due to the use of a large variety of sample geometry's.

F. Calibration Efficiency [0.0%]: considered insignificant relative to other uncertainties.

G. Efficiency - Curve Fitting [5.0%]: considered insignificant relative to other uncertainties.

H. Abundance [2.5%]: used published values for nuclides with FE-59 as the reference.

I. Decay time [0.0%]: considered insignificant relative to other uncertainties.

J. Half-life [0.0%]: based on published values for each nuclide it is considered insignificant relative to other uncertainties.

K. Yield [1%]: an estimated value.

6.2 GAMMA ISOTOPIC ANALYSIS TPU% = $\sqrt{(4.6)^2+X^2}$

7.0 BOTTOM SEDIMENTS

7.1 GAMMA ANALYSIS

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML SP-01).

B. Gamma Calibration Source [2.3%]: used the overall uncertainty for Cesium-137 with the calibration source number MZ6291 (Amersham) dated November 1, 1992.

C. Source Preparation for Gamma Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Attenuation Differences Between Calibration Source and Sample [0.0%]: considered insignificant for samples with density similar to that of the calibration source. A different calibration source is prepared for Bottom Sediments, Charcoal Cartridges, and Air Particulate Filters.

E. Uncertainty in Efficiencies due to Differences in Sample Volume [0.0%]: considered insignificant due to the use of a large variety of sample geometry's.

F. Calibration Efficiency [0.0%]: considered insignificant relative to other uncertainties.

G. Efficiency - Curve Fitting [5.0%]: considered insignificant relative to other uncertainties.

H. Abundance [2.5%]: used published values for nuclides with FE-59 as the reference.

I. Decay time [0.0%]: considered insignificant relative to other uncertainties.

J. Half-life [0.0%]: based on published values for each nuclide it is considered insignificant relative to other uncertainties.

K. Yield [1%]: an estimated value.

7.2 GAMMA ISOTOPIC ANALYSIS TPU% = $\sqrt{(4.6)^2+X^2}$

8.0 FISH

8.1 GAMMA ANALYSIS

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML SP-01).

B. Gamma Calibration Source [2.3%]: used the overall uncertainty for Cesium-137 with the calibration source number MZ6291 (Amersham) dated November 1, 1992.

C. Source Preparation for Gamma Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Attenuation Differences Between Calibration Source and Sample [0.0%]: considered insignificant for samples with density similar to that of the calibration source. A different calibration source is prepared for Bottom Sediments, Charcoal Cartridges, and Air Particulate Filters.

E. Uncertainty in Efficiencies due to Differences in Sample Volume [0.0%]: considered insignificant due to the use of a large variety of sample geometry's.

F. Calibration Efficiency [0.0%]: considered insignificant relative to other uncertainties.

G. Efficiency - Curve Fitting [5.0%]: considered insignificant relative to other uncertainties.

H. Abundance [2.5%]: used published values for nuclides with FE-59 as the reference.

I. Decay time [0.0%]: considered insignificant relative to other uncertainties.

J. Half-life [0.0%]: based on published values for each nuclide; it is considered insignificant relative to other uncertainties.

K. Yield [1%]: an estimated value.

8.2 GAMMA ISOTOPIC ANALYSIS TPU% = $\sqrt{(4.6)^2+X^2}$

ATTACHMENT 1

SAMPLING AND ANALYTICAL UNCERTAINTIES

I. CHARCOAL CARTRIDGES	
* I-131 ANALYSIS	7.2%
II. AIR PARTICULATE FILTERS	
A. GAMMA ISOTOPIC ANALYSIS	7.3%
B. GROSS BETA ANALYSIS	9.0%
III. WATER	
A. GROSS ALPHA ANALYSIS	6.1%
B. GROSS BETA ANALYSIS	7.7%
C. GAMMA ISOTOPIC ANALYSIS	5.2%
D. TRITIUM ANALYSIS	6.8%
IV. MILK	
A. GAMMA ISOTOPIC ANALYSIS	4.6%
B. I-131 ANALYSIS	7.4%
V. VEGETATION	
* GAMMA ISOTOPIC AND I-131 ANALYSIS	4.6%
VI. BOTTOM SEDIMENTS	
* GAMMA ISOTOPIC	4.6%
VII. FISH	
* GAMMA ISOTOPIC	4.6%

ATTACHMENT 2

Total Propagated Uncertainty Equation

$$\mathrm{TPU}(\%) = \sqrt{S_1 + S_2 + S_3 + - - - - S_n}$$

where S_n represents n individual uncertainties

The TPU is the individual uncertainties added in quadrature.

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DETERMINATION OF TOTAL PROPAGATED UNCERTAINTY FOR SAMPLE ANALYSES

PROCEDURE NO. TIML-TPU-01

Prepared by

Teledyne Isotopes Midwest Laboratory

Copy No. ____________

Revision #	Date	Pages	Prepared by	Approved by
0	1-3-94	16	C. Farlow	L.G. Huebner

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1.0 INTRODUCTION

The following constitutes the method for determining and calculating the Total Propagated Uncertainty (TPU) for analyses performed on samples at Teledyne Isotopes Midwest Laboratory. The TPU is a percentage uncertainty that results from an accumulation of systematic errors associated with collecting and analyzing a sample.

A review of the collection procedures and analytical procedures was conducted to define and quantify pertinent systematic errors associated with each process. The TPU for a single sampling and analysis procedure is determined by combining the individual Field Sampling and Analytical errors using the error propagation formula outlined in Attachment 2. Since the counting error varies from sample to sample as the background and counting rates change, the counting error for a specific sample cannot be quantified until the time of the analysis, therefore, it is not assigned a value. Should the collection procedure or analytical procedure change, the associated uncertainties will be reviewed and revised as deemed necessary.

Attachment 1 is a listing of the combined sampling and analytical TPU for individual samples and analysis. Throughout this method of determining the TPU, human errors are not considered and the assumption is made that all equipment is properly calibrated and in good working order. All the errors listed represent the uncertainty at the one sigma confidence level.

Each sample type is listed with the possible sources of uncertainty along with a summary of the associated sampling and analytical uncertainties. The TPU is expressed as a percentage with X representing the counting error as a percentage at the one sigma confidence level.

2.0 CHARCOAL CARTRIDGE

2.1 UNCERTAINTIES ASSOCIATED WITH ANALYSIS OF I-131 IN AIR

FIELD SAMPLING UNCERTAINTIES

A. Charcoal Cartridges [0.0%]: The error associated with Iodine collection by impregnated charcoal cartridge is considered to be insignificant since the efficiency of the cartridge is greater than 99.0%.

B. Master Rotameter [1.0%]: used the calibration report for Fischer & Porter dated August 12, 1993.

C. Pump Flowmeter [0.5%]: an estimated value based on flowmeter performance.

D. Field Rotameter [5.0%]: used the calibration report form Fischer & Porter dated June 21, 1993 and calibration procedure outlined in CECo AP-2 Form.

E. Environmental Changes [0.0%]: uncertainty associated with normal seasonal changes are considered insignificant relative to other uncertainties.

F. Timer Indicator [0.0%]: uncertainties associated with timer inefficiency are considered insignificant relative to other uncertainties.

G. Reading Pump Flowmeter Gauge [2.0%]: the uncertainty in reading the gauge is estimated based on a flowrate of 1 cubic foot per hour and a maximum flowrate of 100 cubic feet per hour.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML I-131-05).

B. Gamma Calibration Source [2.3%]: used the overall uncertainty for Cesium-137 with the calibration source number MZ6291 (Amersham) dated November 1, 1992.

C. Source Preparation for Gamma Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Attenuation Differences Between Calibration Source and Sample [0.0%]: considered insignificant for samples with density similar to that of the calibration source. A different calibration source is prepared for Bottom Sediments, Charcoal Cartridges, and Air Particulate Filters.

E. Uncertainty in Efficiencies due to Differences in Sample Volume [0.0%]: considered insignificant due to the use of a large variety of sample geometry's.

F. Calibration Efficiency [0.0%]: considered insignificant relative to other uncertainties.

G. Efficiency - Curve Fitting [5.0%]: an estimated error based on the inability of the mathematical model to reproduce the curve exactly.

H. Abundance [2.5%]: used published values for nuclides with FE-59 as the reference.

I. Decay time [0.0%]: considered insignificant relative to other uncertainties.

J. Half-life [0.0%]: based on published values for each nuclide it is considered insignificant relative to other uncertainties.

K. Yield [1%]: an estimated value.

2.2 I-131 ANALYSIS IN AIR: TPU(%) = $\sqrt{(8.8)^2 + X^2}$

3.0 AIR PARTICULATE FILTER

3.1 UNCERTAINTIES ASSOCIATED WITH GAMMA ISOTOPIC ANALYSIS IN AIR

FIELD SAMPLING UNCERTAINTIES

A. Air Particulate Filters [1.0%]: an estimated error due to loss during handling.

B. Master Rotameter [1.0%]: used the calibration report for Fischer & Porter dated August 12, 1993.

C. Pump Flowmeter [0.5%]: an estimated value based on flowmeter performance.

D. Field Rotameter [5.0%]: used the calibration report form Fischer & Porter dated June 21, 1993 and calibration procedure outlined in CECo AP-2 Form.

E. Environmental Changes [0.0%]: uncertainty associated with normal seasonal changes are considered insignificant relative to other uncertainties.

F. Timer Indicator [0.0%]: uncertainties associated with timer inefficiency are considered insignificant relative to other uncertainties.

G. Reading Pump Flowmeter Gauge [2.0%]: the uncertainty in reading the gauge is estimated based on a flowrate of 1 cubic foot per hour and a maximum flowrate of 100 cubic feet per hour.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML AP-03).

B. Gamma Calibration Source [2.3%]: used the overall uncertainty for Cesium-137 with the calibration source number MZ6291 (Amersham) dated November 1, 1992.

C. Source Preparation for Gamma Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Attenuation Differences Between Calibration Source and Sample [0.0%]: considered insignificant for samples with density similar to that of the calibration source. A different calibration source is prepared for Bottom Sediments, Charcoal Cartridges, and Air Particulate Filters.

E. Uncertainty in Efficiencies due to Differences in Sample Volume [0.0%]: considered insignificant due to the use of a large variety of sample geometry's.

F. Calibration Efficiency [0.0%]: considered insignificant relative to other uncertainties.

G. Efficiency - Curve Fitting [5.0%]: an estimated error based on the inability of the mathematical model to reproduce the curve exactly.

H. Abundance [2.5%]: used published values for nuclides with FE-59 as the reference.

I. Decay time [0.0%]: considered insignificant relative to other uncertainties.

J. Half-life [0.0%]: based on published values for each nuclide it is considered insignificant relative to other uncertainties.

K. Yield [1%]: an estimated value.

L. Composites [1.0%]: an estimated error based on procedure for compositing air particulate filters (TIML AP-03).

3.2 GAMMA ISOTOPIC ANALYSIS IN AIR: TPU% = $\sqrt{(8.9)^2+X^2}$

3.3 UNCERTAINTIES ASSOCIATED WITH GROSS BETA ANALYSIS IN AIR

FIELD SAMPLING UNCERTAINTIES

A. Air Particulate Filters [1.0%]: an estimated error due to loss during handling.

B. Master Rotameter [1.0%]: used the calibration report for Fischer & Porter dated August 12, 1993.

C. Pump Flowmeter [0.5%]: an estimated value based on flowmeter performance.

D. Field Rotameter [5.0%]: used the calibration report form Fischer & Porter dated June 21, 1993 and calibration procedure outlined in CECo AP-2 Form.

E. Environmental Changes [0.0%]: uncertainty associated with normal seasonal changes are considered insignificant relative to other uncertainties.

F. Timer Indicator [0.0%]: uncertainties associated with timer inefficiency are considered insignificant relative to other uncertainties.

G. Reading Pump Flowmeter Gauge [2.0%]: the uncertainty in reading the gauge is estimated based on a flowrate of 1 cubic foot per hour and a maximum flowrate of 100 cubic feet per hour.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML AP-02).

B. Beta Calibration Source [3.4%]: used the overall uncertainty for calibration source number Sr-90-27 (EMSL) dated February 12, 1992.

C. Source Preparation for Beta Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 45).

D. Preparation of Self Absorption Sample [5.0%]: an estimated error based on diluting, weighting, and transferring variety of separate samples as part of the procedure (QCPM, p. 42).

E. Self Absorption Curve Fit [2.0%]: an estimated error based on the software used to generate the curve.

3.4 GROSS BETA ANALYSIS IN AIR: TPU% = $\sqrt{(9.0)^2+X^2}$

4.0 WATER

4.1 UNCERTAINTIES ASSOCIATED WITH GROSS ALPHA ANALYSIS IN WATER

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [3.0%]: an estimated value based on measurement errors encountered during the preparation required by the procedure (TIML W(DS)-01).

B. Alpha Calibration Source [4.3%]: used the overall uncertainty for calibration source number Am-241-15 (EMSL) dated October 22, 1990.

C. Source Preparation for Alpha Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 45).

D. Plateout [1.0%]: an estimated error due to sampling conditions prior to the sample arriving at the laboratory.

4.2 GROSS ALPHA ANALYSIS IN WATER: TPU% = $\sqrt{(6.1)^2+X^2}$

4.3 UNCERTAINTIES ASSOCIATED WITH GROSS BETA ANALYSIS IN WATER

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [3.0%]: an estimated value based on measurement errors encountered during the preparation required by the procedure (TIML W(DS)-01).

B. Beta Calibration Source [3.4%]: used the overall uncertainty for calibration source number Sr-90-27 (EMSL) dated February 12, 1992.

C. Source Preparation for Beta Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 45).

D. Preparation of Self Absorption Sample [5.0%]: an estimated error based on diluting, weighting, and transferring variety of separate samples as part of the procedure (QCPM, p. 42).

E. Self Absorption Curve Fit [2.0%]: an estimated error based on the software used to generate the curve.

F. Plateout [1.0%]: an estimated error due to sampling conditions prior to the sample arriving at the laboratory.

4.4 GROSS BETA ANALYSIS IN WATER: TPU% = $\sqrt{(7.7)^2+X^2}$

4.5 UNCERTAINTIES ASSOCIATED WITH GAMMA ISOTOPIC ANALYSIS IN WATER

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML GS-01-03).

B. Gamma Calibration Source [2.3%]: used the overall uncertainty for Cesium-137 with the calibration source number MZ6291 (Amersham) dated November 1, 1992.

C. Source Preparation for Gamma Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Attenuation Differences Between Calibration Source and Sample [0.0%]: considered insignificant for samples with density similar to that of the calibration source. A different calibration source is prepared for Bottom Sediments, Charcoal Cartridges, and Air Particulate Filters.

E. Uncertainty in Efficiencies due to Differences in Sample Volume [0.0%]: considered insignificant due to the use of a large variety of sample geometry's.

F. Calibration Efficiency [0.0%]: considered insignificant relative to other uncertainties.

G. Efficiency - Curve Fitting [5.0%]: an estimated error based on the inability of the mathematical model to reproduce the curve exactly

H. Abundance [2.5%]: used published values for nuclides with FE-59 as the reference.

I. Decay time [0.0%]: considered insignificant relative to other uncertainties.

J. Half-life [0.0%]: based on published values for each nuclide it is considered insignificant relative to other uncertainties.

K. Yield [1%]: an estimated value.

L. Composites [2.0%]: an estimated error based on procedure for compositing water samples (TIML COMP-01).

M. Plateout [1.0%]: an estimated error due to sampling conditions prior to the sample arriving at the laboratory.

4.6 GAMMA ISOTOPIC ANALYSIS IN WATER: TPU% $=\sqrt{(7.2)^2+X^2}$

4.7 UNCERTAINTIES ASSOCIATED WITH TRITIUM ANALYSIS IN WATER

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [4.0%]: can estimated value based on measurement errors encountered during the preparation required by the procedure (TIML T-02).

B. Tritium Calibration Source [4.1%]: used the overall uncertainty for the calibration source number T-26B dated April 27, 1992.

C. Source Preparation for Tritium Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 45).

D. Difference in Quenching Between Sample and Standard [0.0%]: considered to be insignificant due to the fact that the sample and the standard are both distilled.

E. Composites [2.0%]: an estimated error based on procedure for compositing water samples (TIML COMP-01).

F. Plateout [0.0%]: considered insignificant since plateout has no significant effect on the tritium analysis results.

4.8 TRITIUM ANALYSIS IN WATER: TPU% = $\sqrt{(6.8)^2+X^2}$

5.0 MILK

5.1 UNCERTAINTIES ASSOCIATED WITH GAMMA ISOTOPIC ANALYSIS IN MILK

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML GS-01-03).

B. Gamma Calibration Source [2.3%]: used the overall uncertainty for Cesium-137 with the calibration source number MZ6291 (Amersham) dated November 1, 1992.

C. Source Preparation for Gamma Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Attenuation Differences Between Calibration Source and Sample [0.0%]: considered insignificant for samples with density similar to that of the calibration source. A different calibration source is prepared for Bottom Sediments, Charcoal Cartridges, and Air Particulate Filters.

E. Uncertainty in Efficiencies due to Differences in Sample Volume [0.0%]: considered insignificant due to the use of a large variety of sample geometry's.

F. Calibration Efficiency [0.0%]: considered insignificant relative to other uncertainties.

G. Efficiency - Curve Fitting [5.0%]: an estimated error based on the inability of the mathematical model to reproduce the curve exactly

H. Abundance [2.5%]: used published values for nuclides with FE-59 as the reference.

I. Decay time [0.0%]: considered insignificant relative to other uncertainties.

J. Half-life [0.0%]: based on published values for each nuclide it is considered insignificant relative to other uncertainties.

K. Yield [1%]: an estimated value.

5.2 GAMMA ISOTOPIC ANALYSIS IN MILK: TPU% = $\sqrt{(6.8)^2+X^2}$

5.3 UNCERTAINTIES ASSOCIATED WITH I-131 ANALYSIS IN MILK

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [4.0%]: can estimated value based on measurement errors encountered during the preparation required by the procedure (TIML I-131-01).

B. I-131 Calibration Source [3.0%]: used the overall uncertainty for the calibration source number I-131-78 (EMSL) dated May 22, 1993.

C. Source Preparation for I-131 Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Standardization of Iodine Carrier Solution [0.5%]: estimated error based on the procedure used for the preparation of carrier solution (TIML CAR-01).

E. Self Absorption [2.0%]: an estimated value.

F. Chemical Yield [1.0%]: an estimated value based on measurement errors.

G. Stable Iodide Concentration in Milk [0.0%]: considered to be insignificant relative to other uncertainties.

H. Decay Time [4.0%]: the maximum amount of error based on the average length of time between collection and analysis.

5.4 I-131 ANALYSIS IN MILK: TPU% = $\sqrt{(7.4)^2+X^2}$

6.0 VEGETATION

6.1 UNCERTAINTIES ASSOCIATED WITH GAMMA ISOTOPIC ANALYSIS IN VEGETATION

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML SP-01).

B. Gamma Calibration Source [2.3%]: used the overall uncertainty for Cesium-137 with the calibration source number MZ6291 (Amersham) dated November 1, 1992.

C. Source Preparation for Gamma Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Attenuation Differences Between Calibration Source and Sample [0.0%]: considered insignificant for samples with density similar to that of the calibration source. A different calibration source is prepared for Bottom Sediments, Charcoal Cartridges, and Air Particulate Filters.

E. Uncertainty in Efficiencies due to Differences in Sample Volume [0.0%]: considered insignificant due to the use of a large variety of sample geometry's.

F. Calibration Efficiency [0.0%]: considered insignificant relative to other uncertainties.

G. Efficiency - Curve Fitting [5.0%]: an estimated error based on the inability of the mathematical model to reproduce the curve exactly.

H. Abundance [2.5%]: used published values for nuclides with FE-59 as the reference.

I. Decay time [0.0%]: considered insignificant relative to other uncertainties.

J. Half-life [0.0%]: based on published values for each nuclide it is considered insignificant relative to other uncertainties.

K. Yield [1%]: an estimated value.

6.2 GAMMA ISOTOPIC ANALYSIS IN VEGETATION: TPU% = $\sqrt{(6.8)^2+X^2}$

7.0 BOTTOM SEDIMENTS

7.1 UNCERTAINTIES ASSOCIATED WITH GAMMA ISOTOPIC ANALYSIS IN BOTTOM SEDIMENTS

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML SP-01).

B. Gamma Calibration Source [2.3%]: used the overall uncertainty for Cesium-137 with the calibration source number MZ6291 (Amersham) dated November 1, 1992.

C. Source Preparation for Gamma Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Attenuation Differences Between Calibration Source and Sample [0.0%]: considered insignificant for samples with density similar to that of the calibration source. A different calibration source is prepared for Bottom Sediments, Charcoal Cartridges, and Air Particulate Filters.

E. Uncertainty in Efficiencies due to Differences in Sample Volume [0.0%]: considered insignificant due to the use of a large variety of sample geometry's.

F. Calibration Efficiency [0.0%]: considered insignificant relative to other uncertainties.

G. Efficiency - Curve Fitting [5.0%]: an estimated error based on the inability of the mathematical model to reproduce the curve exactly.

H. Abundance [2.5%]: used published values for nuclides with FE-59 as the reference.

I. Decay time [0.0%]: considered insignificant relative to other uncertainties.

J. Half-life [0.0%]: based on published values for each nuclide it is considered insignificant relative to other uncertainties.

K. Yield [1%]: an estimated value.

7.2 GAMMA ISOTOPIC ANALYSIS IN BOTTOM SEDIMENTS: TPU% = $\sqrt{(6.8)^2+X^2}$

8.0 FISH

8.1 UNCERTAINTIES ASSOCIATED WITH GAMMA ANALYSIS IN FISH

FIELD SAMPLING UNCERTAINTIES

A. Collection Procedures [0.0%]: considered insignificant since human errors are not included as part of the TPU.

ANALYTICAL UNCERTAINTIES

A. Sample Preparation [0.0%]: considered insignificant due to the minimal amount of preparation required by procedure (TIML SP-01).

B. Gamma Calibration Source [2.3%]: used the overall uncertainty for Cesium-137 with the calibration source number MZ6291 (Amersham) dated November 1, 1992.

C. Source Preparation for Gamma Calibration [3.0%]: an estimated error based on diluting, weighting, and transferring the source as part of the procedure (QCPM, p. 34).

D. Attenuation Differences Between Calibration Source and Sample [0.0%]: considered insignificant for samples with density similar to that of the calibration source. A different calibration source is prepared for Bottom Sediments, Charcoal Cartridges, and Air Particulate Filters.

E. Uncertainty in Efficiencies due to Differences in Sample Volume [0.0%]: considered insignificant due to the use of a large variety of sample geometry's.

F. Calibration Efficiency [0.0%]: considered insignificant relative to other uncertainties.

G. Efficiency - Curve Fitting [5.0%]: an estimated error based on the inability of the mathematical model to reproduce the curve exactly.

H. Abundance [2.5%]: used published values for nuclides with FE-59 as the reference.

I. Decay time [0.0%]: considered insignificant relative to other uncertainties.

J. Half-life [0.0%]: based on published values for each nuclide; it is considered insignificant relative to other uncertainties.

K. Yield [1%]: an estimated value.

8.2 GAMMA ISOTOPIC ANALYSIS IN FISH: $\text{TPU\%} = \sqrt{(6.8)^2+X^2}$

ATTACHMENT 1

SAMPLING AND ANALYTICAL UNCERTAINTIES[a]

I. CHARCOAL CARTRIDGES			
	*	I-131 ANALYSIS	8.8%
II. AIR PARTICULATE FILTERS			
	A.	GAMMA ISOTOPIC ANALYSIS	8.9%
	B.	GROSS BETA ANALYSIS	9.0%
III. WATER			
	A.	GROSS ALPHA ANALYSIS	6.1%
	B.	GROSS BETA ANALYSIS	7.7%
	C.	GAMMA ISOTOPIC ANALYSIS	7.2%
	D.	TRITIUM ANALYSIS	6.8%
IV. MILK			
	A.	GAMMA ISOTOPIC ANALYSIS	6.8%
	B.	I-131 ANALYSIS	7.4%
V. VEGETATION			
	*	GAMMA ISOTOPIC ANALYSIS	6.8%
VI. BOTTOM SEDIMENTS			
	*	GAMMA ISOTOPIC ANALYSIS	6.8%
VII. FISH			
	*	GAMMA ISOTOPIC ANALYSIS	6.8%

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[a] Counting uncertainties not included.

ATTACHMENT 2

Total Propagated Uncertainty Equation

$$\mathrm{TPU}(\%) = \sqrt{\sum_{i=1}^{n} S_i^2}$$

where S_i is the ith individual uncertainty at the one sigma level and n is the number of uncertainty components.

The TPU is the individual uncertainties added in quadrature.

References

G. F. Knoll, Radiation Detection and Measurement, John Wiley and Sons, New York (1979), pp. 87-94.

International Committee for Weights and Measures, "Draft Guide to the Expression of Uncertainty in Measurement," published by International Organization for Standardization (1992).

National Bureau of Standards, Reporting of Environmental Radiation Measurements Data, Ad Hoc Subcommittee on Data Reporting, National Bureau of Standards Special Publication (1980).

National Council on Radiation Protection and Measurements, "A Handbook of Radioactivity Measurements Procedures," NCRP Report No. 58 (1985).

B. N. Taylor and C. E. Kuyatt, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results," National Institute of Standards and Technology, NIST Technical Note 1297 (January 1993).

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DETERMINATION OF GROSS ALPHA AND/OR GROSS BETA IN WATER
(DISSOLVED SOLIDS OR TOTAL RESIDUE)

PROCEDURE NO. TIML-W(DS)-01

Prepared by

Teledyne Isotopes Midwest Laboratory

Copy No. ________

Revised Pages	Revision No.	Date	Pages	Prepared by	Approved by
	0	11-25-85	4	B. Grob	L G Huebner
2,3	1	02-28-91	4	B. Grob	L G Huebner
3	2	05-03-91	4	B. Grob	L G Huebner
3,4	3	08-14-92	4	B. Grob	L. G. Huebner

DETERMINATION OF GROSS ALPHA AND/OR GROSS BETA IN WATER
(Dissolved Solids or Total Residue[a,b])

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 gross beta activity.

Reagents

All chemicals should be of "reagent-grade" or equivalent whenever they are commercially available.

Lucite: 0.5 mg/ml in acetone
Nitric acid, HNO_3: 16 N (concentrated), 3 N (187 ml of 16 N HNO_3 diluted to 1 liter), 1 N (62 ml of 16 N HNO_3 diluted to 1 liter)

Apparatus

Filter, Millipore, membrane Type AA, 0.08
Filtration equipment
Planchets (Standard 2" x 1/8" ringed planchet)
Proportional counter
Electric hot plate
Drying oven
Muffle furnace

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.[a,b] 1

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

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[a] For analysis of total residue (for clear water), proceed as described above but do not filter the water. Measure out the appropriate amount and proceed to Step 3.

[b] For Duquesne Light Company samples ONLY - Procedure, Step 1: Do NOT filter. Shake well and immediately withdraw required aliquot. Do not allow solids to settle. 1

2. Transfer assembly holding filter paper to another filtering flask and wash the non-filterable solids on the filter paper with D.I. water. Discard wash water. (Save the filters with suspended matter for separate analysis. See Procedure No. TIML-W-02.)

3. Evaporate the filtrate to NEAR dryness on a hot plate.

4. Add 25 ml of concentrated HNO_3 and evaporate to NEAR dryness again.

   NOTE: If water samples are known or suspected to contain chloride salts, these chloride salts should be converted to nitrate salts before the sample residue is transferred to a stainless steel planchet. (Chlorides will attack stainless steel and increase the sample solids. No correction can be made for these added solids.) Chloride salts can be converted to nitrate salts by adding concentrated HNO^3 and evaporating to near dryness.

5. Add few mL of 1 N HNO_3. Use rubber policeman to wash the walls. Evaporate to NEAR dryness. 3

6. Transfer quantitatively the residue to a TARED PLANCHET, using an unused plastic disposable pipette for each sample, (not more than 1 mL at a time) evaporating each portion to dryness under the lamp. Spread residue uniformly on the planchet.

   NOTE: Non-uniformity of the sample residue in the counting planchet interferes with the accuracy and precision of the method.

7. Wash the beaker with a minimum amount of 1 N HNO_3 several times and combine the washings and the residue in the planchet, using the rubber policeman to wash the walls. Evaporate to dryness.[c]

   NOTE: Rinse the rubber policeman with D.I. water between samples.

8. Bake in muffle furnace at 450°C for 45 minutes, cool and weigh.

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

10. Store the sample in a dessicator until ready to count because vapors from the moist residue can damage the detector and the window and can cause erratic measurements.

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[c] For Duquesne Light Company and CH_2M Hill samples ONLY - Procedure, Step 7: Do NOT bake. Proceed directly to Step 9.

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

    NOTE: If the gas-flow internal proportional counter does not discriminate for the higher energy alpha pulses at the beta plateau, the activity must be subtracted from the beta plus alpha activity. This is particularly important for samples with high alpha activity.

    Samples may be counted for beta activity immediately after baking; alpha counting should be delayed at least 72 hours (until equilibrium has occurred).

Calculations

Gross alpha (beta) activity:

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

Where:

A = Net alpha (beta) count (cpm)

B = Efficiency for counting alpha (beta) activity (cpm/dpm)

C = Volume of sample (liters)

D = Correction factor for self-absorption (See Proc. TIML-AB-02) | 3

E_{sb} = Counting error of sample plus background

E_b = Counting error of background

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

EPA Prescribed Procedures for Measurement of Radioactivity in Drinking Water. August 1980.