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UNION ELECTRIC

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April 30, 1992

U.S. Nuclear Regulatory Commission
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Gentlemen:

ULNRC-2629

DOCKET NUMBER 50-483
CALLAWAY PLANT
FACILITY OPERATING LICENSE NPF-30
1991 ANNUAL ENVIRONMENTAL OPERATING REPORT

Please find enclosed the 1991 Annual Environmental Operating Report for the Callaway Plant. This report is submitted in accordance with Section 6.9.1.6 of the Technical Specifications and Appendix B to the Callaway Plant Operating License.

Very truly yours,

Donald F. Schnell

NGS/plh

Enclosure

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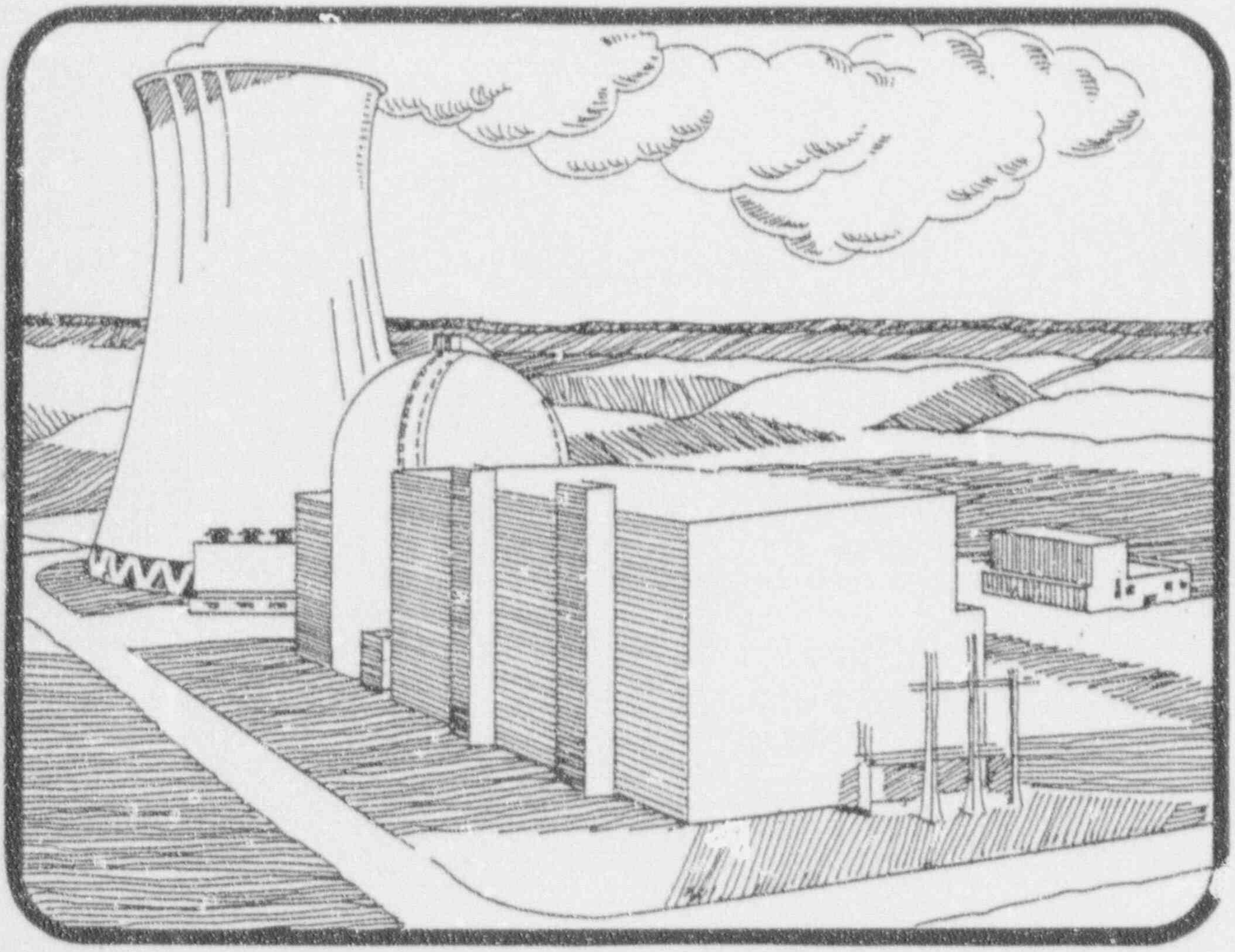
CALLAWAY PLANT

ANNUAL ENVIRONMENTAL OPERATING REPORT

1991



DOCKET NO. 50-483

UNION ELECTRIC

CALLAWAY PLANT

ANNUAL ENVIRONMENTAL OPERATING REPORT

1991

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1.0 INTRODUCTION

The Callaway Plant received an Operating License on June 11, 1984. This report presents the analytical data from the environmental monitoring programs with appropriate interpretation for 1991 and the environmental evaluations for plant modifications completed during 1991.

The third section of this report summarizes and interprets the results of the radiological environmental monitoring program conducted in accordance with Administrative Procedure APA-ZZ-01003, "OFFSITE DOSE CALCULATION MANUAL", Section 9.11. Section four describes non-radiological environmental monitoring and its results conducted in accordance with Section 2.2 of Appendix B to the Callaway Plant Operating License. The fifth section of this report describes changes in plant design or operation, tests, and experiments made in accordance with Section 3.1 of Appendix B of the Callaway Plant Operating License.

This Annual Environmental Operating Report is submitted in accordance with Section 6.9.1.6 of the Technical Specifications and Appendix B to the Callaway Plant Operating License.

2.0 CONCLUSION

The third section of this report contains all the radiological environmental monitoring conducted in the vicinity of the Callaway Plant during 1991. The comparison of the results for the radiological environmental monitoring conducted during 1991 to the preoperational data and data from previous years of operation showed no unexpected or adverse effects from the operation of the Callaway Plant on the environment.

The non-radiological monitoring conducted in the vicinity of the Callaway Plant during 1991 is contained in section four of this report. The monitoring conducted during 1991 showed no evidence of effects of drift from the cooling tower. The foliar disease found in the vegetation during 1991 could be directly attributed to natural causes.

There were no plant modifications completed during 1991 with an unreviewed environmental question as shown in section five of this report.

SECTION 3.0

RADIOLOGICAL

ENVIRONMENTAL MONITORING

UNION ELECTRIC COMPANY

ST. LOUIS, MISSOURI

CALLAWAY PLANT

RADIOLOGICAL ENVIRONMENTAL

MONITORING PROGRAM

ANNUAL REPORT

1991

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FIGURES

Abstract

This report presents the data obtained from analysis of environmental samples collected through the Callaway Plant Radiological Environmental Monitoring Program (REMP) in 1991.

Evaluation of radiation levels in the environs around Union Electric Company's (UEC) Callaway Plant entailed sampling at strategic points in various exposure pathways. The following types of samples were collected and analyzed: milk, vegetation, surface water, well water, bottom sediment, shoreline sediment, fish, airborne particulates, airborne radioiodine, direct radiation (TLD) and soil.

Analytical results are presented and discussed along with other pertinent information. Possible trends and anomalous results, as interpreted by Union Electric Company personnel, are discussed.

1.0 Introduction

This report presents an analysis of the results of the REMP conducted during 1991 for Union Electric Company, Callaway Plant.

In compliance with federal and state regulations and in its concern to maintain the quality of the local environment UEC began its radiological monitoring program in April, 1982.

The objectives of the REMP are to monitor potential critical pathways of radioeffluent to man and to determine radiological impact on the environment caused by operation of the Callaway Plant.

The Callaway plant consists of one 1239 MWe pressurized water reactor, which achieved initial criticality on October 2, 1984. The plant is located on a plateau approximately ten miles southeast of the City of Fulton in Callaway County, Missouri and approximately eighty miles west of the St. Louis metropolitan area. The Missouri River flows by the site in an easterly direction approximately five miles south of the site at its closest point.

2.0 Radiological Environmental Monitoring Program

2.1 Program Design

The purpose of the operational REMP at the Callaway Plant is to assess the impact of plant operation on the environment. For this purpose samples are collected from waterborne, airborne, ingestion and direct radiation pathways. Sampling media are selected which are likely to show effects of plant effluents and which are sensitive to changes in radioactivity levels. The types of sample media collected are: milk, surface water, groundwater, shoreline sediment, bottom sediment, soil, fish, vegetation, airborne particulate, airborne radioiodine and direct radiation (TLD).

Samples are collected by Union Electric personnel and shipped to Teledyne Isotopes Midwest Laboratory (TIML) for analysis. TLD's are analyzed by Union Electric Personnel. The data obtained are reported monthly and summarized in the annual report.

Environmental sample locations are divided into two types, indicator and control. Indicator samples are those collected from locations which would be expected to manifest plant effects, if any. Control samples were collected at locations which are expected to be unaffected by plant operation.

2.2 Program Description

Sample locations for the REMP are shown in Figures 1 and 2. Table I describes the sample locations, direction and distance from the plant, which are control and which are indicator locations, and the types of samples collected at each location. Sample collection frequencies for each of the monitoring locations are given in Table II. The collections and analyses that comprise the program are described in the following pages.

Identification of sample type codes used in Table I are as follows:

Code	Sample Collected
AIO	Air Iodine
APT	Air Particulate
AQF	Fish
AQS	Sediment
FPL	Leafy Green Vegetables
IDM	TLD
MLK	Milk
SOL	Soil
SWA	Surface Water
WWA	Ground Water

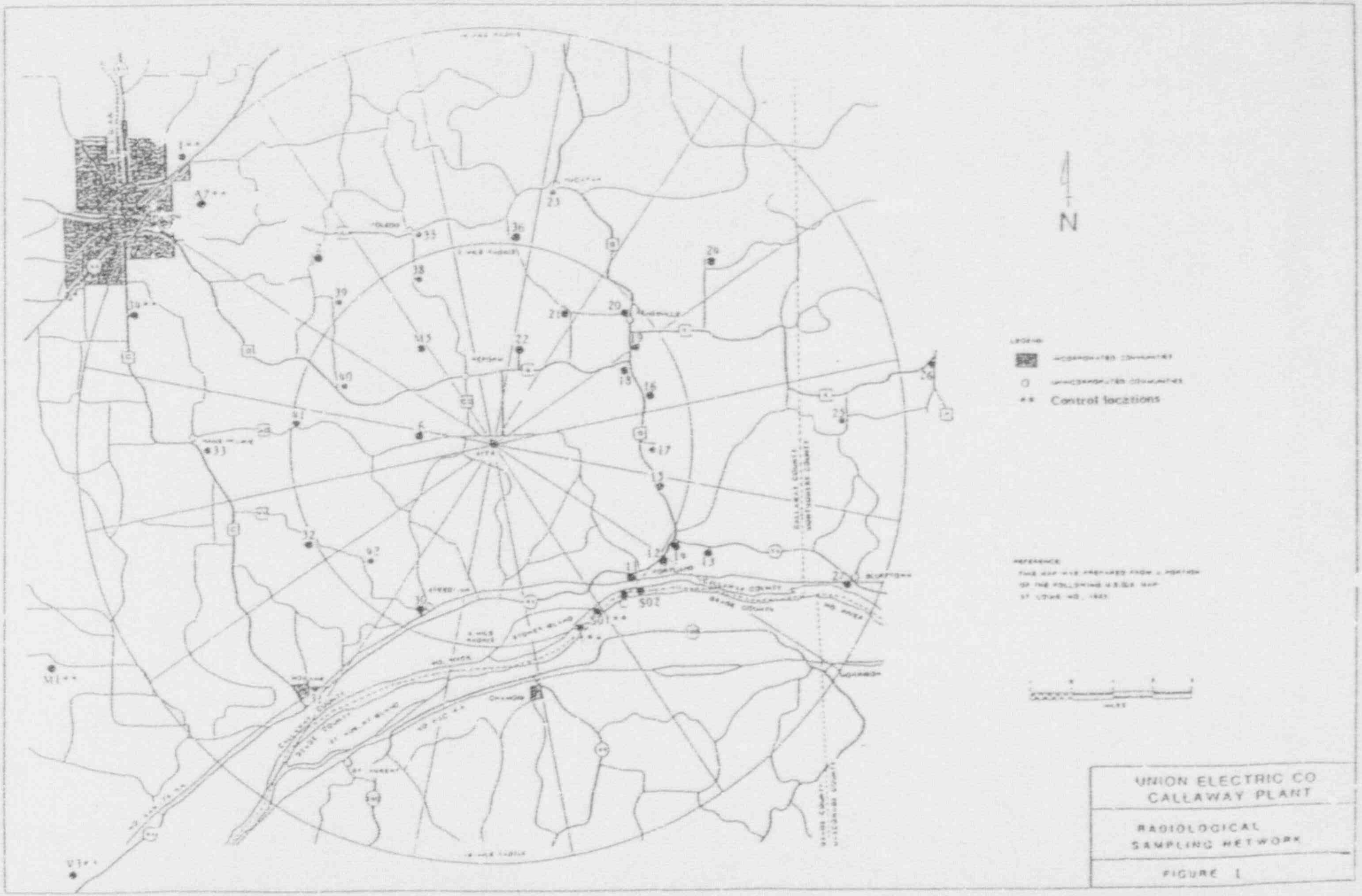
2.2.1 Waterborne Pathway

Surface Water

Monthly composite samples of surface water from the Missouri River are collected from one indicator location (SO2) and from one control location (SO1). The samples are analyzed for gross alpha, gross beta, tritium, Strontium-89, Strontium-90, and by gamma spectrometry.

Ground Water

Ground water samples are collected monthly from two on-site wells (F05 and F15) and one off-site well used for drinking water (D01). The on-site ground water samples are collected using a manual grab sampler which is lowered into the well. The off-site ground water sample is collected from a faucet after allowing the line to flush for two minutes. Ground water samples are analyzed for gross alpha, gross beta, Tritium, Strontium-89, Strontium-90, and gamma emitting nuclides.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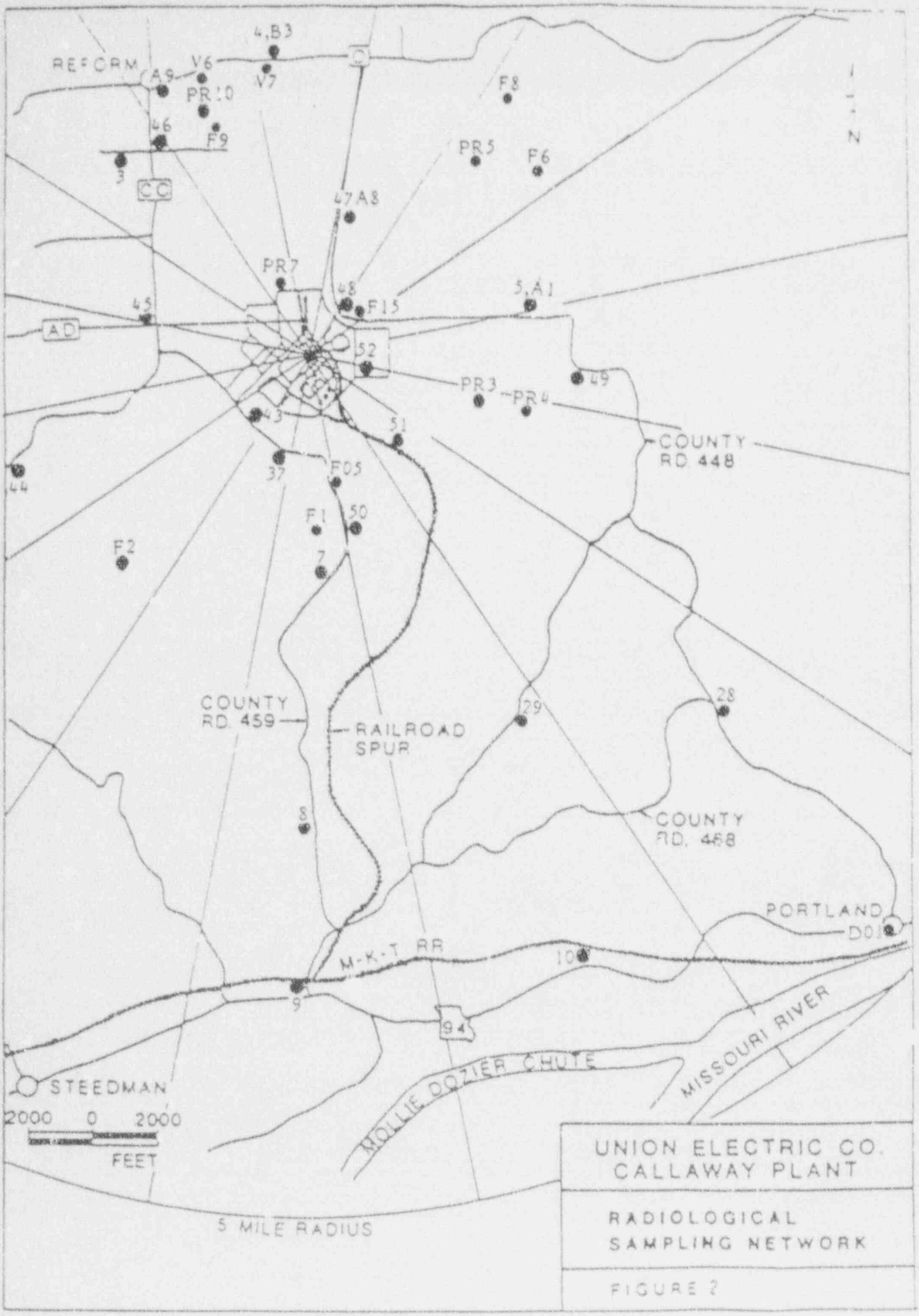
Control locations
UNION ELECTRIC CO
CALLAWAY PLANT
RADIOLOGICAL
SAMPLING NETWORK
FIGURE 1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PR10
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F9
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CC
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COUNTY
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F2
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COUNTY
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RAILROAD
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PORTLAND
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5 MILE RADIUS
UNION ELECTRIC CO.
CALLAWAY PLANT
RADIOLOGICAL
SAMPLING NETWORK
FIGURE 2

TABLE I

SAMPLING LOCATIONS

Location Code	Description	Sample Types
1**	11 mi NW, City Limits of Fulton on Hwy Z, 0.8 mi East of Business 54.	IDM
2	6.6 mi NW; County Road 111, 0.6 mi South of Hwy UU, Callaway Electric Cooperative Utility Pole No. 17571.	IDM
3	1.3 mi NW; 0.1 mi West of Hwy CC on Gravel Road, 0.8 mi South Hwy O, Callaway Electric Cooperative Utility Pole No. 18559.	IDM
4,B3	1.9 mi N;0.3 mi East of the O and CC Junction, Callaway Electric Cooperative Utility Pole No. 18892.	IDM APT,AIO
5,A1	1.3 mi ENE; Primary Meteorological Tower.	IDM,APT,A10
6	2.0 mi W; County Road 428, 1.2 mi West of Hwy CC, Callaway Electric Cooperative Utility Pole No. 18609.	IDM
7	1.3 mi S; County Road 459, 2.6 mi North of Hwy 94, Callaway Electric Cooperative Utility Pole No. 35097	IDM
8	2.9 mi S; County Road 459, 1.4 mi North of Hwy 94, Callaway Electrical Cooperative Utility Pole No. 06823.	IDM
9	3.7 mi S; NW Side of the County Road 459 and 94 Junction, Callaway Electric Cooperative Utility Pole No. 06754.	IDM
10	4.0 mi SSE; Hwy 94, 1.8 mi East of County Road 459, Callaway Electric Cooperative Utility Pole No. 12182	IDM
11	4.8 mi SE; City of Portland, Callaway Electric Cooperative Utility Pole No. 12112.	IDM
12	5.3 mi SE; Hwy 94, 0.6 mi South of Hwy D, Utility Pole on East side on Hwy.	IDM
13	5.6 mi ESE; Hwy 94, 0.75 mi East of Hwy D, Kingdom Telephone Pole No. 2X1.	IDM

TABLE I (Cont'd.)

SAMPLING LOCATIONS

Location Code	Description	Sample Types
14	5.0 mi ESE; SE Side of Intersection D and 94, Callaway Electric Cooperative Utility Pole No. 11940.	IDM
15	4.2 mi ESE; Hwy D, 2.5 mi North of Hwy 94, Callaway Electric Cooperative Utility Pole No. 27379.	IDM
16	4.1 mi ENE; Hwy D, 3.6 mi North of Hwy 94, Callaway Electric Cooperative Utility Pole No. 12976.	IDM
17	4.0 mi E; County Road 4053, 0.3 mi East of Hwy 94, Kingdom Telephone Company Pole No. 3X12.	IDM
18	3.8 mi ENE; Hwy D, 0.4 mi South of O, Callaway Electric Cooperative Utility Pole No. 12952.	IDM
19	4.2 mi NE; Hwy D, 0.3 mi North of Hwy O, Callaway Electric Cooperative Utility Pole No. 12918.	IDM
20	4.8 mi NE; City of Readsville, Callaway Electric Cooperative Utility Pole No. 12830.	IDM
21	4.0 mi NNE; County Road 155, 1.9 mi North of Hwy O, Callaway Electric Cooperative Utility Pole No. 19100.	IDM
22	2.5 mi NNE; County Road 150, 0.5 mi North of Hwy O, Callaway Electric Cooperative Utility Pole No. 19002.	
23	6.7 mi NNE; City of Yucation, Callaway Electric Cooperative Utility Pole No. 12670	IDM
24	7.0 mi NE; County Road 191, 2.1 mi North of Hwy K, Callaway Electric Cooperative Utility Pole No. 12498.	IDM
25	8.7 mi E; County Road 289, 0.3 mi South of County Road 287, Callaway Electric Cooperative Utility Pole No. 11295.	IDM

TABLE I (Cont'd.)

SAMPLING LOCATIONS

Location Code	Description	Sample Types
26	12.1 mi E; Town of Americus, Callaway Electric Cooperative Utility Pole No. 11159.	IDM
27	9.5 mi ESE; Town of Bluffton, Callaway Electric Cooperative Utility Pole No. 11496.	IDM
28	3.3 mi SE; County Road 469, 2.0 mi North of Hwy 94, Callaway Electric Cooperative Utility Pole No. 06896.	IDM
29	2.7 mi SSW; County Road 448, 1.2 mi North of County Road 459, Callaway Electric Cooperative Utility Pole No. 06851.	IDM
30	4.6 mi SSE; W side of County Road 447 and 463 Junction, Kingdom Telephone Company Pole No. 2K1.	IDM
31	7.6 Mi SW; City of Mokane, Callaway Electric Cooperative Utility Pole No. 06039.	IDM
32	5.4 mi WSW; Hwy VV, 0.6 mi West of County Road 447, Callaway Electric Cooperative Utility Pole No. 27031.	IDM
33	7.3 mi W; City of Hams Prairie, SE of Hwy C and AD Junction.	IDM
34**	9.7 mi WNW; NE Side of Hwy C and County Road 408 Junction.	IDM
35	5.8 mi NNW; City of Toledo, Callaway Electric Cooperative Utility Pole No. 17684.	IDM
36	5.2 mi N; County Road 155, 0.8 mi South of County Road 132, Callaway Electric Cooperative Utility Pole No. 19137.	IDM
37	0.7 mi SSW; County Road 459, 0.9 mi South of Hwy CC, Callaway Electric Cooperative Utility Pole No. 35077.	IDM

TABLE I (Cont'd.)

SAMPLING LOCATIONS

Location Code	Description	Sample Types
38	4.8 mi NNW; County Road 133, 1.5 mi South of Hwy UU, Callaway Electric Cooperative Utility Pole No. 34708.	IDM
39	5.4 mi NW; County Road 112, 0.7 mi East of County Road 111, Callaway Electric Cooperative Utility Pole No. 17516.	IDM
40	4.2 mi WNW; NE Side of County Road 112 and Hwy O, Callaway Electric Cooperative Utility Pole No. 06326.	IDM
41	4.8 mi W; Hwy AD, 2.8 mi East of Hwy C, Callaway Electric Cooperative Utility Pole No. 18239.	IDM
42	4.4 mi SW; County Road 447, 2.6 mi North of County Road 463, Callaway Electric Cooperative Utility Pole No. 06326.	IDM
43	0.5 mi SW; County Road 459, 0.7 mi South of Hwy CC, Callaway Electric Cooperative Utility Pole No. 35073.	IDM
44	1.7 mi WSW; Hwy CC, 1.0 mi South of County Road 459, Callaway Electric Cooperative Utility Pole No. 18769.	IDM
45	1.0 mi WNW; County Road 428, 0.1 mi West of Hwy CC, Callaway Electric Cooperative Utility Pole No. 18580.	IDM
46	1.5 mi NNW; NE Side of Hwy CC and County Road 466 Intersection, Callaway Electric Cooperative Utility Pole No. 28242.	IDM
47	0.9 mi NNE; County Road 448, 0.9 mi South of Hwy O, Callaway Electric Cooperative Utility Pole No. 28151.	IDM
48	0.4 mi NE; County Road 448, 1.5 mi South of Hwy O, Plant Security Sign Post.	IDM
49	1.7 mi E; County Road 448, Callaway Electric Cooperative Utility Pole No. 06959, Reform Wildlife Management Parking Area.	IDM

TABLE I (Cont'd.)

SAMPLING LOCATIONS

Location Code	Description	Sample Types
50	0.9 mi SSE; County Road 459, 3.3 mi North of Hwy 94, Callaway Electric Cooperative Utility Pole No. 35086.	IDM
51	0.7 mi SE; Located in the "Y" of the Railroad Spur, NW of Sludge Lagoon.	IDM
52	0.4 mi ESE, Light Pole Near the East Plant Security Fence.	IDM
A7**	9.5 mi NW; C. Bartley Farm	APT,AIO
A8	0.9 mi NNE; County Road 448, 0.9 miles South of Hwy O.	APT,AIO
A9	1.7 mi NNW; Community of Reform	APT,AIO
D01	5.1 mi SE; Holzhouser Grocery Store/Tavern (Portland, MO).	WWA
F05	1.0 mi SSE; Onsite Groundwater Monitoring Well.	WWA
F15	5.5 mi NE; Onsite Groundwater Monitoring Well.	WWA
M1**	12.3 mi WSW; Green's Farm.	MLK
M5	3.1 mi NW; Schneider Farm.	MLK
V3**	15.0 mi SW; Beazley Farm.	FPL,SOL
V6	1.8 mi NNW; Becker Farm.	FPL
V7	1.8 mi N; Meehan.	FPL
A**	4.9 mi SSE; 0.6 River Miles Upstream of Discharge North Bank.	AQS,AQF
C	5.1 mi SE; 1.0 River Miles Downstream of Discharge North Bank.	AQS,AQF

TABLE I (Cont'd.)

SAMPLING LOCATIONS

Location Code	Description	Sample Types
S01**	4.8 mi SE; 84 feet Upstream of Discharge North Bank.	SWA
S02	5.2 mi SE; 1.1 River Miles Downstream of Discharge North Bank.	SWA
F1	0.98 mi S; Callaway Plant Forest Ecology Plot F1.	SOL
F2	1.64 mi SW; Callaway Plant Forest Ecology Plot F2.	SOL
F6	1.72 mi NE; Callaway Plant Forest Ecology Plot F6.	SOL
F8	1.50 mi NE; Callaway Plant Forest Ecology Plot F8.	SOL
F9	1.45 mi NNW; Callaway Plant Forest Ecology Plot F9.	SOL
PR3	1.02 mi ESE; Callaway Plant Prairie Ecology Plot PR3.	SOL
PR4	1.34 mi ESE; Callaway Plant Prairie Ecology Plot PR4.	SOL
PR5	1.89 mi NE; Callaway Plant Prairie Ecology Plot PR5.	SOL
PR7	0.45 mi NNW; Callaway Plant Prairie Ecology Plot PR7.	SOL
PR10	1.55 mi NNW; Callaway Plant Prairie Ecology Plot PR10	SOL

*All distances are measured from the center line of the reactor
**Control locations

TABLE II

COLLECTION SCHEDULE

Collection Site	Air Particulates	Air Radioiodine	Well Water	Surface Water	Sediment	Fish	Milk	Vegetation	Soil
A1, Primary Metrorological Tower	W	W							
A7, C. Bartley Farm	W	W							
A8, County Rd. 448, 0.9 miles South of Hwy O	W	W							
A9, Community of Reform	W	W							
B3, 0.6 miles East of O and CC Junction	W	W							
D01, Holzhouser Grocery Store/Tavern			Q						
F05, Onsite Groundwater Monitoring Well			Q						
F15, Onsite Groundwater Monitoring Well			Q						
M1, Green's Farm							SM/M		
M5, Schneider Farm							SM/M		

Q=Quarterly W=Weekly M=Monthly SM/M=Semi Monthly when cows are on Pasture, Monthly otherwise A=Annually SA = Semi Annually

TABLE II (Cont'd.)

COLLECTION SCHEDULE

Collection Site	Air Particulates	Air Radioiodine	Well Water	Surface Water	Sediment	Fish	Milk	Vegetation	Soil
V3, Beazley Farm								M	A
V6, Becker Farm								M	
V7, Meehan Farm								M	
A,0.6 River miles Upstream of Discharge North Bank					SA	SA			
C,1.0 River miles Downstream of Discharge North Bank					SA	SA			
S01, 84 feet Upstream of Discharge North Bank			M						
S02, 1.1 River miles Downstream of Discharge North Bank			M						
F1, Callaway Plant Forest Ecology plot F1									A
F2, Callaway Plant Forest Ecology Plot F2									A

Q=Quarterly W=Weekly M=Monthly SM/M=Semi Monthly when cows are on Pasture, Monthly otherwise A=Annually SA = Semi Annually

TABLE II (Cont'd.)

COLLECTION SCHEDULE

Collection Site	Air Particulates	Air Radioiodine	Well Water	Surface Water	Sediment	Fish	Milk	Vegetation	Soil
F6, Callaway Plant Forest Ecology Plot F6									A
F8, Callaway Plant Forest Ecology Plot F8									A
F9, Callaway Plant Forest Ecology Plot F9									A
PR3, Callaway Plant Prairie Ecology Plot PR3									A
PR4, Callaway Plant Prairie Ecology Plot PR4									A
PR5, Callaway Plant Prairie Ecology Plant PR5									A
PR7, Callaway Plant Prairie Ecology Plot PR7									A
PR10, Callaway Plant Prairie Ecology Plot PR10									A

Q=Quarterly W=Weekly M=Monthly SM/M=Semi Monthly when cows are on Pasture, Monthly otherwise A=Annually SA = Semi Annually

Bottom Sediment

Bottom sediment samples are collected semi-annually from one indicator location (C) and one control location (A). The samples are taken from water at least 2 meters deep to prevent influence of bank erosion. A Ponar dredge is used to obtain the samples, all of which consisted of the uppermost layer of sediment. Each sample is placed, without preservative, in a plastic bag and sealed. Bottom sediment samples are analyzed for gross alpha, gross beta, Strontium-89, Strontium-90, and gamma isotopic.

Shoreline Sediment

Shoreline sediment samples are collected semi-annually at the same locations as bottom sediment. The samples are collected within two feet of the waters edge and consist of 2 six inch diameter by two inch deep sediment plugs. Each sample is placed in a plastic bag and sealed. Shoreline sediment samples are analyzed for gamma isotopic.

2.2.2 Airborne Pathway

Airborne Particulates

Airborne particulate samples are collected on a 47mm diameter glass fiber filter type A/E (99 percent removal efficiency at 1 micron particulate) [illegible] volumetric rate of one and one half cubic fe[illegible] minute at five locations. The particulate fil[illegible] are collected weekly and shipped to TIML for ana[illegible]ses. The filters are analyzed for gross beta activity approximately five days after collection to allow for decay of naturally-occurring short-lived radionuclides. Quarterly composites of filters by location are gamma-scanned and analyzed for Strontium-89 and Strontium-90. Four of the five locations are indicator locations (A1, A8, A9, and B3) and one location is a control location (A7). One of the indicators (A9) is located at the community with the highest D/Q.

Airborne Iodine

Each air sampler is equipped with a charcoal cartridge in-line after the particulate filter holder. The charcoal cartridge at each location is collected at the same time as the particulate filter and analyzed for Iodine-131 within eight days after collection.

2.2.3 Ingestion Pathway

Milk

Two gallon milk samples are collected semi-monthly during the pasture season (April through September) and monthly during the winter from one indicator location (M5) and one control location (M1). The indicator location supplies goat's milk and the control location supplies cow's milk. The milk samples are shipped in ice chest to be received by TIML within 48 hours of collection. Analyses for Iodine-131, elemental calcium, Strontium-89, Strontium-90, and gamma emitting nuclides are performed on all milk samples.

Fish

The five most abundant fish species are collected semi-annually from one indicator location (C) and one control location (A). The fish samples are filleted and the fillets are analyzed for gross alpha, gross beta, Strontium-89, Strontium-90 and gamma isotopic.

Vegetation

Monthly, during the growing season, green leafy vegetation is collected from two indicator locations (V6 and V7) and from one control location (V1). Vegetation samples consist of mustard greens, turnip greens, cabbage, lettuce, and spinach. The vegetation samples are analyzed for gross alpha, gross beta, Iodine-131, and by gamma spectrometry.

Soil

Once a year soil samples are collected from ten indicator locations (F1, F2, PR3, PR4, PR5, F6, PR7, F8, F9 and PR10) and one control location (V3). To ensure that only the most recent deposition was sampled, only the uppermost two-inch layer of soil was taken at each location. Sampling consist of 2 six inch square soil plugs. The litter at the surface and the root mat is considered part of the sample. The samples are placed in plastic bags and sealed. Each soil sample is analyzed for gross alpha, gross beta, and gamma isotopic.

2.2.4 Direct Radiation

Thermoluminescent Dosimetry

Thermoluminescent Dosimetry (TLD) are employed to determine direct radiation levels in and around the Callaway site. Panasonic model UD-814 TLD's sealed in plastic bags are placed in polypropylene mesh cylindrical holders at fifty two locations and exchanged quarterly and annually. Fifty of the fifty two locations are indicators (2 through 33 and 35 through 52) and two locations are controls (1 and 34).

2.3 Program Execution

The program was executed as described in the preceding section with the following exceptions;

1. No milk samples were available from location M5 during the months of January, February, March, and April. Goats were not producing during these months.

2. The well water samples from locations F05 and F15 were not collected in January due to loss of the well sampler in one of the wells.

3. The downstream surface water composite sampler (S02) was inoperable from 12/19/90 to 02/12/91 due to a frozen sample line. Daily grab samples were taken while the composite sampler was out of service.

4. The air particulate and airborne iodine sample results from location A7 for the collection period ending 01/17/91 are questionable because the sampler flow rate was below the required 1.5 CFM when the sample was collected.

5. Fish samples from location A and C were not collected during January because of adverse river and weather conditions.

6. There was no direct radiation data from Location 30 for the first quarter because of vandalism to the TLD station.

7. The downstream surface water composite sampler (S02) was inoperable from 05/14/91 to 07/05/91 due to a silted over sampler inlet and a failed pump. Daily grab samples were taken while the composite sampler was out of service.

8. The air particulate and airborne iodine sample results from location A8 for the collection periods ending 07/18/91 and 07/25/91 are questionable because the sampler power was not on during the entire sampling period. The sampler hour meter showed the sampler had operated for 35 hours and 141 hours, respectively.

9. The upstream surface water composite sampler (S01) was inoperable from 07/09/91 to 08/13/91 due to a malfunction of the sampling equipment. Daily grab samples were taken while the composite sampler was out of service.

10. There were no air particulate or airborne iodine samples from A1 for the collection period ending 10/16/91 due to a malfunction of sampling equipment.

11. No green leafy vegetation samples were available from location V6 and V7 during September due to lack of plant growth.

12. The upstream surface water composite sampler (S01) was out of service from 10/09/91 to 11/21/91. Daily grab samples were taken while the composite sampler was inoperable.

13. The data for the annual TLD's for locations 11 and 30 was lost due to vandalism of the TLD station.

2.4 Analytical Procedures

Analytical procedures and counting methods employed by the contractor Laboratory follow those recommended by the U.S. Public Health Service publication, Radioassay Procedures for Environmental Samples, January 1967; and the U.S. Atomic Energy Commission health and Safety Laboratory, HASL Procedures Manual, (HASL-300), 1972.

A synopsis of the routinely used analytical procedures for sample analyses is presented below.

2.4.1 Airborne

2.4.1.1 Gross Beta

The glass fiber filter type A/E (99 percent removal efficiency at 1 micron particulate), is placed into a stainless steel planchet and counted for gross beta radioactivity using a proportional counter.

2.4.1.2 Gamma Spectrometry

The filters are composited according to station and counted using a germanium detector which is coupled to a computer based, multi-channel analyzer. The resulting spectrum is then analyzed by the computer and specific nuclides, if present, identified and quantified.

2.4.1.3 Strontium-89 and Strontium-90

The composited filters, with stable strontium and barium carriers added, are leached in nitric acid to bring deposits into solution. After filtration, filtrate is reduced in volume by evaporation. The residue is purified by adding iron and rare earth carriers and precipitating them as hydroxides. After a second strontium nitrate precipitation from nitric acid, the nitrates are dissolved in acid again with added yttrium carrier and are stored for ingrowth period, the yttrium is precipitated as hydroxide and separated from strontium with the strontium being in the supernate. Each fraction is precipitated separately as an oxalate (yttrium) and carbonate (strontium) and collected on a No. 42 (2.4 cm) Whatman filter. The filters are counted using a low background proportional counter and the Strontium-90 activity is calculated from the oxalate data. The Strontium-89 activity is determined by subtracting the previously calculated Strontium-90 activity from the measured gross strontium activity calculated from the carbonate.

2.4.1.4 Iodine-131

Each Charcoal cartridge is placed on the germanium detector and counted. A peak of 0.36 MeV is used to calculate the concentration at counting time. The equilibrium concentration at the end of collection is then calculated. Decay correction between the end of collection period and the counting time is then made.

2.4.2 Direct Radiation

Direct radiation measurements are taken by UEC using Thermoluminescent Dosimeters (TLD's). The UEC program employs the Panasonic Model UD-814 TLD and Model UD-710 automatic dosimeter reader. Each dosimeter consists of three elements of $CaSO_4$:Tm and one element of $Li_2B_4O_7$:Cu. The dosimeters are sealed in a moisture resistant plastic bag and placed inside a polypropylene mesh cylindrical holder in the environment. After exposure in the environment the dosimeters are read and the exposure for the time period is determined from the $CaSO_4$:Tm elements. The $Li_2B_4O_7$:Cu element is not used to determine exposure during routine operations.

2.4.3 Vegetation

2.4.3.1 Iodine-131

A suitable aliquot of wet (as received) sample is placed into a standard calibrated container and counted using a germanium detector which is coupled to a computer based, multi-channel analyzer. A peak of 0.36 MeV is used to calculate the concentration at counting time. The equilibrium concentration at the end of collection is calculated by decay correcting between the end of the collection period and the counting time.

2.4.3.2 Gross Alpha and Gross Beta

A suitable aliquot of ashed sample is transferred to a two-inch ringed planchet. The planchet is counted for gross alpha and gross beta activity using a proportional counter.

2.4.3.3 Gamma Spectrometry

A suitable aliquot of wet (as received) sample is placed into a standard calibrated container and specific nuclides, if present, identified and quantified using a germanium detector which is coupled to a computer based, multi-channel analyzer.

2.4.4 Milk

2.4.4.1 Iodine-131

Two liters of milk containing standardized Iodine carrier are stirred with anion exchange resin for one hour. The resin is washed with NACl and the iodine is eluted with sodium hypochlorite. Iodine in the iodate form is reduced to I_2 and the elemental iodine extracted into CCl_4, back-extracted into water, then precipitated as palladium iodide. The precipitate is counted for I-131 using a proportional counter.

2.4.4.2 Strontium-89 and Strontium-90

One liter of milk containing strontium and barium carriers is passed through a cation-exchange resin column.

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

After counting total radiostrontium the second time after six to eight days, Sr-89 concentrations are calculated. If the Sr-89 concentration shows a positive result, the precipitate is dissolved, yttrium carrier added and the sample is stored for six to eight days to allow for additional yttrium ingrowth. Yttrium is separated from strontium, precipitated as yttrium oxalate and counted to determine Sr-90 concentrations.

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

2.4.4.3 Gamma Spectrometry

3.5 liters or 500 ml aliquot of milk is placed in a standard counting container and specific nuclides identified and quantified using a germanium detector which is coupled to a computer based, multi-channel analyzer.

2.4.4.4 Elemental Calcium

Strontium, barium, and calcium are absorbed on the cation-exchange resin, then eluted with sodium chloride solution. An aliquot of the eluate is diluted to reduce the high sodium ion concentration. From this diluted aliquot, calcium oxalate is precipitated, dissolved in dilute hydrochloric acid, and the oxalate is titrated with standardized potassium permaganate.

2.4.5 [illegible] Ground Water

2.4.5.1 [illegible] Alpha and Gross Beta

A suitable aliquot of water is evaporated to dryness and the residue transferred to a tarred planchet. The planchet is counted for gross alpha and gross beta activity using a proportional counter.

2.4.5.2 Tritium

A 60-70 ml aliquot of 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 thoroughly mixed and counted in a liquid scintillation counter.

2.4.5.3 Strontium-89 and Strontium-90

The acidified 1 liter sample of clear water with stable strontium, barium, and calcium carriers is treated with oxalic acid to precipitate insoluble oxalates. The oxalates are dissolved in nitric acid, and strontium nitrate is separated from calcium as a precipitate in nitric acid. The residue is purified by adding iron and rare earth carriers and precipitating them as hydroxides. After a second strontium nitrate precipitation from nitric acid, the nitrates are dissolved in acid with added yttrium carrier and are stored for ingrowth of yttrium-90. The yttrium is again precipitated as hydroxide and separated from strontium with the strontium being in the supernate. Each fraction is precipitated separately as an oxalate (yttrium) and carbonate (strontium) and collected on No. 42 (2.4 cm) Wh tman filter for counting using a low background proportional counter. The Strontium-90 concentration is determined from the yttrium oxalate counting results and the Strontium-89 concentration is calculated as the difference between the strontium carbonate activity and the activity due to Strontium-90.

2.4.5.4 Gamma Spectrometry

3.5 liters or 500 ml aliquot of the water sample is placed in a standard counting container and specific nuclides identified and quantified using the Method described in Section 2.4.1.2.

2.4.6 Fish

2.4.6.1 Gross Alpha and Gross Beta

A suitable aliquot of ashed fish sample is transferred to a two-inch ringed planchet. The planchet is counted for gross alpha and gross beta activity using a proportional counter.

2.4.6.2 Strontium-89 and Strontium-90

A suitable aliquot of ashed sample transferred to a 250 ml beaker and strontium-yttrium carriers added. The Sample is leached in nitric acid and filtered. After filtration, filtrate is reduced in volume by evaporation. The residue is purified by adding iron and rare earth carriers and precipitating them as hydroxides. After a second strontium nitrate precipitation from nitric acid, the nitrates are dissolved in acid again with added yttrium carrier and are stored for ingrowth or Yttrium-90. The yttrium is precipitated as hydroxide and separated from strontium with the strontium being in the supernate. Each fraction is precipitated separately as an oxalate (yttrium) and carbonate (strontium) and collected on No. 42 (2.4 cm) Whatman filter for counting using a low background proportional counter. The Strontium-90 concentration is determined from the yttrium oxalate counting results and the Strontium-89 concentration is calculated as the difference between the strontium carbonate activity and the activity due to Strontium-90.

2.4.6.3 Gamma Spectrometry

A suitable aliquot of prepared sample is placed in standard calibrated container and specific nuclides identified and quantified using a germanium detector which is coupled to a computer based, multi-channel analyzer.

2.4.7 Bottom and Shoreline Sediment

2.4.7.1 Gross Alpha and Gross Beta

A suitable aliquot of ashed sample is transferred to a two-inch ringed planchet. The planchet is counted for gross alpha and gross beta activity using a proportional counter.

2.4.7.2 Strontium-89 and Strontium-90

A suitable aliquot of ashed sample transferred to a 250 ml beaker and Strontium-Yttrium carriers added. The sample is leached in nitric acid and filtered. After filtration, filtrate is reduced in volume by evaporation. The residue is purified by adding iron and rare earth carriers and precipitating them as hydroxides. After a second strontium nitrate precipitation from nitric acid, the nitrates are dissolved in acid again with added yttrium carrier and are stored for ingrowth of Yttrium-90. The yttrium is precipitated as hydroxide and separated from strontium with the strontium being in the supernate. Each fraction is precipitated separately as an oxalate (yttrium) and carbonate (strontium) and collected on No. 42 (2.4 cm) Whatman filter for counting using a low background proportional counter. The Strontium-90 concentration is determined from the yttrium oxalate counting results and the Strontium-89 concentration is calculated as the difference between the strontium carbonate activity and the activity due to Strontium-90.

2.4.7.3 Gamma Spectrometry

A suitable aliquot of prepared sample is placed in standard calibrated container and specific nuclides identified and quantified using a germanium detector which is coupled to a computer based, multi-channel analyzer.

2.5 Program Modifications

During March of this year several modifications were made to the monitoring program. These changes resulted from the National Pollutant Discharge Elimination System Permit renewal issued to the Callaway Plant by Missouri on March 15, 1991. The changes are:

1) The surface water grab sample from location S03 (near the St. Louis City water intake) was deleted from the program.

2) The ground water sample collection frequency was changed from monthly to quarterly.

3) Washload and bedload sediment sampling was deleted from the program.

4) The sample collection frequency for bottom samples was changed from quarterly to semi-annual and sample location D was deleted.

5) Fish sample collection frequency was changed to semi-annually and sample location D was deleted.

3.0 Isotopic Detection Limits and Activity Determinations

A discussion of the calculations used in determining detection limits and activity by the Contractor Laboratory is found in Appendix C.

Table III gives the required detection limits for radiological environmental sample analysis. For each sample type, the table lists the detection level for each isotope.

TABLE III

DETECTION CAPABILITIES FL RADIOLOGICAL ENVIRONMENTAL SAMPLE ANALYSIS

ANALYSIS	WATER (pC/l)	AIRBORNE (pC/m^3)	FISH (pCi/kg wet)	MILK (pC/l)	FOOD PRODUCTS (pCi/kg wet)	SEDIMENT (pCi/kg dry)
Gross beta	4	0.01				
H-3	500					
Mn-54	15		130			
Fe-59	30		260			
Co-58,-60	15		130			
Zr-Nb-95	15*					
I 131	1	0.07		1	40	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-La-140	15*			15*		

NOTE: This list does not mean only these nuclides will be detected and reported. Other peaks which are measurable and identifiable together with above nuclides, will also be identified and reported.

* Total activity, parent plus daughter activity.

4.0 Quality Control Program

To insure the validity of the data, the contractor laboratory maintains a quality control (QC) program which employs quality control checks, with documentation, of the analytical phase of its environmental monitoring studies. The program is defined in the Quality Control Program, and procedures are specified in the QC Procedures Manual.

The QC Program includes laboratory procedures designed to prevent cross-contamination and to ensure accuracy and precision of analyses. The quality control checks include blind samples, duplicate samples, and spiked samples as necessary to verify that laboratory analysis activities are being maintained at a high level of accuracy.

The Quality Control Program is in compliance with USNRC Regulatory Guide 4.15 and includes appropriate control charts with specified acceptance levels for instrument source checks, background, efficiency, etc. for counting equipment.

The Laboratory participates in the USEPA Interlaboratory Comparison Program (crosscheck program) by analyzing radioactive samples distributed for that purpose. The results of the crosscheck program are presented in Appendix B.

5.0 Data Interpretations

In interpreting the data, effects due to the Callaway Plant must be distinguished from those due to other sources.

The principal interpretation method used in assessment of those effects is the indicator-control concept design of the monitoring program at the Callaway Plant. Most sample types are collected at both indicator locations (areas potentially affected by plant operations) and at control locations (areas not affected by plant discharge). A possible plant effect would be indicated if the radiation level at an indicator location was significantly larger than that at the control location. The difference would have to be greater than what could be accounted for by typical fluctuations in radiation levels arising from other sources.

An additional interpretation method involves analysis for specific radionuclides present in the environmental samples collected around the plant site. For certain isotopes it can be determined if the activity is the result of weapons testing or plant operations because of the different characteristic proportions in which these isotopes appear in the fission product mix produced by a nuclear reactor and that produced by a nuclear detonation.

Other means of distinguishing sources of environmental radiation can be employed in interpretation of the data. Current radiation levels can be compared with preoperational levels. Results can be related to those obtained in other parts of the country. Finally, results can be related to events known to have caused elevated levels of radiation in the environment.

6.0 Results and Discussion

The analytical results for the reporting period January to December 1989 are present in summary form in Appendix D. For each type of analysis of each sampled medium, this table shows the annual mean and range for all indicator locations and for all control locations. The location with the highest annual mean and the results for this location are also given.

The discussion of the results has been divided into four pathways; waterborne, airborne, ingestion, and direct radiation. The individual samples and analyses within each category provides an adequate means of estimating radiation does to individuals from the principal pathways. The data for individual samples are presented in tabular form in Appendix E.

6.1 Waterborne Pathway

The water pathway of exposure from the Callaway Plant was evaluated by analyzing surface water, well water, bottom sediment and shoreline sediment.

Surface Water

Analysis for alpha emitters showed detectable activity in sixteen of the twenty-six samples, with results ranging from 1.2 to 11.2 pCi/l. The average sample concentration at the indicator location was 3.2 pCi/l and at the control location was 3.7 pCi/l. The values are similar to those measured in previous years and can be attributed to natural occurring isotopes.

The average gross beta activity in all surface water samples ranged from 4.1 to 19.3 pCi/liter. The average activity at the control location was 8.0 pCi/l and at the indicator location was 7.4 pCi/l. Essentially similar results were obtained in 1983, 1984, 1985, 1986, 1987, 1988, 1989, and 1990.

The analysis of Tritium in surface water showed detectable activity in fourteen of twenty-six samples with results ranging from 133.0 to 689.0 pCi/l. The mean Tritium concentration at the indicator location was 244.4 pCi/liter and at the control location was 436.8 pCi/l. The LLDs for other samples ranged from 159.0 to 183.0 pCi/l.

There were no gamma emitting nuclides detected in any surface water samples.

Strontium-89 activity was below the detection limit in all samples. Strontium-90 activity was detected in six of the twenty-six samples and ranged from 0.4 to 1.2 pCi/l. The mean sample concentration was 0.6 pCi/l for the indicator location and the control location.

The levels of activity detected in surface water samples during 1989 were consistent with previously accumulated radiological environmental data and indicate no influence from plant operations.

Ground Water

In ground water samples, gross alpha was detected in thirteen of twenty-one samples with results ranging from 0.8 to 4.2 pCi/l. The mean activity for indicator locations was 2.8 pCi/l and for control locations was 2.1 pCi/l. Gross beta results showed positive values in twenty-one of twenty-one samples with the results ranging from 2.5 to 12.1 pCi/l. The average activity for indicator locations was 6.6 pCi/l and for control location was 8.9 pCi/l. The gross alpha and gross beta values are similar to those measured in previous years.

Tritium results were below the detection limit which ranged from 163.0 to 197.0 pCi/l.

There were no gamma emitting nuclides detected in any ground water sample.

No Strontium-89 activity was observed above the detection limit in any of the ground water samples. Strontium-90 was detected in four of the twenty-one samples and ranged from 0.4 pCi/l to 1.3 pCi/l. The mean sample concentration at indicator locations was 0.7 pCi/l. Similar Strontium-90 results were observed in 1984, 1985, 1986, 1989 and 1990. There was no indication of a plant effect on ground water.

Bottom Sediment

Gross alpha analyses of bottom sediment showed positive values in three of the four samples. The alpha activity ranged from 8466.0 to 17208.0 pCi/kg. The average gross alpha activity for the indicator location was 12837.0 pCi/kg and for the control location was 10930.0 pCi/kg. Gross beta activity was detected in all samples with results ranging from 19022.0 to 26424.0 pCi/kg. The mean beta activity for indicator and control locations was 22561.5 pCi/kg and 24756.0 pCi/kg respectively.

Cesium-137 activity was detected in one sample with a concentration of 99.7 pCi/kg. There were no other gamma emitting nuclides detected in Bottom Sediment samples.

Strontium-89 was below the limits of detection in all samples. Strontium-90 activity was indicated in three of the four samples with results ranging from 9.7 pCi/kg to 31.0 pCi/kg. The average activity for the indicator location was 20.8 pCi/kg and for the control location was 9.7 pCi/kg.

The activity levels were within the range observed during preoperational monitoring. No plant effect was observed.

Shoreline Sediment

Shoreline Sediment sample collections were made in April and October, 1991 and analyzed for gamma emitting isotopes. One shoreline sediment sample collected in April from location A showed a positive activity of Cesium-137 (111.0 pCi/kg). There were no gamma emitting nuclides detected in shoreline sediment samples collected in October. Similar levels of activity were observed in 1984, 1985, 1987, 1988, 1989 and 1990.

6.2 Airborne Pathway

The airborne pathways of exposure from Callaway Plant were evaluated by analyzing samples of air particulate and air iodine cartridges.

Airborne Particulate

The gross bet activity in airborne particulate ranged from 0.004 to 0.056 pCi/m^3 in all samples. The average gross beta was similar at both indicator locations

(0.020 pCi/m^3) and control location (0.015 pCi/m^3). The highest annual average (0.023 pCi/m^3) was measured at indicator location A8, 0.9 miles NNE of the plant.

Gamma spectral analysis of quarterly composites of air particulate filters showed Beryllium-7 in all samples. The average Beryllium-7 activity for indicator locations was 0.051 pCi/m^3 and for control locations was 0.038 pCi/m^3. The presence of Beryllium-7 can be attributed to cosmic ray activity. No other gamma emitting isotopes of interest were detected in the quarterly composites.

The Strontium-89 and Strontium-90 analyses performed on the quarterly composites showed all activities to be below their respective detection limits.

Levels and distribution of activity in the air particulate samples are similar to the previously accumulated data and indicate no influence from the plant.

Airborne Iodine

Airborne Iodine-131 results were below the detection limit of 0.07 pCi/m^3 in all samples. Thus, there was no indication of a plant effect.

6.3 Ingestion Pathway

Potential ingestion pathways of exposure for Callaway Plant were evaluated by analyzing samples of milk, fish, vegetation, and soil.

Milk

A total of thirty-one analyses for Iodine-131 in milk were performed during 1991. All samples were below the LLD which ranged from 0.2 to 0.5 pCi/l.

Naturally occurring Potassium-40 was the only gamma emitting isotope found in milk samples. Concentrations ranged from 920.0 to 1910.0 pCi/l. The average concentration at the indicator location (goats milk) was 1757.7 pCi/l and at the control location (cows milk) was 1247.2 pCi/l.

Strontium-89 results were below the LLD for all samples. The LLDs ranged from 0.4 to 1.3 pCi/l. Strontium-90 was detected in all milk samples averaging 5.8 pCi/l at the indicator location (goats milk) and 3.3 pCi/l at the control location (cows milk). The range of detectable results was 1.6 to 10.2 pCi/l.

Calcium was analyzed in all milk samples with levels ranging from 0.63 to 1.14 gm/l. The average calcium concentration at the indicator location was 0.93 gm/l and at the control location was 0.88 gm/l.

In summary, the milk data for 1991 show no radiological effects from plant operation. The presence of Strontium-90 in milk samples exhibits a long range residual effect of previous atmospheric nuclear tests.

Fish

The types of fish species collected during 1991 were: River Carpsucker, Gizzard Shad, Channel Catfish, Shortnose Gar, Largemouth Buffalo, Blue Catfish, Smallmouth Buffalo, Freshwater Drum, Flathead Catfish, Carp, Shorthead Redhorse, Goldeye and Quillback.

Twenty-one of forty samples analyzed for gross alpha showed detectable activity. Concentrations ranged from 44.0 to 174.0 pCi/kg-wet. The mean activity at the indicator location was 83.6 pCi/kg-wet and at the control location was 95.8 pCi/kg-wet.

All fish samples indicated positive gross beta concentrations with levels ranging from 2155.0 to 3315.0 pCi/kg-wet. The average beta activity in fish was similar for indicator and control locations (2673.3 and 2790.8 pCi/kg-wet, respectively).

Potassium-40 was the only gamma emitting isotope detected. The mean Potassium-40 activity was 2784.3 pCi/kg-wet for the indicator location and 2728.5 pCi/kg-wet for the control location.

No Strontium-89 activity was detected in the fish samples collected during 1990. Strontium-90 activity was detected in two samples collected at the control location with mean results of 3.2 pCi/kg-wet.

Activities detected in fish samples were consistent with the levels and fluctuations of previously accumulated environmental data. The gross alpha and gross beta activity can be attributed to naturally occurring isotopes (e.g. Potassium-40). The Strontium-90 activity present in some samples can be attributed to worldwide fallout from atmospheric nuclear testing. It can be concluded that operation of the plant has had no effect on fish samples.

Vegetation

The vegetation samples collecting during 1991 consisted of mustard greens, turnip greens, lettuce, cabbage, and spinach.

Gross alpha activity was observed in thirty-two of forty-eight vegetation samples with the results ranging from 42.0 to 595.0 pCi/kg-wet. The average activity for indicator locations was 209.5 pCi/kg-wet and for the control location was 225.4 pCi/kg-wet.

Gross beta activity was detected in all vegetation samples with results ranging from 1591.0 to 8772.0 pCi/kg-wet. The average gross beta activity for indicator locations was 4416.8 pCi/kg-wet and for the control was 4718.5 pCi/kg-wet.

Iodine-131 activity was below the detection limit in all samples.

Naturally occurring Potassium-40 was found in all vegetation samples. Concentrations ranged from 1750.0 to 9430.0 pCi/kg-wet and averaged 4385.5 and 4967.6 pCi/kg-wet at indicator and control locations respectively. All other gamma emitting isotopes were below their detection limit.

None of the vegetation sample results show statistically significant differences between indicator and control locations and the levels of activity were consistent with previously accumulated data. Therefore, no plant effect was indicated.

Soil

Gross alpha results ranged from 8645.0 to 17898.0 pCi/kg for all eleven samples. The mean activity for indicator locations was 14019.2 pCi/kg and for the control location was 10466.0 pCi/kg. Gross beta activity was also detected in all eleven samples ranging from 17691.0 to 25605.0 pCi/kg. The average gross beta activity was 22271.3 and 19091.0 pCi/kg at indicator and control locations respectively.

Gamma spectral analysis of the soil samples showed Cesium-137 and Potassium-40 in all samples. Cesium-137 results ranged from 375.0 to 1869.0 pCi/kg. The average concentration was 1308.1 pCi/kg at the indicator locations and 375.0 pCi/kg at the control location. Potassium-40 results ranged from 9792.0 to 14900.0 pCi/kg. The average concentration for indicator locations was 11026.7 pCi/kg and for the control location was 14900.0 pCi/kg.

The gross alpha and gross beta activity can be attributed to naturally occurring isotopes (e.g. Potassium-40). The Cesium-137 activity present can be attributed to worldwide fallout from atmospheric nuclear testing. The level of activity and distribution pattern is very similar to previously accumulated data and indicates no influence from the plant.

6.4 <u>Direct Radiation</u>

All TLD results present in this report have been normalized to a 90-day quarter (standard quarter) to eliminate the apparent differences in data caused by variations in length of exposure period.

The range of quarterly TLD results for indicator locations was 10.3 to 20.0 mRem/standard quarter and 12.8 to 16.8 mRem/standard quarter for control locations. The quarterly TLD analyses yielded an average exposure level of 15.6 mRem/standard quarter at all indicator locations and an average exposure level of 14.9 mRem/standard quarter at all control locations.

The annual TLD results ranged from 10.8 to 28.8 mRem/standard quarter. The average exposure levels were nearly identical at the indicator locations and control locations (17.2 mRem/standard quarter and 16.3 mRem/standard quarter, respectively).

There was no significant difference between indicator and control locations for the TLD's during 1991. The exposure levels were consistent with previously accumulated data and no plant effects were indicated.

APPENDIX A

1991 LAND USE CENSUS

APPENDIX A

UNION ELECTRIC COMPANY

CALLAWAY PLANT

1991 LAND USE CENSUS

Prepared by [signature] ______________

Approved by [signature] ______________

1. INTRODUCTION

In accordance with Technical Specification 3.12.2, the annual Land Use Census within a 5 mile radius of the Callaway Plant was performed during August, 1991 by the Union Electric Real Estate Department. Observations were made in each of the 16 meteorological sectors of the nearest milking animals (cows and goats) nearest residence, and the nearest garden of greater than $50m^2$ (500 ft^2) producing broad leaf vegetation. This census was completed by contacting the families identified in the 1990 census and driving the roads within a 5 mile radius of the Callaway Plant noting the location of the above-mentioned items.

The results of the Land Use Census are presented in Table 1 thru 3 and discussed below. In the tables, the radial direction and mileage from the Callaway Plant containment are presented for each location. The radial direction is one of the 16 different compass points. The mileage was estimated from map position for each location.

2. CENSUS RESULTS

2.1 Milking Animals

Table 1 presents the locations where milking animals were observed within the 5 mile radius of the Callaway Plant. All milking animals, whose milk is not used for human consumption and/or not yielding milk, are identified on Table 1. There were several changes in the location and number of milking animals observed during the 1991 census. However, none of the changes observed resulted in changes to the current milk sampling locations.

2.2 Nearest Resident

Table 2 presents the location of the nearest resident to the Callaway Plant in each of the 16 meteorological sectors. There was one change in the nearest resident noted in the 1990 census. This change was in the E radial direction.

2.3 Vegetable Gardens

The location of the nearest vegetable garden of greater than $50m^2$ producing broad leaf vegetation is presented in Table 3. Several changes were noted in the garden locations during the 1991 census. However, the change noted did not result in changes to the current vegetable sampling locations.

TABLE 1

NEAREST MILKING ANIMALS WITHIN FIVE MILES OF THE CALLAWAY PLANT

1991

Meteorological Sector	Radial Mileage	Number of Cows	Number of Goats
ENE	5.00	50*	None
E	3.92	10*	None
ESE	2.28	100*	None
SE	2.38	100*	None
S	2.90	3**	None
SSW	3.30	38*	None
SW	2.72	10*	None
WSW	1.35	13**	None
WNW	2.80	25*	None
NW	3.10	4***	5

* Milk producing animals whose milk is not used for human consumption and/or for milk producing animals that are not yielding milk.

** Milk from one cow is being used for human consumption.

*** Milk from two milk producing animals is being used for human consumption.

TABLE 2

NEAREST RESIDENCE WITHIN FIVE MILES OF THE CALLAWAY PLANT

1991

Meteorological Sector	Radial Mileage
N	1.76
NNE	2.00
NE	2.00
ENE	3.80
E	3.92
ESE	2.28
SE	2.38
SSE	2.58
S	2.64
SSW	2.60
SW	2.57
WSW	1.35
W	1.60
WNW	2.60
NNW	3.10
NNW	1.78

TABLE 3

NEAREST GARDEN WITHIN FIVE MILES OF THE CALLAWAY PLANT

1991

Meteorological Sector	Radial Mileage
N	1.76
NNE	2.00
NE	2.00
ENE	5.00
E	3.92*
ESE	2.28
SE	5.00
SSE	2.58*
S	3.44
SSW	3.30
SW	2.57
WSW	1.80
W	1.92*
WNW	2.80*
NW	3.10
NNW	1.78

* In this sector there were no gardens noted within five miles producing "broad leaf vegetation". The distance noted is the distance to the nearest garden.

APPENDIX B

EPA CROSS-CHECK RESULTS

1991

TABLE B1 (Cont.)

EPA INTERCOMPARISON STUDY RESULTS
1991

SAMPLE TYPE	STUDY DATE	ANALYSIS	TIML RESULTS ± 2σ[a]	EPA RESULTS[b] 1s, N=1	CONTROL LIMITS	UNITS
MILK	APR 1991	SR-89	24.0 ± 8.7	32.0 ± 5.0	23.3 - 40.7	pCi/l
		SR-90	28.0 ± 2.0	32.0 ± 5.0	23.3 - 40.7	pCi/l
		I-131	65.3 ± 14.7	60.0 ± 6.0	49.6 - 70.4	pCi/l
		CS-137	54.7 ± 11.0	49.0 ± 5.0	40.3 - [illegible]7.7	pCi/l
		K	1591.7 ± 180.1	1650.0 ± 83.0	[illegible]06.0 - 17[illegible].0	mg/l
WATER	MAY 1991	SR-89	40.7 ± 2.3	39.0 ± 5.0	30.3 - 47.7	pCi/l
		SR-90	23.7 ± 1.2	24.0 ± 5.0	15.3 - 32.7	pCi/l
WATER	MAY 1991	GR. ALPHA	27.7 ± 5.8	24.0 ± 6.0	13.6 - 34.4	pCi/l
		GR. BETA	46.0 ± 0.0	46.0 ± 5.0	37.3 - 54.7	pCi/l
WATER	JUN 1991	CO-60	11.3 ± 1.2	10.0 ± 5.0	1.3 - 18.7	pCi/l
		ZN-65	119.3 ± 16.3	108.0 ± 11.0	88.9 - 127.1	pCi/l
		RU-106	162.3 ± 19.0	149.0 ± 15.0	123.0 - 175.0	pCi/l
		CS-134	15.3 ± 1.2	15.0 ± 5.0	6.3 - 23.7	pCi/l
		CS-137	16.3 ± 1.2	14.0 ± 5.0	5.3 - 22.7	pCi/l
		BA-133	74.0 ± 6.9	62.0 ± 6.0	51.6 - 72.4	pCi/l[c]
WATER	JUN 1991	H-3	13470 ± 385.8	12480 ± 1248	10315 - 14645	pCi/l
WATER	JUL 1991	RA-226	14.9 ± 0.4	15.9 ± 2.4	11.7 - 20.1	pCi/l
		RA-228	17.6 ± 1.8	16.7 ± 4.2	9.4 - 24.0	pCi/l
WATER	JUL 1991	U	12.8 ± 0.1	14.2 ± 3.0	9.0 - 19.4	pCi/l
WATER	AUG 1991	I-131	19.3 ± 1.2	20.0 ± 6.0	9.6 - 30.4	pCi/l
WATER	AUG 1991	PU-239	21.4 ± 0.5	19.4 ± 1.9	16.1 - 22.7	pCi/l
AIR FILTER	AUG 1991	GR. ALPHA	33.0 ± 2.0	25.0 ± 6.0	14.6 - 35.4	pCi/Filter
		GR. BETA	88.7 ± 1.2	92.0 ± 10.0	80.4 - 103.6	pCi/Filter
		SR-90	27.0 ± 4.0	30.0 ± 5.0	21.3 - 38.7	pCi/Filter
		CS-137	26.3 ± 1.2	30.0 ± 5.0	21.3 - 38.7	pCi/Filter
WATER	SEP 1991	SR-89	47.0 ± 10.4	49.0 ± 5.0	40.3 - 57.7	pCi/l
		SR-90	24.0 ± 2.0	25.0 ± 5.0	16.3 - 33.7	pCi/l
WATER	SEP 1991	GR. ALPHA	12.0 ± 4.0	10.0 ± 5.0	1.3 - 18.7	pCi/l
		GR. BETA	20.3 ± 1.2	20.0 ± 5.0	11.3 - 28.7	pCi/l

TABLE B1 (Cont.)

EPA INTERCOMPARISON STUDY RESULTS
1991

SAMPLE TYPE	STUDY DATE	ANALYSIS	TIML RESULTS ± 2σ[a]	EPA RESULTS[b] 1s, N=1	CONTROL LIMITS	UNITS
MILK	SEP 1991	SR-89	20.3 ± 5.0	25.0 ± 5.0	16.3 - 33.7	pCi/l
		SR-90	19.7 ± 3.1	25.0 ± 5.0	16.3 - 33.7	pCi/l
		I-131	130.7 ± 16.8	108.0 ± 11.0	88.9 - 127.1	pCi/l[c]
		CS-137	33.7 ± 3.2	30.0 ± 5.0	21.3 - 38.7	pCi/l
		K	1743.3 ± 340.8	1740.0 ± 87.0	1589.1 - 1890.9	mg/l
WATER	OCT 1991	CO-60	29.7 ± 1.2	29.0 ± 5.0	20.3 - 37.7	pCi/l
		ZN-65	75.7 ± 8.3	73.0 ± 7.0	60.9 - 85.1	pCi/l
		RU-106	196.3 ± 15.1	199.0 ± 20.0	164.3 - 233.7	pCi/l
		CS-134	9.7 ± 1.2	10.0 ± 5.0	1.3 - 18.7	pCi/l
		CS-137	11.0 ± 2.0	10.0 ± 5.0	1.3 - 18.7	pCi/l
		BA-133	94.7 ± 3.1	98.0 ± 10.0	80.7 - 115.3	pCi/l
WATER	OCT 1991	H-3	2640.0 ± 156.2	2454.0 ± 352.0	1843.3 - 3064.7	pCi/l
WATER	OCT 1991	GR. ALPHA	73.0 ± 13.1	82.0 ± 21.0	45.6 - 118.4	pCi/l
		RA-226	20.9 ± 2.0	22.0 ± 3.3	16.3 - 27.7	pCi/l
		RA-228	19.6 ± ^.3	22.2 ± 5.6	12.5 - 30.9	pCi/l
		U	13.5 ± 0.6	13.5 ± 3.0	8.3 - 18.7	pCi/l
WATER	OCT 1991	GR. BETA	55.3 ± 3.1	65 0 ± 10.0	47.7 - 82.3	pCi/l
		SR-89	9.7 ± 3.1	10.0 ± 5.0	1.3 - 18.7	pCi/l
		SR-90	8.7 ± 1.2	10.0 ± 5.0	1.3 - 18.7	pCi/l
		CO-60	20.3 ± 1.2	20.0 ± 5.0	11.3 - 28.7	pCi/l
		CS-134	9.0 ± 5.3	10.0 ± 5.0	1.3 - 18.7	pCi/l
		CS-137	14.7 ± 5.0	11.0 ± 5.0	2.3 - 19.7	pCi/l
WATER	NOV 1991	RA-226	5.6 ± 1.2	6.5 ± 1.0	4.8 - 8.2	pCi/l
		RA-228	9.6 ± 0.5	8.1 ± 2.0	4.6 - 11.6	pCi/l
WATER	NOV 1991	U	24.7 ± 2.3	24.9 ± 3.0	19.7 - 30.1	pCi/l

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

b EPA results are presented as the known value and expected laboratory precision (1s, 1 determination) and control limits as defined by EPA.

c See Addendum to appendix B for explanation of the reason why the sample results were outside the control limits specified by EPA.

ADDENDUM TO APPENDIX B
1991

SAMPLE TYPE	STUDY DATE	ANALYSIS	EXPLANATION
AIR FILTER	MAR 1991	GR. ALPHA	The cause of the high result is the difference in geometry between the standard used in the TIML lab and EPA filter. No further actions required.
WATER	MAR 1991	RA-228	Sample lost during analyses. No data reported to EPA.
WATER	MAY 1990	GR. ALPHA	Sample was reanalyzed in triplicate. Results of reanalyses 13.4±1.0 pCi/l. no further action is planned.
WATER	JUN 1991	BA-133	Sample was reanalyzed. Results of the reanalyses were 63.8± 6.9 pCi/L within epa limit. The cause of the high result is unknown.
MILK	SEP 1991	I-131	The cause of the high result is unknown. Inhouse spike sample was prepared with activity of I-131 68.3±6.8pCi/L. Results of the analysis was 69.1±9.7pCi/L.

APPENDIX C

Isotopic Detection Limits

And

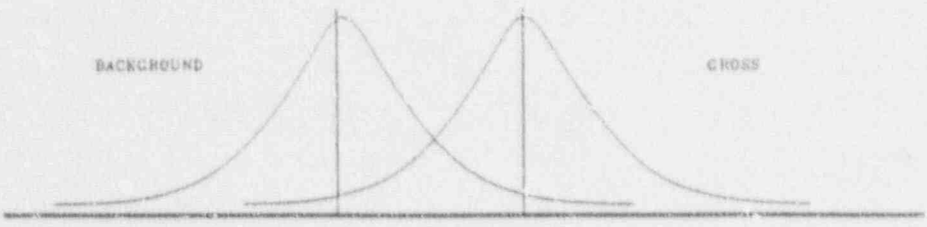
Activity Determinations

Isotopic Detection Limits and Activity Determinations

Making a reasonable estimate of the limits of detection for a counting procedure or a radiochemical method is usually complicated by the presence of significant background.

It must be considered that the background or blank is not a fixed value but that a series of replicates would be normally distributed. The desired net activity is thus the difference between the gross sample activity and background activity distributions.

The interpretation of this difference becomes a problem if the two distributions intersect as indicated in the diagram.



If a sufficient number of replicate analyses are run, it is to be expected that the results would fall in a normal Gaussian distribution. In routine analysis such replication is not carried out. Standard statistics allow an estimate of the probability of any particular deviation from the mean value. It is common practice to report the mean ± one or two standard deviations as the final result.

Analytical detection limits are governed by a number of factors including:

1. Sample Size

2. Counting Efficiency

   The fundamental quality in the measurement of a radioactive substance is the number of disintegrations per unit time. As with most physical measurements in analytical chemistry, it is seldom possible to make an absolute measurement of the disintegration rate, but rather, it is necessary to compare the sample with one or more standards. The standards determine the counter efficiency which may then be used to convert sample counts per minute (cpm) to disintegrations per minute (dpm).

3. Background Count Rate

Any counter will show a certain counting rate without a sample in position. This background counting rate comes from several sources: 1) natural environmental radiation from the surroundings, 2) cosmic radiation, and 3) the natural radioactivity in the counter material itself. The background counting rate will depend on the amounts of these types of radiation and sensitivity of the counter to the radiation.

4. Background and Sample Counting Time

The amount of time devoted to the counting of the background depends on the level of activity being measured. In general, with low level samples, this time should be about equal to that devoted to counting a sample.

5. Time Interval Between Sample Collection and Counting

Decay measurements are useful in identifying certain short-lived isotopes. This disintegration constant is one of the basic characteristics of a specific radionuclide and is readily determined, if the half-life is sufficiently short.

6. Chemical Recovery of the Analytical Procedures

Most radiochemical analyses are carried out in such a way that losses occur during the separations. These losses occur due to a large number of contaminants that may be present and interfere during chemical separations. Thus it is necessary to include a technique for estimating these losses in the development of the analytical procedure.

The following method was used to determine lower limit of detection (LLD) as per NRC Regulatory Guide 4.1, Rev. 1, "Program for Monitoring Radioactivity in the Environs of Nuclear Power Plants", and the NRC Branch Technical Position, November 1979, "An acceptable Radiological Environmental Monitoring Program". The LLD is defined, for purposes of this guide, as the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66 * s_b}{E * V * 2.22 * Y * \exp(-\lambda \Delta t)}$$

WHERE:

LLD = "A prior" lower limit of detection as defined above (as pCi per unit mass or volume).

s_b = Standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute).

E = Counting efficiency (as counts per disintegration).

V = Sample size (in units of mass or volume).

2.22 = Number of disintegrations per minute per picocurie.

Y = Fractional radiochemical yield (when applicable).

λ = Radioactive decay constant for the particular radioisotope.

Δt = Elapsed time between sample collection (or end of the sample collection period and time of counting.

The value of s_b used in the calculation of the LLD for a particular measurement system is based on the actual observed variance of the background counting rate, or, of the counting rate of the blank sample, (as appropriate), rather than on an unverified theoretically predicated variance.

In calculating the LLD for a radionuclide determined by gamma-ray spectrometry, the background included the typical contributions of other nuclides normally present in the samples.

Single Measurements

Each single measurement is reported as follows:

$$x \pm s$$

where x = value of the measurement;

s = 2 counting uncertainty (corresponding to the 95% confidence level).

In cases where the activity is found to be below the lower limit to detection L it is reported as

$$<L$$

where L = is the lower limit of detection based on 4.66 uncertainty for a background sample.

Duplicate Analysis

1. Individual result: $x_1 \pm s_1$

   $x_2 \pm s_2$

   Reported result: $x \pm s$

   where $x = (1/2)(x_1 + x_2)$

   $s = (1/2)\sqrt{s_1^2 + s_2^2}$

2. Individual results: $<L_1$

   $<L_2$

   Reported result $<L$

   where L = lower of L_1 and L_2

3. Individual results: $x \pm s$

   $<L$

   Reported result: $x \pm s$ if $x \geq L$,

   $<L$ otherwise

Computation of Averages and Standard Deviations

Averages and standard deviations listed in the tables are computed from all of the individual measurements over the period averaged; for example, an annual standard deviation would not be the average of quarterly standard deviations. The average x and standard deviation(s) of a set of n numbers x_1, x_2, ...

x_n are defined as follows:

$$\bar{X} = \frac{1}{n} \Sigma X$$

$$S = \sqrt{\frac{\Sigma (X-\bar{X})^2}{n-1}}$$

Values below the highest lower limi' of detection are not included in the average.

If all of the values in the averaging group are less than the highest LLD, the highest LLD is reported.

If all but one of the values are le-s than the highest LLD, the single value x and associated two sigma error is reported.

In rounding off, the following rules are followed:

1. If the figure following those to be retained is less than 5, the figure is dropped, and the retained figures are kept unchanged. As an example, 11.443 is rounded off to 11.44.

2. If the figure following those to be retained is greather than 5, the figure is dropped, and the last retained figure is raised by 1. As an example, 11.446 is rounded off to 11.45.

3. If the figure following those to be retained is 5, and if there are not figures other than zeros beyond the five, the figure 5 is dropped, and the last-place figure retained is increased by one if it is an c.f number or it is kept unchanged if an even number. As an example, 11.435 is rounded off to 11.44, while 11.425 is rounded off to 11.42.

APPENDIX D

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
ANNUAL SUMMARY
1991

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY

Name of Facility: Callaway Plant   Docket No.: 50-483

Location of Facility: Callaway County, Missouri (county, state)   Reporting Period: 1991

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPE AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION[1] (LLD)	ALL INDICATOR LOCATIONS MEAN (f)[2] RANGE	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE & DIRECTION	MEAN (f)[2] RANGE	CONTROL LOCATION MEAN (f)[2] RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Surface Water (pCi/l)	Gross Alpha (26)	0.9	3.2 (11/14) (1.5 - 7.8)	4.8 mi SE; 1.1 ft downstream of discharge	3.7 (9/12) (1.2 - 11.2)	3.7 (9/12) (1.2 - 11.2)	0
	Gross Beta (26)	--	7.4 (14/14) (4.7 - 13.6)	4.8 mi SE; 1.1 ft downstream of discharge	8.0 (12/12) (4.1 - 19.3)	8.0 (12/12) (4.1 - 19.3)	0
	H-3 (26)	159.0	244.4 (10/14) (133.0 - 500.0)	4.8 mi SE; 1.1 ft upstream of discharge	436.8 (4/12) (212.0 - 689.0)	436.8 (4/12) (212.0 - 689.0)	0
	Gamma (26)	--	-- (0/14)	NA	NA	-- (0/12)	0
	Sr-89 (26)	0.4	-- (0/14)	NA	NA	-- (0/12)	0
	Sr-90 (26)	0.3	0.6 (2/14) (0.4 - 0.7)	4.8 mi SE; 1.1 ft upstream of discharge	0.6 (4/12) (0.4 - 1.2)	0.6 (4/12) (0.4 - 1.2)	0
Ground Water (pCi/l)	Gross Alpha (21)	0.8	2.8 (8/14) (0.8 - 4.2)	5.1 mi SE; Portland, MO.	3.2 (6/8) (1.4 - 4.2)	2.1 (5/7) (1.6 - 2.6)	0

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY

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MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPE AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION[1] (LLD)	ALL INDICATOR LOCATIONS MEAN (f)[2] RANGE	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE & DIRECTION	MEAN (f)[2] RANGE	CONTROL LOCATION MEAN (f)[2] RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
	Gross Beta (21)	--	6.6 (14/14) (2.5 - 12.1)	1.0 mi SSE; Onsite well	11.4 (6/6) (9.8 - 12.1)	8.9 (7/7) (8.4 - 9.7)	0
	H-3 (21)	163.0	-- (0/14)	NA	NA	-- (0/7)	0
	Gamma (21)	--	-- (0/14)	NA	NA	-- (0/7)	0
	Sr-89 (21)	0.4	-- (0/14)	NA	NA	-- (0/7)	0
	Sr-90 (21)	0.3	0.7 (4/14) (0.4 - 1.3)	1.0 mi SSE; Onsite well	0.7 (4/6) (0.4 - 1.3)	-- (0/7) --	0
Bottom Sediment (pCi/kg)	Gross Alpha (4)	6276.0	12837.0 (2/2) (8466.0 - 17208.0)	5.1 mi SE; 1.0 mi down-stream of discharge	13891.0 (4/4) 11738.0-17062.0)	10930.0 (1/2) (10930.0 - 10930.0)	0
	Gross Beta (4)	--	22561.5 (2/2) (19022.0 - 26101.0)	4.9 mi SSE; 0.6 mi up-stream of discharge	24756.0 (2/2) 23088.0-26424.0)	24756.0 (2/2) (23088.0 - 26424.0)	0

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY

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MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPE AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION[1] (LLD)	ALL INDICATOR LOCATIONS MEAN (f)[2] RANGE	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE & DIRECTION	LOCATION WITH HIGHEST ANNUAL MEAN MEAN (f)[2] RANGE	CONTROL LOCATION MEAN (f)[2] RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
	Gamma (4)						
	Cs-137	21.9	99.7 (1/2) ---	5.1 mi SE; 1.0 mi down-stream of discharge	99.7 (1/2) ---	--- (0/4) ---	0
	Sr-89 (4)	11.5	-- (0/2)	NA	NA	-- (0/2)	0
	Sr-90 (4)	6.2	20.8 (2/2) (10.6 - 31.0)	5.1 mi SE; 1.0 mi down-stream of discharge	20.8 (2/2) (10.6 - 31.0)	9.7 (1/2) --	0
Shoreline Sediment (pCi/kg)	Gamma (4)						
	Cs-137	26.7	-- (0/2) --	4.9 mi SSE; 0.6 mi up-stream of discharge	111.0 (1/2) --	111.0 (1/2) --	0

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY

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Airborne Particulate (pCi/m³)	Gross Beta (259)	0.010	0.020 (206/207) (0.007 - 0.056)	0.9 mi NNE; Alternate Assembly Area	0.023 (52/52) (0.011 - 0.056)	0.015 (52/52) (0.004 - 0.035)	0
	Gamma (20) Be-7	--	0.051 (16/16) (0.025 - 0.068)	0.9 mi NNE; Alternate Assembly Area	0.060 (4/4) 0.051 - 0.067)	0.038 (4/4) (0.029 - 0.038)	0
	Sr-89 (20)	0.0002	-- (0/16)	NA	NA	-- (0/4)	0
	Sr-90 (20)	0.0001	-- (0/16)	NA	NA	-- (0/4)	0
Airborne Iodine (pCi/m³)	I-131 (259)	0.07	-- (0/207)	NA	NA	-- (0/52)	0

APPENDIX D (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY

Name of Facility: Callaway Plant Docket No.: 50-483

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MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPE AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION[1] (LLD)	ALL INDICATOR LOCATIONS MEAN (f)[2] RANGE	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE & DIRECTION	LOCATION WITH HIGHEST ANNUAL MEAN MEAN (f)[2] RANGE	CONTROL LOCATION MEAN (f)[2] RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Milk (pCi/l)	I-131 (31)	0.2	-- (0/13)	NA	NA	-- (0/18)	0
	Gamma (31) K-40		1757.7 (13/13) (1540.0 - 1910.0)	3.1 mi NW; Goats milk Schneiders farm	1757.7 (13/13) (1540.0 - 1910.0)	1247.2 (18/18) (920.0 - 1400.0)	0
	Sr-89 (31)	0.4	-- (0/13)	NA	NA	-- (0/18)	0
	Sr-90 (31)	--	5.8 (13/13) (1.6 - 10.2)	3.1 mi NW; Goats milk Schneiders farm	5.8 (13/13) (1.6 - 10.2)	3.3 (18/18) (1.7 - 5.3)	0
(grams/liter)	Ca (31)	--	0.93 (13/13) (0.75 - 1.14)	3.1 mi NW; Goats milk Schneiders farm	0.93 (13/13) (0.75 - 1.14)	0.88 (18/18) (0.63 - 1.12)	0
Fish (pCi/kg - wet)	Gross alpha (40)	32.0	83.6 (15/25) (44.0 - 174.0)	4.9 mi SSE; 0.6 mi up-stream of discharge	95.8 (6/15) (70.0 - 95.8)	95.8 (6/15) (70.0 - 95.8)	0

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY

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	Gross Beta (40)	--	2673.3 (25/25) (2155.0 - 3315.0)	4.9 mi SSE; 0.6 mi up-stream of discharge	2790.8 (15/15) (2376.0 - 3124.0)	2790.8 (15/15) (2376.0 - 3124.0)	0
	Gamma (40) K-40	--	2784.3 (25/25) (2250.0 - 3678.0)	53.0 mi ESE; 59.5 mi down-stream of discharge	2860.2 (10/10) (2250.0 - 3678.0)	2728.5 (15/15) (1970.0 - 3360.0)	0
	Sr-89 (40)	2.1	-- (0/25)	NA	NA	-- (0/15)	0
	Sr-90 (40)	1.2	-- (0/25)	4.9 mi SSE; 0.6 mi up-stream of discharge	3.2 (2/15) (3.1 - 3.4)	3.2 (2/15) (3.1 - 3.4)	0
Vegetation (pCi/kg - wet)	Gross Alpha (48)	42.0	209.5 (23/31) (77.0 - 453.0)	1.8 mi N; Meehan farm	237.2 (11/13) (77.0 - 453.0)	225.4 (9/17) (42.0 - 595.0)	0
	Gross Beta (48)	--	4416.8 (31/31) (1591.0 - 8772.0)	15.0 mi SW; Beazley farm	4718.5 (17/17) (2613.0 - 7687.0)	4718.5 (17/17) (2613.0 - 7687.0)	0
	I-131 (48)	8.8	-- (0/31)	NA	NA	-- (0/17)	0

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY

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	Gamma (48)						
	K-40	--	4385.5 (31/31) (1750.0 - 7440.0)	15.0 mi SW; Beazley farm	4967.6 (17/17) (2650.0 - 9430.0)	4967.6 (17/17) (2650.0 - 9430.0)	0
Soil (pCi/kg)	Gross Alpha (11)	--	14019.2 (10/10) (8645.0 - 17898.0)	1.50 mi NE; Forest ecology plot F8	17898.0 (1/1) --	10466.0 (1/1) --	0
	Gross Beta (11)	--	22271.3 (10/10) (17691.0 - 25605.0)	0.98 mi S; Forest ecology plot F1	25605.0 (1/1) --	19091.0 (1/1) --	0
	Gamma (11)						
	K-40	--	11026.7 (10/10) (9792.0 - 12220.0)	15.0 mi SW; Beazley farm	14900.0 (1/1) --	14900.0 (1/1) --	0
	Cs-137	--	1308.1 (10/10) (582.0 - 1869.0)	0.98 mi S; Forest ecology plot F1	1869.0 (1/1) --	375.0 (1/1) --	0

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Location of Facility: Callaway County, Missouri (county, state)   Reporting Period: 1991

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPE AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION[1] (LLD)	ALL INDICATOR LOCATIONS MEAN (f)[2] RANGE	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE & DIRECTION	MEAN (f)[2] RANGE	CONTROL LOCATION MEAN (f)[2] RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Direct Radiation (mRem/Standard Quarter)	Quarterly TLDs (207)	10	15.6 (199/199) (10.3 - 20.0)	4.2 mi NE; 0.3 mi N of HWY O on HWY D	17.7 (4/4) (15.4 - 20.0)	14.9 (8/8) (12.8 - 16.8)	0
	Annual TLDs (51)	10	17.2 (49/49) (10.8 – 28.8)	5.3 mi SE; 0.6 mi S of HWY D on HWY 94	28.8 (1/1) --	16.3 (2/2) (14.1– 18.5)	0

(1) The LLDs quoted are the lowest actual LLD obtained in the various media during the reporting period. The required LLDs for radiological environmental sample analysis is found in Table III. Where all nuclides were LLD for a specific media, no LLD was listed.

(2) Mean and range are based upon detectable measurements only. Fraction of detectable measurements is indicated in parentheses.

APPENDIX E

TELEDYNE ISOTOPES MIDWEST LABORATORY

DATA TABLES

APPENDIX E

LIST OF TABLES

Definition of the term used in the data tables are as follows:

Wet Weight	A reporting unit used with organic tissue samples such as vegetation and animal samples in which the amount of sample is taken to be the weight as received from the field with no moisture removed.
Dry Weight	A reporting unit used for soil and sediment in which the amount of sample is taken to be the weight of the sample after removal of moisture by drying in an oven.
pCi/m^3	A reporting unit used with air particulate and radioiodine data which refers to the radioactivity content expressed in picocuries per cubic meter of air passed through the filter and/or the charcoal trap. Note that the volume is not corrected to standard conditions.
Gamma Emitters or Gamma Isotopic	Samples were analyzed by high resolution (GeLi) gamma spectrometry. The resulting spectrum is analyzed by a computer program which scans from about 50 to 2000 KeV and lists the energy peaks of any nuclides present in concentrations exceeding the sensitivity limits set for that particular experiment.
Error Terms	Figures following " ± " are error terms based on counting uncertainties at the 95 percent confidence level. Values preceded by the "<" symbol were below the stated concentration at the 99 percent confidence level.
Sensitivity	In general, all analyses meet the sensitivity requirements of the program as given in Table 3.1. For the few samples that do not (because of inadequate sample quantities, analytical interference, etc.) the sensitivity actually obtained in the analysis is given.

TABLE F1

AIRBORNE IODINE 131 and GROSS BETA in AIR PARTICULATE FILTERS (pCi/m^3)
1991

COLLECTION DATE	CA-APT-A1 Vol. (M^3)	CA-APT-A1 GROSS BETA	CA-APT-A1 I-131	CA-APT-A7 Vol. (M^3)	CA-APT-A7 GROSS BETA	CA-APT-A7 I-131	CA-APT-A8 Vol. (M^3)	CA-APT-A8 GROSS BETA	CA-APT-A8 I-131	CA-APT-A9 Vol. (M^3)	CA-APT-A9 GROSS BETA	CA-APT-A9 I-131	CA-APT-B3 Vol. (M^3)	CA-APT-B3 GROSS BETA	CA-APT-B3 I-131
01/03/91	423	<0.002	<0.070	428	0.009 ± 0.002	<0.070	431	0.044 ± 0.003	<0.070	431	0.031 ± 0.003	<0.070	431	0.041 ± 0.003	<0.070
01/11/91	494	0.033 ± 0.003	<0.070	488	0.007 ± 0.001	<0.070	486	0.041 ± 0.003	<0.070	487	0.028 ± 0.003	<0.070	489	0.035 ± 0.003	<0.070
01/17/91	365	0.045 ± 0.004	<0.070	368	0.004 ± 0.002	<0.070	365	0.056 ± 0.004	<0.070	364	0.049 ± 0.004	<0.070	363	0.049 ± 0.004	<0.070
01/24/91	428	0.021 ± 0.002	<0.070	370	0.012 ± 0.002	<0.070	428	0.030 ± 0.003	<0.070	431	0.022 ± 0.002	<0.070	431	0.028 ± 0.003	<0.070
02/04/91	675	0.024 ± 0.002	<0.070	675	0.016 ± 0.002	<0.070	673	0.031 ± 0.003	<0.070	670	0.027 ± 0.002	<0.070	673	0.025 ± 0.002	<0.070
02/07/91	183	0.025 ± 0.005	<0.070	181	0.011 ± 0.004	<0.070	183	0.029 ± 0.005	<0.070	183	0.020 ± 0.004	<0.070	183	0.026 ± 0.005	<0.070
02/14/91	428	0.025 ± 0.003	<0.070	428	0.012 ± 0.002	<0.070	431	0.031 ± 0.003	<0.070	431	0.028 ± 0.003	<0.070	428	0.030 ± 0.003	<0.070
02/21/91	428	0.016 ± 0.002	<0.070	428	0.008 ± 0.002	<0.070	428	0.020 ± 0.003	<0.070	431	0.018 ± 0.002	<0.070	431	0.017 ± 0.002	<0.070
02/28/91	428	0.018 ± 0.002	<0.070	428	0.009 ± 0.002	<0.070	428	0.022 ± 0.003	<0.070	426	0.019 ± 0.002	<0.070	426	0.020 ± 0.002	<0.070
03/08/91	487	0.023 ± 0.002	<0.070	488	0.016 ± 0.002	<0.070	486	0.029 ± 0.003	<0.070	489	0.028 ± 0.003	<0.070	486	0.026 ± 0.002	<0.070
03/14/91	364	0.015 ± 0.003	<0.070	364	0.008 ± 0.002	<0.070	365	0.015 ± 0.003	<0.070	365	0.017 ± 0.003	<0.070	365	0.016 ± 0.003	<0.070
03/22/91	492	0.012 ± 0.002	<0.070	491	0.007 ± 0.002	<0.070	489	0.014 ± 0.002	<0.070	487	0.018 ± 0.002	<0.070	488	0.016 ± 0.002	<0.070
03/28/91	362	0.018 ± 0.002	<0.070	375	0.012 ± 0.002	<0.070	370	0.023 ± 0.003	<0.070	367	0.019 ± 0.003	<0.070	367	0.017 ± 0.002	<0.070
04/04/91	426	0.016 ± 0.002	<0.070	421	0.010 ± 0.002	<0.070	428	0.021 ± 0.002	<0.070	433	0.016 ± 0.002	<0.070	433	0.009 ± 0.002	<0.070
04/11/91	426	0.015 ± 0.002	<0.070	425	0.006 ± 0.002	<0.070	425	0.018 ± 0.002	<0.070	423	0.015 ± 0.002	<0.070	423	0.013 ± 0.002	<0.070
04/18/91	432	0.012 ± 0.002	<0.070	431	0.006 ± 0.001	<0.070	432	0.017 ± 0.002	<0.070	433	0.015 ± 0.002	<0.070	433	0.014 ± 0.002	<0.070
04/25/91	424	0.015 ± 0.002	<0.070	425	0.009 ± 0.002	<0.070	428	0.017 ± 0.002	<0.070	426	0.017 ± 0.002	<0.070	426	0.017 ± 0.002	<0.070
05/02/91	426	0.009 ± 0.002	<0.070	428	0.005 ± 0.002	<0.070	426	0.014 ± 0.002	<0.070	426	0.015 ± 0.002	<0.070	428	0.013 ± 0.002	<0.070
05/10/91	487	0.019 ± 0.002	<0.070	484	0.010 ± 0.002	<0.070	484	0.018 ± 0.002	<0.070	484	0.018 ± 0.002	<0.070	487	0.016 ± 0.002	<0.070
05/17/91	433	0.015 ± 0.002	<0.070	433	0.006 ± 0.002	<0.070	433	0.015 ± 0.002	<0.070	436	0.013 ± 0.002	<0.070	436	0.015 ± 0.002	<0.070
05/24/91	431	0.014 ± 0.002	<0.070	428	0.005 ± 0.002	<0.070	428	0.015 ± 0.002	<0.070	428	0.012 ± 0.002	<0.070	428	0.012 ± 0.002	<0.070
05/30/91	367	0.014 ± 0.002	<0.070	370	0.009 ± 0.002	<0.070	370	0.015 ± 0.002	<0.070	367	0.016 ± 0.003	<0.070	367	0.013 ± 0.002	<0.070
06/06/91	428	0.013 ± 0.002	<0.070	431	0.006 ± 0.001	<0.070	428	0.013 ± 0.002	<0.070	433	0.014 ± 0.002	<0.070	431	0.011 ± 0.002	<0.070
06/13/91	428	0.019 ± 0.002	<0.070	426	0.007 ± 0.002	<0.070	426	0.019 ± 0.002	<0.070	421	0.018 ± 0.002	<0.070	426	0.016 ± 0.002	<0.070
06/20/91	428	0.016 ± 0.003	<0.070	428	0.009 ± 0.002	<0.070	428	0.019 ± 0.003	<0.070	426	0.014 ± 0.002	<0.070	423	0.016 ± 0.003	<0.070
06/27/91	426	0.020 ± 0.003	<0.070	428	0.009 ± 0.002	<0.070	428	0.021 ± 0.003	<0.070	428	0.016 ± 0.002	<0.070	431	0.016 ± 0.002	<0.070

Notes:

TABLE E1 (Cont.)

AIRBORNE IODINE-131 and GROSS BETA in AIR PARTICULATE FILTERS (pCi/m^3)
1991

COLLECTION	CA-APT-A1			CA-APT-A7			CA-APT-A8			CA-APT-A9			CA-APT-B3		
DATE	Vol. (M^3)	GROSS BETA	I-131	Vol. (M^3)	GROSS BETA	I-131	Vol. (M^3)	GROSS BETA	I-131	Vol. (M^3)	GROSS BETA	I-131	Vol. (M^3)	GROSS BETA	I-131
07/05/91	492	0.017 ± 0.002	<0.070	489	0.005 ± 0.002	<0.070	489	0.018 ± 0.002	<0.070	492	0.019 ± 0.002	<0.070	492	0.017 ± 0.002	<0.070
07/11/91	336	0.014 ± 0.003	<0.070	367	0.013 ± 0.003	<0.070	367	0.011 ± 0.002	<0.070	367	0.015 ± 0.003	<0.070	367	0.016 ± 0.003	<0.070
07/18/91	431	0.020 ± 0.003	<0.070	428	0.019 ± 0.003	<0.070	150	0.022 ± 0.006	<0.070	428	0.019 ± 0.003	<0.070	428	0.017 ± 0.002	<0.070
07/25/91	426	0.024 ± 0.003	<0.070	426	0.021 ± 0.003	<0.070	359	0.025 ± 0.003	<0.070	428	0.025 ± 0.003	<0.070	426	0.020 ± 0.003	<0.070
08/01/91	428	0.021 ± 0.002	<0.070	428	0.021 ± 0.002	<0.070	428	0.020 ± 0.002	<0.070	428	0.021 ± 0.002	<0.070	428	0.012 ± 0.002	<0.070
08/08/91	428	0.030 ± 0.003	<0.070	428	0.027 ± 0.003	<0.070	426	0.032 ± 0.003	<0.070	426	0.029 ± 0.003	<0.070	428	0.024 ± 0.003	<0.070
08/15/91	431	0.019 ± 0.003	<0.070	431	0.021 ± 0.003	<0.070	431	0.015 ± 0.002	<0.070	431	0.021 ± 0.003	<0.070	431	0.014 ± 0.002	<0.070
08/22/91	426	0.022 ± 0.003	<0.070	426	0.024 ± 0.003	<0.070	428	0.020 ± 0.003	<0.070	428	0.023 ± 0.003	<0.070	428	0.017 ± 0.002	<0.070
08/29/91	428	0.033 ± 0.003	<0.070	431	0.035 ± 0.003	<0.070	428	0.032 ± 0.003	<0.070	428	0.036 ± 0.003	<0.070	428	0.025 ± 0.003	<0.070
09/05/91	426	0.016 ± 0.002	<0.070	418	0.016 ± 0.002	<0.070	421	0.016 ± 0.002	<0.070	423	0.011 ± 0.002	<0.070	423	0.008 ± 0.002	<0.070
09/12/91	431	0.024 ± 0.003	<0.070	428	0.021 ± 0.003	<0.070	428	0.027 ± 0.003	<0.070	431	0.021 ± 0.003	<0.070	431	0.009 ± 0.002	<0.070
09/19/91	431	0.014 ± 0.002	<0.070	431	0.018 ± 0.002	<0.070	431	0.016 ± 0.002	<0.070	431	0.014 ± 0.002	<0.070	431	0.013 ± 0.002	<0.070
09/26/91	421	0.011 ± 0.002	<0.070	423	0.015 ± 0.002	<0.070	423	0.016 ± 0.002	<0.070	421	0.018 ± 0.002	<0.070	421	0.007 ± 0.002	<0.070
10/03/91	433	0.014 ± 0.002	<0.070	433	0.020 ± 0.002	<0.070	433	0.020 ± 0.002	<0.070	436	0.014 ± 0.002	<0.070	436	0.011 ± 0.002	<0.070
10/10/91	426	0.019 ± 0.002	<0.070	426	0.019 ± 0.002	<0.070	426	0.023 ± 0.003	<0.070	426	0.021 ± 0.002	<0.070	426	0.014 ± 0.002	<0.070
10/16/91	0	ND	ND	370	0.018 ± 0.003	<0.070	372	0.016 ± 0.003	<0.070	372	0.018 ± 0.003	<0.070	370	0.016 ± 0.003	<0.070
10/24/91	487	0.021 ± 0.002	<0.070	489	0.022 ± 0.002	<0.070	487	0.024 ± 0.002	<0.070	484	0.0[illegible]3 ± 0.002	<0.070	487	0.015 ± 0.002	<0.070
10/31/91	428	0.014 ± 0.002	<0.070	428	0.018 ± 0.002	<0.070	426	0.017 ± 0.002	<0.070	428	0.018 ± 0.002	<0.070	428	0.010 ± 0.002	<0.070
11/07/91	436	0.026 ± 0.003	<0.070	436	0.034 ± 0.003	<0.070	438	0.038 ± 0.003	<0.070	436	0.036 ± 0.003	<0.070	436	0.020 ± 0.002	<0.070
11/14/91	423	0.021 ± 0.002	<0.070	421	0.027 ± 0.003	<0.070	421	0.029 ± 0.003	<0.070	421	0.023 ± 0.003	<0.070	421	0.016 ± 0.002	<0.070
11/21/91	431	0.025 ± 0.003	<0.070	431	0.029 ± 0.003	<0.070	431	0.033 ± 0.003	<0.070	433	0.027 ± 0.003	<0.070	433	0.017 ± 0.002	<0.070
11/27/91	354	0.015 ± 0.002	<0.070	364	0.019 ± 0.003	<0.070	362	0.022 ± 0.003	<0.070	359	0.016 ± 0.002	<0.070	362	0.013 ± 0.002	<0.070
12/05/91	489	0.019 ± 0.002	<0.070	487	0.022 ± 0.002	<0.070	492	0.022 ± 0.002	<0.070	492	0.025 ± 0.002	<0.070	492	0.015 ± 0.002	<0.070
12/12/91	428	0.022 ± 0.003	<0.070	428	0.022 ± 0.003	<0.070	428	0.027 ± 0.003	<0.070	431	0.026 ± 0.003	<0.070	42[illegible]	0.018 ± 0.002	<0.070
12/19/91	431	0.019 ± 0.003	<0.070	431	0.022 ± 0.003	<0.070	431	0.025 ± 0.003	<0.070	431	0.021 ± 0.003	<0.070	431	0.012 ± 0.002	<0.070
12/26/91	428	0.011 ± 0.002	<0.070	426	0.015 ± 0.002	<0.070	426	0.015 ± 0.002	<0.070	426	0.014 ± 0.002	<0.070	426	0.008 ± 0.002	<0.070

Notes: 1. ND = No Data. See section 2.3 for explination.

TABLE E2

AIRBORNE PARTICULATE - QUARTERLY COMPOSITES (pCi/m^3) 1991

JANUARY - MARCH 1991	CA-APT-A1	CA-APT-A7	CA-APT-A8	CA-APT-A9	CA-APT-B3
Volume (Cubic Feet):	5134	5084	5132	5131	5130
Analysis					
Sr-89	<0.0002	<0.0002	<0.0002	<0.0002	<0.0003
Sr-90	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Be-7	0.0590 ± 0.0110	0.0290 ± 0.0060	0.0670 ± 0.0110	0.0560 ± 0.0090	0.0680 ± 0.0110
Co-58	<0.0010	<0.0006	<0.0010	<0.0007	<0.0009
Co-60	<0.0008	<0.0008	<0.0008	<0.0007	<0.0008
Zr-95	<0.0017	<0.0011	<0.0016	<0.0008	<0.0017
Cs-134	<0.0008	<0.0004	<0.0008	<0.0006	<0.0007
Cs-137	<0.0009	<0.0006	<0.0008	<0.0005	<0.0008
Ba-La-140	<0.0011	<0.0011	<0.0012	<0.0010	<0.0018
Ce-144	<0.0042	<0.0016	<0.0038	<0.0019	<0.0038

APRIL - JUNE 1991	CA-APT-A1	CA-APT-A7	CA-APT-A8	CA-APT-A9	CA-APT-B3
Volume (Cubic Feet):	5562	5559	5564	5564	5572
Analysis					
Sr-89	<0.0003	<0.0004	<0.0003	<0.0003	<0.0003
Sr-90	<0.0001	<0.0002	<0.0001	<0.0002	<0.0002
Be-7	0.0590 ± 0.0090	0.0380 ± 0.0070	0.0580 ± 0.0110	0.0490 ± 0.0080	0.0440 ± 0.0120
Co-58	<0.0008	<0.0008	<0.0007	<0.0009	<0.0010
Co-60	<0.0006	<0.0005	<0.0006	<0.0007	<0.0009
Zr-95	<0.0011	<0.0013	<0.0020	<0.0016	<0.0020
Cs-134	<0.0006	<0.0005	<0.0007	<0.0007	<0.0006
Cs-137	<0.0005	<0.0004	<0.0005	<0.0007	<0.0008
Ba-La-140	<0.0016	<0.0020	<0.0028	<0.0020	<0.0022
Ce-144	<0.0019	<0.0015	<0.0042	<0.0037	<0.0041

Notes:

TABLE E2 (Cont.)

AIRBORNE PARTICULATE - QUARTERLY COMPOSITES (pCi/m^3) 1991

JULY - SEPTEMBER 1991	CA-APT-A1	CA-APT-A7	CA-APT-A8	CA-APT-A9	CA-APT-B3
Volume (Cubic Feet):	5968	5987	5642	5988	5998
Analysis					
Sr-89	<0.0003	<0.0003	<0.0003	<0.0004	<0.0003
Sr-90	<0.0002	<0.0001	<0.0001	<0.0002	<0.0002
Be-7	0.0470 ± 0.0080	0.0410 ± 0.0090	0.0510 ± 0.0070	0.0460 ± 0.0100	0.0250 ± 0.0050
Co-58	<0.0007	<0.0007	<0.0010	<0.0008	<0.0009
Co-60	<0.0007	<0.0006	<0.0007	<0.0008	<0.0006
Zr-95	<0.0015	<0.0016	<0.0017	<0.0014	<0.0015
Cs-134	<0.0005	<0.0006	<0.0008	<0.0006	<0.0006
Cs-137	<0.0007	<0.0007	<0.0008	<0.0007	<0.0007
Ba-La-140	<0.0017	<0.0018	<0.0014	<0.0016	<0.0014
Ce-144	<0.0036	<0.0038	<0.0051	<0.0034	<0.0043

OCTOBER - DECEMBER 1991	CA-APT-A1	CA-APT-A7	CA-APT-A8	CA-APT-A9	CA-APT-B3
Volume (Cubic Feet):	5187	5563	5568	5565	5566
Analysis					
Sr-89	<0.0003	<0.0002	<0.0002	<0.0002	<0.0002
Sr-90	<0.0003	<0.0002	<0.0002	<0.0002	<0.0002
Be-7	0.0470 ± 0.0100	0.0450 ± 0.0070	0.0650 ± 0.0120	0.0450 ± 0.0080	0.0300 ± 0.0050
Co-58	<0.0011	<0.0009	<0.0010	<0.0006	<0.0007
Co-60	<0.0009	<0.0007	<0.0012	<0.0008	<0.0007
Zr-95	<0.0020	<0.0014	<0.0019	<0.0014	<0.0011
Cs-134	<0.0007	<0.0006	<0.0010	<0.0006	<0.0005
Cs-137	<0.0011	<0.0006	<0.0011	<0.0006	<0.0006
Ba-La-140	<0.0023	<0.0011	<0.0022	<0.0011	<0.0010
Ce-144	<0.0052	<0.0039	<0.0054	<0.0022	<0.0022

Notes

TABLE E3

MILK (pCi/kg dry)
1991

Analysis	CA-MLK-M1 (01/08/91)	CA-MLK-M5B (01/08/91)
I-131	<0.4	ND
Sr-89	<0.4	ND
Sr-90	2.7 ± 0.4	ND
K-40	1260.0 ± 80.0	ND
Zn-65	<12.2	ND
Cs-134	<4.6	ND
Cs-137	<5.0	ND
Ba-La-140	<4.1	ND
Ca (g/l)	0.85	ND

Analysis	CA-MLK-M1 (02/12/91)	CA-MLK-M5B (02/12/91)
I-131	<0.2	ND
Sr-89	<0.4	ND
Sr-90	1.7 ± 0.4	ND
K-40	1160.0 ± 110.0	ND
Zn-65	<12.9	ND
Cs-134	<6.0	ND
Cs-137	<6.1	ND
Ba-La-140	<6.3	ND
Ca (g/l)	0.90	ND

Notes:
ND = No Data. See section 8.0 for explanation.

TABLE E3 (Cont.)

MILK (pCi/kg dry)
1991

Analysis	CA-MLK-M1 (03/13/91)	CA-MLK-M5B (03/13/91)
I-131	<0.3	ND
Sr-89	<0.5	ND
Sr-90	2.2 ± 0.5	ND
K-40	1020.0 ± 110.0	ND
Zn-65	<11.9	ND
Cs-134	<3.3	ND
Cs-137	<3.5	ND
Ba-La-140	<2.6	ND
Ca (g/l)	0.65	ND

Analysis	CA-MLK-M1 (04/09/91)	CA-MLK-M5B (04/09/91)
I-131	<0.3	ND
Sr-89	<0.5	ND
Sr-90	2.8 ± 0.6	ND
K-40	1370.0 ± 140.0	ND
Zn-65	<10.3	ND
Cs-134	<4.4	ND
Cs-137	<6.0	ND
Ba-La-140	<3.7	ND
Ca (g/l)	0.87	ND

Notes:
ND = No Data. See section 8.0 for explanation.

TABLE E3 (Cont.)

MILK (pCi/kg dry)
1991

Analysis	CA-MLK-M1 (04/23/91)	CA-MLK-M5B (04/23/91)
I-131	<0.3	ND
Sr-89	<0.6	ND
Sr-90	3.9 ± 0.6	ND
K-40	1330.0 ± 150.0	ND
Zn-65	<16.7	ND
Cs-134	<6.0	ND
Cs-137	<6.6	ND
Ba-La-140	<8.3	ND
Ca (g/l)	0.91	ND

Analysis	CA-MLK-M1 (05/14/91)	CA-MLK-M5B (05/12/91)
I-131	<0.4	<0.4
Sr-89	<0.5	<0.6
Sr-90	3.0 ± 0.5	4.2 ± 0.7
K-40	1370.0 ± 170.0	1630.0 ± 190.0
Zn-65	<22.8	<24.0
Cs-134	<6.5	<6.7
Cs-137	<6.5	<7.7
Ba-La-140	<8.3	<11.7
Ca (g/l)	0.93	1.01

Notes:
ND = No Data. See section 8.0 for explanation.

TABLE E3 (Cont.)

MILK (pCi/kg dry)
1991

Analysis	CA-MLK-M1 (05/28/91)	CA-MLK-M5B (05/27/91)
I-131	<0.3	<0.3
Sr-89	<0.6	<0.6
Sr-90	3.4 ± 0.6	7.5 ± 0.9
K-40	1210.0 ± 140.0	1580.0 ± 160.0
Zn-65	<14.4	<11.2
Cs-134	<4.3	<4.7
Cs-137	<4.4	<7.0
Ba-La-140	<2.0	<5.6
Ca (g/l)	0.89	0.91

Analysis	CA-MLK-M1 (06/11/91)	CA-MLK-M5B (06/09/91)
I-131	<0.2	<0.3
Sr-89	<0.6	<0.7
Sr-90	5.3 ± 0.7	5.4 ± 0.7
K-40	1270.0 ± 120.0	1720.0 ± 180.0
Zn-65	<13.5	<22.4
Cs-134	<4.7	<6.2
Cs-137	<5.6	<7.8
Ba-La-140	<3.8	<6.5
Ca (g/l)	0.88	0.90

Notes:

TABLE E3 (Cont.)

MILK (pCi/kg dry)
1991

Analysis	CA-MLK-M1 (06/27/91)	CA-MLK-M5B (06/24/91)
I-131	<0.2	<0.2
Sr-89	<1.0	<0.8
Sr-90	4.3 ± 0.8	7.4 ± 0.9
K-40	1300.0 ± 150.0	1770.0 ± 150.0
Zn-65	<13.6	<16.0
Cs-134	<5.1	<5.6
Cs-137	<5.0	<5.8
Ba-La-140	<4.6	<8.7
Ca (g/l)	0.95	0.91

Analysis	CA-MLK-M1 (07/09/91)	CA-MLK-M5B (07/08/91)
I-131	<0.3	<0.2
Sr-89	<0.5	<0.6
Sr-90	2.6 ± 0.5	8.4 ± 0.9
K-40	1330.0 ± 150.0	1540.0 ± 160.0
Zn-65	<17.1	<22.4
Cs-134	<5.6	<6.2
Cs-137	<6.1	<7.0
Ba-La-140	<7.9	<7.0
Ca (g/l)	0.86	0.87

Notes:

TABLE E3 (Cont.)

MILK (pCi/kg dry)
1991

Analysis	CA-MLK-M1 (07/23/91)	CA-MLK-M5B (07/21/91)
I-131	<0.4	<0.3
Sr-89	<0.6	<0.6
Sr-90	2.7 ± 0.5	3.4 ± 0.5
K-40	1330.0 ± 160.0	1850.0 ± 190.0
Zn-65	<20.5	<19.2
Cs-134	<5.9	<6.0
Cs-137	<6.7	<6.8
Ba-La-140	<7.9	<9.1
Ca (g/l)	1.12	1.1[illegible]

Analysis	CA-MLK-M1 (08/13/91)	CA-MLK-M5B (08/10/91)
I-131	<0.2	<0.4
Sr-89	<0.6	<0.6
Sr-90	4.1 ± 0.6	1.6 ± 0.4
K-40	1270.0 ± 60.0	1910.0 ± 100.0
Zn-65	<6.6	<10.2
Cs-134	<2.4	<3.5
Cs-137	<2.6	<3.7
Ba-La-140	<9.6	<14.9
Ca (g/l)	0.95	1.03

Notes:

TABLE E3 (Cont.)

MILK (pCi/kg dry)
1991

Analysis	CA-MLK-M1 (08/27/91)	CA-MLK-M5B (08/25/91)
I-131	<0.3	<0.4
Sr-89	<0.6	<0.6
Sr-90	3.9 ± 0.7	5.7 ± 0.8
K-40	1400.0 ± 160.0	1760.0 ± 180.0
Zn-65	<17.6	<22.7
Cs-134	<6.4	<5.9
Cs-137	<6.6	<7.2
Ba-La-140	<11.2	<14.2
Ca (g/l)	0.94	0.86

Analysis	CA-MLK-M1 (09/10/91)	CA-MLK-M5B (09/07/91)
I-131	<0.4	<0.3
Sr-89	<0.8	<0.6
Sr-90	2.3 ± 0.4	4.5 ± 0.6
K-40	1180.0 ± 110.0	1670.0 ± 180.0
Zn-65	<15.6	<18.6
Cs-134	<6.5	<6.8
Cs-137	<6.8	<7.5
Ba-La-140	<[illegible].8	<8.7
Ca (g/l)	1.00	1.01

Notes:

TABLE E3 (Cont.)

MILK (pCi/kg dry)
1991

Analysis	CA-MLK-M1 (09/27/91)	CA-MLK-M5B (09/27/91)
I-131	<0.4	<0.5
Sr-89	<1.3	<0.8
Sr-90	3.4 ± 0.9	6.2 ± 0.9
K-40	1230.0 ± 160.0	1840.0 ± 140.0
Zn-65	<15.0	<16.3
Cs-134	<4.7	<7.7
Cs-137	<5.3	<9.1
Ba-La-140	<6.0	<13.6
Ca (g/l)	0.80	0.86

Analysis	CA-MLK-M1 (10/08/91)	CA-MLK-M5B (10/06/91)
I-131	<0.3	<0.5
Sr-89	<0.8	<1.0
Sr-90	4.5 ± 0.6	10.2 ± 1.0
K-40	1260.0 ± 150.0	1860.0 ± 160.0
Zn-65	<13.3	<15.8
Cs-134	<4.4	<4.8
Cs-137	<5.2	<7.9
Ba-La-140	<4.8	<5.1
Ca (g/l)	0.91	0.75

Notes:

TABLE E3 (Cont.)

MILK (pCi/kg dry)
1991

Analysis	CA-MLK-M1 (11/12/91)	CA-MLK-M5B (11/10/91)
I-131	<0.2	<0.2
Sr-89	<0.6	<0.5
Sr-90	3.0 ± 0.6	5.1 ± 0.6
K-40	1240.0 ± 160.0	1810.0 ± 130.0
Zn-65	<24.0	<12.5
Cs-134	<7.2	<4.9
Cs-137	<8.5	<5.8
Ba-La-140	<8.5	<5.6
Ca (g/l)	0.86	0.90

Analysis	CA-MLK-M1 (12/10/91)	CA-MLK-M5B (12/08/91)
I-131	<0.2	<0.3
Sr-89	<0.6	<0.7
Sr-90	2.9 ± 0.5	5.9 ± 0.9
K-40	920.0 ± 100.0	1910.0 ± 190.0
Zn-65	<15.0	<24.7
Cs-134	<5.2	<7.4
Cs-137	<6.1	<7.4
Ba-La-140	<5.1	<10.5
Ca (g/l)	0.63	0.88

Notes:

TABLE E4

VEGETATION (pCi/kg wet)
1991

Analysis	CA-FPL-V3 MUSTARD GREENS (05/28/91)	CA-FPL-V3 TURNIP GREENS (05/28/91)	CA-FPL-V3 SPINACH (05/28/91)
Gross Alpha	121.0 ± 82.0	<106.0	117.0 ± 56.0
Gross Beta	4268.0 ± 201.0	4486.0 ± 195.0	6042.0 ± 243.0
I-131	<24.2	<16.4	<41.4
K-40	3392.0 ± 400.0	3600.0 ± 275.0	6530.0 ± 401.0
Mn-54	<18.3	<12.1	<23.7
Co-58	<16.6	<12.9	<25.0
Co-60	<14.1	<15.7	<22.0
Cs-134	<13.7	<9.2	<20.8
Cs-137	<16.7	<10.1	<24.4

Analysis	CA-FPL-V3 LETTUCE (05/28/91)	CA-FPL-V6 SPINACH (05/29/91)	CA-FPL-V6 TURNIP GREENS (05/29/91)
Gross Alpha	235.0 ± 109.0	99.0 ± 80.0	179.0 ± 69.0
Gross Beta	3969.0 ± 184.0	4860.0 ± 198.0	4096.0 ± 131.0
I-131	<43.5	<28.0	<15.5
K-40	3390.0 ± 322.0	5905.0 ± 555.0	3695.0 ± 231.0
Mn-54	<24.4	<16.7	<13.7
Co-58	<27.0	<18.8	<13.1
Co-60	<22.8	<20.0	<16.1
Cs-134	<19.6	<17.4	<9.6
Cs-137	<23.4	<17.7	<12.1

Notes:

TABLE E4 (Cont.)

VEGETATION (pCi/kg wet)
1991

Analysis	CA-FPL-V6 MUSTARD GREENS (05/29/91)	CA-FPL-V6 CABBAGE (05/29/91)	CA-FPL-V6 LETTUCE (05/29/91)
Gross Alpha	81.0 ± 42.0	87.0 ± 65.0	127.0 ± 59.0
Gross Beta	2159.0 ± 88.0	2909.0 ± 143.0	3185.0 ± 117.0
I-131	<22.6	<24.2	<22.0
K-40	3206.0 ± 396.0	3503.0 ± 415.0	3050.0 ± 334.0
Mn-54	<16.0	<18.7	<14.5
Co-58	<17.4	<19.7	<14.0
Co-60	<17.7	<21.0	<14.8
Cs-134	<12.4	<11.7	<12.5
Cs-137	<17.1	<11.5	<12.9

Analysis	CA-FPL-V7 LETTUCE (05/29/91)	CA-FPL-V7 MUSTARD GREENS (05/29/91)	CA-FPL-V3 SPINACH (06/11/91)
Gross Alpha	91.0 ± 69.0	233.0 ± 115.0	<120.0
Gross Beta	3932.0 ± 170.0	4487.0 ± 200.0	6398.0 ± 260.0
I-131	<27.0	<20.6	<30.8
K-40	3596.0 ± 321.0	3270.0 ± 342.0	9430.0 ± 754.0
Mn-54	<13.2	<15.8	<24.2
Co-58	<14.3	<16.1	<24.0
Co-60	<12.2	<21.7	<27.6
Cs-134	<10.7	<11.3	<19.9
Cs-137	<13.2	<14.1	<24.8

Notes:

TABLE E4 (Cont.)

VEGETATION (pCi/kg wet)
1991

Analysis	CA-FPL-V3 TURNIP GREENS (06/11/91)	CA-FPL-V3 CABBAGE (06/11/91)	CA-FPL-V3 MUSTARD GREENS (06/11/91)
Gross Alpha	<165.0	<51.0	<122.0
Gross Beta	6177.0 ± 306.0	2613.0 ± 112.0	4904.0 ± 232.0
I-131	<20.7	<16.4	<10.5
K-40	5650.0 ± 267.0	2680.0 ± 158.0	5657.0 ± 266.0
Mn-54	<15.9	<12.1	<8.5
Co-58	<16.1	<12.4	<8.4
Co-60	<15.3	<10.8	<9.2
Cs-134	<13.8	<10.5	<6.2
Cs-137	<16.2	<12.8	<10.5

Analysis	CA-FPL-V3 LETTUCE (06/11/91)	CA-FPL-V6 TURNIP GREENS (06/11/91)	CA-FPL-V6 MUSTARD GREENS (06/11/91)
Gross Alpha	239.0 ± 111.0	<123.0	<129.0
Gross Beta	4439.0 ± 193.0	5286.0 ± 215.0	5379.0 ± 229.0
I-131	<9.7	<10.4	<19.1
K-40	4530.0 ± 248.0	4440.0 ± 271.0	6187.0 ± 323.0
Mn-54	<7.7	<10.6	<11.4
Co-58	<7.8	<10.7	<11.0
Co-60	<8.3	<11.5	<11.8
Cs-134	<6.6	<7.8	<9.9
Cs-137	<7.6	<9.4	<12.1

Notes:

TABLE E4 (Cont.)

VEGETATION (pCi/kg wet)
1991

Analysis	CA-FPL-V6 LETTUCE (06/11/91)	CA-FPL-V6 CABBAGE (06/11/91)	CA-FPL-V7 CABBAGE (06/11/91)
Gross Alpha	176.0 ± 101.0	156.0 ± 47.0	366.0 ± 156.0
Gross Beta	6206.0 ± 237.0	2944.0 ± 97.0	3903.0 ± 214.0
I-131	<41.8	<8.8	<30.3
K-40	6876.0 ± 850.0	3810.0 ± 138.0	4050.0 ± 284.0
Mn-54	<32.4	<5.8	<19.6
Co-58	<32.3	<5.8	<18.1
Co-60	<34.5	<7.0	<18.0
Cs-134	<30.6	<6.2	<17.9
Cs-137	<30.9	<6.3	<18.2

Analysis	CA-FPL-V3 CABBAGE (07/09/91)	CA-FPL-V6 MUSTARD GREENS (07/22/91)	CA-FPL-V6 CABBAGE (07/22/91)
Gross Alpha	<46.0	131.0 ± 56.0	<65.0
Gross Beta	2664.0 ± 96.0	4542.0 ± 122.0	2425.0 ± 110.0
I-131	<20.7	<41.4	<26.4
K-40	2650.0 ± 350.0	4230.0 ± 403.0	2900.0 ± 321.0
Mn-54	<18.9	<27.1	<21.7
Co-58	<17.2	<26.7	<22.1
Co-60	<19.7	<26.3	<21.4
Cs-134	<16.1	<28.0	<20.2
Cs-137	<17.4	<29.9	<22.8

Notes:

TABLE E4 (Cont.)

VEGETATION (pCi/kg wet)
1991

Analysis	CA-FPL-V6 TURNIPS (07/22/91)	CA-FPL-V7 CABBAGE (07/09/91)	CA-FPL-V7 TURNIPS (07/09/91)
Gross Alpha	179.0 ± 118.0	133.0 ± 73.0	265.0 ± 124.0
Gross Beta	4795.0 ± 235.0	3182.0 ± 126.0	3357.0 ± 175.0
I-131	<43.5	<31.1	<21.1
K-40	4240.0 ± 469.0	2760.0 ± 314.0	5406.0 ± 443.0
Mn-54	<30.0	<20.5	<12.5
Co-58	<31.4	<20.5	<11.1
Co-60	<27.8	<23.9	<14.5
Cs-134	<31.0	<21.8	<9.4
Cs-137	<37.1	<26.2	<15.5

Analysis	CA-FPL-V3 TURNIP GREENS (08/13/91)	CA-FPL-V3 LETTUCE (08/13/91)	CA-FPL-V6 TURNIPS (08/12/91)
Gross Alpha	<172.0	262.0 ± 127.0	202.0 ± 118.0
Gross Beta	5579.0 ± 241.0	5150.0 ± 227.0	6125.0 ± 248.0
I-131	<17.6	<33.8	<32.2
K-40	6360.0 ± 466.0	4880.0 ± 755.0	6240.0 ± 828.0
Mn-54	<18.1	<42.5	<42.0
Co-58	<20.2	<42.9	<47.8
Co-60	<24.5	<44.6	<53.7
Cs-134	<15.3	<34.9	<32.7
Cs-137	<17.5	<38.3	<43.3

Notes:

TABLE E4 (Cont.)

VEGETATION (pCi/kg wet)
1991

Analysis	CA-FPL-V6 CABBAGE (08/12/91)	CA-FPL-V7 CABBAGE (08/13/91)	CA-FPL-V7 TURNIPS (08/13/91)
Gross Alpha	<54.0	100.0 ± 58.0	372.0 ± 120.0
Gross Beta	3395.0 ± 132.0	2936.0 ± 122.0	5035.0 ± 178.0
I-131	<13.7	<12.4	<16.8
K-40	3650.0 ± 408.0	1750.0 ± 253.0	4135.0 ± 343.0
Mn-54	<18.9	<14.6	<24.1
Co-58	<22.1	<14.8	<24.9
Co-60	<25.2	<17.8	<25.5
Cs-134	<14.5	<12.1	<19.6
Cs-137	<20.4	<12.7	<25.3

Analysis	CA-FPL-V3 LETTUCE (09/10/91)	CA-FPL-V3 TURNIP GREENS (09/10/91)	CA-FPL-V3 LETTUCE (10/09/91)
Gross Alpha	126.0 ± 63.0	292.0 ± 124.0	<42.0
Gross Beta	3698.0 ± 135.0	5158.0 ± 209.0	3465.0 ± 101.0
I-131	<24.7	<21.7	<26.3
K-40	3500.0 ± 452.0	4090.0 ± 394.0	5550.0 ± 535.0
Mn-54	<20.4	<15.7	<23.4
Co-58	<24.6	<16.4	<19.8
Co-60	<25.2	<18.0	<24.2
Cs-134	<18.2	<15.4	<19.2
Cs-137	<22.7	<15.3	<19.4

Notes:

TABLE E4 (Cont.)

VEGETATION (pCi/kg wet)
1991

Analysis	CA-FPL-V3 TURNIP GREENS (10/08/91)	CA-FPL-V6 MUSTARD GREENS (10/06/91)	CA-FPL-V6 TURNIPS (10/06/91)
Gross Alpha	42.0 ± 25.0	<78.0	<92.0
Gross Beta	3518.0 ± 70.0	5115.0 ± 192.0	5019.0 ± 172.0
I-131	<34.4	<35.4	<30.1
K-40	5690.0 ± 622.0	4440.0 ± 501.0	4360.0 ± 431.0
Mn-54	<32.8	<23.7	<18.1
Co-58	<27.6	<22.0	<20.1
Co-60	<34.2	<22.7	<18.8
Cs-134	<23.4	<19.9	<17.6
Cs-137	<30.6	<21.0	<17.5

Analysis	CA-FPL-V7 LETTUCE (10/08/91)	CA-FPL-V7 CABBAGE (10/08/91)	CA-FPL-V7 TURNIP (10/08/91)
Gross Alpha	<64.0	<114.0	159.0 ± 50.0
Gross Beta	4028.0 ± 120.0	4200.0 ± 195.0	2017.0 ± 67.0
I-131	<24.3	<22.2	<27.4
K-40	3930.0 ± 416.0	3410.0 ± 395.0	5040.0 ± 448.0
Mn-54	<18.6	<19.9	<17.4
Co-58	<19.2	<18.2	<18.5
Co-60	<22.1	<20.9	<17.3
Cs-134	<16.6	<16.0	<16.0
Cs-137	<18.1	<19.8	<17.2

Notes:

TABLE E4 (Cont.)

VEGETATION (pCi/kg wet)
1991

Analysis	CA-FPL-V7 MUSTARD (10/08/91)	CA-FPL-V3 MUSTARD GREENS (11/05/91)	CA-FPL-V6 TURNIP GREENS (11/04/91)
Gross Alpha	360.0 ± 154.0	595.0 ± 227.0	377.0 ± 111.0
Gross Beta	7323.0 ± 253.0	7687.0 ± 316.0	6386.0 ± 183.0
I-131	<29.8	<15.7	<22.9
K-40	5020.0 ± 493.0	6870.0 ± 397.0	5910.0 ± 300.0
Mn-54	<21.0	<13.0	<19.4
Co-58	<22.5	<12.8	<13.9
Co-60	<20.2	<12.9	<16.1
Cs-134	<19.4	<11.7	<12.0
Cs-137	<20.2	<12.1	<13.2

Analysis	CA-FPL-V6 MUSTARD GREENS (11/04/91)	CA-FPL-V7 MUSTARD GREENS (11/05/91)	CA-FPL-V7 CABBAGE (11/05/91)
Gross Alpha	416.0 ± 178.0	453.0 ± 202.0	77.0 ± 32.0
Gross Beta	7333.0 ± 294.0	8772.0 ± 355.0	1591.0 ± 58.0
I-131	<19.6	<16.0	<13.3
K-40	6410.0 ± 327.0	7440.0 ± 442.0	3090.0 ± 274.0
Mn-54	<11.0	<13.4	<9.8
Co-58	<11.4	<13.1	<10.4
Co-60	<11.6	<14.3	<11.0
Cs-134	<10.9	<11.2	<9.9
Cs-137	<10.9	<12.4	<10.5

Notes:

TABLE E5

SOIL (pCi/kg dry)
1991

Analysis	CA-SOL-F1 (12/17/91)	CA-SOL-F2 (12/17/91)	CA-SOL-F6 (12/17/91)
Gross Alpha	14052.0 ± 4212.0	11805.0 ± 5579.0	15414.0 ± 4078.0
Gross Beta	25605.0 ± 2733.0	21282.0 ± 3531.0	17691.0 ± 2094.0
K-40	11520.0 ± 1271.0	12220.0 ± 1008.0	11000.0 ± 641.0
Mn-54	<60.0	<53.4	<35.5
Co-58	<52.9	<43.6	<37.0
Co-60	<68.1	<56.1	<40.3
Cs-134	<51.8	<47.8	<47.9
Cs-137	1869.0 ± 132.0	1524.0 ± 106.0	582.0 ± 44.0

Analysis	CA-SOL-F8 (12/17/91)	CA-SOL-F9 (12/17/91)	CA-SOL-PR10 (12/17/91)
Gross Alpha	17898.0 ± 4708.0	17421.0 ± 3954.0	11752.0 ± 5410.0
Gross Beta	23881.0 ± 2605.0	24038.0 ± 2224.0	23048.0 ± 3361.0
K-40	9792.0 ± 786.0	10745.0 ± 549.0	11440.0 ± 1055.0
Mn-54	<45.4	<42.1	<48.6
Co-58	<36.7	<37.9	<53.3
Co-60	<44.3	<43.8	<50.8
Cs-134	<37.0	<37.0	<52.5
Cs-137	1713.0 ± 95.0	1719.0 ± 64.0	1255.0 ± 110.0

Notes:

TABLE E5 (Cont.)

SOIL (pCi/kg dry)
1991

Analysis	CA-SOL-PR3 (12/17/91)	CA-SOL-PR4 (12/17/91)	CA-SOL-PR5 (12/17/91)
Gross Alpha	8645.0 ± 3720.0	15758.0 ± 6100.0	14715.0 ± 5803.0
Gross Beta	19236.0 ± 2340.0	22505.0 ± 3536.0	23255.0 ± 3488.0
K-40	10100.0 ± 668.0	11150.0 ± 1002.0	11400.0 ± 890.0
Mn-54	<38.1	<45.4	<43.6
Co-58	<41.2	<45.4	<34.0
Co-60	<46.5	<51.[illegible]	<54.0
Cs-134	<51.2	<51.0	<40.0
Cs-137	868.0 ± 58.0	1011.0 ± 103.0	1150.0 ± 87.0

Analysis	CA-SOL-PR7 (12/17/91)	CA-SOL-V3 (12/17/91)
Gross Alpha	12732.0 ± 3792.0	10466.0 ± 3882.0
Gross Beta	22172.0 ± 2267.0	19091.0 ± 2502.0
K-40	10900.0 ± 800.0	14900.0 ± 912.0
Mn-54	<43.7	<39.9
Co-58	<49.3	<46.5
Co-60	<56.5	<62.5
Cs-134	<64.6	<59.1
Cs-137	1390.0 ± 79.0	375.0 ± 43.0

Notes:
ND = No Data. See section 2.3 for explanation.

TABLE E6

SURFACE WATER (pCi/l)
1991

Analysis	CA-SWA-S01 (01/08/91)	CA-SWA-S02 (01/08/91)	CA-SWA-S03 (01/31/91)
Gross Alpha	2.1 ± 1.1	2.8 ± 1.5	1.8 ± 0.6
Gross Beta	6.7 ± 0.8	5.8 ± 1.0	6.1 ± 0.6
H-3	<173.0	216.0 ± 94.0	<174.0
Sr-89	<0.6	<0.6	<0.7
Sr-90	<0.4	<0.6	<0.5
Mn-54	<7.9	<7.8	<4.9
Fe-59	<28.5	<14.4	<10.4
Co-58	<9.6	<7.7	<4.7
Co-60	<11.2	<7.2	<6.2
Zr-Nb-95	<13.4	<13.2	<9.1
Cs-134	<8.9	<8.1	<4.2
Cs-137	<7.6	<8.3	<4.4
Ba-La-140	<11.5	<10.9	<12.4

Analysis	CA-SWA-S01 (02/12/91)	CA-SWA-S02 (02/12/91)	CA-SWA-S03 (02/08/91)
Gross Alpha	<0.9	2.6 ± 0.5	3.8 ± 0.7
Gross Beta	4.1 ± 0.6	7.3 ± 0.4	6.8 ± 0.6
H-3	<174.0	133.0 ± 65.0	<174.0
Sr-89	<0.5	<0.4	<0.7
Sr-90	<0.5	<0.3	<0.6
Mn-54	<1.7	<2.3	<3.9
Fe-59	<3.5	<5.0	<9.3
Co-58	<1.5	<2.4	<3.9
Co-60	<1.7	<2.4	<3.3
Zr-Nb-95	<2.9	<4.2	<8.8
Cs-134	<1.5	<2.9	<3.3
Cs-137	<1.8	<2.8	<4.0
Ba-La-140	<1.4	<3.3	<3.8

Notes:

TABLE E6 (Cont.)

SURFACE WATER (pCi/l)
1991

Analysis	CA-SWA-SO1 (03/12/91)	CA-SWA-SO2 (03/12/91)
Gross Alpha	1.2 ± 0.8	2.2 ± 0.8
Gross Beta	7.1 ± 0.6	7.5 ± 0.6
H-3	<179.0	173.0 ± 95.0
Sr-89	<1.2	<0.7
Sr-90	<0.9	0.7 ± 0.3
Mn-54	<3.1	<6.3
Fe-59	<6.0	<12.8
Co-58	<3.2	<6.2
Co-60	<3.6	<8.3
Zr-Nb-95	<5.5	<11.3
Cs-134	<3.8	<5.3
Cs-137	<3.9	<6.3
Ba-La-140	<4.2	<7.0

Analysis	CA-SWA-SO1 (04/09/91)	CA-SWA-SO2 (04/09/91)
Gross Alpha	2.9 ± 1.4	1.8 ± 1.2
Gross Beta	7.0 ± 1.0	6.5 ± 1.0
H-3	<163.0	182.0 ± 91.0
Sr-89	<0.5	<0.6
Sr-90	<0.4	<0.5
Mn-54	<7.6	<6.2
Fe-59	<14.2	<14.5
Co-58	<7.4	<5.8
Co-60	<6.9	<7.0
Zr-Nb-95	<14.2	<12.3
Cs-134	<7.5	<5.7
Cs-137	<7.3	<6.4
Ba-La-140	<6.0	<10.1

Notes:
ND = No Data. See section 8.0 for expanation.

TABLE E6 (Cont.)

SURFACE WATER (pCi/l)
1991

Analysis	CA-SWA-S01 (05/14/91)	CA-SWA-S02 (05/14/91)
Gross Alpha	6.9 ± 1.9	1.6 ± 1.2
Gross Beta	8.4 ± 1.2	6.4 ± 1.0
H-3	456.0 ± 116.0	199.0 ± 106.0
Sr-89	<0.5	<0.5
Sr 90	<0.4	<0.4
Mn-54	<6.2	<5.9
Fe-59	<12.3	<14.6
Co-58	<7.1	<5.9
Co-60	<7.9	<8.1
Zr-Nb-95	<12.1	<9.3
Cs-134	<4.9	<5.1
Cs-137	<5.5	<6.0
Ba-La-140	<12.8	<8.7

Analysis	CA-SWA-S01 (06/11/91)	CA-SWA-S02 (06/11/91)
Gross Alpha	2.7 ± 1.5	3.1 ± 1.2
Gross Beta	7.6 ± 1.1	7.7 ± 0.8
H-3	689.0 ± 113.0	<177.0
Sr-89	<0.7	<0.8
Sr-90	0.5 ± 0.3	<0.4
Mn-54	<8.6	<6.9
Fe-59	<13.7	<13.1
Co-58	<8.1	<6.2
Co-60	<7.8	<6.4
Zr-Nb-95	<13.3	<10.5
Cs-134	<6.1	<5.1
Cs-137	<6.4	<5.8
Ba-La-140	<11.0	<11.5

Notes:
ND = No Data. See section 8.0 for expanation.

TABLE E6 (Cont.)

SURFACE WATER (pCi/l)
1991

Analysis	CA-SWA-SO1 (07/09/91)	CA-SWA-SO2 (07/09/91)
Gross Alpha	11.2 ± 4.6	7.8 ± 2.2
Gross Beta	19.3 ± 1.8	12.6 ± 1.3
H-3	390.0 ± 104.0	<183.0
Sr-89	<1.1	<1.2
Sr-90	1.2 ± 0.6	<0.4
Mn-54	<5.0	<4.6
Fe-59	<11.9	<12.3
Co-58	<5.2	<5.4
Co-60	<6.0	<5.3
Zr-Nb-95	<8.4	<10.0
Cs-134	<5.1	<5.4
Cs-137	<5.3	<5.4
Ba-La-140	<8.1	<12.2

Analysis	CA-SWA-SO1 (08/13/91)	CA-SWA-SO2 (08/13/91)
Gross Alpha	<2.1	2.6 ± 1.7
Gross Beta	7.0 ± 1.2	7.2 ± 1.2
H-3	<183.0	339.0 ± 104.0
Sr-89	<0.6	<0.6
Sr-90	<0.4	<0.4
Mn-54	<6.6	<7.4
Fe-59	<14.4	<14.3
Co-58	<8.4	<7.6
Co-60	<8.2	<6.7
Zr-Nb-95	<14.1	<13.8
Cs-134	<6.9	<8.1
Cs-137	<7.8	<8.6
Ba-La-140	<9.4	<10.4

Notes:
ND = No Data. See section 8.0 for expanation.

TABLE E6 (Cont.)

SURFACE WATER (pCi/l)
1991

Analysis	CA-SWA-S01 (09/11/91)	CA-SWA-S02 (09/11/91)
Gross Alpha	2.8 ± 1.4	<1.8
Gross Beta	12.4 ± 1.4	5.2 ± 1.0
H-3	212.0 ± 98.0	222.0 ± 98.0
Sr-89	<0.8	<1.0
Sr-90	0.4 ± 0.3	<0.6
Mn-54	<7.3	<7.3
Fe-59	<16.7	<15.8
Co-58	<6.7	<8.0
Co-60	<8.0	<7.7
Zr-Nb-95	<14.1	<13.7
Cs-134	<6.5	<7.0
Cs-137	<7.0	<8.0
Ba-La-140	<14.8	<10.1

Analysis	CA-SWA-S01 (10/09/91)	CA-SWA-S02 (10/09/91)
Gross Alpha	1.3 ± 0.7	5.6 ± 1.5
Gross Beta	5.7 ± 0.6	13.6 ± 1.0
H-3	<182.0	196.0 ± 98.0
Sr-89	<1.1	<1.0
Sr-90	<0.5	<0.4
Mn-54	<6.8	<9.2
Fe-59	<18.5	<18.3
Co-58	<6.9	<8.7
Co-60	<7.3	<8.1
Zr-Nb-95	<13.7	<14.6
Cs-134	<5.9	<7.8
Cs-137	<7.5	<9.5
Ba-La-140	<8.4	<13.3

Notes:
ND = No Data. See section 8.0 for expanation.

TABLE E6 (Cont.)

SURFACE WATER (pCi/l)
1991

Analysis	CA-SWA-SO1 (11/12/91)	CA-SWA-SO2 (11/12/91)
Gross Alpha	<2.2	<2.2
Gross Beta	5.0 ± 1.3	4.7 ± 1.3
H-3	<161.0	500.0 ± 100.0
Sr-89	<0.8	<0.8
Sr-90	0.4 ± 0.2	0.4 ± 0.2
Mn-54	<4.6	<6.3
Fe-59	<10.4	<9.7
Co-58	<4.9	<5.7
Co-60	<4.7	<6.1
Zr-Nb-95	<7.7	<8.9
Cs-134	<4.3	<5.5
Cs-137	<4.9	<6.7
Ba-La-140	<5.3	<5.8

Analysis	CA-SWA-SO1 (12/10/91)	CA-SWA-SO2 (12/10/91)
Gross Alpha	1.8 ± 1.2	<2.6
Gross Beta	5.3 ± 1.0	6.1 ± 1.1
H-3	<159.0	284.0 ± 90.0
Sr-89	<0.7	<0.6
Sr-90	<0.6	<0.4
Mn-54	<6.8	<6.8
Fe-59	<13.8	<15.0
Co-58	<7.2	<7.0
Co-60	<7.6	<6.8
Zr-Nb-95	<11.9	<14.7
Cs-134	<5.8	<6.8
Cs-137	<6.5	<8.3
Ba-La-140	<13.0	<11.3

Notes:
ND = No Data. See section 8.0 for expanation.

TABLE E7

GROUND WATER (pCi/l)
1991

Analysis	CA-WWA-D01 (01/08/91)	CA-WWA-F15 (01/08/91)	CA-WWA-F05 (01/08/91)
Gross Alpha	4.2 ± 1.0	ND	ND
Gross Beta	3.4 ± 0.5	ND	ND
H-3	<173.0	ND	ND
Sr-89	<0.6	ND	ND
Sr-90	<0.4	ND	ND
Mn-54	<4.8	ND	ND
Fe-59	<9.8	ND	ND
Co-58	<5.0	ND	ND
Co-60	<5.3	ND	ND
Zr-Nb-95	<9.8	ND	ND
Cs-134	<5.6	ND	ND
Cs-137	<5.3	ND	ND
Ba-La-140	<10.1	ND	ND

Analysis	CA-WWA-D01 (02/12/91)	CA-WWA-F15 (02/12/91)	CA-WWA-F05 (02/12/91)
Gross Alpha	1.4 ± 0.7	1.6 ± 0.7	1.9 ± 0.7
Gross Beta	3.4 ± 0.6	8.7 ± 0.7	11.9 ± 0.7
H-3	<174.0	<174.0	<174.0
Sr-89	<0.5	<0.6	<0.5
Sr-90	<0.4	<0.5	<0.4
Mn-54	<3.2	<6.3	<4.1
Fe-59	<6.7	<12.4	<9.5
Co-58	<3.6	<6.4	<4.0
Co-60	<3.6	<5.4	<4.9
Zr-Nb-95	<6.4	<11.2	<7.3
Cs-134	<5.0	<6.0	<4.0
Cs-137	<3.8	<6.4	<3.8
Ba-La-140	<4.7	<4.6	<5.6

Notes:
ND = No Data, See section 8.0 for explanation

TABLE E7 (Cont.)

GROUND WATER (pCi/l)
1991

Analysis	CA-WWA-D01 (03/12/91)	CA-WWA-F15 (03/12/91)	CA-WWA-F05 (03/12/91)
Gross Alpha	4.0 ± 1.0	1.8 ± 0.6	0.8 ± 0.6
Gross Beta	3.2 ± 0.6	9.3 ± 0.5	11.2 ± 0.7
H-3	<179.0	<179.0	<179.0
Sr-89	<0.7	<0.6	<0.7
Sr-90	<0.5	<0.5	1.3 ± 0.4
Mn-54	<6.5	<4.4	<3.7
Fe-59	<11.3	<10.2	<9.3
Co-58	<6.9	<5.1	<3.8
Co-60	<5.4	<4.9	<3.9
Zr-Nb-95	<13.4	<9.2	<6.8
Cs-134	<7.1	<4.3	<2.8
Cs-137	<6.8	<4.6	<4.3
Ba-La-140	<5.0	<3.4	<1.7

Analysis	CA-WWA-D01 (04/09/91)	CA-WWA-F15 (04/09/91)	CA-WWA-F05 (04/09/91)
Gross Alpha	3.7 ± 1.0	2.6 ± 1.4	<1.9
Gross Beta	2.8 ± 0.6	8.5 ± 1.1	9.8 ± 1.2
H-3	<168.0	<168.0	<163.0
Sr-89	<0.6	<0.6	<0.5
Sr-90	<0.5	<0.5	0.4 ± 0.2
Mn-54	<6.3	<6.9	<6.8
Fe-59	<11.2	<13.2	<12.5
Co-58	<7.0	<6.5	<7.0
Co-60	<6.1	<8.3	<6.4
Zr-Nb-95	<10.1	<11.3	<13.4
Cs-134	<7.8	<6.6	<6.7
Cs-137	<5.8	<6.4	<7.5
Ba-La-140	<9.6	<10.4	<5.3

Notes:

TABLE E7 (Cont.)

GROUND WATER (pCi/l)
1991

Analysis	CA-WWA-D01 (05/14/91)	CA-WWA-F15 (05/17/91)	CA-WWA-F05 (05/14/91)
Gross Alpha	3.6 ± 1.8	2.5 ± 1.1	ND
Gross Beta	3.1 ± 0.7	9.7 ± 0.8	ND
H-3	<197.0	<197.0	ND
Sr-89	<0.6	<0.4	ND
Sr-90	<0.4	<0.3	ND
Mn-54	<6.9	<8.2	ND
Fe-59	<13.7	<13.5	ND
Co-58	<7.1	<8.4	ND
Co-60	<6.3	<5.8	ND
Zr-Nb-95	<13.8	<13.0	ND
Cs-134	<8.5	<7.3	ND
Cs-137	<7.4	<7.8	ND
Ba-La-140	<6.6	<6.7	ND

Analysis	CA-WWA-D01 (07/09/91)	CA-WWA-F15 (07/09/91)	CA-WWA-F05 (07/09/91)
Gross Alpha	<1.8	<1.6	<1.3
Gross Beta	3.2 ± 0.8	9.0 ± 0.7	12.1 ± 1.1
H-3	<183.0	<183.0	<183.0
Sr-89	<1.1	<0.8	<1.0
Sr-90	<0.5	<0.4	0.5 ± 0.3
Mn-54	<5.4	<5.8	<4.7
Fe-59	<11.6	<13.5	<11.4
Co-58	<5.[illegible]	<6.7	<5.4
Co-60	<4.[illegible]	<6.8	<6.5
Zr-Nb-95	<9.6	<11.7	<9.9
Cs-134	<5.7	<5.9	<5.1
Cs-137	<4.9	<6.6	<5.4
Ba-La-140	<11.2	<13.4	<9.2

Notes:
ND = No Data, See section 8.0 for explanation

TABLE E7 (Cont.)

GROUND WATER (pCi/l)
1991

Analysis	CA-WWA-D01 (08/13/91)	CA-WWA-F15 (08/13/91)	CA-WWA-F05 (08/13/91)
Gross Alpha	2.4 ± 1.6	<2.0	<2.2
Gross Beta	2.8 ± 1.1	8.4 ± 1.1	12.1 ± 1.4
H-3	<183.0	<183.0	<183.0
Sr-89	<0.8	<0.6	<0.6
Sr-90	<0.5	<0.4	0.6 ± 0.3
Mn-54	<9.3	<7.0	<7.4
Fe-59	<15.9	<16.5	<17.3
Co-58	<8.8	<7.1	<8.2
Co-60	<6.4	<5.7	<8.2
Zr-Nb-95	<14.8	<14.1	<15.0
Cs-134	<9.1	<6.9	<8.2
Cs-137	<9.2	<7.1	<8.3
Ba-La-140	<10.9	<9.7	<11.1

Analysis	CA-WWA-D01 (10/09/91)	CA-WWA-F15 (10/09/91)	CA-WWA-F05 (10/09/91)
Gross Alpha	<1.2	2.1 ± 0.9	<0.8
Gross Beta	2.5 ± 0.6	9.0 ± 0.7	11.5 ± 0.8
H-3	<182.0	<182.0	<182.0
Sr-89	<1.0	<1.0	<1.0
Sr-90	<0.4	<0.4	<0.5
Mn-54	<7.7	<4.4	<4.4
Fe-59	<18.2	<11.5	<9.0
Co-58	<6.3	<4.8	<4.7
Co-60	<7.8	<4.4	<4.2
Zr-Nb-95	<14.0	<8.4	<8.3
Cs-134	<7.3	<4.8	<4.5
Cs-137	<6.7	<4.3	<5.0
Ba-La-140	<7.8	<10.6	<8.4

Notes:

TABLE E8

BOTTOM SEDIMENT (pCi/kg dry)
1991

Analysis	CA-AQS-A (04/29/91)	CA-AQS-C (04/29/91)
Gross Alpha	10930 ± 3763	8466 ± 2615
Gross Beta	23088 ± 2757	19022 ± 1863
Sr-89	<11.8	<11.5
Sr-90	9.7 ± 5.2	10.6 ± 4.4
Mn-54	<56.9	<49.4
Fe-59	<147.0	<116.7
Co-58	<49.0	<42.8
Co-60	<73.9	<56.3
Zr-Nb-95	<101.8	<90.8
Cs-134	<53.5	<36.0
Cs-137	<67.0	<50.7
Ba-La-140	<138.7	<104.9

Analysis	CA-AQS-A (10/29/91)	CA-AQS-C (10/29/91)
Gross Alpha	<6276	17208 ± 6127
Gross Beta	26424 ± 3756	26101 ± 3592
Sr-89	<16.2	<17.7
Sr-90	<6.2	31.0 ± 7.3
Mn-54	<25.0	<25.2
Fe-59	<73.5	<78.3
Co-58	<26.7	<30.4
Co-60	<31.1	<28.5
Zr-Nb-95	<52.2	<54.5
Cs-134	<19.5	<35.7
Cs-137	<21.9	99.7 ± 18.0
Ba-La-140	<72.3	<181.0

Notes:

TABLE E9

SHORELINE SEDIMENT (pCi/kg dry)
1991

Analysis	CA-AQS-A (04/29/91)	CA-AQS-C (04/29/91)
Mn-54	<38.9	<42.5
Fe-59	<99.5	<106.7
Co-58	<33.6	<48.1
Co-60	<48.0	<54.8
Zr-Nb-95	<80.0	<96.1
Cs-134	<31.1	<40.8
Cs-137	111.0 ± 46.0	<49.4
Ba-La-140	<65.8	<114.6

Analysis	CA-AQS-A (10/29/91)	CA-AQS-C (10/29/91)
Mn-54	<29.1	<37.3
Fe-59	<97.2	<171.6
Co-58	<35.6	<56.6
Co-60	<29.8	<43.4
Zr-Nb-95	<71.5	<113.5
Cs-134	<41.9	<32.9
Cs-137	<26.7	<39.7
Ba-La-140	<393.0	<373.8

Notes:

TABLE E10

FISH, CA-AQF-A (pCi/kg WET)
1991

Analysis	FRESHWATER DRUM (01/31/91)	RIVER CARPSUCKER (01/31/91)	GIZZARD SHAD (01/31/91)	CHANNEL CATFISH (01/31/91)	BLUE CATFISH (01/31/91)
Gross Alpha	<0.0	<0.0	<0.0	<0.0	<0.0
Gross Beta	<0.0	<0.0	<0.0	<0.0	<0.0
Sr-89	ND	ND	ND	ND	ND
Sr-90	ND	ND	ND	ND	ND
K-40	<0.0	<0.0	<0.0	<0.0	<0.0
Mn-54	<0.0	<0.0	<0.0	<0.0	<0.0
Fe-59	<0.0	<0.0	<0.0	<0.0	<0.0
Co-58	<0.0	<0.0	<0.0	<0.0	<0.0
Co-60	<0.0	<0.0	<0.0	<0.0	<0.0
Cs-134	<0.0	<0.0	<0.0	<0.0	<0.0
Cs-137	<0.0	<0.0	<0.0	<0.0	<0.0

Analysis	SHORTHEAD REDHORSE (02/05/91)	GOLDEYE (02/05/91)	RIVER CARPSUCKER (02/05/91)	GIZZARD SHAD (02/05/91)	SMALLMOUTH BUFFALO (02/05/91)
Gross Alpha	<47.0	100.0 ± 53.0	70.0 ± 50.0	<67.0	<60.0
Gross Beta	2638.0 ± 124.0	2376.0 ± 114.0	2545.0 ± 119.0	2776.0 ± 130.0	3124.0 ± 141.0
Sr-89	<7.2	<3.3	<9.1	<2.3	<3.8
Sr-90	<5.6	<2.5	<6.9	<1.8	<2.6
K-40	3157.0 ± 432.0	1970.0 ± 226.0	2395.0 ± 407.0	2962.0 ± 299.0	2147.0 ± 426.0
Mn-54	<17.1	<11.0	<20.6	<14.8	<15.7
Fe-59	<41.9	<30.3	<54.8	<30.0	<45.2
Co-58	<17.4	<13.3	<16.2	<13.9	<17.6
Co-60	<20.6	<11.5	<21.6	<14.1	<19.3
Cs-134	<12.5	<12.5	<16.3	<10.9	<14.9
Cs-137	<18.6	<12.2	<18.0	<14.6	<17.1

Notes:
ND = No Data. See section 8.0 for explanation.

TABLE E10 (Cont.)

FISH, CA-AQF-A (pCi/kg WET) 1991

Analysis	CARP (04/29/91)	FLATHEAD CATFISH (04/29/91)	BLUE CATFISH (04/29/91)	RIVER CARPSUCKER (04/29/91)	FRESHWATER DRUM (04/29/91)
Gross Alpha	<39.0	<5[illegible].0	118.0 ± 44.0	<54.0	<77.0
Gross Beta	2814.0 ± 63.0	2867.0 ± 85.0	3121.0 ± 90.0	3036.0 ± 103.0	2726.0 ± 121.0
Sr-89	<2.8	<2.4	<3.4	<4.4	<2.6
Sr-90	<1.7	<1.4	<2.2	3.4 ± 1.8	<1.5
K-40	2855.0 ± 220.0	2600.0 ± 428.0	2980.0 ± 358.0	2921.0 ± 296.0	3004.0 ± 485.0
Mn-54	<29.1	<20.6	<19.0	<14.3	<23.7
Fe-59	<82.6	<64.0	<62.4	<44.2	<88.1
Co-58	<32.6	<25.3	<19.7	<16.2	<20.7
Co-60	<25.3	<19.7	<19.1	<14.1	<25.2
Cs-134	<24.6	<17.3	<14.3	<12.0	<17.5
Cs-137	<28.5	<18.4	<15.7	<12.6	<16.7

Analysis	CHANNEL CATFISH (10/30/91)	CARP (10/30/91)	FRESHWATER DRUM (10/30/91)	RIVER CARPSUCKER (10/30/91)	LARGEMOUTH BUFFALO (10/30/91)
Gross Alpha	105.0 ± 51.0	95.0 ± 50.0	<47.0	87.0 ± 60.0	<54.0
Gross Beta	2877.0 ± 116.0	2764.0 ± 85.0	2489.0 ± 105.0	2698.0 ± 124.0	[illegible]1.0 ± 110.0
Sr-89	<3.9	<4.5	<4.5	<5.4	<5.8
Sr-90	<1.8	<1.9	3.1 ± 1.4	<2.4	<2.3
K-40	2598.0 ± 356.0	2630.0 ± 416.0	3360.0 ± 393.0	2670.0 ± 258.0	2678.0 ± 432.0
Mn-54	<15.2	<21.8	<20.5	<16.4	<24.8
Fe-59	<63.7	<100.2	<94.0	<57.8	<86.2
Co-58	<20.5	<26.2	<28.2	<20.0	<15.8
Co-60	<14.4	<23.5	<[illegible]7.9	<14.5	<17.3
Cs-134	<12.5	<17.8	<22.9	<12.3	<15.1
Cs-137	<11.6	<22.1	<20.0	<14.0	<18.4

Notes:

TABLE E10 (Cont.)

FISH, CA-AQF-C (pCi/kg WET)
1991

Analysis	FRESHWATER DRUM (01/31/91)	RIVER CARPSUCKER (01/31/91)	GIZZARD SHAD (01/31/91)	CHANNEL CATFISH (01/31/91)	BLUE CATFISH (01/31/91)
Gross Alpha	<0.0	<0.0	<0.0	<0.0	<0.0
Gross Beta	<0.0	<0.0	<0.0	<0.0	<0.0
Sr-89	ND	ND	ND	ND	ND
Sr-90	ND	ND	ND	ND	ND
K-40	<0.0	<0.0	<0.0	<0.0	<0.0
Mn-54	<0.0	<0.0	<0.0	<0.0	<0.0
Fe-59	<0.0	<0.0	<0.0	<0.0	<0.0
Co-58	<0.0	<0.0	<0.0	<0.0	<0.0
Co-60	<0.0	<0.0	<0.0	<0.0	<0.0
Cs-134	<0.0	<0.0	<0.0	<0.0	<0.0
Cs-137	<0.0	<0.0	<0.0	<0.0	<0.0

Analysis	GIZZARD SHAD (02/05/91)	CARP (02/05/91)	GOLDEYE (02/05/91)	QUILLBACK (02/05/91)	SHORTHEAD REDHORSE (02/05/91)
Gross Alpha	<60.0	60.0 ± 41.0	<36.0	48.0 ± 23.0	93.0 ± 40.0
Gross Beta	2611.0 ± 126.0	272[illegible].0 ± 118.0	2210.0 ± 84.0	2611.0 ± 62.0	2623.0 ± 90.0
Sr-89	<5.8	<3.6	<3.1	<3.6	<3.5
Sr-90	<4.5	<2.8	<2.4	<3.0	<2.8
K-40	2810.0 ± 345.0	[illegible]620.0 ± 358.0	2461.0 ± 256.0	2535.0 ± 202.0	2930.0 ± 363.0
Mn-54	<16.7	<17.4	<11.1	<14.7	<19.1
Fe-59	<43.9	<45.4	<29.0	<39.4	<48.9
Co-58	<21.4	<19.0	<9.7	<15.7	<21.2
Co-60	<17.1	<18.9	<13.5	<14.6	<18.8
Cs-134	<16.4	<16.2	<9.6	<15.0	<22.2
Cs-137	<17.7	<16.9	<11.7	<15.2	<21.1

Notes:
ND = No Data. See section 8.0 for explanation.

TABLE E10 (Cont.)

FISH, CA-AQF-C (pCi/kg WET)
1991

Analysis	CHANNEL CATFISH (04/29/91)	FLATHEAD CATFISH (04/29/91)	CARP (04/29/91)	FRESHWATER DRUM (04/29/91)	RIVER CARPSUCKER (04/29/91)
Gross Alpha	72.0 ± 32.0	98.0 ± 53.0	46.0 ± 29.0	94.0 ± 38.0	70.0 ± 38.0
Gross Beta	2392.0 ± 70.0	2732.0 ± 116.0	2570.0 ± 76.0	2635.0 ± 76.0	2207.0 ± 79.0
Sr-89	<4.0	<13.6	<2.1	<2.6	<4.3
Sr-90	<2.6	<8.2	<1.4	<1.6	<2.9
K-40	237[illegible] ± 66.0	2980.0 ± 44[illegible].0	3130.0 ± 364.0	3050.0 ± 333.0	2350.0 ± 289.0
Mn-54	<24.7	<30.8	<17.6	<32.6	<15.7
Fe-59	<62.3	<95.7	<38.8	<85.5	<43.8
Co-58	<1[illegible].9	<34.6	<18.5	<33.2	<17.2
Co-60	<25.8	<30.8	<16.7	<22.9	<18.3
Cs-134	<16.5	<21.6	<14.0	<27.9	<14.9
Cs-137	<22.4	<21.9	<16.0	<27.9	<16.1

Analysis	CHANNEL CATFISH (10/30/91)	CARP (10/30/91)	FRESHWATER DRUM (10/30/91)	RIVER CARPSUCKER (10/30/91)	LARGEMOUTH BUFFALO (10/30/91)
Gross Alpha	<64.0	<54.0	103.0 ± 55.0	174.0 ± 76.0	<64.0
Gross Beta	2623.0 ± 95.0	2924.0 ± 82.0	2672.0 ± 116.0	2842.0 ± 122.0	2679.0 ± 101.0
Sr-89	<4.9	<5.5	<4.1	<2.6	<5.0
Sr-90	<2.3	<2.5	<[illegible].7	<1.2	<2.2
K-40	2907.0 ± 404.0	2500.0 ± 266.0	2440.0 ± 339.0	2660.0 ± 304.0	3233.0 ± 487.0
Mn-54	<[illegible]4.0	<[illegible]7.0	<21.2	<17.3	<22.0
Fe-59	<60.8	<63.2	<79.8	<59.7	<90.5
Co-58	<23.3	<23.1	<27.6	<21.7	<28.5
Co-60	<14.3	<16.[illegible]	<23.6	<20.0	<18.8
Cs-134	<12.0	<14.[illegible]	<1[illegible].8	<13.7	<17.6
Cs-137	<16.3	<14.1	<17.8	<14.8	<21.9

Notes:

TABLE E10 (Cont.)

FISH, CA-AQF-D (pCi/kg WET)
1991

Analysis	FRESHWATER DRUM (01/18/91)	RIVER CARPSUCKER (01/18/91)	GIZZARD SHAD (01/18/91)	CHANNEL CATFISH (01/18/91)	BLUE CATFISH (01/18/91)
Gross Alpha	<34.0	44.0 ± 30.0	[illegible]0.0 ± 44.0	59.0 ± 20.0	57.0 ± 28.0
Gross Beta	2749.0 ± 81.0	2849.0 ± 79.0	3315.0 ± 104.0	[illegible]856.0 ± 53.0	2751.0 ± 74.[illegible]
Sr-89	<8.0	<3.3	<10.0	<3.4	<7.1
Sr-90	<7.3	<2.6	<8.7	<2.7	<6.6
K-40	2805.0 ± 326.0	2910.0 ± 338.0	2750.0 ± 270.0	3678.0 ± 288.0	2510.0 ± 230.0
Mn-54	<12.9	<16.9	<11.8	<20.3	<10.7
Fe-59	<40.6	<37.6	<35.1	<33.6	<27.9
Co-58	<12.4	<15.2	<13.1	<18.8	<10.8
Co-60	<13.8	<16.4	<12.3	<22.8	<12.0
Cs-134	<10.1	<13.6	<13.8	<19.2	<9.9
Cs-137	<13.3	<13.8	<13.6	<23.8	<11.4

Analysis	RIVER CARPSUCKER ([illegible]6/91)	GIZZARD SHAD (02/06/91)	BLUE CATFISH (02/06/91)	LARGEMOUTH BUFFALO (02/06/91)	SHORTNOSE GAR (02/06/91)
Gross Alpha	[illegible] ± 75.0	<81.0	<32.0	<49.0	<47.0
Gross Beta	[illegible] ± 136.0	2717.0 ± 143.0	2630.0 ± 79.0	2595.0 ± 127.0	2155.0 ± 104.0
Sr-89	[illegible]	<2.5	<9.6	<3.3	<5.1
Sr-90	[illegible]	<1.7	<6.5	<2.2	<4.0
K-40	2948.0 ± 310.0	2724.0 ± 382.0	2250.0 ± 315.0	2937.0 ± 435.0	3090.0 ± 343.0
Mn-54	<14.4	<9.9	<32.7	<20.1	<16.7
Fe-59	<41.1	<53.2	<81.0	<55.[illegible]	<37.7
Co-58	<14.7	<15.2	<36.7	<15.9	<17.4
Co-60	<12.4	<16.8	<26.8	<17.8	<20.6
Cs-134	<12.8	<13.2	<23.6	<16.8	<14.7
Cs-137	<13.5	<14.0	<29.7	<18.5	<16.6

Notes:

TABLE E11

THERMOLUMINESCENT DOSIMETRY
1991

LOCATION CODE	FIRST QUARTER FIELD TIME (DAYS)	FIRST QUARTER TOTAL EXPOSURE (MREM ± 2σ)	FIRST QUARTER NET EXPOSURE (MREM/STD QTR ± 2σ)	SECOND QUARTER FIELD TIME (DAYS)	SECOND QUARTER TOTAL EXPOSURE (MREM ± 2σ)	SECOND QUARTER NET EXPOSURE (MREM/STD QTR ± 2σ)	THIRD QUARTER FIELD TIME (DAYS)	THIRD QUARTER TOTAL EXPOSURE (MREM ± 2σ)	THIRD QUARTER NET EXPOSURE (MREM/STD QTR ± 2σ)	FOURTH QUARTER FIELD TIME (DAYS)	FOURTH QUARTER TOTAL EXPOSURE (MREM ± 2σ)	FOURTH QUARTER NET EXPOSURE (MREM/STD QTR ± 2σ)	ANNUAL FIELD TIME (DAYS)	ANNUAL TOTAL EXPOSURE (MREM ± 2σ)	ANNUAL NET EXPOSURE (MREM/STD QTR ± 2σ)
CA-IDM-01	78.0	13.4 ± 0.7	15.4 ± 0.8	89.0	15.1 ± 0.6	15.3 ± 0.6	104	17.3 ± 0.2	15.0 ± 0.1	95.0	17.7 ± 4.0	16.8 ± 3.8	366	75.4 ± 9.0	18.5 ± 2.2
CA-IDM-02	78.0	14.5 ± 0.3	16.7 ± 0.4	89.0	15.5 ± 0.3	15.7 ± 0.3	104	16.8 ± 0.6	14.5 ± 0.5	95.0	15.7 ± 0.8	14.9 ± 0.7	366	73.1 ± 2.1	18.0 ± 0.5
CA-IDM-03	78.0	15.2 ± 1.5	17.6 ± 1.8	89.0	16.6 ± 0.8	16.8 ± 0.8	104	18.0 ± 0.7	15.6 ± 0.6	94.9	16.5 ± 0.7	15.6 ± 0.7	366	80.6 ± 3.5	19.8 ± 0.9
CA-IDM-04	78.0	12.6 ± 0.7	14.5 ± 0.8	89.0	14.3 ± 0.8	14.5 ± 0.8	104	15.1 ± 0.8	13.1 ± 0.7	94.7	14.2 ± 0.2	13.5 ± 0.2	366	56.5 ± 3.6	13.9 ± 0.1
CA-IDM-05	78.0	11.9 ± 0.5	13.8 ± 0.6	89.0	12.8 ± 0.7	13.9 ± 0.7	104	14.6 ± 0.6	12.7 ± 0.5	94.9	13.1 ± 0.4	12.5 ± 0.4	366	60.5 ± 2.6	14.9 ± 0.6
CA-IDM-06	78.0	14.6 ± 0.7	16.9 ± 0.8	89.9	15.7 ± 0.7	15.8 ± 0.7	104	17.8 ± 0.8	15.4 ± 0.7	94.9	16.2 ± 0.7	15.3 ± 0.6	366	64.7 ± 0.9	15.9 ± 0.2
CA-IDM-07	78.0	13.4 ± 0.5	15.4 ± 0.5	89.0	15.6 ± 0.3	15.8 ± 0.3	104	17.7 ± 0.8	15.3 ± 0.7	95.1	16.4 ± 2.4	15.6 ± 2.3	366	62.5 ± 3.3	15.4 ± 0.9
CA-IDM-08	78.0	15.0 ± 0.7	17.3 ± 0.8	89.0	16.7 ± 0.7	16.9 ± 0.8	104	18.6 ± 1.1	16.1 ± 0.9	94.9	17.5 ± 0.3	16.6 ± 0.2	366	70.1 ± 9.7	17.2 ± 2.4
CA-IDM-09	76.0	15.3 ± 0.7	17.6 ± 0.8	89.0	18.3 ± 1.0	18.5 ± 1.0	104	20.0 ± 2.1	17.3 ± 1.8	94.9	17.9 ± 0.8	16.9 ± 0.8	366	77.4 ± 7.8	19.0 ± [illegible].9
CA-IDM-10	78.0	13.9 ± 0.8	16.1 ± 0.9	89.0	16.1 ± 0.5	16.3 ± 0.5	104	17.9 ± 0.9	15.5 ± 0.8	94.9	16.3 ± 0.3	15.5 ± 0.3	366	64.1 ± 2.2	15.8 ± 0.5
CA-IDM-11	78.0	15.4 ± 0.5	17.8 ± 0.6	89.0	17.4 ± 0.9	17.6 ± 0.9	104	19.3 ± 1.1	16.7 ± 0.9	94.9	18.2 ± 0.4	17.3 ± 0.4	366	69.2 ± 1.2	17.0 ± 0.3
CA-IDM-12	78.0	14.7 ± 0.4	16.9 ± 0.5	88.9	17.9 ± 1.1	18.2 ± 1.1	104	19.2 ± 1.3	16.6 ± 1.1	95.0	18.0 ± 0.6	17.1 ± 0.6	366	117.2 ± 25.0	2[illegible].8 ± 6.1
CA-IDM-13	78.0	14.2 ± 0.7	16.4 ± 0.8	89.0	17.6 ± 0.5	17.8 ± 0.5	104	18.6 ± 0.4	16.1 ± 0.4	94.9	17.4 ± 0.7	16.5 ± 0.6	366	68.8 ± 2.6	16.9 ± 0.6
CA-IDM-14	78.0	14.8 ± 0.[illegible]	17.1 ± 0.8	89.0	17.1 ± 0.6	17.3 ± 0.6	104	18.3 ± 0.6	15.9 ± 0.5	94.9	16.6 ± 0.5	15.8 ± 0.5	366	71.2 ± 9.0	17.5 ± 2.2
CA-IDM-15	78.0	14.3 ± 1.2	16.5 ± 1.4	89.0	15.9 ± 0.6	16.1 ± 0.6	104	18.0 ± 0.8	15.6 ± 0.7	94.9	16.4 ± 0.5	15.5 ± 0.5	366	64.5 ± 2.5	15.9 ± 0.6
CA-IDM-16	78.0	12.6 ± 0.7	14.6 ± 0.8	89.0	14.8 ± 0.3	14.9 ± 0.3	104	15.9 ± 0.3	13.8 ± 0.2	94.9	14.7 ± 0.6	14.0 ± 0.6	366	58.8 ± 3.7	14.5 ± 0.9
CA-IDM-17	78.0	14.0 ± 0.3	16.1 ± 0.4	89.0	16.0 ± 0.6	16.1 ± 0.6	104	17.3 ± 0.6	15.0 ± 0.5	94.9	15.8 ± 0.5	15.0 ± 0.5	366	84.2 ± 12.2	20.7 ± 3.0
CA-IDM-18	78.0	13.6 ± 0.7	15.7 ± 0.8	89.0	16.0 ± 0.6	16.2 ± 0.6	104	17.7 ± 0.7	15.3 ± 0.6	94.9	16.3 ± 0.3	15.5 ± 0.2	366	65.1 ± 2.0	16.0 ± 0.5
CA-IDM-19	78.0	14.7 ± 0.8	16.9 ± 0.9	89.0	18.2 ± 1.8	18.4 ± 1.8	104	17.8 ± 0.3	15.4 ± 0.3	95.0	21.1 ± 4.0	20.0 ± 3.8	366	95.2 ± 3.5	23.4 ± 0.9
CA-IDM-20	78.0	14.7 ± 1.1	16.9 ± 1.3	89.0	16.7 ± 0.9	16.9 ± 1.0	104	18.6 ± 2.0	16.1 ± 1.7	94.9	16.8 ± 0.6	15.9 ± 0.5	366	71.1 ± 9.0	17.5 ± 2.2
CA-IDM-21	78.0	13.4 ± 0.5	15.4 ± 0.5	89.0	16.4 ± 0.3	16.6 ± 0.4	104	17.3 ± 0.6	15.0 ± 0.5	94.9	16.4 ± 0.6	15.5 ± 0.6	366	64.0 ± 3.0	15.7 ± 0.7
CA-IDM-22	78.0	14.7 ± 0.6	17.0 ± 0.7	89.0	17.7 ± 2.2	17.9 ± 2.2	104	18.5 ± 0.7	16.0 ± 0.6	94.8	17.4 ± 0.6	16.5 ± 0.6	366	84.6 ± 8.7	20.8 ± 2.1
CA-IDM-23	78.0	14.3 ± 0.4	16.5 ± 0.4	89.0	16.2 ± 0.3	16.4 ± 0.3	104	18.8 ± 2.1	16.3 ± 1.8	94.9	16.8 ± 0.6	15.9 ± 0.6	366	76.2 ± 20.5	18.7 ± 5.1
CA-IDM-24	78.0	13.0 ± 0.8	14.9 ± 0.9	89.0	15.2 ± 1.0	15.4 ± 1.0	104	16.5 ± 1.1	14.3 ± 1.0	94.9	15.4 ± 0.5	14.6 ± 0.4	366	57.4 ± 1.1	14.1 ± 0.3
CA-IDM-25	78.0	14.0 ± 0.6	16.2 ± 0.6	89.0	15.6 ± 0.7	15.8 ± 0.7	104	17.6 ± 1.0	15.2 ± 0.8	94.9	16.3 ± 0.5	15.4 ± 0.5	366	65.4 ± 1.7	16.1 ± 0.4
CA-IDM-26	78.0	10.1 ± 0.4	11.7 ± 0.5	89.0	11.6 ± 2.2	11.7 ± 2.2	104	12.0 ± 0.4	10.4 ± 0.3	94.9	10.9 ± 0.4	10.3 ± 0.4	366	44.0 ± 3.8	10.8 ± 0.9

Notes:

TABLE F11 (Cont.)

THERMOLUMINESCENT DOSIMETRY
1991

LOCATION CODE	FIRST QUARTER FIELD TIME (DAYS)	FIRST QUARTER TOTAL EXPOSURE (MREM ± 2σ)	FIRST QUARTER NET EXPOSURE (MREM/STD QTR ± 2σ)	SECOND QUARTER FIELD TIME (DAYS)	SECOND QUARTER TOTAL EXPOSURE (MREM ± 2σ)	SECOND QUARTER NET EXPOSURE (MREM/STD QTR ± 2σ)	THIRD QUARTER FIELD TIME (DAYS)	THIRD QUARTER TOTAL EXPOSURE (MREM ± 2σ)	THIRD QUARTER NET EXPOSURE (MREM/STD QTR ± 2σ)	FOURTH QUARTER FIELD TIME (DAYS)	FOURTH QUARTER TOTAL EXPOSURE (MREM ± 2σ)	FOURTH QUARTER NET EXPOSURE (MREM/STD QTR ± 2σ)	ANNUAL FIELD TIME (DAYS)	ANNUAL TOTAL EXPOSURE (MREM ± 2σ)	ANNUAL NET EXPOSURE (MREM/STD QTR ± 2σ)
CA-IDM-27	78.0	15.0 ± 1.3	17.3 ± 1.5	89.0	16.9 ± 1.1	17.1 ± 1.2	104	18.2 ± 0.8	15.8 ± 0.7	94.9	17.6 ± 1.6	16.7 ± 1.5	366	67.1 ± 2.3	16.5 ± 0.6
CA-IDM-28	78.0	14.6 ± 1.2	16.8 ± 1.4	89.0	16.9 ± 1.4	17.1 ± 1.4	104	18.0 ± 0.7	15.6 ± 0.6	94.9	16.6 ± 1.2	15.8 ± 1.2	366	84.2 ± 18.2	20.7 ± 4.5
CA-IDM-29	78.0	13.1 ± 0.5	15.1 ± 0.6	89.0	16.2 ± 1.9	16.4 ± 2.0	104	15.9 ± 0.7	13.8 ± 0.6	94.9	14.9 ± 0.4	14.1 ± 0.4	366	66.5 ± 12.4	16.4 ± 3.1
CA-IDM-30	77.9	ND	ND	88.9	ND	16.0 ± 0.4	104	ND	13.9 ± 0.7	95.0	ND	15.1 ± 0.3	366	ND	ND
CA-IDM-31	78.0	14.1 ± 0.4	16.3 ± 0.5	89.0	17.4 ± 0.4	17.6 ± 0.4	104	19.1 ± 3.5	16.5 ± 3.0	95.0	16.6 ± 0.7	15.7 ± 0.7	366	65.0 ± 1.2	16.0 ± 0.3
CA-IDM-32	78.0	13.8 ± 0.4	16.0 ± 0.5	88.9	16.3 ± 0.4	16.5 ± 0.4	104	18.1 ± 0.5	15.6 ± 0.5	95.0	16.1 ± 0.6	15.3 ± 0.6	366	83.9 ± 18.6	20.6 ± 4.6
CA-IDM-33	78.0	14.4 ± 0.4	16.6 ± 0.4	88.9	15.2 ± 0.5	15.4 ± 0.5	104	16.9 ± 0.4	14.6 ± 0.4	95.0	15.5 ± 0.3	14.7 ± 0.3	366	63.6 ± 5.5	15.6 ± 1.4
CA-IDM-34	78.0	13.5 ± 0.8	15.5 ± 0.9	89.0	15.0 ± 0.6	15.2 ± 0.7	104	15.3 ± 0.7	13.2 ± 0.6	95.0	13.5 ± 0.4	12.8 ± 0.4	366	57.3 ± 2.4	14.1 ± 0.6
CA-IDM-35	78.0	12.5 ± 0.5	14.4 ± 0.6	89.0	14.5 ± 0.6	14.6 ± 0.6	104	16.1 ± 0.7	14.0 ± 0.6	95.1	14.3 ± 0.4	13.5 ± 0.4	366	59.3 ± 3.3	14.6 ± 0.8
CA-IDM-36	78.0	13.9 ± 0.9	16.1 ± 1.0	89.0	16.1 ± 0.6	16.2 ± 0.6	104	17.8 ± 0.6	15.4 ± 0.5	94.9	16.1 ± 0.6	15.2 ± 0.6	366	82.3 ± 11.0	20.2 ± 2.7
CA-IDM-37	78.0	13.6 ± 0.3	15.6 ± 0.4	89.0	15.3 ± 0.4	15.5 ± 0.4	104	17.4 ± 0.9	15.1 ± 0.8	95.1	15.3 ± 0.4	14.5 ± 0.4	366	63.0 ± 4.2	15.5 ± 1.0
CA-IDM-38	78.0	10.6 ± 0.7	12.2 ± 0.8	89.0	11.8 ± 0.4	11.9 ± 0.4	104	13.0 ± 0.6	11.3 ± 0.5	95.1	11.5 ± 0.5	10.9 ± 0.5	366	45.6 ± 1.3	11.2 ± 0.3
CA-IDM-39	78.0	13.7 ± 0.9	15.8 ± 1.1	89.0	16.4 ± 0.6	16.6 ± 0.6	104	17.4 ± 0.4	15.1 ± 0.3	95.0	18.2 ± 4.0	17.3 ± 3.8	366	93.8 ± 4.5	23.1 ± 1.1
CA-IDM-40	78.0	14.4 ± 0.7	16.6 ± 0.8	89.0	16.9 ± 0.7	17.1 ± 0.7	104	17.9 ± 0.8	15.5 ± 0.7	95.0	16.3 ± 0.4	15.5 ± 0.4	366	76.2 ± 8.0	18.7 ± 2.0
CA-IDM-41	78.0	13.1 ± 0.6	15.1 ± 0.7	88.9	15.0 ± 0.5	15.1 ± 0.5	104	21.9 ± 8.5	19.0 ± 7.4	95.1	15.0 ± 0.2	14.2 ± 0.2	366	67.4 ± 2.4	16.6 ± 0.6
CA-IDM-42	78.0	12.1 ± 0.9	13.9 ± 1.0	88.9	17.0 ± 6.5	17.2 ± 6.6	104	15.3 ± 0.7	13.2 ± 0.6	95.0	13.5 ± 0.5	12.8 ± 0.5	366	70.3 ± 14.1	17.3 ± 3.5
CA-IDM-43	78.0	13.4 ± 0.6	15.5 ± 0.7	89.0	15.5 ± 0.4	15.7 ± 0.4	104	17.1 ± 1.0	14.8 ± 0.9	95.1	15.6 ± 0.7	14.8 ± 0.6	366	62.8 ± 2.2	15.4 ± 0.5
CA-IDM-44	78.0	13.6 ± 0.8	15.7 ± 1.0	89.0	15.8 ± 0.4	16.0 ± 0.4	104	17.9 ± 0.9	15.5 ± 0.8	95.1	16.0 ± 0.6	15.1 ± 0.5	366	64.9 ± 1.0	15.9 ± 0.2
CA-IDM-45	78.0	13.8 ± 0.6	16.0 ± 0.6	89.0	15.3 ± 0.7	15.5 ± 0.7	104	20.8 ± 1.5	18.0 ± 1.3	94.9	15.1 ± 0.6	14.3 ± 0.6	366	69.8 ± 1.4	17.2 ± 0.3
CA-IDM-46	78.0	14.4 ± 0.7	16.6 ± 0.8	89.0	16.1 ± 0.6	16.3 ± 0.6	104	18.6 ± 1.2	16.1 ± 1.0	94.9	16.[illegible] ± [illegible]	15.3 ± 0.5	366	84.3 ± 17.4	20.7 ± 4.3
CA-IDM-47	78.0	14.0 ± 0.4	16.1 ± 0.5	89.0	15.2 ± 0.6	15.4 ± 0.6	104	17.1 ± 0.9	14.8 ± 0.7	94.9	15.5 ± 0.3	14.7 ± 0.3	366	71.8 ± 6.8	17.7 ± 1.7
CA-IDM-48	78.0	15.7 ± 1.1	18.1 ± 1.3	89.0	16.4 ± 0.7	16.6 ± 0.7	104	17.9 ± 0.5	15.4 ± 0.5	94.9	16.4 ± 0.7	15.6 ± 0.7	366	66.8 ± 5.0	16.4 ± 1.2
CA-IDM-49	78.0	13.9 ± 0.9	16.0 ± 1.1	89.0	15.5 ± 0.6	15.6 ± 0.6	104	17.2 ± 0.3	14.9 ± 0.2	94.9	15.6 ± 0.8	14.8 ± 0.7	366	69.0 ± 6.4	17.0 ± 1.6
CA-IDM-50	78.0	13.9 ± 0.4	16.0 ± 0.5	89.0	16.7 ± 0.8	16.9 ± 0.8	104	18.4 ± 0.8	16.0 ± 0.7	95.1	17.3 ± 2.5	16.4 ± 2.3	366	64.9 ± 5.6	16.0 ± 1.4
CA-IDM-51	78.2	14.4 ± 0.7	16.5 ± 0.8	88.8	16.3 ± 0.7	16.5 ± 0.7	104	18.3 ± 0.9	15.8 ± 0.8	95.2	17.3 ± 2.7	16.4 ± 2.6	366	63.8 ± 1.0	15.7 ± 0.3
CA-IDM-52	78.2	13.9 ± 0.4	16.0 ± 0.5	88.8	16.0 ± 0.8	16.2 ± 0.8	104	18.1 ± 0.7	15.7 ± 0.6	94.9	15.8 ± 0.6	15.0 ± 0.5	366	63.4 ± 2.1	15.6 ± 0.5

Notes: 1. ND = No Data. See section 2.3 for explination.

SECTION 4.0

NON-RADIOLOGICAL

ENVIRONMENTAL MONITORING

SECTION 4.0

UNION ELECTRIC COMPANY

CALLAWAY PLANT

NONRADIOLOGICAL ENVIRONMENTAL MONITORING

1991

CONTENTS

SECTION 1.υ

CULTURAL RESOURCES

1.0 CULTURAL RESOURCES

In accordance with Sections 4.3 and 5.4 of Appendix B to Facility Operating License No. NPF-30, a description of the implementation of Cultural Resources requirements follows.

Union Electric has submitted an amendment request dated 2/21/92 (ULNRC-2566) which proposes to revise the Callaway Facility Operating License NPF-30, Appendix B, Environmental Protection Plan (Non-radiological), by removing Sections 2.3 and 4.3, "Cultural Resources." Union Electric has developed and maintains a management plan for the protection of cultural resources on the Callaway Plant site including those within the area of potential effects. This management plan was revised and forwarded to NRC by letter dated 4/16/92 (ULNRC-2620). The amendment request provides the status and disposition of each portion of the present Appendix B which addresses cultural resources.

SECTION 2.0

AERIAL PHOTOGRAPHIC MONITORING AND INTERPRETATION OF VEGETATION AT CALLAWAY

2.0 AERIAL PHOTOGRAPHIC MONITORING AND INTERPRETATION OF VEGETATION AT CALLAWAY

The final report of the 1991 Callaway aerial infrared vegetation monitoring study completed by Applied Biology, Inc. follows. This study was completed in order to fulfill the requirements of Section 4.2 of Appendix B to Facility Operating License No. NPF-30.

The vegetation monitoring conducted during 1991 was the fifth operational monitoring effort. As with prior efforts, no evidence of detrimental effects from cooling tower drift was found; vegetation stress in the vicinity of the plant site was determined to be caused by natural factors.

A copy of the color photographic prints and color transparencies have been sent under separate cover to:

Mr. L. R. Wharton
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
1 White Flint, North, Mail Stop 13E21
11555 Rockville Pike
Rockville, MD 20852

AERIAL PHOTOGRAPHIC MONITORING AND INTERPRETATION OF VEGETATION AT CALLAWAY

AUGUST 1991

FINAL REPORT

NOVEMBER 1991

Prepared for

UNION ELECTRIC COMPANY

St. Louis, Missouri

Prepared by

APPLIED BIOLOGY, INC.

Decatur, Georgia

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Environmental information on the condition of vegetation at the Callaway site during the seventh year of plant operation was developed through infrared aerial photography, photointerpretation and ground truthing of stressed vegetation, vegetation mapping and phytopathological diagnoses of stressed vegetation during July and August, 1991.

Ten terrestrial study plots were photographed with infrared film at a scale of 1" = 250'. Residual lands were photographed at a scale of 1" = 1000'. Photointerpretation was performed based upon the differential infrared reflectance characteristics of healthy versus stressed tree cover. The infrared photographic record was then verified with a ground truthing field inspection. On-site and laboratory phytopathological diagnoses were made for stressed vegetation identified from aerial photography. A vegetation map was produced to show the location of stressed vegetation.

No evidence of the effects of drift from the cooling tower was found. Vegetation stress in the vicinity of the plant site was found to be caused by natural factors such as oak wilt, insect damage, root and butt rot, and beaver girdling and damming. No distributional pattern of these diseases was identified during the study. Therefore, the foliar disease found in the Callaway vegetation during 1991 can be directly attributed to natural causes and not to operation of the Callaway cooling tower.

1.0 INTRODUCTION

1.1 Purpose

Union Electric Company (UE), in response to Nuclear Regulatory Commission (NRC) mandate, has undertaken a program to monitor the potential impacts of cooling tower drift on the local flora surrounding the UE Callaway Plant in Callaway County, Missouri. The goals of the program are to establish a record of baseline and operational phase vegetation conditions at the Callaway Plant site using color infrared aerial photography, to document any naturally occurring vegetation stress, and to determine if any vegetation damage can be attributed to operation of the cooling tower. Interpretation of aerial photographs was used to prepare this information. This was supplemented by ground truthing to assure accurate interpretation of photographs and field phytopathological assessment to identify the causes of any vegetation stress encountered.

Using these investigative methods, preoperational baseline environmental information on the condition of vegetation at the Callaway Plant site was developed during July and August, 1984. Observations during the first, second, third and fifth years of plant operation were made during August, 1985; July and August, 1986; August, 1987; and July, August and September, 1989. During July and August, 1991 monitoring was performed to assess the condition of vegetation during the seventh year of plant operation. The results of these six years of monitoring complement other vegetation monitoring undertaken at the study site. Prior to the present program of infrared aerial photographic monitoring, classical field botany techniques were used to describe the species composition of the vegetation community at the Callaway Plant. This work was performed in 1973 - 1975, 1981, and 1983 - 1984, and concentrated on a set of permanent terrestrial study plots.

2.0 STUDY METHODS

Applied Biology, Inc. (ABI) acted as coordinator for the infrared aerial photography, photointerpretation and ground truthing of stressed vegetation, vegetation mapping and phytopathological assessment of stressed vegetation conducted at the Callaway Plant site in 1991.

2.1 Aerial Photography

Aerial photography for this project was flown from 0835 to 0910 hours on 16 July 1991 by Walker and Associates, Inc. of Fenton, Missouri. No cloud cover was present. Atmospheric conditions were haze- and dust-free. Color infrared film was exposed in a Wild RC-8 precision aerial mapping camera with 6 inch focal length lens. Ten one-hectare terrestrial study plots were photographed with 60 percent forward overlap at a scale of 1" = 250'. The residual lands of the plant site were photographed with 60 percent forward overlap and 30 percent side overlap at a scale of 1" = 1,000'. Overlapping of photo frames is used to assure adequate coverage that avoids any visual distortion or loss of infrared photograph brightness that may occur along the edges of an aerial photographic exposure. Duplicate sets of positive film transparencies and positive prints were produced in 9" by 9" format.

2.2 Photointerpretation

Analysis of color infrared aerial photographs for the presence of vegetation stress is based upon the changes in infrared foliage reflectance that occur as a result of plant stress. A number of technical sources describe the theory and application of color infrared vegetation analysis and were used as a guide for the photointerpretation in this study. Plants under stress due to insect attack, disease or environmental conditions such as drought exhibit discoloration of their foliage on color infrared film because of loss of reflectance. This decrease of infrared reflectance occurs when normally highly reflective spongy leaf mesophyll cells collapse because of plant stress (Colwell, 1956). Vegetation color differences can be used to make inferences about plant vigor (Murtha, 1982; Barrett and Curtis, 1976). Healthy deciduous trees are highly reflective of the infrared light spectrum and appear as red and magenta in color infrared photographs. Evergreen pines and cedars at the site appear in shades of reddish grey. Stressed vegetation, with leaf yellowing apparent in normal spectral color photography, appears in shades of mauve, blue-grey, yellow and white in color infrared photography. When vegetation is dead and dry, it appears as yellow and tan on color infrared photography.

Using these differential reflectances as signature guides, examination of photographs was performed with simple magnification. Trees that were possibly in stressed condition were marked on photographic prints for subsequent ground truthing.

2.3 <u>Ground Truthing</u>

Ground truthing of stressed vegetation was the process used to locate (with the aid of aerial photographs and topographical maps) potentially stressed trees recorded on aerial photograph prints. The condition of these trees and the assessment made during phytopathological investigations were then correlated with the infrared photographic signature in order to identify stressed trees. Ground truthing took place on 24 and 25 August 1991.

2.4 Vegetation Mapping

After photointerpretation and ground truthing, the locations of stressed or dying trees were plotted on a map of the Callaway Plant site at a scale of 1" = 2,000' (Figure 1). Individual stressed or dying trees were represented by a diamond (◆) on the vegetation map. A considerable number of the trees that were plotted on the site vegetation map were inspected for photointerpretation ground truth correlation and phytopathological appraisal.

2.5 Phytopathological Investigations

Individual trees that were located at the Callaway site from aerial photograph plotting were appraised by plant pathologist Barbara Lucas Corwin of Hallsville, Missouri. The purpose of this appraisal was to provide diagnoses of the causes of vegetation stress found on specimens at the study site. The causes of plant stresses were categorized as environmental, disease, or insect. Plant species vary in their tolerance of, or sensitivity to, adverse conditions brought about by any of the above categories. It is pertinent to note that stress symptoms in plants, especially trees, can be very similar among the categories of causes mentioned above.

Freezing and thawing, drought, flooding, lightning damage, chemical injury, mechanical injury, or high winds are all examples of environmental conditions that can result in stressed plants. These conditions may cause outright death of plants or may

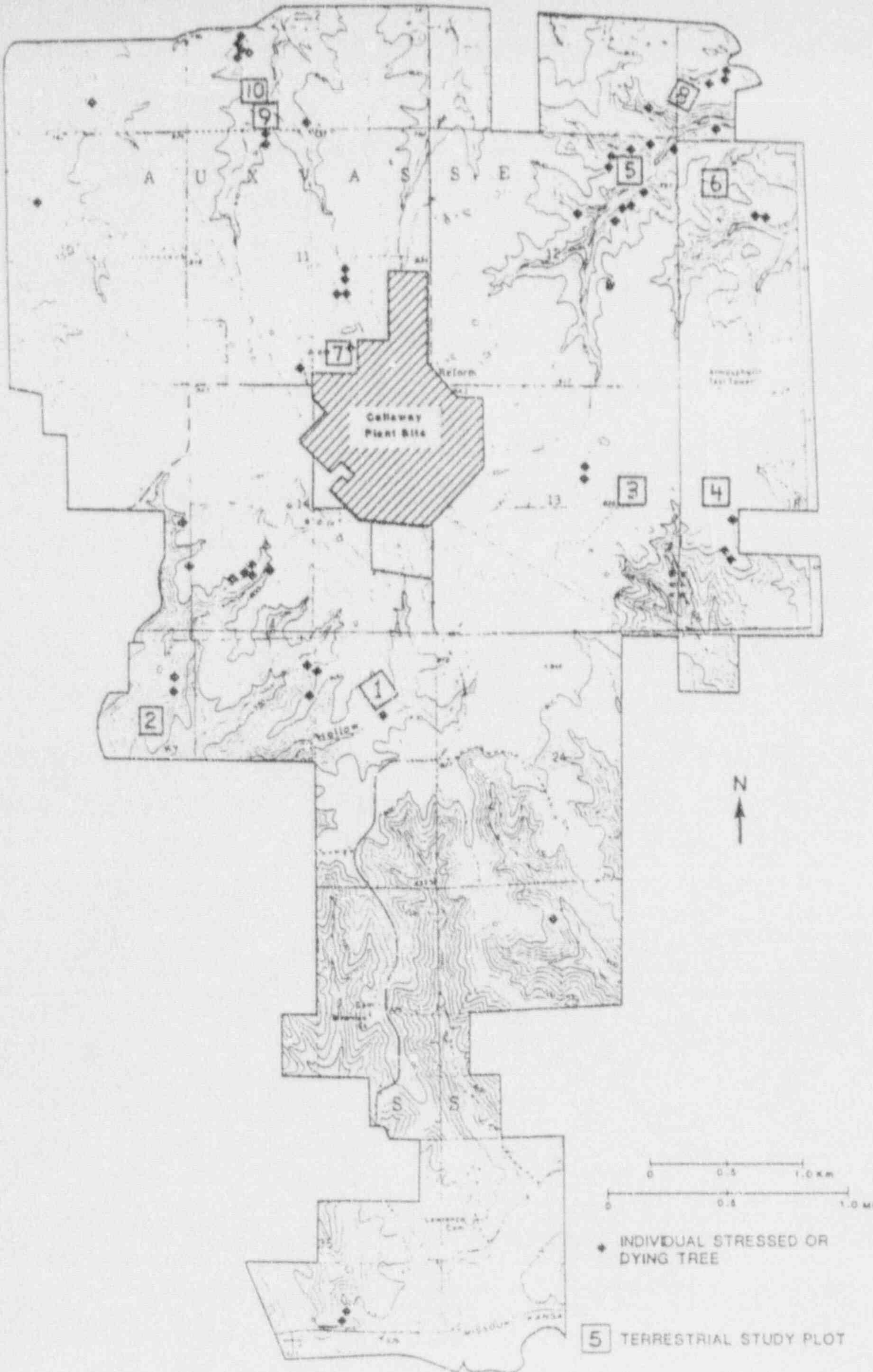

Figure 1: Location of stressed and dying trees, Callaway Plant, July - August 1991

stress them to a point where they are unable to withstand invasion by secondary disease organisms or insect pests.

Disease is a condition in plants brought about as a result of invasion of plant tissues by other living microorganisms. Primary diseases, such as oak wilt and Dutch elm disease (DED), are caused by microorganisms that can invade healthy plant tissues. These organisms consume plant-supplied water and nutrient reserves for their own growth, thereby creating a stress on the plant. Secondary diseases, such as maple decline, are caused by "disease complexes" that usually occur on plants that have already been stressed from other causes. Disease complexes are generally caused by microorganisms that by themselves cannot invade tissues of healthy plants. When plants are stressed, however, their normal resistance to invasion by insect and disease organisms is lowered. The disease-complex organisms then are able to invade plant tissues, causing further stress and/or death of the plant.

Insects may cause direct or indirect damage to plants that may result in stress. Direct damage usually is a result of feeding on plant parts such as leaves, bark (cambial layers), wood, or roots. Oviposition (egg-laying) is another type of direct damage that can restrict the flow of water or nutrients in the plant. Insects may also cause indirect damage by serving as vectors of disease-causing organisms; insects feeding on diseased plants inadvertently carry spores of disease organisms to healthy plants.

The elements that were analyzed during diagnoses of stressed tree specimens were: history of forest management practices or herbicide application, site edaphic conditions, condition of surrounding vegetation, recent meteorological record, and inspection of tree leaves, branches, bark and roots. In addition to field observations, standard culturing procedures using twigs and small branches were carried out in the laboratory in 1984 and 1987 in an attempt to recover the causal fungus in cases of suspected fungal infestation. Samples were plated on two culture media: 1) oak wilt agar (Nutrimigen base) and 2) acid potato-dextrose agar. These laboratory procedures were inconclusive in 1984 and were not repeated in 1985 or 1986. In 1987, twig samples from tw , oak specimens were again cultured in an attempt to isolate the causal fungus. The oak wilt fungus Ceratocystis fagacearum was isolated in 1987. Further attempts to isolate this fungus were not repeated in 1989 or 1991.

appeared as stressed aggregations on infrared aerial photography. In an area to the west of Vegetation Ecology Site 2, numerous trees appear as whitish, barren trunks on infrared aerial photography. These dead trees have been left standing on this site for some time and have been noted in the five previous annual reports on aerial photographic vegetation monitoring at the Callaway site. This area is not mapped as a tree damage zone in this 1991 report since the observed trees at this location have been dead for several years and the area is now in a process of regrowth/recovery. Selective cutting along the lowland timber edges, performed by the Missouri Department of Conservation in the general vicinity of Sites 3, 4, 5, 6, 8, 9 and 10, was noted but was not mapped during the 1989 Callaway vegetation monitoring report. Some of these trees were observed during the 1991 vegetation photointerpretation and field survey to be still standing as dead stems. August 24, 1991 field investigations revealed that there had been very recent cutting and clearing of trees along the woodland/field edges in the general vicinity north of Site 2. This tree clearing had apparently occurred since the July 16, 1991 aerial photography flight at the Callaway site, because these dead or dying cleared trees were not visible on 1991 aerial photography. Because of their scattered occurrence these trees could not be effectively illustrated as a tree damage zone on the accompanying topographic map of the survey site. No other new tree damage zones were noted over the entire Callaway study site in 1991 vegetation monitoring.

Healthy eastern redcedar (Juniperus virginiana) and plantation grown white pine (Pinus strobus), both evergreen species, displayed reddish grey coloration in infrared photography. A single recently dead white pine, overgrown with poison ivy vines which appear as pinkish white on infrared aerial photographs, was located in a cultivated

3.0 RESULTS AND DISCUSSION

3.1 Photointerpretation and Ground Truthing

Analysis of color infrared aerial photographs indicated that the vast majority of deciduous trees at the Callaway Plant site were in good health as indicated by their intense magenta reflectance. Certain deciduous trees observed across the study site displayed somewhat lighter magenta or pink coloration or a light fringed appearance on infrared aerial photographs. Ground truthing in 1991 and in previous years has revealed these trees to be species such as red maple (Acer rubrum), sycamore (Platanus occidentalis), persimmon (Diospyros virginiana), cottonwood (Populus deltoides) and mulberry (Morus rubra) that were in good health. Such trees possess a somewhat different infrared color signature than the deep magenta of the oaks and hickories that are dominant at the Callaway site. Deciduous trees that showed signs of stress reflected in shades of light pinkish mauve, grey and tan on infrared photography. These deciduous trees were plotted as individual stressed or dying trees on the site vegetation map (Figure 1). The distribution of these trees showed no apparent pattern. Ground truthing and phytopathological examination revealed that a variety of stress factors (detailed in Section 3.2) were affecting these trees. During previous years of vegetation monitoring, areas with relatively high densities of stressed, dying or dead deciduous trees were observed on the aerial photographs. These areas were recorded in past years as tree damage zones on the site vegetation map. Field inspection revealed that these zones were subject to forest management practices carried out by the Missouri Department of Conservation in which less robust tree specimens or undesired species were girdled by chain saw cutting. The culled dead and dying trees stand just northwest of the complex of power plant buildings. As a whole, the stand of white pine was in fairly good condition but with some lower branch dieback, perhaps due to crowding and sunlight shading, as well as with some ongoing root and butt rot decline. Eastern redcedars were in good condition across the study site in general.

3.2 Phytopathological Investigations

Oak wilt (OW), a vascular disease caused by the fungus Ceratocystis fagacearum, was diagnosed as the cause of stress in a number of oak specimens. All of the oak trees which were identified in the field in 1991 to be affected by oak wilt were black oaks (Quercus velutina). Diagnoses were based on symptom expression in the field. Symptom development begins in the upper crown of infected trees. Leaves exhibit marginal scorching, a moisture stress symptom, and often fall from the tree. Leaf scorch symptoms develop because the fungus multiplies in the vascular system, effectively blocking the uptake of water. The disease develops rapidly in the red oak group (which includes black oak), spreading throughout the entire tree. Infected trees in this group are often killed in a single season.

Once a tree dies, the fungus produces mycelial mats underneath the outer bark. The mycelial mats, or "pressure pads", often split the bark, exposing the pad surface upon which spores are produced. The spores have a fruity odor that is attractive to the sap- and bark-feeding beetles that vector the fungus to healthy trees. Pressure pads are formed in the late summer of death if adequate moisture is available. If moisture is limiting, pads may not form until early spring if at all (Boyce, 1957; Tainter and Gubler, 1973). Invasion of the oak-wilted trees by secondary disease organisms inhibits pad formation (Shigo, 1985; Tainter and Gubler, 1973). Oak wilt symptoms were observed at Sites 1, 2, 5 and 8.

Dutch elm disease (DED), caused by the fungus Ceratocystis ulmi, has been identified for several years at the Callaway site as a stress factor on American elm (Ulmus americana) trees. Diagnoses were based on visual symptoms: wilting, dieback of branches, and discoloration of the vascular system. DED is a vascular disease similar to oak wilt. It has been devastating on American elm (Ulmus americana) and other native species because it is caused by an "introduced" pathogen against which native American elms have not developed genetic resistance. Although DED has been encountered for several years during Callaway vegetation monitoring, particularly at Site 9, no trees were located by 1991 aerial photointerpretation or ground truthing which were affected by this disease.

Another disease that was encountered was root and butt rot. Root and butt rot was observed on plantation grown white pine (Pinus strobus) at Site 7. Root and butt rots are caused by a variety of fungi capable of attacking healthy trees and killing the roots and the living bark of the lower trunk. Many of the root and butt rot fungi survive as saprophytes in cut stumps. They utilize the stump as an energy source for growth through the soil until a healthy root is encountered. These rots are therefore common in logged areas. Above-ground symptoms of root and butt rot are expressed as branch dieback and sparse, off-color foliage. Fruiting bodies (basidiocarps) of the causal fungi, when they occur, are usually formed in the fall. Decay and discoloration and fungal mats can be observed at the base of the trunk and on large roots just under the soil surface.

The 1991 ground truthing of stressed vegetation identified by aerial infrared photography was conducted at the Callaway Plant site on 24-25 August. The purpose of the ground truthing, as in previous years, was to describe the causes of vegetative stress whether of environmental, insect or disease origin. No extensive laboratory isolations were necessary, although leaves of dogwood and persimmon were examined microscopically to verify field diagnoses. Following is a site-by-site assessment of the causes of stress detected in 1991.

Site 1

Oak wilt, confirmed by isolation in 1987, remains active on this site. Symptoms included defoliation from the upper crown (slides 1-1, 1-3), leaf scorch, and vascular discoloration (slide 1-2). No photograph was taken of a fourth oak that was completely dead, probably as the result of oak wilt.

Site 2

The dogwoods in the understory were expressing symptoms of a fungal leaf spot, caused by Septoria sp. (slide 2-0). Infection is favored by abundant rainfall in the early spring, which the area experienced in 1990 and 1991. The disease is not considered serious, because severe symptoms do not develop until late in the season. Specimen 2-1 was an oak exhibiting leaf scorch and defoliation characteristic of oak wilt (slide 2-1). Persimmons, specimen 2-2, were infected with a fungal leaf spot caused by Cercospora sp. This disease has been observed every year at all sites where persimmons are growing. It is a common disease almost always found in association with persimmon. Infected leaves may yellow and drop early. Shagbark hickories were also exhibiting symptoms of a fungal foliar anthracnose (slide 2-3), common where the species occurs. Again, severe symptoms develop late in the season, causing trees to defoliate slightly earlier than they normally would. The last problem encountered on this site was oak wilt (slides 2-1, 2-4).

Site 3

The stressed trees detected on this site were dying honeylocusts, specimens 3-1 and 3-2 (slide 3-2). It is suspected that herbicide was used to selectively destroy this species.

Site 4

Specimen 4-1 was an eastern redcedar that had been intentionally girdled (slide 4-1). Shagbark hickories on this site had foliar anthracnose (slide 4-2).

Site 5

Two white oaks, specimens 5-1 and 5-2, were in a state of decline. A fungal twig blight and damage from a foliar feeding insect were evident (slides 5-1, 5-2). Specimen 5-3 was a large white oak with a forked main trunk. Half the tree was dead. The bark had sloughed and cracked, suggesting physical damage as the probable cause. Additionally, black oaks on this site, specimens 5-4, 5-5 and 5-6, were exhibiting the characteristic symptoms of oak wilt.

Site 6

Specimen 6-1 was a white oak damaged by lightning strike (slides 6-1). Specimen 6-4 was a white oak with symptoms of iron chlorosis (slide 6-4). Iron chlorosis is an iron deficiency symptom caused by reduced uptake of iron under high pH soil conditions. The oak was growing near a spoil pile dug from an adjacent limestone quarry. It is likely that the soil pH on the site is very high due to leaching from this limestone debris.

Site 7

Only one recently dead pine, specimen 7-1, was detected in the pine plantation on this site. The infrared imaging was the result of poison ivy vines growing on the dead tree. The pine plantation has an ongoing decline problem due to root and butt rot. A new stress was identified in an area approximately 1,000 feet east and northeast of the pine plantation. A beaver colony has become established in the area, resulting in death of trees due to girdling and to increased soil saturation or stream flooding caused by beaver dam construction (slide 7-2). Specimens 7-2 through 7-5 were black gums that had been girdled by the beavers. Specimen 7-5 was actually in standing water. Specimen 7-6 was an American elm girdled by beavers.

Site 8

Active oak wilt was observed on two black oak specimens (slides 8-1, 8-2). Specimens 8-3 and 8-4 were two large basswoods that had died recently (slides 8-3, 8-4). There was no sign of physical injury, disease or insect problem to account for this. The problem may have been due to environmental effects, such as unfavorable steeply sloped terrain.

Site 9

A large old silver maple located on an old house site continued to show evidence on aerial photographs of dieback and decline. The condition has been ongoing for several years and is probably due to a combination of environmental stress and age of the trees. Several catalpa trees located in an old fence row continued to show off-color foliage conditions on aerial photographs. The trees have suffered damage in the past and have exhibited some branch dieback. The off-color appearance is due in part to the damage and part to the species which tends to have a pale yellow green color in late summer. Because the same trees continued to show similar conditions on aerial photography, and because no newly stressed trees were apparent on aerial photographs, no on-site phytopathological investigations were necessary at Site 9.

Site 10

An American elm (specimen 10-1) and a slippery elm (specimen 10-2) along a fence row were exhibiting severe foliar damage from elm leaf beetle feeding (slide 10-1). The trees were part of a group of elms located along an old fence row, adjacent to a home site, which showed stress from leaf beetle feeding.

4.0 CONCLUSIONS

Although there was an increased incidence in foliar diseases this year, the unusually wet springs in 1990 and 1991 account for this. Foliar diseases in general are favored by abundant rainfall early in the season. Oak wilt continued to be active on Sites 1, 2, 5 and 8. New problems encountered this year included damage from activities of a beaver colony on Site 7, severe elm leaf beetle feeding injury on elms on Site 10, and iron chlorosis of white oak on Site 6. There was no apparent directional pattern to the distribution of diseased and stressed vegetation.

No directional patterns of stressed vegetation were noted, and no stress symptoms were found to be due to the effects of drift from the cooling tower. Overall, there was a moderate increase in the number of stressed trees discernible on infrared aerial photography in 1991 as compared to 1989, and a moderate decrease in the number of stressed trees in 1991 as compared to other previous years.

Most of the deciduous tree cover at the Callaway site is healthy and reflects intense magenta on infrared aerial photography. Those specimens that are stressed or dying are recognizable on color infrared photography because of their mauvish pink, grey or tan reflectance. Tree damage zones sufficiently large to be illustrated on the topographic map of the survey site were not observed at the Callaway site in 1991. However, tree cutting along woodland/field margins has been performed by the Missouri Department of Conservation in some limited areas in the general vicinity north of Site 2. Essentially all of the evergreen species at the study site (white pine and eastern redcedar) are in good condition and are recognizable by their reddish grey infrared reflectance. Recently dead, defoliated evergreens are apparent because of their pinkish white or tan infrared reflectance.

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SECTION 5.0

PLANT MODIFICATION

ENVIRONMENTAL EVALUATION

SECTION 5.0

UNION ELECTRIC COMPANY

CALLAWAY PLANT

PLANT MODIFICATIONS

ENVIRONMENTAL EVALUATIONS

1991

1.0 INTRODUCTION

In accordance with Appendix B, Section 5.4.1 of the Callaway Plant Operating License, the following report was prepared by Union Electric on all changes in plant design, operation, tests or experiments which involved a potentially significant unreviewed environmental question in accordance with Section 3.1 of Appendix B.

The report covers all plant modifications/changes that were completed for January 1, 1991, through December 31, 1991.

During 1991 there were five plant modifications/changes that involved a potentially significant unreviewed environmental question. The interpretations and conclusions regarding these plant modification/changes along with a description of the changes are presented below.

2.0 ENVIRONMENTAL EVALUATIONS

2.1 Callaway Modification Package 88-3034

2.1.1 Description of Change

This change involved the addition of a foundation and compressor house enclosure to the plant south side of the service building. A trench drain was also installed south of the enclosure to an existing surface ditch.

2.1.2 Evaluation of Change

The installation of the compressor house enclosure and trench drain did not result in a significant increase in any adverse environmental impact, since all measurable non-radiological environmental effects were confined to the areas previously disturbed during site preparation and plant construction. Therefore, this change does not constitute an unreviewed environmental question per section 3.1 of Appendix B to the Callaway Plant Operating License.

2.2 Request for Resolution 08372

2.2.1 Description of Change

The change involved the installation of a pre-manufactured metal building next to the UHS pond. This building will be used for the storage of non-radioactive chemical wastes.

2.2.2 Evaluation of Change

The installation of the chemical waste storage building did not result in any adverse environmental impact, since all measurable non-radiological environmental effects were confined to the area previously disturbed during site preparation and plant construction. Therefore, this change does not constitute an unreviewed environmental question per section 3.1 of Appendix B to the Callaway Plant Operating License.

2.3 Request for Resolution 09439

2.3.1 Description of Change

This change involves temporarily locating two sealand cargo boxes outside of the radwaste building roll-up-door on the northeast side. The cargo boxes will be used to temporarily store bagged radioactive material during refuel 5.

2.3.2 Evaluation of Change

Temporarily positioning of the sealand cargo boxes to store radioactive material outside the radwaste building does not impact any of the cultural resources of the area. The location of the cargo boxes is a position onsite that was already disturbed during site preparation and plant construction. Therefore, this change does not constitute an unreviewed environmental question per section 3.1 of Appendix B to the Callaway Plant Operating License.

2.4 Plant Procedure CTP-DE-06112, Rev. 0

2.4.1 Description of Change

This procedure describes a test to determine the effectiveness of adding Western Water 900N (ferrous sulfate) to "c" intake pump bay. The test was to be conducted for several one week periods to determine if the additional contact time for the ferrous sulfate would improve coagulation or solids removal at the water treatment plant during periods of low river solids. Ferrous sulfate was to be added at a concentration not to exceed 10ppm to "c" intake pump bay with two intake pumps running.

2.4.2 Evaluation of Change

With two intake pumps operating and with administrative controls in place, there should have been no release of this product to the river through the free discharge valve. Small amounts of ferrous sulfate would be released to the river for short periods each day via the desilting process and through the traveling water screen spray wash system. This product was previously approved by the Missouri Department of Natural Resource (DNR) and is normally added to the water treatment plant stilling basin. The Missouri DNR granted approved to conduct the test as described above. Therefore, this change did not constitute an unreviewed environmental question per section 3.1 of Appendix B to the Callaway Plant Operating License.

Ferrous sulfate addition was initiated on January 26, 1992. However, due to a blocked line in the addition system, approximately 13 gallons of ferrous sulfate was released to the Missouri River at the intake structure. Testing of the product at this location was discontinued.

2.5 Plant Procedure ETP-AQ-ST002, Rev. 0

2.5.1 Description of Change

This procedure describes a test to evaluate the effectiveness of Morpholine for pH control in the secondary system as an alternative to ammonia. The test was conducted for 30 to 60 days beginning in mid October.

2.5.2 Evaluation of Change

During the test period 40 percent morpholine was stored in a 360 gallon porta feed located in the turbine building. A spill of this material was highly unlikely, however, if a spill were to occur it would be collected in the turbine building drain. Morpholine was not previously identified in the Callaway NPDES Permit. However, the Missouri Department of Natural Resources was notified of our intent to perform this test and did not have any objections. Therefore, this change does not constitute any unreviewed environmental questions per section 3.1 of Appendix B of the Callaway Plant Operating License.