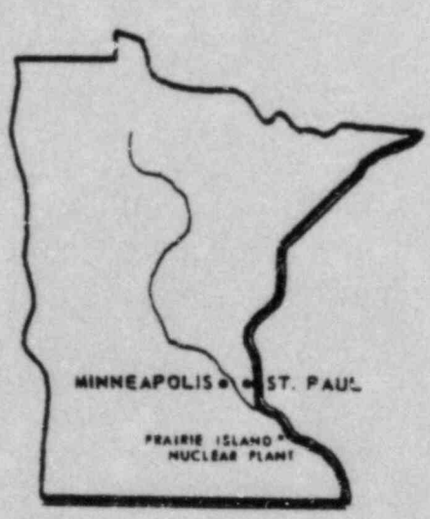
PRAIRIE ISLAND NUCLEAR GENERATING PLANT

Red Wing, Minnesota

UNITS 1 AND 2



ANNUAL REPORT

to the

UNITED STATES NUCLEAR REGULATORY COMMISSION

Radiation Environmental Monitoring Program

January 1, 1983 to December 31, 1983

NORTHERN STATES POWER COMPANY
MINNEAPOLIS, MINNESOTA

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MINNEAPOLIS, MINNESOTA

PRAIRIE ISLAND NUCLEAR GENERATING PLANT
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Radiation Environmental Monitoring Program
January 1, 1983 to December 31, 1983

Prepared Under Contract
by
TELEDYNE ISOTOPES MIDWEST LABORATORY
Project No. 8010

Approved by: L. G. Huebner

L. G. Huebner
General Manager

6 February 1984

PREFACE

The staff of Teledyne Isotopes Midwest Laboratory (formerly Hazleton Environmental Sciences), was responsible for the acquisition of data presented in this report. Samples were collected by members of the staff of the Prairie Island Nuclear Generating Plant.

The report was prepared by L. G. Huebner, General Manager. He was assisted in the report preparation by L. Nicia, Group Leader, and D. Cohen, Scientist.

TABLE OF CONTENTS

List of Tables

1.0 INTRODUCTION

This report summarizes and interprets results of the Radiation Environmental Monitoring Program (REMP) conducted by Teledyne Isotopes Midwest Laboratory (formerly Hazleton Environmental Sciences) at the Prairie Island Nuclear Generating Plant, Red Wing, Minnesota, during the period January - December, 1983. This program monitors the levels of radioactivity in the air, terrestrial, and aquatic environments in order to assess the impact of the plant on its surroundings.

Tabulations of the individual analyses made during the year are not included in this report. These data are included in a reference document (Teledyne Isotopes Midwest Laboratory, 1984) available at Northern States Power Company, Nuclear Generation Department.

Prairie Island Nuclear Generating Plant is located on the Mississippi River in Goodhue County, Minnesota, and operated by Northern States Power Company. The plant has two 550 MWe pressurized water reactors. Unit 1 achieved initial criticality on 1 December 1973. Commercial operation at full power began on 16 December 1973. Unit 2 achieved initial criticality on 17 December 1974. Commercial operation at full power began on 21 December 1974.

2.0 SUMMARY

The Radiation Environmental Monitoring Program (REMP) required by the U.S. Nuclear Regulatory Commission (NRC) Technical Specifications for the Prairie Island Nuclear Generating Plant is described. Results for 1983 are summarized and discussed.

Program findings show background levels of radioactivity in the environmental samples collected in the vicinity of the Prairie Island Nuclear Generating Plant. No effect on the environment due to the operation of the Plant is indicated.

3.0 RADIATION ENVIRONMENTAL MONITORING PROGRAM (REMP)

3.1 Program Design and Data Interpretation

The purpose of the Radiation Environmental Monitoring Program (REMP) at the Prairie Island Nuclear Generating Plant is to assess the impact of the plant on its environment. For this purpose, samples are collected from the air, terrestrial, and aquatic environments and analyzed for radioactive content. In addition, ambient gamma radiation levels are monitored by thermoluminescent dosimeters (TLDs).

Sources of environmental radiation include the following:

(1) natural background radiation arising from cosmic rays and primordial radionuclides;

(2) fallout from atmospheric nuclear detonations;

(3) releases from nuclear power plants.

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

A major interpretive aid in assessment of these effects is the design of the monitoring program at the Prairie Island Plant which is based on the indicator-control concept. Most types of samples are collected both at indicator locations (nearby, downwind, or downstream) and at control locations (distant, upwind, or upstream). A 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 could be accounted for by typical fluctuations in radiation levels arising from other sources.

An additional interpretive technique involves analyses for specific radionuclides present in the environmental samples collected from the Plant site. The Plant's monitoring program includes analyses for tritium and iodine-131. Most samples are also analyzed for gamma-emitting isotopes with results for the following groups quantified: zirconium-95, cesium-137, cerium-144, beryllium-7, and potassium-40. The first three gamma-emitting isotopes were selected as radiological impact indicators because of the different characteristic proportions in which they appear in the fission product mix produced by a nuclear reactor and that produced by a nuclear detonation. Each of the three isotopes is produced in roughly equivalent amounts by a reactor: each constitutes about 10% of the total activity of fission products 10 days after reactor shutdown. On the other hand, 10 days after a nuclear explosion, the contributions of zirconium-95, cerium-144, and cesium-137 to the activity of the resulting debris are in the approximate ratio 4:1:0.03 (Eisenbud, 1963). Beryllium-7 is of cosmogenic origin and potassium-40 is a naturally-occurring isotope. They were chosen as calibration monitors and should not be considered radiological impact indicators.

The other group quantified consists of niobium-95, ruthenium-103, and -106, cesium-134, barium-lanthanum-140, and cerium-141. These isotopes are released in small quantities by nuclear power plants, but to date their major source of injection into the general environment has been atmospheric nuclear testing. Nuclides of the final group, manganese-54, iron-59, cobalt-58, and -60, and zinc-65, are activation products and arise from activation of corrosion products. They are typical components of a nuclear power plant's effluents, but are not produced in significant quantities by nuclear detonations.

Other means of distinguishing sources of environmental radiation can be employed in interpreting the data. Current radiation levels can be compared with previous levels, including those measured before the Plant became operational. Results of the Plant's Monitoring Program can be related to those obtained in other parts of the world. Finally, results can be related to events known to cause elevated levels of radiation in the environment, e.g., atmospheric nuclear detonations.

3.2 Program Description

The sampling and analysis schedule for the environmental radiation monitoring program at Prairie Island is summarized in Table 5.1 and briefly reviewed below. Table 5.2 defines the sampling location codes used in Table 5.1 and specifies for each location its type (indicator or control) and its distance, direction, and sector relative to the reactor site. To assure that sampling is carried out in a reproducible manner, detailed sampling procedures have been prescribed (Hazleton Environmental Sciences Corporation, 1983).

To monitor the air environment, airborne particulates are collected on membrane filters by continuous pumping at five locations. Also, airborne iodine is collected by continuous pumping through charcoal filters at all of these locations. Filters are changed and counted weekly. Particulate filters are analyzed for gross beta activity and charcoal filters for iodine-131. A monthly composite of all particulate filters is gamma-scanned on a Ge or Ge(Li) detector. One of the five locations is a control (P-1), and four are indicator (P-2, P-3, P-4, and P-6). One of the indicators (P-3) is located near the residence expected to be most susceptible to any atmospheric emissions from the Plant (highest X/Q residence).

As a "Lessons Learned" commitment, ambient gamma radiation is monitored at thirty-two (32) locations, using three (3) LiF_2 chips at ea h location: ten (10) in an inner ring in the general area of the site boundary, fifteen (15) in the outer ring within 4-5 mile radius, six (6) at special interest locations and one control location, 11.1 miles distant from the Plant. They are replaced and measured quarterly. Also, a complete emergency set of TLDs for all locations is placed in the field at the same time as regular sets. The emergency set is returned to TIML quarterly for annealing and repackaging.

Milk samples are collected monthly from five farms (four indicator and one control). All samples are analyzed for iodine-131 and gamma-emitting isotopes. In addition, goat's milk is collected in the vicinity of the Plant, when available, and analyzed for iodine-131.

For additional monitoring of the terrestrial environment, leafy green vegetables (cabbage) are collected annually from a garden nearest the Plant and a control location (P-25) and analyzed for iodine-131. Corn is collected annually from the highest X/Q farm (P-14) and a control location (P-25) and analyzed for gamma-emitting isotopes. Also, well water is collected quarterly and analyzed for tritium and gamma-emitting isotopes.

River water is collected weekly at two locations, one upstream of the Plant (P-5) and one downstream (P-6, Lock and Dam No. 3). Monthly composites are analyzed for gamma-emitting isotopes. Quarterly composites are analyzed for tritium.

Drinking water is collected weekly from the City of Red Wing well. Monthly composites are analyzed for gross beta, iodine-131, and gamma-emitting isotopes. Quarterly composites are analyzed for tritium.

The aquatic environment is also monitored by semi-annual upstream and downstream collections of fish, periphyton or invertebrates, and bottom sediments. Shoreline sediment is collected semi-annually from one location.

3.3 Program Execution

The Program was executed as described in the preceding section with the following exceptions: The TLD data for the third quarter of 1983 for location P-13B and for the fourth quarter of 1983 for location P-03S were not available because they were lost in the field.

3.4 Laboratory Procedures

All iodine-131 analyses in milk were made by using a sensitive radiochemical procedure which involves separation of the element by use of an ion-exchange resin and subsequent beta counting.

All gamma-spectroscopic analyses were performed with a Ge or Ge(Li) detector. Levels of iodine-131 in cabbage were determined by Ge or Ge(Li) spectrometry. Levels of airborne iodine-131 in charcoal samples were measured by Ge or Ge(Li) spectrometry.

Tritium levels were determined by liquid scintillation technique.

Analytical procedures used by the Teledyne Isotopes Midwest Laboratory are specified in detail elsewhere (Hazleton Environmental Sciences, 1981, presently under revision). Procedures are based on those prescribed by the National Center for Radiological Health of the U. S. Public Health Service (U. S. Public Health Service, 1967) and by the Health and Safety Laboratory of the U. S. Atomic Energy Commission (U. S. Atomic Energy Commission, 1972).

Teledyne Isotopes Midwest Laboratory has a comprehensive quality control/quality assurance program designed to assure the reliability of data obtained. Details of TIML's QA Program are presented elsewhere (Hazleton Environmental Sciences, 1982, presently under revision). The TIML QA Program includes participation in laboratory intercomparison (crosscheck) programs. Results obtained in crosscheck programs are presented in Appendix A.

3.5 Program Modifications

Effective January 1, 1983, the following modifications were made in the REMP.

a. Number of air sampling locations were increased from four to five;

b. Number of charcoal sampling locations were increased from three to five;

c. Gamma-isotopic analysis of air particulates was changed from monthly composites from all locations to quarterly composites from each location;

d. Number of TLD locations was reduced from 36 to 32;

e. Collection and analysis of natural vegetation, soil, and aquatic vegetation was dropped from the program;

f. Analysis for strontium-89 and strontium-90 was dropped from the program (all samples);

g. Lower limit of detection (LLD) for iodine-131 in milk was changed from 0.25 to 1.0 pCi/l;

h. Analysis for iodine-131 in drinking water was added to the program.

3.6 Land Use Census

In accordance with Technical Specification 4.10, paragraph B1, a land use census shall be conducted and shall identify the location of the nearest milk animal, the nearest residence, and the nearest garden of greater than 500 ft^2 producing fresh leafy vegetables in each of the 16 meteorological sectors within a distance of 5 miles. This census shall be conducted at least once per 12 months between the dates of May 1 and October 31. New locations shall be added to the radiological environmental monitoring program within 30 days, and sampling locations having lower calculated doses or a lower dose commitment may be deleted from this monitoring program after October 31 of the year in which the land use census was conducted.

This land use census insures the updating of the radiation environmental monitoring program should sampling locations change within the 5 mile radius from the plant.

The 1983 land use census was conducted July 27, 1983 and resulted in changing a dairy farm location from 3.5 miles at 181°/S to another dairy farm located 3.7 miles at 88°/E from the plant. This change occurred October 17, 1983, and is reflected in changes to the map and table identifying the locations of sampling presented in the Offsite Dose Calculation Manual (ODCM). These changes are found in the Semi Annual Radioactive Effluent Release Report submitted to the NRC within 60 days after the end of each 6 month period.

4.0 RESULTS AND DISCUSSION

All collections and analyses were made as scheduled except as listed in Table 5.3.

All results are summarized in Table 5.4 in a format recommended by the Nuclear Regulatory Commission in Regulatory Guide 4.8. For each type of analysis of each sampled medium, this table lists the mean and range for all indicator locations and for all control locations. The locations with the highest mean and range are also shown.

4.1 Atmospheric Nuclear Detonations

There were no reported atmospheric nuclear tests in 1983. The last reported test was conducted by the People's Republic of China on 16 October 1980. The reported yield was in the 200 kiloton to 1 megaton range.

4.2 Program Findings

Program findings show background levels of radioactivity in the environmental samples collected in the vicinity of the Prairie Island Nuclear Generating Plant. No plant effect on the environment was indicated.

Ambient Radiation (TLDs)

Ambient radiation was measured in the general area of site boundary, at outer ring 4 - 5 mi distant from the plant, at special interest areas, and at one control location. The means ranged from 12.4 mR/91 days at inner ring locations to 13.4 mR/91 days at outer ring locations. The mean at special locations was 12.7 mR/91 days and 14.9 mR/91 days at control location. The differences are not statistically significant. The dose rates measured were similar to those observed in 1978 (12.1 and 15.1 mR/91 days, respectively; in 1979 (12.6 and 15.3 mR/91 days, respectively), in 1980 (11.2 and 13.5 mR/91 days, respectively), in 1981 (13.0 and 14.5 mR/91 days, respectively), and in 1982 (12.0 and 13.0 mR/91 days, respectively). No Plant effect on ambient gamma radiation was indicated.

Air Particulates

The average annual gross beta activity in airborne particulates was identical at both indicator and control locations (0.024 pCi/m^3) and was about the same as in 1982 (0.025 pCi/m^3). The highest averages for gross beta were for the month of December and the fourth quarter.

The reason for the elevated activity in December and the fourth quarter is not clear. It probably is attributable to the increased use of wood burning stoves. The spring peak, which usually is observed in April - May (2nd quarter) was not observed in 1983. This peak has been observed almost annually (1976, 1979, and 1980 were also exceptions) for many years (Wilson et al., 1969). The spring peak has been attributed to fallout of nuclides from the stratosphere (Gold et al., 1964).

Two pieces of evidence indicate conclusively that the elevated activity observed during the fourth quarter was not attributable to the Plant. In the first place, elevated activity of similar size occurred simultaneously at both the indicator and control locations. Secondly, an identical pattern was observed at the Monticello Nuclear Generating Plant, about 100 miles distant from the Prairie Island Nuclear Generating Plant (Northern States Power Company, 1984).

Except for beryllium-7, which is produced continuously in the upper atmosphere by cosmic radiation (Arnold and Al-Salih, 1955), all other gamma-emitting isotopes were below their respective LLD levels. None of the activities detected were attributable to the Plant operation.

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.

Milk

Iodine-131 results were below the detection limit of 1.0 pCi/l in all samples.

Cesium-137 results were below the LLD level of 15 pCi/l in all samples. Cesium-137 is a long-lived component (with a half-life of 30.24 years) of worldwide fallout and is found in the environment in trace quantities.

No other gamma-emitting isotopes, except potassium-40, were detected in any of the milk samples. This is consistent with the finding of the National Center for Radiological Health that most radiocontaminants in feed do not find their way into milk due to the selective metabolism of the cow. The common exceptions are radioisotopes of potassium, cesium, strontium, barium and iodine (National Center for Radiological Health, 1968).

In summary, the milk data for 1983 show no radiological effects of the Plant operation.

Drinking Water

In drinking water from the City of Red Wing well, tritium activity was below the LLD level of 330 pCi/l in all samples. Iodine-131 activity was also below the LLD level at 1.0 pCi/l in all samples. As with the other well water samples, all analyses for gamma-emitting isotopes yielded results below detection limits. Gross beta averaged 8.0 pCi/l and was similar to the levels observed in 1979 (10.5 pCi/l), 1980 (11.8 pCi/l), 1981 (10.7 pCi/l), and 1982 (8.9 pCi/l).

River Water

At the upstream and downstream collection sites, quarterly composite tritium levels were below the LLD level of 330 pCi/l in all samples.

River water was also analyzed for gamma-emitting isotopes. All gamma-emitting isotopes were below their respective detection limits. There was no indication of a Plant effect.

Well Water

At the control well P-25, Kinneman Farm and two indicator wells (P-8, Kinney Store, and P-10, Lock and Dam #3) no tritium was detected above LLD level of 330 pCi/l in any of the analyses. At the remaining indicator well (P-9, Plant Well #2), tritium was detected in one quarterly sample and was 590 pCi/l. The activity was similar to that observed in 1982 (380 - 590 pCi/l).

Gamma-emitting isotope levels were below detection limits in all cases.

Crops

Cabbage samples were collected on August 23 and August 29, 1983, and analyzed for iodine-131. Corn samples were also collected on August 23, 1983, and analyzed for gamma-emitting isotopes. All results, except for potassium -40, were below detection limits. There was no indication of a Plant effect.

Fish

Fish samples were collected in May and September, 1983. The only isotope detected was naturally-occuring potassium-40 and there was no significant difference between upstream and downstream results. There was no indication of a Plant effect.

Aquatic Insects and Periphyton

Aquatic insects (invertebrates) and periphyton were collected on June 6 and September 28, 1983. The samples were analyzed for gamma-emitting isotopes. All gamma-emitting isotopes, except for naturally-occuring potassium-40, were below their respective LLD's. No Plant effect was indicated.

Bottom and Shoreline Sediments

Sediment collections were made on May 23 and November 7, 1983. The samples were analyzed for gamma-emitting isotopes. Cesium-137 was detected in two bottom sediment samples and was 0.067 pCi/g dry weight in indicator sample and 0.117 pCi/g dry weight in upstream (control) sample.

The only other gamma-emitting isotope detected was naturally-occuring potassium-40. No Plant effect was indicated.

5.0 TABLES

Table 5.1 Sample collection and analysis program, 1983. Prairie Island

Medium	Locations No.	Locations Codes (and Type)[a]	Collection Type and Frequency[b]	Analysis Type and Frequency[c]
Ambient radiation (TLDs)	32	P-01A - P-10A P-01B - P-15B P-01S - P-06S P-01C	C/Q	Ambient gamma
Airborne particulates	5	P-1(C), P-2, P-3, P-4, P-6	C/W	GB, GS (QC of each location)
Airborne iodine	5	P-1(C), P-2, P-3 P-4, P-6	C/W	I-131
Milk	5	P-16 to P-18, P-25(C), P-14	G/M	I-131, GS
River water	2	P-5(C), P-6	G/W	GS(MC), H-3(QC)
Drinking water	1	P-11	G/W	GB(MC), I-131(MC) GS(MC), H-3(QC)
Well water	4	P-25(C), P-6, P-8, P-9	G/Q	H-3, GS
Edible cultivated crops - leafy green vegetables	2	P-25(C), P-24	G/A	I-131

Table 5.1 (continued)

Prairie Island

Medium	Locations No.	Locations Codes (and Type)[a]	Collection Type and Frequency[b]	Analysis Type and Frequency[c]
Edible cultivated crops - corn	2	P-25(C), P-14	G/A	GS
Fish (one species edible portion)	2	P-5(C), P-6	G/SA	GS
Periphyton or invertebrates	2	P-5(C), P-6	G/SA	GS
Bottom sediment	2	P-5(C), P-6	G/SA	GS
Shoreline sediment	1	P-12	G/SA	GS

[a]Location codes are defined in Table 5.2. Control stations are indicated by (C). All other stations are indicators.
[b]Collection type is coded as follows: C/ = continuous, G/ = grab. Collection frequency is coded as follows: W = weekly, M = monthly, Q = quarterly, SA = semi-annually, A = annually.
[c]Analysis type is coded as follows: GB = gross beta, GS = gamma spectroscopy, H-3 = tritium, I-131 = iodine 131. Analysis frequency is coded as follows: MC = monthly composite, QC = quarterly composite.

Table 5.2 Sampling locations. Prairie Island

Code	Type[a]	Name	Location
P-1	C	Air Station P-1	16.5 mi @ 348°/NNW
P-2		Air Station P-2	0.5 mi @ 294°/WNW
P-3		Air Station P-3	0.8 mi @ 313°/NW
P-4		Air Station P-4	0.4 mi @ 359°/N
P-5	C	Upstream of Plant	0.6 mi @ 60°/ENE
P-6		Lock & Dam #3 & Air Station P-6	1.6 mi @ 129°/SE
P-8		Kinney Store	2.0 mi @ 280°/W
P-9		Plant Well #2	0.3 mi @ 306°/NW
P-11		City of Red Wing	7.1 mi @ 135°/SE
P-12		Recreational Area	3.4 mi @ 116°/ESE
P-14		Gustafson Farm	2.2 mi @ 168°/SSE
P-16		Johnson Farm	2.5 mi @ 39°/NE
P-17		Place Farm	3.5 mi @ 25°/NNE
P-18		Birk Farm	3.5 mi @ 181°/S
P-24		H. Larson Residence	1.6 mi @ 287°/WNW
P-25	C	Kinneman Farm	11.1 mi @ 331°/NNW
P-01A		Property Line	0.4 mi @ 359°/N
P-02A		Property Line	0.3 mi @ 19°/NNE
P-03A		Property Line	0.5 mi @ 183°/S
P-04A		Property Line	0.4 mi @ 204°/SSW
P-05A		Property Line	0.4 mi @ 225°/SW
P-06A		Property Line	0.4 mi @ 249°/WSW
P-07A		Property Line	0.4 mi @ 268°/W
P-08A		Property Line	0.4 mi @ 291°/NNW
P-09A		Property Line	0.7 mi @ 317°/NW
P-10A		Property Line	0.5 mi @ 333°/NNW
P-01B		Thomas Killian Residence	4.7 mi @ 355°/N
P-02B		Roy Kinneman Farm	4.8 mi @ 17°/NNE
P-03B		Wayne Anderson Farm	4.9 mi @ 46°/NE
P-04B		Nelson Drive (Road)	4.2 mi @ 61°/ENE
P-05B		County Road E and Coulee	4.1 mi @ 97°/E
P-06B		William Houschildt Residence	4.4 mi @ 112°/ESE
P-07B		Red Wing Service Center	4.7 mi @ 140°/SE
P-08B		David Wnuk Residence	4.1 mi @ 165°/SSE
P-09B		Highway 19 South	4.2 mi @ 187°/S
P-10B		Cannondale Farm	4.9 mi @ 200°/SSW
P-11B		Wallace Weberg Farm	4.5 mi @ 221°/SW
P-12B		Roy Gergen Farm	4.5 mi @ 247°/WSW
P-13B		Thomas O'Rourke Farm	4.4 mi @ 270°/W
P-14B		David J. Anderson Farm	4.9 mi @ 306°/NW
P-15B		Holst Farms	4.2 mi @ 347°/NNW
P-01S		Federal Lock & Dam #3	1.6 mi @ 129°/SE
P-02S		Charles Suter Residence	0.5 mi @ 155°/SSE
P-03S		Carl Gustafson Farm	2.2 mi @ 168°/SSE
P-04S		Richard Burt Residence	2.0 mi @ 228°/SW
P-05S		Kenney Store	2.0 mi @ 270°/W
P-06S		Earl Flynn Farm	2.5 mi @ 299°/WNW
P-01C		Robert Kinnemen Farm	11.1 mi @ 331°/NNW

[a] "C" denotes control location. All other locations are indicators.

Table 5.3 Missed collections and analyses, 1983. Prairie Island NGP. All required samples were collected and analyzed as scheduled except the following:

Sample	Analysis	Location	Coll. Date or Period	Comments
Thermoluminescent Dosimeters (TLDs)	Ambient Radiation	P-13B	3rd Qtr. 1983	Lost in the field
Thermoluminescent Dosimeters (TLDs)	Ambient Radiation	P-03S	4th Qtr. 1983	Lost in the field

Table 5.4 Environmental Radiological Monitoring Program Summary.
Name of facility Prairie Island Nuclear Generating Plant Docket No. 50-282, 50-306
Location of facility Goodhue, Minnesota (County, state) Reporting period January-December 1983

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean(F)[c] Range[c]	Location with Highest Annual Mean		Control Locations Mean(F) Range	Number of Non-routine Results[e]
				Location[d]	Mean(F) Range		
TLD (mR/91 days) (Inner Ring, General Area at Site Boundary)	Gamma 40	3.0	12.4 (40/40) (9.1-15.0)	P-09A, Property Line 0.7 mi @ 317°/NW	13.2 (4/4) (10.9-15.0)	(See control below)	0
TLD (mR/91 days) (Outer ring, 4-5 miles distant)	Gamma 59	3.0	13.4 (59/59) (9.8-17.8)	P-15, Holst Farm 4.2 mi @ 347°/NNW	15.0 (4/4) (13.3-17.8)	(See control below)	0
TLD (mR/91 days) (Special Interest Areas)	Gamma 23	3.0	12.7 (23/23) (8.9-18.1)	P-04S, Near Richard Burt Residence 2.0 mi @ 228°/SW	14.6 (3/3) (12.3-18.1)	(See control below)	0
TLD (mR/91 days) (control)	Gamma 4	3.0	None	P-01C-R, Kinneman Farm 11.1 mi @ 331°/NNW	14.9 (4/4) (12.0-17.0)	14.9 (4/4) (12.0-17.0)	0
Airborne Particulates (pCi/m^3)	GB 260	0.002	0.024 (208/208)	P-4, Station P-4 0.4 mi @ 359°/N P-6, Station P-6 1.6 mi @ 129°/SE	0.025 (52/52) (0.009-0.078) 0.025 (52/52) (0.007-0.070)	0.024 (52/52) (0.002-0.070)	0
	GS 20						
	Be-7	0.010	0.120 (16/16) (0.064-0.174)	P-4, Station P-4 0.4 mi @ 359°/N	0.129 (4/4) (0.077-0.174)	0.113 (4/4) (0.089-0.137)	0
	Mn-54	0.0020	<LLD	-	-	<LLD	0
	Co-58	0.0034	<LLD	-	-	<LLD	0
	Co-60	0.0023	<LLD	-	-	<LLD	0
	Zn-65	0.0057	<LLD	-	-	<LLD	0
	Nb-95	0.0043	<LLD	-	-	<LLD	0

Table 5.4 (Continued)
Name of Facility Prairie Island Nuclear Generating Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean(F)[c] Range[c]	Location with Highest Annual Mean		Control Locations Mean(F) Range	Number of Non-routine Results[e]
				Location[d]	Mean(F) Range		
Airborne Particulates (pCi/m^3) (cont'd)	Zr-95	0.0065	<LLD	-	-	<LLD	0
	Ru-103	0.0064	<LLD	-	-	<LLD	0
	Ru-106	0.019	<LLD	-	-	<LLD	0
	Cs-134	0.0017	<LLD	-	-	<LLD	0
	Cs-137	0.0019	<LLD	-	-	<LLD	0
	Ba-140	0.0050	<LLD	-	-	<LLD	0
	La-140	0.0074	<LLD	-	-	<LLD	0
	Ce-141	0.0012	0.013 (1/4) -	P-4, Station P-4 0.4 mi @ 359°/N	0.013 (1/4) -	<LLD	0
	Ce-144	0.0098	0.016 (1/4) -	P-3, Station P-3 0.8 mi @ 313°/NW	0.016 (1/4) -	<LLD	0
Airborne Iodine (pCi/m^3)	I-131 260	0.07	<LLD	-	-	<LLD	0
Milk (pCi/l)	I-131 64	1.0	<LLD	-	-	<LLD	0
	GS 60						
	K-40	100	1330 (48/48) (1110-1660)	P-16, Johnson Farm 2.5 mi @ 39°/NE	1350 (12/12) (1140-1560)	1290 (12/12) (1150-1510)	0
	Cs-134	15	<LLD	-	-	<LLD	0
	Cs-137	15	<LLD	-	-	<LLD	0
	Ba-La-140	15	<LLD	-	-	<LLD	0

Table 5.4 (Continued)
Name of facility Prairie Island Nuclear Generating Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean(F)[c] Range[c]	Location with Highest Annual Mean		Control Locations Mean(F) Range	Number of Non-routine Results[e]
				Location[d]	Mean(F) Range		
Drinking Water (pCi/l)	GB 12	1.0	8.0 (12/12) (6.1-10.0)	P-11, City of Red Wing 7.1 mi @ 135°/SE	8.0 (12/12) (6.1-10.0)	None	0
	I-131 12	1.0	<LLD	-	-	None	0
	H-3 4	330	<LLD	-	-	None	0
	GS 12						
	Mn-54	15	<LLD	-	-	None	0
	Fe-59	34	<LLD	-	-	None	0
	Co-58	15	<LLD	-	-	None	0
	Co-60	15	<LLD	-	-	None	0
	Zn-65	30	<LLD	-	-	None	0
	Nb-95	21	<LLD	-	-	None	0
	Zr-95	33	<LLD	-	-	None	0
	Cs-134	10	<LLD	-	-	None	0
	Cs-137	10	<LLD	-	-	None	0
	Ba-La-140	16	<LLD	-	-	None	0
	Ce-144	109	<LLD	-	-	None	0
River Water (pCi/l)	H-3 8	330	<LLD	-	-	<LLD	0
	GS 24						
	Mn-54	15	<LLD	-	-	<LLD	0
	Fe-59	49	<LLD	-	-	<LLD	0
	Co-58	15	<LLD	-	-	<LLD	0
	Co-60	15	<LLD	-	-	<LLD	0
	Zn-65	30	<LLD	-	-	<LLD	0
	Nb-95	28	<LLD	-	-	<LLD	0

Table 5.4 (Continued)
Name of facility Prairie Island Nuclear Generating Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean(F)[c] Range[c]	Location with Highest Annual Mean Location[d]	Location with Highest Annual Mean Mean(F) Range	Control Locations Mean(F) Range	Number of Non-routine Results[e]
River Water (pCi/l) (Cont'd)	Zr-95	30	<LLD	-	-	<LLD	0
	Cs-134	15	<LLD	-	-	<LLD	0
	Cs-137	18	<LLD	-	-	<LLD	0
	Ba-La-140	15	<LLD	-	-	<LLD	0
	Ce-144	99	<LLD	-	-	<LLD	0
Well Water (pCi/l)	H-3 16	330	590 (1/12) -	P-9 Plant Well #2 0.3 mi @ 306° NW	590 (1/4) (350-520)	<LLD -	0
	GS 16						
	Mn-54	15	<LLD	-	-	<LLD	0
	Fe-59	30	<LLD	-	-	<LLD	0
	Co-58	15	<LLD	-	-	<LLD	0
	Co-60	15	<LLD	-	-	<LLD	0
	Zn-65	30	<LLD	-	-	<LLD	0
	Nb-95	15	<LLD	-	-	<LLD	0
	Zr-95	25	<LLD	-	-	<LLD	0
	Cs-134	10	<LLD	-	-	<LLD	0
	Cs-137	10	<LLD	-	-	<LLD	0
	Ba-La-140	15	<LLD	-	-	<LLD	0
	Ce-144	108	<LLD	-	-	<LLD	0
Crops-Cabbage (pCi/g wet)	I-131 3	0.025	<LLD	-	-	<LLD	0
Crops-Corn (pCi/l)	GS 2						
	Be-7	0.31	<LLD	-		<LLD	0
	K-40	0.5	2.14 (1/1) -	P-14, Gustafson Farm 2.2 mi @ 168°/SSE	2	2.08 (1/1) -	0

Table 5.4 (Continued)
Name of facility Prairie Island Nuclear Generating Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean(F)[c] Range[c]	Location with Highest Annual Mean		Control Locations Mean(F) Range	Number of Non-routine Results[e]
				Location[d]	Mean(F) Range		
Crops-Corn (pCi/l) (Cont'd)	Mn-54	0.039	<LLD	-	-	<LLD	0
	Co-58	0.030	<LLD	-	-	<LLD	0
	Co-60	0.033	<LLD	-	-	<LLD	0
	Zn-65	0.097	<LLD	-	-	<LLD	0
	Nb-95	0.050	<LLD	-	-	<LLD	0
	Zr-95	0.073	<LLD	-	-	<LLD	0
	Ru-103	0.040	<LLD	-	-	<LLD	0
	Ru-106	0.23	<LLD	-	-	<LLD	0
	Cs-134	0.029	<LLD	-	-	<LLD	0
	Cs-137	0.030	<LLD	-	-	<LLD	0
	Ba-140	0.093	<LLD	-	-	<LLD	0
	La-140	0.026	<LLD	-	-	<LLD	0
	Ce-141	0.048	<LLD	-	-	<LLD	0
	Ce-144	0.16	<LLD	-	-	<LLD	0
Fish-Flesh (pCi/g wet)	GS 4						
	K-40	0.1	2.88 (2/2) (2.15-3.60)	P-6 Lock & Dam #3 1.6 mi @ 129° SE	3 23 (4/4) (1.94-3.35)	2.64 (2/2) (2.44-2.85)	0
	Mn-54	0.032	<LLD	-	-	<LLD	0
	Fe-59	0.12	<LLD	-	-	<LLD	0
	Co-58	0.046	<LLD	-	-	<LLD	0
	Co-60	0.042	<LLD	-	-	<LLD	0
	Zn-65	0.082	<LLD	-	-	<LLD	0
	Nb-95	0.097	<LLD	-	-	<LLD	0
	Zr-95	0.097	<LLD	-	-	<LLD	0
	Cs-134	0.034	<LLD	-	-	<LLD	0
	Cs-137	0.036	<LLD	-	-	<LLD	0
	Ba-La-140	0.088	<LLD	-	-	<LLD	0

Table 5.4 (Continued)
Name of facility Prairie Island Nuclear Generating Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean(F)[c] Range[c]	Location with Highest Annual Mean Location[d]	Location with Highest Annual Mean Mean(F) Range	Control Locations Mean(F) Range	Number of Non-routine Results[e]
Invertebrates (pCi/g wet)	GS 4						
	Be-7	6.5	<LLD	-	-	<LLD	0
	K-40	3.4	7.24 (1/2) -	P-5, Upstream of Plant 0.6 mi @ 60°/ENE	10.40 (1/2) -	10.40 (1/2) -	0
	Mn-54	0.50	<LLD	-	-	<LLD	0
	Co-58	0.76	<LLD	-	-	<LLD	0
	Co-60	0.49	<LLD	-	-	<LLD	0
	Zn-65	1.29	<LLD	-	-	<LLD	0
	Nb-95	1.23	<LLD	-	-	<LLD	0
	Zr-95	1.33	<LLD	-	-	<LLD	0
	Ru-103	0.97	<LLD	-	-	<LLD	0
	Ru-106	3.91	<LLD	-	-	<LLD	0
	Cs-134	0.39	<LLD	-	-	<LLD	0
	Cs-137	0.44	<LLD	-	-	<LLD	0
	Ba-140	1.36	<LLD	-	-	<LLD	0
	La-140	0.39	<LLD	-	-	<LLD	0
	Ce-141	1.58	<LLD	-	-	<LLD	0
	Ce-144	2.39	<LLD	-	-	<LLD	0

Table 5.4 (Continued)
Name of facility Prairie Island Nuclear Generating Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean(F)[c] Range[c]	Location with Highest Annual Mean Location[d]	Location with Highest Annual Mean Mean(F) Range	Control Locations Mean(F) Range	Number of Non-routine Results[e]
Bottom and Shoreline Sediments (pCi/g dry)	GS 6						
	Be-7	0.89	<LLD	-	-	<LLD	0
	K-40	1.0	10.48 (2/4) (9.86-11.10)	P-5, Upstream of Plant 0.6 mi @ 60°/ENE	11.04 (4/4) (9.01-14.00)	11.04 (4/4) (9.01-14.00)	0
	Mn-54	0.062	<LLD	-	-	<LLD	0
	Co-58	0.074	<LLD	-	-	<LLD	0
	Co-60	0.058	<LLD	-	-	<LLD	0
	Zn-65	0.19	<LLD	-	-	<LLD	0
	Nb-65	0.13	<LLD	-	-	<LLD	0
	Zr-95	0.14	<LLD	-	-	<LLD	0
	Ru-103	0.11	<LLD	-	-	<LLD	0
	Ru-106	0.59	<LLD	-	-	<LLD	0
	Cs-134	0.11	<LLD	-	-	<LLD	0
	Cs-137	0.056	0.067 (1/2) -	P-6, Lock & Dam #3 1.6 mi @ 129°/SE	0.117 (1/4) -	0.117 (1/4) -	0
	Ba-La-140	0.11	<LLD	-	-	<LLD	0
	Ce-141	0.14	<LLD	-	-	<LLD	0
	Ce-144	0.31	<LLD	-	-	<LLD	0

[a] GB = gross beta; GS = gamma scan.

[b] LLD = nominal lower limit of detection based on 4.66 sigma error for background sample.

[c] Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

[d] Locations are specified (1) by name and code (Table 2) and (2) distance, direction, and sector relative to reactor site.

[e] Nonroutine results are those which exceed ten times the control station value. If no control station value is available, the result is considered nonroutine if it exceeds ten times the preoperational value for the location.

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Appendix A

Crosscheck Program Results

Appendix A

Crosscheck Program Results

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

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

The results in Table A-1 were obtained through participation in the environmental sample crosscheck program for milk and water samples during the period 1980 through 1983. This program has been conducted by the U. S. Environmental Protection Agency Intercomparison and Calibration Section, Quality Assurance Branch, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada.

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

Table A-1. U.S. Environmental Protection Agency's crosscheck program, comparison of EPA and Teledyne Isotopes Midwest Laboratory results for milk and water samples, 1980 through 1983[a].

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/l[b] TIML Result ±2σ[c]	EPA Result ±3σ, n=1[d]
STW-206	Water	Jan. 1980	Gross Alpha	19.0±2.0	30.0±8.0
			Gross Beta	48.0±2.0	45.0±5.0
STW-208	Water	Jan. 1980	Sr-89	6.1±1.2	10.0±0.5
			Sr-90	23.9±1.1	25.5±1.5
STW-209	Water	Feb. 1980	Cr-51	112±14	101±5.0
			Co-60	12.7±2.3	11±5.0
			Zn-65	29.7±2.3	25±5.0
			Ru-106	71.7±1.5	51±5
			Cs-134	12.0±2.0	10±5.0
			Cs-137	30.0±2.7	30±5.0
STW-210	Water	Feb. 1980	H-3	1800±120	1750±340
STW-211	Water	March 1980	Ra-226	15.7±0.2	16.0±2.4
			Ra-228	3.5±0.3	2.6±0.4
STM-217	Milk	May 1980	Sr-89	4.4±2.6[g]	5±5
			Sr-90	10.0±1.0	12±1.5
STW-221	Water	June 1980	Ra-226	2.0±0.0	1.7±0.8
			Ra-228	1.6±0.1	1.7±0.8
STW-223	Water	July 1980	Gross Alpha	31±3.0	38±5.0
			Gross Beta	44±4	35±5.0
STW-224	Water	July 1980	Cs-137	33.9±0.4	35±5.0
			Ba-140	<12	0
			K-40	1350±60	1550±78
			I-131	<5.0	0
STW-225	Water	Aug. 1980	H-3	1280±50	1210±329
STW-226	Water	Sept. 1980	Sr-89	22±1.2	24±8.6
			Sr-90	12±0.6	15±2.6
STW-228	Water	Sept. 1980	Gross Alpha	NA[e]	32.0±8.0
			Gross Beta	22.5±0.0	21.0±5.0
STW-235	Water	Dec. 1980	H-3	2420±30	2240±604

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/l[b] TIML Result ±2σ[c]	EPA Result ±3σ, n=1[d]
STW-237	Water	Jan. 1981	Sr-89	13.0±1.0	16±8.7
			Sr-90	24.0±0.6	34±2.9
STM-239	Milk	Jan. 1981	Sr-89	<210	0
			Sr-90	15.7±2.6	20±3.0
			I-131	30.9±4.8	26±10.0
			Cs-137	46.9±2.9	43±9.0
			Ba-140	<21	0
			K-40	1330±53	1550±134
STW-240	Water	Jan. 1981	Gross alpha	7.3±2.0	9±5.0
			Gross beta	41.0±3.1	44±5.0
STW-243	Water	Mar. 1981	Ra-226	3.5±0.06	3.4±0.5
			Ra-228	6.5±2.3	7.3±1.1
STW-245	Water	Apr. 1981	H-3	3210±115	2710±355
STW-249	Water	May 1981	Sr-89	51±3.6	36±8.7
			Sr-90	22.7±0.6	22±2.6
STW-251	Water	May 1981	Gross alpha	24.0±5.3	21±5.2
			Gross beta	16.1±1.9	14±5.0
STW-252	Water	Jun. 1981	H-3	2140±95	1950±596
STW-255	Water	Jul. 1981	Gross alpha	20±1.5	22±9.5
			Gross beta	13.0±2.0	15±8.7
STW-259	Water	Sep. 1981	Sr-89	16.1±1.0	23±5
			Sr-90	10.3±0.9	11±1.5
STW-265	Water	Oct. 1981	Gross alpha	71.2±19.1	80±20
			Gross beta	123.3±16.6	111±5.6
			Sr-89	14.9±2.0	21±5
			Sr-90	13.1±1.7	14.4±1.5
			Ra-226	13.0±2.0	12.7±1.9
STW-269	Water	Dec. 1981	H-3	2516±181	2700±355

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/l[b] TIML Result ±2σ[c]	Concentration in pCi/l[b] EPA Result ±3σ, n=1[d]
STW-270	Water	Jan. 1982	Sr-89	24.3±2.0	21.0±5.0
			Sr-90	9.4±0.5	12.0±1.5
STW-273	Water	Jan. 1982	I-131	8.6±0.6	8.4±1.5
STW-275	Water	Feb. 1982	H-3	1580±147	1820±342
STW-276	Water	Feb. 1982	Cr-51	<61	0
			Co-60	26.0±3.7	20±5
			Zn-65	<13	15±5
			Ru-106	<46	20±5
			Cs-134	26.8±0.7	22±5
			Cs-137	29.7±1.4	23±5
STW-277	Water	Mar. 1982	Ra-226	11.9±1.9	11.6±1.7
STW-278	Water	Mar. 1982	Gross alpha	15.6±1.9	19±5
			Gross beta	19.2±0.4	19±5
STW-280	Water	Apr. 1982	H-3	2690±80	2860±360
STW-281	Water	Apr. 1982	Gross alpha	75±7.9	85±21
			Gross beta	114.1±5.9	106±5.3
			Sr-89	17.4±1.8	24±5
			Sr-90	10.5±0.6	12±1.5
			Ra-226	11.4±2.0	10.9±1.5
			Co-60	<4.6	0
STW-284	Water	May 1982	Gross alpha	31.5±6.5	27.5±7
			Gross beta	25.9±3.4	29±5
STW-285	Water	June 1982	H-3	1970±1408	1830±340
STW-286	Water	June 1982	Ra-226	12.6±1.5	13.4±3.5
			Ra-228	11.1±2.5	8.7±2.3
STW-287	Water	June 1982	I-131	6.5±0.3	4.4±0.7
STW-290	Water	Aug. 1982	H-3	3210±140	2890±619
STW-291	Water	Aug. 1982	I-131	94.6±2.5	87±15

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/l[b] TIML Result ±2σ[c]	EPA Result ±3σ, n=1[d]
STW-292	Water	Sept 1982	Sr-89	22.7±3.8	24.5±8.7
			Sr-90	10.9±0.3	14.5±2.6
STW-296	Water	Oct. 1982	Co-60	20.0±1.0	20±8.7
			Zn-65	32.3±5.1	24±8.7
			Cs-134	15.3±1.5	19.0±8.7
			Cs-137	21.0±1.7	20.0±8.7
STW-297	Water	Oct. 1982	H-3	2470±20	2560±612
STW-298	Water	Oct. 1982	Gross alpha	32±30	55±24
			Gross beta	81.7±6.1	81±8.7
			Sr-89	<2	0
			Sr-90	14.1±0.9	17.2±2.6
			Cs-134	<2	1.8±8.7
			Cs-137	22.7±0.6	20±8.7
			Ra-226	13.6±0.3	12.5±3.2
			Ra-228	3.9±1.0	3.6±0.9
STW-301	Water	Nov. 1982	Gross alpha	12.0±1.0	19.0±8.7
			Gross beta	34.0±2.7	24.0±8.7
STW-302	Water	Dec. 1982	I-131	40.0±0.0	37.0±10
STW-303	Water	Dec. 1982	H-3	1940±20	1990±345
STW-304	Water	Dec. 1982	Ra-226	11.7±0.6	11.0±1.7
			Ra-228	<3	0
STW-306	Water	Jan. 1983	Sr-89	20.0±8.7	29.2±5
			Sr-90	21.7±8.4	17.2±1.5
STW-307	Water	Jan. 1983	Gross alpha	29.0±4.0[g]	29.0±13
			Gross beta	29.3±0.6	31.0±8.7
STM-309	Milk	Feb. 1983	Sr-89	35±2.0	37±8.7
			Sr-90	13.7±0.6	18±2.6
			I-131	55.7±3.2	55±10.4
			Cs-137	29±1.0	26±8.7
			Ba-140	<27	0
			K-40	1637±5.8	1512±131

Table A-1. (continued)

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

Table A-1. (continued)

Lab Code	Sample Type	Date Collected	Analysis	Concentration in pCi/l[b] TIML Result ±2σ[c]	EPA Result ±3σ, n=1[d]
STAF-326	Air filter	August 1983	Gross beta	42±2	36±8.7
			Sr-90	14±2	10±2.6
			Cs-137	19±1	15±8.7
STW-328	Water	Sept. 1983	Gross alpha	2.3±0.6	5±8.7
			Gross beta	10.7±1.2	9±8.7
STW-329	Water	Sept. 1983	Ra-226	3.0±0.2	3.1±0.81
			Ra-228	3.2±0.7	2.0±0.52
STW-331	Water	Oct. 1983	H-3	1303±32	1210±570

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

[b] All results are in pCi/l, except for elemental potassium (K) data which are in mg/l.

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

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

[e] NA = Not analyzed.

[f] Analyzed but not reported to the EPA.

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

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

Lab Code	TLD Type	Measurement	mR		
			Teledyne Result ±2 [a]	Known Value	Average ±2 [d] (all participants)
2nd International Intercomparison[b]					
115-2[b]	CaF_2:Mn Bulb	Gamma-Field	17.0±1.9	17.1[c]	16.4±7.7
		Gamma-Lab	20.8±4.1	21.3[c]	18.8±7.6
3rd International Intercomparison[e]					
115-3[e]	CaF_2:Mn Bulb	Gamma-Field	30.7±3.2	34.9±4.8[f]	31.5±3.0
		Gamma-Lab	89.6±6.4	91.7±14.6[f]	86.2±24.0
4th International Intercomparison[g]					
115-4[g]	CaF_2:Mn Bulb	Gamma-Field	14.1±1.1	14.1±1.4[f]	16.09.0
		Gamma-Lab (Low)	9.3±1.3	12.2±2.4[f]	12.0±7.6
		Gamma-Lab (High)	40.4±1.4	45.8±9.2[f]	43.9±13.2
5th International Intercomparison[h]					
115-5A[h]	CaF_2:Mn Bulb	Gamma-Field	31.4±1.8	30.0±6.0[i]	30.2±14.6
		Gamma-Lab at beginning	77.4±5.8	75.2±7.6[i]	75.8±40.4
		Gamma-Lab at the end	96.6±5.8	88.4±8.8[i]	90.7±31.2

Table A-2. (Continued)

Lab Code	TLD Type	Measurement	mR Teledyne Result ±2σ[a]	mR Known Value	mR Average ± 2σ [d] (all participants)
115-58[h]	LiF-100 Chips	Gamma-Field	30.3±4.8	30.0±6[i]	30.2±14.6
		Gamma-Lab at beginning	81.1±7.4	75.2±7.6[i]	75.8±40.4
		Gamma-Lab at the end	85.4±11.7	88.4±8.8[i]	90.7±131.2

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

Appendix B

Data Reporting Conventions

Data Reporting Conventions

1.0. All activities are decay corrected to collection time.

2.0. 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 of detection L it is reported as

$$< L \ .$$

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

3.0. Duplicate Analyses

3.1. Individual results: $x_1 \pm s_1$
$x_2 \pm s_2$

Reported result: $x \pm s$

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

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

3.2. Individual results: $< L_1$
$< L_2$

Reported result: $< L$

where L = lower of L_1 and L_2

3.3. Individual results: $x \pm s$
$< L$

Reported result: $x \pm s$ if $x \leq L$;
$< L$ otherwise

4.0. Computation of Averages and Standard Deviations

4.1 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 $\bar{x}$ and standard deviations of a set of n numbers $x_1, x_2, \ldots x_n$ are defined as follows:

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

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

4.2 Values below the highest lower limit of detection are not included in the average.

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

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

4.5. In rounding off, the following rules are followed:

4.5.1. 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.

4.5.2 If the figure following those to be retained is greater 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.

4.5.3. If the figure following those to be retained is 5, and if there are no 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 odd 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 C

Maximum Permissible Concentrations of Radioactivity in Air and Water Above Background in Unrestricted Areas

Table C-1. Maximum permissible concentrations of radioactivity in air and water above natural background in unrestricted areas.[a]

Air			Water	
Gross alpha	3	pCi/m^3	Strontium-89	3,000 pCi/l
Gross beta	100	pCi/m^3	Strontium-90	300 pCi/l
Iodine-131[b]	0.14	pCi/m^3	Cesium-137	20,000 pCi/l
			Barium-140	20,000 pCi/l
			Iodine-131	300 pCi/l
			Potassium-40[c]	3,000 pCi/l
			Gross alpha	30 pCi/l
			Gross beta	100 pCi/l
			Tritium	3 x 10^6 pCi/l

[a]Taken from Code of Federal Regulations Title 10, Part 20, Table II and appropriate footnotes. Concentrations may be averaged over a period not greater than one year.
[b]From 10 CFR 20 but adjusted by a factor of 700 to reduce the dose resulting from the air-grass-cow-milk-child pathway.
[c]A natural radionuclide.